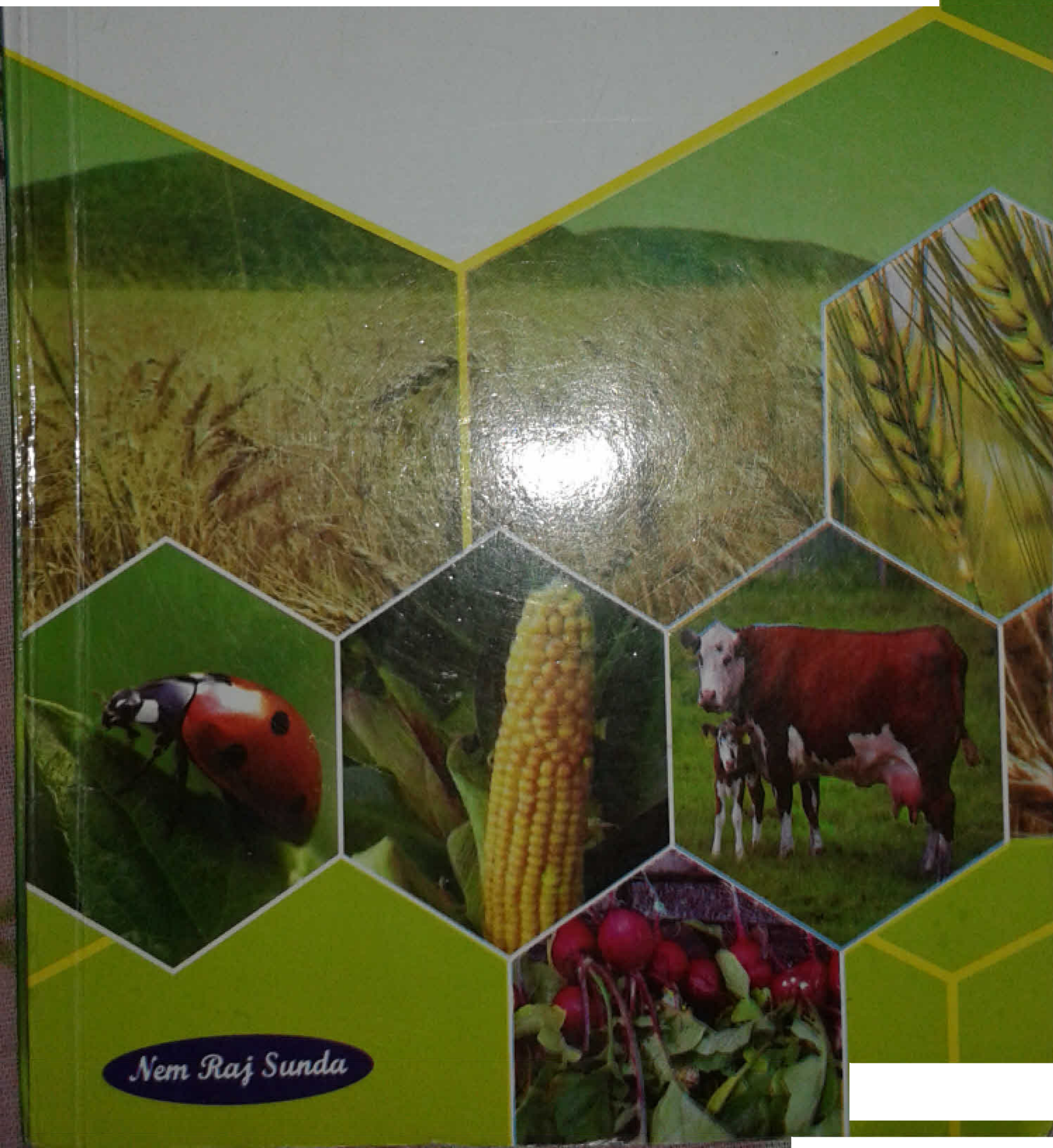
A Co ipetitive Book of

AGRICULTURE



CONTENTS

LEVOLUTION OFsAGRICULTUItE AND RELATED TEOIS

The term agriculture and related subjects are derived from the **words of:**

/. **Agriculture- Latin word-** *`ager'* or *`agri'* meaning *`soil'* **and** *`cultura'* meaning *'cultivation'*

2. **Agronomy- Greek word-** *`agros'* meaning *'field'* and *`nomos'* meaning *'manage'*

3. **Horticulture- Latin word-** *'hortus'* meaning *'garden'* and *cultura'* meaning *'culture or growing'*

4. **Pomology-** Latin -Greek word- Combination of Latin word *`ponum'* meaning *'fruit'* and greek word *'logy'* or *'logos* meaning *'discourse, treatise, or science'.*

5. **Olericulture-** Latin word- *`oleris'* meaning *'pot herb'* and english word *'culture'* meaning *'cultivation'*

6. **Floriculture-** Latin word- •

7. **Extension- Latin** word- 'ex' meaning 'out' and `tensio' meaning 'stretching'

8. **Soil Science-** Latin word- `catena' meaning 'chain'

9. **Soil-** Latin word- *`so/um'* meaning *"ground'*

10. **Monsoon-** Arabic word- `mausim' meaning 'season'

11. **Biodynamics-** Greek word- *`bios'* meaning *'life'* and *'dynamics'* meaning *'energy'*

12. **Truck gardening-** French word truck- *'torquer'* meaning *`to barter or exchange'*

13. **Nematode-** Greek word- *`nema'* meaning *'thread'* **and** *'told'* meaning

14. **Pedology-** Greek word- `pedon' meaning 'soil or earth'

15. **Pedogogy-** Greek word- *'paid'* meaning *'child'* and *`agogus'* meaning *'leader'*

16. **Market-** Latin word- *`marcatus'* meaning *'place of trade, traffic or merchandise'.*

17. **Evolution-** Latin word- `evolutio' meaning 'unrolling or rolling out'

18. **Enzyme-** Greek word- *'en'* meaning *'in'* and *`zyme'* meaning *'ferment/living'*

19. **Credit-** Latin word- *'credo'* meaning *'I trust you'.*

20. **Society-** Latin word- *`societas'* which was derived from noun *`socius'* meaning *'comrade, friend,ally'.*

21. **Vulgarization-** French word- *'vulgarize'* meaning *'popularize'*

22. **Cell** — Latin word- *`cellula'* meaning *'small compartment'*

23. **'In- vivo' and 'In- vitro'** — Latin word- *'In -vivo'* meaning *`within the living'* and *'In -vitro'* meaning *'within the glass'*

24. **Plastid** — GreA word- *plastikas'* meaning *'formed or moulded'*

25. **Ecology-** Greek word- *'Oikos'* meaning *'house/dwelling place'* and *'logos'* meaning *'study'*

26. **Entomology-** Greek word- *'entomo'* meaning *'insect'* means *'cut into(section)'* and *'logos'* meaning *'discourse'*

27. **Arthropoda-** Greek word- *`arthros'* meaning *'segmented'* and *`podu.s'* meaning *'leg'*

28. **Phytopathology-** Greek word- *`phyton'* meaning *'plant'* , *`pathos'* meaning *'ailments'* and *`logus'* meaning *`knowledge'*

29. **Fungicide-** Latin word- 'fungus' meaning 'fungus' and `caedo' meaning 'to kill'

30. **Meteorology-** Greek word- `Meteoro' meaning above the earth's surface' (atmosphere) and 'logy' meaning 'indicating science'

HISTORY OF AGRICULTURE

Agriculture, since its invention and inception, has been the prime and foremost activity of every culture and civilization throughout the history of mankind.

The first man on the was ***Homo erectus*** evolved on the earth around **1.5 million years ago** and after **5 lakh years** he spreads throughout the old world **[First in tropical region and then in temperate region].** The evolution of modern man was as follows:

Monkey (>1.5 million year ago) Java man *IHomo erectus* (15 lakh years ago)— ---÷ Cro-Magnan Modern man / *Homo sapiens sapiens* (250 thousand years ago).

'Homo' meaning ***`continous'*** , ***'erectus'*** meaning *'erect'* and ***`sapeins'*** meaning *'learning habit'*

The ancestor of modern man , *Homo sapiens* first time appeared in Africa around 35 **thousand** years ago. The *Homo sapiens* different from fellow animals due to presence of large brain, small teeth and chin, intelligence and skill in making and use of tools. The genus ***Homo*** get knowledge of fire control around 500 thousand years ago.

The living development of Homo *sapiens* is as follows:

Intelligence/brain development making tools [First tools was **boulders (rock/stone) and spears of wood tipped with blades of flint] 0. Hunting of animals cooked meat on fire started domestication of dog dog helped in hunting started gathering seeds, leaves and fruits from jungle.**

Important events in history of agriculture

Years ago		**Event**
70 million		Earliest primates, prosimians developed in trees
40 million		Evolution of monkey and apes
20 million	;0	A giant ape, *Dryonithecus* in Indian Siwaliks
15 million		Oldest primate , *Ramapithecus* with man- like

		traits in Africa and India
5 million		Closet primate ancestor to man in Africa
3 million		Oldest known tool designed in Africa
1.5 million		First true man , *Homo erectus* emerged in Indonesia and Africa
1 million		*Homo erectus* migrated through old world tropics
0.8 million		*Homo erectus* populated temperate regions
0.5 million		*Homo erectus pekinensis* learnt use and control of fire
0.4 million		Man made shelters out of tree branches
90,000	>	Neanderthal man emerged in Europe
32,000	>	Cromagnon man , *Homo sapiens sapiens* emerged in Europe
22,000		Artists decorated walls and ceiling in France and Spain
Earlier than 10,000 B.C.	D	Hunting, gathering
8700 B.C.	D	Domestication of sheep
7700 B.C.	D	Domestication of goat
7500 B.C.	D	Cultivation of crops (Wheat and barley
6000 B.C.	D	Domestication of cattle and pigs
4400 B.C.	D	Cultivation of maize
3500 B.C.	D	Cultivation of potato
3400 B.C.		Wheel was invented
3000 B.C.	D	Bronze was used to make tools
2900 B.C.	'	Plough was invented. Irrigated farming was started.
2700 B.C.		Silk moth domestication in China.
2300 B.C.		Cultivation of chick pea, pear, sarson and cotton --
2200 B.C.		Domestication of Fowl, buffalo and elephant
1800 B.C.		Cultivation of finger millet *(Ragi)*

. 1725 B.C.		Cultivation of sorghum
1700 B.C.	:-	Taming of horses
1500 B.C.	).-	Cultivation of sugarcane. Irrigation from wells.
1400 B.C.	Y	Use of Iron in Middle East
1000-600 B.C.	>	Second , Aryan -migration wave, age of iron, iron -plough share and axe invented, crop cultivation in Punjab, Uttar Pradesh and Bihar
543-491 B.C.	-	Reference to farming operations in Kullavagga and Mahavagga and Budhist literature in Pali
500 A.D.	'.–	Classification of plants and animals in Brahat Samhita of Varahamihira
760-800 A.D.	)–	Persian wheel used Araghatta (India)
900-1000 A.D.	4	Construction of anicuts and tanks, *Krishi Parashara* and *Vrikshayurveda*, manuals on agricultureand botany written, A text book on Agriculture prepared by Kashyapa by the name *Krishi Sukti*
15 Century A.D.	r	Cultivation of sweet orange, sour orange, wild brinjal. Pomegranate
16 Century A.D.	- -	Introduction Of Several Crops Into India By Portuguese. They Are Potato, Sweet Potato, Arrow Root, Cassava, Tomato, Chillies, Pumpkin, Papya, Pineapple , Guava, Custardapple, Groundnut, Cashewnut, Tobacco, American cotton, rubber
1550 A.D.	Y	Portugese introduced grafting technique in horticulture
1795 A.D.	Y	Flora India, published , Lieutenant William Frazer started study farm at PUSA (Bihar) to breed horses

1820 A.D. 1824 A.D. 1865 A.D.	Y	G.L. Blane constructed Western Jainuila Lanai Journal of Agriculture and Horticulture published Famine in Bengal and Orissa (15 lakh people died)
1868-69 A.D.		Severe famine
1871	>	Department of Revenue. Agriculture and Commerce (DRAC)
1874 A.D.	)>	Severe famine in Bihar
1875 A.D.	)>	Indian Meteorological Department (IMD) at Pune (Maharastra)
1876 A.D.		Famine in Madras and Bombay presidencies
1877 A.D.	>	Famine in Punjab, Central province (101ac died
1878		Higher Education in agriculture at Coimbatore.
1880	>	Famine commission appointed.
1881 A.D.	>	Government of India started Department o Revenue and Agriculture in provinces
1882 A.D.		Veterinary college established at Lahore (now in Pakistan)
1890 A.D.		Higher Education in agriculture at Pune.
1891 A.D.	)•	Dr J A Volcker's report on improvement o Indian Agriculture
1892 A.D.		Agriculture chemist and an assistant chemist were appointed to look after research and teaching
1899-1900	i.	Famine (Chhapaniya Kal)
1900 A.D.		Forest research Institute
1901-1905 1901 A.D.	,–	Agricultural Colleges were established at Pune, Kanpur, Sabour, Nagpur, Lyallapur and Coimbatore First Immigration commission.

		Model Village by Daniel Hamilton
~~1~~903 A.D.	Y	An Entomologist were appointed
1905 A.D.		Established the Imperial (now known as Indian) Agricultural Research Institute at Pusa, (Bihar) shifted to new Delhi in 1936.
1906 A.D.	)-•	Started Agriculture Journal India
1908 A.D.	Y	Tagore started Youth organization in the village in the Kaligram Pargana
1919 A.D.	D	Constitutional Reforms made Agriculture as a state subject
1920 A.D.		GURGAON Project by F L Bryne
1921 A.D.		SHRINIKETAN Project by R.N.Tagore
1921 A.D.	)=.	MARTHANDAM Project by Spencer Hatch
1921 A.D.	).-	SEVAGRAM Project by Mahatma Gandhi. Adarsh Seva Sangh , Pohri (Gwalior) by Col. Shitole
1921 A.D.	fr-	Indian central cotton committee.
1926 A.D.	'fr.	Appointment of Royal Commission Agriculture headed by Lord Linlithgow
1929 A.D.	fr-	Establishment of Imperial (now Indian) Council of Agricultural Research (ICAR) ,New Delhi
1930 A.D.	fr,	SEVAGRAM Project by Mahatma Gandhi
1931 A.D.	)%	Indian Central Lac Committee
1932 A.D.	fr-	Rural reconstruction movement by V.T. Krishnamachari in Barod
1935 A.D.	-	Rural Development Programme
1936 A.D.	).-	Indian Central Jute committee.
1940 A.D.	).	Monthly Journal (Popular) Indian Farming started by Imperial (Indian) Council of Agricultural Research (ICAR), New Delhi
_ 1942 A.D.	)--	Department of Food created.

1942 A.D.	D	Grow more food campaign (Failed and again started in 1947 GMF)
1943 A.D.	D	Great Bengal Famine (Caused by ***Helminthisporium*** *oryzae)*
1944 A.D.	D	Indian central Sugarcane committee.
1944 A.D.	D	Dr W. Burns report on Technological Possibilities of Agricultural Development in India
1945 A.D.	D	Sir, Pheroze Kharegat's memorandum on the development of Agriculture and Animal Husbandry in India
1945 A.D.	D	Indian central- Coconut committee.
1945 A.D.	D	Indian central tobacco committee.
1945 A.D.	>	Inclian Village Service by A.T. Mosher and B.N.Gupta, D.Tharugad
1946 A.D.	>	Directorate of planet projection & quarantine.
1946 A.D.		Central Rice research institute.
End of 1946 or 1947	D	Firka Development by Madras State by T.Prakasha and D. Tharugad
1947 A.D.	D	Food policy committee.
1947 A.D.	D	Indian central Oil Seeds committee.
1947 A.D.	D	Fertilizers & chemicals Travancore.
1947 A.D.	D	Mazdoor Manzi! at Nilokheri by S.K.Dey
Jan.1948	D	GATT (General Agreement on Tariffs and Trade)
1948 A.D.		Etawah Pilot Project by Albert Mayer
1948 A.D.		Indian Village Service by Mr. Arther, T.Mosher and B.N.Gupta
1949 A.D.		Arecnut Committee
1952 A.D.	D	Pilot Training cum Development Project by Ford

		Foundation
/F'd Oct.1952		Community Development
2 nd Oct.1953		National Extension Services (NES)
1956 A.D.	)--	Project for intensification of regional research on cotton, oil, seeds, millets(PIRRCOM)
1957 A.D.	p	All India Coordinated maize improvement Project.
1958	ir	Status of Deemed University accorded to IARI under UGC Act,1956.
1958 A.D.	-;-	Spices and Cashewnut Committee
Oct. 1958		NAFED (National Agricultural Cooperative Marketing Federation)
2 ' d Oct.1959	_	Panchayati Raj (Democratic decentralization) 3-tier system by Balwant Roy Mehta , inaugurated by J.L.Nehru on 2"d Oct.1959 in Nagaur District of Rajasthan
1960 A.D.	);-	First agricultural University at Panthnagar , on the pattern of Land grant system of USA
1960-61		Intensive Agriculture District Programme(IADP)
1963 A.D.	>	National Seed Corporation.
1964	).-	National Demonstration
March,1964	'>>	Intensive Agriculture Area Programme(IAAP)
1964 A.D.	)--	Intensive Cattle Development Project (ICDP)
1965 A.D.	)0	National demonstration Programme(NDP)
1965 A.D.		ACRIPs were started on other crops as well as in other areas of Research
1966	)=.	Placement of different agricultural research institutes under the purview of ICAR

1->--Taigh yielding Varieties Programme.

F9-6-C-A.tTh7;7-Directorate of Extension.

Multiple cropping schemes (MCP)

..._ . _._

1966-67	>	Green Revolution
1967-68	>	Farmers Training and Education Centre (FTEC)
1969 A.D.	)•	Second Irrigation compassion.
1970 A.D.	)P.	National commission on agriculture.
1971 A.D.		Minikit Programme (MKP)
1970-71	Y	Drought Prone Area Programme (DPAP)
1971 A.D.	>	All India coordinated project for dry land agriculture.
1971 A.D.	).	Small Farmers Development Agency (AFDA)
1971 A.D.		Marginal Farmers and Agricultural Labour Project **(MFAL)**
1972 A.D.		**ICRISAT**
1973		Creation of Department of Agricultural Research and Education (DARE) in the Ministry of Agriculture
1973 A.D.		Minikit **trials programme.**
1974 A.D.	**Y**	**Training & Visit system (T&V) formulated by Daniel Benor and Baxter of Israel. Turkey was the first started in Rajasthan Canal Area in Rajasthan and Chambal area in Madhya Pradesh**
1974 A.D.		**Command Area Development Authority (CADA)**
1974 A.D.		Operational Research Project
1974 A.D.	>	Food for Work Programme (FWP)
1974 A.D.	>	Minimum Needs Programme (MNP)
1974 A.D.	Y	Krishi Vigyan Kendra . Mohan **Singh Mehta committee recommended (First at Pondichery ,under TNAU, Coimbatore**

1975		Establishment of Agricultural Research Service and Agricultural Scientists' Recruitment Board
i st July,1975		20 Points Programme
1976 A.D.	')>	National Rural Employment Programme (NREP)
1976 A.D.	';=.	Desert Development Programme (DDP)
1976 A.D.		Antyodya Yojana
1976 A.D.		National Academy of Agricultural Research and Management (NAARM)
1976 A.D.	>	Ashok Mehta Committee proposed two tiers Panchayat Raj System
April, 1978	p	integrated Rural Development Programme (IRDP)
1979 A.D.		Training for Rural Youth for Self Emplyment (TRYSEM)
Jan. 1979		National Agricultural Research Project (NARP)
1st June, 1979		Lab to Land Programme (LLP) , on the ICAR golden jublee year
1979	p	Integrated Rural Development Programme (IRDP)
1980	–	District Rural Development Programme
1980		National Rural Employment Programme (NREP)
1980		National Agricultural Research Project (NARP)
1982 A.D.		Development of Women and Children in Rural Areas (DWACRA)
1982 A.D.		Council for Advancement of Peoples Action and Rural Technology (CAPART)
12th July, 1982	p	National Bank for Agriculture & Rural development (NABARD)
1983		National Agricultural Extension Project (NAEP)
1983		Rural Landless Employment Guarntee

		Programme (RLEGP)
1985 A.D.	)-	Crop Insurance Scheme (CIS) now National
		Agricultural extension project (NAEP)
1986		Technology Mission on Oilseeds (TMO) _
1986 A.D.	D	National Agricultural research project (Phase -11)
1988	>	Special Food Production Programme (SFPP)
1989		Jawahar Rozgar Yojana (Formed after merger of NREP and RLEGP)
2nd Oct.1993	>	Prime Minister Rozgar Yojana (PMRY)
2 ' Oct.1993	)%'	Assured Employment Scheme (AES)
1994	>	Mahila Samrudhi Yojana
1995	D	Institution Village Linkage Programme (IVLP)
1995	D	National Social Assistance Scheme
1996	D	Establishment of National Gene Bank at New Delhi
1997	D.	Swarana Jayanti Sahari Rozgar Yojana (SJSRY)
1998	D	National Agricultural Technology project (NATP)
1998-99		Kisan Credidt Card Scheme
1999	D	Jawahar Gram Samridhi Yojna (JGSY)
1999	D	Swarana Jayanti Gram swarozgar Yojana (SGSY) [IRDP,TRYSEM,DWACRA,SITRA-merged in to SGSY]
1999-2000		Indira Awas Yojna (lAY)
Rabi 1999-2000.	D	National Agricultural Insurance Scheme (NAIS)
Dee.2000		Antyodaya Anna yojana (AAY)
25" Dec. 2000		Pradhan Mantri Gram Sadak Yojana (PGSY)

2001		Sampoorna Grameen Rozgar yojana (SGRY)
1st Apri1,2004	Y	The four erstwhile schemes of OPP, OPDP, NPDP and AMDP have been merged into one Centrally Sponsored Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize (ISOPOM) being implemented from 1.4.2004
14'1' Nov. 2004	>	National food for work programme (NFWP)
2004	)>	Marine Fishing Policy
2004	D	National Commission on Farmers (Chairman Dr M S Swaminathan)
July ,2006	>	National Agricultural Innovation Project (NAIP) Through world bank
May,2005	>	National Horticulture Mission (NHM)
2005-06	0-	Bharat Nirman
2006-07		National bamboo Mission
6th Feb. 2006	'r	Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)
2006	.-.	National Rainfed Area Authority (NRAA) on 3.11.2006
August, 2007	-	National food security mission (NFSM)
August, 2007	.-	Rashtriya Krishi V ikash yojana (RKVY)

Domestication of plants and animals in N a rious world regions

Estimated time	**Animal/plant**	Place
10,000 B.C.	Dog	Iraq and Israel
8,400 B.C.	Dog	North -Western America

9,000 B.C.	Sheep and goat	Middle- East region
7,000 B.C.	Pig	Turkey
6,300 B.C.	Cattle	Greece
6,000 B.C.	Wheat	Greece
6,000 B.C.	Lentil and peas	Middle —East
6,000 B.C.	*Phaseolus lunatus*	Peru
6,000 B.C.	*Phaseolus vulgans*	Peru
5,000 B.C.	Kidney bean	Peru and Mexico
5,000 B.C.	Maize	Mexico and South America
4,000 B.C.	Rice	China and Thailand
3,000 B.C.	Cotton	Africa and India
3,000 B.C.	Horse	Southern Russian Turkestan
3,000 B.C.	Ploughing began	Latin America and old world
2,500 B.C.	Buffalo	South Eastern Asia
1,800 B.C.	Sorghum	North Africa and India
Before 1,000	Sunflower	Central North America
4000 years ago	Potato (cultivated)	South America
-	Chickens	India
18'h Century	First plant hybrid	
1920	Artificial mutation	

Source: Charles B. Heiser Jr. (1981)

INDIAN COUNCIL OF AGRICULTRAL RESEARCH (ICAR)

\1928 Royal Commission on Agriculture , headed by Lord Linlithgow recommended setting **up Imperial Council of Agricultural** Research to promote , **guide and coordinate agricultural** research throughout the India.

16th July, **ICAR** was set up on **16ffi July, 1929, as registered**

1929		society under the Societies Registration Act 1860. On the recommendation of Royal Commission of Agriculture.
March,1946	)-•	Under the president ship ofJogendra Singh it was decided to change the 'Imperial' in to "Indian" and now it is called Indian Council of Agricultural Research.
1963		The Agricultural Review Team headed by Dr. Marion W. Parker of USDA was appointed
1965	>	A policy was made to appoint an Agricultural scientist as the Chief Executive of ICAR , with the designation of Director General ;Dr. B. P. Pal become the first DG of ICAR in 1965
1966	>	ICAR was made a fully autonomous organization on the recommendation of Agricultural Review Team
June,1972	'1=	**Gajendragadkar Committee** was established to review the recruitment and personal policies of ICAR and its institutes, which submitted its report in 1973.
1973	),-.	Department of Agricultural Research and Education (DARE) was created in Ministry of food and Agriculture.
1st Nov.1973		The Agricultural Scientists Recruitment Board (ASRB) was established on 1 November 1973 as an independent recruitment agency in pursuance of the recommendations of the Gajendragadkar Committee.

1905		Agricultural Research Institute was established at Pusa, Bihar under the viceroyalty of Lord Curzon. Earlier it was in West Bengal . Help of sum of rupees 9 lakh was donated by an American Philip of USA
1911	Y	Renamed as Imperial Agricultural Research Institute
1923	) ;	Institute started offering Diploma of Associate ship.
1934		Major Earth quake damaged the building at Pusa, Bihar.
1936	'),-	Shifted to Pusa Road , New Delhi
1936	)--	B.Vishwanath became the first Indian Director of Institute
1946	)=-	The Diploma of Associate ship was recognized _ equivalent to M.Sc.
1947	**r•**	Name has been changed from Imperial Agricultural Research Institute to Indian Agricultural Research Institute.
1958	**>**	Recognized as "Deemed University" under UGC Act 1956. PG school was established.

2. GENERAL A6RICULTURE

About to Indian Agriculture:

V	Geographical area of India is:	**328.74 mha.**
V	Total reporting area of India is:	**306 mha**
V	Total degraded land of India is:	**187 mha**
V	Gross cropped area of India is:	**193 mha**
V	Gross irrigated area of India is:	**76 mha**
V	Net irrigated area of India is:	57 **mha**
V	Net cropped area of India is:	**141 mha**
V	Cropping intensity of India is:	135 %
V	Forest area of India is:	**20.4 % of total geographical area**
V	State having highest geographical in India	**Rajasthan.**
V	The state which is 2 n in geographical area:	**M P**
V	Highest forest area in the state:	**M P**
V	The state which is I in pulse production:	**M P**
V	The state which is 1st in food grain production:	**U. P.**
V	The state which is 1s1in total coarse cereal prod.:	Rajasthan
V	The state which is 2"d in food production:	Punjab.
V	The state which is I' in wheat production:	**U. P.**
V	The state which is 2 n in wheat production:	Punjab.
V	Water vapor in the atmosphere constitute only about:	**0.001 % of the total global water**
sf	Annual World precipitation is:	**1000 mm**
V	Average annual rainfall of India:	**1194 mm**
V	C;:nerated rainfall volume:	**400 mha-m**

,./	Maximum area under irrigation is in:	**Ganga basin**
V	Optimum forest area required:	33% of Geographical area
V	Maximum area under drip irrigation is in:	**Maharashtra**
V	Highest fertilizer consumption rate (Includes States and Union Territories)	**Pundicherry (1091.0** kg/ha)
V	Highest fertilizer consumption rate(Among States) :	**Punjab** (212 kg/ha)
V	Total fertilizer consumption is maximum in :	**U.P.**
V	Maximum area under irrigation is in :	**Punjab** (92.7% of cultivated area).
	Important facts:	
,/	**Most poisonous pollutant in water is:**	**Arsenic.**
.4	**Maximum concentration of ozone is found in:**	**Lower stratosphere.**
V	**Forest conservation act was made in the** year:	**1980.**
V	**The test has self purification capacity of water body:**	**BOD test.**
V	**Most commonly disinfectant in water purification is:**	**Chlorine.**
V	**Gases responsible for acid rain:**	**SO_2 and NO_2**
V	**Pollutant free alternative to petrol for automobiles:**	**Propane.**
V	**The gas responsible for Bhopal gas tragedy 1984:**	**MIC (methyl isocyanate).**
V	**MIC was used for manufacturing of insecticide:**	**Carbaryl**
V	**Author of famous book "silent spring" 1962 is:**	**Rachel Carson.**
V	**Largest ocean:**	**Pacific.**
V	**Establishment of NA BA RD:**	**12 July, 1982.**

V	R.B.I. was established in which year:	1935.
V	Proteins are made up of:	Amino acids.
V	Ozone depletion mainly due to:	CFC (chloro floro carbon).
V	One mol. of CFC is destroyed about 100,000 mol.:	of Ozone.
V	Gas filled in fire extinguisher cylinders is:	CO_2
V	Contribution of agriculture to GDP (2010-11):	14.2 %
V	Plough is used to turn over the soil is:	Mould bould plough
V	Carbohydrate which is only present in animal cells:	Glycogen
V	The pesticide consumption is maximum in:	Andhra Pradesh
V	Present Union Agriculture Minister:	Sharad pawar
V	Total KVK up to Oct,2013	630
V	Present DG of ICAR:	Dr. S. Ayyappan
V	Recently banned pesticides is:	Phosphamidon
V	Pesticide which is going under procedure to ban:	Endosulfan
V	First all India Co-ordinate Research Project (AICRP):	On Maize (1957)
V	First National Research Center (NRC) for:	Groundnut(Junagarii. Gujarat).
V	The region inhabited by living organism on land, ocean and atmosphere:	Biosphere.

Name the plants which produce lbod themselves through photosynthesis: *Phototrophs/autofrophs.*

- Sui generis" used in GATT proposals is a Latin ‘‘ord means *'a system of its own'.*

India won, Neem patent in March 2005. from G. R. Grace Company of America since, 1999.

v **In** northern India, sometimes **rain takes** place in **winter** which is due to: ***Western depression*** *(JRF-97/RPS(', A0-09).*

V National agricultural insurance scheme **(NAIS)/ Rashtriya Krishi Bima Yojna** is sponsored by **General Insurance Corporation.**

In total agricultural credit the contribution of **commercial banks is highest (74%),** followed by co-operative banks (17%) and rural banks (9%) in 2009. *(Pre -PG -2013)*

V **Agriculture** came into existence in: **7500 B.C.** when **cultivation of wheat** and **barley first started.**

Minimum support prices of various crops are recommended by *Commission on Agricultural Cost & Price (CACP),* at present 24 crops under MSP.

Accumulation of nutrients in a lake or pound due to human intervention or natural process is: *Eutrophication*

Maximum number of campuses under a single agricultural university: *JNKVV, Jabalpur (MP)*

Central Agricultural University, *Imp/sal (Manipur)* is the only multi state, agricultural university with seven colleges among sister states.

ICAR Institutes:

Deemed to be universities:

.	**IARI:**	Indian Agricultural Research Institute, **Pusa** (New Delhi)
.	**IVRI:**	Indian Veterinary Research Institute, **Izatnagar** (UP)
N.	**NDRI:**	National Dairy Research Institute, **Karnal** (Haryana).
4.	**CIFE:**	Central Institute of' Fisheries Education,Mumbai, MH
5.	AAI: _	Allahabad Agricultural Institute, **Allahabad** (UP)

Agricultural Research Institute:

1.	**CARL**	Central Agricultural Research Institute, **Port Blair** (Andaman & Nicobar)
.	**CARL**	Central Avian Research Institute, Izatnagar, UP
3.	**CAZRI:**	Central Arid Zone Research Institute, **Jodhpur** (Rajasthan), 1959

4.	CIAE:	Central Institute of Agricultural Engineering, Bhopal (Madhya Pradesh).
5.	CICR:	Central Institute for Cotton Research, **Nagpur** (Maharashtra).
6.	CIPHET:	Central Institute of Post Harvest Engineering and Technology, **Ludhiana** (Punjab).
7.	**CRIDA:**	Central Research Institute for Dry land Agriculture, **Hyderabad (AP),** 1985
8.	CRUAF:	Central Research Institute for Jute & Allied Fiber, Barrackpore, WB.
9.	**CRRI:**	Central Rice Research Institute, **Cuttack** (Orissa)
10.	CSSRI:	Central Soil Salinity Research Institute, **Karnal** (Haryana).
11.	CSWCRTI -	Central Soil and Water Conservation Research and Training Institute, **Dehradun** (Uttrakhand).
12.	**CTRI:**	Central Tobacco Research Institute, **Rajahmundry** (Andhra Pradesh).
13.	IASRI:	Indian Agricultural Statistics Research Institute, Pusa (New **Delhi).**
14.	**1GFRI:**	Indian Grassland and Fodder Research Institute, **Jhansi.**
15.	**IGS1:**	Indian Grain Storage Institute, Hapor, UP
16.	**IIPR:**	**Indian** Institute of Pulse Research, **Kanpur,** (UP)
17.	IISS:	Indian Institute of Soil Science, **Bhopal** (MP)
18.	**HSR:**	Indian Institute of Sugarcane Research, **Lukhnow,** UP
19.	**ILRI:**	Indian Lac Research Institute: **Ranchi,** Jharkhand
20.	**IIVR:**	Indian Institute of Vegetable Research, **Varanasi** (Uttar Pradesh).
21.	**NIRJAFT**	National Institute of Research on Jute and Allied _ Fiber Technology, **Calcutta** (West Bengal).
22.	SBI:	Sugarcane Breeding Institute, **Coimbatore** (TN)
23.	VPKAS:	V ivekananda Parvatiya Krishi Anusandhan Sansthan, **Almora** (UK)

Animal sciences and fisheries:		
I.	**CARL**	Central Avian Research Institute, **Izatnagar (UP)**
.	**CIFRI:**	Central Inland Fisheries Research Institute, **Barrackpore** (West Bengal).
.	**CIFT:**	Central Institute of Fisheries Technology, **Cochin** (Kerala).
4.	**CIRG:**	Central Institute for Research on Goats, **Mathura** (Uttar Pradesh).
5.	**CSWRI:**	Central Sheep and Wool Research Institute, **Avikanagar,** Tonk (Rajasthan)
6.	NIANP:	National Institute of Animal Nutrition and Physiology, **Bangalore** (Karnataka).
7.	**NFDB:**	National Fisheries Development Board, Hyderabad (AP), 2006
National Bureaus:		
I.	**NBPGR:**	National Bureau of Plant Genetic Resources, **New Delhi.**
.	**NBSSLUP:**	National Bureau of Soil Survey and Land Use Planning, **Nagpur** (MH).
.	NBAGR:	National Bureau of Animal Genetic Resources, **Karnal** (Haryana).
.	**NBFGR:**	National Bureau of Fish Genetic Resources, **Lukhnow** (Uttar Pradesh).
5.	NBAIM:	National Bureau of Agriculturally Important Micro-organisms, **Mau, UP**
6.	**NBAII:**	National Bureau of Agriculturally Important Insects, **Bangalore, 2009.** (Formerly it was named **Project Directorate of Biological Control).**
International institutes:		
1.	**IRR1:**	International Rice Research Institute at **Manila** (Philippines) in **1960.**
.	**CIMMYT:**	It is a **Mexican** word which denotes International Center for **Maize** and **Wheat** improvement at

110,42

		Mexico in **1966** ***(RAS Pre. -09)***
3.	**ICARDA:**	International Center for Agricultural Research in - Dry land Area, **Aleppo** (Syria), 1977
4.	**ICRISAT:**	International Crop Research Institute for Semi Arid Tropics, **Hyderabad** (India), 1972

– International Laboratory for Research on Animal Diseases, Nairobi, Kenya, 1973

ICGEB: **International Center for** Genetic Engineering & Biotechnology, Triesta, Italy & New Delhi, India

IBPGR: International Board of Plant Genetic Resources, Rome, Italy (1974)

IIM1: International Irrigation Management Institute: **Digana** (Shri Lanka).

AVRDC: Asian Vegetable Research and Development Center, **Taiwan.**

10. **TITA:** International Institute of Tropical Agriculture, Nigeria, **1968**

11 **ICRISAT:** International Crop Research Institute for the Semi -Arid Tropics, **Hyderabad (AP).** 1972

12. **ICARDA:** International Center for Agricultural Research in Dry Area at **Aleppo** (Syria) in 1977

13 **CIAT:** **International Center for Tropical Agriculture, Columbia,** 1967

Other institutes:

I. **NAARM:** National Academy of Agricultural Research and Management, **Hyderabad (Andhra Pradesh).**

FR!: Forest Research Institute: **Dehradun** (UK)

NCERT: National Council of Education Research and Training, **New Delhi.**

NRC-WS: National Research Center for Weed Science, Jabalpur **(MP)**

NRC-WT: National Research Center for Water technology, **Bhubaneswar** (Odissa)

NRC- National Research Center for ***Women in***

WAR: *Agriculture Research*, **Bhubaneswar (Odissa)** ***ARS exam -07***

7. **PDWMR:** Project Directorate of Water Management Research, **Patna** (Bihar).

S. **PDRR:** Project Directorate of Rice Research, Hyderabad

9. **PDMR** Project Directorate of Maize Research, Pusa, New Delhi.

10. **PDWR:** Project Directorate of Wheat Research, Karnal (Hariana).

11.	**N1OF:**	National Institute of Organic Farming, **Ghaziabad (UP)**
12.	**NC1PM:**	National Center for Integrated Pest Management, New Delhi.
13.	WMO:	World Meterological Organization, Head Quarters in Geneva (Switzerland).
14	**DFR:**	Directorate of Flowericulture Research, New **Delhi**
15.	**DIPA:**	Directorate of Information and Publication in Agriculture, **New Delhi** FluitAci-tit z:Tc.
16.	**NBB:**	National Biodiversity Board, NoN 113*14i_Chenr-c:u
17.	**NASM:**	National Agricultural Science Museum, (ICAR),New Delhi, 2004
18.	**ARFIS:**	Agricultural Research Finance Information System, ---------, 2004
19.	**DRMR:**	Directorate of Rape seed & Mustard Research, Sewar, Bharatpur (Raj.), 2009 (Formerly it was NRC for rape seed & mustard)
20.	**APEDA:**	Agricultural and Processed Food Product Export Development Authority, New Delhi.
21.	**NAFED:**	National Agricultural Cooperative Marketing Federation, Oct. 1958
22.	**NABARD:**	National Bank for Agriculture and Rural Development, 12 July 1982
23.	**GATT:**	General Agreement on Trade and Tariffs (Now it

		replaced by WTO in 1995) .
24.	CACP:	Commission for Agriculture Costs and Prices
25.	NIAM:	National Institute of Agricultural Marketing, Jaipur (RAJ.), 1988
26.	LAMPS:	Large Sized Adivassi Multipurpose Cooperative Society
27.	CFQCTI:	Central Fertilizer Quality Control & Training Institute, Faridabad, UP
28.	**NPPTI:**	National Plant Protection Training Institute, Hyderabad, AP
29.	**DMI:**	Directorate of Marketing and Inspection, Faridabad, UP

About to ICAR:

1.	**1926:**	Established **Royal Commission on Agriculture,** to examine the condition of rural economy in India
2.	**1928:**	Royal Commission on Agriculture **submitted its report**
3.	**1929:**	16, July **Imperial Council of Agricultural Research** was formerly born to promote Co-ordinate agricultural research in India
4.	**1947:**	ICAR, named as **Indian Council of Agricultural - Research**
5.	**1965:**	1st DG of ICAR was **Dr. BP Pal,** he Initiated All India Co-ordinate Research Projects **(AICRPs)**
6.	**1966:**	**ICAR** regarded as **Autonomous body**
7.	**President** of ICAR: **Union Minister of Agriculture**	
8.	DG of ICAR also **Secretary** of **DARE:** (Department of Agriculture Research and Education) established in 1973.	
9.	1st **President** of ICAR: Khan Bhadur ***Sir Mohammad Habib ullah***	

ICAR awards:

SN	Award	Field
1	Hari Om Ashram Trust award	Published Research in Crop Science

2	Punjabrao Deshmukh Women	For woman Agricultural Scientist
3	Jawaharlal Nehru award	Best work in Ph. D in the field of Agriculture & Allied Sciences
4	Jagjivan Ram Kishan award	Two **Innovative** Farmers in Agriculture & Allied Sciences
5	Choudhary Charan Singh award	For Excellence Journalism in the field of Agriculture Research and development

Important publication related to agriculture:

JournaUmagazine	I Published by	Place
kurukestra	Ministry of Rural Development	**New Delhi 1**
Current science	Current Science Association & Indian Academy of Science	**Bangalore**
Science reporter	**C.S.I.R**	**New Delhi**

Chronology of agriculture:

1875:	**Indian Meteorological Department (IMD), Pune (MH)**
1881:	**Separated Department of Agriculture.**
1901:	**First Irrigation Commission**
1905:	**Imperial Agricultural Research Institute (IARI)** started a **Pusa (Bihar)**
1926:	**Royal Commission on Agriculture, chairman: *Lord Linlithgow***
1928:	**RCA submitted its report**
1929:	**Imperial Council of Agricultural Research (ICAR), 16, July at New Delhi.**
1936:	**IARI shifted to New Delhi after a devastating earthquake in Pusa, Bihar in 1934**
1943:	**Great Bengal Famine (due to *Helminthosporium oryzae*)**
1947:	**Grow More Food campaign**
1952:	**Community Development Programme (CDP)**
1953:	**National Extension Service (NES)**
1958:	**IARI became Deemed University**

1959: Panchayati Raj (3 tier), by **Balwant Roy Mehta,** inaugurated by **J. L. Nehru** on 2"d **Oct., 1959** firstly in Nagaur district of **Rajasthan**

1960: **First Agricultural University** in India, G. B. Pant University of Agriculture & Technology, **Pantnagar,** on the pattern of **Land- Grant system** of USA

1960: Intensive Agricultural District Programme **(IADP)**

1964: Intensive Agriculture Area Programme **(IAAP)**

I 1I t L-IVI I V II,G I- 1 GNIUGIII til P.- /AIN, LI . D r r att

1966:	High Yielding Varieties Programme **(HYVP),** cause **Green Revolution**
1979:	Lab to Land Programme, on ICAR **golden jubilee year**
1970:	Small Farmers Development Agency **(SFDA)**
1971:	Drought Prone Area Programme **(DPAP)**
1973:	Started Agricultural Research Services (by **Dr. MS Swaminathan)**
1973:	**Tiger project** started
1974:	Command Area Development Authority **(CADA)**
1974:	**T&V System** by **Denial benor,** first in **Rajasthan**
1974:	Started **KVK,** recommendation of **Mohan Singh Mehta,** First in **Pondicherry**
1975:	Formed Agricultural Scientist Recruitment Board **(ASRB)** based on recommendation of **G. Gadekar Committee**
1975:	Started **20 Point Programme**
1976:	National Academy of Agricultural Research & Management (NAARM)/Central Staff Collage of Agriculture, Hyderabad
1976:	National Rural Extension Programme **(NREP)**
1976:	Desert Development Programme **(DDP)**
1976:	**Antyodya Vojna**
1976:	**Ashok Mehta Committee** proposed **two tiers** Panchayati Raj system.

111111111111111ENMW

1978:	Integrated Rural Development Programme (IRDP)
1979:	Training of Rural Youth for Self Employment (TRYSEM)
1982:	Development of Women & Children in Rural Areas (DW C RA)
1985:	Crop Insurance Scheme (CIS), now NAIS
1986:	Technology Mission on Oil seeds (TMO)
1986:	National Watershed Development Programme for Rainfed Areas
1998:	ICAR Launched **World Bank** funded Programme 'National Agricultural Technology Project' (NATP)
1999:	National Agricultural Insurance Scheme (NAIS), **from Rabi 1999**
2004:	Inauguration of National Agricultural Science Complex **(NASC)** at **New Delhi**
2004:	**National Commission on Farmers** constituted with **Dr. Swaminathan** as its first chairman
2005:	National Horticulture Mission
2006:	ICAR Launched National Agricultural Innovation Project **(NAIP)** with financial support from **World Bank.**
2006:	6 Feb. 2006 National Rural Employment Guarantee Scheme (NAREGA), later (Oct. 2, 2009) it replaced by Mahatma Gandhi National Rural Employment Guarantee Scheme
2007:	**NFSM** (National Food Security Mission)
2007:	**RK'VY** (Rashtriya Krishi Vikas Yojna)

Contribution **of Agriculture Experts:**

I. Dr. M. S. Swaminathan:

- Wheat breeder
- Father of **Green Revolution** in India,
- Ex. Member of Planning Commission
- **World Food Prize (1987)** given by **FAO**
- Was honored as a **'Millennium prize'** by former Prime Minister A. B. Vajpai in 88th National Science Congress held on 3-7 Jan, 2001 at IARI, New Delhi.

- Ex. President of **National Commission on Farmers of India.**
- The book entitled" **Wheat Revolution"** Written by him.

2. **Dr. N. E. Borlaug:**
   - Father of 'Green **Revolution'** in World
   - He was American wheat scientist **(Plant Pathologist)**
   - Awarded **Noble Peace Prize** in **1970.**
3. **Verges Kurien:**
   - Father of **White Revolution** in India
   - Ex. Chairman of **NDDB,** Anand (Gujarat)
   - Brain behind the scheme **'Operation Flood'** (1970-1996)
   - **Magsaysay** Award, in 1963.
   - **Got 'World Food Prize'** in 1989.
4. S. **K. Vashal:**
   - **Maize breeder** working at **CIMMYT.**
   - Awarded" **World Food Prize"** in the year 2000 for research on **QPM** (maize rich in amino acids **tryptophan** and **lysine** along with Dr. E. Villegas.
5. **Dr. K. L. Chadda:**
   - Pomologist
   - Father of **'Golden Revolution'** in India.
6. **Dr. R. S. Paroda:**
   - **Forage Breeder**
   - Ex. D.G. of 1CAR
7. **Amrita Patel:**
   - Chairperson of **NDDB,** Anand
8. **Sanjay Raja Ram:**
   - International **wheat breeder.**
   - Awarded **"Chinas Friendship Mandel** "in **2001.**
9. **Dr. G. S. Khush:**
   - Rice breeder.
   - **'Wolf Prize'** for agriculture, **2000** for his extra ordinary contribution to **plant breeding** and **genetics** especially in **rice.**

Crop Improve Achievements:

[redacted]

a. **Genetically Modified Crops:**

- The crops in which one or many of its **traits** are **altered** or **enhanced** through a process of **genetic engineering** known as **GM crops** i.e. ***Bt.* Cotton** developed against cotton **boll worms.**
- ***Bacillus thuringensis*** is a soil bacterium that produces **proteins lethal** to insect **larvae** affecting the **digestive system** of **boll worms.**
- **The** gene responsible for this effect is **Cry-lAc.**
- **GM cotton** is only crop permitted by Genetic Engineering Approval Committee **(GEAC)** under **Ministry of Environment and Forestry** first permitted on **March, 2002.**
- Bt. Cotton varieties developed by Mahyco: **MECH-12, MECH-162, MFCH-184** for Southern States and **RCH-134, RCH-138** suitable for Northern India.
- **Mahyco** collaborated with **Monsanto** to developed ***Bt.*** Variety **Bollgourd-1,** using Cry -I Ac gene.
- Recently ***Bt.*** Variety developed as **Bollgourd-ll,** having both genes of **Cry I** Ac and Cry 2 Ab gene.
- First transgenic crop was: ***Bt. Tobacco (1987)***
- Country having first position for transgenic plants is:USA
- Rank of India for transgenic plants is: **Fourth**
- The position of transgenic plants in world (in area): **Soyabean (> 60 %) > Maize > Cotton > Canola.**
- Mostly GM traits are used as **herbicides** resistant traits followed by **quality improvements** and **insecticides resistant** traits.

b. **Genetically modified mustard:**

- These are **glyphosate** resistance mustard developed by **Pro-Agro Seed Company Ltd.** (an ancillary Company of Bayer Crop Science, Germany).
- Project on Indian mustard oil with higher B -carotene is initiated **by: TERI (Tata Energy Research Institute).**
- Varieties developed of ***Bras,s.ica juncea at "{ER!*** are: TERI-**unnat** and **TERI-uttam.**

c. **Golden Rice:** (RPSC, AO Exam -2012)

- It is **genetically** modified rice.
- Having **a -carotene** (precursor of **Vit-A)** rich rice.

d. **Super Rice:**

- Developed by **Dr. Gurdev Singh Khush** at **IRRI,** which would bring an improvement of 25% of over present day varieties.

e. **Hybrid Rice:**

- Ist time in World developed in **China** in 1974 by **Prof. Long Ping Yuan,** hence known as **'Father of Hybrid Rice'.**
- India is **second** to developed hybrid after China i.e. **MGR-**1(earlier named as **CoRH-1)** developed first by **TNAU,** Coiinbatore and **PRH-1 & P14II-6** developed by **JAR!.**

f. **Hybrid Mustard:**

- Developed by DRMR (Directorate of Rapeseed and Mustard Research), Bharatpur (Rajasthan)
- Varieties developed by DRMR are: ***NRC-HB-506*** (first hybrid mustard in India).
- Other is: NRC-HB-1

g. **Super Wheat:**

- The research on super wheat is in progress at **DWR, Karnal**
- It was expected to come by 2005, yield increase **15-20** per cent.

11. **Green Revolution:**

- The term G.R. coined by **William S. Gaud** in 1968 of **USAID;** to describe the productivity based improvement in food production particularly in **wheat and rice.**
- Main components in green revolution are **High yielding varieties, use of chemical fertilizers** and **plant protection chemicals.**

i. Ever **Green Revolution:**

- This term coined by **Dr. M S. Swaminathan** to denote the green revolution based on sustainable methods of crop **intensification** and **diversification.**

j. **Vertical Revolution in Agriculture:**

- **Maximizing production per unit land area** per unit of time using **intensive cropping** system cropping system, high production inputs and improved management practices.

k. **Other Revolutions in Agriculture:**

Revolution:	**Related to:**
1. White Revolution:	**Milk** Production
2. Blue Revolution:	**Fish** Production
3. Brown Revolution:	**Food** Processing
4. Grey Revolution	**Fertilizer Production**
5. Yellow revolution:	**Oil** Seeds Production **(mustard)**
6. Red Revolution	**Tomato/Meat** Production
7. Pink Revolution:	**Prawn /Onion** Production
8. Golden Revolution:	**Fruit** Production
9. Round Production:	**Potato Production**
10. Silver Revolution:	**Egg/ poultry** production
11. Black revolution:	**Biofuel/Jatropha** Production
12. Rainbow revolution:	**All sector of agriculture**
13. Prabhani revolution:	**Okra production**

India shares in world:

- Total geographical area: **2.4 %**
- Population: **17.5%**
- **Livestock: 15%**
- **Forest: 1.5%**

India's position in World Agriculture:

1. **First position in:**
   - Mango production
   - Banana production
   - Total irrigated area
   - Sugarcane production
   - Tea production
   - Live stock production
   - Cashew production
   - Coconut prod! tion
   - Total pulses production
   - Milk production
   - Jute & allied fibers
2. **Second position:**
   - Wheat production
   - Oilseeds production
   - Vegetables production
   - Rice, production
   - Fruits production
   - Silk production

3. **Third position:**
   - Tobacco production
   - Cotton production
4. **Fourth position:**
   - Natural Rubber (share 8.5%) of total world NR production
   - Despite this India has emerged as the second largest consumer of NR, overtaking the United States with share of 9.6 per cent in world consumption in 2009.

     In coffee production India has **sixth position**

   .(Out of total production of coffee 65-70 % is exported

Position of Agricultural trades in India:

a. **Agriculture export commodities:**
   - **Rice >** Cashew > Wheat > Tea > Tobacco

b. g. **imports commodities:**
   - **Vegetable oil >** Cashew > Pulses > Fruits

t8,04cieu4.v, their tl

Deficiency	Effect/disease	Source
A (Retinol)	***Night blindness,*** growth failure, ***Xerophthalmia***	Liver is rich source, milk, carrot, papaya, mango etc.
131 (Thiamine)	***Ben -ben*** (disturbance in digestive system)	Rice polishing, leafy veg. fish, egg, meat
132(Riboflavin)	***Photophobia, inflamed*** lips, cracks on *skin/aribollavinosis*	Milk powder, fish, pulses
B5 (Niacin or Nicotinamide)	***Pellagra/black*** tongue	
B6 (Pyridoxine)	Degeneration of nerves	Yeast, wheat germ, legumes
Bi2 (Cobalomine)	*Pernicious* ***anemia***	Animal food (liver, meat, fish, egg)
C (Ascorbic acid)	***Scurvy*** (soft tissues around the Joints become swollen and painful) 4libti	Aonla, guava, citrus fruit

D (Calciferol)	*Rickets* (bone deformation), *Pigeon chest* in children & *Osteomalacia* in adults	Sun light, fish & liver oil
E (Tocopherol)	*Sterility* (reproductive failure)	Outer layer of grains
H (Biotin)	*Dermatitis*	
K (Phylloquinone)	*Delayed clotting*	Cauliflower, liver, soybean
Folic acid	*Anaemia*	Palak, karonda, green leafy veg.

Common medicinal plants and their uses:

CoMM011 Mime	Botanical name	Part used	Chemical content	Uses
Belladona	*Atropa belladona*	Leaves	Atropine	Neurologic pains
Ashwagandha	*Withania somnifera*	Roots	Withanine	General medicine
Sarafgandha	*Rauvolfia serpentina*	Roots	Serpentine reserpine	Treat hypertension High blood pressure
Sated mush i	*Chlorophytum spp.*	Roots	Saponin	Diabetics, Known as T'd Shilajeet
Opium poppy	*Papaver saminiferum*	Fruit	Morphine Codine Narcotine	Painkiller, god of sleep, cure leukemia
lsabgol	*Pantago ovata*	Husk, Seed	Mucilage	Laxative, used against irritation in gastrointestinal tract
Guggal	*Conuniphora wightii*	Gum, Resin	Guggulipids	Treat obesity, arthritis Reduce cholesterol

Minerals	Deficiency symptoms
Calcium:	*Rickets/milk fever*
Phosphorous:	*Rickets/Osteomalacia/Pica*
Iron:	*Anaemia*
Zinc:	*Parakeratosis*

manganese:	*Paresis*
lod me:	*Goiter*
Cobalt:	*Coast disease*

Minerals	**Excesses**
Mo:	*Molybdenosis*
Fluorine	*Fluorosis*
Selenium:	*Degnala/alkali disease*

Elements:	**Disease**
Ca & Mg oxalate	*Kidney stone*
Lead	*Mental retardation*
Fluoride	*Fluorosis*
Arsenic	*Poisoning*
Iron	*Constipation or Dysentery*

Growth substances and their function:

SN	Hormone	Functions
I	Auxin	Named by F.W. Went, It has apical bud dominance, inhibit root elongation and promote cell division in *tissue culture*
	. IAA	Prevent premature fruit drop
	b. IBA	Root formation
	. NAA	Fruit thinner, prevent fruit drop
	d. 2,4-D	Fruit setting hormone (<20 ppm), and also used as a herbicide (>20ppm)
	Cytokinin	Dormancy breaker, stimulate cell division
3	Gibberellins	Cell elongation, increase fruit size
	Abscisic acid (ABA)	Dormancy induced, stomata closer, also called as anti gibberellins.
	Ethylene	Ripening of fruits, isodiametric growth of stem & roots
	Clormequat (CCC)	Logging preventer, also known as cycocel
	Mallic hydrazide	Growth retardant, prevent onion sprouting in storage, sold under trade name *Sproutstop*
	Ethephone	T. Name: Ethrel, Used as banana fruits ripener

Vitamins and enzymes:

- The term **vitamin** was introduced by: **Funk** (1912)
- **Vitamins** are accessory food factors **play vital** role in growth, nutrition and metabolic process.
- **Fat soluble** vitamin: **A, D, E &K.**
- **Water soluble** vitamin: **B & C.**
- **Folic acid** is essential for maturation of **RBC** (Red blood corpuscles).
- The largest concentrations of **minerals** are found in **bones** and **teeth.**
- **Calcium** is essential component of all living cells, helps in **body building.**
- **The term enzyme was coined by: W. Kuhne (1898)**
- Enzymes are **those organic substances which are capable of catalyzing chemical reactions in living system.**

Essential amino acids: (They can not be synthesized in our body)

- **These are ten in number: (Tricks *'TV, MILL, PATH')***
- ***Tryptophan, Valine, Metheonine, Iso-leusine, Leucine, Lysine, Phenyl-alanine, Arginine, Threonine, Histidine.***

Essential fatty acids:

- **Four in number, (Remember tricks *`OLLA)***
- ***Oleic acid, Linoleic acid, Linolenic acid, Arechidonic acid***

Imported years related to agriculture:

2004: International Year of *Rice (OBC, Bank -08)*
2005: International Year of Physics
2006: International Year of Desert and Desertification
2007: International Year of Water
2008: International Year of Potato
2009: International Year of Fiber
2010: International Year of Biodiversity
2011: International Year of Forest, and
: International Year of Chemistry
2012: International Year of Co-operative

2012: Year of Horticultural (declared by Ministry of Ag. & Food Processing, Govt. of India).

SN	Date	Famous day
1	15th March	World Consumer Day
2	21st March	World Forestry Day
3	30th March	Rajasthan Day
	5th June	World Environment Day
5	11th July	World Population Day
6	16th July	ICAR Day
7	16th September	Ozone Day
8	16th October	Word Food Day
9	4th December	Women in Agriculture Day
10	23rd December	Kishan Day, *birth day of* ***Choudhary Charan Singh***

Fertilizer Trade:

- India is meeting **85 per cent** its urea requirement through **indigenous** production but depends heavily on **imports** for its **phosphatic and potash fertilizer** requirements.
- Farmers pay **only 25 to 40** per cent of the **actual cost** and the rest of the cost is **borne by the Government** in the form of a **subsidy,** which is reimbursed to the manufactures/importers.
- The production of urea is estimated at **215.37 lakh tonnes** in **2010-11** and that of **DAP** and **complexes** at **39.58 lakh tonnes.**

There have been major policy initiatives in the fertilizer sector:

1. Introduction of **nutrient -based subsidy** scheme with effect from **1 April 2010.**
   - Under the nutrient based subsidy scheme (NBS), Government has amended subsidy **per kg of nutrients** N, P, K and S contained in P & K fertilizers **as well as per MT** of fertilizers.

Irrigation trade:

- The total irrigation potential in the country has increased from **81.1 million** hectares in **1991-92 to 108.2 mha** in **March 2010.**
- **More than 75 per cent** of annual rainfall is received during the southwest monsoon season (June -September).

The major schemes/programmes:

1. National Food Security Mission (NFSM):

- The NFSM was launched in **Rabi 2007** with a view **to enhancing the production** of **rice, wheat, and pulses** by 10 mt, **8** mt, and 2 mt, respectively by the **end of the Eleventh Plan.**
- The Mission aims to **increase production** through area expansion and productivity; **create employment** opportunities; and **enhance the farm -level economy** to restore **confidence of farmers.**
- The NFSM is presently being implemented in **476 identified districts** of **17 States** of the country.
- A new programme under the NFSM called the **Accelerated Pulses Production Programme (A3P):**

Under A3P:

1000 block demonstrations of technology have been **launched from 2010-11.**

This programme will essentially promote plant nutrients and plant protection -centric technologies in compact blocks of **1000 ha each for five major** pulse crops, namely, tur, moong, urad, gram, and lentil.

Components/activities of NFSM:

- Demonstrations of improved **package of practices.**
- Demonstrations of the **system of rice intensification** (SRI).
- Distribution of **high yielding variety** seeds of rice, wheat, and pulses and hybrid rice.
- Soil ameliorants, such as **gypsum/lime/micro nutrients** to restore soil fertility for higher productivity.
- Integrated Pest Management **(IPM).**

- Improved **farm machineries,** including water -saving devices have been distributed.
- Farmers' field school **(FFS)** — level trainings.
- In addition, about **several lacks block demonstrations** have been conducted during the **2010 kharif under the A3P.**

2. **Rashtriya Krishi Vikas Yojana (RKVY):**
   - The RKVY was launched in **2007** with an outlay of **'25,000 crore'** for the Eleventh Plan to incentivize States to **enhance public investment** so as **to achieve a 4 per cent growth rate** in agriculture and allied sectors during the **Eleventh Plan.**
   - The RKVY has emerged as the **principal instrument in financing development** of **agriculture and allied sectors in the country.**
   - **Its convergence with other schemes like the Mahatma Gandhi National Rural Employment Scheme is expected to boost development of the agrarian economy.**

3. **Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM): Launched** in 2004
   - **The ISOPM is being implemented in 14 major States for oilseeds and pulses, 15 for maize, and 10 for oil palm.**
   - **The pulses component has been merged with the NFSM with effect from 1 April 2010.**
   - **The** Scheme provides **flexibility to the states in implementation based on a regionally differentiated approach to promoting crop diversification.**
   - **Under the Scheme, assistance is provided for purchase of breeder seed, production of foundation seed, production and distribution of certified seed, distribution of seed minikits, plant protection chemicals, plant protection equipment, weedicides, gypsum/liming, sprinkler sets, and water carrying pipes, supply of rhizobium/ PSB culture and improved farm implements, publicity etc.**

4. **Agricultural Technology Management Agency (ATMA):**
- At **district level to operationalize** the extension reforms with the **active participation of farmers/farmer groups,** non-government organizations **(NG0s), Krishi Vigyan Kendras, Panchayati Raj Institutions** and other **stakeholders** operating at **district level** and **below Up to October 2010, 591district-level ATMAs** have been established.
- Gender concerns are being mainstreamed by mandating that **30 per cent of resources** on **programmes** and **activities are allocated for women farmers** and extension functionaries.

5. **The National Horticulture Mission (NHM): May. 2005**
- **The Ministry of Agriculture** has been implementing the **centrally sponsored NHM** for **the holistic development** of the horticulture sector since 2005-06.
- All the States and the **three Union Territories** of Andaman and Nicobar Islands. Lakshadk\ eep, and Puducherry are covered under the Mission **except the eight north-eastern States.**
- The latter are covered under the Horticulture Mission for the North East and Himalayan States **(HIVINEH).**
- The per capita availability of **fruits and vegetables** has increased from **391 gram/day** in **2004-05 to 466 gram/day in 2008-09.**

6. **National Mission on Micro Irrigation (NMMI): 2010**
- The **Centrally sponsored** National Mission on Micro Irrigation was launched in **June 2010** in addition to the earlier **Micro Irrigation Scheme launched in January 2006.**
- The Mission is being implemented during the **Eleventh Plan period** for enhancing **water -use efficiency** by adopting **drip**

and sprinkler irrigation systems in **all States** and **Union Territories** for both **horticulture and agricultural crops.**

7. **National Bamboo Mission (NBM): November, 2004**
    - With **a view to harnessing the potential** of the bamboo crop in the country.
    - The **Ministry of Agriculture** has been implementing the **centrally sponsored NBM in 27 States** in the country during the year **2006.**
    - The Mission **aims to promote holistic growth** of the **bamboo sector** by adopting an area -based, regionally differentiated strategy and to increase the area under bamboo cultivation and marketing.

8. **Kisan Credit Card Scheme (KCCs):**
    - From **Kbarif 2006-07 to 2008-09,** farmers were **receiving crop loans** up to a principal amount of' **3 lakh at 7 per cent interest.**
    - In the **year 2009-10,** Government provided an additional 1 per cent interest subvention to those farmers who repaid their short-term crop loans as per schedule.
    - The Government has raised this subvention for timely repayment of crop loans from **1 per cent to 3 percent** from the year **2010-11.**
    - Thus the effective rate of interest for such farmers **will be 4 per cent per annum.**

9. **National Agricultural Insurance** Seheni:2 (NAIS):
    - The NAIS is being implemented in the country from **rabi 1999-2000 season.**
    - Minimum indemnity level of **70 per cent instead of 60 per cent,** and private -sector insurers with adequate infrastructure allowed (at present, **ICICI-Lombard, 1FFC0-Toltio and Cholamandalam-MS).**

0.Weather Based Crop Insurance Scheme (WBCIS):

- Announced in the **Union Budget 2007** in selected States and Union Territories.
- The WBCIS is intended to provide insurance protection to farmers against **adverse weather incidences,** which are deemed to unfavourably impact crop production.
- It has the advantage of **settling claims within the shortest possible time.**

11.Kisan Call Centre:

- The Kisan Call Centre scheme was **launched in 21, Jan 2004** to provide **agricultural information** to the farming community through **toll -free telephone** lines.
- A country -wide common **11 -digit number-1800-180-1551—has** been allocated for **KCCs.**
- **Replies** to the queries of the **farming community** are being provided in **22 local languages.**
- Calls are **attended to from 6.00 am to 10.00 pm** on all seven days of the week.

12.Agri-clinic and Agri -business Centres:

- The Agri -clinic and Agri -business Centres Scheme was **launched in 2002** to provide **extension services** to **farmers on payment basis** through setting up of **economically viable self—employment ventures.**
- Selected trainees are provided **agri-preneurship training.**
- **NABARI) monitors** the credit support to Agri -Clinics through **commercial banks.**
- Provision of **credit -linked back -ended subsidy at 33 per cent** of the capital cost of the project **funded througkb** loan as well as full interest subsidy for **the first** tw **the bank credit has rept)**

13.Protection of Plant Varieties and Farmers' Rights (PPV&FR):

- Authority established in **November 2005 at New Delhi** has been mandated to implement provisions of the **PPV&FR Act, 2001.**

14.Buffer Stock:

- The stock position of food grains in the Central pool as on **1 October, 2010** is **46.2 million tonnes** comprising **18.4 million tonnes** of **rice** and **27.8** million tonnes of **wheat.**
- FC1 has Buffer stock, Oct. 2009: **16.2 mt.**

UNIT -2

.Agriculture

The term agriculture is derived from the two **Latin** words:

Ager	=	Soil
Cultura		Cultivation

- Hence **Cultivation** of soil is called **agriculture.**

Sustainable agriculture/eco-farming:

- Sustainable agriculture is one which makes of use of low cost inputs, lower amounts of chemical fertilizers: maintain soil fertility and ecological harmony **(FAO, 1989).**
- It is also known as **ecological farming/natural farming** or **organic farming/permaculture.**

Shifting cultivation/land rotation/jhuming:

- **The productivity** of soil **is lost** due to cultivation of **same crop** generally rice on the **same forest land** year after year hence. the crop is **shifted to other burnt land.**
- It causes **soil erosion.**
- It practiced in **Jharkhand, MP and hilly areas** of Northern states of India.

Response farming:

- **Stewart, 1988**, coined this term based on [illegible] data.

- **It** refers to the **prediction of mansoon season** (rainfall), based on analysis of weather data of pre-mansoon period and managing crops accordingly.

Precision farming/site specific farming:

- The target **specific** use of **inputs** (like seeds, fertilizers, pesticides etc.) for crop production according to crop requirement on localized basis.

Advantages of precision farming:

- Minimized the cost of production
- Maintains ecological balance
- Conserve resources

Ideotype (modal plants):

- The concept of Ideotype was given by **Donald** in 1968.
- The single plant would give the better result in a group when the crop has at least competition with the same type of the crop.
- Ideotype is the model plant which may be defined as "a biological modal which is expected to perform or behave in a predictable manner within a defined environment.

Terra -forming:

- To develop the mars **(planet)** according to the earth's environment is called terra- forming.
- At present **bacteria** and **plants** are being developed by creating the environmental condition of mars on the earth.

Hydroponics:

- Growing of plants under 5oil **less** condition is called **hydroponics.**
- Solution culture is being used for raising **flowers and vegetables** at homes.

Response curve:

- Suggested by **Holliday,** 1960:
- The **relationship** between **plant population & yield**

Two types of response curve.

I. **Asymptotic response:**

- Where entire dry matter is the economic product as in the case of fodder crops or most of dry matter as in tobacco.
- It means increase plant density with increase yield e.g. cereal crops for fodder.

2. Parabolic: after reaching a level, increase plant density with decrease yield (wide space between plants cereals/pulses for grain purpose.

A close functional relation between input & output:

- Quadratic response: y = a + bx + cx2
- Linear response: y = a + bx
- Mitscherlish equation: y = y + a (1-10-").

Or y = dy/dx = (A -y) c

Zero tillage:

- Father of zero tillage Glubler B. Triplets (USA), 1950
- Primary tillage completely avoided.
- Secondary tillage restricted to seedbed preparation in the row zone only.
- Keeps 50-100% of residue on soil surface.
- Before sowing, herbicides Paraquat, Glyphosate are used for weed control.
- Till planting is adopted.

Till planting: It is the practice in zero tillage including four operations.

1 Cleaning the crop row
Opening of soil for seed insertion
1 Placing of seed
1 Covering the seed

- These functions are accomplished in one tillage operation.

Minimum tillage:

- Can be defined as a method aimed at reducing tillage to the minimum necessary for ensuring a good seedbed, rapid germination, satisfactory crop stand and favorable growing conditions.

- Started in **USA,** because of **high cost** of tillage due to steep rise in **oil price in 1974.**
- Tillage operation is done only for **seed bed preparation.**
- **Keep 30-50** % crop residues on soil surface.
- **It improves soil condition** due to in situ decomposition of plant residue.
- Weed control can be done by herbicide

Global warming:

- Surface of the **earth** is **warmth** from **sun heats.**
- Earth absorbs most of sun energy but **reflects** back some energy in the form of **infra red radiation.**
- **Green house** gases e.g. CO_2(55%), **Methane** (25%), **CFC (11%)** and N_2O (4%).
- These **gases are present** in atmosphere. **transmit the infrared radiation** and **reflect back** to the earth.
- This reflected energy falls on the earth surface and keeps it **warmer.**
- This is called **global warming** or green house effect.

Source of green house gases:

- In **developed** countries: **Emission** from **automobiles &** factories contains CFCs.
- In **developing** countries: **Deforestation** cases rise in CO_2 level, **methane** gas from paddy field & livestock and **nitrous oxide** from N base fertilizer.

Effect of global warming on world and agriculture:

- Increase overall **temperature** on earth e.g. earth's surface temperature has increased **1.4° F** in first on **Century (** It has been forecasted that **5 °F** will rise in **next Century).**
- Cause changes in **climate** tremendously.
- Results in **melting of ice** in polar region.
- Increase sea level resulting in **submerging** of coastal areas.
- **Drought** in warmer region.

3. AGRONOMY

important points:

,./	**Mycorrhiza** is a symbiotic association between:	**Fungus & roots of higher plants**
V	VAM: *Vascular Arboscular yycorrhyza* is used to:	**P solubilizing in plant roots**
V	Cereals are deficient in which amino acid:	Lysine
V	Amino acid which is deficient in legumes:	**Methionine**
V	Power tiller is most suitable for the cultivation of:	**Paddy**
V	Ammonium polyphosphate contains:	15% N & 62 % P205. ***(RPSC, ,40-09)***
•7	**Tz** (tetrazolium) test is done for:	**Viability of** seeds.
V	In wet nursery of rice, level of water is maintained:	5 **cm**
V	The optimum depth of **puddling** in rice is:	5 **cm.**
V	Ultra violet radiations are absorbed by:	**Ozone layer.**
V	First Indian director of IARI was:	**Dr. B. Vishvanath.**
V	The most critical stage of irrigation in wheat is: ,	**CR1 stage** (21 days after sowing)
v	Jhum cultivation mostly found in:	**Eastern part of India.**
V.	Objective of sustainable agriculture is:	**To maintain ecological balance**
V	The plants growing in salt water are known as:	**Halophytes**
V	Crop canopy temperature is measured by:	**Infra -red thermometer.**
v	Reclamation disease due to deficiency of:	**Copper**
v	Hormone related to drought tolerance is:	**Abscisic acid**
V	Contribution of live stock to agriculture GDP:	**29.7 %**
1	Hormone used as an herbicide:	**2, 4-D** (>20 PPM)

V	Element available in both anion and cation ions is:	**Nitrogen *(LAR', PILD-11)***
V	Dormancy breaking hormone is:	**Cytokine.**
V	Ring worm disease is caused by:	**Fungus.**
V	Wind which is cause rainfall in Tamil Nadu:	**North East monsoon**
V	Stress hardening in plants can be achieved by:	ABA.
V	Maximum allowable biurate content of Urea is:	1.5%.
V	Carbon content in organic matter:	58 %.
V	Nitrogen biofertilizer used for wheat:	**Azatobacter.**
V	Nitrogen biofertilizer used for sorghum:	**Azospirillum**
I	Vertical mulch is used in soils:	**Black cotton soils.**
V	Criteria of essentiality were given by:	**Arnon & Stout, 1939.**
V	The optimum spacing for wheat is:	22.5 em(line to line)
V	The nontraditional area for cultivating wheat is:	**Eastern India.**
V	Major P fertilizer in India in India is:	DAP.
I	Very few poor (BPL) peoples are in:	**Punjab.**
V	Very large number of BPL peoples are in:	**Bihar**
V	Bio fertilizer more suited for sugarcane is:	**Azatobacter**
V	Depth of sowing of soybean seed:	3 **cm.**
V	First variety of rice introduced in India is:	**TN -1 (1964-65)**
V	Indian mustard known ***as:***	***Brassica juncea.***
V	Explosive fertilizer is:	**Ammonium nitrate.**
V	Most prominent soil group of India:	**Alluvial soil.**
V	In SSP sulphur contains:	12 %.
V	Micro nutrient deficient in Indian soils:	**Zn.**
V	**Spike tooth** harrow is a type of implement:	**Secondary tillage**
V	Most widely used for correcting soil	***Lime.***

	acidity: •	
../	**Diara** cultivation method is followed in:	**Cucurb its.**
../	**C: N** ratio of organic matter is:	10:1
V	National Seed Act passed in:	**1966.**
,./	National Seed Corporation in:	**1963.**
.4	Root promoting hormones:	**IBA**
1	Flower and fruit setting hormone:	**NAA**
./	Bench terracing is done when slope is more than:	**15 %**
1 k	Mass per unit volume is called:	**Bulk density.**
V	Disk plough is used when the soil is:	**Tough.**
.(	First man made cereal is:	**Triticale.**
V	Cheapest N contains fertilizer is:	**Urea.**
\ .7 -	First product of urea hydrolysis:	**Ammonium carbamate.**
1	**NABARD** was set up on the recommendation of:	**Siva Raman committee**
1	Free living nitrogen fixing organism is:	Azatobacter
1	The fruit of mustard is known as:	**Siliqua.**
1	Supplemental irrigation is known as:	**Life saving irrigation**
V	Major agricultural import in India is:	**Edible oil**
V	Lunishree is a variety of:	**Super rice.**
V	Plants with male and female flower are:	**Monoecious**
1	National biodiversity board is situated at:	**New Delhi.**
N	**Beautfort** scale is used to measure:	**Wind force**
1	Die back of shoots occur due to deficiency of:	**Copper**
V	Grey spots on leaves occur due to deficiency of:	**Manganese.**
V	Indian soils are mainly deficient of:	**Nitrogen.**
i	Most destructive disease of sugarcane is:	**Red rot of sugarcane.**

V	Potatoes are borne on:	Stolons
1	Potato tubers are a modified form of:	_Stem
V	Sugarcane sowing in trench method to prevent:	Lodging
V	For seed purpose carrot is grown as:	Biennial
V	Boron is harmful for plants having concentration:	More than 3 ppm
V	Maximum productivity among cereals:	Maize
V	Kaolin is a type of antitranspirants:	Reflecting type
V	Cycocel (CCC) is a:	Growth retardants
V	Family of sesame:	Pedaliaceae
V	Family of jute:	Tilliaceae
V	Which family of crop is more exhaustive:	Graminae
V	Origin of maize:	Mexico
V	Origin of soybean:	China
V	Origin of tobacco:	Mexico
V	Highest area of summer maize:	Bihar
	Indian Journal of Agriculture Sciences is published by:	ICAR
	Yellowing of tea leaves occurs due to the deficiency of:	**Sulphur**
	The green house gas that released from paddy field is:	Methane
	The edible part of sweet potato ***(Ipomoea batata)*** is:	**Adventitious** root
	Carbon dating technique is used to determine age of:	**Fossils**
V	The irrigation method which is suitable for saline soil:	**Flooding method**
V	Element contributing to the disease & drought resistance:	**Potassium**
V	Element involved in energy transfer and storage in plants:	**Phosphorus**

V	Nutrients are termed as essential elements for plants:	16 **nutrients**
V	Apical bud dominance is caused by which hormone:	**Auxin**
	Highest consumption of k fertilizer:	**Maharashtra**
	Highest production of cereals in world:	**Wheat**
V	Seed rate of sorghum is:	**9-12 kg/ha**
V	De suckering is a process of a crop:	**Tobacco.**
V	The weed, which was first biological controlled:	***Lantana camera***
V	State, where seed law are adopted:	**Karnataka**
V	Soil moisture tension directly measured by:	**Tensiometer**
V	Evapo-transpiration measured by:	Lysimeter
V	Parshall flame is used for measurement of:	Water flow
V	Flooding irrigation method commonly used for:	Rice
V	Fertilizer application through irrigation known as:	**Fertigation**
V	One of most important cultural practice in rice field:	**Puddling**
V	Post harvest losses for cereals accounts for:	**10%**
V	Saltation is a process of:	**Wind erosion**
v	Irrigation efficiency of loamy soils:	**70% (highest)**
V	In saline soils the methods of irrigation:	**Flood method**
V	Sowing pattern used in dry land:	**Broadcasting**
V	Most efficient method of irrigation is:	**Drip irrigation**
.v	Extensively grown pulse crop in India:	**Chick pea**
v	Relative humidity measured by:	**Psychrometer**
V	Crops growing for conserve soil moisture known as:	**Mulch crops**

/	Example of erosion permitting crop:	**Maize**
.4	Example of erosion resistant crop:	Cow **pea**
.4	The herbicide used as pre -plant incorporation is:	**Fluchloralin**
.4	Example of C_4 weed is:	**Common lamsquarter**
.4 \	The botanical name of **two rowed** barley ***is:***	***Hordeum distichon***
.4	The name of **six rowed barley is:**	***Hordeum vulgare***
.4	First **AICRP** was started in which crop:	**Maize 1957**
.4	What is the optimum plant population for Bt -cotton:	**10,000 plants/ha**
I	Dropsy disease in human being is caused by which weed:	***Argemone Mexicana***
.1	Crop is suitable for having PH 4-6:	**Rice, tea and potato**
I	Red hemoglobin in root nodule is responsible for:	**Transport of 02**
V	Annual rainfall in Rajasthan:	575 mm
I	Aminophilic plants:	**Sugarcane and rice**
I	Country having 100% of the cropped area under irrigation:	**Egypt**
I	Country having highest irrigation efficiency:	**Israel**
I	Country having highest irrigated area:	**India**
I	In **remote sensing** optical wave lengths from:	0.3 to 15 **urn** are used
V	India is the **first** country to develop and use of hybrids in:	**Pear millet (HB-1 ' in 1965**
V	Crop having maximum area under irrigation:	**Wheat**
.4	Most extensively fruit grown crop in the world:	**M**
V	**Pusa giant** is the variety of both:	

	Type of soil water which is most useful for plants:	**grass.** **Capillary water.**
V	At **equator** day and nights are always:	**Equal.**
V	Atmosphere pressure always **decreases** with:	**Altitude.**
V	**Horizontal** heat transfer from warmer area to cooler area:	**Cloth line effect**
V	**Vertical** heat transfer from warmer to cooler crop area:	**Oasis effect**
V	The enzyme of **nitrogen reduction** is:	**Nitrogenase**
V	The component of **nitrate reduction** is the:	**Molybdenum.**
V	Major of field crops require for optimum growth is:	**6.5-7.0** p'
V	Hence; cultivated mostly crops are:	**Acidic** in nature *(IFFCO-* ***09)***
V	Depth of water required by a crop is known as:	**Delta**
V	Area irrigated by one cusec discharge of water is:	**Duty**
V	Period in days for which irrigation is supplied to a crop is:	**Base period**
V	Rancidity in sunflower oil due to:	**Oxidation.**
V	Varieties of black gram:	**T-9. Pant U-19**
V	Famous variety of moth bean is:	**RMO-40**
V	Elite varieties of moong bean are:	**Pusa baisakhi. SML-668**
	0.1% solution in **500 liters** of water is:	**500 ml** *(RPSc.* ***AO-09/SRF-09)***
V	**BioclimatiC** low proposed by	**Hopkins**
V	Chemical safeners also known as **hei bicide antidote** e *g*	**NA** **(it** used first in maize)
V	**Crop** which has **highest** K up take	Potato

- The low pressure area near the equator is called: **Doldrums**
- **Triacontanol** is a growth stimulant obtains from: **Leaves of Lucerne**
- **Tillage increases the water holding capacity** and **infiltration** of soil but reduce bulk density.
- **Wet land plough is smallest** of the wooden ploughs it used in **puddle soil &** efficiency is **0.1 ha** for 8 hours.
- The **sprinkler system** of irrigation provides **protection from cold** by the **release of latent heat of fusion.**
- **Splitting** open of a **pod** or **fruit** in characteristic manner at **maturity** is known as ***Dehiscent*** e.g. pods of pulse.
- Continuous consumption of Lathyrus causes a disease known as ***lathyrism*** as its grains contains **BOAA** (Benzo-oxalin acitic acid), a neurotoxin.
- Fertilizer is preferred to grow succeeding crop in green manure soil: ***Phosphatic***
- The cattle consuming grasses of **low** magnesium content suffer from **hypomagnesaemia,** commonly called as ***'Grass Tatany'*.**
- ***Weather*** is a state or condition of atmosphere at a given place at a given instant of time.
- Recently scientists separated germs in maize corn for manufacturing: ***Contraceptives***
- India's rank **first** in production and consumption of **sugar** in the world.
- The tobacco contributes the largest **excise revenue** among agricultural commodities in India.
- India is the only country to have developed and grown **hybrid cotton** commercially.
- **Karnataka** is the largest producer of ***coffee*** in the country.
- **China** is the largest producing and consuming country of **tobacco** in **the world, India** is the **third** position of production of tobacco in **world.**

Phenyl mercuric acetate **(PMA)** is a chemical used in agriculture crops in order to: ***Reduce transpiration***

Jowar is known as: ***Camel crop/Kings of coarse grains***

- India is the **second country** after china to have commercialized the **hybrid rice** technology.

HD 2329 wheat variety contributed maximum producing during green revolution in India.

Plant rectangularity is: **Plant to plant distance/row to row distance.**

In water erosion **3 m deep,** more than **18 m** wide gully is known as: ***Small gully (G2)***

3-9 m deep, width **18 m or more,** side **slope 8-15 4Y0** is known as: ***Medium gully (G3)***

The direction from which the winds are coming called as: **Wind ward side.**

Agronomic measures used to reduce erosion where slope is: ***Less than 2%.***

Bench terracing usually practiced on slopes ranging from: ***16-33***

The highest award presented to an agricultural scientist in the country: ***Rafi ahmad kidwai award.***

Over the years the contribution of agriculture to GDP of Indian economy has been: ***Decreasing***

Agro climatic regional planning in India was initiating in which five year plan: ***71h five year plan (1988)***

Nitrogen fixation in rice field is carried out by blue green algae with: water fern ***Azolla.***

The pattern of planting has maximum plant population: ***Cubodial pattern***

Cultivations of such crops which have different natural habit and zero competition is known as: ***Parallel cropping***

The variety of wheat which is resistant to all the three rusts is: ***Chou lerma***

•V In sugarcane, taking of **ratoon** crop is advisable only: **Once time**

I Cultivation of two or more than two crops of **different heights** simultaneously on a certain piece of land in a certain period is called: ***Multistoried cropping***

I Nursery area required for seedling of rice one hectare field is: *0.10 ha*

Tip burn of paddy is due to reduced 02 and N2 under submerged condition.

1 Maize leaf develop **red** and **purple** color due to the deficiency of: ***Phosphorus***

V The size of **Thomson** seedless grape increased by the hormone: *GA3*

Center of ori2n:

- Vavilon **c 8 center of origin** and **3 sub center.**

Major crops and their origin place:

Crop	**Origin**	**Crop**	**Origin**
Rice	S. E. Asia(Burma)	Tea	China
Sugarcane	New Guinea	Soybean	China
Wheat	S. W. Asia (Turkey)	Mustard	China
Gram	S. W. Asia	Cow pea	Africa
Maize	S. America (Mexico)	Cotton	India
Tobacco	C. America	Brinjal	India
Groundnut	Brazil	Arhar	Africa
Moong	India	Jowar	Africa
Potato	S. America (Peru)	Bajra	Africa

Terms and related agronomists:

	Terms/field	**Agronomist**
,/	**Irrigation** Agronomy	Dr. N.G. Dastane
V	Cropping System	Dr. S.S. Bains
V	Irrigation Engineering	A.M. Michele
V	SRNF(slow release nitrogen fertilizer)	Dr. Rajendra Prasad
V	CRI in wheat:	B. L. Bhardwaj

/	Functional nutrient	Nicholus, 1963
V	Essentiality of nutrient	Arnon & Stout 1939 (refined by Arnon 1954)
V	Agrobiology	Wilcox
V	IW/CPE Ratio	Parihar *et al* 1974
V	Transplanting in pearl millet	Dr. Gautum
V	Coefficient of effectiveness	Nichiporovic (1950)
V	H-4 hybrid of cotton	Dr. C.T. Patel (GUJ.) 1970
V	Jaya (first Indian variety of rice)	Dr. Shastry
V	Low of minimum	J.V. Liebig in 1840
V	Low of limiting factor	Black man (1905)
V	Increase yield N low	Wilcox (1929)
V	Leaf area index	Watson (1947)
V	Nutrient mobility concept	Brays R.H
V	**A"** value concept	Dean & Friend (for P
V	Harvesting index	Donald
.1	Photoperiodism concept	Gardener & Allard 1920
V	Thermoperiodism	F. Went
V	Vernalization	Lysenko
V	Antibiotics (Penicillin)	Alexandrian Fleming 1939
V	***Bacillus radicicola*** *(now* ***Rhizobium)***	Beijerinck 1890
V	Rothamsted experimental station	J.B. Lawes & J.H. Gilbert (1843)
	Founders/father of different fields:	
V	Father of field plot experiment:	J. B. Boussingault
V	Father of pedology:	V.V. Dokuchaiv
V	Father of golden revolution:	Dr. K.L. Chadda
V	Father of tillage/weed science:	Jethrotull
V	Father of soil testing technique:	M. L. Troug
V	Father of soil microbiology:	S. N. Winogradsky
V	Father of agriculture chemistry:	J. V. Liebig

a

icq

AGRONOMY

The term derived from of two **Greek** words:

- ***Agros*** = **Field**
- *Nomos* = *to manage*

Definition:

- Can be defined as a branch of agricultural sciences that deal with methods which provide favorable environment to the crop for ***higher productivity.***
- Indian agriculture is predominantly of the **subsistence type**
- **Peter Decresenzi** (1230-1307 A.D.) He collected many literatures related to agronomy in his book ***"Opus Rural/urn Kamo Durum"*** for the first time. He known as **'Father of agronomy'.**
- Van Helmont (1577-1644 A.D.) Concluded that the main principle of vegetation is water.
- **Jethrotull** (1674-1741 A.D.) He published a book ***'Horse Hoeing Husbandry'*** and the words ***'Weeds'*** and ***'Zero tillage'*** firstly given by him. He known as **'Father of weed science'.**
- **Aurthor Young** (1741-1820 A.D.) Conducted pot culture experiments to increase the yield of crops by applying several materials like poultry dung, litter, gunpowder etc. published his work in 46 volumes as' *Annals* ***of Agriculture'.***
- A truly **scientific approach** to farming was started in 1840 by ***Justus von Liebig.***

important **concepts:**

1 Leaf area index:

- **Concept developed by Watson, 1948**
- **LAI =** $\frac{\text{Total leaf area}}{\text{Ground area}}$

2. **Land equivalent ratio** (LER):

- It means the relative land area occupied by a sole crop that is required to produce the yield achieved in intercropping.
- **LER** = $\frac{\text{Yield of inter crop (a + b)}}{\text{Yield of sole crop (a)}}$

here.

- a = Sole crop
- b = Inter crop

- When **LER** > **1:** Intercropping is **beneficial.**
- E.g.- **LER: 1.10** means mixture gives 10% more yield.

3. **Cropping intensity:**

- C.1. = $\frac{\text{Total cropping area}}{\text{Net cultivated area}} \times 100$
- Cropping intensity of India is nearly: 135%.

4. **Crop rotation:**

- In crop rotation **land is fixed but crop is rotated** year after year on **same land.**
- **1.e.** after cultivation of **cereals** should be taken **pulse** crop in next year.
- It **maintains** and **improves** soil **fertility.**
- It checks the soil **erosion** and **conserves** moisture.
- The **incidence** of harmful pathogens, insect -pest, nematode and weeds which is associated with particular crop can be **managed.**

5. **Crop rotation intensity:**

- C.R.I. = $\frac{\text{No. of crop in crop rotation}}{\text{No. of year in crop rotation}} \times 100$
- Crop rotation for **I** year: Rice - Pea (200%).
- Crop rotation for 2 years: Groundnut - Wheat - Sugarcane (150%).

- Crop rotation for 3 years: Paddy - Potato - Sugarcane - Arhar - Wheat (166%).

6. **Cropping system:**
   - It refers to the cropping patterns used on a farm and their interaction with farm resources, associated farm enterprises and the available component technology.
7. **Harvesting index:**
   - The efficient utilization or assimilation of CO_2 in the form of photosynthesis is expressed in terms of harvest index. **H.I.** is also called **coefficient of effectiveness.**
   - $$\text{H.I.} = \frac{\textbf{Economic yield (grain)}}{\textbf{Biological yield (grain + straw)}} \times \mathbf{100}$$
   - Biological yield x K = Economic yield
   - Where K is constant and is expressed as the ***coefficient of effectiveness*** or ***harvest index.***
   - **H.I.** is similar to ***partitioning coefficient.***
8. **Coefficient of effectiveness:**
   - **C. E. = Sink/Source x** 100.
   - ***Source:*** **Parts of the plant where photosynthesis occurs, generally leaves.**
   - ***Sink:*** **Where photosynthesis accumulates,** generally **grain is the sink** but may **be exceptions *viz,* stem in potato, roots** in **sugar beet and leaves in Palak is the *sink.***
9. **Sorghum sickness:**
   - **The stubbles of sorghum takes a long time to decompose due to wide C: N** ratio **hence, during the process of decomposition** soil nitrogen **gets blocked or temporally immobilized, affecting the growth of succeeding crop by showing early nitrogen deficiency symptoms due to wide C/N ratio of** sorghum residue.
   - **To reduce sorghum effect, 25 °A more nitrogen is applied at the time of first fertilizer dose of succeeding crop.**

Dry land agriculture:

- Means cultivation of crops entirely under **Rainfed** condition.

a. **Dry farming:**

- Cultivation of crops in areas where annual rainfall is **less than 750** mm.
- **Crop failure** due to prolonged dry spells during crop period is most common.
- Dry farming is practiced in **arid regions** with the help of moisture **conservation** practices.
- **Alternate land** use system is suggested in this region.

b. **Dry land farming:**

- Cultivation crops in areas where annual rainfall is **more than 750** mm but **less than 1150** mm is called dry land farming.
- The soil moisture conservation measure is the key **for dry land farming** practice in **semi -arid** regions.
- **Drainage** facility may be required especially in **black soils.**

c. **Rainfed farming:**

- Means cultivation of crops in regions where annual rainfall is **more than 1150 mm** is called as **rain fed farming.**
- This farming is practiced in **humid regions.**

SN	Constituent	Dryland farming	Rainfed farming
1	Rainfall (mm)	<800 mm	>800
2	Moisture availability to crop	Shortage, PET > P	Enough, PET< P
3	Growing season	<200 days	>200 days
4	Growing region	Arid, sub arid & sub humid	Humid & sub humid
5	Cropping system	Single or mixed cropping	Double or Intercropping
6	Constraints	Wind & Water erosion	Water erosion

1. **Aiwa -climatic regional planning:**
   - It was initiated in **1988** by the **Planning Commission** under the **Seventh Five Year Plan.**
   - Regional planning was come into force on the basis of agro. climatic factors for balanced regional growth.
   - Planning commission is headed by **Prime Minister** of India.

2. **Agro-climatic zones:**
   - Agro-climatic zones are classified on the basis of criteria of homogeneity in agro-characteristics such as rainfall, temperature, soil, topography, water resources and cropping system.
   - According to planning commission India has been divided into **15 agro-climatic zones.**
   - According to NARP/ICAR India has divided into **131 agro climatic zones.**

a. The trans-gangetic plain zone:
   - It consists of Punjab, Haryana, Union Territories of Delhi *and* Chandigarh and Ganganagar district of Rajasthan.
   - It has highest irrigated area, highest net sown area, high cropping intensity and high ground water utilization.

3. **Agro-ecological region:**
   - Agro-ecological region is the land unit cut out of agro climatic region when superimposed on land form and the kind of soils and soil conditions that act as modifiers to climate and length of growing period.
   - According to **NBSS&LUP** India has been divided into 21 agro ecological zones.
   - According to **ICAR** ago -ecological zones are divided in to 8 zones.

4. **Drought:**
   - As a situation occurring in any area in a year when annual rainfall is less **than 75 %** of the normal is known as drought.

- **When deficiency of rainfall is above 50% of the normal, called severe drought.**

5. Moisture Availability Index (MAI):

- **It is the ratio between rainfalls (weekly/monthly) at 50 % probability level to potential evapotranspiration of the corresponding period.**
- **MM Rainfall at 50 % probability/PET**

6. Evapo-transpiration (ET):

- **Soil moisture is the most limiting factor in dry land agriculture.**
- **About 60-70% of the rainfall is lost through evaporation.**
- **The evapo-transpiration is the evaporation from the soil surface and transpiration from the plant surface.**
- **ET losses can be reduced by use of mulches, antitranspirants and wind breaks.**

a. Anti -transparent:

- **Materials are applied to plant surface to reduce transpiration from the plant.** •
- **Anti -transparent reduce** photosynthesis.
- Hence, their use should be limited to save the crop from death **under severe moisture stress.**
- **They** have **some practical use in nurseries and horticultural crops.**
- **Anti-transparents are mainly four types:**

(i) Stomata closing type:

"
- **They reduce water loss through closing stomata.**
- E.g. Phenyl mercuric acetate **(PMA @ 104), Atrazine** and **C./2** is also an effective anti-transpirant.

(ii) **Film forming:**

- Checks transpiration loss due to **formation of thin film** which **act as physical barrier.**
- E.g. **Mobileaf, hexadecanol, silicone, oils, waxes.**

(iii)Reflecting **type:**

- These chemicals **reflect the radiation** and reduce leaf temperature.
- Application of kaolin @ 5% reduces transpiration losses.

(iv) **Growth retardants:**

- These chemicals **reduce shoot** growth and increase root growth and thus enable the plants to resist drought.
- They also induces **stomata closing e.g. Cycocel (CCC).**

b. Wind breaks and shelterbelts:

- **Wind breaks** are such structures which break the wind flow and **reduce wind speed.**
- **While shelterbelts** are rows of trees or shrubs planted across the wind direction for protection of crop against wind.
- Wind break & shelterbelt provides the protective shelter against desiccating winds to the extent of **5-10 times** the height of tall tree on **windward** side and up to **30 times** on **leeward** side.

7. **Agro-forestry:**

- Agro-forestry is a **sustainable land management** system which increases the use of land **combines** the production of crops, fruits, forest plants and or animals.
- It is also known as tree -crop planting system.

Components of agro forestry:

a. Agri -silviculture: The growing of agricultural crops along with the forest **crops is known as Agri -silviculture.**

- **Agriculture crops + Forest crops (silviculture).**

b. Sylvo-pastoral system: Forests are managed for the production of wood as well as for rearing of domesticated animals.

- **Silviculture + Pasture management.**

c. Agro-sylvo-pastoral system:

- **Apiculture crops + Forest crops + Pasture management.**

d. Agri. Horti- silvicultural system:

- **Agriculture crops + Horticulture Silviculture.**

e. Agri-Silvi-Aquaculture System:

- **Agriculture crops + Forest crop + Fish Production.**

Land capability classification:

- On the basis of capability or limitations, the lands are grouped into **eight** classes by U.S. **Soil conservation service.**
- These classes divided into **two major** groups.

1. **Lands suitable for cultivation:**
   - Such lands have **four** classes.
   - But for the **regular cultivation,** only **first three** classes viz. **I, II,** III are **suitable.**
2. **Land not suitable for cultivation:**
   - **Remaining four** classes are not capable of supporting cultivation of crops.
   - These lands are used, for **growing grasses, forestry** and supporting **wild life.**

a. **Class!:**

It has no limitation, good for **intensive** crop cultivation.

1 Such lands need only **crop management practices** like **fertilizer, manures, crop rotation etc. to maintain their productivity.**

Example of class I soils are alluvial soils of Indo-gangatic plains.

b. **Class H:**

1 **It has some limitations** such as **gentle slope, moderate erosion hazard, slightly alkali or saline conditions which reduce choice of crops.**

I **Hence require moderate conservation tactics like strip** cropping, contour tillage, crop rotation etc.

- **Example: deep red and black soils.**

C. **Class HI:**

- **Have severe limitations like steep slope, high erosion hazard, slow water permeability and restricted root zone**

1 **Fertility status of such soils is poor.**

- **Requiring special conservation measures.**

I **Examples; shallow red soils, slightly saline black soils.**

d. **Class IV:**

Very severe limitations on choice of crops.

- **Suitable for occasional cultivation.**
- **Mainly use for pasture/hay.**
- **Example: shallow soils, saline soils, alkaline soils.**

e. **Class V:**

- **Stony or rocky soils and pond area where drainage is not possible.**
- **Mainly used for grazing and forestry.**

E.g. Arid and rocky soils.

f. **Class VI**

- **Have some limitations on use for grazing/forestry.**

g. **Class VII:**

- **Severe limitation on use for grazing/forestry.**

h. **Class: YUI:**

- **Extremely rough land, not suitable for any kind of crop production.**
- **It is restricted to wild life, aesthetic purpose and watershed protection.**

E.g. Sandy beaches, river washes etc.

Soil conservation measures:

1. **Agronomic measures:**

- **Adopted where slope is less than 2% and erosion problems are not severe.**
- **It includes contour cultivation, tillage, mulching, and strip cropping.**

a. ***Contour cultivation:***

- **Cultivation of crops by sowing (ploughing) across the slope.**
- **It conserves soil, soil fertility and water.**

b. ***Mulching:***

- **Mulch is any material applied on the soil surface to check evaporation and improve soil water.**
- **It is most important tactics to conservation of soil [redacted] and reduce erosion for agriculture in dry rev[redacted]**

- E.g. **Crop residues,** leaves, manures, **polythene films** etc.

c. ***Strip cropping:***

- System of cropping in which long and narrow strips of erosion resisting crops (close growing crops) are alternated with strips of erosion permitting crops.

2. **Mechanical measures:**

- Adopted to supplement the agronomical practices and when land slope is **more than 2 %.**
- It includes following practices.

a. ***Contour bunding:***

- Contour bunding is adopted up to **6% slope** of land and used in **arid and semi arid** areas with high infiltration and permeability.

b. ***Graded bunding:***

- Recommended in areas receiving rainfall of **more than 800 mm per year.**
- In general **bunding** is suitable for lands having slopes from **2-10 %**
- **Contour** and **graded** bunding are mostly used in India.

c. ***Sub -soiling:***

- Breaking of hardpan of soil by the sub soiler at 30-60 cm depth and 90-180 cm interval.

d. ***Broad Bed and furrow*** **(BBF)** system:

- Suitable for managing rainwater in **deep black soils** where surface drainage during the monsoon period is a problem.

e. ***Bench terracing:***

- Adopted in lands where slope ranging from **16-33%** on steep slopping and undulating land.

f. ***Zing terracing:***

- Adopted in lands with ***3* -10 %** slopes.
- Zing terraces are constructed in medium to **deep soils in** moderate to high rainfall areas.

g. ***Vegetative barriers:***

- These are closely spaced plantations, usually a few rows of grasses or shrubs grown along contours fro erosion control.
- Khus *(veniveria zelanica)* is the most suitable plant for this purpose.

h. ***Vertical mulching:***

- Digging narrow trenches across the slope at intervals and placing the straw or crop residues in these trenches.
- It is mostly practiced in **coffee gardens.**

Unit -5

CLIMATE

Weather: a sate or condition of atmosphere at a given place and at a given time.

Atmosphere:

,4 It is a colourless, tasteless and odourless mixture of gases that surround the earth.

'7 It extends up to a height of about ***1600 km.***
However 99 per cent of total mass of the atmosphere is within 40 km from the earth.

Structure of atmosphere: Based on ***vertical temperature differences***

I. Troposphere:

- It is the lower layer of atmosphere
- Extending up to a height of 8 to 18 km from the earth surface. ***(RPSC, AA0-09).***
- **Temperature decreases** with increase in altitude at the rate of **6 'V /km.**
- It influences **earth climate.**
- It is dense part of atmosphere, contains **85 per cent** of the atmosphere's mass.
- All weather phenomena like clouds, rain, mist, fog, dew **etc. occur in** troposphere. ***(JAR!, Ph. D -09)***

2. Stratosphere:

- **It lies beyond the height of 8 to 18 km extending up to 50 km.**
- **Warmest layer, Uniform temperature with altitude.**

- **It** is the actual seat of most of the photochemical reactions in air.
- Presence of ***Ozone layer,*** hence also called ***ozonosphere***

3. **Mesosphere:**
   - It lies above the stratosphere; a height of **50 km** extending up to **80 km** from the earth surface.
   - Cold region.
   - Strong decrease in temperature with increase in altitude

4. **Thermosphere:**
   - **It** is the outermost layer called ***exosphere.***
   - From earth surface extending a height of 80 km up to 1600 km.
   - The lower layer of thermosphere is called ***ionosphere.***
   - Long distance radio communication is made possible through this ionized layer.
   - Temperature **increase** with altitude.

I. **Composition of atmospheric air:**

Gases	**Volume %**
Nitrogen	78.08
Oxygen	20.95
Argon	**0.93 *(RPSC, AA 0-09)***
Carbon dioxide	0.03

2. **Composition of soil air:**
   - **Nitrogen percentage is more or** less **same as in atmosphere.**
   - **Oxygen levels decrease as compared to atmosphere.**
   - **CO_2 levels** will be nearly **8-10 times more** (0.25%) as compare to atmosphere.

Solar constant:

- Defined as the energy falling in one minute on a surface area of one square centimeter at the outer boundary of the atmosphere, held normal to the sunlight, at the mean distance of the earth from the sun.

- Solar constant value is: 1.94 cal/cm2/min or SI unit is: 1353 Watts/m2
- The solar radiation is received in the form of electromagnetic waves/particles are called *quanta* or *photons*.

PAR (photo synthetic active radiation):

- photosynthesis in green leaves use solar energy in wavelengths from 0.4 to 0.7 um
- Or the radiation 400-700 nm is most active in photosynthesis.
- Measured by Quantum sensor.
- Unit *Einstein* or Watt/m2
- *Lux:* is the oldest unit to measures intensity of solar radiation.
- *Spectrometer* measures solar radiation in narrow wave bands.

Lapse rate:

- The vertical temperature decrease or gradient is expressed as *lapse rate.*
- Normally lapse rate is 6.5 °C/km.

Adiabatic lapse rate:

- The rate at which the temperature changes as air rises or falls is called *adiabatic lapse* rate:
- Dry adiabatic lapse rate: 10 °C/km
- The condition in which there is abrupt rise instead of fall in temperature is called *inversion.*

Albedo

- It's the ratio between incoming and outgoing radiations.
- It is the percentage of the incident solar radiation reflected by a surface is known as *Albedo.*
- Albedo of the surface is equal to 0.4

Cyclone:

- A cyclone is a roughly circular low pressure area whose diameter may be from hundred to a thousand miles. Atmospheric pressure is always lowest in the center of this region and increases rapidly outward e.g. *Tornado, Typhons, Herr ikens etc.*

Climate:

- Climate is a generalized weather or **summation of weather condition** over a given region during a comparatively longer period.

Classification of climate:

a. **De CandoIle** (1900 AD):

- The first person to attempt the classification of climate **based on vegetation.**

b. **Koppen** (1936):

- Divided the world climate into 5 **groups,** based on **weather elements.**

c. **Troll (1965):**

- This classification has been found satisfactory to explain vegetation zones of tropical **Africa & S. America.**
- This classification is suitable for agricultural purpose
- The **ICRISAT** (Hyderabad) adopted this method for classifying semi arid tropics in **India.**

d. **Thornthwaite:**

- Based on PE index, TE & Season distribution of rainfall

- PE index = P/E x 100

Where,

- PE = Precipitation of effectiveness
- P = Annual precipitation.
- E = Annual evaporation.

e. **Moisture Deficit Index (MDI):**

- AICRP on dry land (ICAR) adopted classification based on MDI.
- MDI = P-PET/PET x 100

Types **of climate**	**MDI values**
Sub humid	0 to 33.3
Semi arid	-33.3 to -66.6
Arid	> **- 66.6**

Measures of humidity:

- Humidity means water vapor content of the atmosphere.

a. **Relative humidity:**

- $$\textbf{RH} = \frac{\text{Water vapor present in the air}}{\text{Water vapor required for saturation}} \textbf{ x100}$$

- Relative humidity is expressed in: **Percentage (%)**
- Mostly useful for agriculture.

b. **Absolute humidity:**

- Unit of absolute humidity is: ***g/m3***

c. **Specific humidity:**

- Unit of specific humidity is: **WIT.**

Forms of precipitation:

- **Rain:** Drops of > 0.5 to 6 mm
- **Drizzle:** Drops of < 0.5 mm
- **Snow:** Ice crystal resulting from sublimation
- **Dew:** Moisture condensed in small drops upon cool surface
- **Frost:** A feathery deposit of ice
- **Fog:** A thin cloud of varying size
- **Mist:** **A** very thin fog
- **Vapor:** Water vapor in the atmosphere constitutes only about 0.001 per cent of the total global water.

Measurement of temperature:

a. Celsius: in Celsius scale, the melting and boiling point of water are **0** and **100 °C** respectively.

- C = **(F-32) 5/9**

b. **Fahrenheit:** in Fahrenheit scale, the melting and boiling point of water are **32** and **210 °F**

- **F = C (9/5) + 32**

c. **Kelvin:** ***absolute temperature*** is measured in Kelvin units.

- When there is no activity of molecules of substances, then it is said to be at **0 °K.**

- **The melting point of water in Kelvin scale is 273 °K**
- **K = C + 273.**

Instruments:

a. **Maximum thermometer: It is used to measure the highest temperature attained during the day. It consists of hollow glass tube filled with *mercury*.**

b. ***Minimum* thermometer: It is used to measure lowest temperature. It consists of a glass tube with *alcohol* in bulb.**

c. **Soil thermometer: It is a mercury thermometer with a *bend* at the bulb end.**

d. **Thermo -couples: these are used for measuring soil temperature and they are two types, viz., *thermo-electric* and *resistance*.**

Phenomenons:

- **Contour: Lines joining equal *elevations*.**
- **Isopleths: Line joining uniform values of any *phenomena*.**
- **Isobar: Imaginary lines connecting points of equal *atmospheric pressures*.**
- **Isohyets: Lines of connecting points of equal *amounts of rainfall*.**
- **Isobaths: Imaginary lines connecting points of equal *water table elevations*.**
- **Isohels:Lines connecting points of equal *sunshine hours*.**
- **Isophene: Lines connecting points of similar *seasonal phenomenon*.**
- **Isotherm: Lines connecting points of equal *temperature*.**
- **Isotope: Elements having equal *number of neutrons*.**
- **Isopluvial: Lines joining equal *depth of rainfall*.**
- **Isotech: Lines connecting points of equal *wind velocities*.**
- **Isostere: Lines connecting points of constant *moisture contents*.**
- **Isodemic: Lines which join the places of similar *disease severity*.**

- **Isoclines: A curve connecting the *least cost combinations of input for all output.***

Instruments and their use:

Instrument	Uses
Altimeter	Height
Aneroid barometer	Atmospheric pressure
Anemometer	Wind speed
Crescograph	Growth of plant
Dynamometer	Convert mechanical energy to electrical
Ca mbel stokes	Duration of sun shine
ECG	Movement of heart
Wind wane	Wind direction
Tensiometers	Soil moisture tension
Galvanometer	Electric currents
Porometer	Stomal behavior
Hydrometer	Measures relative density of liquids
Hygrometer/Psychrometer	Relative humidity
Lactometer	Density of milk, milk purity
Lysimeter	Evapotranspiration/leaching
Manometer	Root pressure
Planimeter	Area of an irregular figure
Pyrheliometer	Amount of direct solar radiation
Pyranometer	Total incoming solar radiation
Pycnometer	Specific gravity of soil
Peizometer	Depth of water table
Potometer	Transpiration

Classification of irrigation projects:

Project	CCA (ha)	Cost (Rs).
Major	>10,000	> 50 Crores
Medium	2000-10,090	5 Crores to 25 Lacs
Minor	< 2000	< 25 Lacs

Monsoon:

- The word monsoon has originated from the Arabic ***term* which** means "Season".
- India is situated in the north-east trade wind zone and these trade winds continue throughout the year
- Total amount of precipitation in Country is: **1194 mm.**
- Or total rainfall generated volume in India is: **400 mha-m**
- Average rainy days in country: **130 days/year.**
- **Rainy day: >** 2.5 mm rains during 24 hours called rainy day

1. **The South -West monsoon:**
   - S. W. monsoon reach south India (in Kerala) around **1st June** of every year
   - It moves at average speed ***30 km/hour***
   - It's called as **'Grand period'** of rainfall in India.
   - It contributes around > **75** % of total rainfall in India.

South-West monsoon has two branches:

a. **Arabian Sea branch:**
   - Contributes 770 mm/ 80 % of SW monsoon.
   - This moves northward (in **Delhi).**

b. **Bay of Bengal:**
   - Contributes 340 mm/about 20 % of SW monsoon.
   - This move up to **Assam.**

2. **The North-east monsoon:**
   - North -east monsoon is limited mostly to southern states **(AP & TN).**
   - This monsoon is also known as **retreating monsoon.**
   - It contributes about **15** °A of total rainfall in India
   - **EL Nino** is a phenomenon that leads to rise in the ocean temperatures and consequent **dry weather and drought.**

   River which utilize maximum flow: **Ganga**

Artificial rain making/Cloud seeding:

- Application of foreign material to clouds to induce precipitation is called cloud seeding.

a. ***Cold seeding:*** Silver iodide (AgI) or dry ice is applied at one nuclei for a liter of clo- ' air. In dynamic cloud seeding, massive quantities of lOr 1000 nuclei for a liter of cloud air are applied.

b. ***Warm clouds:*** Generally used Sodium chloride (Nacl).

Weather forecasting:

- Short range: < **3 days** or up to 72 hrs
- Medium range: 3 -10 days
- Long range: > **10 days**
- The long range forecasts are issued thrice in a year and are useful for choosing cropping patterns.
- Synoptic method of forecasting is used for short range forecasts.
- **NC-MRWF:** National Center for Medium Range Weather Forecasting, **New Delhi.**

Properties of water:

1 Latent heat of vaporization: **580 CaUg at 100 °C**

•(**Heat** of fusion is: **80 CaUg.**

1 Highest density of water at: **4 "C**

1 Water expands on freezing: **9% by volume.**

1 Dielectric constant of water is: **- 80**

1 Heat of sublimation is: **620 CaUg.**

1 Water has highest **specific heat 1 CaUg** of any known substances **except liquid ammonia** i.e. 1.03 cal/g.

Water logging:

- A situation where all the pores both macro and micro are filled with water temporarily or permanently.

Demerit of water logging:

1 Reduces **ODR** (oxygen diffusion rate).
Reduce **Eh:** Eh of **well aerated** soil is: **400-700my**

st **Eh of waterlogged soil:** **-250** to **-300 my**

- **Denitrification loss** more in waterlogged soils.

In submerged rice SO_4 are reduced to sulphide that is further reduced to H_2S that causes **"Alciochi"** in rice due to toxicity of H_2S.

Approaches of irrigation scheduling:

a. **Transpiration ratio** approach:

- Amount of water transpired by a crop to produce unit amount of dry matter.
- This is also known as **absolute approach.**

b. **Soil moisture deficit approach:**

- **For maize & wheat 25%** depletion of available soil moisture.
- **For drought resistant** crops **50%** depletion of available soil moisture.

c. **Clinfatologically** approach or **IW/CPE** approach:

- Known as soil **moisture index approach.**
- The ratio IW/CPE serve as soil moisture stress index.
- Lower the ratio will be more stress.
- It is scientific approach but not practical utility.

d. **Critical stage approach:**

- The state of growth when plants are most sensitive to shortage of water and most responsive to correction of deficiency.

Crop	**Critical stage**	**IW/CPE ratio**
Rice	Panicle initiation, flowering	**1.2** (highest)
Wheat	**CRI,** jointing, milking	0.9
Maize	**Tasseling,** silking	0.9
Cotton	Flowering, boll formation	0.7
Gram	**Pre -flowering,** pod development	0.6
Groundnut	Flowering, **pegging,** pod filling	0.6
Pigeon pea	Flower initiation, **pod formation**	0.6
Safflower	Flower initiation	v0.4 (lowest)

Percentage irrigated and water requirement of Major field crops:

Crop	% irrigated area.	Water requirement (mm)
Sugarcane	93%	1500-2500
Wheat	**85%**	650-800
Rice	50%	1500
Oil seed	25%	500-700
Pulses	10%.	450-700

Measurement of irrigation water:

- 1 Cusec: **28.3 litres**
- 1 Cumec: 1000 litres or 103
- 1 ha mm: 10, 000 litres or 104
- 1 ha cm: 100, 000 lit. or **105**
- 1 ha m: 100, 000, 00 lit. or **107**

Measures of water height:

- **1 Atmosphere** = 1036 cm of water
- **1 Bar** = 1023 cm of water

Conversion units of:

- One acre = 0.405 **ha**
- One ha = 2.47 **acre.**

Ploughing is classified (according to **CRIDA,** Hyderabad 1985) as:

Type	**Depth (in cm)**
Shallow	5- 6
Medium	15-20
Deep	**25-30**

Watershed management:

- It may be a **natural unit of land** whose runoff collects and flows out of the area through a single common outlet in to a river or other water body.

Irrigation

Irrigation is the artificial application of water to partially meet the crop evopo-transpiration requirement.

Irrigation methods:

I. Surface irrigation:

- **Most common method of irrigation in India.**
- **It includes following methods.**

a. Flood irrigation:

- **Water is applied to the crop by flooding it on the soil surface.**
- **This method is practiced where irrigation water is abundant.**
- **Mostly adopted in wetland rice.**
- **Useful in uniform surface soils with good water holding capacity.**

b. Check -basin:

- **Most common among surface methods, suitable for close growing crops e.g. wheat, groundnut, pearl millet etc.**
- **It consists in running water in to relatively level basins surrounded by small ridges.**
- **Field with slope up to three per cent can be irrigated by using this method.**
- **A limitation of this method is that it has too many ridges which occupy large area of land.**

c. Ring basin:

- **Suitable for fruit crops**

d. Border strip method:

- **In this method the field is divided into number of strips, which are separated by ridges.**
- **Soils with a slope of 0.5-1% is suitable for this method.**
- **Field with slope up to seven percent can be irrigated when pasture crops are grown.**
- **Suitable for *all close growing crops* on medium to heavy texture soils**
- **But not suitable for sandy soil**

e. **Furrow** method:

- This method is generally used to irrigate row crops and vegetables and is suited to soils in which infiltration rates are between 0.5-2.5 cm/hour.
- It is ideal for slopes varying from 0.2-0.5 % and a stream size of 1-21/second.
- The length of furrows may vary from 30 m for sandy soils at lesser slope to 300m for heavy soils at greater slope.
- Furrow irrigation is suitable to most type of soils except sands that have a very high infiltration rate.
- Furrows are mostly suitable for root and tuber crops

f. **Corrugation:**

- Small and shallow furrow are known as corrugation, suitable for close growing crops like wheat, ground nut etc.

g. Surge irrigation:

- **The term" Surge irrigation" is the intermittent application of water to the field surface under gravity flow which results in a series of ON & OFF modes of constant or variable time span.**
- **This process of ON- OFF water supply and cut off results in minimized deep percolation and runoff losses (hardly exceeding 20%).**
- **Surge irrigation systems do not show marked differences** in **land and water saving in extremely clay or sandy soils hence, not popular in India.**

h. Cab legation:

- **It's an automatic method of surface irrigation.**

2. **Sub -surface or sub soil irrigation system:**

- **Water is applied into a series of field ditches through underground pipe lines, generally followed in Western Countries.**
- **This method is practiced in Kerala for coconut, garden and in Gujarat and Kashmir on sandy loam soi] for vegetables.**
- **Drip system can be used in sub $urface method.**

3. Sprinklers:

- **Water is applied with pressure to the surface of any crop or soil in the form of a thin spray, somewhat resembling rainfall.**
- **This system consists of sprinkler heads or nozzles, which are mounted on risers in lateral lines taken from main line, which is further connected to a pumping unit.**
- **The rate of spray of water can be regulated and natural rainfall can be simulated.**
- **Sprinkler irrigation can be used for all most all crops, (except rice and jute) and on most soils (except heavy clay soils).**
- **It is especially suited for fields with steep slopes or irregular topography.**
- **If soil erosion is a hazard, it can be used in conjunction with contour bunding, terracing, mulching and strip cropping.**

Advantages of sprinkler irrigation:

- Suitable for **undulating topography** and **sandy soils.**
- **Saving** of water from **25-50%** for different crops
- Discharge rate is more than **1000 lit/hr.**
- Sprinkler pressure **2.5-4.5 kg/cm2.**
- Water use efficiency can be as high as 60 % much higher to surface method of irrigation.
- Increase 40 % in irrigated area with same amount of water as compared with surface method of irrigation.
- About 40-60 % saving in labour compared with surface.
- It can be used to protect crops against frost and high temperatures.

4. Drip irrigation:

- Introduced from **Israel.**
- Drip or trickle irrigation is one of the latest methods of irrigation which is becoming increasingly popular in areas with **water scarcity** and **salt problems.**
- This irrigation is defined as the precise but slow application of water as discrete drops or continuous drops through

mechanical devices, called emitters located at selected points along water delivering lines.

- This system involves the slow application of water, drop by drop to the root zone of a crop.
- In this method water is used very economically, since losses due to deep percolation and surface evaporation are reducing to the minimum.
- Drip irrigation is best suited in water scarcity area where water quality is marginal, topography is undulating or steep, 'soil depth is restricted, labour is expensive and crop value is high.

Advantages of drip irrigation:

- Suitable for water scarcity area water saving 50-70% as compare to surface.
- Fertilizer or other chemical amendment can be efficiently applied to individual or separate plants.
- Discharge rate of water per dripper is generally 1- 4 lit/hr at 2.5 kg/cm2 pressure.
- Fertilizers (Fertigation) and herbicides (Herbigation) also possible to apply with drip.
- Most suitable for widely spaced crops, orchard trees and in green houses (protected cultivation of vegetables & flowers).

5. **Typhoon system of drip irrigation:**
    - In sugarcane modified drip, in this method a particular water depth maintained at a particular growth stage.

Drainage: Agricultural drainage is the removal of excess water known as free water or gravitational water from the surface or below the surface of the farm land so as to create favorable soil conditions for plant growth.

Drainage methods: 1. Surface drainage 2. Sill) surface drainage.

1. **Surface drainage:**
    - Simplest and cheapest
    - Most common in India by digginCopen drains at suitable intervals and depth

a. **Drainage_of flat areas:**

- **Where slope less than 2%**
- Used for flat areas.

b. **Broad bed and furrow system (BBF):**

- Field is laid out into **120-150 cm** width beds and **45 cm** wide furrows across the slope.
- About **0.5 %** slope is provided for free drainage.
- Crops are sowed on beds having two or more than two rows each. The beds are **15 cm** raised.
- BBF methods are widely practiced in **groundnut (clay soil).**

2. **Sub -surface drainage:**

- Purpose is to lower down the ground water level **below root zone.**

Sub -surface drainage is includes:

a. **Tile drains:** Including **perforated pipes.**

b. **Mole** drainage: Suitable for **clay** soil.

c. **Vertical** drainage: Drainage **by digging wells** is called vertical drainage . This practiced in coffee gardens.

Methods of water measurements:

I. Orifices:

- To measure water in comparatively small streams like flow into border stripes furrows/ check basin.

2. **Weirs:**

- Used to measure the flow in an irrigation channel or the discharge of a **channel** outlet at the source.
- Basic equation for discharge through weir is: Q = **CLIP'**
- Discharge relationship for suppressed weirs is = **0.0184 LH3/2**

900 -V" notch weir: is an excellent device for measuring small flows. The discharge maybe computed using the formula.

- **Q = 0.0138 H25**

3. **Parshall flume** (venture flume):

, • Combination of weir and the submerged orifice

- Can be used even in relatively shallow channels like irrigation furrows with flat grades.

Soil moisture constants

Metric potential:

- The total water potential that is attributed to the solid colloidal matrix of the soil system

Capillary potential:

- The energy with which water is held by soil is defined in terms of capillary potential.

Seepage:

- Horizontal flow of water channel is called seepage.
- Water loss from the irrigation channel or canal is mainly due to seepage.

Percolation:

- Down ward movement of water through saturated or nearly **saturated soil** in response to the gravity.

Infiltration:

- Entry of water from the upper layer of soil is called infiltration.
- It occurs in **unsaturated soil.**

Leaching:

- Downward movement of nutrients and salts from the root zone with the water is called leaching.

Saturation capacity:

- When all the soil pores are filled with water at a tension of zero **"o"** bars is termed as saturation capacity.

Field capacity:

- **The** soil moisture content after 2-3 days of irrigation and after drainage of gravitational water has become very slow and soil moisture content had become relatively stable.
- At the field capacity, the large pores filled with air and the micro pores are filled with water.

- It is considered as the **upper limit** of water availability to plants.
- The tension at field capacity ranges from **-0.1 to —0.33** (1/3)
- It is determined with the help of **pressure plate apparatus.**

PWP:

- The concept permanent wilting point (PWP) proposed by **Briggs and Shantz** in 1912.
- They utilized dwarf **sunflower** as an indicator plant.
- Soil moisture content at which plants can be no longer obtains enough moisture to meet their requirement and remained unless water is added to the soil.
- It is the **lower limit** of available water to plant.
- Although plants not dead, but they are now in a permanently wilted condition and die if water is not added.
- Soil moisture tension is **-15 bars**

Wilting coefficient:

- The percentage of moisture in root zone at the **permanent wilting** of plants is called the wilting coefficient or critical moisture point.

Available water:

- Concept of available water given by **Veihmayer and Hendrickson** 1981
- It is the portion of capillary water held between **Field Capacity** to **PWP** (i.e. - 0.3 to -15 bars).

Ultimate wilting point:

- The moisture content at which **wilting is complete** and the **plant die** is called **UWP.**
- At **UWP** the soil moisture tension is as high as **-60 bars.**

pH: the term pH given by **SPL Sorenson** (1909):

- Defined as the negative logarithm of hydrogen ion activity.
- Log 1/ (Fr)
- Range: **0-14**
  Acidic: < 7
  Neutral: 7

Basic: > 7

PF Value: it is defined by **Schoefild** (1935).

- The logarithm of centimeter height of a water column to give the necessary suction.
- Expressed in **centimeter** of water (based on the height of a water column above free water level in cm).

Soil condition	**PF values**	**Pressure (atm/bars)**
Saturated soil:		0.001
Field capacity:	**2.53**	**1/3**
PWP:	**4.18**	**15**
Hygroscopic point	4.50	31"
Oven dry soil:	7.0	10000

PE given by **Silen:**

- **It** is negative logarithm of electron activity.
- PE= **Eh/0.0591**
- **It** measure intensity of **oxidation-reduction.**

Measurement of soil moisture:

- **Indirect method** (on the basis of tension):

a. **Tensiometer/irrometer:**

- **Tensiometers** ale sensitive up to **0.85 bar of soil moisture**
- Suitable for **sandy** soil in which most of the available water **below 1 bar** tension.
- **Not suitable for clay** soil.
- Tensiometers are vrAN7 useful in scheduling irrigation to **frequently** irrigated crop.

b. **Electrical resistance/bouyoueous** moisture meter/gypsum **block:**

- Based on conductivity of electricity low resistance at field capacity and high at **PWP**
- Gypsum block perform satisfactory measurement in ***dry soil***
- **Not suitable for saline** soil as salt in soil increase conductivity.

- It is used for measuring soil moisture tension up to **0-15 bar** and for scheduling irrigation of crops of delayed intervals.

C. **Neutron moisture meter:**

- Rapid method used for **Field** or **in situ** measurement of soil moisture from large volume of soil based on the measurement of number of 1-1+ nuclei present in a unit volume of soil.
- This is **best method** at present available for quantities estimation of changes in soil moisture. ***(ARS-05)***

4. **Pressure member and pressure plate apparatus:**

- Used for laboratory measurement of soil moisture potential.
- Generally used for estimating FC, PWP and moisture content at different pressures.
- Suitable for measuring soil moisture tension: 0-15 bar.

Soil **moisture characteristic curve:**

- **A curve** showing relationship between the energy statuses of water i.e. tension and amount of moisture in soil.

Soil moisture characteristic curve:

- For sandy soils= **L** shaped
- For clay soils= **I shaped** (almost a straight line).

ET (evapo-transpiration):

- Total amount of water lost due to transpiration by crop and evaporation from the soil surface during a specified time from a particular area.
- Evapo-transpiration constitutes nearly **99 %** of the total water uptake.

PET (potential evapo-transpiration):

- Concept of PE9twas given by **Thornthwaite (1948)**
- the ET occurs 4ihen the ground is fully or completely covered by actively growing vegetation and no limitation of soil moisture.
- ' PET is **the upper limit** of ET for a crop in a given climate.

Measurement of ET:

a. Lysimeter:

. ;

- It consists growing of crops in large containers installed in a crop field measuring their water loss and gains.
- Leaching losses can also be measured by lysimeters.

b. **Soil moisture depletion studies:**

- Depletion (D) = FC-PWP x D. Db.

Where,
FC = Field capacity, PWP = Permanent wilting potential
D = Depth, Db = Bulk density.

c. ET can **be measured by evaporation data:**

(i) USWB class "A" open pan evaporimeter:

- **It** is standard evaporimeter most widely used by agro-meteorological observatories.
- It having diameter of **120** cm with a depth of 25 cm and it filled with water up to 20 cm
- It is painted **white.** Evaporation is expressed as mm/day

(ii) **Sunken** screen evaporimeter:

- Developed by Sharma and **Dastane,** 1968
- It is used to measure evaporation (ET) under field conditions.
- It is determination of PET/ET ratio which according to them varies from 0.95 to **1.05.**

(iii)Portable **evaporimeter:**

- It was developed in Israel in 1984 to measure evaporation for ***very short periods.***

Consumptive use of water:

- **It** is used to designate the losses due to evapo-transpiration and the water used by the plant for its metabolic activities.
- CU = ET + Water used in metabolic activities.
- About **99** percent of water loss in plant due to evapo-transpiration, only 1 % of water is used in actual metabolic process.

Estimation of PET/ET:

a. **Penman method:**

inglatatatimmui,.4

- Developed by penman, 1950 for estimating evaporation from free water surface,
- It is most accurate estimation of ETo.
- As it utilize all meteorological parameter responsible for ET.

b. Water use efficiency (WUE):

- **It** is the yield of a marketable crop produced per unit of water used in evapo-trt.nspiration. **OR**
- WUE = The dry matter produced per unit of water used and it expressed as kg/ha-mm.
- Water use efficiency of are **two types:**

(i) Crop water use efficiency:

- **It** is the ratio of crop yield (y) to the amount of water depleted by the crop in the process of evapo-transpiration (ET).
- WUE (Crop) = **Y/ET**

(ii) **Field water use efficiency:**

- It is the ratio of crop yield (y) to the total amount of water used in the field (WR).
- WUE (Field) = **Y/VVR**

Water use efficiency of major field crops:

S.N	Crop	WUE (kg/ha mm)
1	Finger millet	**13.4**
2	Wheat	12.6
3	Groundnut	9.2
4	Sorghum	9.0
5	Pear millet, maize	8.0
6	Rice	**3.7** (lowest)

Terms

Terms	**Crop**
Curing:	Tobacco, tea
Stripping:	Jute
Nipping:	Gram, cotton
Wrapping:	Sugarcane
Propping:	Banana
Trashing:	Sugarcane

Oil percentage in field crops:

Crop	**Oil (%)**
Coconut:	60
Sesame:	46-52
Ground nut:	44-50
Castor:	35-58
Safflower:	24-36
Rape seed and mustard:	33
Soybean:	20

Protein content in cereals:

- Rice: 6-7% Wheat: **11-12% (Gluten'** protein)
- Maize: **10%** Sorghum: **10-12%**
- Bajra: **11-12%** **Barley: 11.5% (Albuminoids)**

Protein content in pulses:

- Gram: **21.1%** Lentil: 25%
- Pea: 22.5% Arhar: 21-25%
- Moong: 25% Urd: 24%
- Cow pea: 23.4% (Known as vegetable **meat).**

Protein content in oilseeds:

- Soybean: 42% Groundnut: 26%
- Sesame: **18-20%** Linseed: 36%
- Safflower: 40-45%

Classification of crop based on families:

1. Graminae (Poaceae): **Cereals, napier grass.**
2. Leguminaceae (Papilionaceae): Pulses,groundnut, **sunhemp.**
3. Solanaceae: Brinjal, tomato, potato, chilies, **tobacco.**
4. Cruciferae (Brassicaceae): Mustard, **radish,** cabbage, **cauliflower.**
5. Cucurbitaceae: **All gourds,** cucumber, **pumpkin.**
6. Malvaceae: Cotton, **bhindi.**
7. Asteraceae: Sunflower, safflower, niger.
8. Chenopodiaceae: **Spinach,** beet, sugar beet.
9. Euphorbiaceae: Castor, topica.

to. Convolvulaceae: Sweet potato.

11. Umbelliferae: Coriander, cumin, carrot.
12. Aliaceae: Onion, garlic
13. Zingiberaceae: Ginger, turmeric.

Cron Production

1. Padth (*Oryza staira*): 2n =24

V Rice is the stable food of **more than 60%** world population and most of the people of S.E. Asia, about **90%** of rice grown in the world is produced and consumed in **Asia.**
it is a crop which is grown in wet tropical climate and also grown in humid regions of subtropics.

1 In India, rice occupies the first position among the cereals in respect of both area and production. Rice contains less protein **6-7** % and contains 2-2.5 % fat which is lost during milling.

•7 **Hulling** percent in rice is **66%** or **2/3** of paddy.

1 In general cereal crops required about **400-500 liters** of water for the production of one kg of plant dry matter.

1 But rice consumed ten times more water **i.e. 5000** liters of water to produced 1 kg rice grain.(0BC, ***Bank -09)***

1 In rice field to prevent **denitrification** and **leaching** losses N-fertilizer should be incorporated in **reduced zone** so that the process of nitrification is delayed.

1 Rice field submergence in 5cm deep water during the reproductive and grain formation stages is beneficial. (NET -2001)

1 Rice grain relatively rich in ***lysine*** which is 4 % of total protein fraction.
The main protein in rice is: ***Oryzenin***

•./ **Propanil (Stam F-34)** is the most widely used post emergence herbicide in **rice.**

Area & Distribution:

- Area: **India** > China > Indonesia
- Production: **China** > India > Indonesia
- Productivity: **USA** > Japan > China

In India:

- Area: **West Bengal >** UP > Bihar
- Production: **West Bengal** > UP > Andhra Pradesh

- Productivity: **Punjab** (34 q/ha).

Classification:

Genus ***Oryza*** have **24** species out of which two are cultivated.

1. ***Oryza saliva,*** Diploid, **2n=24,** it has three main geographic races.
   a. **Indica-grown throughout** tropics and sub -tropics in India and characterized by **tall** stature, weak stem, and droopy leaves and **irresponsive** to high input conditions, low productivity.
   b. **Japonica:** grown in temperate and sub -tropical regions of **Japan** and characterized by **short** stature sturdy stem, narrow erect & dark leaves and **responsive** to intensive input condition having highest productivity, grain shape short.
   c. **Javanica/Balu rice:** Grown in **Indonesia,** few tillers, **wild form** of rice, has many awns.
2. ***Oryza glaberrima:*** it is grown in **West Africa** only.

Origin: Indo-Burma region.

Rice is **self pollinated** crop, fruit type is ***caryopsis.***

The grain or caryopsis is tightly enclosed by the **lema** and **palea** called the ***hull.***

Test weight (wt. of **1000 grains)** is = **25g**

,1 Rice stem is commonly called the ***haulm*** or *cu/m*.

Inflorescence is **panicle** which is a group of spikelet.

Climate: C3, short day plant and required hot & humid climate.

Soil: clay and **clay loam.** Most suitable pH range is between 5.5 and **6.5.**

Rice is semi aquatic plant grown best under submerged condition, under these conditions the atmosphere oxygen is transported by **aerenchymatous tissues of leaves.**

Seasons:

- **Aus: Sowing time April -May.**
- **Aman** (Kharif): Sowing time **June -July.**
- **Boro** (spring): Sowing time **November - December.**
- In North West part of country only **kharif** crop is taken.

Varieties:

- First dwarf variety of rice developed in world is ***TN-/* in Taiwan in 1964-65.**
- First high yielding dwarf variety developed in world is **IR-8,** by cross between ***Dee -Gee -Woo -Gen x Peta.*** it was the first known variety to be released by International Rice Research Institute in **1966.**
- Literally meaning of Dee-gee-woo-gen is: ***Brown tipped short legged.***
- **In 1964,** the introduction of **Taichung Native 1** (TN- l) in India signaled a new era in the improvement of rice yield.
- It was followed by the **introduction of IR 8** in India from The IRRI, Manila (Philippines) **in 1965.**
- First Indian high yielding earliest semi -dwarf variety ***Jaya*** released in **1968,** evolved by **Dr. Shastry,** and it's a cross between ***TN-I x Type 141.*** It's out yielded **TN-1 & IR-8 both; hence called *'Miracle rice in India'*.**
- **Cuttack (odissa) evolved two** varieties: ***Malinga & Mahsuri***
- Mutant variety of rice: ***Jaganath* and *Sattari.***
- Variety suitable for direct **seeding: *Bala***
- BLB (bacterial leaf blight) tolerant: ***TKM-6***
- Salinity tolerant: ***IR-8, Lunishree***
- Suitable for waterlogged *area:* ***Jalmagna***
- First hybrid of basmati **in world: *PRH-10.***
- First hybrid of rice in India is: ***CORH-1 (1994)***
- Variety released from **IARI:** ***Norin-8, 18, pusa 2-21*** *and basmati-370, Pankaj, IR-20.*
- **Pusa Basmati-1: Its** world's **first** high yielding dwarf variety **under quality rice has been** developed by IARI through **convergent breeding.**

Seed rate:

- **Broadcasting:** 100 kg/ha
- Drilling: 60 kg/ha
- Hybrid rice: 15 kg/ha
- **Dapog method:** [illegible]

- 50 hills per m2sufficient to assure adequate population in rice field.

Fertilizer management:

- NPK ratio 100:60:60 is generally recommended in rice for high yielding varieties.
- The water logged puddle soil develops two zones; the upper zone (1 to 10 mm), a thin surface layer which contains oxygen is called *"oxidized zone"* and immediately below the oxidized layer lies a reduced layer which contains no oxygen is called *"reduced zone"*. (RPSC,AA0-2012)
- Use of nitrate fertilizer in paddy field should be avoided due to more susceptibility to loss of nitrogen through leaching and denitrification.
- Hence, the deep placement of the ammonical form of nitrogenous fertilizers in the reduced zone has been proved to be efficient method of nitrogen application than other methods.
- Nitrogen use efficiency in rice: 30-40%.

Biological Nitrogen Fixation:

- It has been estimated that the total nitrogen requireffient of rice could be brought down by about 25-30 per cent through biofertilizer (algae).
- In addition to blue green alagae (BGA), the association of the water fern Azolla with the blue green algae *Annabaena azollae* also helps in biological nitrogen fixation.
- Azatobaeter, a non -symbiotic nitrogen fixing bacteria also fixes atmospheric nitrogen biologically in rice *field.*

Khaira disease:

- Zn deficiency causes *Khera* disease in rice usually at nursery stage.
- The tip of the zinc deficient leaves first become
  then dry.

- Zinc deficiency is marked by the appearance of **rust. coloured** or brownish red coloration on the surface of the outer leaves.
- First reported by **Y.L. Nene** in **1966 at Pantnagar,** Uttrakhand.
- It is managed by spray of @ **5 kg zinc sulphate** in nursery.
- or foliar spray of 0.5 per cent zinc sulphate.

Browning of rice:

- Iron toxicity in rice is known as ***browning of rice***
- **Iron toxicity** is the major problem to rice production in water logged acid -sulphate soils of ultisols & oxisols soil orders.
- The beginning of iron toxicity is characterized by the appearance of a **puple coloration** at the **leaf tips** and finally has a **scorched** appearance.
- **Phalguna** variety is tolerance to **Fe -toxicity.**

Silicon in rice:

- Silicon is regarded as essential nutrient in rice production.
- Silicon deficient plants are soft and droopy.
- Silicon supply mostly required during the panicle initiation stage because during this stage root activity is relatively reduced and the rate of transpiration is high.
- It has been noticed that silicon provides a **thick cuticle -silica layer** which functions as a barrier against attack by insects-pests.
- Silicon deficiency can be corrected by application of **basic slag @ 1.5 2.0 t/ha. Because basic slag is the most common** source of calcium silicate.

Weed management:

- ***Echinochola crusgali*** (barn yard grass) **and *E.* *colonum*** (jangli rice) are major weeds in rice.
- The weed problem is **less in transplanted rice** compared to upland direct seeded.
- In upland condition weed problem are **generally** severe.

Herbicides used in rice crop:

- **Benthiocarb @ 2** kg a.i. /ha is applied as pre -emergence.
- Propanil **(Stam F-34): @** 3 kg a.i. /ha is applied at 1 week after transplanting.
- Other herbicides Butaclor **(Machete) @** 2-3.0 kg/ha is used as pre -emergence.
- Anilphos @ ......

Beushening:

- It involves **cross ploughing** the young crop, 4-6 weeks after sowing with a light country plough in 5-10 cm standing water, ones or twice.
- Purpose behind this to **control weeds, optimize** crop stand and provide soil **aeration.**

Puddling:

- It is a process of destruction of soil aggregates by mechanical force in soils with excessive moisture content.
- Puddling destroys the soil structure which **hampers** root penetration and the development of the succeeding upland crops grown in rotation with rice.
- Puddling **increases the bulk density** of soil about from 1.4 to 1.7 g/cc.
- It is done with a **puddler.**

Objective of puddling:

- To **reduce percolation** losses of water. (main object)
- To reduce **weeds infestation.**
- To increase **nutrients availability.**

Critical stages **for water.**

- **Booting stage:** Most critical stage for water in rice crop.
- **Tellering** stage: Comes 2-20 days after transplanting.

Dapog method of rice cultivation:

- Introduced from **Philippines.**
- in this method, seedling becomes ready **for** [redacted] le day after seeding.
- It comprises raising of a dense **stand** [redacted] contact with soil.

- Rate for nursery sprouted seeds @ **1.5-3 kg/m^2** on wooden planks, trays, concrete floor, and seedbed covered with polythene sheet.
- Seedling from Im2 nursery area is sufficient for 200m2 field.
- Hence, **45-50 m2** nursery area is sufficient for one ha.

Hybrid rice:

- In the last decade of 1970, hybrid rice was firstly developed by **China** by using **cytoplasm male sterility -fertility restore gene system.**
- After China, India is the **second** country to commercialized hybrid rice of **APRH-1, APRH-2** (AP), **KRII** (Karnataka), and **MGR -1** (TN).
- **PH13-71 is the only hybrid rice which is released by private organization.**

Processing of rice:

1. **Milling: The aleurone layer and embryo are removed during the polishing of rice grain. All the grain constituents except the carbohydrates are reduced by the process of polishing. There is a loss of vitamin B, particularly thymine, the deficiency of which causes the disease called *'ben -ben'* in those persons who continuously eat polished rice.** ***(UPPCS Exam -2010)***
2. **Polishing of rice: The removal of very fine bran clinging to milled rice and smoothening of the surface is called *polishing*.**
3. **Parboiling: It is a hydrothermal process in which the crystalline form of starch is changed in to an amorphous form on account of irreversible swelling and fusion of starch.**

Important questions:

1	**Sowing time of Aus/autumn rice:**	**April- May**
1	**Sowing time of Boro rice:**	November -December
1	**Rice inflorescence is known as:**	**Panicle.**
1	**Rice is a type of plant:**	***Short day plant***
1	**Cardinal temperature of rice is:**	**30-32 degree**
1	**Hulling % of rice is:**	**65%.**
•/	**Fruit of rice is known *as:***	**Caryopsis.**

	Widely used nitrogenous fertilizer in **rice:**	**Ammonium sulphate**
V	Optimum pH of soil required for growing rice is:	**4-6 pH.**
	Mat type nursery is related to crop:	**Paddy.**
	Test weight of basmati rice:	**21 g.**
	Maximum exporter of rice in world:	**Thailand.**
	Hybrid rice which is released by private sector:	**PHB-71.**
V	Most critical stage of water for rice:	**Booting** stage.
V	Biofertilizer for rice is:	**Azolla.**
V	Seedling ready for transplanting in Dapog method:	**12-14 days.**
V	Most dominant weed species in rice:	***Echinochola sp.***
V	**White** eye of rice due to:	**Fe deficiency.**
V	The gas emits from rice field is:	**Methane.**
V	Akiochi disease in rice due to:	**H_2S toxicity.**
V	Highest nitrogen losses in the rice crop by:	**Denitrification.**
V	Paira & Utera cropping system is closely related to:	**Rice**
V	Parboiling of rice conserve the vitamin:	**Vitamin BI2**
V	Seed rate in Dapog method for rice:	**3-4 kg/m^2**
V	Area required for seedling preparation in Dapog method:	**25-30 m^2**
V	Miracle rice of India is:	***Jaya***
V	Gene responsible for dwarfness in rice:	**Dee -gee -Woo -Gene**
V	Spacing for rice sowing of seedling:	**20 X 10 cm**
	Khaira disease of rice is due to:	**Zinc deficiency**
v	Reclamation disease of cereals due to:	**Copper deficiency**
v	A rice grain is said to be extra long if it **is:**	7 **mm or more**

2. Wheat (*TriIleum tieslirunt*): 2n = 42

- **Wheat ranks first in the world** among the cereals both in respect of area and production.
- In India wheat crop is the **second** most after rice so wheat is called as *'king **of cereals'***.
- The word ***"Cereals"*** derived from a **roman word *'Ceres'*** which means the ***Goddess of grain.***
- Wheat contains spongy **protein** i.e. ***Gluten*** (this is colloidal complex of **gliaidine** and **glutenin** in equal amounts) which is essential for ***baking.***
- **Perling index** in wheat: to determine the **hardiness** of grain, a **higher value** of P.I. means **lower kernel hardness.**
- In wheat the **permanent adventitious roots** develops below the soil surface after the appearance of the first leaves is called ***clonal roots.*** **(NET -2001)**
- Wheat **inflorescence** known as ear or **spike** and seed is **caryopsis.**
- Mustard is very common crop usually intercropped with wheat.
- **Test weight** of wheat grain is about **40g.** While test weight of ***phalaris minor*** is only **2g.**
- Gene responsible for dwarfness in wheat is **Norin-10** which is a Japanese variety isolated by **Dr. Borlaug** in 1960 at **Mexico.**
- In 1963 **Lerma Rojo, Sonaro 63, Sonaro-64** and **Mayo 64** were imported by then Minister of Agriculture, Shri *C.* Subramaniam and released for commercially cultivation in **India (1965)** these varieties were responsible for **green revolution** in India.

Area & Production (India):

- Area: **UP>M** P> Punjab
- Production: **U P**> Punjab > Haryana
- Productivity: **Punjab** (45q. /ha) > Haryana

- **The highest productivity** of wheat in **Punjab** due to **nearly 100 % area** of wheat is under **irrigated** conditions and **higher doses** of fertilizer consumption.

Classification:

1. Common breed wheat ***(T. aestivum):***
   - Its **hexaploids, 2n =42** (imported species but mostly grown in **India).**
   - Occupying about 87% of wheat area.
   - Introduced in India by **Borlaug** from **Mexico,** hence called **Mexican** dwarf wheat and responsible for green revoluation.
2. Durum/Macaroni wheat ***(T. durum):***
   - Tetraploids, 2n=28.
   - Used for **Suji, Semya** preparation.
   - This occupies about **12%** of wheat area, confined to **Central** and **Southern** India.
4. Emmer wheat ***(T. diccocum):***
   - Tetraploids, 2n=28
   - Occupies about **1%** wheat area confined to **MIL AP, KN and TN,**
   - **Preferred for granular preparation of south Indian dish"Uppumay"**
5. **Indian dwarf wheat *(T. sphaeroccocum):*** 2n=42, hexaploid.
   - This is **out dated** due to **low** productivity and **susceptible** to diseases particularly **rusts** disease.

Origin of place: **S. W. Asia (Turkey).**

Irrigation stages of wheat (by **R.B.L. Bhardwaj)**

1. **CRI** (crown root initiation) stage: **21' days** after sowing
   - Transition zone between root and shoot is known as **crown root initiation.**
2. **Tellering** stage: Up to 40-45 Day after sowing.
3. **Jointing** stage: Up to 60-65 Day after sowing.
4. **Flowering** stage: Up to 80-85 Day after sowing.
5. **Milking** Stage: Up to **100-105 Day after sowing.**
6. **Dough stage: Up to 115-120 Day** after sowing.

- V' Dough stage is refers to when **milky fluid** in wheat **grains turns harden.**
- V If water is available to provide one irrigation, then it should be applied at **CR.!** stage.

  If water is available to provide two irrigations, **then** it is preferred at: **CRI** and **late jointing.**

Climate: C3, Long day plant. The most ideal conditions for desirable wheat growth are:-

1. Cool and moist weather during the vegetative growth period.
2. Warm and dry weather during grain formation. (icsittAs)

Booting stage:

- It is reproductive stage in wheat characterized by the swelling of the upper most internode.
- The spike which is inside is held by the last leaf calledflag ***leaf*** This is the stage of the maximum leaf areas.

Wheat *(T. aestivum)* Varieties:

- Norin 10 has cretaed a new chapter in the history of wheat breeding.
- The dwarfness of norm n was the result of two particularly recessive genes, which marked with the symbols of ***Sd I*** and ***Sd 2. (ICS Exam -2002)***

1. Single gene dwarf:

- **Lerma Rojo 64-A**
- **Sujata**
- **Sonalika:** developed from selection of ***HD 1553*** and ***RR 21***

2. Double gene dwarf:

- **Kalyan Sona:** developed from ***Kalyan 227*** and ***Sona 227*** •
- **Sonaro-64, Chhoti Lerma**
- HD -2009 **(Arjun),** HD -2329, **Janak,**

3. Triple gene dwarf:

- Heera, Moti, Lal Badshah.

4. Mutant varities: released from **IAR1,** New Delhi

- **Sharbati sonora** developed from: **Sonoro 64**
- **Pusa lerma** from: Lerma Rojo 64-A

Other popular varieties:

- **Lok-1:** Suitable for late sowing.
- Tall variety of wheat is: **C-306.** (Farmy wheat).
- **K-65:** Suitable for late sowing and saline soils.
- **Sujata:** Suitable for dry land (unirrigated) area.
- WH-147: Suitable for making good quality of ***'Chapatti'***
- **PBW-502** (2004):Good yielder under irrigated, cool climate
- DBW- 17 (2006):Suitable for **'bread'** making
- **RAJ -3765:** Late sowing variety, resistant to lodging
- **RAJ -4037** (2004): Suitable for warm climate
- **RAJ -3077:** Suitable for saline and late sowing.
- RAJ -4120 (2009):Resistant to ***UG-99 race*** of rust, yield 48-58 q/ha.

Seed rate:

- For normal sowing: 100kg seeds/ha.
- For late/broadcasting: 125kg seeds/ha.
- For dibbling required: 25-30 kg seeds/ha.

Sowing date: 1st fortnight of **November** is the best time of wheat sowing.

Sowing methods:

I. **Drilling:** Fertilizer -cum -seed drills are most common
2. **Broadcasting:** Required more seeds
3. **Dibbling:** Required less seeds than other sowing methods
4. **Behind the plough method:** these are two types
   (a) **Kera method:** When seeds are dropped by hand in the furrows made by country plough is known as ***Kera method***
   (b) **Pora method:** When seeds are dropped in furrow by ***funnel/ nai*** attached to the plough is known as ***Pora method***

5. **FIRB Method:** New method of sowing is furrow irrigated raised bed system: it gives average to higher yield than other methods.

Spacing:

- **22.5 cm** x 10 cm depth for **irrigated.**
- 25-30 cm x 5-6 cm depth for **rainfed.**

Depth of sowing is depends on **length of coleoptiles.**

- **Tall** varieties 8-9 cm depth.
- Triple **dwarf** varieties 3-4cm depth.
- An average **5cm depth** is ideal for wheat sowing.

Fertilizer and Manures:

- Nitrogen: 120 kg/ha
- Phosphorus: 60 kg/ha
- Potash: 40 kg/ha

Dose: **Half dose** nitrogen and **full dose** of P & K applied as basal and remaining **half dose** of nitrogen applied as **top dressing** at 1st and 2"d irrigations.

Weed management:

a. Monocot weeds:

- ***Phalaris minor*** (applied isoproturon @ 0.75 a.i. /ha.).
- Phalaris minor has showed resistance against isoproturon reported by **Dr. R.K. Malik** at **Hissar,** hence **Sulfosulfuron** can be used instead isoproturon against ***Phalaris minor.***
- ***Avena fatua*** (wild oat): to control ***Phalaris minor*** and ***Avena fatua*** a **post** emergence application of **Tribunil** (now **banned** in India due to carcinogenic properties).

b. Dicot weeds:

- ***Chenopodium, Anagalis*** and ***Melilotus alba*** etc. Applied 2, 4-D Eater Salt as post -emergence i.e. **30-35** DAS @ **500m1/ha** to control **dicot** (broad leaved weeds).

Important questions:

- Botanical name of (common bread) wheat is: ***Triticum aestivum.***
- **Origin** of wheat is: ***South West*** *Asia (turkey)*
- Flowering portion of wheat is called: ***Spike***
- Macaroni wheat is known as: ***Triticum durum***
- Emmer wheat is known as: ***T. diccocum***
- Suitable late sown variety of wheat: ***Lok-I, Raj -3765, Sonalika.***
- Spacing of row to row of wheat: ***22.5cm***
- Most critical stage for irrigation: ***CRI (21 DAS)***

- Gene responsible for dwarfness in wheat is: ***Norin-10***
- Important mimicry weed of wheat is: ***Phalaris minor***
- Test weight of wheat seed: ***40gm***
- **Triple** gene dwarf varieties of wheat: ***Heera, Moti, Arjun***
- Central **zig zag axis** of wheat grain is called: ***Rachis***
- Fruit type of wheat is: ***Caryopsis***
- First **man made** cereals: ***Triticale***
- **Triticale** is a cross of: ***Wheat x Rye***
- **DT -46** is a variety of: ***Triticale***
- Temperature for germination of wheat seed: ***20-25 °C.***
- **Protein** content in wheat: ***8-11%***
- World staple food grain: ***Wheat***
- **Most of the present days Indians wheat varieties contain the gene:** ***Rht I & Rht 2***
- The wheat protein which is essential for good bread quality and **chapatti making is:** ***Gluten***
- For ***safe*** **storage** moisture content of grain should be ranges from: ***10-12%***
- ***Triticum aestivum*** was **first introduced in the India by:** ***NE Borlaug of Mexico***
- Moisture content **at harvesting stage in wheat is:** ***25-30%***
- **Triple gene dwarf varieties were released in the year:** ***1970***
- **The sate which has highest production and cultivation** ***area*** **of wheat:** ***UP***
- **Export quality of wheat is influenced by:** ***Kornai bunt***
- **Dwarfing agent for wheat crop is:** ***Cycocel***
- **Objectionable weed of wheat is:** ***Convolves arvensis***
- **Variety of wheat , susceptible to 2, 4-D where spike deformity occur:** ***HD -2009 (Arjun)***
- **Primary roots in wheat that support and nourish the plants at initial stage is called:** ***Seminal roots***
- **In wheat hybridization method most common use:** ***Goojo method***

- Absolute weed of wheat is: ***Chenopodium album***
- Recommended ratio for wheat + mustard intercropping is: ***9:1***
- Biofertilizer for wheat is: ***Azatobacter***
- Multiline in wheat are produced by: back cross breeding.

- The earliest type of barley is two **-**rowed but now days most barley growing groups are six -rowed barley.
- Barley is comparatively more tolerant to saline and alkali soils than other cereals.
- The barley flour does not contains gluten.
- The barley grains are mostly used in the production of **malt** which is used in breweries to make beer, alcohol, malt, vinegar and yeast.

Classification of varietal groups of barley:

1. **Vulgare:**
   - It is **six -rowed** barley
   - All the three spikelets are fertile.
   - Spikelets in six distinct rows are arranged at a uniform distance around the rachis
   - Lemma of all the florets are awned or hooded
   - This group is most commonly cultivated in India. **(ICS/NET-2002)**
2. **Irregulare:**
   - In this group ear may be **six -rowed** and **two -rowed.**
   - Lemma does not bear awns or hoods
3. **Distichon:**
   - It consist of only **two -rowed** barley
   - Only central spikelet is fertile

Varieties:

- **Ratna, Jyoti, RS -6, Rajkiran**
- **RD -2052, RD -2552, RD -2035**

4. \la ize: *Zeu*

- Maize is a **non tiller** plant.
- Maize is usually a cross-pollinated crop.
- In maize yellow color due to presence of: ***Cryptoxanthin***
- Maize possesses the **highest yield potential** among the cereals.
- Maize protein is called ***zein'*** and is **deficient** in ***tryptophan*** *and* ***lysine.***
- Maize required optimum temp. for germination is 18.3 °C.
- Maize is sensitive to **water logging.**
- **Seminal roots** present in maize to nourished seedling plants.
- **Maize is *monoecious* plant having two different types of inflorescences.**
- **If maize is sowing in east -west direction it helps to augment the grain productivity due to greater availability of light. (NET -2001)**
- **In the persons which wholly depended on maize lead to a disease called 'pellagra' due to low content of vitamin B complex, niacin and tryptophan in maize.**
- **The terminal male flower clusters are called *tassel*, it is a branched panicle bearing of pollen or staminate inflorescence.**
- **The style is a very long silky filament, bears the female hairy cluster of which is known as *"silk"*.**
- **The female pistillate inflorescence also called the ear or cob, comes out from a node generally half way on the stem.**
- **Idea of hybrid maize was first conceived by E.M. East and G.H. Shull in 1910 by single cross technique among the inbred lines.**
- **An inbred line is a 'pure line' developed by self pollination and selection until apparently homozygous plants are obtained. (ICS Exam -1993)**

- **D.F. Jones (1920) proposed the use of Double cross technique for hybrid seed production.**
- **At present double cross techniques are mostly used in India.**

Classification of maize on the basis of endosperm characters: Shurtevant (1899) classified into seven groups:-

	Dent corn	*Zea mays* ***bidet:1114a***	**The kernel of the dent corn appears like a - tooth so named as dent corn, extensively grown in the USA.**
2	**Flint corn**	*Zea mays* ***indurata***	**Its kernel is hard and smooth, commonly cultivated in India.**
3	**Sweet corn**	*Zea mays* ***saccharata***	**Known as sweet corn, the sweet corn kernel present a transluscent and horny appearance before maturity. This corn is chiefly cultivated to produce kernels for the canning industry.**
4	**Flour corn**	*Zea mays* ***amylacea***	**Kernels almost entirely consist of soft starch so also name *soft corn.***
5	**Pop corn**	*Zea mays* ***everta***	**When pop corn grains are heated, the** endosperm cracks open due to the vapour pressure consequently releasing the loose floury mass. Its is chiefly used to prepare the food products like **corn flakes, corn chips and pop corn** etc.
6	**Waxy corn**	*Zea mays* ***ceratina***	The waxy corn caryopsis has two -layered **endosperm, and it is used to produce starch.**
7	**Pod corn**	*Zea mays* ***junicata***	**Husked, primitive type of corn,** no significantly importance.

Varieties:

- **First time in India (1961), four double cioss hybrids were released: Ganga-1, Ganga-101, Deccan, and Ranjeet.**
- **Mahi Kanchan and Mahi Dhavan varieties of maize originating from Rajasthan.**
- **Top cross varieties: Ganga-2 and Hi -Starch.**
- **A top cross hybrid is obtained by combing an inbred line and an open -pollinated variety.**

- In 1967, six composites were released: **Vikram, Vijay, Amber, Kisan, Jawahar & Sona.**
- In 1971, **Lysine** rich Opaque -2 composites **Protina (4%** lysine), **Shakti** and **Rattan** were released.
- **Synthetic variety:** Means their advanced generations of a multiple hybrid increased by open -pollination e.g. **Amber**
- New varieties of quality protein maize **(QPM)** have released by using ***Opaque -2 gene*** e.g. **Shaktiman-1, Shaktiman-2** and **HQPM-1.**
- Optimum plant population in Kharif is **65,000-70,000** plants/ha.

ieed rate:

- 15-20 kg seeds/ha is recommended for **kharif** crop.
- 25 kg/ha for **hybrid** maize.
- 40-50 kg/ha is recommended for fodder purpose.

Critical stages for water:

- **For moisture and nutrients point of view period between tasseling** and **silking stage is critical.**

Important question:

- **Suitable temperature for growing of** *Zea mays: 32 °C.*
- **Commonly herbicide used in maize is:** ***Simazine*** *(0.5-1.0 kg)*
- Hybrid varieties of maize: ***Sangum/Ganga safed***
- **Double cross techniques of prod. of maize introduced *by:D.F Jones (1920)*.**
- On maize plant, first appearance *is:* ***Tassels*** *(male flower).*
- Water requirement for the maize crop *is:* ***500-800mm.***
- Protein content of maize: ***10%***
- **Rabi** maize is extensively grown in: ***Bihar***
- ***White bud:*** In ***maize*** due to deficiency **of zinc the apical leaves become white.**

Bajra: *Pcnnisettan americaumn.*

- Bajra is known by different names like cattail millet, candle millet, dark millet, spiked millet etc.
- Highest quantity of minerals (2.7%) are found in bajra among the cereals.
- Rajasthan having **first position** both in area and production
- In pearl millet the roots coming out from the second and third nodes provide support to the plant and are called ***prop*** or ***brace roots.***
- **Highest drought** tolerant crop among cereals & millets.
- Among the cereals, the water requirement for pearl millet is lowest (250mm).
- In pearl millet the inflorescence is predominantly protogynous and therefore stigmas are seen a few days before the appearance of anthers which greatly facilitate natural cross-pollination.

Varieties:

Pusa moti

Hybrids:

- Tift 23 -Al was the first male sterile line of pearl millet.
- First hybrid: **HB-1** released in 1965 from Ludhiana. Its cross of Tift 23-A (male sterile) x Bil 3B.
- HHB-67, BJ-104, Pusa moti are other
- Napier grass: For development of forage variety **PUSS napier-1;** the first inter -specific hybridization was carried out in 1947 between *Pennisetum purpureum* x *Pennisetum glaucum.*

6. Jim a r: *.sOrghUM bicolor.*

- First hybrid of sorghum: ***CSH-1***
- Jowar is native of: ***Africa***

- Witch weed ***(Striga spp.)*** a root parasite weed, which is a major problem in sorghum production.
- Seed rate of Jowar: ***10-12 kg/ha***
- Seed rate for fodder purpose: ***40-50 kg/ha.***
- The best high yield variety of Rabi Jowar is: ***M35-1***
- Drought and salinity tolerant variety of sorghum is: CSH-9
- Sorghum is considered as camel crop because of: ***Resistance to drought.***
- Most important male sterile variety: ***Combine kafir-60.***
- Sorghum crop for fodder purpose should be used after 50% flowering because sorghum leaves at knee stage possess a high amount of hydrocyanic acid ***(HC1V)*** or ***dhurrin/prussic acid*** which is poisonous to the animals. **(ICS Exam -1993)**
- Under drought condition if animal is grassed of sorghum leaves with 0.5g of HCN may be die.
- Sorghum is called the ***camel of desert*** because it produces good yields under high temperature and low soil moisture.

SUgarcane *(Suecharum Vicinarum)*

- Also known as **Noble cane,** developed **by T.S. Vankataraman.**
- **The** word **"Saccharam" derived from "Sanskrit"** word **sarkara" which means sugar.**

,1 Sugar industry is the **largest agro based processing industry after textiles in India.**

1 **In India (2006) there are about 582 sugar factories maximum in Maharashtra (134) .**

1 **The** maximum sugar factories **(317)** are in cooperative sector followed by private sector (203 factories).

Area and distribution:

- **Area:** **India >** Brazil > Cuba
- **Production:** **Brazil >** India > China

" **Productivity:** **Peru (115 t/ha) > Australia**

Area & Production (India):

- Area: **UP >** Maharashtra > Tamil Nadu
- Production: **UP >** Maharashtra > Karnataka
- Productivity: **Tamil Nadu (99.3** t/ha.)

Botany:

- Family: **Graminae** (poaceae).
- 2n=80, **perennial** plant.
- **Inflorescence** of sugarcane known as ***Arrow*** which is an open branched panicle.
- **C4*, intermediate short day*** plant.

Origin: New Guinea

Classification: there are **three cultivated** and **two** wild species.

1. ***S. officinarum:*** Noble/thick and **juicy** cane, low fiber content: 2n = 80.
2. ***S. Barbari:*** **Indian** cane, medium sucrose and high fiber content, 2n = **82-124.**
3. ***S. sinense:*** **Chinese cane, medium sucrose,** high fiber content, 2n = **118**

Wild species:

1. ***S. spontaneum:*** Very **low sugar and very high fiber content.**
2. ***S. robustum:*** Very low sugar

Seeds **and sowing:**

- Material used for sowing is known as seed **pieces** or **sets.**
- **Top 1/3 to 1/2 portion** of cane being comparatively **immature** having **high glucose** content good for germination.
- **Three budded: 35,000-40,000 setts/ha (which** can be obtained from **75-80 qt.** of cane).
- Sets should be treated with **0.5% solution of Agallol.**

Time of planting:

1. **Autumn planting:** planting in October in N. India.
2. **Adsali planting:** planting in June -July in S. India and takes 15-18 months for harvesting.
3. **Eksali planting: Jan. -Feb. in S. India** and takes about one year time for harvesting.

planting methods:

1. **Flat planting:**
    - Planted **shallow 8-10** cm deep furrows at **75-90 cm** distance
    - It followed in **N. India.**
2. **Furrow method:**
    - Particularly in **heavy soils.**
    - Adopted **10-15** cm deep furrow in N. India
    - About **20 cm** deep furrow in S. India.
3. **Trench method:**
    - Followed in **tall growing** cane areas such as **coastal** areas to **protect** from **lodging.**

Manures and fertilizer:

- **Heavy feeder** crop but higher doses of **nitrogen** during ripening stage **decrease sucrose** content in **maturing** canes.
- **Blanked** application of nitrogen (120-150kg): phosphorus (80 kg): potash (60 kg).
- The best source of nitrogen in normal soil is Ammonium sulphate, in saline soil is urea and in acidic soil is used CAN.

Irrigation stages:

	Phase	**Duration**
1.	Germination	0-60 DAP
2.	**Formative**	60-130 DAP (maximum requirement of water in this stage)
3.	Grand growth	130-250 DAP
4.	Maturity	250-365 **(DAP =** Days after planting)

- **Furrow method** of irrigation is **most common** method of irrigation in sugar cane.
- Under high temperature, sucrose gets converted into glucose and quality of the produce becomes poor.
- **Ratooning** of sugarcane: it is economical to take **only one ratoon** crop, in ratoon crop **20% more nitrogen** required as compare to planted crop.
- Artificial ripening of sugarcane: **Polaris, Glyphosine @ 5 kg** a.i. **/ha.**

Blind hoeing:

- An important practice in sugarcane, hoeing after planting and before crop emergences for the purpose of weed control.

Harvesting: cane maturity measures as:

a. **Brix ratio:**
   - Sugarcane consider mature if **brix** value or **refractometer** reading is **16-18.**
   - For brix reading juice should be taken from **middle** portion of stalk.

b. **Fehling** test:
   - For maturation of cane **Fehling test solution** reading should be **less than 0.5% glucose.**

Crop logging:

- **H.F. Clements** in Hawaii developed the concept of crop logging.
- It is the **foliar diagnosis** comparing the **nutrient status** of comparable leaves of high and low yield crop plants generally used in **sugarcane** in **Hawaii.**

Crop lodging:

- The **falling down** of crop due to **strong wind,**
- It prevented by trench planting, earthling up, wrapping and propping.

Water lodging:

- The falling down of crop due to **flooding**
- I.e. saturation of both macro and micro pore.

By-products of sugarcane:

1. Bagasses: Used for **fuel** and **paper** making. **(RAS-2013)**
2. Molasses: For alcohol production.
3. Press **mud:** (Contain lime), **reclamation** of **acidic** soils.

- In **Brazil,** sugarcane is also used as a source of energy.
- **Gasohol** is prepared from **80% petrol + 20% alcohol** (from **sugarcane)** which are used in **automobiles.**

Important questions:

- Inflorescence of sugarcane is called as: ***Arrow***

- Higher dose of nitrogen decrease the: ***Sucrose content***
- Most critical stage for irrigation is: ***Formative stage***
- Most popular planting method in the north India: ***Flat bed planting***
- Brix reading should be for the proper maturity: ***16-18%*** TSS (total soluble solids)
- Soils which are unsuitable for sugar cane are: ***Saline soils***
- Noble cane is: ***Saccharum officinarum.***
- Adsali sugarcane planted in: ***June -July*** (18 month crop).
- State, have highest productivity of sugarcane: ***TN***
- **Earthing** in sugar cane should be done in: ***June -July.***
- **Tying** should be done in the month of: ***August***
- Spacing row to row: ***90 cm***
- Name of wild cane: ***Saccharum spontaneous***
- Burning of canes is done for: ***Improve sucrose & juice quality.***
- Indian cane indigenous to north and eastern India: ***Saccharum barberi.***

8. Chick-pea/Bengal gra iiilgra m : *Cicer aretimmi*

- Gram is rich source of ***calcium*, iron** and **niacin.**

I Used as **blood purifier** and germinated seeds are recommended to cure scurvy disease.

,f India is the largest producer of gram in the world sharing 65% area & 70% of total global **production.**

- Major pulse crop in India and share largest acreage and production among the pulse crop in the country, followed by pigeon pea.

Origin of place: **Afghanistan** (Persia)

Area **and distribution:**

- Area: **India** > Pakistan > Turkey
- Production: **India** > Turkey > Pakistan

In India:

- Area: **MP** > **Raj** > UP
- Production: **MP** > **Raj** > UP

Classification:

I. **Desi** or **brown gram** ***(C. aretinum),*** 2n = **14, 16**

- Most **widely** grown.
- **Good branching.**
- Yellow to dark brown seed
- **small sized**
- Cosmopolitan in nature.
- **Test weight: 140-200g**

2. **Kabuli/white** gram ***(C. kabulim),*** 2n = **16**

- **Bold** attractive **white** seed
- **Test weight: 340-375** g
- Its **poor yielder** as compare to desi gram.

Botany:

- Family: **Leguminaceae,** sub family: **Papilionaceae**
- The **sour taste** of **leaves** and **pods** is due to the presence of **Mallic** acid **90-96%** and **Oxalic** acid **4-10%,** about 4-10 kg of these acid can be obtained from one ha crop.
- **Tap root** system, **cloddy** and **rough seed bed** is required to provide adequate aeration for proper germination of seeds
- **C3, long day** plant.
- Gram is **highly susceptible** to **frost** at **flowering** stage.

Varieties:

Desi gram:

Variety	Features
Avrodhi:	**Wilt resistant**
Pusa-256/BG 256:	Most common and **best for Rainfed** condition
C-235:	Widely adopted for **dry land,** tolerant **Ascochyta blight.**
Gaurav:	Resistant to **Ascochyta blight.**
RS -11:	**Mutant variety**
ICCC-2:	**Short duration** variety

Aparna (2006): **Grains** remain in **green colour**

Other varieties: Chaffa, RSG-2, GNG-16, Radhey.

Kabuli:

- **C-104, K-4**

Preparation of Seed bed:

- **Rough** seed bed is required for gram to provide good **aeration.**
- **Sowing: rd** fortnight of **October** is optimum time.
- Seed rate: **80-100** kg 'seeds/ha.
- Spacing: Row to Row **30 x 10** at the depth of **6-8cm.**
- **Delayed** planting **increases** the incidence of (pod borer) ***Helicoverpa armigera.***
- **Early** and **shallow** sown crop is more liable to be damaged by **wilt.**

Irrigation management:

- **Pre -flowering** and **pod development** are the **most critical** stages.

Practices in gram:

Nipping and **topping:**

- Pruning of **top** branches of the plants to encourage reproductive growth
- Practice at **50-60** days after sowing
- It can be done by a **flock of sheep.**
- Chemical for **nipping: TIBA @ 75 PPM** i.e. Tri-iodo-benzoic Acid.
- **Yield** of gram **20-25** q/ha.

Important points:

- Root system of gram is: ***Tap root system***
- Sour test of gram leaf is due to: ***Maleic & oxalic acid***
- Best variety for dry land is: ***C-235***
- Sowing time of gram is: ***15 October- 20 Oct.***
- Gram fruit is known as: ***Pod***
- Protein content of gram: ***21 %***

- **Deep sowing of gram is protect from:** ***Wilt disease***
- **Critical stage for irrigation:** ***Pre flowering, pod development stage.***

Pigeon pea: *Cajanns cajun*

- **Known as red** grP• - -har/tur
- **Most dr, , LS tolerant among pulses.**

Origin: Africa

Classification:

I. *C. cajun* var. **bicolor:**
   - **Perennial, tall, much branched**
   - N/ **Late maturity,** 4-5 grains/pod
   - Commonly grown **in North India.**

2. C. *cajan* var. **flavus:**
   - .4 **Annual,** Short plant
   - ,7 **Early maturity,** 2-3 grains/pod.
   - ',/ Mainly grown in **South India** as a *seed crop.*

Area and distribution:

- Area: **India** > **Malari** > Uganda
- Production: Same trend in area and production

In India:

- Area: **Maharashtra > UP > Karnataka**
- Production: **UP** > **MH** > Gujarat
- Productivity: **Bihar > UP**
- **In India 90% area** and **85% production** on **Global** basis.

Botany: Features

- **Deep** rooted, **self** pollinated.
- **Hypogeal** germination.
- **C3, short day** plant.
- **Hardy** crop, **most drought tolerant** crop among major pulses.

Varieties:

a. Short duration:
   - UPAS-120: It takes about 120-125 days.

- Prabhat: Extra -early, 110-120 days
- ICPH-8: 1st hybrid of arhar in world developed at ICRISAT, Hyderabad, 1991.
- PPH-4, ICPL-15

b. Medium duration: 150-180 days
- BDN1, 2,
- C-11
- Mulcta (wilt resistant).

c. Long duration: 180-300 days.
- PUSA-9.

Seeds and sowing:
- Seed rate: **12-15 kg/ha.**
- Spacing: **60 x 15 cm.**
- Plant population for kharif is: 55,000 plants/ha
- Plant population for winter crop: 3.33 lakh plants/ha
- Sowing time: 1st fortnight of **June,**
- Harvesting Index is: **19% lowest** in among **pulses**

Important points:
- Botanical name of Arhar: ***Cajanus Capri.***
- Origin of arhar: ***South Africa.***
- Sowing of arhar: ***15 June***
- Highest production of arhar in: ***UP***
- Protein content of arhar is: ***25%.***
- **Highest** productivity of arhar: ***Bihar (1115 kg/ha).***

10. Cotton, *(Gos.sypiiiiii* sp.)

White gold
- **King** of **appraisal fiber.**
- ***Bt*** cotton is effective against **boll worm** pest complex of cotton.

V In India ***Bt.*** **Cotton** is grown about **8.4 Mha** (86% of total cotton area) in 2009. **(ARS/NET-2009)**

Origin: India

Area and **distribution:**

•

- Area: **India** > USA > China
- Production: **China >** USA > India

In India:

- Area: M11 > AP>Gujarat
- Production: **MH** > A P> Haryana

Botany:

,7 Family: **Malvaceae.**

- Cultivated cotton is **annual.**

,(**Tap root** system.

Two type of branches:

1. Monopodial: **Vegetative** branches
2. Sympodial: **Reproductive** branches

Classification:

Out of **20** species of cotton only **4** are cultivated.

1. ***G. arborium:*** 2n = **26,** diploid
2. ***G. herbaceum:* 2n = 26, diploid**
   - **These above two are known as desi cotton/old world/Asiatic cotton.**
3. ***G. hirsutum:* 2n=52, tetraploids. Generally called American**
   • **cotton.**
4. ***G. barbadence:*** **2n=52, tetraploids. Highest fiber length 3.6-5.0 cm.**
   - **These two species are known as Egyptian/sea Island cotton.**

India: is the only country in the world where all four species of cotton are grown on commercial scale besides hybrid.

- **Hybrid: 40 % area**
- ***G. hirsutum:*** **36 % area**
- ***G. arborium:*** **16 % area**
- ***G. herbaceum-:*** **8% area**
- ***G. bardadence:*** **0.2 % area.**

Varieties:

- ***G. arborium:*** **Lohit,Virnar**
- ***G. herbaceum:*** **Digvijay,Sanj ay**

- *G. hirsutum:* **Ganganagar agety, Bikaneri nerma.**
- *G. barbadence:* **Suvin** and **Sujata** (sujata is the first spinning variety of **Egyptian** cotton released in India).

Hybrid varieties:

a. **II -4:**

- It was **first** commercially **hybrid** variety of cotton.
- Developed in the world by crossing G-67 x **American Nectorless** by **Dr. C.T. Patel** of GAU, **Surat** in **1970.**
- It's a cross of **intra hirsutum.**

b. **Varalaxmi:**

- **It is 1st interspecific hybrid** between ***G. hirsutum*** and ***G. barbadence***
- Released from **UAS, Dharwad.** (RPSC-AO-2012)

c. **MCU-5:**

- **It** is **extra long staple** variety of cotton ***(SRF-09).***

d. **Maru Vikas/Raj.**

- **It's 1st hybrid of hirsutum** in Rajasthan ***(JRF-09).***

Savita, Surya:

- **Intra specific** hybrid of hirsutum.

F. **Dhanlaxmi:**

Delinting/deffusing:

- Done with concentrate **sulphuric acid** in a ratio of acid to cotton seed about 1:10.
- This helps in grading the seed
- Kill **hibernating** insect stages
- **Destroy** the diseased **pathogens**
- It makes seeds **easy** to sowing & **germinates** rapidly.

Seed rate:

- **Desi cotton:** 10-18 kg at 67.5 x 30 cm spacing
- **American** cotton:15-25 kg at 67.5 x 30cm spacing
- **Hybrid** cotton: **2-3 kg at 100 x 60** cm spacing.
- Optimum population: **50,000-80,000** (average 66,000).
- For Bt cotton: **1-1.5 kg/ha** (ay. 10,000 plant population)

Sowing time:

- **North India:** **1st** fortnight of **May.**
- **Central India:** Last week of **June** to first week of July.
- In **Tamil Nadu:** September - October

Ultra Narrow Row:

- The concept of **ultra -narrow -row** (UNR) was developed in **USA** in which the Row to Row and Plant to Plant spacing kept **19** x **19 cm2.**
- Keeping a plant population of **2, 77,000 plants/ha.**

Square in cotton:

- The appearance of **flower bud** in cotton.

Topping:

- **Removal of terminal growing point once from each plant at a height of 1-1.2 m (80-90 DAS) to protect further terminal growth and to** encourage **sympodial branching and good boll development by diverting the energy flow.**

Ginnine/o:

- **Separation of fiber from the seed cotton is known as ginning,**
- In general its **ranges 30-35%.**

Weeds management:

- **Important weed** ***flora-Trianthima, Echinochola, Diseria*** etc.
- **Pre-emergence/post emergence spray of diuron (mostly used) @ 0.5 kg a.i. /ha.**
- **Cotton is highly sensitive to 2, 4-D & glyphosate, injured by a spray drift.**
- **2, 4-D resistant cotton- gene-tfd-A**

Physiological disorder:

1. **Tirak/bad ball opening/pre-mature defective opening of balls due to early sowing, water stress on light sandy or in alkaline soils.**
2. **Red leaf: American cotton more susceptible, leaves turn red & rolled downward. In severely affected plants the whole lamina becomes red, leaving the veins green.**
3. **Little leaf in cotton: due to Zn deficiency.**
4. **Crinkle leaf of cotton: due to Mn toxicity.**

Important points:

- **Fiber length** and fiber fineness are: ***Genetic traits.***
- Origin of cotton: ***India***
- Lint per cent in cotton is: ***33 %***
- **Fiber maturity** measured by: ***Arealometer***
- Fiber **thickness** by: ***Nepiness***
- **Spinning** performance measured by: ***Number of counts***
- **One bale** of cotton: ***170 kg.***
- **Oil content** in cotton seed varies from: ***14.5 to 25.6%***
- **Toxic** pigment/phenol compound present in cotton seed is: ***Gossypol.***
- **Cotton fiber** is **an elongation/outgrowth of an epidermal cell of seed coat.**

11. Jute (*Corchorm.* spp.): F. Tilliaccae

1 Most important **fiber** crop **in India.**
1 **India's first rank in both area and production of jute in world.**
1 **In India West Bengal** has **first position** both in area and production.
1 ***C. olitorius*** known as meth-pat/tossa. Grown on **well drained high** lands only.
1 ***C. capsularis*** known **white jute/tita,** due to presence of glycoside **`Corcharin'.** Covers 70% area of total jute cultivation.
1 Weight of one bale of jute is: ***180 kg***
1 Seed rate of jute: ***6-8 kg/ha***

Harvesting:

- Optimum time of harvesting is about 90 DAS, but this stage the grain yield low.
- So to obtain **quality fiber and good yield** jute is harvest **at small pod stage i.e. 135-140 DAS.**

Ribboning:

- This practice is very common in **China** and Taiwan, but **not popular** in India
- It consists of **peeled out** of raw bark from the green plant, immediately after harvest and bundles of the ribbons thus obtained are retied.

Retting:

- It is a **microbial process** in which **aerobic** and **anaerobic** bacteria and fungi **loosen** the **fiber** by decomposing & dissolving the pectin, hemicelluloses and other cementing agents.
- It completes within **8-30** days.
- Slow moving clear water best for good retting.
- Optimum temperature required for retting is about **34 0 c.**

I 2. Potato *(S'o/unrini //Mews'/nil)*

,1 **King** of vegetable.

Cash crop (high marketable value per unit area).

,4 Rich source of starch i.e. **farina** and vitamin especially **B1**

Origin: Peru **(South America)**

True potato seed (TPS):

- Developed by **Ramanujan**
- **100-150 g** seeds/ha in **nursery** is sufficient.

Area and distribution:

- Area: **Uttar Pradesh** > West Bengal > Bihar
- Production: Same **trend** as area
- Potato occupies **largest** area under any **single** vegetable in the World.

Botany:

,/ **Perennial** plant but as a **crop treated** as an **annual** plant.

,4 Propagation by **tubers** i.e. an enlarged underground stem produced on the end of a **stolon** and not on the root properly.

C_3, short day plant from **tuberization** point of view while **flowering** point of view long day plant.

V Fruit type is **berry** and potato requires temperature for satisfied tuber growth **17-19** °C.

p" requirement about **5.0-6.5,** as **acidic** condition **reduces** scab disease incidence.

Varieties:

a. **Early maturity:** Takes only 75 **days**

- Kufri chandramukhi
- K. ashoka **(extra early)**
- **K.** alankar, K. lavkar and K. navtal

b. **Medium duration**

- K. sheetman (Frost resistant variety)
- K. chamatkar
- K. badshah

c. **Late maturity:**

- K. deva
- K. sinduri

d. **Suitable for processing:**

- **K.** chipsona-1
- K. chipsona-2

Seed **sowing:**

- **25 g cut (piece)** of tuber with **3-5 buds/eyes @** 15-20 q/ha
- As getting high yield @ 20-25 q/ha for 15g/seed
- Spacing: 60 x 20cm

Seed plot technique (S PT):

- Developed by **Pushkarnath** *et al.* in **1967**
- **It** is a technique of multiplication of disease free (Virus free) seed in Northern plains of **Country.**

Disorders:

a. **Black heart:** Due to lack of O_2 in stored potato the internal tissues break down and become black. Avoid staorage temperature above 35 C and poor ventilation.

• aMMINIIMOMMINE.

b. Rollo heart: due to excessive use of N -fertilizer, an irregular cavity in the centre of tubers develops.

c. **Chilling injury:** Due to prolonged storage of tubers at temperature of about 0 °C.

Important points:

- **Dormancy breaker:** May be used **1% Thiourea** with I ppm of GA3 for 10 minutes.
- Fertilizer **KCL not used** in **solanaceae** crops because **chloride** has **adverse** effect on dry matter and **starch** content of potato.
- The **stolen formation** (20-50 DAP) and **tuber elongation** (50-80 DAP) are **most critical** stages of irrigation.
- Insect of potato which infect the tubers in field as well as storage is : Potato tuber moth *(Gnorimoschema operculella)*
- Potato leaf roll viruses **is transmitted by: Aphids** *(Myzus persicae).*
- Wart **disease of potato is due to: Fungus *(Synchitrium endobioticum)***
- ***Domestic quarantine* is adapted (transport of planting materials i.e. tubers from Darjeeling area to other parts of the country is restricted due to wart disease.**

1 3. G round lint: .-1*rach is hypogea*

- **Known as Peanut/earthnut/monkey nut**
- **Contains 45% oil in kernel**
- **And 26% protein in kernels**

Origin: Brazil

- **Area:** **India > China > Nigeria**
- **Production:** **China > India > Nigeria**

In India:

- **Area:** **AP > Gujarat > TN.**
- **Production:** **Gujarat > AP > TN**
- **Productivity:** **Tamil Nadu (17 q/ha)**

Classification:

- **Bunch type/erect type:** ***A. hypogea*** **var.** ***fastigiata***
- **Spreading/trailing** type: ***A. hypogeal*** **var.** ***procumbens.***

Botany:

- Family: **Leguminaceae**
- **Self** pollinated
- C3, short day plants
- Fruit known as **pods.**

Dormancy:

- Bunch type **non dormant** while spreading type is **dormant** which require a **resting period** of 2-2.5 months for germination,
- It can be broken by **high temperature, storage** and use of ethylene chloro'nydrins @ 0.7% and seed soaking in **5-10 PPM** solution of **NAA, IAA.**

Important variety:

- Bunch type: **Jyoti**
- Spreading type: **Chandra**

Soils:

- Light texture, sandy loam soil is excellent.
- **Ammonium sulphate** and SSP are excellent source of N & P. respectively.
- **Popping** in Groundnut: **pods without kernels** or unfilled grains due to **Calcium** deficiency.
- Application of 250 kg **gypsum/ha** at **pre -flowering** stage (30 DAS), which is essential for **pod formation and development.**
- Generally sowing time is **last week of May** to **1" fortnight** of **June.**
- **Aflatoxin** contamination in Groundnut **(fungal infection** of Groundnut kernel) caused by ***Aspergillus flavits*** due to high moisture content in stored kernels. (RPSC-2009)
- **Management** of Aflatoxin is **storage** of kernels at **8 %** moisture level.

Important points:

- Botanical name of ground nut: ***Arachis hypogea***
- Origin of ground nut: ***Brazil***
- State which is largest producer: ***Gujarat***
- Shelling percentage: ***70 %***
- Oil percentage: ***40-45%***
- Nitrogen % in groundnut cake: 7.8 %
- Best soil for ground nut production: ***Sandy***
- Spacing of ground nut: ***30 x 10 cm***
- High yield type of ground nut: ***Spreading type***
- Pegging stage comes after: ***55 DAS***
- Chemical used for floral initiation: ***NAA @ 40 PPM.***
- Fruit of ground nut known as: ***Nut.***
- Herbicide used for groundnut is: ***Tok E-25***
- Bitterness of kernel due to: ***Aflatoxin.***
- Protein content in ground nut: ***26 %***
- Gynophores of ground nut are known as: ***Peg.***
- Yellowing of groundnut leaves due to: ***Iron deficiency***
- Rosette disease is due to: ***Virus*** *(vector* ***aphids)***
- Major pest of ground nut: ***White grub.***
- Bud necrosis in ground nut due to: ***Thrips***

I -4. Soybean: *Glysine m ay*

V known as **wonder crop** or **yellow jewel**

.4 World first rank crop as a source of vegetable oil.

.4 Soybean is the **major oilseed** crop in the **World** accounts for **50%** of the total **area** as well as **production.**

V' It provides approximately **60%** of **vegetable protein &** 30% of **oil** in the World.

Contains 42 per cent **protein (rich,** in **lysine)** and 20 per cent oil.

Origin: **China**

Area and distribution:

In India:

- Area: **MP >** MH < Rajasthan
- Production: **MP >** MH < Rajasthan
- s Productivity: Andhra Pradesh (>40 Oa)

Botany:

- '1 Family: **Leguminaceae.**
- 1 Inflorescence: **Raceme**
- 1 Fruit: **Pod**
- Soyabean is: **C_3, short day plant.**

Varieties:

a. **Introduced from USA are:**

- Bragg
- Kent
- Blackheart
- Lee
- **Clark -63**

b. **Indian varieties:**

- **Shilajeet**
- **Ankur**
- **Alankar**
- **Punjab -1**

Seeds and sowing:

- / **Sowing time is: 3rd week of June to 1st fortnight of July.**
- **Spacing: 45-60 x 15-20 cm.**
- •7 **Depth of sowing: 3 cm.**
- •4 **Seed rate: 70-80 kg/ha**
- **Plant population: 300,000-400,000 plants/ha.**

Weed management:

- **Major weeds are:** *Eichinocola colonum, Cyprus rotandus, Sorghum helepense and Trianthema.*

Management:

- " **PPI application (Pre plant incorpotion) of Fluchlorin lkg/ha.**
- **Pre -emergence application of Alachlor/Metribuzin @ 1-1.5 kg/ha.**

Pungency in mustard is due to **isothiocynate,** enzyme hydrolysis product of glucosinolates (in all crucifers).

Due to presence of toxic **glucosinolates** in its cake, it is **unsuitable** source of **protein** for both **human & cattle. It** causes **goiter** and effect growth and development. The **upper limit** is fixed at **0.5 % by the govt.**

Varieties:

a. **Rapeseed:**

- **Brown sarson** *(Brassica corn.* var. **sarson): *Pusa kalyani***
- **Yellow sarson** *(Brassica corn.* var. **sarson): *Benoy***

b. **Mustardkaandian mustard *(B. juncea):***

• Kranti	Varuna (T-59)
• Rohini	Pusa bold

c. **New released varieties of mustard:**

• Laxmi	Vasundara
• Ashirwad	Basanti
• Pusa jai Kisan	NRC-11B-506

- **Pusa jai Kisan (Bio-902): Its** first variety ***Brassica juncea*** developed in the world **by Prof. V.L. Chopra** *et. Al.* with the help of biotechnology through ***somatic hybridization*** in India.
- **NRCHB-506:** It is the first hybrid of mustard in India developed from Directorate of Rape seed and Mustard Research, Bharatpur, Rajasthan in Feb., 2009.
- NRCHB-101: suitable for late sowing, irrigated areas of MP, UP, Rajasthan.

I 6. Tea *(Cammelia*

,(Queen of beverage

Family: Theaceae/Camaliaceae

Origin: **China**

Area and distribution:

- **India is the largest producers, consumer and exporter** of tea in the World.
- **In India** Assam has first position in production
- Another growing area is Darjeeling (West Bengal), Nilgiree hills (TN) etc.
- The best method of plucking is **two leaves** and a bud.
- ***Imperata cylindrica*** **(thatch** grass) important ***weed*** of tea.

I 7. Tobacco

- Sodie **soils** are unfit for tobacco production because the plants absorb a lot of **chloride ions** (Cl-) which results in a **poor burning quality** of leaves and a mild **acidic soils** (pH 5-6) are **always better** for the production of **superior quality leaves.**
- Nicotine is produced mainly in **roots** and is carried through stem to leaves where it is **stored.**
- First hybrid variety of tobacco in India is: **GTH-1**

Indian tobacco has **two spp.**

a. ***Nicotiana tabacum***

- Plant height **150-250** cm.
- **Large** and narrow leaf
- **Nicotine** content is **0.5-5.5%**
- Used for **smoking** and **chewing** purpose
- Grown on **light soils.**

b. ***Nicotiana rustica***

- Plant **smaller** than tabacum
- **Nicotine** content is **3.5-8.0%.**
- Used for **hookah, chewing** and **snuff purpose.**
- Mostly grown on **heavy soils.**

Indian tobacco (are grouped in to):

a. **Flue Cured Virginia** (FCV):

- **Cigarette** tobacco
- Major **exportable** type

- Covers 30% area and 20% production of total.

b. **Non -Virginia types:**

- **Bidi, hookah** and **chewing** tobacco
- **70% area** and **80 % production** of total **tobacco**

Important operations:

a. **Topping:** •

- Removal of **flower heads** either alone or with few upper/top leaves from the plant to **improve** the size, and **quality** of **leaves.**

b. **De -suckering:**

- After topping, auxiliary buds grow; **removal** of such lateral branches or **suckers/auxiliary buds** is called **de -suckering.**
- The main aim of **topping** and **de -suckering** is to **divert energy** and **nutrient** from **flower head** to **leaves.**

c. Priming:

- **Removal** of **matured leaves**
- Entire harvest needs **5-6 priming**
- Used in **cigarette** and **wrapper** tobacco.

d. **Curing:**

- It is essentially a **drying process** whereby most of the **moisture** of leaf is **removed** to impart required **colour, texture** and **aroma** to the final product
- E.g. **Flue curing** used for **cigarette process.**

18. Buck “ heal: *Phagoprra esculanium*

I Family: **Polygenaceae**

I Known as **pseudocereal**

- Fruit of buck wheat is known as: **Achene**

Tokyo is the variety of buck wheat

1 Leaves and flower contains alkaloid: **Rutin**

- Sowing time of buck wheat: **June -July**

Crop cultivation terminology:

1. **Arable crops:** Crops which require preparatory tillage eg. Potato, tobacco, rice, sugarcane, maize.
2. **Alley crops:** Crops such as sweet potato, urd, turmeric and ginger are grown in the passages formed by the rows of eucalyptus, subabool and cassia mainly to hasten soil fertility restoration, enhance soil productivity and reduce soil erosion
3. **Augmenting crop:** These crops supplement the yield of the main crops e.g. Sowing of mustard with berseem or lucerne to get higher yield in the first cutting.
4. **Avenue crops:** These crops are grown along farm road and fences eg. Arhar, sisal, glyricidia.
5. **Cash crops:** Such crops are grown for sale to earn hard cash e.g. Jute, cotton, tobacco, sugarcane.
6. **Catch crops:** These are gown as substitute for the main crop that has failed on account of unfavorable condition. They are of very short duration, quick growing, early harvestable or usable at any time eg. Moong, urd, cowpea, onion.
7. **Cole crops:** Cole crops are essentially cold weather crops belonging to the family **cruciferae** and capable for withstanding considerable frost eg. Cabbage, cauliflower and sprout.
8. **Cover crops/ Mulch crops:** These crops are grown mainly to cover the soil and to reduce soil moisture and erosion by wind and water e.g. Lobia, groundnut, urd, sweet potato etc.
9. **Complementary crops:** In this cropping each other crop is benefited by intercropping e.g. Jowar + lobia. Jowar receives nitrogen from lobia and lobia requires support from jowar.
10. **Ley crops: Such** crops are grown for grazing or harvesting for immediate or future feeding to livestock eg. Berseem, mustard.

I I.Nurse crop: These crops are **nourished** other crops by providing shade and acting as climbing sticks eg. Rai/mustard in peas and jowar in cowpea.

12. **Paired row cropping:** Each third row is removed or growing of crops in paired row is called paired row cropping. It is suitable for dry land and objective is to conserve moisture.

13. **Restorative** crops: Such crops provide a good harvest along with enrichment or restoration or amelioration of soil eg. Legumes.

14. **Skip cropping:** A line is left unsown in the regular row series of sowing is called skip cropping.

15. **Smother crops:** These crops provides large canopy and quick growing ability e.g. Cowpea, mustard, sorghum.

16. **Trap crop/decoy crops:** Grown on boundary of the field to attract insect pests and soil borne harmful biotic agents such as parasitic weeds e.g. Orobanche (weed) is trapped by solanaceae plants.

17. **Silage crops:** Such crops are grown to preserve in pits in a succulent condition by a process of natural fermentation or acidification for feeding livestock during lean months or offseason e.g. berseem, cowpea. .

18. **Mixed farming:** It is a system of farming on a particular farm which includes crop production, livestock, poultry, fisheries, bee keeping sustaining and satisfying as many needs of the farmer as possible.

19. **Crop rotation:** Refers to the sequence of crops grown on the same land in a recurring succession.

20. **Mono cropping/mono culture:** Refers to growing of only one crop on a piece of land year after year.

21 Multiple **cropping:** Growing two or more crops on the same piece of land in one calendar year is known as multiple crops. It includes inter cropping, mixed cropping and sequence cropping.

- **Inter cropping:** Growing two or more crops simultaneously on the same piece of land with a define row pattern.
- **Mixed cropping:** Growing two or more crops simultaneously intermingled without any row pattern.
- **Sequence cropping:** As growing of two or more crops in sequence on the same piece of land in farming year.

12.gday cropping: Refers to growing a second crop boween the rows of the main crop which is ready to harvest shortly..

13.1Intooning: The practice of tacl, in the second crop from pre look one is known as *Ratoonink*

- Weed as a plant growing where it is not desired.

Important points:

Jethrotull is called as **father of weed science.**

V Weeds cause drastically annual losses to Indian agriculture which is more than the combined losses caused by insect -pest and diseases.

V In India 25% of crop losses due to weeds.

,7 Congress grass or carrot grass i.e. ***Parthenium hysteropholus*** and sneeze weed ***Helenium spp*** responsible for dermal **allergies** in human beings.

- **Allelopathy:** any direct/ indirect harmful effect, one plant has on another through the production of chemical compounds that escape in to environment known as **allelopathy.** These chemicals are **secondary metabolites.**
- **Weeds interfere** with crops as competition + allelopathy.

Johnson grass ***S. helepens*** at its **Tellering** stage is poisonous to animal due to their high prussic acid/HCN **(Dhurin)** content.

Dropsy: Mexican poppy i.e. ***Argemone mexicana*** seeds mixed with **mustard** seeds and crushed brought death and blindness in human being. Dropsy tragedy has occurred in **Delhi in 1998.**

- **Censer mechanism:** e.g. ***Argemone mexican*** the wind swings the intact plant and forces their mature pods to disperse seeds some distance away from the mother plant.

Vegetable propagation of weeds:

Weeds	**Prorogation**
• Bermuda grass	Rh izome/runners/stolons
• Tiger grass	Rhizome
• Johanson grass	Rhizome
• Purple nut sedge	Tubers

- **Waterhycinth** **Offsets**

Weed act as host for insect -pest and diseases:

60,VP4 _	Insect-pest/disease	Crop affected
Echinochola colonum	Stem borer	Rice
Chenopodium album	Gram caterpillar	Cotton, pea, and tomato
Agropyron portulaca	Wilt	Tomato
Cenchurus ciliaris	Ergot	Pearl millet
Leersia oryzoides	Bacterial leaf blight	Rice
Saccharum spontaneum	Downy mildew	Maize
Agropyron repens	Rust	Wheat

Weed dormancy:

- It is a stage of suspended development

Three type:

- **Enforced:** Due to deeper placement of seeds.
- **Innate dormancy:** Genetically controlled dormancy.
- **Induced:** Due to sudden physio changes like water logging.
- Wild oat ***(A. fatua)*** exhibits all **three kinds** of dormancy, reported by **Thurston,** 1959.

Example of biennial weeds:

- **Chicory** Wild carrot
- *Launea* *Plantago sp.*
- *Canada thistle (Circium arvense)*

Perennial weeds: Completes their life cycle in **more than** two year.

- Shallow rooted: ***Cynodon, Agropyron***
- Deep rooted: ***Cyprus rotundus, Sorgum he/pens.***

,/ Difficult perennial weeds are also called **pernicious** weed.

Weeds association:

a. **Season bound:**
- Grow in **specific season** of year with disregard to crop species.
- E.g. *Sorghum helepens, Circium arvense.*

h. **Crop bound weeds:**

- **Species of weeds which usually parasitize the host plant.**
- **It includes following:**

(i) Dodder/Cuscuta:

- **Total stem parasite.**
- **Host crop: Lucerne.**
- **It can be managed by spray of paraquat**

(ii) *Loranthusldandropthoe falcate:*

- **Partial stem parasite.**
- **Host crops: plantation crops.**

(iii)Broom *rapelorobanche sp.*

- **Total root parasite.**
- **Host crops of orobanche: Mustard, tobacco, chili, brinjal, potato.**

(iv) Witch weed/ *Striga sp.*

- **Partial/semi root parasite.**
- **Host plants of striga: Sorghum, maize, sugarcane, sunflower.**

c. Crop associated weeds:

(i) Crop specific weeds:

- **Due to need for specific microclimate**
- **E.g. chicory and coronopus require cool & moist climate.**

(ii) Mimicry weeds:

- **Survive well because of their similarity in morphology with host crops.**
- **Wild rice *(0. saliva* var. fatua) in paddy**
- **Wild oat *(A. fatua) &* canary grass *(Phalaris minor)* in wheat.**

d. Ready contamination of crop seeds:

- **Weeds *Allium sp.* (wild onion), wild garlic and *Phalaris minor* mature their seeds at the same height and time as the winter grain, thus they easily contaminate crop seeds at harvest time.**

e. **Obligate weeds:**

- Occurs only in the cultiva.ted/otherwise disturbed land.
- **never** found in wild form
- E.g. ***Chenopodium,*** field bind weed ***(Convolves arvensis).***

f. **Facultative** weeds:

- Such weeds are grown **both** as wild and in cultivated habits
- E.g. ***Argemone Mexicana, Euphorbia hirta.***

g. **Noxious weeds:**

- Weed being especially undesirable **troublesome** and **difficult** to control.
- **Example of noxious weeds are:**
  - *Cyperous rotandus*
  - *Echornnia craspes*
  - *Saccharum moonja*
  - *Imperta cyliderica*
  - *Lantana camara*
  - *Cynodon dactylon*
  - *Parthenium hysterophorus*

h. **Satellite/ Objectionable** weed:

- A noxious weed, whose seeds are **difficult** to separate, once mixed with crop seeds.
- The weeds that mature at the **same** time and **height** as host plant and have **similar** size and **shape** of their seeds as the crop seeds.
- Like ***Avena fatua, Pltalaris minor,*** *Chicory, Cuscuta* etc.

Stale seed bed:

- Before sowing to crops **irrigation** is applied to allow the germination of weeds and emerging weeds are **destroyed.**
- It is practice when **1-2 flushes** of weeds are destroyed before planting of any crop.

Biological control of weeds:

1. Use of Bioherbicides/pathogens:

Product	**Contains**
Devine	**Liquid** suspension of fungal spores of ***Phylopihora palinivora*** it cause **root rot** in weeds.
Collego	**WP** of fungal spores of ***Colletotrichum gleosporiodes*** It cause stem & leaf blight.

Biopolaris	**Suspension** of fungal spores of ***biopolaris sorghicola.*** it is used against **Johanson grass.**
Biophos	**Fermented product** of ***Streptomyces hygroscopicus.***

2. Biological control of weeds by use of insects:

- Biological control of weeds by insects is known as: parabiological control.

a. Prickly pear *(Opuntia vulgaris):*

- In India first outstanding success in biological suppression of weeds, was achieved when ***DacOlopies ceylonicus*** (dactylopidae: Hemiptera) introduced from **Brazil** in 1795 for the suppression of ***Opuntia vu/guns*** in central & north India.
- In Australia prickly pear ***(Opuntia inermis)*** was accidentally introduced in 1840. The moth borer ***Cactoblastis cactorum*** was introduced in 1925 from **Argentina** to control *Opuntia inermis.*

b. Water hyacinth *(Eichhoronia crassipes):*

- This weed introduced in India as ornamental pond plant in 1896. For the control of water hyacinth a mite ***Orthogalumna terebrantis*** was introduced from **Florida,** in 1982.
- Weevil ***Neochetina eichhorniae & N. bruchi*** were introduced to control hyacinth in 1983 from **Argentina.**

c. Congress grass *(Parthenium hysterophorus):*

- It's one of the notorious weed in India introduced through import of food grains from USA.
- This weed first reported from **Pune** (Maharastra) in 1955.
- A leaf feeding chrysomelidae beetle ***Zygrogramma bicolorata*** was introduced in 1983 from **Mexico** for the control of congress grass.

d. **Lantana weeds** *(Lantana camara):*

- It introduced in India as ornamental plant in 1809 from **Australia.**

- It contains toxin **lantadene A &** B in fruits and **lancamarene** in leaves, toxic to animals.
- For the control of lantana a Lace bug: ***Teleonemia serapalora*** was introduced from 1941 from **Australia.**
- **It** is also brought under control by a seed fly ***Ophiomyia lantanae.***

e. **Water fern** *(Salvinia molesta):*

- It was first observed in **Veil lake** (Kerala) in 1950.
- For the control of water fern; a Curculionidae weevil, ***Cryptobagous salvinae*** was introduced from **Australia** in **1982.**

Classification of weeds based on relativity:

a. **Absolute weeds:**

- **These are always weeds**
- **Plants of no economic importance for human being e.g. *Cyprus rotandus.***

b. Relative weeds:

- **These are other crop plants.**
- **Undesirable crop plants in the main crop field i.e. barley in wheat field.**

C. Rogue weeds:

- **Other variety plants in the same crop**
- **I.e. A few plants of C-306 variety in PBW-502 wheat field.**

d. Volunteer weeds:

- **Such weeds are grown from the fallen seeds of previous or preceding crop in the field.**

Pesticides use in agriculture:

Pesticides consumption order:

- **In world: Herbicides > insecticides > fungicides**
- **In India: Insecticides > fungicides > herbicides.**
- **The largest pesticide consuming crop in India is cotton followed by *rice* & vegetables.**
- **Largest consumption of herbicides in wheat followed by rice and tea.**

- The largest **manufacturer** and **consumed** herbicides in India is **Isoproturon.**
- Per hectare consumption of pesticide in India less than 0.5 kg/ha
- Highest consumption of pesticides in the world: Japan (10-12 kg/ha)
- Per ha herbicides consumption in India is: 40 g/ha

Classification of herbicides:

1. **Based on chemistry:**

SN	Group	Herbicides
1	**Aliphatics**	**Dalapon, TCA**
2	**Amides**	**Alachlor, Butachlor, Propanil**
3	**Bipyridilliums**	**Paraquat, Diquat**
4	**Dinitro anilines**	**Fluchloralin, Pendimethalin ,**
5	**Phenoxy acids**	**2, 4-D, MCPA**
6	**Thiocarbamates**	**Benthiocarb/thiobencarb**
	Triazines	**Atrazine, Simazine, Terbutryv i I ; Metribuzin**
	Phenyl Ureas	**Monuron, Diuron**
9	**Sufonylureas**	**Metsulfuron, Sulfosulfuron**
10	**i Unclassified**	**Glyphosate**

- **Glyphosate is a non selective, translocated herbicides**
- **Sulfosulfuron is a systemic foliage applied herbicide**
- **Fluchloralin is volatile in nature hence, used as PPI.**
- **2, 4-D = (2, 4-dichlorophenoxy acetic acid).**

2. **Based on time of application:**

   a. **Pre -Plant Incorporation (PPI): such herbicides are applied before planting of crop in field.**
      - **Soil applied: Fluchloralin, Alachlor**
      - **Foliage applied: Glyphosate, Paraquat**

   b. **Pre -emergence:**

- Application of herbicides after sowing of the crop but before emergences of crop or weeds is called pre-emergence application.
- E.g. generally selective herbicides **(Triazines** and **ureas).**

c. **Post emergence:**

- Applied **after** emergence of the crop and weeds.
- E.g. **2, 4-D, Propanil,** Diquat (all the foliage applied herbicides).

d. **Lay by application:** applied **after** last cultivation.

3. **Based on mode of action:**

a. **Contact herbicides:**

- **Diquat**
- **Paraquat.**

b. **Systemic herbicide:**

- **Soil applied: Fluchloralin, Pendimethalin**
- **Foliage applied: 2, 4-D, Triazines**

4. **Based on selectivity:**

a. **Selective herbicides:**

- 2, **4-D** **Triazines**
- **Isoproturon** **Fluchloralin**
- **Pendimethal in**

b. **Non selective:**

- **Glyphosate** **Paraquat.**

Herbicides and their trade names:

Herbicides	**Trade name**
Atrazine	**Atratex, Atrataf**
Alachlor	**Lasso**
Butachlor	**Mechate**
Dalapon	**Dowfon**
Isoproturon	**Ronak,** Arelon
Fluchloralin	**Basalin**

Monuron	Telvar
Metalochlor	**Dual**
Metribuzin	**Sencor**
Lectophan	**Cobra**
N itrofen	**Tok E-25**
Oxadiazon	Ronstar
Metsulfuron	Escort
Oxyflorfen	**Goal**
Paraquat	Sweep, Gramoxone
Pendimethalin	Stomp
Propanil	**Stamp F-34**
Sulfosulfuron	**Leader**
Benthiocarb	**Bolero**
Glyphosate	**Round up**
2, 4-D	**Plantguard,** Weedone

- **Atrazine** has both contact (when foliage) as well as systemic (when soil applied) action.
- **Metribuzin** and **Alachlor** are generally soybean herbicides.
- **Weedicides:** chemical use for the control of weeds, its **restricted term.**
- **Herbicides:** chemicals use for killing of **herbaceous plant,** there is a **concept** of **selectivity.**

Residuality of herbicides:

- **2, 4-D:** For 3-4 weeks.
- **Triazines:** For 1-2 year.

Non residual herbicides:

- Paraquat Diquat.

Families of some weeds:

Weed	Family
• *Lantana camara:*	**Verbenaceae**
• *&riga spp.:*	**Scrophulariaceae**

- *Argemone Mexicana:* *Papavaraceae*
- *Echinochola spp.:* **Graminae**

Other important points:

Angstrom (A°):

- It is the one ten -millionth of a meter.
- A = 10' m **or le** mm or 10 cm. ***(RPSC, A0-09)***

A -value: ***(JRF-Agronomy)***

- Proposed by **Friend** and **Dean,** 1952 and defined as an available soil nutrient determined in terms of a standard fertilizer used.
- Used for the assessment of available P and S in soils.
- Expressed as = **B (1-y).**

Acid forming fertilizer:

- Ammonium sulphate
- Ammonium chloride,
- Anhydrous ammonia
- Urea.

Acid sulphate soil:

- **Very acid soil** (pH <4) in which sulphuric acid is formed by the oxidation of **S -bearing** ferrous pyrite minerals.
- Found primarily in coasty, deltaic estuarine area of the humid tropics. ***(RAS -09)***
- Also referred as **cat clays.**

Adhesion:

- The force of attraction that binds the molecules of **different kind** e.g. **soil** and **water.**

Azolla:

- An **aquatic fern** which fixes atmospheric **N in symbiotic** association with ***Anabaena azollae,*** blue green algae which lies in its **cavities.**

Aeroponics:

- It is a system for growing plants with their **roots supplied** with moisture in **the air e.g. citrus, olive.**

Anhydrous ammonia:

- Dry and **highly acidic**
- Having **148** equivalent acidity
- **82** % N: **highest** nitrogen % among all **N** fertilizer.

Alumina silicate

- These are most common and principle soil forming minerals i.e. **feldspars,** micas, quarts.

Argillation:

It's a process by which the **dispersed** clay particles are migrated from upper to the lower soil horizons resulting a **textural horizon.**

Agronomic efficiency:

- Unit of **crop produced per unit input (nutrient) added.**

Antidote:

- **A chemical applied to prevent the harmful effect of a specific pesticide on human beings.**

Blind cultivation:

- Cultivation **before the crop is emerged especially practiced in potato and sugarcane is done for weeds control.**

Biostatic effect:

- **Reduced microbial decomposition of a pesticide in the presence of some chemical called extender.**
- **Boron is a biostatic to 2, 4-D.**

Baule unit:

- **Amount of a nutrient associated with 50% of the maximum possible yield.**

Blotch:

- **Disease of barley caused by *Helminthosporium spp.***

Base temperature:

- **Lowest temperature at which there is no growth is referred as base temperature.**
- **4 °C for wheat.**
- **10 °C for rice/sorghum.**

Cupping

- The upward turning of leaf edge to form a cup -like structure as seen in case of Mo deficiency.

Cohesion:

- The force of attraction that binds the molecules of **same kind** e.g. **water** and **water molecules.**

Ceiling leaf area index:

- Leaf area index at which **mutual shading** of leaves in a **canopy** is complete and net photosynthesis is **zero.**
- Gross photosynthesis **equals** the respiration losses of the whole crop.

Cropping intensity:

- Total sown area/net cultivated area x 100.

Cardinal temperature:

- Concept by **Sachs.** 1860.
- Maximum + **minimum + optimum combines called cardinal temperature.**

For cool season cereals:

- Minimum 0-15 °C
- **Optimum 25-30 °C**
- **Maximum 31-37 °C**

For warm season cereals:

- **Minimum 15-18 °C**
- **Optimum 3137°C**
- **Maximum 44-50 °C**

Epinasty:

- **Increased growth on the upper surface of a plant organ or part (leaves) causing it to bend downwards.**

Ecesis/ecess:

- **Adjustment of an organism to a new habitat where it can complete its life cycle.**

Ephemerals:

- Plants complete their life cycle **within 2-4 weeks due** to **moisture stress** (drought escaping plants).

Furrow slice:

- Surface soil with depth of **0-15 cm** over one ha is known as **furrow slice.**
- Weight of furrow slice is **2.25 x 106** kg soil/ha or 1 cm soil over one ha **=150 ton/cm/ha.**

Intensity factors (available P):

- The amount of $H_2Po_4^-$ and 1-1Po_4^{-2} present in **soil solution.**

Methaemoglobinaemia:

- A condition associated with **nitrate toxicity** as result of consuming nitrate rich water
- **Infants** suffering from this condition have been referred to as **blue babies** due to development of **grayish -blue** skin and the problem referred as **blue baby syndrome.**

Micron (μ):

- One micron is one millionth of a meter
- 1 = 10^{-6}m or 10^{-4} Clfl

Nanometer (nm):

- It is the one nine -millionth of a meter
- nm = 1 019 m or 10^{-6} mm or 10 A

Porometer:

- Instrument used to measure **leaf temperature** in addition to **transpiration** and **stomatal** resistance measurements.

Physiological maturity:

- When fruit growth is complete and photosynthesis are no longer translocated to fruits, it is known as physiological maturity

Harvesting maturity:

- At physiological maturity, the moisture percentage of grains is about 20 per cent.

Popping:

- In groundnut pod **without kernel** or unfilled due to: **Ca deficiency.**

Light use efficiency:

- The **conversion efficiency** or quantity of dry matter production per unit light interception is known as light use efficiency.

$$\text{LUE} = \frac{\text{Amount of dry matter produced (gm12)}}{\text{Amount of cumulative light absorbed (MJ m-2).}}$$

Light compensation point:

- The minimum light intensity at which photosynthesis and respiration rates are equal.
- Rice crop has high compensation point of 1400 ft. candles at 27 °C.

Light saturation point:

- The light intensity at which there is no further increase in the rate of photosynthesis is called light saturation point.
- Light saturation is high in C_4 plants compared to C_3 plants.

Crop geometry:

- It is a **spatial arrangement** or **plant rectangularity** of crops.
- The way in which the crop plants are arranged in the field is usually referred to as **crop geometry.**

Kor watering:

- The **first irrigation** of crops is known as kor watering and the depth applied in the first watering is **kor depth.**

Row crop:

- Crops which are sowing in uniform spacing e.g. **cotton.**

Selectivity ratio:

- **It** is the ratio of **maximum** dose **tolerated** by the crop to the minimum dose required to kill weeds.

Saturation light intensity:

- It is the maximum intensity at which the rate of photosynthesis reaches a maximum value.
- Most of crops reach light saturation point at 115th of full sunlight.

Sodium absorption ratio: *(JRF exam. many times)*

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

- The water contains SAR value > **10** is **harmful** to crops.
- Soils having SAR value >13 are considered as **alkali** or Sodic **soil.**

Thermoperiodism:

- Concept given by **Gardner.**
- Response of living organism to regular changes in temperature either day/night or seasonal in called as **thermoperiodism.**

Transpiration ratio:

- Amount of water transpired by a crop to produce 1 kg of *dry* matter.
- It expressed in **liter/kg** of dry matter.

Transpiration coefficient:

- Amount of water needed by a crop to produce 1 kg of dry matter. I.e. rice crop used **5000** liters of water to produce 1 kg of dry matter.

VAPSA/Vetier:

- Condition of **optimum moisture** to carry out **agricultural** operation **easily** and **efficiently.**
- Generally at **25** to **50 %** moisture **depletion.**

4. SOIL SCIENCE

Important points:

.7	Canker nodules are found mostly in:	**Red soils**
i	Process of moving out of sesquioxide is known as:	**Podzolization.**
i	Process of mixing of soils is known as:	**Pedoturbation**
/ '	Soils having at least 20% organic matter known as:	**Organic soils**
/	Law of minimum was proposed by:	**J. V. Liebig, 1840**
,/	0' horizon is absent in:	**Arable soils**
/	Top most mineral horizon is:	**A' horizon**
•7	Diameter of clay particle is:	**Less than .002 mm**
/	Soil structure which is best for cultivation is:	**Crumby structure**
,4	Particle density of most of the soil is:	2.65 gkc
/	Bulk density of general soil:	1.33 g/cc
'7	Total pore space highest in:	Clay soils
/	Kaolinite is a type of mineral:	**1:1 non expanding**
V	**Montmorillonite** is a type of mineral:	**2:1 expanding type**
V	**Vermiculate is a type of mineral:**	**2:11imited expanding**
V -	**Chlorites** are type of mineral:	2:1:1 **type mineral**
,7	Recently formed soils found order is:	**Entisols**
V	Black cotton soil found in:	**Maharashtra.**
'7	The weight of soil **furrow slice is:**	**2.25 x 106** kg/ha.
/	One **cm** of surface soil over **one ha of** land weight is:	**150** tones.
'7	Permissible soil loss by water is:	**12 t/ha.**
v	Chief constitute of sandy fraction:	**Quartz.**
7	Most dominant mineral on the earth **crust:**	**Feldspars (48%).**
v	Pulse crop does not fix N from atmosphere:	**Rajma.**
v	**First** manufactured fertilizer in India is:	SSP
v	Classification of soils by [CAR in:	**8 groups.**

V	Adverse effect of salinity on plant due to increased:	Osmotic pressure
V	Apical bud dominance is caused by which hormone:	Auxin
1	The crops which absorb the Ammonical form directly:	Paddy & potato
1	Ammonical fertilizers should be applied in:	Reduced zone.
V	Nitrate fertilizer should be applied in:	Oxidized zone.
1	Major source of nitrogen absorption:	Nitrate (NO_3) form
1	Pascal (Pa) is the SI unit of:	Pressure.
V	The smallest volume of soil (Ito 10 m^2) called a:	Pedon
V	Most of exchange of gases in soil is due to:	Diffusion
V	In addition of organic matter bulk density:	Decreases
V	In red soils the dominant clay mineral is:	Kaolinite
V	The red soils are red in colour due to presence of:	Iron oxide
V	Black soils are best suitable for:	Dry land agriculture.
V	In black soils the dominant clay mineral is:	Montmorillonite
1	Black cotton soils are deficient in:	Nitrogen.
i	Azolla is widely used bio fertilizer *in:*	*Rice* crop.
V	Formula of backing soda is:	$NaHCO_3$.
V	Formula of castic soda is:	NaOH.
V	USA is the first country to introduce:	Zero tillage.
V	Urea in the presence of ureas forms into:	Ammonium Carbamate.
V	Electrical conductivity is used to express:	Salinity of the soil.
V	Sterility in wheat due to:	Boron-deficiency
V	Ballast element:	Al and Silicon.

V	Red soils are dominate in:	**Tamil Nadu**
V	Laterite soils are dominant in:	**Karnataka** ***and*** **Kerala**
V	Organic matter content in Indian soils is generally:	- Less **than 0.5%**
V	Most outstanding green manure crop:	- ***Sunhemp(Crotalaria juncea)***
V	Wood is mainly decomposed by:	**Actinomycetes.**
1	**Nif:** gene responsible for	**N -fixation**
1	Population of **actinomycetes** is higher-in:	**Alkaline** soils.
1	**Fine texture** soils are more sensitive to:	**Water erosion.**
1	The soils which are most suitable for the most of the crops are:	**Sandy loam**
1	Rice can tolerate very low level even complete ....of oxygen in the soil.	**absence**
I	Desired size of the soil sample for soil testing is:	***0.5 kg***
1	Crop having the highest tolerance to boron is:	***Sugar beet***
1	Insoluble fraction of organic matter is:	***Humin***
1	Lowering of the B.D. of a soil indicates:	***Better physical properties***
1	Recently formed soil order:	***Entisol***
1	Ppm=per cent/10000 or ppm equal to	***0.0001 %***

1 Red soils are found in ***Tamil nadu***

- Soil pH measures active acidity of soil.
- Th element required for **seed formation:** ***P***

1 Oxidation: means addition **of oxygen or loss of electron**

Reduction means: addition of H2 or removal of 02 **or gala** of

electron

✓ On the number basis population of microbes in soil:

Bacteria > Actinomycetes > Fungi

- **The first antibiotic penicillin was discovered by *Alexander Flemming, 1929***
- **If gamete is fertile but seed is not produce due to: *Self incompability***
- **Oldest method of breeding for improving variety is: *Selection***
- **Zinc deficiency is produced in: *Calcarious soil***
- **In weed infested pond in high fishes are suddenly death become: *0 2deficiency***
- **Due to water logging the availability of which nutrient is increased in rice field is: *Manganese***
- **Light receptor pigment in animals is: *Melanin***
- **In lac production which country has monopoly: *India***
- **Skill development (improve skill) through: *Method demonstration***
- **Porosity: 100 -bulk density/particle density x 100.**
- **Bulk density of sub soil is higher as compared to urface soils.**
- **Active acidity: it is present (I-1 & A1+3) in soil solution.**
- **Soil texture is an inherent property of soil it can't be changed.**
- **Provision of adequate drainage is the basic principle in reclamation of saline and alkali soils.**
- **Alluvial soils most recently formed soils.**
- **Red soils are best suitable for agriculture.**
- **Many Pedon within defined limit is called soil series that is basic unit of classification.**
- **Chisel ploughs are also used to break hard pans present even at 60-70 cm.**
- **In general ploughs are used for primary tillage and harrows for secondary tillage.**
- **In zero tillage, primary tillage is completely avoided and secondary tillage is restricted to seed bed pre parathion in the root zone only.**
- **Soil erosion: detachment and transportation of soil particles by water/wind is soil erosion.**

- Portion of capillary water lying between field capacity (1/3 Atm.) to wilting coefficient (15 atm) is known as: **Available water**
- **Tillage** is the **mechanical manipulation** of soil for loosening the surface crust and brings about favorable condition for the germination of seeds.
- **Tilth** is the **physical condition** of soil in relation to plant growth.
- Stages of wind erosion: **Saltation** (75% of wind erosion)- suspension -surface creep
- Total N **content** of soils ranges from less than **0.02%** in **subsoil** to more than 2.5% in peats.
- **Warabandi:** rotational supply of water in canal irrigated area.
- **Cabbage** is highly sensitive to boron toxicity (< **0.33ppm)**
- Most common ureas inhibitor commercially available is **Agrotain** or NBPT (N -serve in **India)** recently **ATS** (ammonium thiosulphate) as a urease inhibitor.
- $H_2PO_4^-$ is **greatest** absorbed at acidic **PH** 6.5 or less. ***(IFFC0-09)***
- PO_4^{3-} is absorbed at higher value of pH (slightly **alkaline).**
- The uptake of HPO_4^{2-} is much slower than $H_2PO_4^-$
- Chelate: organic compound with combine **Fe, Mn, Cu, Zn.** E.g. EDTA (slow released micro organic **fertilizer).**
- **Pedalfer:** an absolute term used for a **group** of a soil with an **accumulation** of sesquioxide (Fe & Al) in lower part of Solum.
- **Adsorption: gathering** of molecules on a surface.
- Sun hemp ***(Crotalaria juncea)*** best suited crop for green manuring, it accumulate higher amount of N **134 kg/ha** followed by dhaicha ***(Sesbania encotata).***
- ***Sebania rostata:*** found stem nodules, hence aerial N fixation.
- **Foliar spray** method useful in small quantity fertilizer e.g. **micronutrient**
- **Organic matter** is major source of **nitrogen, phosphorus** (5-60 %) and 80% **sulphur.**
- The temperature of surface soil is **always higher than** atmosphere.
- For each **unit increase** in pH the **concentratke** of Mn^{+2}, Fe^{+2} decreases by **100 fold.**
- **Ideal NPK** ratio **should be: 4;2;1** for cereals and 1:2:1 for pulses.

V' The most widely occurring clay mineral in soil is *kaonite*

Underground reservoirs are usually found in porous rock formation called: *Aquifer*.

1 The fertilizer prepared with Rhizobium culture is known as *"Nitrogin"* Nif gene is responsible.

Alkali soil: ESP > 15, EC <4 dsm, Ph>10 also called Sodic or Usar soil. *(RPSC, A0-09)*

Mostly plants absorbed micronutrients in reduced form (Fe^{+2}, Mn^{+2} etc).

1 A unit change in pH represent a 10 fold change in 1-1+or Off activity.

1 Substances added to soils for the improvement of their condition known *as: Amendments*

1 The book 'Nature & properties of soil" is written by N.C. Brady. *(RPSC, AA0-09)*

Fertilizer most concentrate used for nutrient supply to crops is: *Anhydrous ammonia (82%N)*.

1 Complementary reactions between intercrops is: *Annidation*

• Sandy soils have higher bulk density than clay soils.

1 Green leaf manuring crops e.g. *Glericidia acculata, Pongamia pinnetta, Ipomoea cornea*

1 Green manuring crops e.g. *Crotolaria juncea* (Sunhemp), *Sesbania acculata* (dhaicha), and cowpea.

Sheet stage of water erosion most dangerous because it's not noticed by farmers

Plant geometry refers to the shape of plant

Crop geometry refers to the shape of space available for individual plants.

Muck soil: are having highly decomposed organic matter.

• *Peat soil:* organic matter partially decomposed and found under excessive moisture condition. PH of peat soils is 3.9 hence suitable for paddy.

Secondary clay mineral: A mineral that has been formed as a result of subsequent changes in rocks is known as secondary mineral eg. Kaolinite, montmorillonite, illite, gypsum.

Soil science:

- The word 'Soil' originated from Latin word *'So/um'* means Floor.

Definition of **Soil:**

- The soil is a dynamic natural body composed of minerals and organic materials as well as living forms in which plants grow.

a. **Edaphology:**

- It is the study of various **properties** of soil in relation to **growth, nutrition & yield of crops.**
- **It** derieved from two **Greek** words

Edaphos	**=**	Soil
Logos	=	Discourse

- According to Edaphology soil is natural habitat for plants.

b. Pedology:

- To study the **origin, classification** and **description** of soil is known as **Pedology.**
- It derived from **two Greek words:**

Pedon	**=**	Soil
Logos	=	Study

- **Father** of pedology is known as: **V.V Dokuchaiv.**
- According to pedology, soil is a **natural body.**

Types of rocks:

Rocks:	**Examples:**
• Igneous rocks	Granite, basalt
• Sedimentary rocks	Lime stone, sand stone and dolomite
• Metamorphic rocks	Gneiss, marble, quartz and slate

Metamorphic rocks and their parent material:

Metamorphic product:	**Derived**
• Gneiss	From granite
• Marble	From lime stone
• Quartz	From sand stone
• Slate	From shale

Earth minerals:

a. Quartz: silica or S102:

- Chief constituent of sandy fraction
- Constitute **36 %** of earth's crust.
- Rocks containing free silica in abundance, which is not combined with bases, are called **"acid rocks".**
- **In granite** (acid rock), **quartz** is present in a pure form as a prominent constituent.
- In basic rocks like **basalt** contain only a **little,** if any of free silica.

b. Feldspars:

- Formula **K20. A103. 6 Si 02**
- Such mineral constitute about **48 %** earth's crust.
- Feldspar weather easily and give rise to clay on hydrolysis.

c. Micas:

- **White mica** is **more resistant** to weathering than black mica.
- Micas are more **resistant** to weathering than feldspar and other silicates.
- Micas constitute **10 °A** of earth's crust. Two types:

(i) **Potash mica:** Potash mica is **white,** clear **and transparent and known as muscovite** mica

(ii) **Magnesium mica: It** is called ***biotic*** *black* mica

Soil formation:

- Soil is formed from weathering of rocks and minerals.
- Soil formation is a slow process, formation of one inch soil needs 800-1000 years.

According to jenny:

- Soil property is determined by the relative influence of these factors:

a. **Passive factors:**

(i) **Parent material: it** is the unconsolidated mass from which the solum develops.

(ii) Relief/topography:

b. Active factors:

(i) Climate

(ii) Organisms (biosphere)

c. **Natural factors:**

(i) Time or age of land

Soil profile:

- A **vertical section** of the soil through all its horizons *and* extending into the parent material and the Individual layers are regarded as ***horizons.***
- It grouped into: **0, A, B & C horizons.**

1. **O' horizon:**

- **Organic** horizon is present above mineral soils.
- It is generally found in **forest** areas.
- Such 0" horizon is visible in **virgin** soil and absent in **arable** soils.

2. **A'** (Eluvial) **horizons:**

- **Top most** mineral horizon.
- Containing mixtures of **organic matter** which **tends imparts a darker** colour than that of the lower horizon.
- It is zone of **washing out/maximum leaching.**
- **Mobilization** of **nutrients** takes place.

A' horizon having sub horizons:

(a) ***A1 Horizon:*** It is uppermost mineral soil horizon rich in organic matter.

(b) ***E' or A2' Horizon:*** Horizon of maximum eluviations of clay, Fe Al oxides.

(c) ***AB or EB horizon:*** Transition horizon between A/E and B (also called A3).

3. **B'** (Illuvial) **horizon:**

- It is zone of **washing in** or horizon of **maximum accumulation (immobilization)** of materials such as Fe and Al oxides and silicate clays.
- Deposition of $CaCO_3$, $CaSO_4$ and other salts in **arid zones.**
- This horizon some time also referred to as **sub soil.**
- It **can't** be **cultivated** by **tillage** operation.

4. **C' horizon:**

- It is **unconsolidated** material underlying **the** *Solum* (A & B **horizon).**

- It is zone of least weathering.
- Accumulation of Ca, Mg carbonates, and cementation.

Major component of soil:

Mineral	=	45%
Organic soil	=	5%
Air space	=	25 %
Water	=	25 %.

Properties of soil:

1. Soil texture:

- Soil texture refers to the relative proportions of various types of soil particles. OR
- It is refers to the ***size of the soil particles.***
- It is basic property of a soil, it ***can't*** be changed.

Mechanical analysis of soil separates i.e. the percentage of sand, silt and clay is done by ***Hydrometric method.***

Classification of soil particle size:

Classification	**According to** IISS (dia. in mm)
Gravel	>2.0
Coarse sand	0.2 - 2.0
Fine sand	0.02 - 0.2
Silt	0.02 - 0.002
Clay	< **0.002**

Textural classes:

- **Sandy soil:** **Soil contains more than 85% sand.**
- **Silt soil:** **When more than 80%** silt.
- **Clay soil:** **When** more than **40%** clay.
- **Clay soils have highest pore space then other.**

Loamy soil:

- **These are** best for **agricultural production because** they **retain more water and nutrients than sandy soils.**
- **Suitable for most of crops**
- **Have better drainage, aeration and tillage properties than clay soils**

Heavy soils:

- **The clay soil imparts cohesion and stickiness and fine texture to the soil and induces resistance to the passage of implements.**
- **In other words it makes the soil "heavy"**
- **These soils are suitable for cotton, rice, sorghum.**

Light soils:

- **In comparison to clay soil sandy soils offer little resistance to implements and called light soil.**
- **E.g. Light soils suitable for groundnut, potato, tobacco and legumes.**

Hence;

- **The term heavy and light refers to the degree of resistance offered by soil to the passage of implements**
- **But not to weight in fact the heavy soil weights less than an equal volume of the light soils.**

2. Soil structure:

- **Refers to the arrangement or grouping of primary soil particles viz., sand, silt, clay and their aggregates into certain defined pattern is called soil structure.**
- **Individual aggregates are known as Peds or secondary units.**
- **Soil structure can be changed by agronomic practices i.e. ploughing, cultivating, drainage, liming and manuring.**
- **Natural aggregates are called *Peds.***
- ***Clod:* It is used for a coherent mass of soil broken into any shape by artificial means such as by tillage.**

Shapes of soil structure: most agricultural importance soil shape /structures are following types:-

I. Spheroid:

- **Rounded aggregates or pads not more than 2 cm in diameter often in a loose condition in the A" horizon.**
- **It is grouped in to granular and crumbs.**

(a) Granular:

- **Fine aggregates of soil, good for crop cultivation.**

(b) Crumb:

- **When granules are especially porous known as crumb.**
- **It is most suitable for cultivation of crops.**

PAINMEIMINEW&O-

- Hence, both granular and crumb structures are most favorable for plant growth.

3. **Density of soil:**

- It is measured by ***Pycnometer***
- Two types:

(a) **Particle density:**

- It is the density of the oven dried soil particles when air is excluded.

$$\text{P.D.} = \frac{\text{Mass}}{\text{Volume of soil particles}}$$

Particle density of soil is: ***2.65 g/cm3*** *org/cc.*

- P.D. some time also known as ***real density*** or *gain density or absolute density.*
- Particle density is **lower** when the **organic matter** added in soil.

(b) **Bulk density/apparent density:**

It is the ratio of the weight of oven dried soil to its bulk volume.

$$\text{B.D.} = \frac{\text{Weight of } \textbf{oven dry} \text{ soil}}{\text{Volume of soil}}$$

It is also called the volume weight.

- Bulk density is generally **half** of particle density.
- Bulk density: **1.33 g/cc**

Sandy soils have high bulk density than clay

- Organic matter decrease B.D
- Tillage operations also reduce B.D

4. **Thermal conductivity:**

- It is defined as amount of **heat flowing** in unit time through a unit cross section of soil.
- The thermal conductivity is **high** for **sandy** soils compared to clay soils.
- Soil **moisture** content **increases,** thermal conductivity also increases.

- **Addition of organic matter in soil decrease thermal conductivity.**
- **Thermal conductivity decreases with increase in porosity**
- **Tillage decreases thermal conductivity**

5. Redox potential:

- **It is measured by: Eh**
- **For well drained soil: 400 to 700mv**
- **Water logged** soil: **-250 to -350mv.**

6. Soil plasticity:

- **Soil containing > 15 % clay** exhibit plasticity.
- Range of moisture content in soil which exhibit plasticity is known as ***plasticity index*** *or limit.*
- **Plasticity index** given by **Alterberg,** 1911 also gave limits **of soil.**

(a) Lower plastic limit: **Lowest moisture** content at which soil can be deformed **without cracking or it is upper** limit of moisture for tillage.

(b) ***Liquid limit*** *or upper limit:* Higher moisture content which destroys soil aggregates or moisture at which cease to be plastic.

- **Soil plasticity** determined by apparatus: ***liquid limit devices.***

7. Soil consistency:

- Resistant soil at various moisture content to **mechanical stress**
- Soil consistency order is: **dry soil** > **moist soil** > **wet soil**

8. ODR (oxygen diffusion ratio):

- It measured by **platinum weir** electrode.
  Range of ODR **22.9 x 10^{-8} to 39.5 x** 10^{-8} g/cm^2/minute
- **For irrigated** ***pea:*** **39.5 g/cm^2/min** (highest ODR)
- **For rice:** **22.1** x 10^{-8} g/cm^2/min (lowest)

9. Soil colour:

- Determined by ***Mulsan colour chart.***

(a) **HUE:** It denotes the dominant spectral colour (yellow, red blue, brown).

(b) **VALUE:** Denotes the lightness and darkness of colour.

(c) **CHROMA:** Denotes purity of colour.

10. Specific heat: unit is (cal/g)

- For water: 1
- For soil: **0.2**
- For organic matter: 0.5

Note:

- The heat gain or loss by the soil is five times quicker than by the water because the specific gravity of the soil is **0.2** and the specific gravity of the water is **1.0**

Silicates minrals:

a. Olivine:

- It is Ferro -magnesium silicate (Fe Mg) 2 S104
- Two hydrated forms of olivine are **talk** and **serpentine,** is a hydrated silicate of **Mg.**

b. Tourmaline:

- It is boron- alumina silicate.

Some Silicates which are source of plant nutrient:

- Phosphorus: **Apatite**
- Potassium: **Biotite,** Orthoclase
- Magnesium (Mg): **Dolomite, Olivine**
- Calcium: Anorthite, Dolomite
- Boron: **Tourmaline**
- Molybdenum: Olivine
- Manganese (Mn): Pyrolusite

Minerals resistant to weathering (descending sequence):

II **Quartz >** Muscovite > Feldspar > Biotite > Calcite

Composition of earth's crust:

Element	**°A amount**
Oxygen	**47.02**
Silicon	28.06
Aluminum	**8.16**
Ferrous	4.64
Calcium	3.50
Sodium	2.63
Magnesium	2.62

Silicate clay mineral:

- **The** most important silicate clay is known as ***phyllosilicate.***
- The silicate clay unit consists of alternate sheets comprised of one type if sheet is dominated by **silicon** (Si) and other by **Al/ Mg.**
- Silica -dominated sheet is called **tetra hedral** and Al/Mg sheet is called **octahedral** because of eight sided building block.
- Si^{4+} is surrounded by four oxygen ions and Al/Mg **by** six hydroxyl/oxygen ions.

Classification of silicate clays:

A. **On** the basis of number and arrangement of tetrahedral and octahedral sheet, silicate clays are classified in to 3 -different group:

1. **1:1 type minerals** (one ***tetrahedral Si*** **to** one ***octahedral Al sheet):*** e.g. ***Kaolinite.***

2. **2:1 type minerals: (two Si** sheet to **one Al sheet). Means alumina is sandwiched between two tetrahedral silica** sheets. Eg. ***Montmorillonite, illite*** **and** ***vermiculate.***

3. **2:1:1 or 2:2 type mineral: eg. *Chlorites.***
   - **These are basically ferro-magnesium** silicates **with some amount of aluminum present.**
   - **It is having an extra layer of Mg -dominated alumina sheet, called *Brucite*** (Mg $(OH)_2$).
   - But Mg^{2+} also **dominates the alumina sheet of 2:1 type minerals.**
   - **Thus crystal unit has two silica** sheets **and two magnesium** dominated alumina sheet.
   - **Hence it is also *called 2:2 type clay minerals.***
   - It is **non- expanding** in nature.

B. **On the basis of expending and non expending nature the silicate minerals are grouped in to following** types:

1. **Expanding type:**
   - It includes **montmorillonite (Smectite group) and vermiculate group.**

a. **Montmorillonite:**

- **Montmorillonite** is prominent in clay soils.
- It is most common **Smectite** in soils where Mg^{+2} is substitute for Al^{+3} in alumina sheet (octahedral).
- It is loosened by ***"wonder wall force"*** **.**

b. **Vermiculate:**

- In this group the degree of swelling is considerably less than Smectite, so also called ***limited expansion clay mineral.***
- But the CEC (cation exchange capacity) of vermiculites exceeds that of all other silicate clays due to very high ***negative charges.***

2. **Non -expanding type:**

a. **Illite:** Found in clay soil

b. ***Micas:*** (Muscovite, Biotite): These are found in sand and silt.

Basic properties of major silicate minerals:

SS	Property	Kaolinite	Illite	Montmorillonite	Vermiculate	Humus
I	Type of silicate clays	1: !type non expanding	2:1 non expanding	2:1 expanding type	2:1 limited expanding	
1	Total surface area m2/g	37-45	120-170	580-750	**780-900** (highest among silicates)	1200
2	External surface	Very low	Low	Medium	High	–
3	Internal surface	None	Low	High	Less than montmorillonite	-
4	Cohesion, plasticity, swelling	Very low	Low	High	medium	lo'N
5	CEC (meq/100 g soil)	3-15	30-40	80-150	100-150	>200
6	Size (in μ)	0.1-5.0	0.1-2.0	0.01-1.0	--	-
7	P fixing	–	Low	Highest	Medium	

Soil taxonomy:

Modern classification:

- **It is US comprehensive soil classification system based on 7th approximation.**
- **This system maintains the natural body concept and two major features adopted were (1975):**

a. **Primary basis for identifying different classes are properties of soils rather than genesis of soil.**
b. **Latin or Greek words are the basis for nomenclature.**

Six categories were adopted for this system: is

- **Order**
- **Sub -order**
- **Great group**
- **Sub -group**
- **Family and**
- **Series.**
- **The smallest unit of** soil classification **is the *soil series*.**

Soil orders in the 7th approximation and their derivation: 12 soil orders.

SN	Soil order	Features
1	Inceptisols	Young, embryonic soils with few diagnostic . features.
	Entisols	Recently formed (Alluvial soils), little profile development
	Vertisols	Dark or black swelling clays, deep cracks develop when dry
	Oxisols	Oxide, sesquioxide rich soils, highly weathered soils of tropical regions
	Alfisols	Relatively young soils, acid soils, larger in forest soils
6	Histosols	Called organic soil, have more than 20 % O.M.
7	Aridosols	Desert soils of arid regions
	Spodosols	Such soils are with sub soil accumulation of sesquioxide and humus
9	Ultisols	Low nutrient, low base status, forest soils
10	Mollisols	Soft; grassland dark soils of steppes and prairies, high base status
II	Endisols	
12	Celisols	

Soils of India:

- **Broadly eight groups but four major groups are described as:**

1. **Alluvial soils:**
   - **Formed mainly from *Entisols***
   - **Deposited in flood plains by transportation in streams and rivers.**
   - **Largest soil group with occupying about 143 mha (highest area in UP followed by Haryana, Delhi, Rajasthan and western Gujarat).**
   - **Alluvial soils are azonal soil (no horizon).**
   - **It is geographically two types:**
     - **Khaddar or newely formed alluvial, more sandy.**
     - **Bhangar or older alluvium, more clayey soils.**
2. **Black soils:**
   - **Formed mainly from vertisol soil order.**
   - **Rich in montmorillonite clay minerals.**
   - **In Maharashtra soil derived from *Deccan* trap is called *Regur* or *black cotton* soils, mostly high clay content.**
   - **It is dark, fine grained soils.**
   - **It is second largest soil group after alluvial with occupying 55 mha (mainly found in Maharashtra & MP).**
   - **Poor in phosphorus, nitrogen and organic matter.**
3. **Red soils:**
   - **Formed mainly by Allis°Is soil order.**
   - **Red soil occupied about 15 mha (largest area in TN followed by Karnataka and Goa).**
   - **Red soils have high P fixation capacity due to presence of kaolinite clay mineral.**
   - **The red colour due to presence of iron.**
   - **These soils are rich in Fe and Mn.**
   - **Red soils also called as early soils because in the light and frequent rains of south west monsoon, red soils permit sowing being done earlier than other soils.**
4. **Laterite soils:**
   - **Formed mainly from ultisols and oxisols soil groups.**

- **Kaonite** is dominated silicate clay.
- Occupied about **25 mha**
- Mainly found on hills of Kerala, Karnataka, Orissa, Assam and coastal area of Goa, Maharashtra.
- Formed under **heavy rainfall** and **high temperature.**
- **Maximum leaching** takes place.
- Good physical condition due to presence of hydrous oxide of Fe & Al.
- Shifting cultivation adopted
- Suitable for **plantation crop** and **rice cultivation.**

Soil fertility:

- **The inherent** capacity of the soil to **supply** plant nutrient in adequate amount in suitable proportion for the growth of plants.

Soil productivity

- The capacity of the soil to produces in a unit area, expressed in kg/ha or Rs/ha.
- A fertile soil may or may not be productive but a productive soil always fertile.

Basic differentiate between soil fertility and productivity:

Soil fertility	**Soil productivity**
It is the ability of the soil to provide all essential plant nutrients in available forms in a suitable balance	Capability of soil to produce specified crop yield under well defined and specified system of management of inputs & environ. condition
It is an index of available nutrient to plants	It is used to indicate crop yields
Influenced by the physical, chemical and biological factors of the soil	Depends upon fertility and location
All fertile soils are not productive	All productive soils are fertile
It is an inherent property of the soil	It is not the inherent property of the soil

Humus:

- Humus is a complex and rather resistant mixture of brown or dark brown amorphous and colloidal substances modified from the original tissues or synthesized by the various soil organisms.
- Humus contains **40-45% lignin** and **30-33 % protein,** hence humus is also called **lingo -protein** complex.
- The C: N ratio of humus is: 10:1
- C: N ratio of normal soils: 12:1
- C: N ratio of Legumes: 20:1 to 30:1
- C: N ratio of FYM: 20-30:1
- C: N ratio of micro organism: **4:1 to 9:1**

Organic matter:

- **Humus and organic matter contains nitrogen about 5 to 5.5 % while in humus & organic** matter **Carbon** ranges from **50 to 58%** that given a C: N ratio **9:1 to 12:1.**
- **Year after year the quantity of organic matter in soil is declined.**
- Organic matter is the key of production & maintain of soil health
- **Organic matter is found higher** in **grass land than forest area.**
- **Method of organic matter is calculated by multiplying the organic carbon values by a conversion** factor of: **1.724.**
- Organic matter = Organic carbon x 1.724
- **1.724 is called *Bern/en factor*.**
- **The status of nitrogen in general soil is 0.03-0.05%, that means** presence of **1000** kg of N/ha.

Soil buffering:

- Means resistance to change in soil **pH.**
- Its regulate ***availability* of nutrients to plants.**

Cation adsorption order is:

- **A1+3> Ca'2> Mg+2> K+**
- Here, K+ is **less tightly held by colloids hence K+** ion **radially available for plant or subjected to leaching.**

Anion exchange order:

- **H2Po42 > OH- > S042> NO3**
- **NO;** is less tightly held hence, **easily available** to plants or subjected to **leaching.**

Flocculation:

- The colloidal particles are coagulated by adding an oppositely charged ions process is called flocculation.

Order of flocculation:

- A141> Ca+> H+> Mg'2

Sequence of availability/absorption of nutrient:

- **Nitrogen > potassium > phosphorous**

Availability of nutrients with 13" values:

Availabitlity at pH	pH <6.0	pH 6.0-6.5	pH > 6.0
Nutrients	Al, **Fe, Mn, Zn**	**P**	**Ca, Mo**

- Ca & Mo availability increase with **increase in pH**

Soil acidity:

- **Active acidity:** as the acidity develops due to presence of **hydrogen** (H4) and A1+3 ions on the **soil solution.**
- **Exchange acidity:** as the acidity develops due to II+ and A1+3 ions **(adsorbed)** on the **soil colloids.**
- In acidic soils conc. of Fe, Mn Al and **I-1** ions increases and the concentration of P. Mo, **N, K,** S decreases

Problematic soils of India:

a. Acidic soils:

- Highest acidic soils found in **West Bengal**
- Acidity due to adsorption of Alf3, Fe+2, Mn ions on soil colloids.

Acid soil management:

- Use of agriculture **liming material** such as oxide, hydroxide, carbonates of Ca & Mg

b. Saline soils:

- White crust of salt hence called **white** alkali/solon chalk.
- Soluble salt i.e. Cl & SO4 ions of sodium and calcium in root zones
- EC is used for measurement of soil salinity

- Found in arid and semi arid zones.

Reclaimation of saline soil:

- **Flooding** or **leaching** of soluble salts by **good irrigation** water.
- Keep soil moist or frequent irrigated the field.
- Use of *FYM* for salin, cclamation

c. Alkaline soils:

- Boron, Mo, and sodium toxicity in alkaline soils
- Black coloured, found in semi arid & sub humid area
- Developed due to excess NaCO3 and **NaHCO3** ions in soil
- In alkali soils should be used CAN or DAP instead urea

Reclamation of alkali soils:

1. **Gypsum @** 8 qt/ha used for reclamation of sodic or alkali or soils having Ph > 8.5.
2. **Iron pyrite (Fes2) @** 12 qt/ha can be used for amendments of alkali soil
3. Green manuring should be adopted
4. Cultivation of salt tolerant crops:

Relatively salt sensitive crops are:

Crop	High tolerant	Medium tolerant	Sensitive crops
Field crops	Barley, dhaicha, sugarbeet, tobacco, cotton, mustard	Rice, sorghum, pearl millet, arhar, wheat, rye, oat	Sunhemp, pea, groundnut, moong, gram, urd
Fodder crops	Rhodes grass, Khush grass	Sudan grass, berseem, Lucerne, sorghum	Cluster bean
Vegetables	Spinach, raphanus, sugar beet, *B. repa*.	Cabbage, cauliflower, tomato, carrot, onion, potato	Sam, English varieties of raphanus
Fruit crops	Date palm, Phalsa	Pomegranate, grapes, guava, mango, banana	Apple, ber, lemon, straw bery, almond

v in case of **saline** soils **Gypsum shouldn't** be recommended because sulphate also increases salt concentration.

I Substances that influence the plant growth favorably by emulating the soil physical and chemical properties are called *soil amendments.*

Parameters of different problematic soils:

Parameters	Saline soil	Alkaline soil	Saline -Alkali
PH	<8.5	> 8.5	> 8.5
EC (in ds/m)	> 4	< 4	>4
ESP	<15	>15	>15

Physical classification of soil water:

a. Hygroscopic water:

- It held mostly by soil colloids.
- Tension varies from 31-10,000 atmospheres
- It held at hygroscopic coefficient.
- Mostly non -liquid
- Moves in vapor form therefore biologically inactive.

b. Capillary water:

- It present in capillaries of soil.
- Held between field capacity and hygroscopic coefficient in micro pores
- At a tension of 0.3 (1/3) to 31 atm.
- Function as soil solution.
- Mostly available form of water to crops

C. Gravitational water:

- It held by a negative tension of less than 0.3 atm.
- Free water which drains out
- It is also called drainage water.
- Undesirable and usually present in macro pores.

Soil erosion

- The process of the removal of soil particles from the parent body and transportation of such particles by wind and/or water.

1. **Water erosion:**

a. **Splash/rain drop:**

- It is first stage of water erosion.

b. **Sheet erosion:**

- **Highest and uniform removal of soil particles.**
- **It is unnoticed by farmer hence most serious form of water erosion.**

c. **Rill erosion:**

- **Can be removed by normal tillage operation.**

d. **Gully erosion:**

- **It can't be removed by normal tillage operation.**

2. **Wind erosion: Grouped into three** stages:

a. **Saltation:**

- The movements of soil particles through bounces/jumps on ground.
- Saltation is the first stage of movement of soil particles in series ofjump.
- Particles **0.1-0.5** mm diameter is moved by saltation.
- Soil loss account for 50-75 % by Saltation.

b. **Surface creep:**

- **Rolling or sliding** of larger soil particles
- Particle size > **0.5mm.**
- Generally **5-25 %** soil loss by surface creep.

c. **Suspension:**

- Floating of small size particles < **0.1** mm in size,
- Soil loss accounts 3-4 % by suspension.

3. **Wave erosion:**

- Erosion by combined action of wind and water also known as strive bankes
- The permissible limit of soil loss in India is: ***12 ton/ha/year***
- The rate of soil erosion in India per hectare is: ***16.4 t/ha***
- When erosion is caused by excessive grazing, deforestation etc called: ***Anthropogenic erosion (Pre-PG,1993)***

Deposition of soils:

- The accumulation of **transported** soils at another place is known as **deposition.**
- **It** may be following types ace. to transportation source

Transportation source:	**Known as:**
Gravity	Col luvial

Water	Albivial
Ice	Glacial
Wind	Aeolian (sandy soil)
Wind	Loess (silt soil)

Mineralization and immobilization:

a. **Mineralization:**

- **It is the conversion of an element from an immobilized form to an available form as a result of microbial decomposition.**

b. **Immobilization:**

- **It is the reverse of mineralization where available form of an element is fixed as immobile form.**

In case of nitrogen:

- **When C: N ratio exceed 30:1, immobilization occurs and**
- **When C: N ratio is below 20:1, mineralization takes place.**
- **C: N ratio > 30:1 = Net Immobilization**
- **C: N ratio < 20:1 = Net Miner:az' ation**
- **C: N ratio = 15-30 both immobilization and mineralization.**

Aminization:

- **The final stage is the decomposition of protein and the release of amines, amino acid and urea.**
- **This step is termed aminization and these produced turned in ammonia (NH_3) called *ammonification.***

Nitrification:

1 **The microbial conversion of NH_3 into nitrate mediated by microbes known as nitrification.**

(i)	NH_3^+	(Nitrosomonas)	NO_2^- (Nitrite)
(ii)	NO_2^{-2}	(Nitrobacter)	NO_3^- (Nitrate)

- **Optimum temperature for nitrifying bacteria is 30-35 C and optimum pH is 6.5-7.5.**

In case of phosphorus:

- **25-80 % of P present in soil is in Organic form.**
- **Major source of P in humus is present in the form of phytin and small amount as 0-10% in nucleic acid.**
- **C: N: P ratio 100:10:1**
- **C: N: P ratio > immobilization occurs.**

Unit: Manure and fertilizer:

Manures:

- Manures supply plant nutrients in **small quantities** and provide **organic** matter in large quantities.
- Compost that is prepared with the help of earthworms is called ***vermicompost.***
- ***Night soil*** is human excreta, both solid and liquid.

Green manure: Green, undecomposed plant material used as manure is called green manure. It is two types;

a. **In situ green manuring:** growing of green manure crops and decomposed in the same field e.g. Sunhemp, dhaicha, clusterbeans and *Sesbania rostrata*. ***Sesbania rostrata*** is a stem nodulating green manure crop which is a native of West Africa.

b. ***Green leaf manuring:*** Collecting green leaf along with twigs eg. Glyricidia, Pongamia, Neem, Mahua.

Nutrient contents in some Manure:

Product	**N**	**P**	**K**
FYM	**0.5**	**0.2**	**0.5**
Town compost	1.5	0.4	1.4
Vermicompost	3.0	1.0	1.5
Night soil	5.5	4.0	2.0
Ground nut cake	_**7.3**	**1.5**	**1.3**
Safflower cake (decorticated)	**7.9**	**2.2**	**1.9**

Fertilizers:

- Fertilizers are generally inorganic in origin and they supply one/more essential plant nutrients in large proportions.

Classification of fertilizer:

a. **Straight fertilizer:** Fertilizer which supply only **one major** plant nutrient e.g. Urea

b. **Complex fertilizer:** Fertilizer which supplies **two or more** of the primary nutrients e.g. **DAP**

c. **Mixed fertilizers:** Are the products made by **mixing** two or more fertilizer e.g. **NPK**

d. **Complete fertilizer:** Fertilizer having all **three primary major** nutrients e.g. **NPK**

e. **Low analysis fertilizers: Having less than 25 % of the primary nutrient e.g. SSP**

f. **High analysis fertilizer: Contains more than 25 % of the total primary nutrient e.g. Urea**

Fertilizer grade:

Refers to the guaranteed analysis of its plant nutrient.

It is minimum guarantee of the plant nutrient content in the terms of available N, P, and K eg. NPK: 19:19:19.

Fertilizer ratio:

- **Refers to the relative percentage of N, P_2O_5 and K_2O.**
  Eg. a ratio of 2:1:1 means 80 Kg N, 40 Kg P_2O_5 and 40 Kg K_2O.

Order of hygroscopic nature of fertilizers (decreasing)

- **Ammonium nitrate > Urea > ammonium sulphate > CAN**

Acidic residual nature of fertilizer:

- **Anhydrous ammonia > ammonium chloride > ammonium sulphate > urea > ammonium nitrate (lowest).**

Order of basic residual nature of fertilizer:

- **Calcium cyanamide > sodium nitrate > di calcium phosphate > calcium nitrate**

Equivalent acidity of fertilizers:

- **Anhydrous ammonia: 148 meq/100g**
- **Ammonium chloride: 128**
- **Ammonium sulphate: 110**
- **Urea: 80-85**
- **DAP: 77**
- **Ammonium nitrate: 60**

Equivalent basacity of fertilizers:

- **Sodium nitrate: 29**
- **Calcium nitrate: 21**

1. **Nitrogenous fertilizers:**
   - **The ultimate source of nitrogen is *atmosphere* and immediate and important source of nitrogen is *organic matter*.**
   - **Maximum consumption of N & P in the state: UP**

Nitrate fertilizer:

- **Highly.mobile in soil**

- I Suitable for top dressing.
- 1 Nitrate fertilizers are basic residual in nature.
- 1 Leaching and denitrification loss high.

Examples of nitrate fertlizer:

- **Sodium nitrate:** 16% N, good for acidic soils
- **Calcium nitrate:** 15.5% N.
- **Potassium nitrate (KNO3):** 13 % N and 46 % P20 .

Ammonical fertilizer:

- Less leaching but readily soluble in soil.
- I Suitable for water logged soils.
- Acidic residual nature.
- Volatilization and denitrification losses more.

Examples of ammonical fertilizer:

a. **Ammonium sulphate (N114SO4):**
- Contains 20.6 % N and 24.5 % Sulphur.
- Most suitable for paddy, tea, groundnut & sugarcane

b. **Ammonium chloride (NH4C1-):**
- It contains 25.5 % N
- Being acidic residual nature it is extensively used in paddy.

c. **Both NH4+and NO3- N fertilizer:**

(i) **Ammonium nitrate (NW-NO3-):**
- It contains 33 % N (half of ammonium form and half nitrate)
- Highly hygroscopic nature
- Explosive fertilizer

(ii) **Calcium ammonium nitrate (CAN):**
- Commonly known as Kishan khad
- it contains 26% N
- Neutral in nature.

d. **Amide fertilizer: two types**

1. **Organic form:**

Urea (NH2CO NH2):
- Most commonly used N- fertilizer in India
- Cheapest source of nitrogen
- Contains 46 % N

- **It is hygroscopic therefore produced in granular/pellet form.**
- **Acidic in residual: continuous use of urea for several years results reduce soil pH**
- **Neem coated urea: being slow release properties it increase the nitrogen use efficiency.**

2. Inorganic form:

Calcium cyanamide:

- **Contains 21 °A N**
- **Neither import or nor manufactured in India**

Analyzing process for determination of available nitrogen is:

- **Alkaline permanganate method.**

Biuret:

- **It is formed by the combination of two molecules of urea during manufacturing of urea.**
- **Biuret toxic to plants hence, concentration in urea should not exceed 1.5%**
- **When urea will be applied as foliar spray on crop canopy the biuret concentration should not exceed 0.25%.**

Nitrogen losses:

a. Volatilization/non biological loss of NH3+:

- **When PH > 8, nitrogen is lost in the form of NH3in alkaline medium**
- **Volatilization increase in poor drainage e.g. rice field**
- **About 60 °A of nitrogen loss in India is due to volatilization; hence in alkali soil the N application is raised at least by 25%.**
- **Gaseous losses of nitrogen (ammonia) are carried out by both volatilization and denitrification.**

b. Denitrification:

- **Formation and loss of gaseous form of N by biological reduction of NO3+ and NO2- are known as *Denitrification*.**
- **Denitrifying bacteria: *PseutIonionas* and *Bacillus***
- **Denitrification and volatilization occurs rapid at higher pH.**

C. Leaching loss:

- **Leaching or drainage loss mostly of nitrate fertilizer**
- **Mostly occurred in humid area**

Nitrification **inhibitors:**

- It is used in **non —nitrate fertilizers,** inhibitors **decrease** the activity of nitrifying bacteria. Examples are following:
- **Thiourea:** **36.8 %** N
- Oxamide: 31 % N
- **AM (Pyrimidine)**
- **N -Serve** (Nitropyrin).
- Neem Cake.

Slow release fertilizer:

- Nitrate fertilizers mostly used as slow release due to **overcome** the problem of **leaching.**
- The solubility of nitrogen fertilizer is reduced by two types of compounds:

a. Synthesizing compound:

- **Urea formaldehyde/urea** form: **38 - 42 % N**
- Isobutylidene diurea **(IBDU):** **32.2 %** N.
- Crotonilidene diurea **(CDU):** 32.5 % N

b. **Coating barrier:**

- Sulphur coated urea
- **Neem coated urea**
- Modified form/super **granules:**
- **GROMOR:** trade name of **urea & ammonium phosphate grade 29:29:0.**

2. Phosphate fertilizers:

a. Water soluble:

- SSP: 16% P_2O_5, 19%, **Ca, 12 %** S.
- DSP: 32 % P_2O_5
- TSP: 46-48 % P_2O_5
- **DAP** (complex): **18 ')/0 N, 46 % P_2O_5.**
- **MAP*:** **11 % N, 48 % P_2O_5**
- ***** Mono -ammonium phosphate is new grade P fertilizer

b. Citrate soluble p fertilizer:

- Di calcium phosphate: 33-40 %
- Basic slag: **14-18 % 13,0 5**

c. Citrate & water insoluble p fertilizer:

- Rock phosphate: 20-40 % P_2O_5 **(It** is used for acid soil reclamation)
- Row bone meal: 20-25% P_2O_5
- Steamed bone meal: 20-30% P_2O_5

Bio-super:

- It is form of **organic fertilizer** mostly in **Australia.**
- **Biosuper =** Rock phosphate + Sulphur + **S** oxidizing bacteria *(Thiobacillus)*.

Conversion factor for P:

- **% P_2O_5 = % P x 2.29**
- **%** P = % P_2O_5 x **0.43**

Phosphorous **extracted** in soil by following methods:

(i) **Bray no. 1:** for acidic soil (pH 5.5 or less).

(ii) **Olsen method:** for alkaline **0.5 N $NaHCO_3$:** for **PH8.5.**

3. Potassic fertilizer:

- Highest use of potassic fertilizer in the state: **Maharashtra.**

a. KCL:

- It is most common and cheap fertilizer among potassic fertilizers
- It contains highest (60 % K_2O) among all potassic fertilizer
- Also known as muriate of potash/ potassium chloride
- This fertilizer is suitable for acidic and heavy soils but not for alkaline soils
- It shouldn't be used in sugarcane, sugar beet, tobacco, tomato and potato because in sugar crops, accumulation of sugar is affected due to chloride ion present in the fertilizer.
- Higher content of chloride ion reduce burning quality of tobacco and interfere with starch content in solanaceae crops.
- In these crops should be used K_2SO_4 and KNO_3 instead KCL.

b. K_2SO_4 (Potassium sulphate):

- Contains 48 % K_2O, 17.5 % S.

c. KNO_3:

- Potassium nitrate or salt petre or nitre
- It contains 44 % K_2O, 13%N

- **It is an excellent source of potassium and nitrogen and mainly used for fruit trees, tobacco and vegetables**

Conversion values for K:

- **% K = % K_2O x 0.83**
- **% K_2O = % K x 1.20**

Activity ratio:

- **Measures of the intensity of labile k in the soil**
- **It represents 'le that immediately available to crop roots.**

Ark= Activity k+

117 **Activity of Ca++,Mg+++**

1 K & Na is determined by: ***Flame photometer***

Micronutrients:

1. ***Ferrous sulphate:*** **is the most commonly used fertilizer which is sprayed @ 0.5 % on the standing crops to control iron chlorosis. It contains 19 % Fe.**
2. ***Manganese sulphate:*** **is the most popular manganese fertilizer which contains 26 % manganese.**
3. ***Zinc sulphate:*** **contains 36 % zinc is the most commonly used zinc fertilizer. It applied as both to soil (at 25 kg/ha) and plant (0.5 % as spray). Zinc oxide (78 %) used as seed treatment.**
4. ***Borax:*** **is the most commonly used for boron fertilizer which is white compound containing 11 % boron. It is highly soluble in water, hence should be used as boron fits.**
5. ***Copper sulphate:*** **is commonly used for both spraying on plants and applying as soil. It contains 22.5 % copper.**
6. ***Ammonium molybdate:*** **used as foliar spray. In pulses Mo is more important nutrient because it is constitute of leghaemoglobin hence, can be used @ 3g/kg seed of pulses**

Gypsum ($CaSO_4 . 2H_2O$):

- **Contains 29.2 % ca & 18.6 % sulphur**
- **In pulses formed undigestible protein in the deficiency of sulphur**
- **Agriculture grade gypsum 70 %**

- In general case 250 kg/ha gypsum used for sulphur & calcium especially in onion, mustard, groundnut and pulse crops.
- In alkali soil for reclamation purpose zypsum is used @ 800 kg/ha

Methods of fertilizer application:

a. **Basal dose:**
- Application of fertilizer/pesticides at the time of sowing
- ■ Phosphorus fertilizers applied at basal dose due to their slow release nature.

b. **Deep placement of fertilizer:**
- ■ In paddy only ammonium form (NH_4^+) incorporated in reduced zone to prevent leaching and volatilization losses.

c. **Starter dose:**
- In legume and vegetable seedling at transplanting applied NPK at 1:2:1 ratio.

d. **Split doses of N fertilizer:**
- To increase N efficiency, applied 2 split doses in most of cereals having crop duration 45 months.
- Applied 3 split doses for crop having duration more than five months.

Suitability of fertilizers:

Potassium sulphate is used where quality of crop is required because KCL reduce the quality of crops.

1 For rice crop: ammonium sulphate is the best.
- In acidic soils: Rock phosphate and SSP is used instead DAP:
- In saline & alkali soils ammonical fertilizers are not recommended because alkalization of ammonia takes place.

1 Indian soils are universal deficient in Nitrogen and Zinc.

1 - Fertilizer grade indicate the percentage of plant nutrients in a fertilizer.

1 Fertilizer ratio is the relative proportion of three major (NPK) plant nutrients.

1 In water logged soils ammonium sulphate is best suitable N fertilizer.

Potassium chloride or Murate of potash is the **most common** and **cheap** fertilizer among potassic fertilizers.

Potassic fertilizer is suitable for **acidic** and **heavy** soils but not for **alkaline** soils.

Denitrifying bacteria ***Pseudomonas*** and ***Bacillus.***

Conversion of ammonium jn to nitrite in the presence of **nitrosomonas.**

Conversion of nitrite to nitrate through: **nitrobacter.**

1 Nitrogen % in Thiourea: **36.8%.**

AM & N -serve are nitrification inhibitors.

In anaerobic soils, sulphates are reduced to hydrogen sulphide by the action of ***Desulfovibro bacteria.***

Elemental sulphur when applied to the soil is converted to sulphate by ***Thiobacillus spp.***

Bio-fertiliXers or Bio bioinoculants:-

- These are preparations containing micro organisms that supply nutrients especially nitrogen and phosphorus.
- It can be used through application of seed, and soil or **composting** areas with the objective of **increasing** the number of such micro-organisms and accelerates certain **microbial** process to augment the extent of the **availability of nutrient** in a form which can be assimilated by plants.
- On the basis of nutrient supply these are broadly classified in two types:

A. Nitrogen fixation organisms: These are three types.

1. Free living:
   a. Aerobic bacteria: ***Azatobacter chroccum:*** Free fixers commonly used for **wheat, rice, cotton, sugarcane.**
   b. Anaerobic bacteria: ***Clostridium***
2. **Associative symbiotic:**
   a. Micro -aerobic: *Azo.spirillum:* Associated with roots of grasses inside root symbiosis.
      - Used for **sorghum, pearl millet.**
3. **Symbiotic fixation:**
   a. Nodule forming:
   (i) **Rhizobium.**

- Rhizobium is an **aerobic and heterotrophic** bacteria.
- It symbiotically fixes atmospheric nitrogen with the presence of leghaemoglobin in nodules of legume roots.

Common bio strains of Rhizobium:

Rhizobium spp.	**Legumes inoculated**
1. *Rhizobium* ***meliloti***	***Medicago, Trigonella, Me/i/o/us***
2. *R.* ***trifoli***	***Trifolium*** (berseem)
3. *R. leguminosarum*	***Pea,*** Lentil
R. phaseoli	***Phase°lus***
R. japonicum	**Soybean,** Cow pea, **Groundnut,** Sunhemp

(ii) **Actinomycetes:** From the genus ***Frankia*** and ***Casuarinas alder.***

b. **Without nodule:** The blue green algae ***Anabaena azollae*** is having a **symbiotic** association with water fern, ***Azolla pinnata.***

- Anabaena is habits in the cavities in the leaves of floating fern ***Azolla pinnata.***

B. Phosphorus: these are two types:

- (i) Phosphate solubilizer and (ii) phosphate absorber.
- PSB culture should be used in soils because continuous use of DAP & NPK creates problem like sulphate & phosphate residues in soils so PSB & VAM solublise them.

a. **Seed inoculants:**

- One packet of Rhizobium culture contains **200g** mass of culture with lignite.
- **3 packets** are sufficient for one hectare. Required quantity of water is boiled with 300g of jaggery and cooled the solution. Rhizobium inoculums is mixed in the jaggery solution and sprinkled over the seeds and seeds are thoroughly mixed.

b. **Soil inoculants:**

- 2kg/ha carrier based **Azatobacter/Azospirillum/PSB** culture is mixed with 25 kg ***FYM*** and broadcasted in the field uniformly before transplanting.

Utility:

- BGA can add up to about **20-25 kg Vita to rice field.**

- Rhizobium increases the yield by 25-30 % in succeeding crop.

Micro flora:

- Bacteria grows well within Ph range of 6.5 to 8.0
- Fungi prefer acidic range 4.5 to 6.5 pH
- While actinomycetes prefer slightly alkaline conditions.

Order of micro flora presence in per gram of soil (number basis):

- Bacteria > actinomycetes > fungi > algae

Plants used for nutrient deficiency indicator:

Nutrients	Indicator plants
• **Nitrogen**	**Cauliflower,** cabbage
• **Phosphorus**	**Mustard**
• **Potassium**	**Potato**
• **Calcium**	**Cauliflower,** cabbage
• **Sodium**	**Sugar beet, Turnip**
• **Boron**	**Sunflower**
• **Ferrous**	**Sorghum**

Plants nutrients:

A. General classification:

1. **Major or macro -nutrients: Those nutrients which are required by the plants in concentrations *more than 1 ppm* are termed as major or macro -nutrients. These are grouped in to:-**
   a. **Basic nutrients: C, H, 0 Provides basic structure to plants.**
   b. **Primary nutrient: N, P, K**
   c. **Secondary: Ca, Mg, S**
2. **Minor or micro -nutrients:**
   - **The elements which are required by plants in concentration *less than 1 ppm* are put in this category.**
   - **They are also called as *trace elements* or *oligo elements.* These are Fe, Mn, Zn, Cu, Bo, Cl and Molybdenum.**
3. **Immobile nutrients: *Ca* & B**
4. **Energy exchange: H & 0**
5. **Cation nutrients: K, Ca, Mg, Fe, Mn, Cu, Zn**
6. **Anion nutrients: P. B, Mo, Cl, So4**
7. **Both anion & cation form: N (NH4 , NO3-)**
8. **Non metals nutrients: B**

B. Other classification of plant nutrients:

L **Essential nutrient:**

- According to Anion & Stout **there are 16 essential nutrients** for plants e.g **C, H_2O, NPK, Ca, Mg, S, *Fe, Mn,* Mo, B, Zn, Cu, Cl.**
- Nickel is the **17th essential element** known in 1987

Criteria of essentiality of plant nutrients:

- Given by **Arnon & Stout in 1939.**
- They stated that plant **can't be** completed their **life cycle** without the deficiency or complete absence of a single nutrient among the essential nutrients.
- **Arnon** (1954) refined the criteria of essentiality of nutrients.

Liebing Low of Minimum:

- According to **Justus Von Liebig (1840)**
- The growth of plants is limited by the plant nutrient present in smaller quantity, all others being in adequate amounts. This has been re -stated as ***barrel concept.***

2. **Beneficial** nutrients: are four in number-
   - Vanadium (V), Silicon (Si), Cobalt (Co), Sodium (Na).
3. **Functional nutrients:**
   - The term functional nutrient was proposed by **D. J. Nicholas 1963.**
   - Functional nutrients are **(20) =** Essential nutrients (16) + Beneficial nutrients Co, V. Si, Na (4).
   - Includes all sixteen essential nutrients in addition to four beneficial nutrients (Co, V, Si, Na), collectively known as functional nutrients.

ential elements and their form of availability:

SN	Element	Conc. in plants	Form of uptake
1.	**Major nutrients**		
	Carbon (C)	45%	CO_2
	Hydrogen (H)	6%	H_2O
	Oxygen	45%	H_2O, O_2
.	**Primary nutrients**		
	Nitrogen (N)	1.5%	NH_4^+, NO_3^-
	Phosphorus (P)	0.2%	$H_2PO_4^-$, HPO_4^{2-}
	Potassium (K)	1.0%	**K^+**

Secondary nutrients

Calcium (Ca)	**0.5%**	**Ca**
Magnesium (Mg)	**0.2%**	**Mg**
Sulphur (S)	0.1%	SO_4^{2-}, SO_2

Micronutrients

Iron (Fe)	**100 ppm (0.01%)**	**Fe + (mainly), Fe +**
- Zinc (Zn)	**20 ppm**	**Zn^{2+}**
Manganese (Mn)	**50 ppm**	**Mn^{2+}**
_Boron (B)	**20 ppm**	**- H_3BO_3(boric acid)**
Copper (Cu)	**6 ppm**	**- CT^{2+}**
Molybdenum (MO)	**<1 ppm (0-1PPm)**	**MoO_4^{2-}**
Chlorine (Cl)	**100 ppm**	**CI**
Nickel (Ni)	**0.1-1.0 ppm**	**Ni^{2+}**

1 **In acidic soils phosphorus is available in $H_2PO_4^-$ form and at alkaline (high pH) phosphorus is available in PO_4^{3} form. Most of plants absorbed nutrients in reduced form (e.g. Fe^{+2} or Mn^{+2}) rather than oxidized form (e.g. Fe^{+3} or Mn^{+3}).**

Soil test rating chart for available nutrients:

Nutrients	Compounds (units)	Rating		
		Low	**Medium**	**High**
Carbon	Organic carbon (%)	<0.4	0.4-0.75	> 0.75
Nitrogen	Alkaline $KMnO_4$ (kg/ha)	<280	281-560	> 560
Phosphorus	Olsen's (kg/ha)	<12.5	12.5-25	>25
Potassium	Ammonium acetate (kg/ha)	<135	135-335	> 335
Calcium	Ammonium acetate, cmol (p)/kg	<1.5	-	> 1.5
Sulphur	0.01M $CaCl_2$ (kg/ha)	<22.4	22.4-35	> 35
Magnesium	Ammonium acetate, cmol (p)/kg	<1.0	-	>1.0
Zinc	DTPA extractable (mg/kg)	- <0.6	0.6-1.2	>1.2
Iron	DTPA extractable (mg/kg)	<4.5	4.5-9.0	> 9.0
Manganese	DTPA extractable (mg/kg)	<3.5	3.5-7.0	>7.0
Copper	DTPA extractable (ml .)	<0.2	0.2-0.4	> 0.4
Boron	Hot water soluble (k. a)	<0.5	0.5-1.0	>1.0
Molybdenum	Ammonium oxalate extractable (phi 3.3) (mg/kg)	<0.2	0.2-0.4	> 0.4

Role of nutrient:

1. **Nitrogen:**
   - **Impart green colour to plant, encourages vegetative growth.**

- **Nitrogen** is essential constituent of **protein.** ***(JAR!, Ph. D-09)***
- Constituent of protoplasm of chlorophyll and coenzyme.
- Play important role in synthesis of auxin

Deficiency:

- Lower leaves become **yellow** and dries.
- **'V' shaped** chlorosis on older leaves or **yellowing at tip.**

Disease:

- **Starvation** disease due to nitrogen deficiency.
- **Buttoning** in cauliflower

2. Phosphorus:

- Increase the disease **resistance,**
- Enhance new cell formation and necessary for **root development**
- Required for grain formation and maturity of grains
- Phosphorous is essential constituent for **nucleic acid & phytin.**
- Most essential functions are **energy storage** and transfer of energy (ADP and ATP), act as" **energy currency".**

Deficiency:

- Due to **deficiency** of single element (phosphorus), the life cycle of plant can't be completed hence, Phosphorous is called as" key **of life"**
- **Deficiency imparts dark** green colour in leaves
- **Bronzing** appearance on **older** leaves.
- Later develops **red purple** coloration.

Disease:

- Sickle leaf disease.

3. Potassium:

- Most essential function of k+is stomata regulation
- Provides disease **resistant** in plants
- Cofactors for enzymes
- Responsible for quality products
- Formation and **translocation** of sugars
- Helps in chlorophyll formation.

- In plants K+ also reduced the **transpiration rate** and increase **photosynthetic rate.**
- Because it is stress avoider.
- Pottash useful in stress condition because it secretes 60 enzymes
- The term **luxury consumption** is often used to describe **nutrient absorption** by the plant that does not influence yield e.g. **Potassium.**

Deficiency symptoms:

- Spot of dead tissue at tips.
- **Scorching & burning** on **margins** of bottom leaves.

Disease:

- Rosette/die back disease.

Calcium:

- It is constituent of cell wall
- Calcium **immobile** in plants and deficient symptoms appear on **meristem tip** portion.

Deficiency:

- Terminal bud die

Disease:

- Tip hooking
- Blossom end rot of tomato (BER)

Magnesium (Mg):

- Essential constituent of **chlorophyll**
- **Magnesium** is a constituent of **chlorophyll** (central **atom** of chlorophyll).
- Chlorosis between veins (mottled chlorosis).

Disease:

- Sand -drown disease of tobacco.

Sulphur:

- Sulphur oxidizing bacteria is: ***Thiobacillus.***
- Sulphur is essential for oil seeds and pulses because it improves oil content and protein content in oil seeds and pulses, respectively.
- Thiourea @ lg./liter spray on standing crops best for N 84 deficiency

Disease

- **Akiochi** of rice due to excess of HS
- Tea yellow disease of tea

Iron

- Required for nitrogen fixation
- During respiration act as 02carrier (leghaemoglobin)
- Act as enzyme in oxidation-reduction process

Deficiency

- **Inter veinal complete chlorosis**
- *Scorching* of leaf margin
- *Yellowing or Iron chlorosis* in groundnut.

Manganese

- Formation of chlorophyll
- Co -factor of enzyme
- Mn toxicity causes **crinkle leaf** of cotton

Deficiency

- Dead spot on leaves.

Disease

- Pahala blight of sugarcane
- Grey spike of barley/oat
- Marsh spot of pea

Copper:

- Compound of plastocyan in
- Essential for photosynthesis/respiration
- Resetting & excess gumming occurs due to: Copper deficiency.
- Guminosis and xanthomenia disease of citrus
- Die back and reclamation disease due to deficiency of **copper**

Boron:

- Necessary for pollen germination
- **Boron** is the only **non metal** element among the **micron utrient**
- It is necessary for translocation of sugars and is involved in reproduction and germination of pollens. ***(RAS-07)***
- It concerned with water reactions in cells and regulates the intake of water in to cell

- It may act as regulator of potassium ratio and keep calcium in soluble form within the plants
- Taste in cauliflower due to presence of boron

Disease: due to deficiency

- **Browning** of cauliflower is caused by **boron** deficiency.
- Top sickness of tobacco
- Fruit cracking of tomato
- Hard fruit of citrus
- Hen & chick disease of grape

Zinc:

- In plants its required for biosynthesis of **hormones**
- **White bud** of maize is due to deficiency of **zinc.**
- Khaira disease of **rice**
- Little leaf of cotton
- Mottled leaf of citrus
- Rosette formation

Cobalt:

- **It** is component of B12
- It is essential for formation of a type of **hemoglobin** in N-**fixing nodule** tissue known as **leghaemoglobin.**
- act as 02 **carrier** in roots
- Also known as animal **protein factor.**

Molybdenum:

- **Mo:** absorbed as **molybdate** Mo04-2 forms.
- Mo is important component of enzyme: **Nitrate reductage.**
- N -fixation in pulses
- Whiptail of cauliflower due to deficiency of Mo.
- Mo is required for carrot & raphanus for sweetness.

Chlorine:

- Absorbed as Cl form
- High CI- sensitivity crop: ***Legume and tobacco.***

Other facts:

Fruit cracking of tomato is due to deficiency of ***boron.***

- Reclamation disease also called **white tip** is caused due t° deficiency of: *Copper*.
- **Sodium** (Na) is important constituent of CAM plants.

- **Silicon absorbed by plants as monosilicic acid and it is essential for *rice. (RAS-7)***
  Pollen grain sterility of wheat is due to: *Deficiency of boron.*
- **Sodium is essential for osmo-regulation.**
  Sodium: responsible element for drought tolerance in sugar beet.
- **Chlorosis between the veins and veins remain green shows: *Deficiency of mg***
- **Complete inter veinal chlorosis occurs due to: *Mn deficiency***
- **In *iron deficiency,* the principal veins remain conspicuously green and other portions of the leaf turn yellow tending towards whiteness.**
  In manganese deficiency, the principal veins as well as the smaller veins are green.
- **Silicon is essential for: *Rice and maize***
  Black heart of potato is due to deficiency of oxygen.
  Metabolic transformation of inorganic plant nutrients into organic plant constituents is known as *assimilation.*

Terminology:

Catena (Milne):

- **An absolute term for a sequence of soils within a soil zone derived from similar parent material, climatic and age**
- **But having different soil characteristics due to variation in relief and in drainage.**

Caliche:

- **A pedologic layer near the surface, more or less cemented by secondary carbonates of Ca^{+2} and Mg^{+2} precipated from the soil solution.**

Clod:

- **It is an artificial produced compact coherent mass of soil ranging in size from 2-200 mm.**

Crotovina:

- **It is typical kind of Chanel in the soil horizon produce by action of earth worms and other animals and is filled with organic matter or matter from other horizon.**

Cat clays:

- Cat clay is clay -sulphate which shines like cat's eye.
- Wet clay soils have high amount of sulphur in reduced forms that upon being drained become extremely acid due to oxidation of S' compound and formation of sulphuric acid.

Solum:

- The horizon A + B combines known as Solum or *true soil*

Regolith:

- The unconsolidated product of rock by weathering
- Regolith = A + B + C horizons

Regosol:

- Any soil of the azonal order without definite genetic horizons.

Organic soil:

- Soil having at least 20% organic matter in low clay content soil.

Mineral soil:

- Such soil has usually less than 20 % organic matter.
- Mineral soils are the biochemically and physically weathered upper portion of the regolith

Soil eradibility factor (K):

- Soil eradibility factor gives an indication of the soil loss from a unit plot of 22 m long with a 9 % slope under continuous fallow. It normally varies from near zero to about 0.6.

Soil eradibility:

- It is the susceptibility nature of soil to erosion (mostly <0.1 mm particles).

Soil erosivity:

- Soil erosivity is the capacity of agent causing erosion.

Soil colloids:

- Colloidal particles are generally smaller than 1 um (micro meter) in diameter.
- Colloidal solution: size of particles 10^{-6} to 10^{-9}.

Micelles (micro cells):

- The individual particle of a colloid is called micelle.

- This contains ncgatise charges on their surface; lune luso surtke area per unit v.eight.

)rder of strength of adsorption. flocculate soil colloids:

- Al ‘.> 11+> Ca' K - Na (least).

SW kaiak*

S. HORTICULTURE

Important facts:

V	Edible part of cauliflower:	**Curd**
V	Blanching is an important process of:	**Cauliflower**
V	Whiptail of cauliflower due to:	**Mo deficiency**
V	Pusa ruby is a variety of:	**Tomato**
V	Swaran roopa is the early variety of:	**Litchi**
V	**Pajaro:** is the variety of:	**Strawberry**
V	**Bolero** is the variety of:	**Marigold**
V	Richest source of **vitamin C is:**	**Barbados cherry**
V	Largest importer of cut flower in the world:	**Germany**
V	The dwarf variety of mango:	**Am rapali**
V	**California Papershell** is the variety of	**Almond**
V	Fruit of rose known as:	**Hips**
V	Fruit of okra is:	Capsule
V	**Coconut fat rich source of:**	**Lauric acid**
V	Coconut is propagated by:	Seeds
V	Mango is mostly propagated through:	Veneer grafting
V	Inflorescence of **cauliflower** known as:	Cat **ken**
V	Black heart of potato due to:	0 2deficiency
V	**Pusa snow ball** is a variety of:	**Cauliflower**
V	India's share in the fruit production in the World is:	10%.
V	Development of fruits without fertilization is called:	**Parthenocarpy** ..
V	Development of embryo without fertilization is known as:	**Apomixis**
V	**Oleoresin** is an important product of:	**Chilli**
V	Kesar **(saffron)** belong to the family of:	**Iridiceae**
V	Concentration of sugar is used for preservation is:	60-70 %
V	Mango variety suitable for high density planting is:	**Amrapali**
V	Most salt tolerant fruit crop is:	**Date palm** ,

V	Fruit repining hormone is:	**Ethylene.**
V	A form of low pruning to about 2 m up to stem is called as:	**Po'larding**
V	Early variety of ber is:	**Gola**
V	Planting season for deciduous plants is:	**Jan- Feb**
V	The variey of date- palm is used for dry dates (Chhuhara):	**Halawi**
V	All fruits in general nature are of which type:	**Acidic**
V	Baradari is an important feature of:	**Mughal garden**
V	The fruit of pine apple is known as:	**Sorosis**
V	By means of **`bulbils'** which crop is propogated:	**Garlic**
V	Edible banana fruit is seedless because of:	**Ambryo abortion**
V	Multistoried cropping is popular in:	**Coconut plantation**
V	Which is the late ripening cultivar of ber:	**Umran**
V	The exclusion of micro-organism is known as:	**Asepsis**
V	**Production of off- season vegetables** is known as:	**Vegetable forcing**
V	**"Alphanso"** variety of mango is grown in which state	**UP**
V	The common chemical preservative for colorless fruits:	**KMS**
V	Shade loving annual flower plant is:	**Salvia**
V	The commonly cultivated variety of table pea in India is:	**Bonneville**
V	**Crescent** is well known for:	**Flower arrangement**
V	Saffron is obtained from:	**Style and Stigma**
V	Grapes are generally dried in:	**Sun**
V	Sago is prepared from:	**Cassava**
V	Tea is commonly propagated by:	**Soft wood cutting**
V	Origin place of Date palm is:	Iraq
V	Spacing recommended for Pusa Nanha	**1.25 x 1.25 m`**

	van y pay	
I	Which state is the leading producer of litchi:	**Bihar**
V	Onion variety suitable for export having yellow colour:	**Phule suwarna**
V	The **hard** fruits of citrus are due to the:	**Boron deficiency.**
V	**Bael** is the richest source of:	**Vit-B*2* (riboflavin)**
V	Leaves of **Bad** are used to offer:	**'Lord Shiva'.**
V	Causal organism of **Fig** rust is:	*Cerololiumfic,.*
V	Peach **leaf curl** is caused by fungus:	*Tap/irma deformens.*
V	**Sanjose** scale is the most **serious** pest of:	**Apple.**
V	**Coffee** leaf rust is caused by:	*Hemelia vestratrix*
V	**Kent** is the mutant variety of:	**Coffee.**
V	**Rekha,** Swarna Rekha **Rajjat** are of:	**Tuberose** varieties
V	**Polyembryony** present in fruit crop:	**Mango, Citrus, Jamun.**
V	when pollination is carried out by Insects known as:	**Entomophilous**
V	Pollination in **mango** carried by:	House flies *(Alusca doinestica)*
V	Pollination in fig carried by:	Fig wasp ***(Blasiophaga** pens)*
V	Pollination in **oil palm** is camed by:	Weevil ***(Elaeidobius*** spp). NET -2013
V	Center of **origin of Isabgol** and **Sarpagandha** is:	**India.**
V	Center of origin of **Bael, Phalsa** and **Kagzilime** is:	**India.**
V	Origin of orchid is:	**India**
V	Double century is the variety of:	**Coconut.**
V	Finest fruit of the world:	**Mango Steen.**
V	Dioecious fruit plants:	**Papaya, Datepaim. Grape**
V	Gynodioecious fruit:	**Fig**
v'	Pollu beetle *(Longitarsus* ***nigripenis)*** is	**Black pepper** 'JRF-

	the pest of:	*09)*
s/	Pest of sweet potato weevil:	***Cylas formicarius*** *(JRF-05)*
.7	Pusa chikni is a variety of:	**Sponge gourd**
V	The clove required for planting garlic/ha **is:**	**500 kg**
V	Cucumber native of:	**India.**
V	Water melon native of:	**T. Africa**
V	Sponge gourd is:	***Luffa cylindirica.***
./	Most serious disease of rose:	**Die back**
V	Tissue culture is common in:	**Orchid**
V	Annud flower of Indian origin:	***Gomphrene***
V	Popular climber of Indian origin:	***Gloriosa superba***
V	Annual flower suited for planting in shade is:	***Cineraria.***
V	**Karonda:** richest source of:	**Iron.**
V	**Maroon:** is the variety of:	**Karonda.**
V	Powdery mildew disease in mango is caused due to:	***Odium mangiferae.***
V	Naphthalene acetic acid **(NAA)** is used to control:	**Mango Malformation**
V	Following vegetable is known as multivitamin greens:	**Chekurmams**
v	In which flower arrangement fruit, flower & foliage are used:	**Morimona**
V	Clove, commonly used spice is taken from which part of the plant:	**Flower**
V	Higher temperature induces which type of flower in bottle gourd:	**Male**
v	Planting system enabling maximum nu.of plants in the orchard:	**Hexagonal**
V	**Cricket ball** and **Murrabba** are the popular varieties of:	**Sapota.**
V	**Scartlet gol** and **Red fuzi** are the high yielding varieties of:	**Apple.**
1	The chemical used to prevent sprouting	**MH** (Maleic

	during storage of onion is:	hydrazide)
1	**Rayan** as rootstock is most accepted and commercial method of:	**Sapota.**
V	Most promising rootstock for **mandarins** and **sweet orange** is:	**Rangpur lime.**
1	**Tea mosquito bug *(Helopellis antonit)*** is a pest of:	**Cashew.**
I	**Coffee berry borer *(Hypothenemus hampei)*** is a serious pest of:	Coffee.
„/	***Trimming:*** removal of **undesired** plant parts generally practice is done in	**Rose** and **marigold**
7	***Bromalin:*** enzyme obtained from:	***Pineapple***
V	Aroma in fruits is due to presence of:	***Esters***
V	Acid content is a very important consideration for the preparation of:	***Jelly***
V	Domestic quarantine in India exist for:	***Sanjose scale***
V	In the grafting upper part of stem is called:	***Scion***
V	In onion bolting takes place due to:	***High temperature***
V	Hand pollination is most useful in:	***Date palm***
V	Highest source of energy:	***Walnut (contains maximum fat)***
V	Hogarth curve is also known as:	***Line of beauty***
V	Fruit of new world:	***Avocado***
V	Orchid is propagated by:	***Micropropogation***
./	Most important fruit used in processing industries in India:	***Pine apple***
V	Pagoda is a name of:	***Japanese monument***
V	Red colour in jelly is due to:	***Charring of sugar***
V	Vista vision is a theme for:	***Landscape***
V	A vegetable crop of which all parts are edible is:	***Winged bean***
V	Sex form of pointed gourd is:	***Dioecious***
V	Sex form of cucumber is:	***Monoecious***

V	The best site for the seed production of temperate type varieties of vegetables is:	*Hills*
V	Edible part of lettuce is:	*Leaf*
V	Edible part of parsley is:	*Leaves*
1/	Edible portion of celery is:	*Leaf stalk*

- *Asparagus* is a perennial crop
- Edible parts of asparagus is: *Underground young shoots* (known as *spears)*
- Sex ratio in cucurbits is modified by. *Silver nitrate*
- Bolting (emergence of seed stalk prior to their time of formation) is a disorder of: *Onion*
- Blindness (absence of curd/head in cole crops) is a disorder of: *Cole crops*
- Buttoning (Formation of small curds in cauliflower) is due to: *Deficiency of nitrogen*
- Blanching in vegetables is done for: *To inactivate enzyme activities*
- Seed of carrot is VOIONN n *as: Schizocarp*
- Forking of carrot is due to: *Compact soil*
- Han esting stage for long distance transport of muskmelon is: *Half slip stage*
- Chief pollinating agent in onion is: *Honey bee*
- Sex form of water melon is: *Monoecious*
- Seed rate of hybrid tomato is: *100-150 g/ha*
- Origin of cucumber: *India*
- Physiological process responsible for rapid deterioration of fruits and vegetables is: *Respiration*
- Serious disease of cumin is: *wilt*
- Sugary disease is common in fennel is caused by: *Virus*
- Vitamin C act *as: Anti -oxidants*
- Tuberization of potato require: *Short day length*
- The element which improve quality of fru k: *Boron*
- Edible part of knoll khol is: *Swollen .%tem*
- Onion varieties suitable for dehydration *are: White coloured*
- Anti -fungal factor in onion is: *Catechol* [redacted]
- Vitamin lost during processing is: *Vitamin C* [redacted]

- **Rutabaga is a man made vegetable is across between: *Brassica oleracea x B. nap us***

  Self -incompatibility exists in mango, aonla, apple, almond and cherry.
- **India is the largest producer, processor, consumer and exporter of cashew in the world.**
- **Major tea growing pockets are located in Assam (53%), West Bengal (23%), Tamil Nadu (11%) and Kerala (8%).**

Horticultural institutes:

Abbr.	Name of Institute	Place	State
C1STH	Central Institute for Subtropical Horticulture	Lukhnow	UP
CITH	Central Institute of Temperate Horticulture	Srinagar	J&K
CTCRI	Central Tuber Crops Research Institute	Thiruvantha puram,	Kerala
CPCRI	Central Plantation Crops Research Institute	Kessorgod	Kerala
CPR]	Central Potato Research Institute	Kufri	H.P.
IIHR	Indian Institute of Horticultural Research	Bangalore	Karnataka
IISR	Indian Institute of Spices Research	Calicut	Kerala
CIAH	Central Institute for Arid Horticulture	Bikaner	Rajasthan
CRIC	Central Research Institute for Chikoo	Muzaffarpur	Bihcor
NRCB	National Research Center for Banana	Tiruchirapali	IN
NRCC	National Research Center for Cashew	Puttur	Kaagts
NRCC	National Research Center for Citrus	Nagpur	MH
NRCG	National Research Center for Grapes	Pune	MH
NRCM	National Research Center for Mushroom	Solan	H.P.
NRCNIAP	National Research Center for Medicinal & Aromatic Plants,	Anand,	Gujarat
NRCOG	National Research Center for Onion & Garlic	Nasik	MH
NRCO	National Research Center for Orchids	Gangtok	Sikkim
NRCSS	National Research Center for Seed Spices	Ajmer	Rajasthan
IIVR	Indian Institute of Vegetable Research	Varanasi	Up
NH B	National Horticultural Board	Gurgaon	HaD'ana

Suitable plants for intercrops in orchard:

Main crop	Intercrop
Mango	Papaya, Garlic
Coconut	Banana

Fruits leading in area:

- **Mango > Citrus > Banana**

Leading in production:

- **Banana > Mango > Citrus**

Vegetables leading in area:

- Potato % Onion >Tomato

Leading in production:

- **Potato > Onion > Tomato**
- Highest onion production in the state: **Maharashtra.**
- Total vegetable production highest in **West Bengal** followed by **Uttar Pradesh.**

Classification of fruits:

A. According to **Fruit ripening condition:**

Climacteric fruits: (Fruit can ripe after removing from plants).

Mango	Banana
Sapota	Guava
Papaya	Apple
Fig	Plum
Peach	Pear

2. **Non -climacteric:** (Don't ripe after **picking).**

Citrus	Grape
Pineapple	Pomegranate
Litchi	Ber

3. **Day neutral plant:**

Papaya	Guava
Banana	

B. According to Climate:

1. Tropical:

Mango	Banana
Papaya	Pine apple
Cashew	Coconut

2. **Temperate:**

Apple	Almond
Strawberry	Starberry

3. **Sub tropical:**

Phalsa	Ber
Litchi	Grape
Badl	Date palm
Citrus	Pomegranate
Guava	Fig, Aonla

C. According to Fruit type:

1. **Berry:**

Banana	Papaya
Grape	Arecanut
Date palm	Guava

2. **Drupe/ Stone:**

Mango	Ber
Coffee	Coconut
Almond	Jamun

3. Balausta:	Pomegranate
4. **Amphisarca:**	Bael
5. **Pepo:**	Water melon
6. **Pome:**	Apple
7. **Hesperidium:**	Citrus
8. **Syconus:**	**Fig**
9. **Sorosis:**	**Pineapple**
10. Nut:	**Litchi, Cashew**
11. Schizocarp:	**Carrot**
12. Capsule:	**Okra, Aonla**

D. According to Edible part of fruits:

• **Pericarp:**	**Ber**
• **Mesocarp:**	**Papaya, Mango**
V **Endosperm:**	**Coconut**
Thalamus:	**Apple, Strawberry**
Placenta:	**Bael**
• **Fleshy aril:**	**Litchi**
Bracts:	**Pineapple**
Juicy seed coat:	**Pomegranate**
1 **Juicy placental hairs:**	**Citrus**
• **Fleshy receptacle:**	**Fig**

Daily requirement: (per day per capita):

• **Cereals:**	**475 g**
• **Pulses:**	**80 g**
• **Fruits:**	**120 g**
• **Vegetables:**	**285 g** *.300* 9-
• **Milk:**	**240 g**
Sugar	**40g**

Nutritive value of fruits and vegetables:

Nutrients	Fruit	Vegetable
- Vitamin A	Mango 4800 IU/100g Papaya 2020 IU/100g	Bathua leaves 11,300 IU/100g
Vitamin-BI/Thymine	Cashew nut	Chilies 0.55 mg/100 g
Vitamin B2/Riboflavin	Bad l > papaya	Fenugreek leaves
Vitamin C/Ascorbic acid	Barbados Cherry 2000 mg Aonla 600 mg/100 g	Coriander leaves 135 mg/I 00 g
Carbohydrates	Raisins (dehydrated grape)	Topica (38.1%)
Protein	Cashew nut 21.2%	Peas (7.2/100g)
Fat	Walnut 64.5%	Potato 11.8g/100g
Fiber	Fig	Potato
Calcium	Litchi 0.21%	Agathi 1130 mg/100g
Phosphorus	Almond > Cashew nut	Amaranthus 800 mg/100g
Iron	Dry Karonda 39.1 % Date palm (pind) 10.6%	Amaranthus 22.9%
Calorific value	Walnut 687calorie/100g	Tapioca 338 calorie/100g

Major Nutritional Deficiency diseases:

	Disease	Deficiency of nutrient:
	Fruit cracking in apple	Boron
1	Internal necrosis of Aonla	Boron
•	Hen & chicken disease of grape	Boron
1	Hollow heart/ heart rot of sugar beet	Boron
1	Fruit cracking of pomegranate	Boron
1	Necrosis/black tip of mango	Boron
1	Die back, little leaf & gummosis of citrus	Copper
N	Browning & whiptail of cauliflower	Molybdenum
1	Buttoning of cauliflower	Nitrogen
1	Grey spike of oat/Pahala blight of sugarcane	Manganese
1	Khaira disease of rice & white bud of maize	*Zinc*

Causes of colour/bitterness in fruits/vegetables:

Yellow colour in papaya is due to: Caricaxanthin

V	Redness of apple is due to:	Anthocyanin.
V	Red colour in tomato is due to:	Lycopine. ---.
V	Red colour in chilli is due to:	Capcyanthin. ----.
V	Pungency in chilli is due to:	Capsaicin.
V	Orange colour in carrot is due to:	Carotene.
V	Red colour in carrot is due to:	Anthocyanin
V	Yellow colour in turmeric is due to:	Curcumin
V	Bitterness in bitter gourd is due to:	Memordicocite.
V	Bitterness in cucumber is due to:	Cucurbitacin
V	Yellow colour of onion is due to:	Quercetin
V	Red colour in onion is due to:	Anthocyanin
V	Punaeno in onion is due to:	Allyl propyl di -sulphide-
V	Pungency in *raphanus* is due to:	lsocyanate
V	Pungency in mustard is due to:	Glucosilates
IV	Pungency in garlic is due to:	Alycine/amino acid
! V	Green colour in potato tuber due to:	Solanin
V	Sour taste of gram leaves is due to:	Malic/oxalic acid
V	Pungency in pepper is due to:	Oleoresin
V	Pungency in cabbage leaves due to:	Sinigrin

Epithets for fruits/crops and others:

King of fruits	Mango
Queen of fruits	Litchi /Ma o S-teen
King of pulses:	Gram
Queen of pulses:	Pea
Queen of spices:	Cardamom
Queen of flowers:	Gladiolus Rohe
Food of god:	Cocoa
Queen of beverage:	Tea
King of temperate fruits:	Apple
Butter fruits:	Avocado
King of arid fruits:	Ber
Poor man's fruits:	Ber

Kalp vrkasha: Coconut
- Miracle fruit: China kiwi fruit
White gold: Cotton
Century plant: Date palm
Adam's fig: Banana
./ King of forest: Teak

Location and site selection of orchard:

a. **Location:**
- Refers to **geographical** of the field in **relation to city, highway, town** etc. ***(Pre P.G-05)***

b. **Site of orchard:**
- Place in **relation to topography, altitude, water body** and other factor which affect tree ***behaviaring.***

Factors affecting selection of site:

1. **Land slope:**
   - Should not be **more than 5%.** If slope more than **15% unsuitable** for orchard.
2. **Direction of slope:**
   - **Southern** slope receive **more sunshine** hence produce **early flowering** so, early crop can be taken.
3. **Soil fertility:**
   - **High fertility** requiring crops: Mango, citrus, grape.
   - **Poor fertile** crops are: Phalsa, aonla.
4. **Soil texture:**
   - **Light texture** for **papaya** and **Ber.**

Training of orchard:

- Refers to judicious removal of plant parts to develop a proper shape of plant **capable of bearing heavy crop load.**
- While pruning defined as the judicious removal of parts like root, leaf, flower, fruit etc. **to obtain good and qualitative yield.**

Method of training:

a. Center leader system (this method not suitable for high altitude and hot arid places where wind velocity is high)
b. Open center system (not suitable for frost prone area)

c. Modified leadership system (this is most acceptable for commercial fruit production.

Training system for grape vines:

a. **Head system:** (suitable for less vigorous cultivar & it is very simple and inexpensive)

b. **Kniffin:** (also known as 4 -canes system)

c. **Telephone system** (6 -canes system, suitable for vigorous cultivar)

Pruning:

- Refers to removal of plant part especially shoots, roots, buds etc. to obtain better and qualitative yield is termed as pruning
- Pruning is started in later part of plant life when becomes produce fruits and flowers.

Method of pruning:

a. Thinning:

- Selective or complete removal of plant parts is termed as thinning

b. **Ringing or girdling** ***(NET -08)***

- In this method a circular ring measuring about 3 cm in length is removed to hasten bearing by allowing greater accumulation of photosynthesis in upward portion of the plant.
- This is important practiced is done in **grapes.**

c. Notching:

- Making a notch above a bud by removing a wedge shaped piece of bark is termed as notching
- It checks the influence of hormone and encourages growth
- Notching is commonly practiced done in **Fig**

Lay out of orchard:

- **it** includes **system of planting** and **planting distance.**

System of planting:

a. **Square system:**

- **Simplest and widely** adopted /popular method
- In this method R x R and P x P distances are kept similar'
- The plants are planted exactly at right angle at each corner.

- **Number of plants/ha = 10,000 m2/x2**
- **Where, x2 = R x R/P x P.**

b. Rectangular system:

- **More plants can be planted as compare to square system.**
- **Keeping more space between row to row and plant to plant distance is kept comparatively less.**
- **Number of plants = 10,000 m2/X x Y.**

c. Hexagonal or equilateral triangle system:

- **It accommodated 15% more plants than square system.**
- **The plants are planted at the corner of equilateral triangle.**
- **This is very intense method of planting and difficult to layout.**
- **Requires fertile land.**

d. Quincunx system/diagonal/filler system:

- **Most suitable in highly fertile soil.**
- **This method is similar to square system but an additional 'filler' plant is planted in the center of square.**
- **Almost double number of plants can be planted than square method.**
- **The most common filler plants are papaya, banana, date palm etc.**
- **Filler plants give additional income for non bearing orchard.**

e. Contour system:

- **Adopted in hilly areas**
- **Planting distance is not uniform.**

f. Triangular system:

- **It is mostly used in HDP (high density planting).**
- **E.g. Amrapali variety of mango.**

Commercial propagation methods of major fruit crops:

Fruit crop	Propagation method
• Citrus	Seeds/Air layering
• Grape	Hardwood cutting
• Pomegranate	Cutting/Air layering
• Tea	Softwood cutting

- Litchi Air layering/Gootee
- Guava Stooling
- Banana Sword sucker
- Date palm Offshoot/sucker
- Pineapple Suckers/ slips
- Strawberry Runners
- Aonla T-budding/Patch
- Badl Patch budding/Seed
- Ber Ring & T -budding
- Custard apple T-budtling
- Sapota Inarching
- Rose/Apple Shield budding
- Papaya. Phalsa, Coffee and Jamun are propagated by: ***Seeds***

Important families of fruit crops:

Family	Common name	Botanical name
Bromeliaceae	Pineapple	***Annanas comosus***
Anacardiaceae	Cashew	***Anacardium occidentak***
Annonaceae	Custard apple	A. ***squamosa***
Apocyanaceae	Karonda	***Carrisa carandas***
Lau raceae	Avocado	***Persia americana***
Moraceae	Fig	***Ficus carica***
Rosaceae	Strawberry	***Fragaria ananasa***
Rutaceae	Bael	***Aegk marmelos***
Sapindaceae	Litchi	***Litchi chinensis***
Tilliaceae	Phalsa	***Grewia subinequalis***
Rubiaceae	Coffee	***Collett robusta***

UNIT -1

Fruit production

I. Mango: ***Mattgifera indica,*** Anacardiaceae

Known as national fruit of India/king of fruits.

Fruit type of mango: Drupe

V Origin of mango was: **Indo-Burtna**

Edible part of mango is known as: **Mesocarp.**

Highly cross pollinated mediated by: **House fly**

./ **India's** rank in mango production: **First** (50% of world)

State first in mango production is: **Uttar Pradesh**

Mango is the richest source of: **Vitamin A**

- **Rumani** used for dwarfing effect in: **Dasheri**

Major pest of mango: ***Mango hopper*** *(Amritodus atkinsoni)*

Major disease of mango: ***Powdery mildew***

Mango malformation is due to: ***Low temperature & fungL***

Spongy tissue is due to: ***Convection heats.***

Internal fruit necrosis is due to: ***Boron deficiency.***

Deblossoming is done for: ***Control of malformation.***

Clustering or **jhumka** in mango is due to: ***Low temperature, improper pollination and poor fertilization***

Mango is a **climacteric and tropical** fruit

In mango, **only 0.1 %** flower develops fruits to maturity.

VHT (vapor heat treatment) is recommended for **disinfection** of mango against **fruit flies** and **stone weevil.**

Kanyakumari and Maduri districts of Tamil Nadu produces two crops of mango in a year.

Alphonso: most commonly grown in Maharastra

vı Propagation of mango is done by the method: ***Veneer grafting***

Sal sugandha: It is regular bearing variety and free from **malformation.**

Soil: **Well drained** loamy soil.

· Planting time: ***Jun -July.***

. Distance: **10-12 m, Amrapali: 2.5 x2.5** m- (1600 plants/ha).

Propagation:

- Commercial method is: **Veneer grafting** (April -Oct.).
- Recent method: **Epicotyl stone** grafting (in **Konkan, MH.)**
- Other method: **marching &** Soft wood grafting
- Soft wood grafting method, standardized by **Dr. R.S Amin** at GAU, Gujarat.

_ **Varieties:**

IVanetyiety	**Character**

1	Alphonso	Best **export variety** but *susceptible to spongy tissue*
2	Chausa	**Sweetest** variety, late variety of mango
3	Banganapalli	Most commercial variety of **Andhra Pradesh**
4	Bombay Green	Earliest variety of **north** India
5	Kesar	It has good **processing quality,** popular in Gujarat
6	Langra	North Indian variety, has characteristic turpentine flavor
7	Niranjan	**Off season** variety (bear fruits in October)
8	Lal sindhuri	Powdery mildew resistant **new variety of** mango
9	Neelam	Ideal for **long transport, two** crops are taken in a year
10	Edward	Resistant to **anthracnose**
11	Fazli	Commonly grown in Bihar & West Bengal

Hybrid varieties of mango:

SN	**Hybrid**	**Cross**	**Characters**
1	Arka anmol	Alphonso x Janardan pasand (AJA)	**Free** from **spongy tissue**
2	Arka puneet	Alphonso x Banganpalli (ABA)	Free from **spongy** tissue
3	Arka aruna	Banganpalli x Alphonso (BAA)	**Free** from **spongy** tissue
4	Ratna	Neelam x Alphanso, (NAR)*	Sponge tissue **disease resistant**
5	Amrapali	Dasheri x Neelam (DNA)	Dwarf, Suitable for **HDP** (2.5 x 2.5 m2)
6	Sindhu	Ratna x Alphanso (RAS)	First seed less variety in world
7	Mallika	Neelam x Dasheri (NDM)	Highest **vitamin** content
8	Sai sugandha	Totapuri x Kesar (TKS)	New **hybrid** variety of mango

***(]AR) means: Neelam x Alphanso = Ratna**

Types of mango varieties:

a. **North Indian** cultivar: These **are alternate bearer.** monoembryonic, **self incompatible.**

b. **South Indian** varieties: **These are regular bearing, polyembryonic.**

c. **Regular bearing** varieties:

- Neelam and Totapuri

d. Alternate bearer:

- Langra and Deshehari

e. **Off season** bearing:

- Niranjan and Madhulica

f. **Poly embryonic** varieties:

- ()lour Goa
- Chandrakaran Bellary
- Mulgoa

Insect -pests:

a. Mango mealy bug: ***Drasicha mangiferae*** **(Family: Margodidae)**

- It is **major** pest of mango.
- Nymph and adult suck the cell sap from leaves and tender trunks.

Management:

- **Alkathene banding** 30-45 cm **wide & 30** cm **above** ground.
- Spray **carbaryl @** 0.25%.

b. Mango Hoppers: ***Amritodes atkinsoni***

- Nymph and adult suck cell sap.

c. Stem borer: ***Bactocera rufomaculata.***

d. Fruit fly: ***Bactocera dorsalis***

- Use vapour heat treatment **(VHT)** for export of mango

e. Stone weevil: ***Sternochetus mangiferae:***

- Use of **irradiation.**
- This is **quarantine** importance pest. ***(ARS-07)***

Diseases:

a. Powdery mildew: ***Oidium mangiferae***

- Severe during **Feb -March.**
- Spray **Karathane 0.1%.**

b. **Anthracnose:** ***Colletotrichum gloesporoides***

- Severe in **humid** and high rainfall area.

c. Malformation: ***Fusarium monilliformae*** var. ***suhglutinana***

- Vegetative and floral malformation; bunchy top appearance
- It is a serious problem in north India (in PB, Delhi & UP).
- **Bombay green** and **Chausa** more **susceptible.**

Management:

- Pruning
- Spay of **Mencozeb @** 2g/liter.
- Spray of NAA or planofix @ **200 ppm** by deblossoming at bud burst stage.

Physical disorders:

a. **Black tip: Due to deficiency of boron.**

- Near brick kilns **distal end** of affected fruits get **turned black** and become hardened.
- **Smoke** of **brick -kilns** containing gases like **CO, CO2, SO2& Acetylenes** are responsible for this.

Management:

- Orchard planting **away** from brick kilns at **least 1 km** distance.
- Three spray of **borax (0.6%) (before** flowering, during flowering and at fruit set)
- Borax contains: **11% boron.**

b. Spongy tissue: Due to soil heat convection (high temp.)

- Major problem in **Alphonso**
- **Fruit from outside look normal, but inside a patch of flesh becomes spongy, yellowish.**
- **It is also known as internal break down.**

Resistant varieties:

- **Neelam** and **Deshehari** are almost free from it.
- Other new resistant varieties: **Arka aruna, Ratna, Arka puneet. Arka anmol** etc. are free from spongy tissue.

c. Leaf scorching: Due to **Potassium deficiency.**

- **Spray Potassium sulphate 5%.**

d. Internal necrosis: Boron deficiency.

- **Management:** Application of boron /borax @ 0.6 %

e. **Alternate bearing:**

- **On year:** Bears flowering.
- **Off year:** Bears no flowering.
- It is problem especially in **Dashehari, Langra** and **Chausa.**

Management:

- Application of **Cultar** (Paclobutrazol), it induces flower
- Planting regular bearing varieties: **Amrapali, Neelam and Ratna.**

2. Banana/kalpatharu: *Musa sp.*, Musaceae

India is the largest producer of banana in the world.

- Propogated by suckers/corrns.

  Weight of sword suckers generally used: *5U0 -750 g*

/ Most of cultivated banana is: ***Trip/oh/in nature***

- In banana commonly found: ***Vegetative parthenocarpy***

V Diploid banana variety is: ***Lady finger***

Cut rhizomes used for propagation is known as: ***Peepers***

Seedlessness in banana is controlled by spray of:2, ***4-D @*** *25 PPni•*

High density 1.2 x 1.2m to 1.5 x 1.5m is common now days.

V For the ripening of banana is used low concentration of ethylene with 15-18 °C in controlled chamber. But use of acetylene is not good.

Banana fruits can be stored at 13 °C temperature & 85-95% humidity for three weeks. ***(RPSC-AO 2012)***

Varieties:

- Dwarf eavandish
- Robusta
- Rasthali
- Poovan
- Honda
- Champa
- Nendran (Kerala and **TN)**

Disease:

a. Panama wilt: ***Fusarium oxysporium*** pv ***cubensis.***

b. Sigatoka leaf spot: ***Cercospora musicola***

C. Bunchy top: ***Viral,*** transmitted by banana aphids.

d. Moko disease: ***Pseudomonas solanacearum*** **(bacteria)**

e. Kokkan disease: ***Viral,*** transmitted by aphids

Insect -pest:

a. Rhizome weevil: ***Cosmopolitus sordisus.***

- It is mono phagus pest of banana ***(JRF-09)***

b. Aphids: ***Pentalonia nigronervosa,*** vector of **Bunchy top** virus.

3. Citrus fruits:

(a) Mandarin: *Citrus reticuiata•*

- Most common among citrus fruits grown in India.

Mandarins are highly susceptible to: ***Water logging.***

Mandarin, sweet orange, acid lime and grape fruit are: ***Highly polyembryonic.***

Citrus fruits have a special kind of fruit skin referred as: ***Leathery rind.***

Spacing of lime, lemon and sweet orange is: **6 m x 6m**

1 Kinnow can be grown in HDP by using *"**Troyer citrange**"* as a **rootstock** by spacing the plants at **1.8 x 1.8** m2.

Varieties of mandarin:

- Laddu.
- Coorg: commercial variety in south India.
- **Kinnow:** Cross between ***King Sweet x Willow Leaf mendarins*** developed by **H.B. Frost,** USA -1935). It first introduced in Punjab

(b) Sweet Orange: *C. sinensis.*

Preharvest **fruit drop** is common in **citrus.**

1 It can be checked by spray of 2, 4-D @ 20 ppm.

- Ranpur lime is the best rootstock for mosambi.
- T' budding or Patch budding are most common method for sweet orange propagation.

Varieties: •

- Satgudi Mosambi
- Blood red Jaffa
- Pine apple Valencia

(c) Kagzi lime: *C. aurcmtifolia*

1 known as ***Acid lime/sour lime.***

1 Acid lime commonly propagated by seeds.

1 **Kagzi lime** *(C. aurantifolia)* is the indicator plant for **Tristeza (highly susceptible** to this disease).

1 Citrus **canker** is most serious disease of **acid lime.**

Varieties of kagzi lime:

- Chakradhar: **Seedless** variety of **acid lime.**
- Pramalini: Good yielder
- Mithachikna: sweet, juicy variety.
- Sai sarbati: **Tolerant** to **tristeza** and **canker.**

Diseases of citrus:

a. Gummosis: ***Phytophthora spp.***

b. Bacterial canker: ***Xanthontonas compestris*** p.v ***dirt*** (transmitted by **leaf minor)**

c. Tristeza: **Virus** (vector is aphids: ***Toxoptera sp.)***

d. Citrus greening: Earlier **Mycoplasma** (now causal organism is ***Ca liberobacter,*** a gram negative, walled, bacteria).

- Transinitted by citrus **psylla, *Diaphorina curl***

e. Exocortis: **Viroids.**

Physiological disorder:

a. Granulation: Due to high **temperature & R.H.** during **ripening.** It managed by spray **lime &** application of 2,4-D (12 ppm)

b. Exanthema: **Copper deficiency.**

c. Yellow leaf of citrus: Mo deficiency.

d. Die back due to: **Cu deficiency**

e. Little leaf: Cu deficiency

Insect -pest of citrus:

a. Psylla: ***Diaphorina curl*** (vector of **greening** disease)

b. Leaf minor: ***Phyllocnistis cure/la*** (vector of citrus **canker)**

c. Aphids: ***Toxoptera auranti*** (vector of **Tristeza** disease)

d. Lemon butterfly: ***Pupil° demoleus.*** (Controlled by **bagging** of fruits).

e. Fruit sucking moth: ***Othreis fullonica*** (only **adult** suck the juice from ripening fruits)

4. Papaya: *Cakica papaya* (Caricaceae)

,(Papaya is a: ***Polygamous*** *plant. Produces* fruits throughout the year.

1 It is a tropical fruit and more sensitive to frost

1 Yellow pigment in papaya: ***Caricaxanthin. (RPSC, A0-09)***

1 Milk (lactate) obtained from unripe fruit of papaya: ***Papain***

- In dioecious varieties of papaya: ***10% male*** *plants are planted*
  Papaya is commercially propagated by: ***Seed***

\(Seed rate of papaya: ***250-300 g/ha***

,f Enzyme present in dried latex of papaya is: ***Pepsin***

- Carp me obtained from papaya is utilized as: ***Diuretic*** *and* ***heart stimulant***
- Recommended spacing for Pusa nanha is: ***1.25 x 1.25 m2*** *(6000 plants/ha)*.

,/ Frost is the most limiting factor in papaya in: ***North India***

- Papaya is susceptible to: ***Water logging***
- Most serious disease of papaya seedlings is: ***Damping off***

Cynodioecious varieties: `DMCTSS'

- Pusa delicious

- Pusa majesty (nematode resistance)
- Coorg honey dew
- Taiwan **(blood red coloured)**
- *Sllrya (RPSC, AA0-09)*
- Sunrise solo **(pink flesh)**

Dioecious varieties:

- Pusa giant **(used in canning)**
- Pusa dwarf
- CO -5 (for **papain production).**
- Pant C-1
- Betty
- Hatras gold
- Pusa nanha **(extremely dwarf,** suitable for **HDP/pot** garden).

Diseases:

(d) Damping off/stem rot is due to: ***Pythium aphanidermatum.***

(e) Ring spot: **Viral**

- Upper leaves of papaya is **Mottled.**
- Transmitted by **aphids *(Aphis gossip!).***

(1) **Papaya leaf curl: Viral**

- Transmitted by **white flies.**

Management:

- Both **white flies** and **aphids** can be managed by spraying of any **systemic** insecticides i.e. **Acephate @ 1.0** mllliter of water or **Dimethoate 30 EC @ 1** ml/liter of water or
- **Imidacloprid @ 0.5** ml/liter of water with Streptocyclin a **0.1** g **/liter** of water is also effective.

5. Pome granate: ***Punica granalum*** (Punicaceae).

It is highly **drought tolerant** among fruit crops.

1,4 Origin of pomegranate probably: ***Iran***

Pigment responsible for the red colour in pomegranate fruits: ***Anthocyanin.***

India has first position in the world with respect to pomegranate area and production.

bi In India Maharashtra is the leading state in area and production followed by KR, AP, GJ, TN and RAJ.

- Juice of pomegranate is useful for patient suffering from ***leprosy.***

- **July -August** is ideal time of planting in tropics.
- ***Ambe bahar*** is most commonly preferred by the growers because of high yield as compared to other flowering season.
  Wild type Anar is known: ***Daru***
  Presently ***Bhagawa*** is the leading variety of pomegranate cultivation in India specially in Maharashtra.
- Propagated by ***stern cutting*** and ***air layering*** *(Gootee)*.

'Uttar treatment (Crop regulation):

SN	Bahar	Flowering time	Harvesting	Remark
I	Annbe	Jan- Feb.	Jun -August	More flowering and high yield.
2	Mrig	June -July	Nov -Jan.	Fruit quality is not very good, More prone to insect -pest *and* diseases.
	Hasta	Sept -Oct.	Feb- April	High flowering, Good fruit quality & colour, Preferred for export.

Varieties:

SN	Variety	_Features
1	Jalore seedless	Commonly grown in Rajasthan
_2	Ganesh	Selection from Alandi, popular in **MU**
3	Kandhari	Medium fruit
4	Arakta	Suitable fro processing
5	Mridula	Cross from Ganesh x Gul a -Shah red
6	Ruby	It is hybrid from a 3 way cross from **IIHR**
7	Dolka	Grow in Gujarat
8	- **Bhagawa**	Bright red coloured, popular in MH, also known as **Shendari,** Mastani, Jai maharastra
9	**Amlidana**	Ganesh x Nanha (new pomegranate hybrid)
10	**Wonderful**	Originating from USA, fruit size large (ay. 700g wt.).

Insect -Pests:

a. **Anar butterfly:** ***Virachola (Deudorix) isocrates. (JRF-05)***

- **Serious** pest of pomegranate
- **Pencil size bored holes can be seen on fruits from which larval excreta comes out continuously**
- It is managed by **Covering** of fruits with **butter paper.**
- Spray Carbaryl 50 WP @ 2-4 g/liter or **Methomyl** 40 SP @ 1.0 m1/1 or Monocrotophos 36 SL @ 1 ml/liter spray on plants.

b. Fruit fly: ***Bactrocera zonata*** (Tephritidae). ***(JRF-05)***

- Minor pest of pomegranate

c. Fruit sucking moth: ***Othreis spp.***

Disease:

a. **Bacterial blight:** Caused by *Xanthomonas axonopodis* pv. ***punicae.***

- **Also known as nodal blight or blak spot**
- In Maharashtra commonly known as oily spot or ***Telya.***

Physiological disorder:

a. **Fruit cracking:** Due to **Ca, B & K** deficiency.

- More in Rajasthan (dry areas).
- Managed by spray of **Borax @** 0.5 %.

b. **Internal breakdown:**

- Disintegration of arils in matured pomegranate.
- Arils become brown and blackening.
- The incidence is more in ***ambe bahar*** *(Jan -June)*

6« *Ber; Zizyphus mauritiana.*

- Best time for pruning in ber is: April- May (in Rajasthan)
- Ber crop is heavily/drastically pruned

Varieties:

- **Dodhia:** Resistant to **fruit fly.**

Early varieties (suitable for **dry area):**

- Gola
- Kaithali
- **Seb** ***(RAS-09)***

Mid maturity:

- Mundia   Banarasi
- Jogia   Meharun

Late maturity:

- Umran: Originating from **Rajasthan *(RPSC, A0-09)***
- **Illaichi:** Triplets variety, Found pollen sterility
- **Katha:**
- Pathani:

Diseases:

- Powdery mildew: ***Odium jujube*** var ***indica.***

Insect -Pest:

- Fruit fly ***Carpomia vesuviana***

7. Guava: *Psidium guajava* (Myrtaceae)

Practice of tacking **winter crop** instead of **rainy** season crop is known as **crop regulation** (to escapes the attack of **fruit flies).**

,7 **Stooling** is the most common & cheapest method of guava propagation.

1 Allahabad region of UP is known for best quality guava production.

1 Guava can tolerate salinity but is susceptible to soil acidity.

s/ **Rainy season** crop can be removed by spraying of ***urea*** at the time of **peak flowering** period.

Wilt is serious problem in guava (common in **Alkali soil)**

Varieties:

- Allahabad safeda
- Lucknow-49 (known as **Sardar)**
- Chittidar **(numerous red dots** on skin).
- Harijha (popular in Bihar)
- Hafsi **(Red fleshed** guava)
- Behat coconut (seedless guava)
- Lalit **(pink flesh** fruit, dual purpose fruit)
- Kohir safed
- Arka mridula (soft seeded, **dwarf variety)**
- Allahabad Safeda: famous variety of Allhabad
- Allahabad Surkha (fruit with **deep pink flesh)**
- Apple colour: (pink coloured)

Hybrid:

- **Hybrid -45 =** Allahabad safeda x Sardar (L-49).

Disease:

a. Guava wilt: ***Fusariunt oxysporium*** p.v. **Psidii.**

Symptoms:

- **Wilting appearance of plants and leaves of young plants is dries up.**

Management:

- **Soil drench with Carbendazim/Bavistin @ 2g/liter water.**
- **Grow resistant varieties i.e. Allahabad Safeda.** ***(RAS -09)***

Insect pest:

a. **Striped mealy bug: *Ferrisa virgata,* serious pest in South India**
b. **Guava tea mosquito bug: *Helopeltis antonh:*** *(JAR]. Ph. D- 07)*
c. **(Corky out growth/scab formation in guava)**

Physiological disorder:

a. **Bronzing:** *Due to* ***Zn deficiency***

8. Aonla: *Emblica officinalis (Euphorbiaceae)*

‘4 **It is also known as Indian gooseberry is an indigenous fruit**
- **Propogation by patch budding in north india.**
- **Aonla fruits is contains vitamin *C. 600 mg/100g***

,4 **Large sized, sound fruits are mostly utilized for: *preservation* *and* *candy***

Varieties:

Varieties	Features
Banarasi	Early maturity, best for Murrumba
Kanchan	Regular bearing, known as NA -4
Chakia	Alternate bearing
Hathijhool	Suffers from fruit necrosis, also named as Francis

Disease:

a. **Ring rust: *Ravenelia Emblica,* it is serious disease in aonla.**
b. **Fruit necrosis: *B -deficiency.* Francis variety highly suffered**

Insect -Pest:

a. **Bark eating caterpillar: *Indarbella quadrinotata.***

9. Grape: *Vitis vinifera, Vitaceae*

- **Ideal time of planting unrooted grape cuttings is: *October.***
- **Rooted cuttings are planted in January -February.**

*4 **Grape is a deciduous crop.**
Propagated by hard wood cuttings.

Thompson seedless with its clone occupies 55% area under grape cultivation.

.7 **Training system** of grapes which is mostly adopted in India is: ***Bower system.***

Element that is universal deficient in grape is: ***Mg***

- ***Tartaric*** acid is present in grape fruits

In northern India grapes are pruned in: ***December -January***

- The **chemical** used to reduce post harvest **fruit drop** in grape is: ***NAA (50 ppm).***
- Outstanding cultivar of **raisin (dehydrated** grape) is: ***Kismis Rely***

Varieties of grape:

Varieties	Features
Arka Trishna & Soma	**Wine purpose**
Dilkhush	**-**
Arka Hans	**White wine**
Arka Kanchan	**Late maturity** variety
Thomson Seedless	**Mostly grown** variety
Muscat	**Coloured seeded** variety
Perlette	**-**
Anab-e-Shahi	**-**

Diseases:

a. Downy mildew: ***Plasmophora viticola*** (major disease)

b. Powdery mildew: ***Etysiphe viii***

Physiological disorder:

a. **Hen & Chicken** disease is due to: ***Bo*** *deficiency.*

b. **Berry** or Blossom **drop** in Grape: ***Improper*** *pollination & fertilization.*

c. **Pink berry** formation is due to: ***High temp,*** *common in* ***Thompson*** *seedless.*

d. **Calyx end rot:** ***Ca*** *deficiency.*

Insect -pests:

a. Thrips: ***Rhiphiphothrips cruntatus*•**
   - It can be managed by spray malathion 50 EC @ Iml/liter

b. Flea beetle: ***Scelodenta strigicollis***

- **It is managed by spray carbaryl 50 WP @ 2.5 kg/ha of orchard.**

1111111111111111bli nuciferat Antatetae **ll**

India's rank 311 in coconut production after Indonesia and Philippines.

,1 Kerala share in coconut production is: 42%

Chowgghat green dwarf and Pratap are cocout varietiees

Insect -Pest of coconut:

a. **Rhinoceros beetle:** ***Oryctus rhinoceros***
   - **Fan like appearance of leaves.**

b. **Red palm weevil:** ***Rhyncophorus ferrugineus***
   - **Gummosis (oozing of brown liquid)**

c. **Black headed caterpillar:** ***Opisinia arenosella***
   - **Monophagus pest of coconut.**

d. **Coconut mite:** ***Aceria guerreonis. (IARI, Ph. D-05)***

Diseases of Apple:

a. **Crown gall:** ***Agrobacterium tumefaciens***
b. **Fire blight of apple/pear:** ***Erwinia amylovora***
c. **Apple scab:** ***Venturia subinaequalis*** **(fungi)**
d. **Water core:** ***Bo deficiency***
e. **Bitter pit and cracking:** ***Ca deficiency***

Insect -pest of apple/pear/peach:

a. **Sanjose scale:** ***Quadraspidiotus perniciosus.***
   - **Suck the cell sap from leaves, twigs and fruits, the infested fruits also have a scaly appearance & each spot is surrounded by a scarlet or red area.**
   - **Important parasitoid of sanjose is** ***Encarsia perniciosi***

b. **Wooly apple aphid:** ***Eriosoma lanigerum***
   - **The infested plants have pale -green leaves and whitish cotton patches on stem and branches, characteristic galls/knots are formed on roots & underground portion of plants.**
   - **Its main parasitoid is:** ***Aphelinus mali*** **(attacks on *4th* and 5`11nymphal stage).**

insinr.2 -

Vegetable production

Important points:

Vegetables are rich source of **vitamins** and **minerals.**

India 2'd largest producer of **vegetable** after **China.**

- Vegetable crops in India occupy only **2.8 %** of the **total cropped** area.

India accounts for **13.38** % of World **production** of vegetables.

State having largest **area** and **production** of vegetables: ***West Bengal***

State having maximum **productivity** of vegetable: ***Tamil Nadu***

Market garden is very intensive method of vegetable cultivation.

Truck garden is very **extensive** method of **vegetable** cultivation.

Green leafy vegetables are rich source of **follic acid.**

Major **mineral** present in **fruit** and **vegetable** is **potassium.**

Cucumber is the **non climacteric** vegetable fruits.

- **Quecertin** compound presence in onion and garlic protection against **cancer** and **heart** disease.

Vitamin present in chilli is: ***Vitamin P.***

- The **garlic flavor** is due to sulphur compound: ***Di ally! di sulphide***

1 Flower colour of **pointed gourd, bottle gourd** and **chilli is:** ***White. (ARS-09)***

Flower colour of all **cruciferous is:** ***Yellow***

Popular variety of **pumpkin is:** ***Pusa vishwas and Arka chandan***

- **Arka harit** and **Pusa visesh** are varieties of bitter gourd
- Pointed gourd propagated by vine cutting @ 2000-2500 cuttings/ha.

Ridge gourd commercially trained on kniffin system.

1 **Pusa nasdar** and **Satputia** (hermaphrodite) are the varieties of ridge gourd.

- **Pusa supria** and **Pusa chikni** are varieties of **sponge gourd.**
- **PBOG-1, Pusa manjari** and **Pusa maghdoot** are the varieties of: ***Bottle gourd***

1 **Pine sett** and **Pusa sanyog** are varieties of: **Cucumber**

1 **Pusa parvati** is mutant variety of **French** bean.

Pusa suffaida and **Pusa lal** are the variety of: **Sweet potato.**

I RS -1 and RZ-19 are varieties of cumin.
RCR-41 and UD-20 are the varieties of coriander.
RMT-1, R1'IT-141, Rajendra kranti are: Fenugreek varieties.

Chapter -1

Classification of vegetables:

1. Botanical classification of vegetables:

Family	Common name	Botanical name	Origin	Edible part
Alliaceae	Onion	*Allium cepa*	Central	Bulb
	Garlic	*Allium sativum*	Asia	Cloves
Lilliaceae	Asparagus	A *officinalis*		Spwears
Araceae	Taro	*Colocasta esculenta*		Corms
Chenopodiaceae	Beet root	*Beta vulgaris*		Roots
	Palak	*Beta vulgaris* var *bengalensis*		Leaves
	Spinach	*Spinacea oleracea*		Leaves
Compositae	Lettuce	*Lactuca saliva*		Leafy heads
Amaranthaceae	Amaranthus	*Amaranthus sp.*	India	Leaves, stem
Convolvulaceae	Sweet Potato	*Ipomea batata*	S. America	Tuber
Cruciferae /Brassicaceae	Cabbage	*B oleracea* var. *capitata*	-	Head
	Cauliflower	*B oleracea* var. *botrytis*	-	Curd
	Broccoli	*B oleracea* var. *italic*	-	Flower *bud*
	Turnip	*Brassica rapa*	-	Root
	Radish	*Raphanus sativus*	-	Root &leaves
Cucurbitaceae	Cucumber	*Cucumis sativus*	*India*	Fruit
	Musk Melon	*Cucumis melo*	T. Africa	Fruit
	Water Melon	*Citrullus lanatus*	T. Africa	Fruit
	Pumpkin	*Cucurbita moschata*	Mexico	Fruit
	Bottle gourd	*Lagenaria siceraria*	-	Fruit
	Bitter gourd	*Momordica charantia*	-	Fruit

	Pointed gourd	***Trichosanthus dioca***	**India**	Fruit
	Snake gourd	***Trichosanthus anguina***	**India**	Fruit

Malvaceae	Okra	***Ablmoschus esculantus***	Africa	Fruit
- Leguminaceae	Peas	***Pisum sativum***	Asia	Pod
	French bean	***Phaseolus vulgar's***	Mexico	Pod
	Cluster bean	***Cyamopsis tetragonolobus***	**India**	Pod
	Cow pea	***Vigna unguiculata***	Africa	Pod
Umbeliferae	Carrot	***Daccus carota***	Afghanistan	Root
	Coriander	***Coriandrum sativum***	**-**	leaves
Solanaceae	Potato	***Solanum tuberosum***	**S. America**	**Tuber**
	Tomato	***Lycoperisicon esculentum***	**-**	Fruit
	Brinjal	***Solanum melongena***	**India**	Fruit
	Chilli	***Capsicum annum***	**Mexico**	Fruit
Euphorbiaceae	Cassava	***Manihot escuianta***	**Brazil**	**Tuber**

2. Classification of vegetables based on life cycle:

a. Annual vegetables:

- **Okra** **Tomato**
- **Cow pea** **Brinjal**

b. Biennial vegetables:

- **Radish** **Carrot**
- **Cabbage** **Cauliflower**
- **Onion**

C. Perennial vegetables:

" **Sweet potato** **Parval**

'1 **Garlic** **Ginger**

3. Classification of vegetables based on photoperiod.

a. Long day vegetables:

- Onion — Cabbage
- Cauliflower — Radish
- Palak — Carrot
- Turnip — Potato (Flowering point of view)

b. **Short day vegetables:**

- Sweet potato — Cluster ban

c. **Day neutral vegetables:**

- Tomato — Brinjal
- Chili — Okra
- Cucurbits — Cowpea

4. **Classification of vegetables based on presence of male/female.**

a. **Dioecious vegetables:** both male & female flowers are present on separate plant. Examples are:-

- Pointed gourd — Beet root
- Spinach

b. **Monoecious:** both flowers are present on same plant.

- Cucurbits — Cassava
- Amaranths

1. **Tomato:** ***Lycopersicon esculenturn, Solanaceae***

Botanical name of tomato: ***Lycopresicon esculentutn***
Origin of tomato: **Peru**
Fruit of tomato is: **Berry**
v i Red colour in tomato due to: **Lycopine**
Popular variety of tomato: **Pusa ruby, Arka vikas**
VI Seed rate of tomato: **350-400 gm/ha**
Major pest of tomato: Fruit borer ***(Helicoverpa sp.)***
vi Tomato susceptible for: **Frost**
VI Tomato fruits generally regarded as: **Protective food**
In adverse conditions tomato crop is sprayed with: ***PCPA*** for higher fruit setting.
v i ***Punjab chhuhara*** is determinate variety of tomato
A period of drought followed by **sudden heavy irrigati011** during fruiting may cause **cracking of fruits**
Chemical used for tomato sauce preservation: **Sodioni benzoate**

- **BER (blossom end rot) disease of tomato is due to: Ca deficiency**

  Tomato is day neutral and self pollinated plant

1 **Basically warm season crop but may be grown in all seasons.**

Seed rate:

- **For normal:** **350-400 g/ha**
- **For hybrid:** **100-150 g/ha**

Varieties:

- **Pusa ruby:** **Sioux x Improved Meeruti.**
- **Pusa-120:** **Nematode resistant**
- **Arka sourabh:**
- **Pusa gaurav:**
- **Arka vikash:**
- **Hissar lalit:** **Nematode resistant *(RPSC, A0-09)***
- **Pusa sheetal:** ***W* inter season**
- **SL -120:** **Nematode resistant**
- **Roma:** **Suitable for transport and processing**
- **Parker:** **Fruit borer *(H armigera)* resistant**
- **Punjab chhuhara and Roma: Suitable for processing.**
- **Flar savr: Delay ripening variety of tomato developed through Biotechnology in 1994 by Calgene Company.**

I. **Blight of tomato: bacterial disease.**
   - **It can be managed by use of Copper fungicides i.e. Copper oxychloride @ 3g/liter of water with Bacteromycin @ 0.1 g/liter of water or Mencozeb @ 3g/litre.**

2. **Leaf curl: virus**
   - **Transmitted by white fly.**

Insect -pest:

1. **Fruit borer: *Helicoverpa armigera.***
2. **White fly: *Bemisia !abaci* (transmitted leaf curl disease)**
3. **Serpentine leaf minor: *Liriomyza trifoli.***

Physioloeical disorders:

SN	Disorder	Character	Causes
	Fruit cracking	Cracking in tomato fruits is common, radial and concentric, cracking are severe	Effect of soil moisture and **Boron deficiency**

2	Blossom end rot (BER)	BER is severe disorder in green house cultivated tomatoes	Due to Ca deficiency and high temperature
3	Puniness	Fruit surface is generally flattened and locules are unfilled with pulp and seeds	Poor pollination, Low or high temperature
	Sun scald	Whitish, sunken and papery lesion develops due to sun heat	Exposer of fruits to high temperature > 40 °C
5	Cat face		

2. Brinjal: ***Solanum melongena, Solanaceae***

- Pigment present in brinjal is: **Anthocyanin.**
  Brinjal fruits are good source of: **Vitamin B.**

Seed rate:

- **200 g/ha** for nursery sowing

Varieties:

- Pusa purple long (extra early maturity)
- Pant samrat **(Phomopsis** blight and bacterial **wilt** resistant).
- Azad kranti
- Black beauty (nematode resistant)
- Arka sheel, Arka nidhi

Hybrid:

- Pant rituraj:
- Pusa bindu:
- Pusa upkar:
- **Pusa bhairav** (Phomopsis blight resistant)
- Arka navneet (Highest yielding):
- Arka neelkantha (Nematode resistant).
- Annamalai: Aphid resistant, recommended for TN
- Arka **keshav**

Insect -pest:

a. Fruit and shoot borer: ***Leucinodes orbonalis, Pyralidae, Lepidoptera*** (Major pest of brinjal).
Cause **'dead heart'** in young plants, tender growing ***shoot*** is killed by larvae in early stage and later bore *into fruits*.
1 It can be managed by application of **Spirotetramat 150** SC @ 75 g a.i. /ha. or Flubendiamide 48 SC @ 60 g a.i. /ha.

b. Hadda beetle: ***Epilachna vignitictopunctata (F. Coccinelidae)***

c. **Brinjal brown leaf hopper: *Cestius phycitis* (vector of little leaf of brinjal).**

d. **The white flies and jassids/leaf hopper in brinjal can be controlled by application of lmidacloprid 200 SL @ 75 g a.i /ha**

Diseases:

1. **Little leaf of brinjal due to: Mycoplama**

- **Transmitted by leaf hoppers: *Cestius phycitis***

3. Chilli: *Capsicum* spp.(Solanacae)

Red colour of chilli due to: *Capcyanthin*

1 **Pungency of chili due to: *Capsaicin.***

1 **Major pest of chilli is: *Thrips (Scirtothrips dorsalis).***

1 **Anthracnose/die back due to fungus: *Colletotrichum capsicL***
NAA (Planofix) @ 10 ppm and Triacontanol is *used* to control: *Fruit drop*

1 **India is a major producer, consumer and exporter of chilli in the world**

1 **Andhra Pradesh is pioneer in chilli production.**

1 **capsicum annum also known as sweet pepper**

1 **Leaf curl of chilies: Viral, transmitted by thrips.**

1 **To prevent fruit rot should be used Calcium nitrate (CN) @ 1 litre/ha or broadcasting about 25 kg/ha.**

Seed *rate:*

- **For chili: 1.0-1.5 kg/ha**
- **For capsicum annum(hybrid): 250g seeds/ha**
- **Sown in nursery and transplanted after 45 days of seedling**

Varieties:

- **California wonder**
- **Arka mohini**
- **Andhra jyoti**
- **Pusa jwala (thrips resistance)**
- **Jwalamukhi (suitable for HDP)**
- **Arka lohit (powdery mildew tolerant)**
- **Bhaskar**
- **Bhagyalakshmi**
- **lndra**

- Punjab lal (resistant to fruit rot, die back, curl)
- Mathania long
- Bharat

Pest management:

1. Chilli thrips: ***Scirtothrips dorsalis***
   - Symptoms is the inward curling of leaves
2. White flies: ***Bemisia tabaci***
   - It is responsible for transmission of **chilli mosaic virus**
   - Both **white flies and thrips** can be managed by spraying of any **systemic** insecticides i.e. **Acephate @ 1.0** mUliter of water. Or Thiomethoxam @ 0.4 ml/liter spray or
   - **Imidacloprid @ 0.5** mUliter of water with Streptocyclin @ **0.1 g /liter** of water.

4. Okra: *Ablmoschus esculantus.*

•(Major pest of okra is: Fruit borer ***(Earias vile/la)***

1. Blister beetle: ***Mylabris pustulata is apes! of okra.***

- **Yellow vein mosaic is due to: Virus, transmitted by white fly.**

Seed rate:

- **For kharif season: 8-10** ***kg/ha is optimum***
- **For spring -summer the seed rate is:** ***20 kg/ha***

Varieties:

- **Pusa sawani: Day neutral and spineless**
- Varsha uphar: White flies resistant
- Punjab padmini
- Pusa mukhmali
- Prabhani kranti: White fly resistant
- Arka anamica
- Arka abhay
- **Hissar** unnat

,/ All Cole crops are: ***Protovny.***

•I Major pest of Cole crops is: ***DBM*** *(Plutella xylostella)*

_OLt

- Club rot of cauliflower is due to: ***Plasmodiophora brassicae***
- Curd rot/soft rot of cole crops due to: ***Erwinia crotovera.***
- White rust/white blister of cruciferus: ***Albugo candida***
- Self incompatibility is most common in: ***Cruciferae family***
- The characteristic flavour of cole crops is due to presence of: ***Di methyl tri sulphite***

Insect -pest of cole crops:

1. Diamond back moth (DBM): ***Plate/la xylostella***
   - **It** is serious pest of **cabbage**
   - Larvae feed on leaves and later make galleries in head/cabbage fruits
   - DBM has developed the resistance against most of insecticides

Management:

- Indian mustard which attract 80-90 % DBM used as ***trap*** crop. ***(ARS-07)***
- **Alternative sprays of following pesticides:**
- Spray of Quinolphos 35 EC @ 250 ml/ha
- Spray Cartap hydrochloride @ 500 g a.i/ha
- Spray Fenvalerate 20 EC @ 45 g a.i. /ha

2. Mustard saw fly: ***Athalia proxima lugens*** (only one pest from order: **Hymenoptera,** F: Tenthredinidae)
3. Cabbage semi-looper: ***Plusia orichalcea*** (Noctuidae)

5. Cabbage: *Brassica oleracea* var. *capitata*

India rank 31d in cabbage production.

Cabbage has **anticancer** property due to presence of **Indole-3-carbinol.**

The incidence of club root of cabbage is 100% at pH 5.7

- Fruit of cabbage is known as: **Head**
- Fruit type of cabbage: Siliqua.

Seed rate:

- 500-750g of seed is required for one ha.

Varieties:

- Golden Acre
- Copenhagen Market (early variety).
- Pride of India (early and round variety)

Hybrids:

- Pusa drumhead
- ***Pusa mukta***
- Pusa ratnar
- Pusa red
- Pusa sambandh

6. Cauliflower: *B. oleracea* var. *botrytis*

Blanching is done in cauliflower to **protect curd** from **attaining yellow** colour after their direct exposer to sun and to **arrest** enzymatic activity.

- Fruit of cauliflower known as: **Curd**
- Three season varieties are available in: **Cauliflower**
- **Scooping:** removal of central portion of curd for earlier initiation of flower stalk in cauliflower
- **Pusa himjyoti** and **Pusa snowball** have self blanched habit.

Seed rate: **450-700g** seeds are sufficient for one ha.

Early variety:

- Pusa early synthetic
- Early kunwari
- Pusa deepali
- Pusa katki
- Pusa sharad

Late variety:

- **Pusa snowball**
- **Pusa himjyoti:** Can be grown from **April to July** in the hills.

Disorders of cauliflower: *(RAS mains exam -2013)*

SN	Disorder	Character	Causes
	Blindness	Plants having no terminal buds and fail to form any curd	Damage in early stage *by* insects, low temp. & frost
	Buttoning	Development of small curds in young plants	**Nitrogen deficiency**
	Hollow	Excessive growing plants of	Excessive use of

stem (RAs **pre-2012)**	cauliflower develops hollow stem and curd	fertilizers especially **'nitrogen'**
Whiptail	Only midrib of leaf blade is develops so the name' ***whiptaiP*** is given	Mo deficiency in acidic soils
Chlorosis	lnterveinal, yellow mottling of lower leaves	Mg deficiency
Riceyness	The surface of curd is loose and has velvet appearance due to formation of small white flower buds at the curding stage	Fluactuation of temp., Heavy application of N & high humidity
Browning	Light brown to dark spots on stem, brown colour of curd	**Boron** deficiency

7. **Onion: *Allium cepa***

•(Rich source of: **Vitamin B.**

./ Pollination of onion chiefly by: **Honey bees**

,7 Pungency in onion due to: **Allyl propyl di sulphide.**

•(Onion is a cool season crop

11 The **colour** of outer skin of onion is due to: **Quecertin.**

•(Onion is very useful in: **Sun stroke.**

•7 **Bolting** in onion/stem elongation due to: **Low temperature**

17 In **onion & garlic:** Purple blotch due to: ***Alternaria porii.*** Lassalgoan in Maharashtra is the biggest onion market in India.

•(**Cate chol** is a phenolic factor present in onion has **antifungal property.**

1 In onion to check **sprouting** or germination during **storage** is spraying **MB @ 2500 ppm15-20** days after storage.

,7 Important pest of onion is **thrips.** It can be controlled by spraying **Acephate 1 ml/liter** of water.

Seed rate:

- **10-12 kg Seeds/ha** for nursery
- Or planting by bulbs: 750 kg medium sized bulb/ha

Varieties:

Rabi season:

- **Pusa red**
- **Nasik red**
- **Patna red**
- **Udaipur 101, 102, 103**
- **Pusa ratnar**
- **N-53**
- **Kalyanpur red round**
- **Pusa madhavi**
- **Arka bindu**

Kharif season:

- **Arka kalyan**
- **Agrifound dark red**
- **N-53**
- **Arka pragati (grow in both season).**

8. Root crops:

- **Allicin is the antibacterial substance of: Garlic**
- **Allin water soluble amino acid present in: Garlic**

a. Radish: *Raphanus sativus*

- **Mustard saw fly and painted bug are the pest of radish.**
  Roots of radish prepared for seed production is known as: Stacldding
  Brown heart is common in radish is due to: Boron deficiency
  Seed rate: 5.5-11 kg/ha

Varieties:

- **Arka nishant (multiple diseases resistant)**
- **Pusa chetki (suitable for summer)**
- **White icicle**
- **Japanese white.**
- **Pusa safed**
- **Scarlet globe**
- **Pusa rashmi**
- **Pusa himani (can be grown throughout the year)**
- **Round Cherry Belle: Red coloured variety of radish**

b. Carrot: *Daccus carota*

V Carrot is an annual crop for root production and biennial for flowering and fruit set.

- Kanji (beverage is prepared from black carrot)
- **Forking** of carrot is due to: **Hard pan of soil.**

Seed rate:

- **5-6 kg/ha** of seeds is sufficient.

Varieties:

- Pusa kesar: suitable for early sowing
- Pusa meghali: highest vitamin A
- Chantenay: for canning and storage
- Imperator: late maturity
- Ooty-1:

9. Cucurbits:

- **Pusa vishwas** is variety of: **Pumpkin.**
- **Pusa chikni** and **Arka chandan are the variety of: *Turai*** (Sponge gourd)
- Biakner green, Dilpasand, Hisar selection -1, are the varieties of: ***Tinda/Round gourd***
- Powdery mildew in cucurbits due to: ***Erysiphe cichoracearum***
- Downey mildew in cucurbits due to: ***Pseudoperanospora cubensis (RAS-6).***
- Yellow vine of cucurbits is due to: ***Serratia marcescens***

  Bud necrosis: mostly in water melon, viral, transmitted by seeds.

Insect- pests of cucurbits:

1. **Red pumpkin beetle:** *Raphidopalpa foeicollis*
   - Both grub and adult beetle cause damage, the grub damage the plants by boring in to roots and underground stem.
   - But beetle are very destructive to vegetable particularly March -April when creepers are very young.

Management:

- Apply Carbofuran 3 g @ 7.0 kg/ha or Methyl parathion 2% dust @ 20 kg/ha.
- Spray Malathion 50 EC @ 0.05 %.

2. **Cucurbits fruit flies:** *Bactrocera cucurbitae*
   - Maggots feed pulp and seeds infested fruits may fall prematurely & fruit become soft and rotten.
   - It can be controlled by bait spray containing 50 ml of Malathion 35 EC and 0.5 kg Gur/molasses in 50 liters of water for one ha.
3. **Cucurbit mite:** *Tetranychus cucurbitae*
   - Known as **red spider mite**
   - Suck cell sap by making webbing on **underside of leaves**
   - Damage confined to under surface of leaves
   - It controlled by **Dicofol/ Ethion 50 EC @** 1.5 ml/liter

10. Cucumber: *Cucumis sativus* ANON

,(Known as *`**kheera'***

,(Sex form of cucumber is : **Monoecious**

••(**Pillow** disease of cucumber is due to: **Calcium** deficiency.

- Vector of cucumber mosaic virus is: **Aphid**

,f Seed rate: **2.5 kg/ha**

Varieties:

- Pusa sanyog (gynoecious variety)
- Japanese long green
- Pinesett
- Balaam kheera

11. Water melon: *Citrullus lanatus* 1

Water melon fruit contains: ***92-95 % water. (RAS-09)***

V Metallic sound at the time of harvesting shows: *immaturity.*

Heavy **dull sound** at the time of harvesting shows: *MaturiV.,*

The drying of tendril at the base of the fruit is also a sign of maturity

Bud necrosis in watermelon is due to: ***Aphids (Aphis craccivora)*** 1

^:Eit.itVOtars*,fr,

... .

.(Seed rate: ***4-4.5 kg/ha.***

Varieties:

- **Sugar baby (very sweet, 11-13% TSS)**
- **Durgapura meetha**
- **Durgapura kesar (yellow fleshed)**
- **Pusa rasal**
- **Asahi yamato**
- **Arka jyoti**
- **Improved shipper: an american introduction**

Hybrids:

- **Arka Manic (Powdery mildew resistant)**
- **Pusa bedana (seedless hybrid, triploid variety).**

12. Musk melon: *Cucumis melo*

1 **High temperature at the time of fruit maturity and ripening increases the sweetness.**

1 **Musk melon is harvested at full slip stage, except Hara madhu at netting.**

1 **Seed rate: 1.5-2.0 kg/ha.**

1 **Seed rate: 1 kg/ha by dibbling method**

Varieties: •

- **Durgapura madhu: Early variety (RPSC, AA0-09).**
- **Nara madhu:** **Late variety**
- **Arka jeet:** **Excellent flavor, very sweet**
- **Pusa madhuras:**
- **Pusa rasraj:** **Early variety**
- **Punjab sunhari:**
- **Arka rajhans:** **Excellent transport quality**
- **DMDR-2**

13. Bottle gourd: *Lagenaria siceraria*

" **Known as *lauki***

- **Seed rate: 3-6 kg/ha**

Varieties:

- **Pusa summer prolific long.**

- P130G-1 (Pant sanker)
- Samrat (highest yield)
- Pusa manjari: grow in spring season
- Punjab komal
- Arka bahar
- Pusa maghdut (Fi hybrid by public sector)

14. Pea: *Pisan: sativian, Legruninacae* 4.14

1 Garden pea is: *Pisani saiivran var. hortense*
1 Pea is rich source of protein: about 25%
- State which is first in area and production of pea: *UP*
- In India pea is the most popular canned vegetable

1 Maturity of pea is measured by: *Tendromeier*
I Stem borer of pea: *Erizophera particella.*
1 Powdery mildew of pea: *Erysiphe polygon:1*

Seed rate:

- 75-80 kg/ha

Varieties:

In Azad P-1
- Jawahar mator-1 (susceptible to powdery mildew)
- Bonneville (suitable for dehydration)

111 Arkel (sickle shaped pods)
- Sylvia (whole pod is edible)
- Arka Ajit (resistant to powdery mildew).
- Harbhajan (extra early variety)
- Hissar harit-1
- Aparna/HFP-4:- *first dwarf variety (JAR!, Ph.D-09)*
- Rachna (powdery mildew resistant)

1111111111111111111111111easiff ambia): Legundesic

1 Native place: Africa
I Seed rate for rainy season is: 12-15 kg/ha
1 For summer vegetable: 20-25 kg/ha
For fodder purpose: 20-30kg/ha
1 Pest of cow pea is pod fly: *Opkitnnyia phaseoil*

Varieties:

- Pusa barsati — Pusa dofasali
- Pusa rituraj — Pusa komal
- Kansi gouri — Pusa phalguni (dwarf variety)

17. Cluster bean: ***Cyantopsis tetragonairliMilktaceae)***

- Rajasthan is first in production and area of cluster bean
- It is used as cattle feeds and fodder, making gum, resins and explosive.
- But immature pods are also used as green vegetable.

Varieties of cluter bean as green consumption:

- Pusa sadabahar
- Pusa mosami
- Durgapura safed
- Pusa navbahar

16. Palak (Spinach): ***Beta vtdgaris'*** **var** ***heagaleasis***

Seed rate: 20-25 kg/ha

Varieties of palak:

- Punjab green
- All green
- Pusa harit
- Pusa jyoti
- Jobner green (mutant variety).
- Pusa bharti: Polyploidy variety)

UNIT -3
floriculture

1 Leading flower product exporting country: *Netkerkmds 57%.*
- Leading flower product importing country: *Germany_*

1 Country having largest market of cat flowers: *Germany.*

State having maximum area under flowericulture in India: *Karnataka*

1 State having max. production under floriculture in India: *Tamilnadu.*

1 Largest importer of flowericulture products from India: *USA 27%.*
- Maximum cut flower production in India: *West Bengal*

- **Flower crop covering maximum area in India:** ***Jasmine***
- **Hogarth course is also known as:** ***Line of beauty.***
- **Book 'Beautiful Gardens' is written by:** ***M.S Randhawa.***
- HP **B.P. Pal and Priyadrashani are varieties of: Rose**

s/ **Japanese flower arrangement is known as:** ***Ikebana. (R4S-06)***

India is the largest producer of loose flower in the world

Famous gardens:

Garden	Place
• Mughal garden:	Pinjore, Haryana
• Rose garden:	Chandigarh
• Mandhor garden:	Jodhpur.
• Buddha Jayanti Park:	New Delhi
• Brindavan garden:	Mysore(Biggest formal garden)
• National botanical garden: Lukhnow	

Style of gardening:

1. **Formal style:**
   - **Plan is symmetrical**
     E.g. Mughal gardens, Persian gardens, Pinjore garden
2. **Informal style:**
   Plan is asymmetrical:
   It reflects naturalistic effect of total view and represents natural beauty
   E.g. Japanese garden, English garden
3. **Freestyle:**
   1 **Combination of both formal and informal style.**
   1 **E.g. Rose garden of Ludhiana/Chandigarh, English garden.**

Main features of garden

1. **Mughal garden:**
   1 **Terraces**
   - **Running water**
   1 **Baradari**
   - **High protecting wall**
   1 **Terminal building**
2. **Japanese garden: features**

- **Garden lanterns**
  Garden pagoda
- **Dry landscape**
- Wells
- E.g. **Buddha jayanti park, New Delhi**

3. **English garden:**
   - Herbaceous border
   - Cottage garden
   - **Lawn**
   - **Rockery *(RAS-09)***
   - **E.g. Persian garden, Rastrapati garden, Tea garden**

Lawn:

- Regarded as **heart of garden**
- No garden is complete without lawn
- Planting of grass in lawn by **turf method**
- It is **best and quickest** method for planting of lawn
  In this method used turf -piece of earth with grasses

Flower crops:

1. Rose: ***Rosa spp.*** (Rosaceae)
   - Origin place of rose: **India.**
   - **Rose known *as:*** **Queen** of flowers
   - Rose is: **Symbol of beauty**
   - National flower of: **England**
   - Best time of planting: **September -October.**
   - Commercial method of propagation: **T -budding.**
   - Best time of budding: **Nov. to Feb.**
   - Fruit of rose: **Rose hips.**
   - **Dr. BP Pal** related to: **Rose breeding.**
   - Gulkand is prepared by mixing: **Petals** and **sugar** in 1:1 ratio ***(RAS-09).***
   - **White** flower variety of rose is: **Tushar. *(RAS-09)***
   - **Red** flower variety of rose is: **Crimson Glory.**
   - **Thorn** less variety of rose: **Pusa mohit, Suchitra**
   - To increase shelf life of flower: **Pulsing treatment is done.**

2. Gladiolus: ***Gladiolus hybridus***
   Family: Iridaceae
   Propagation by: **Corms/tissue culture**

Varieties:

- Priyadrashani — Happy end
- Suchitra — Freindship

3. **Chrysanthemum:** ***Dendranthema gradiflora*** (Compopsiteae)
   - s/ Common name **`Guldaudi'**
   - '7 **Origin: China.**
   - ,7 **Propagation:** root **suckers.**

Varieties:

- **Diana** — Basanti
- Ralchi — Birbal sahani
- Indira — Red gold

Principle of preservation:

1. **Canning:**
   - **Fruits** can **be** processed at a temperature of **100 °C.**
   - **Vegetable** can be processed at temperature of **115-121** °C.
2. **Pasteurization:**
   - Heating of fruits and vegetable juice at **85-90 °C** for 30 minutes.
   - It kills **only harmful** microbes.
3. **Sterilization:**
   - **Heating** of fruits and vegetables above **100 °C**
   - It kills both **beneficial** and **harmful** bacteria.
4. **Freezing:**
   - Cooler storage: 15 °C
   - Refrigeration or chilling: 0-5 °C
5. Cry preservation: Preserve in liquid nitrogen at **-196** °C.
6. Drying: Removal of moisture by applying heat is called drYing e.g. Raisins *(Kismis).*
7. **Preservation through osmosis:**
   - High concentration of sugar: e.g. **Jam** (68 % sugar), **Agli ka petha.**
   - **Salt preservation:** Salt conc. **10-25 %** is sufficient (in pickles: **15%).**
8. **Preservation by chemicals:**

a. **KMS** (Potassium Meta bi Sulphite): @ 500 ppm/0.05%.

- **Sulphur di oxide** is responsible for preservation.
- It used against **colour less** fruit Juices/pulp.

b. **Sodium benzoate: @** 700 ppm/0.07%.

- **Benzoic** acid is responsible for preservation.
- Used in **colored fruit** (only in **non acid fruits).**

9. Fermentation: grape wine **(alcohol** 7-20%) is oldest example of fermented beverage.

10. Asepsis: prevent entry of microbes.
11. Oxidation can be checked by **antioxidants** (Ascorbic acid /vit. C)
12. Checking of **enzymatic** spoiling: **Blanching** in **cauliflower**

Difference between **Jam** and **Jelly:**

SN	Jam	Jelly
1	Ripe and thick flaccid fruits are used.	Used firmed and mature fruits
2	Pectin is not important.	Pectin is necessary (0.5-1.0%) Pectin tested by: Alcohol, Jelmeter, Sheet test
3	It is opaque	This is transparent
4	Sugar is added according to acid content (68.5% sugar)	Sugar is added according to pectin content (generally 60-65%)
5	Prepared from mixing of fruits eg. apple, papaya, tomato, strawberry	Fruit don't mixed Eg. Guava, apple
6	Temperature: 219-221 °F	End point 221-222 °F7105.5 °C
	TSS: 68.5%	TSS: 70 %
7	Acid should be: 0.5-0.6%	Fruit acid should be: 1.0%

Difference between **squash and cordial:**

SN	Squash	Cordial

I	**Strained juice** containing moderate quantity of **fruit pulp** with concentrate **sugar** and **water**	Cordial is made by Clear sweetest juice of **fruit pulp**
	E.g. Mango, pine apple, lemon squash.	It contains fruit juice **25%**

Difference between Squash and **Sarbat:**

SN	I Squash	Sarbat
1	it contains **fruit juice,** sugar and water	Clear **sugar syrup with artificial flavor**
2	TSS: 40%	TSS: 70%
3	Mango, pine apple Squash	E.g. Almond, Khus-khus Sarbat

Difference between **preserve and candy:**

SN	Preserve	Candy
	Preserve made from **natural fruits** by **cocking** whole or cut.	A fruit cover with **sugar** and **glucose,** subsequently grind and dried.
2	In heavy sugar syrup it is becomes tender transparent e.g. ***Aonla murrabba.***	E.g. ***Agra ka petha.***

Terminology:

Bonsai:

- Japanese art of growing miniature trees and shrubs by extreme dwarfing

Topiary:

- It is an **art** of **training** plants in to **different shape** i.e. shape of animals, birds etc. Plants used in topiary are evergreen. i.e ***Duranta, Minya panniculata.***

Edge:

- **When low growing perennial, annual plants are grown on the border of plots, beds are called edge. Alternanthera, Sunrose**

Hedges:

- **When shrubs are planted on boundary for fencing. It may be ornamental or protective. Karonda, Bougainvillea, Mehndi, Hibiscus, Clerodendron and Lantana are the best example of hedge.**

Fruit preservation:

- **The art and science of keeping fruits for longer time without detonation in quality.**

6. ENTOMOLO6Y

Important points:

1 NPV is mostly used to control: ***Lepidopteran insects***

Bud necrosis in groundnut is transmitted by: ***Thrips***

I **Binomial nomenclature** was first given by: *C.* ***Linnaeus***

1 The scientific name of maize stem borer is: ***Chilo partellus***

V Termite control can also be done by: ***Irrigation***

• The chief excretory organ in insect is: ***Malpighian tubules***

I **Juvenile hormone** secreted by: ***Corpora allaia***

I **Tree banding** is useful for control of: ***Mango mealy bug*** **(NET.. 2013)**

• The ***main*** **characteristic** feature of an insect is: ***Three pairs of legs***

I Which is the best suitable species for bee culture: ***Apis mellifera***

I What is optimum plant population for Bt — cotton?: **10,000 plants/ha**

Largest size of the honey bee is: ***Apis dorsata***

• Bromadiolone (0.005 %) is an effetive: ***Rodenticide***

I Bacteria is produced at commerical level for pest: ***Bacillus thuringiensis***

1 House fly spread the disease: ***Cholera***

I The safe insecticide for vegetable ***is:Malathion***

1 The most widely used pheromone is: ***Sex pheromone (female)***

I Major pest of cucurbits is: ***Pumpkin beetle***

1 Diamond back moth is a peat of: ***Crucifers***

1 The bollgard ***is: Transgenic cotton***

I The most suitable fumigant for quarantine purpose is: ***Methyle bromide***

I The most effective moulting hormone in insects is: ***Ecdysone***

1 The major excretory product of insects are: ***Uric acid***

• Nosema disease of honeybees is caused by a protozoa: ***Nosema apis***

• **Silver shoot and onion leaf** in rice is caused by gall midge: ***Orseolia oryzae***

Bud necrosis in watermelon and muskmelon is transmitted by: *Aphids*

Insect can survive at higher temperature and low humidity is: *Khapra beetle (T. granarium)*

Protein hydrolysate is used as an attractant for the control of: *Fruitfly*

Aphelinus mall **has been a successful parasitoid in controlling:** *Apple wooly aphis* **(NET -2013)**

Rodolia cardinalis **has been successful predator in controlling:** *Cottony cushion scale*

The infestation of which insect starts from the field: *Angountois grain moth*

If a pest is confined to a particular area and occurs regularly, its infestation is termed *as: Endemic*

The toxin produced by *Bacillus thuringiensis* **interferes with the insect's:** *Digestive system*

The headquarters of Directorate of Plant Protection, Quarantine and Storage is located at: *Faridabad, Haryana*

I *Epiricania melanoleuca* **is a lepidopteron parasitoid effective against:** *Sugarcane pyrilla*

I **Enforcement of laws for the control of insect pests in India is governed by:** *Destructive Insects and Pests Act (1914)*

Rice stem borer *(Scirpophaga incertulus) is* **absolute/ monophagus pest of rice**

Vector of rice `Tungro' is Green Leaf Hopper *(Nephoteitix virscence)*

Vector of rice 'Grassy stunt' disease is Brown Plant Hopper *(Nilaparvata lugens)*.

Chaffy grains with black spot in rice are due to Gundhi bug *(Leptocorisa acuta)*

In rice gundhi bug cause damage on the stage: *Milky stage*

Serious pest of wheat is: *Termite*

Wheat stem borer *(Sesamia inferens)* **attack** *in: Night*

Specific pest of wheat nursery is: Ghujhia weevil *(Tenymecus indicus)(ARS-07)*

- **Control of tundu disease:** ***Hot water treatment 50 °C for 2 hrs.***
- **'Hopper burn' symptoms in rice due to:** ***BPH (Nilaparvata lugens)***
- **Vector of cotton leaf curl virus:** ***White fly (Bemisia tabact)***
- **Flaring of squares in cotton is due to:** ***Spotted bollworm (Earias vile/la)***
- **Resetting of cotton flowers due to:** ***Pink boll worm (Pectinophora gossypiella)***
- **Double seed formation in cotton bolls is due to: pink boll worm** ***(Pectinophora gossypiella).***
- **Large circular bore holes with faecal pellets on bolls is the symptoms of: American boll worm** ***(Helicoverpa armigera)***
- **Safest insecticides for honey bee:** ***Endosulfan***
- **Pest population should be kept below: Economic Threshold Level** ***(ETL).***
- **The appropriate time for insecticides application to control damaging pests:** ***ETL*** **(NET -2013)**
- **The pest which attacks all the parts of the plant is:** ***Termite.***
- **White grubs prefer to lay eggs on:** ***Sandy or sandy loam soils.***
- **Pest which has a status of 'International pest'** ***is: Desert locust (Schistacera gregarea)***
- **Recently method of control of bollworm is:** ***Bt. Transgenic plants.***
- **Number of eggs /second lay by termite:** ***One egg/sec.***
- **The insects are** ***poikilothermic*** **i.e. they have no precise mechanism for regulating the body temperature so also called** ***cold blooded*** **organisms.**
- **The total heat required for the completion of physiological processes in the life -history of a species is considered as constant a** ***thermal constant (ARS-04).***
- **Control of weeds by biological agent known** ***as: Parabiological control.(IARI, Ph.D-09)***
- **International Institute of Biological Control in West Indies, 1927**
- **International Organization for Biological Control:** ***Zuriec, Switerzerland.***

Cryptobiosis: a phenomenon when insect become quiescent due to **adverse climatic** condition and show **no visible** sign of metabolic activity

Lininetic zone: The open water zone to the depth of effective light penetration.

Wax moth *(Galleria melonella)* most serious pest of **apiculture.** ***(JRF-03)***

- **Cubicula:** Hind legs of honey bees also Known as **auricle.**

The word entomology derived from **Greek** words:

- ***Entomo*** = Insect
- ***Logos*** Discourse

Classification:

A. Phylum: **Arthropoda**

- Arthropoda is a Greek word means **segmented legs.**

Class:

- Mainly two classes of insect -pest that is **agricultural importance** are below:

1. Class: Hexapoda/Insecta
   - Body is divided into three viz, head, thorax and abdomen.
   - Eg. Insects are 97% of total population of the phylum arthropod.

What is insect:

- The insects are tracheate arthropods in which the body is divided in to head, thorax and abdomen.
- A single pair of antennae is present and the head bears a pair of mandibles and two pairs of maxillae, the second pair fused medially to form the labium.
- The thorax carries three pairs of legs and usually one or two pairs of wings.
- The abdomen is devoid of ambulatory appendages and the genital opening is situated near the posterior end of the body.
- Postembryonic developments rarely direct and metamorphosis usually occurs.
- The widely accepted classification of insects was given by the taxonomist: ***A.D Imms.***

- **According to A.D. Imms there are 29 insects order out of which seven orders are mostly agricultural importance e.g. Hymenoptera, Diptera, Coleoptera, Lepidoptera, Thysanoptera, Hemiptera and Isoptera.**
- **The class insect has two subclasses viz apterygota (4 order) and pterygota (remaining 25 order).**
- **Pterygota further divided in to:- exopterygota and endopterygota.**

SN	Order	Example	Features
Apterygota:- Primarily wingless, metamorphosis absent, pregenital appendages present			
1	Protura	Telsonfly	Antennae and eyes absent, *anomorphosis* present (12 segmented abdomen)
2	Diplura	Japygids	Malphageal tubules absent or represented as *papillae,* abdomen with lateral *sryliform* appendages.
3	Collembola	Springtails	Abdomen six segmented, M.T. absent, *collophore, retinaculum* present.
4	Thysanura	Silverfish	A pair of many segmented cerci ending in a segmented median process.
Pterygota:- Winged or evolved from winged ancestors (e.g. fleas, head louse, bugs etc.), metamorphosis present, pregenital abdominal appendages absent.			
A	**Exopterygota:** Wing developed external, metamorphosis incomplete, pupa absent,immature nymphal stage present.		
1	Ephemeropetra	Mayflies	Primitive because it came before odonata. in ephemeroptera presence of *monocondylic* type mandibles
	Odonata	Dragon/damsefly	Wing can't be moved, *dicondylic* mandibles so its advanced than above, nodus wings and presence of pterostigma.
3	Plecoptera	Stonefly	Soft bodied insects, *tracheal gills* in nymphs.
4	Grylloblatodia	Rock crawlers	Apterous eyes reduced, well developed ovipositor
5	Orthropetra	Grasshopper, locust	Fore wing forming *tugmina,* hind legs modified for jumping.
' 6	Phasmida	Stick & leaf insects	Presence of compound eyes
7	Dermaptera	Earwing	Cerci modified in to a *sclerotized forceps*
8	Embioptera	websprinners	Living in silken tunnels, anterior tarsi great. *swollen*
9	Dictyoptera	Cockroach.	Fore wing modified to *iagmina, 0^{-elli}*

		mantis	represented as fenestrae
	Isoptera	Termites/white ants	Social and polymorphic insect, rectal pouch present, *fronlane//, term//aria/rn ou*lds presence.
jj	Zorapetra	Zorapterans	Y-shaped epicranial suture present
	Psocoptera	Book lice	I -lead with y -shaped suture
j'f	Mallophaga	Bird lice	Biting lice, Apterous, ***actoparasitic*** *on* birds,
'iT	Siphonculata	Head, body louse	Apterous insects, transmits typhus disease
15	Hemipetra	Bugs	Rhynchota, cerci absent, *scutellum* on dorsal
	Thysanoptera	Thrips	Right mandible absent, cerci absent
B	Endopterygota: Wing developed internal, metamorphosis complete, pupa present, immature stage is larva.		
	Hymenoptera	Bees, wasp, ants	Presence of *propodium,* venation greatly reduced, acuteness of vision. ***corbicula*** or pollen basket on hind legs.
2	Lepidoptera	Butterflies, moths	Scale wings, m.p. suctorial proboscis formed by the maxillae of *galeae,* thorax posses ***patagia,*** wings is ***trigamma.***
3	Coleoptera	Beetles, weevils	Largest insect order, fore wings as leathry elytra,
4	Diptera	True fly	One pair of wings, presence of' halters, ***puparium***
5	Strepsiptera	Stylopids	***Endoparasilic*** insects, fore wing modified as ***pseudo/i****alters.*
	Neuroptera	Antlions, owlflies	Lace wings,
7	Mecoptera	Scorpionflies	Males carry the terminal segment of the abdomen upward curved.
8	Trichoptera	Caddisfly	***Thyridium*** present on wings, *Gilsons glands* on thorax.
9	Siphonoptera	Fleas	Apterous, actoparasitic warm on blood animals

Exopterygota: Incomplete metamorphosis, presence 01 3 stages viz, eggs, ***iiyulpu,*** 1..14

Endoptrygota: Complete metamorphosis, presence of 4 stages viz, eggs, larva, pupa, adult.

2. Class: **Arachnida**
   - Head and thorax are fused and known as ***cepha!otlwrax.***
   - **Four pairs** of waling legs are present and legs are unsegmented.
   - It has **no antenna e.g. mites, ticks, spiders.**

lypes of larva:

a. **Nymph:** Hemiptera (bugs, white fly, aphids and jassids).

b. Caterpillar: Lepidoptera (moths, boliworms, borers)

c. **Grub:** Coleopteran, and hymenoptera

d. **Maggot: Diptera** (all true flies)

Types of mouth parts:

- Biting and Chewing type: **Grasshoppers, locust, beetles, larval Lepidoptera**
- Piercing and sucking type: **Mosquito, aphids, bugs, leafhoppers**
- Sponging type: **House fly**
- Siphoning type: **Butterfly, moths**
- Chewing and lapping type: **Honey bee**
- Rasping and sucking type: **Thrips**

Economic decision levels for pest population concepts of threshold are:

a. **Damage Boundary *(DB):***

- Where loss can be recognized.

b. **Economic Threshold Level** (ETL):

- The pest density at which **control measures should be applied** to prevent an increasing pest population from reaching the economic injury level.
- It is also referred as ***'Action Threshold Level'.***

c. **Economic Injury Level** (EIL):

- The lowest population density of the pest that will cause economic damage.
- It is also known as ***'Damage Threshold Level*** (DTL).

d. **General Equilibrium Position** (GEP):

- , GEP is the **average population density** of an insect c population over a long period of time, unaffected by the temporary, interventions of pest control.

Chronology of entomology:

1951: R.H. Painter coined the term 'Resistance' and published his book **'Insect Resistance in Crop Plants'.** He has known as **'father of host plant resistance'.** d,

1962: Publication of the book "Silent ***spring*** - by Rachel Carson

1964: Publication of the book ***'Biological Control of Insect Pest and Weeds'*** by **Paul de bach.**

1973: Development of first photostable pyrethroid ***"Permethrin".***

1975: ***Elear*** (Helicoverpa NPV) registered for control of bollworm & tobacco bud worm on Cotton.

1987: Development of first transgenic plant reported by M. Vaeck and co-workers of 'Belgian biotechnology company' plant genetic system by transferring ***B.1*** (endotoxin) gene to tobacco for the control of ***Manduca seva.***

1988: **NC -IPM:** National Center for Integrated Pest Management, New Delhi.

What is a pest?

- An insect or any living being whose population increase to such an extent as to cause **economic losses** to crop or a **nuisance** and health hazard to man and his livestock will be declared as a pest eg. Insects, rats, mites, weeds etc. **(NET -2013)**

Categories of pests:

a. **Key pest:**

- These are most severe and **damaging pest.**
- **GEP lies well above the** DB and EIL.
- E.g. **Cotton boll worm, DBM, gram pod borer.**

b. **Major pest:**

- **GEP** is close to EIL but economically damage avoided by **timely intervations.**
- Sucking pests of cotton and rice.

c. **Minor pest:**

- **GEP** lies below **EIL** and **Damage boundary.**
- Under favorable environmental condition the population may cross EIL and DB for a short interval and a single application of insecticides is usually enough to prevent damage.
- E.g. **Thrips, mites and sugar cane mealy bug.**

Regular pest:

- Affect specific seasonal crops like cereals, pulses, fruits, passes through many generations during the crop period.

" E.g. **rice stem borer**

e. **Sporadic pest:**

- Population of these insect is usually **negligible** but in certain year under favorable environmental condition they appear epidemic and crossing many times over EIL and DB.
- Required suitable cultural tactics to reduce population of these pests.
- White grub, hairy caterpillar, cut worm, grass hopper.

f. **Potential pest:**

- These insects are presently not causing any economic damage.
- Therefore as such should not be labeled as pests.
- The GEP lies below the DB and doesn't cross EIL even under favorable conditions.
- But any change in ecosystem may push their GEP higher and there is a danger of economic damage from these pests if control operations against the other categories of pests are under taken in an indiscriminate manner.
- ***Spodoptera litura*** on cotton/Soyabean.
- **Army worm** on wheat are example of potential pest.

IPM:

- IPM is a broad ecological approach that minimizes pest population below ELL through utilizing most of or all the suitable techniques like cultural, physical, mechanical, biological & chemical methods in a compatible manner.

Components of IPM or common methods of pest management:

1. **Cultural methods:** (it includes certain cultural practices viz.)

   a. **Crop rotation:**
   Effective against limited host range and relatively immobile in some stages of their development.

   b. **Deep ploughing:**
   The resting stages of soil dwelling insects, weeds and pathogen are destroyed by summer deep ploughing

   c. **Clean cultivation:**
   Field sanitation and destroy plant debris of previous crop

   d. Use **of trap crop:**

Grow trap crops around the main crop to attract the pest of main crop and then easily destroyed through spraying any effective pesticides.

./ E.g. sowing okra in cotton crop as a trap crop for boll worms, castor in soyabean for spodoptera and mustard in cabbage for DBM.

e. **Pruning and thinning:**
- Infected parts should be pruned out.

  Thinning also increase the vigour of plants.

f. **Growing resistant plant varieties:** (NET -2013)

  E.g. In rice,CoRH-1: BPH and gall midge resistant
- **Suraksha:** gall midge resistance

2. **Mechanical method:**

a. **Hand picking:**

  Large sized insects i.e. caterpillars, bugs, and beetles are hand picked and destroyed.

b. **Shaking and beating of branches:**
- Done by hands or mechanically to drop larvae & eggs of insects from plants.

c. **Banding:**
- Prevent climbing pests e.g. mango mealy bug

d. **Wire gauge screen:**
- Protects fruits from borer

e. **Trench digging:**

  Against nymphs of locust and larvae of red hairy caterpillar

f. **Trapping:**

  Various type traps are used eg. light trap, bait trap, sticky trap, pheromone trap and sound trap etc.

g. **Flooding and draining:**
- To destroy soil dwelling insects.

3. Physical **method:**

  Involve manipulation of temperature, humidity & use of radiations.

  Flame throwers against grass hoppers

drying of grains at minimum moisture level to reduce storage pests infestation.

- e.g.in cereals should be kept at moisture level < 12 % for safe storage.

  In **oil seeds** moisture level should be **at least 8 %** for safe storage

4. **Legal control:**

   I **Adopted various quarantine measures at various frontier area of country.**

   ,/ **Domestic quarantine also** adopted for some insect -pests.

5. **BioloEical control:**

Definition:

- The utilization of parasitoids, predators and pathogens for the regulation of host population density is called as ***biological control.***

a. **Parasitoid:**

- A parasitoid is a special kind of parasite which is often about the same size as its host, kills its host and requires only one host for developing into a free living adult.

Examples of some parasitoids:

- Egg parasitoid: ***Trichogramma spp.***
- Larval parasitoid: ***Campoletis chloridae, Cotesia spp., Bracon hebetor*** etc.
- Majority of parasitoids utilized in biological control of insect pest belong to two orders namely **Hymenoptera** (Chalcidoidea, Ichneumonoidea and Proctotrupoidea) and **Diptera** (Tachnid flies).

b. **Predator:**

- Predator is a free living organism throughout life and usually larger in size, kill their prey and require more than one pray for developing free living adult.
- E.g. Lady Bird Beetle ***(Coccinella septumpuctata),*** lace wing ***(Chrysoperla carnea),*** syrphid fly etc.

Classical control:

- The searching, importing, colonizing and dispersal of a natural enemy in to an area where they don't already exist for the suppression of pest population.

c. Microbial control: stern hauns, 1949.

- The control of pests by the use of micro organisms such as viruses, bacteria, protozoa, fungi, rickettsia and nematode or their by products are known as ***microbial control.***
- Father of insect pathology: ***Agastino bassi.***

Symptoms of virus and bacteria infested larvae:

SN	Virus infested	Bacteria infested
1	Infested larvae stop feeding	Larvae reduce feeding
2	the larvae turn into pinkish white in ventral side because of accumulation of polyhedral bodies	Body become dark or black in colour and reduce its activity
3	Larvae become flaccid and skin become fragile & finally ruptures.	Fluid discharge from anus and mouth and ***septicemia*** (blood poisoning) occurs.
4	Larval crawls top of plant & hang upside down by prologs, this symptoms known as ***tree top disease***	Nervous system dis-coordinated and finally death of larvae.

Advantages of biological control:

- It's environmentally safe and non hazardous to men and domestic animals.
- Supplement the natural balance.
- Long lasted control, may establish slowly but once establishment gives permanent control
- Economical: initiate cost may be high.
- Self perpetuate and permanent.

Disadvantages:

- Slow control and not guaranteed result.
- Research intensive & require large budget.
- Less efficient compare to chemical and mechanical control.

- Since method is depends on environmental factors, failure **can't be unavoided.**

6. **Genetic control:**
   1. Sterile insect control
   2. Sterile insect release methods,. • 3
7. **Chemical control:** Conventional insecticides with their trade names are classified as:

a. **Organochlorines:**

• Endosulfan (35 EC)	Thiodon
• Dicofol (18.5 EC)	Kelthane

b. **Organophosphates:**

• Diclorvos/ DDVP (76 EC)	Vapon
• Monocrotophos (36 SL)	Nuvacron
• Malathion (50 EC)	Cythion
• Dimethoate (30 EC)	Rogor
• Methyl parathion (2 % dust)	Metacid
• Chlorpyriphos(20 EC)	Dermate
• Quinolphos (25 EC)	Ekalux
• Acephate (75 % SP)	Asataf
• Phorate (10 G)	Thimet
• Ronnel (excellent animal systemic insecticide)	

c. **Carbamate insecticides:**

• Carbaryl 75 WP	Sevin
• Carbofuron 3 G	Furadon (nematicide)
• Aldicarb 10 G	Temik
• Methomyl 40 SP	Lannate
• Aprocarb	Baygon

Insecticides of plant origin/botanicals:

a. **Rotenone:** Derived from roots of ***Lonchocarpus/Derris elyptica.***

b. **Pyrethrum:** Derived from flowers of ***Chrysantheum cinerarifolium.***

C. **Azadirachtins:** From seeds & leaves of Neem, ***Azadiracta indica.***

d. **Nicotine:** Derieved from roots of tobacco: ***Nicotiana spp.***

New group of insecticides:

a. **Neonicotinoids:**

- Imidacloprid: Confldor 17.8 SL
- Thiomethoxam: Actara (70 WS) and Cruiser
- Acetamiprid: Pride (20 SP)
- Spirotetramat: (Recently introduced by Bayer crop science)

b. **Other:**

Indoxacarb: Avaunt (14.5 SC)

c. **New insecticides from microorganism:**

- Abamectin: **Vertimac**
- Spinosad: **Tracer**

d. **Insecticides from animal origin:**

- Neries toxin is poison originated from a marine annelid, ***Lumbrineris heteropoda*** isolated by Nita in 1934.
- Synthetic derivatives of neries toxin is Cartap hydrochloride (Padan).

Animal systemic insecticides:

- **Co-ral**
- **Ronnel** and
- **Rodene**

Management control:

- Method which aid in the control of live stock pests are preferably referred to as management control.
- Cattle grub, screw worm, helminthus (internal pest) and external pest like flies, mites, lice, ticks that are killed by these above insecticides without producing any adverse effect on host.

Examples of plant systemic insecticides with trade name:

Pesticide	Trade name
• Dimethoate	Rogor
• Oxydemeton methyl	Metasystox R
• Phosphamidon	Dimecron
• Monocrotophos	Nuvacron
• Acephate	Acetaf

- Imidacloprid — Confidor

Toxicity (in order) of insecticides:

- Phorate > Dimeton > Parathion > Aldicarb

Safer (selective) order of insecticides:

- Methoprene > Permethrin > Methoxychlor > Malathion

MRL: **Maximum residues limit: *(ARS/NET-10)***

- It is the **optimum safe concentration** of the left over pesticides or its degradation products.
- Expressed in **mg/kg body weight.**

Propesticides:

- It is a pesticidally active material or compound which in its original form is inactive and is transformed into an active state by a plant, animal or microorganism.
- ***Eg. Acephate, Cartap hydrochloride.***

Plant protection equipments:

a. **Dusters:**

- It consists essentially of a ***fan*** or **blower** and a type of container named **'hopper'.**
- To produce **air blasts** is the **basic principle of duster.**
- **The efficiency of dusting is ten times more than that of spraying** but the average job of spray is equivalent to very good dusting

b. **Sprayers:**

- Sprayers are the most commonly used in the pesticides application.
-

Spray	**Size (in micron/Ft)**
Coarse spray	400 or more
Fine spray	100-400
Mist	**50-150 (NET -2013)**
Fog	**1-50**
Smoke	**0.001-0.1**

IPM Modules for Rice:

Pest	ETL
Hispa	**1-2 adult/hill**
BPH	**5-10 hopper/hill**

- **Avoiding** use of **excess nitrogen** which increases population of Brown plant hopper (BPH) and **leaf folder.**
- Alternate wetting & drying for **BPH.**
- Avoided close planting in case of **BPH** epidemic area.
- Passing the rope on the crop and draining of water for **case worm.**
- Using the light traps to monitor BPH, Green plant hopper and stem borer.
- Clipping of seedling tips for **rice hispa, thrips & yellow stem borer**
- Use of **NSICE** (Neem seed kernel extract) 50% or Neem oil for **ear head bug.**

IPM Modules for cotton:

- ETL values of different pest of cotton.

Pest	**ETL**
Leaf hopper	1-2/leaf
White flies	5-10/leaf for adult or 20 nymphs/leaf
Boll worms	10% shoots/bolls damaged
Stem weevil	10% infested plants
Spodoptera	8 egg masses/100 m row

- Use light trap for hoppers, Spodoptera & bollworms
- Use pheromone trap for monitoring and destruction
- Collection and destruction of plant parts & infected bolls.
- Use of Natural enemies of cotton pest i.e. ***Chrysoperla cornea, Trichogramma spp.***

Insect- pests of major field crops:

Rice crop pests:

1. Yellow stem borer: ***Tryporyza/ScirPophaga incertulus.***

- **Family: Pyralidae** (Lepidoptera)
- Monophagus/absolute pest of rice.
- Full grown larvae hibernate in **rice stubbles.**
- It pupates inside the plant.
- Full grown larvae measures about 20 mm.
- adults are **dirty white** or greenish yellow front wings.

Symptoms of damage:

- **Caterpillar alone is destructive, construct an emergence hole which always located above the water level.**
- **Caterpillar produce *dead hearts* on affected plants.**
- **Plants that is attacked in early stages produce ears devoid of grains and are known as" *white ear"*.**
- **Basmati varieties suffer heavy damage then coarse varieties.**

Management:

- **Removal & destruction of crop stubbles.**
- **Since eggs of stem borer are laid near tip of leaf hence, clipping and burning of tips of the seedling as a routine before transplanting.**
- **Application of *Cartap hydrochloride* 4G @ 2.5 kg a.i. /ha.**

2. Rice hispa: *Diclodispa armigera*

- **F. Chrysomelidae, Coleoptera**
- **Serious pest of rice.**
- **Small bluish black beetle, recognized by numerous short spines on the body which gives a characteristic appearance.**

Symptoms:

- **Damage is done by larvae as leaf minors, produce transparent blotches on the leaf surface.**
- **The adult also feed on green matter and produce parallel whitish streaks on leaves**
- **Severely infected leaves dry up and present a white dried up appearance in the field.**

Management:

- **Nursery beds are flooded; the floated beetles are collected by nets and killed.**
- **Clip off the leaf tips before transplanting seedlings to kill the eggs.**
- **Chlorpyriphos @ 625 ml spray with 250 liters of water.**
- **Larval parasitoid of hispa is: *Eulophus femoralis.***

3. Rice gundhi bug: *Leptocorisa acuta*

- **F. Coreidae: Hemiptera**
- **Periodic pest of rice**
- **Adult bugs have long legs and are slender about 20 mm long.**

Symptoms of damage:

- Rice field severely attacked by this pest **emit a repugnant smell** which gives to this pest the name ***"gundhi bug".***
- The nymphs and adults **suck juice** from developing grains in the **milky stage,** causing incompletely filled panicles or panicles with ***empty grains.***
- Black and brown spots are appearing around the holes made by the bugs on which a ***sooty mould*** may develop.
- This pest attacks the rice crop ***periodically.***

Management:

- **Clean cultivation:** Paddy field and surrounding bunds should be kept clean from weeds.
- Adult bugs captured through light traps and destroyed.
- Hand collection of bugs
- Resistant variety: Grow **Badshabhog variety.**
- Spray Malathion 50 EC @ **675 ml/ha**

4. Brown plant hopper: *Nilaparvata lugens*

- **F. Delphacidae: Hemiptera**
- **Serious pest of high yielding varieties of paddy.**

Symptoms:

- Both nymph & adult cause damage by sucking cell sap from leaves which **turn yellow.**
- **Under the favorable condition of high humidity, high nitrogen application and no wind, the population increase and *"hopper burn"* is obtained in various localities.**
- **It transmitted the *"grassy stunt"*** virus disease of rice.

Management:

- Closer spacing should be avoided (follow a spacing of 20 x 15 cm).
- Alternate drying & wetting of field.
- **Alley 30 cm** wide after **every 3 m** of rice planting provide proper aeration to crop
- Spray of 100 ml **Imidaeloprid** (200 SL) with 250 liters of water.
- Multi gene resistant varieties: IR-36, IR-60.

5. Rice case worm: ***Nymphula depunctalis***

- F. **Pyralidae:** Lepidoptera
- The larvae are **light green** with a light brownish **orange head.**
- The presence of filamentous gills on the sides of body of the larvae is helpful for its ***semi aquatic*** life as it derives its **02 requirement** from the water found inside the leaf case.

Symptoms:

- **Tubular *case*** is constructed by the larvae.
- Larvae feed by **scrapping** the under surface of the **leaf blade** leaving the upper epidermis intact.

Management:

- **A rope** may be passed to over the young crop for **dislodging** the larval cases.
- Put **filter barrier** between irrigation channels of different field.

Other pests of rice:

a. Green leaf hopper: *Nephotettex nigropictus/virescens.*

- **Hemiptera: F. Cicadelidae**
- **This is responsible for vector of virus diseases, of which Tungro is most serious.**

b. White backed plant hopper: *Sogatella furcifera*

- **F. Delphacidae: Hemiptera**
- **Cause rust red symptoms**

c. Rice gall midge: *Orseolia oryzae*

- **F. Cecidomyiidae: Diptera**
- **Cause "silver shoot & onion leaves"** symptoms.

d. Rice thrips: *Stenochaelothrips biformis*

- **F. Thripidae: Thysanoptera**
- **Important pest of rice nursery *(JRF-09)***

e. Rice grass hopper: *Hieroglyph us banian*

- **F. Acrididae: Orthoptera**
- **Damage by nibbling of rice ear head**

Insect -Pest of cotton:

I. Cotton jassid: *Amrasca biguttula*, Cicadelidae: Hemiptera.

- Destructive pest of **American cotton**
- Nymphs are **wedge shaped** and adults are **winged** form.

Symptoms:

- Adult and nymph cause injury to crop is due to **loss of sap** and probably also due to the **injection of toxins.**
- **Yellowing** and **downward rolling/cupping** of leaves due to toxins.

2. Cotton whitefly: ***Bemisia tabaci,*** Aleyrodidae: Hemiptera

- The pale yellow body is slightly dusted with a **white waxy** powder.
- They have two pairs of **pure white** wings and have prominent long hind wings.

Symptoms: damage done by two types.

a. The **vitality** of the plants is lowered through the **loss of cell sap.**
b. The normal photosynthesis is **interfered** with due to the growth of a **sooty mould** on the **honey dew** excreted by the insects.

I It transmit a number of viral disease including the **leaf curl disease of tobacco, vein curling** disease of okra and **leaf curl of sesame.**

Management:

I Both jassids and whiteflies can be effectively managed **by** spraying of Imidacloprid 200 SL @ 75 g a.i. /ha or Thiomethoxam @ 45 g a.i. /ha.

I Spray of Dimethoate @ 1 ml/liter of water

3. Pink boll worm: ***Pectinophora gossypiella,*** Gelechidae: Lepidoptera

- Most destructive pest of cotton.
- The caterpillars are **pink** in colour and found inside the **flower buds, panicles** and the **bolls of cotton.**

Symptoms:

- Damage done by caterpillar in various ways there is **excessive shedding** of the fruiting bodies.
- **"Rosette flower" is** characteristic symptoms. **(IARI, Ph. D-09)**

- The total shedding is caused by all the boll worms collectively **one half** may be due to the attack of pink boll worm.
- **Double seed** formation: The two adjoining seed are joining together within damaged boll by pink boll worm.

Management:

- Growing of **Bt. cotton varieties** is the effective method for boll worm complex.
- Destruction of cotton sprouts, alternative host plants or burning of the **plant debris.**
- Deep ploughing (with furrow turning plough) done by the end of February.
- Larval: Parasitoid ***Bracon greeni, Chelonus pectinophorae.***

4. Spotted boll worm: ***Earias insulenalvitella,*** **Noctuidae:** Lepidoptera.
   - It is serious pest of **cotton** and **okra.**
   - A series of longitudinally **black spots** on the body with **dull green** colour and having tiny **stout bristles** are the main identification mark of spotted boll worm.

Symptoms:

- Cause **heavy shedding** of fruiting bodies.
- **'Flare square'** (Flare-up) is characteristic symptoms. ***(JRF-07)***
- In the attacked bolls the lint is **spoiled** by larval feeding.
- The infected bolls open **prematurely** and produce **poor lint** resulting in lower market values.

Other pests of cotton:

a. Dusky cotton bug: ***Oxycarenus laetus,*** Lycaenidae: Hemiptera.
b. Red cotton bug: ***Dysdercus singulatus,*** Pyrrhocoridae: Hemiptera. Red cotton bug **stain** the lint in ginning factories when it crushed with cotton.
c. American boll worm: ***Helicoverpa armigera,*** Noctuidae: Lepidoptera.
d. Cotton leaf roller: ***Sylepta derogata,*** Pyralidae: Lepidoptera.

Insect -pests of sugarcane:

1. Top borer: ***Tryporhyza/Scirpophaga novella,*** Pyra l idae:

Lepidoptera.

- Caterpillar are **creamy white** or **sluggish** and the moths are **pure white** in colour.

Symptoms:

- Young plants attacked by caterpillars show characteristic **reddish streaks** on the **mid rib.**
- They show a number of shoot holes in leaves which ultimately cause **dead hearts.**
- After cane formation it attacks the **terminal portion** of canes causing **"bunchy tops".**

Management:

- Collect and destroy moths and egg clusters.
- Cut the attacked shoots at ground level from April to June.
- Application of **Carbofuran** 3G @ 25 kg/ha or **Cartap hydrochloride 4G @** 25 kg/ha in July.

2. Sugar cane leafhopper: ***Pyrilla perpusilla,*** Lophopidae: Hemiptera.

- **Jet** like body pasture.
- The leaf hoppers are very agile and jumps around in large numbers making a patient noise when a person walks through **heavily infested** field.

Symptoms:

- Owing to the loss of cell sap the leaves turn **pale yellow** and **shrivel up** later.
- Leaf hoppers secrete a thick transparent liquid known as **honey dew** on which black mould is developed.
- Leaves acquire a **sickly black** appearance and the attacked crop can be **spoiled** from a distance.

Management:

- Spray Malathion 50 EC @ 1 liter/ha.
- **Egg** parasitoid: ***Epiricania melanoleuca*** (single parasitoid belonging to order **Lepidoptera).**

Other pests of sugarcane:

a. Sugar **cane white fly:** ***Aleurobolus barodensis,*** Aleyrodidae: Hemiptera, (Only **nymphs cause damage by sucking cell sap,** yellowing streaks appears on the attacked leaves and a crop acquires *a* ***polish green*** appearance).

b. Sugar cane mealy bug: ***Saccharicoccus sacchari,*** Pseudococcidae, Hemiptera

c. Sugar cane shoot borer: ***Chilo infuscatellus,*** Pyralidae: Lepidoptera.

d. Gurdaspur borer: ***Acigona steinella,*** Pyralidae: Lepidoptera.

e. Sugar cane intemodes borer: ***Chilo sacchariphagus indicus,*** Pyralidie, Lepidoptera.

f. Sugar cane scale insect: ***Melonapsis glomerats.***

Insect -pest of wheat:

1. Army worm of wheat: ***Mythimna separata,*** Noctuidae: Lepidoptera.

- The freshly emerged larvae **spin threads** from which they suspend themselves in the air and then with the help of air current reach from one plant to another
- Early stage feeds on tender leaves in to **central whorl** of the plants but later caterpillars are able to feed on older leaves and **skelerotized** them totally
- In case of severe attack by the army worm whole leaves including the mid ribs are consumed and the field looks **as "grazed by the cattle".**
- Spray **Quinolphos** 25 EC @ 500 ml/ha.

2. Ghujhia weevil: ***Tanymecus indicus,*** Curculionidae: Coleoptera.

- It is specific pest of wheat **nursery.** ***(ARS-07)***
- Damage caused by **adult weevil** only.
- They cut the **germinating seedlings** at the ground level.
- Mainly damage is done in the months of **October November.**

Other pests of wheat:

a. Termite: ***Odontotermes obesus,*** Termitidae: lsoptera.

b. Wheat aphid: ***Macrosi,phum miscanthi,*** Aphididae: Hemiptera.

C. Wheat mite: ***Petrobia la/ens,*** Acarina. ***(ARS-05)***

1nsect-pests of maize:

1, Maize/ Sorghum stem borer: ***Chilo partellus,*** Pyralidae: Lepidoptera.

- Most **destructive** pest of maize/sorghum.
- Caterpillars infect the crop usually **one month** after sowing.
- It cause **pin holes** on leaves or **"dead hearts"** in stem.
- The infestation may be noticed **till harvesting.**
- Larvae remains hibernate in ***maize*** **stubbles.**

Management:

- Destroy **stubbles,** weeds & alternate hosts.
- Application of **Phorate 10 G @** 20 kg/ha or **Carbofuran 3G** @ 25 kg/ha.
- Release of ***Cotesia (Apanteles) spp.***

Other pests of maize:

a. Maize aphid: ***Rhapalosiphum maydis,*** Aphididae: Hemiptera

b. European corn borer: ***Ostrinia nubilalis,*** Pyralidae: Lepidoptera. (It **doesn't** occur in India).

c. Asian maize borer: ***O. furnacalis:*** present in some part of India.

d. Pink borer: ***Sesamia inferens,*** Noctuidae: Lepidoptera.

- It mainly feeds on ***maize, rice*** and **wheat**
- It cause ***'dead heart'*** on central shoot in wheat ***(IARI, Ph.D-04)***

Insect -pest of sorghum:

1. Sorghum shoot fly: ***Atherigona soccata,*** Muscidae: Diptera.

- The insect attacks the young crop when it is in the **six leaves** stage.
- **Six *weeks*** after planting the crop is **seldom** attacked.
- **Maggots** feed on the ***main*** **shoot** and **growing point** is destroyed which is **easily plucked** out.
- The young plants show typical **'dead hearts'** symptoms **(NET-2013)**
- **Cloudy weather** favorable the multiplication of this insect.
- It is believed that infestation is also higher in **irrigated** fields.

Management:

" **Early sowing,** just after the onset of monsoon. ***(ARS-06)***

- Use of **higher seed rate (NET -2012/13)**

- Use of fish meal trap **(NET -2012)**
- **Removed** infested plants.
- Application of **Phorate 10 G** or **Carbofuran 3 G @** 2.5 kg a.i. /ha at the time of sowing. **(NET -2013)**
- Foliar application of **Cartap hydrochloride** a week after emergence of crop.

Other pests of sorghum:

a. Sorghum midge: ***Contarinia sorghicola,*** Cecidomyiidae: Diptera.

b. Sorghum ear head bug: ***Calocoris angustatus,*** Miridae: Hemiptera. (it laid cigar shaped eggs on sorghum leaves) ***JRF-06***

c. Red spider mite: ***Oligonichus indicus,*** Tetranchydae, Acarina ***(JAR!, Ph. D Ento-05)***

Insect -Pests of pulses:

1. Gram pod borer: ***Helicoverpa armigera,*** Noctuidae: Lepidoptera
   - It is **polyphagous & cosmopolitan** in nature.
   - Caterpillar feed foliage, when young and on seeds in the later stages.
   - Larvae pupate in soil.

Management:

- Timely sowing (up to mid **October).**
- Grow **early maturity** varieties.
- Mixed/intercropping with barley, wheat, mustard.
- Application of NPV @ **250-500 LE/ha. *(RPSC, A0-09)***
- Egg parasitoid ***Trichogramma chilonis.***
- Larval parasitoid of Helicoverpa is ***Cosmopletis chloridae.***
- Use of light traps and Pheromone traps.
- Application of Monocrotophos @ 1.25 liter/ha at evening time.

2. Gram cut worm: ***Agrotis ipsilon,*** Noctuidae: Lepidoptera

- Polyphagous pest but cause much damage to gram crop.
- **Cannibalism** habit present in larvae.
- The young larvae feed on the **epidermis** of leaves.
- During day time larvae live in **cracks** and **holes** in grourid and come out **at night** and fall the plants by cutting their stein either below the surface or above the ground.

anagement:

- Hand picking & destruction of larvae.
- Application of Flubendiamide (Fume) @ 0.5 % sprays at **evening time.**
- Application of Malathion 5 % dust @ 25 kg/ha at evening time

3. Red gram pod fly: ***Melanagromyza obtusa,*** Agromyzidae: Diptera.

- The maggots **eat away** only a part of the seed.
- The partially damaged seeds become subjected to **bacterial** and **fungal infection.**
- Grains are **rendered,** unfit for human consumption.
- Maggots pupate in **pods.**

Management:

- Application of **Dimethoate @** 1.0 liter in 250 liter water/ha.

Other pests of pulses:

a. Tur pod bug: ***Clavigralla gibbosa,*** Coreidae: Hem iptera
(Both nymph and adult suck the cell sap on leaves and pods of arhar, cow pea and gram).

b. **Plume** moth: ***Exelastis atomosa,*** Pterophoridae: Lepidoptera.
   - It is ***specific*** pest of arhar
   - Caterpillar **scrapes** of pods and make **hole** on pods.

c. Girdle beetle: ***Oberia bravis,*** Cerambycidae: Coleoptera.
   - It is **specific** pest of **soybean.**
   - The ovipositing female beetle **girdles** the stem twice.
   - It makes three **punctures** just above the lower ring before inserting a single egg through the largest hole into pith.
   - **Management:** spray methyl parathion 50 EC 1.25 liter/ha.

d. Bean fly: ***Ophiomyia phaseoli,*** Agromyzidae: Diptera.
   - Feed on phaseolus, cow pea, soybean, arhar.

e. Lentil pod borer: ***Edell(' zinckenella,*** Phycitidae: Lepidoptera.

Insect -pest of mustard:

1. Mustard aphid: ***Lipaphis erysimi,*** Aphididae: Hemiptera.

- Both nymph and adult **suck cell** sap from leaves, stem, inflorescence or **developing pods.**

- The leaves acquire a **curly appearance.**
- Breed parthenogenetically may be produced **45 generations** in a year.

Management:

- Spray **Imidacloprid 200 SL @** 100 ml/ha.
- Application of **Oxydemeton methyl @** 625 ml/ha.
- Use of predator lady bird beetle: ***Coccinella septempunctat***

2. Painted bug: ***Bagrada cruciferarum,*** Pantatomidae: Hemiptera.

- Both nymph and adult **suck cell sap** from leaves and pods.
- The nymph and adult bugs also excrete a short of resinous material which **spoils the pods.**
- **Over wintering** of adult stage under **heaps** of dried oil seed plants lying in field.

Management:

- Egg parasitoid: ***Gryon spp.***
- Spray **Malathion** 50 EC @ I litre in 200 liters water/ha.

3. Mustard saw fly: ***Athalia lugens proxima,*** Tenthredinidae: Hymenoptera.

- Damage done by larvae which are dark green and have **8 pairs of abdominal prolegs.** ***(ARS-07)***
- and have **five black stripes** on the back.
- Prolegs of mustard saw fly is without **crochets.**

Insect pest of Sesame:

1. Til hawk moth: ***Acherontia styx,*** Sphingidae: Lepidopetra.

- This insect is variously known as **hawk moth, sphinx** moths or **death head** moth based on its structure and behavioral characteristics.
- Thorax has a prominent **death head** mark on the prothorax.
- The moths are **swift fliers** and often make hawk like darts to a source of light at **dusk.**
- Full grown caterpillar which measure about 5 cm in length one cm width often retracts and looks like a **sphinx.**
- **The horn** like projection on the hind end of the abdomen is conspicuous.

pest of sweet potato:

1. Sweet potato horned caterpillar: ***Agarius convolvulus,*** Sphingidae: Lepidoptera.

- Larvae with presence of characteristic **anal home.**

2. Sweet potato weevil: ***Cylas formicarius,*** Apioniodae: Coleoptera. ***(JRF-07)***
   - It's a pest of both in **field and storage.**

Polyphagous pest:

I. Red hairy caterpillar: ***Amsacta moorei,*** Arctiidae: Lepidoptera.

- Body of caterpillars is covered with the numerous **long hairs** arising from the fleshly tubers.
- The entire abdomen is **scarlet red** there are **black bands** and **dots** on the abdomen.
- Feed on gregariously and as they grow older **moult 6 times.**
- Feed on all kind vegetations of **kharif season.**
- Full gown caterpillar prefers to eat the **growing points** of plants.
- The caterpillars are **voracious defoliating** the plants
- During a severe attack, the caterpillars in bands destroying fields after field.
- Field after field is **devastated** by the moving army of caterpillars in the year of severe infestation there may be a **complete failure** of the kharif crop.

Management:

- Hairy caterpillars emerge with rainfall of mansoon so in initial stage of larvae can be managed by digging trenches around the field and dusted methyl parathion 2% dust.
- Vegetation or field where infestation can be seen dusts Quinolphos 1.5 % @ 25 kg/ha.
- Application of diclorvos 100 EC @ 625 ml in 500 liter water/ha.
- Larvae can be killed by application of **Methyl parathion** 0.2 % dust @ 25 kg/ha.

2. White grub: ***Holotrichia consanguinea,*** Melolonthidae: Coleoptera.

- Polyphagous feed on all kharif crops, as Groundnu., Bajra, Jowar, Sesame, Cotton, Sugarcane etc.
- Damage done by **grub** in field crops and by **adults in trees.**
- The damage caused by grub is so much so that entire stand crop is destroyed thereby necessitating the **resowing in field.**
- **During the** last few years white grub has posed such a serious and alarming situation in the country that it has been designated as a **'National pest'.**
- **The plant** damaged by the grub gives a **wilted appearance and finally dries out.**
- **In** case of severe grub infestation crop is destroyed and infested plants **easily uprooted.**
- **The** full grown grubs move down deeper in the soil in search of moisture & for pupation.
- The grub constructed an **earthen cell** in which it passes a quiescent or pre -pupal stage.
- After pre mansoon rain/ first shower of mansoon the adult comes out from soil and cause damage to trees during night
- Eggs are laid in singly in **loose moist sandy** or sandy loam soil on the **onset of monsoon.**
- Grubs feed on the roots and rootlets of almost all types of kharif crops.

Management:

- Collection and destruction of beetles during night with the help of light trap
- Sumer ploughing to expose the hibernating stages.
- In standing crop soil application of 4 liter Chlorpyriphos 20 EC @ 4 liter/ha
- Application of Quinolphos 25 EC (Ekaux) @ 3 liter/ha has been found effective.
- Application of Phorate 10 G @25 kg/ha before sowing
- Seed treat with Chlorpyriphos 2 ml/kg of groundnut kernels.
- The adult can be brought under biological controlled by a fungus ***Matarrhizium anisopliae.***

3. **Locust: Family: Acrididae,** Orthoptera

- Locusts belonging to the Indian subcontinent are being described below:

a. Bombay locust ***(Pantanga succinct L.):***

- Mostly confined to **Gujarat** and **Tamil Nadu**
- Its breed during mansoon in the Western Ghats and has **only one brood** in a year.

b. Migratory locust ***(Locusta migratoria):***

- Mainly occurs in **Rajasthan** and **Gujarat**
- **Its** breed twice in a year: winter -spring breeding occurs in Pakistan and summer-mansoon breeding in Rajasthan and Gujarat.
- It may, have many broods a year.

c. Desert locust ***(Schistocera gregarea):***

- This is **most destructive** of all locust

The adult of this species occurs in two phases:

a. **Solitary phase** (solitaria): wherein the insects remain scattered
b. **Gregarious phase** (gregarea): wherein the insects congregates as nymphs and adults.

Life -history:

- Mating occurs between sexually mature yellow adults.
- Egg -laying starts after 8-24 hours of mating, a single female can lay up to 500 eggs in about 5 egg -pods or capsule.
- Female inserts her long ovipositor in sandy soil to bore a hole 2-4 inches deep.
- The summer breeding occurs during June —September (mansoon) in this quiescent eggs are hatched out and nymphal period is about 12-15 days, within this period emerges in five nymphal instars.
- Within the period of **one month** nymphal stage emerges into adult.

Damage:

- Both nymphs and adults cause damage

Host plants:

- Mainly **pearl millet, sorghum,** maize but being Polyphagous nature it's eat on all kind of vegetation except a few namely, **aak, neem, dhatura, Jamun** and **sheesham.**

Management:

- Eggs can be destroyed by deep summer ploughing or flooding
- The **nymphs are** t!.e **most vulnerable** stage for management point of view
- Because at second and third nymphal stage is key stage where pest population can be checked.
- A trench can be dug around the breeding field of locust so that when nymphs emerge, they can be buried under soil, or methyl parathion 2% can be dusted to kill the emerging nymphs.
- When infestation starts on field crops or vegetation around the field duts, methyl parathion 2% or Malathion 5% @ 25 kg/ha on field crops including field border and vegetation of non cropped area.

4. Termite: ***Odontotermes obesus,*** Termitidae: Isoptera.
   - Also known as **white ants.**
   - Termite lives in **social colony** in underground nets make earthen moulds **(termatoria).**

A. Reproductive castes:

(i) Colonizing individuals:

- Winged individuals of both sexes and are produced in large number during rainy season.
- After mating they cast off the wings and start a new colony.

(ii)Queen:

- Only perfectly developed female in the colony.
- It measures about 5.0-7.5 cm in length and she is known as a phenomenon, ***'Egg laying machine'.***
- It laying one egg/second or **70,000-80,000** eggs in 24 hours.
- Queen fed by workers, choicest food live in **"royal chamber"** which situated in centre of nest (0.5 m depth).

(iii) **King:**

- It developed from **unfertilized** eggs.

- **It lives with queen in royal chamber & smaller than queen and mates with queen from time to time.**

(iv) Complementary caste:

- **Short winged or wingless of both sexes lead a subterranean life**
- **They replaced in place of queen & king after ultimately death of them.**

(v) Sterile caste:

a. Workers:

- **They develop from fertilized eggs but remain stunted.**
- **Actual members that cause damage to crops.**
- Smaller than soldier & numerous in population
- Except reproduction and defense of community, practically all other duties are performed by the workers they take care of eggs, fed queen and cultivate fungus food **ambrosia in underground gardens.**

b. Soldier:

- **They develop from** unfertilized egg and remaining underdeveloped.
- They most specialized member of the community and can be recognized by the large head & strong chitinized sickle shaped mandibles adopted for protection of colony.

Management:

- When a colony is established, it is not so easy to eradicate; only **sure method** is to reach the centre of nest and kill the **queen** and the **complementary forms.**
- Before sowing granular application of **Regent** (Fipronil 5 % SC) @ 20 kg /ha.
- Shouldn't be use of **undecomposed** green manure and **FYM** at termite susceptible field.
- Seed treat with **Chlorpyriphos 20 EC @ 450m1/100 kg of seeds in wheat.**
- **In standing crop application of Chlorpyriphos 20 EC @** 4 liter/ha

- **Or Fifronil (Regent) 5 SC @ 18 kg/ha granular form effective against termite in standing crops.**
- **Seed treat with lmidacloprid (Provodo) is effective to protect from termite infestation in nursery stage.**

Storage insect -pests and their management:

List of storage insects:

SN	Common name	Scientific name	Family	Order
1	Rice weevil	*Sitophilus otyzae*	Curculionidae	Coleoptera
2	Grain weevil	*Sitophilus granarium*	Curculionidae	Coleoptera
3	. Larger rice weevil	*Sitophilus zea mais*	Curculionidae	Coleoptera
4	Lesser grain borer	*Rhizopertha dominica*	Bostrichidae	Coleoptera
5	Red rust four beetle	*Tribolium castaneum*	Tenebrionidae	Coleoptera
6	Khapra beetle	*Trogoderma . granarium*	Dermestidae	Coleoptera
7	Saw tooth beetle	*Oryzaephilus surinamensis*	Silvanidae	Coleoptera
8	Tobacco (cigarette) bettle	*Lasioderma serricorne*	Anobidae	Coleoptera
9	Drug store beetle	*Stagobium penisecum*	**Anobidae**	Coleoptera
10	Pulse beetle (gram dhora)	*Callosobruchus chinensis*	Bruchidae	Coleoptera
11	Groudnut beetle	*Caryodon cerratus*	Bruchidae	Coleoptera

12	Large head four beetle	*Latheticus otyzae*	Tenebrionidae	Coleoptera
13	Anguimois grain moth	*Sitotroga cerealella*	Gelechidae	Lepidoptera
14	Almond moth	*Ephestia cautella*	Phycitidae	Lepidoptera
15	Indian meal moth	*Plodia interpunctella*	Phycitidae	Lepidoptera
16	Rice moth	*Corcyra cephalonica*	Pyralidae	Lepidoptera
17	Potato tuber moth	*Phthorimaea operculella*	Gelechidae	Lepidoptera

Storage insects carried infestation by two types:-

1. **Internal Feeder:** Larvae/pupae remains inside the grains and insects lay eggs inside or on the seeds. e.g. Rice weevil, Pulse beetle, Sitotroga, Rhizopertha.
2. **External feeder:** Passes all life stages out side the grain and all stages are visible. e.g. Khapra beetle, Corcyra, Red flour beetle, Oryzaephilus etc.

Other category:-

1. **Primary pests:** Which infests the whole grains and are capable of damaging all kind of storage grains e.g. Sitophilus, Rhizopertha, Bruchids etc.
2. **Secondary pests:** infets which is already infected by other insects or they are capable of attack the broken or milled grains only e.g. Tribolium castaneum, Oryzaephilus etc.

Common storage pests:

A. Coleopteran pests:

1. Rice weevil: ***Sitophilus oryzae***

Host:

- **Serious pests of wheat, rice and barley**

Mark of identification:

- **First reported in rice so named rice weevil**
- **It prefers humid climate**
- **Dark brown in colour**
- **Most identified structure is presence of *rostrum***
- **Head is protruded into *snout (rostrum)***
- **Reddish orange circular markings on the elytra**
- **Grub is most injurious stage of damage**
- **Very difficult for this weevil to survive at low moisture**
- **In adult two pair of spot are presented on elytra**

Other species:

a. ***Sitophilus granarium:*** **Could not fly, wings are fused, other species are strong fliers**
b. ***Sitophilus zeamais:*** **Largest in sized, can tolerate to high moisture and damage is done at *milky stage.***

2. Lesser grain borer: *Rhizopertha dominica*

Host:

- **Prefer the dark and moist place**
- **Wheat, rye, jowar**

Mark of identification:

- **Beetle is more harmful than grubs**
- **Pronotum is rounded at the front where as the transfer row of teeth centrally and posterior flattened**
- **Lay eggs pear shaped and white later change into pinkish colour**
- **Pupation takes place inside the grains**
- **Profuse powdery substances is characteristic feature of its damage**
- **adults are good fliers**

3. Khapra beetle: *Trogoderma granarium*

- **External feeder, secondary pest**

Damage:

- **At high temperature & less humidity damage is done by grub (larvae).**

Mark of identification:

- Its eggs stage is highly sensitive to oxygen
- Can be live at less moisture availability
- Adult are harmless only larvae cause damage on whole grain
- Adults are blackis in colour usually 2.5mm in size with distinct marking on wings
- Larvae having long hairs on the hind end of body which helps in movement of body
- It can be live without food upto 4-5 year even 7 years
- At serious infestation in wheat grain eaten completely and white portion left looked like rice.

4. **Red four beetle:** ***Tribolium castaneum***
   - it is germ (external) feeder

Damage:

- Adult and larvae both are damaging stage
- Damage the processed food, flour, *suji*, *meda*
- In case of huge damage the flour turned grayish yellowish colour & gives peculiar pungent smell.

Mark of identification:

- Female lay eggs singly in flour upto 400 eggs
- Eggs are white cylindrical and hatch about 4-10 days
- In adult head, thorax and abdomen is very distinct
- Cannibalism is also very common in this insect

5. **Saw tooth beetle:** ***ayzaephilus surinamensis***
   - Secondary pest

Mark of identification:

- Larvae are straw coloured & dark patches on both side of the body
- In adult each side of thorax found six teeth like projection
- Generally larvae feed endosperm of the grain

6. **Pulse beetle:** ***Callosobruchus chinensis***
   - First discovered in China so named *chinesis*

- Mostly damage the pulses in storage but its also pest of pulse field

Mark of identification:

- Only eggs and adult are visible
- Antennae are serrate in female but pectinate in male
- Elytra covers the full body
- In hind femur spine teeths are present
- Adults are small chocolate dark brown coloured

B. LeDidonteran pests:

1. Anguimois grain moth: *Sitotroga cerealella*
   - Its also pest of field
   - In storage the infestation is restricted by surface
   - Damage is done by larvae
   - At high moisture infestation is more
   - Eggs are red coloured
   - The hole made by the larvae is very small
   - After entering the larvae hole is closed by silken web so difficult to see
   - If grain is small the pupation occur 2-3 grains holding together
   - Adult moth are golden brown coloured with two pair of wings
   - Wing margin is fringed and wings are pointed at the tip
2. Rice moth: *Corcyra cephalonica:* Pyralidae, Lepidoptera
   - Present in humid area
   - External feeder
   - Heavy infestation recognized by webbing
   - Larvae are pale white except the head capsule brown
   - Hind wing are mid brown & fore wing with thin lines of darker along the wing veins
3. Almond moth: *Ephestia cautella*
   - External feeder
   - Only larvae are germ feeder
   - Larvae covers with hairs

- Adult are 13mm in length wings are roof like on the abdomen
- Fore and hind wings are rounded at the tip

Factors ovetg_'Aiig..81_fi._gvdrain infestation

A. Physical factors:

1. **Temperature:** It is one of the most important factor of environment as the multiplication of insect pests of stored grains depends on it. The minimum temperature at which theseinsects are able to develops and multiply is between 15.5 to 18.3 °C many of insects can live for long periods at lower temperature. the optimum temperature for most of the species lies between 28-32 °C.
2. **Moisture:** Most of storage insects needs more than 10% moisture and the optimum is around 14% therefore, grains having less than 10% moisture is considered safe for storage **(NET -2013).** If moisture is less than 10% the most of insects avoided the infestation except Khapra beetle. Low moisture avoided the growth of insects and maintains the viability of seed.
3. **Oxygen:** Insects required more 0 2 as compare to grain respiration. Khapra beetle at eggs stage is highly susceptible to oxygen concentration.

B. Biological agencies:

1. **Insects:** The average loss due to stored grain pests is about 10-1 % of grains but contaminate the rest with undesirable odour and flavors. The majority of storage insects belongs to the order coleopteran (60%) and Lepidoptera (8-9%) of total number of species.
2. **Mites:** Mites infect and deteriorate the quality and quantity of grains.
3. **Rodents:** It includes rats, mice and squirrels, these are omnivorous and feed on grains. Rodents are responsible for causing enormous losses to stored grains.
4. **Birds: Birds also cause damage to grain crops and fruits.**
5. **Fungi:** At favorable moisture availability development of fungi also serious causes for grain spoilage common storage grains fungi are *Aspergillus spp.* and *Fusurium spp.* etc.

Management of storage pests:

1. **Seed treatment: Malathion 5% dust * 250g/qt.** of seeds is recommended or 2m1 of fenvalerate in 500 ml of water for one qt. of seeds.
2. **Surface treatment:** Bags dipped into **0.0125% fenvalerate** 20 EC or cypermethrin 25 EC for 10 minutes and drying them in shade or **Spray 0.05% malathion** 50 EC emulsion on floor, wall and ceilings.
3. **Fumigation:** Fumigats the stored grains with **Ethylene dichlorine + Carbon tetrachloride @, 1 lit/20 qt.** of grains or **Methyl bromide @ 3.5 kg/100 m3** for 10-12 hours or **Hydrogen phosphide** or **aluminium phosphide 1 tab./metric tonne** of grains.

Insect ecology:

- It may be defined as that branch of biological sciences which is concern with the relation of the insect to their environment.
- These environmental relationships which can be analyzed and organized constitute the subject matter of ecology.

Ante ecology:

- The study of individual organisms or species in relation to its environment.

Synecology:

- The study of groups of organism comprising different species in relation to their environment.

Population:

- A group of organisms of the same species occupying a particular area at a specific time is called a **population.**

Biome:

- Biome is an ecosystem of a large area in which the nature of stable communities is similar in appearance.

Ecological niche:

- Every organisms occupies a particular physical location at a given time and does a given thing **(eats, copulates** and **rests** etc) at that place and time at the location is known as **niche** of a particular organism.

- Actually niche is the **occupation** of an organism in a particular ecosystem.

Guild:

- A group of species within a community which have the same or very similar niches or different niches whose living is similar as they obtained & utilize response in the same ways e.g. **foliage feeders.**

Homeostasis:

- The term generally applied to the tendency for biological system to a resist changes and to remain in a state of equilibrium.
- Also known as ***stability in ecosystem or balance of nature.***

Bioluminescence:

- **The production of light by living organism** is called bioluminescence. It has one or more functions viz. illumination, attracting potential prey and matting behavior e.g. spring tails, cicadas and certain families of coleoptera.

Sibling species:

- Group of similar closely related species which are reproductively isolated but morphologically identical or nearly so.

Life table:

- The tabular representation of **death rate, cause• of death, chances of survival** and **life expectancy** is called life table.

Law of tolerance:

- Given by **V. E. Shelford 1913.**
- Law of tolerance deals with the limiting effect of maximum as well as minimizes temperature on the presence and success of organisms.

7. PLAP4 PATHOLOGY

Important points:

Father of plant pathology: ***Anton de berry***

Bordeaux mixture was developed by: ***P.M.A. Millardet*** *(1885)*

Wart disease of potato is caused by: ***Synchytrium endobioticum***

Bunchy top of banana: caused by: ***Virus***

Late blight of potato is caused by: ***Phytophthora infestans***

Club root of cauliflower is caused by: ***Plasmodiophora brassicae.***

Father of microbiology: ***Louis Pasteur***

Ooze test is done for detecting: ***Bacteria***

- White rust of cruciferous is caused by: ***Albugo candida***

Papaya mosaic disease is: ***Viral***

Brown spot of rice caused by: ***Helminthosporium oryzae*** ***(ARS-I0)***

Systemic fungicide is discovered by: ***Van Schleming*** *and* ***Kulka***

- Caulflower mosaic virus contain: ***DNA***

Bacteria used in biological control: ***Pseudomonas fluorescens***

Most of plant viruses are: ***ss-RNA*** (78% of all plant viruses)

The largest single group of plant viruses family is: **Potyviridae**

Carboxin (Vitavex) is very effective against: ***Smuts disease***

Downy mildew of bajra is caused by: ***Sclerospora graminicola***

Generally viruses are composed of: ***Nucleic acid and protein***

The causal organism of black rust of wheat is: ***Puccinia graminis tritici***

The prions are considred to be ***infectious protien*** which have no nucleic acids.

Agar agar is produced by: ***Nostoc*** *(Red algae)*

Agar -agar is obtained from: ***Red sea algae***

Wart disease of potato in the country is restricted to: ***Darjeeling hills***

Mycoplasma is sensitive to: ***Tetracycline***

First transgenic plant was developed in the world is: ***Tobacco***

The downy mildew of pearl millet is suppressed by: *Chlorine* ***(RAS Pre -09)***

- Loose smut pathogen of wheat is: ***Internally seed borne***

1 **One** of factors causing malformation of mango is: ***Fungus***

e'^

- The most effective fungicide for the control of powdry mildew: ***Sulphur fungicide*** (Karathane)
- The vector responsible for spread of potato leaf roll virus disease is: ***Aphids***
- Majority of plant disease viruses are: ***ssRNA(+) viruses***
- **Alexander Fleming (1929)** first time discovered antibiotic ***Penicillium.***
- The MLO's when, appeared in spiral (helical) in shape and are motile known as: ***Spiroplasma.***
- The sum total of all symptoms and signs is: ***Syndrome***
- The first bacterial disease was discovered: ***Fire blight of pear.***
- The fungus causing late blight of potato and white rust of crucifers belong to order ***Peronosporales***
- The ***cybrids*** contain: nucleus of one and the cytoplasm of both the parents
- In rust fungi repeating spores are: ***Uredospores***
- Sexual spores in downy mildew fungus is: ***Oospores***
- The incidence of blast disease can be reduces by application of: ***Silicon in rice***
- Smut fungi belongs to the genera: ***Ustilaginales***
- Vertical resistance is also known as: ***Major gene/qualitative/race specific resistance***
- Examples of prokaryotes are: ***BGA, bacteria and phytoplasma***
- ***Moko*** disease of banana is caused by: ***Pseudomonas solanacearum***
- '***Pine -apple*** disease' is associated with sugarcane caused by: ***Ceratocystis paradoxa (fungi).***
- Agr, °bacterium mediated gene transfer is only effective for: ***Dicots***
- Antibiotic used to kill MLOs (no cell wall in ML0s) is: ***Tetracycline*** (because it acts on cell membrane)
- Coffee rust occurred in Sri Lanka 1867 by: ***Heti:dela vastatrix***
- of virus particles first obtained by: ***Stanley 1935***
- Downey mildew fungi belongs to order: ***Peronosporales***
- ELISA (Enzyme -Linked Immune-Sorbent Assay) test is mainly done for: ***Viral diseases.***
- Purification (crystallization) of TMV is done by: *Stanley* ***(1935)***

- Ergot is a mycelium form called: ***Sclerotia***

The most common vectors of plant viruses are: ***Aphids***

In downey mildew of Bajra Oospores are resting spores, which are responsible for primary infection

- Gram staining method in bacteria was given by: ***Christian Gram 1884***

The effective and new fungicide for the control of Oomycetous fungi is: ***Metalaxyl*** (marketed under the trade names of ***Ridomil & Apron)***

I Most dangerous and poisonous mushroom is: ***Amanita phalloides***

- Purple blotch of onion is caused by: ***Alternaria porri***

I ***Pathogenesis:*** The chain of metabolic events that bring about the disease is pathogenesis.

- ***Pathogenicity:*** The relative capability of a pathogen to cause disease
- ***Virulence:*** The degree of infectivity of a given pathogen.
- ***Virion:*** it consist of nucleic acid (may be DNA or RNA) and a surrounding protein coat (known as a **capsid).**
- ***Infection:*** establishment of pathogen after penetration, has host parasitic relationship

1 ***Inoculums:*** Part of pathogen, which on contact can cause infection in the host, is called inoculums e.g. conidia, spores, sclerotia etc. serves as inoculums.

- ***Invasion:*** The penetration and spread of a pathogen in the host

Incubation period: The period of time between penetration of a pathogen to the host and the first appearance of symptoms on the plant.

1 ***Disease potential: It*** is defined as the ability of the host to contract disease.

Unit -1

Plant pathology

- Name derived from two Greek words.

Pathos = Suffering
Logus = Study

- **Means plant pathology is the study of causes of suffering plants and their management.**

Historical background:

a. Iris famine: 1845:

- **Occurred due to late blight of potato** ***(Phytophthera infestans).*** **This disease destroyed the entire potato crop.**
- **In Ireland 20 lacks peoples were died due to starvation.**

b. Coffee rust 1867:

- **Occurred in Shri Lanka due to** ***Hemilia vestetricola.***

c. Downy mildew of grapes in France:

- **It was caused by** ***Plasmapora viticola.***
- **Millardet discovered Bordeaux mixture in 1885 for the control of downy mildew of grapes.**
- Composition: **Copper sulphate (5** pound): **lime (5 pound): water (50 gallon).**

d. Bengal famine, 1943:

- **Due to brown spot of** ***rice (Helminthosporiwn otyzae).***

e. Theophrastus: (380-287 B.C.)

- **Wrote two** books: **'The nature of plants' and 'Reasons of vegetable growth'.**
- **For this works Theophrastus called as** ***'Father of Botany'.***

f. Anton van Leeuwenhoek (1675):

- **Developed the first microscope and he first** described **bacteria.**
- **He known as father of microbiology**

g. **P.A Michell (1729):**

- **He studied the fungi and saw fungal spores.**
- **Known as father of Mycology.**
- **Wrote a** book *'Nova* ***Plantarum Genera'***

h. Linnaeus (1753):

I **Gave 'Binomial system of nomenclature' in 10th Edition of his famous** book ***Systema naturae (1958)***

V. **Famous book 'Species Planetarium' written** by: **Linnaeus.**

- **He known as** ***'Father of Zoological Classification'.***

i• Tillet (1755):

- Published a paper on **bunt** or stinking **smut of wheat**

j. **Prevost (1807):**
- Proved that bunt of wheat caused by a fungus.
- Used copper sulphate to controlled bunt of wheat.
- So credit for **discovering** the life cycle of the **bunt** fungus goes to **Prevost.**

k. **Anton de berry** (1861):
- Known as father of **modern mycology**
- **He** conducted detail study of **potato late blight** and **proved** that fungus *phytophthora infestans* was the cause of late blight.
- The discovery of **heteroecious** nature of rust fungi was reported by him in 1885.

1. **Brefeld (1875):**
- Developed methods of **artificial culture** of microbes.
- Father of pure culture technique.

m. **Robert Koch (1876):**
- Father of medical bacteriology
- Discovered first bacterial etiology of **anthrax** disease
- He gave the famous **Koch's postulates** (theory) for proving that a particular organism caused is a particular disease.

n. **T. J. Burril (1882):** (USA)
- First reported that a plant disease **(fire blight of pear)** was caused by a bacterium (now known as ***Erwinia amylovora*).**

o. **Flor (1946):**
- Proposed **gene for gene** concept of disease resistance and susceptibility with working on linseed rust.

p. **Vanderplank (1963):**
- Suggested two kinds of resistance i.e. **vertical** resistance and **horizontal** resistance.

q. **Kassanis (1962):**
- Satellite viruses were discovered by him. he observed that some trains of Tobacco Necrosis Virus (TNV) contained a

smaller particles of virus (satellite virus) that was dependent for its replication on TNV.

r. **Shepherd** *etal.* (1968):

- First reported **double -stranded DNA** in cauliflower mosaic virus, followed by the discovery of single stranded DNA Geminiviruses by **Goodman** (1971).

s. **Diener** (1971):

- Discovered *viroid*, a new kind of plant pathogen which is associated with potato spindle disease. they don't have protein coat.

History of plant pathology in India:

a. **K.R. Kirtikar:**

- First Indian scientists who collected and identified the fungi in India.

b. **E.J. Butler:**

- Known as Father of Indian Plant Pathology
- Wrote a book ***"Fungi and Diseases in Plants"***

c. **Dr. K.C. Mehta:**

- At Agra, discovered the disease cycle of **wheat rust in** India.

d. **B.B. Mundkur:** 1948

- He started work on control of **cotton wilt** through **varietal resistance.**
- The most **significant** contribution of Mundkur to plant pathology in India will be **recommended** through the **Indian Phytopathological Society** which he started almost single handed in **1948** with its journal ***'Indian phytopathology'.***
- He also authored a text book **"Fungi and Plant Diseases".**

Classification of plant disease: based on occurrence.

a. **Endemic disease:**

- When a disease is more or less constantly present from year to year in moderate to severe form in a particular part of country or state it is classified as endemic to that area.
- The word ***"endemic"*** means prevalent in, and confined to, a particular country, district, or location.

- **E.g. Early blight of potato.**

b. **Epidemic disease:**
   - A disease which occurs widely in severe but periodically
   - It assumes severe form only on occasions.
   - Examples: **Red rot of sugar cane, Late blight of potato, Wheat rusts.**

c. **Sporadic disease:**
   - Occur at very irregular intervals and locations e.g. **Green ear disease of Bajra.**

d. **Pandemic disease:**
   - When a disease prevalent throughout the country continent or the world is known as ***pandemic disease.***

General symptoms of diseases:

SN	Symptoms	Character
1	**Downy mildew**	**The superficial growth of the pathogen is a cottony or downy layer of leaves surface.**
2	**Powdery mildew**	**Dusty or powdery appearance (growth) of fungus on upper surface of plants.**
3	**Rust**	**Rusty appearance and appear as relatively small pustules of spores.**
	(i)	***Autocious rust:*** **Complete its life cycle *in same* host eg. Linseed rust.**
	(ii)	***Heteroecious rust:*** **The rust which requires alternate host or completes their life cycle more than one host eg. Wheat rusts.**
4	**Anthracnose**	**Ulcer -like lesions on stem and pods.**
5	**Smut**	**Sooty or charcoal -like powder. Plant shows a black or purplish black dusty mass composed of the fungus spores particularly in ovulary part of floral organs.**
6	**White blisters**	**Generally on leaves of crucifers plants there may be found numerous white, blister -like pustules which break open and expose white powdery mass of spores. known as *white rusts*.**
7	**Scab**	**Refers to a roughened or crust -like lesion or to a freckled appearance of the diseased organ.**
8	**Sclerotia**	**A compact, often hard, mass of dormant fungus mycelium.**

	Phyllody	It is a serious problem of sesame and **pearl millet.** Transformation of floral part in green leafy structure.
10	Etiolation	When the **loss of green colour** is due to prolonged exposure to darkness the condition is called ***etiolation.***
11	Exudation	Masses of bacterial cell ooze out to the surface of affected plant parts and form some drops or smear, it is called ***exudation.***
12	Chlorosis	**Yellowing** of leaves due to **lack of chlorophyll.**
12	Necrosis	Refers to **death of tissues or cells.**
14	Hyperplasia	It is the abnormal increase in size of the organ due to an ***increase in number of cells*** of organ (due to cell division).
15	Hypertrophy	Increased size of organ is due to ***increase in size of cells*** (owing to nucleus division)
16	Curl	Leaves are arched, twisted and curled appearance
17	Wilt	Drying or drooping of leaves due to loss of turgor
18	Damping off	Stem affected the near of soil at seedling stage by ***Pythium spp.***
19	Blight	**Burnt** like appearance on plant parts.
20	Canker	Dead area in the bark or cortex of stem of woody plants.
21	Die -back	drying of twigs and branches of plants from the top backwards.

Unit -2

Fungi

Fungi are filamentous, multi -cellular organisms, having organized nucleus with nuclear membrane, always lacking of chlorophyll, but presence of cell wall in true fungi and multiplication by production of asexual or sexual spores of vegetative cells.

- The fungal branches are known as hypae and the entire vegetative body is known as ***mycelium.***

Vegetative structure of fungi:

- In the true fungi true cell wall is present whether the thallus is a unicellular or a multicellular branching body.
- The branches are known as **hyphae** and the entire vegetative body is called **mycelium.**

Reproduction of fungi:

a. **Asexual reproduction:**

- In asexual reproduction the hyphae cut off minute spores.
- The structure and origin of these spores vary greatly and each types has been given different names i.e. ***chlamydospores,*** ***conidiophores*** (conidia), in mastigomycotina sporangium, ***sporangia*** are formed, in aquatic forms, sporangia liberate naked protoplasmic bodied, the *swamspore or* **zoospores.**
- In the ascomycotina and deuteromycotina, the conidia may be produced in special structures known as ***pycnidia, sporodochia, acervali.***

b. **Sexual reproduction:**

- Involves two separate gametes.
- The sexual reproduction by union of two morphologically dissimilar gametes is known as **oogamy** (leads to development of simple structure **oospores** or a complex fruit **cleitothecium, perithecium, apothecium).**
- **In** most of higher form of fungi the sexual process involves the union of two similar gamatangia. This is known as **isogamy** (lead to formation of **zygospore or zygote).**

Common group of plant diseases fungi are:

I.	Ustilaginales :	Smut fungi
2.	Uredinales :	Rust fungi
3.	Erysiphaceae :	Powdery mildews
4.	Peronosporaceae :	Downy mildews

Fungicides: are chemicals used to kill fungi.

1. **Sulphur fungicides:**

- Two main groups:

a. **Elemental sulphur:** is used as **dust** and **wettable powder**

b. **Lime sulphur:** is used as **dormant spray**

- Sulphur fungicides are effective against **powdery mildews.**

2. Copper compound fungicides:

a. **Copper sulphate:**

- It was first discovered by **Prevost .1807** and used against bunt of wheat.

b. **Bordeaux mixture:**

- PME Millardet Prof. of botany at Bordeaux in France (1885) discovered Bordeaux mixture from the mixture of copper sulphate and lime.
- It was used against **downy mildew of grapes**
- Composition = Copper sulphate + lime + water (5: 5: 50: ratio).

c. **Burgundy mixture: 1887**

- In this mixture lime is replaced by sodium carbonate or washing soda. ***(ARS-I0)***
- Bur,,clidv mixture: Copper sulphate + sodium ea ,• + water (5:6:50)

d. Chant r Riste:

- *11u ised **as** a wound dressing fungicides against dise - !. apple and pear as black stem, brown stem etc.
- Con- :ition: Copper carbonate + red lead + raw (8:8

3. **Thiocarbot fungicides:**

- **s till • is** an important component in the structural form i of Thiocarbonate fungicides.

a. **Thiram.**

- **It i• isically used as a seed protectant**

b. Ziram:

- **It i, nc** containing Fungicide.

- It cc,,,caining both zinc and Mn.
- **Best** and **widely** used **fungicide**

d. Vapam/Metham-sodium:

- **It is soil fungicides.**

- Used as soil sterilient for fungicides, nematodes and herbicides.

4. **Systemic fungicides:**

a. **Oxathiin:**

- The first systemic fungicide Carboxin was developed by **Von Schmeling and Kulka** in **1966.**

(i) Carboxin/DMO:

- Trade name is ***Vitavax.***
- Used against smuts and rusts
- Especially is used against loose smut of wheat and *Rhyzocionia* disease of cotton.

(ii) **Oxycarboxin:**

- Trade name ***Plantvax***
- used against **rusts** of wheat
- It can be used in controlling disease related to ***fungi imperfecti.***

5. **Benzimidazoles:**

- It comes under the name of Benomyl or **Bavistin.**
- **It** is a **superior systemic fungicide** which acts as a good eradicate and protectant.

6. **Phenylamides:**

- **Metalaxyl M** was the superior fungicides introduced in 1977.
- Active on oomycetous fungi and it inhibit rRNA synthesis.

7. **Organo-mercurial fungicides:**

- Its effective fungicides and bacterial-cide
- Because of its high toxicity it is not used to control plant diseases.
- E.g. Agrosan GN, Aretan, Ceresan, Agallol.

8. **Other fungicides:**

a. **Captan:**

- Seed treatment and soil drenching @ 0.5 % for protection against damping off

b. **Karathane:**

- Used against **powdery mildew** disease in plants and controlling of mites.

c. **Antibiotics:**

- Streptomycin: at 100 ppm or more has been found effective against bacterial seed borne pathogen.
- To reduce the possibility of development of resistant strain in bacteria, streptomycin is mixed with Oxytetracyclin **(Terramycin).** This mixture is called **Agrimycin.**

d. **Triazoles:**

- This is most active on powdery mildews, rusts and leaf spot fungi.
- This is important member of **sterol biosynthesis inhibitors** (SBIs).

Fungicides and their trade name:

S.N.	Common name	Trade name
1	**Copper fungicides**	
	Bordeaux mixture	Cu_2SO_4: lime: water
	Burgandy mixture	Lime replaced by Na_2CO_3
	Copper oxychloride	**Blitox-50,** Fytolan,
	Copper sulphate	**Blue copper**
.	**Organo mercurial**	
	Ethyl mercury chloride	**Ceresan**
	Methoxy ethyl mercuric chloride	Aretan, Agallol
	Phenyl mercury acetate + ethyl mercuric chloride	**Agrosan G N**
.	**Benzimidazoles**	
	Benlate	Benomyl
	Carbendazim	**Bavistin**
4.	**Dithiocarbamate**	
	Maneb	Dithane M-22

	Mencozeb	**Dithane m-45, Indofil**
	Zineb	**Dithane Z-78**
5.	**Other fungicide**	
	Thiram	Arasan
	Phthalimides Dinocap	Captan Karathane
	Oxycarboxin	Plantvax
	Carboxin	Vitavax
	Phenylamides	Metalaxyl M
	Metham N sodium	Vapam (nematicide)
	Streptocyclin	Bacteromycin
	Sterol biosynthesis inhibitors	Triazoles

General Principal of plant disease control:

1. **Preventive measures:**

   Avoidance of the pathogen
   - Selection of geographical area
   - Selection of field

   Choice of the time of sowing
   - Disease escaping varieties

   Selection of seed
   - Modification of cultural practices
   - **Exclusion:** Method which prevent a disease from entering into a new area. E.g. Quarantine inspection and embargo certification etc.

2. **Eradication:**

   This measure is taken for the elimination of the pathogen after its establishment on the host.

It includes crop rotation, sanitation, elimination of alternate and over wintering hosts, elimination of pathogen from the seeds, tubers etc.

3, **Protective:** application of chemical fungicides.

A. Seed treatment (by physical methods):

1. Hot water treatment method:

It was developed by Jensen in 1887.

1 Provide hot water to seeds about **54**° C for 10 minutes.
E.g. **loose smut** of wheat controlled by hot water treatment of seeds.

2. **Solar energy treatment:**

1 To control loose smut of wheat was first developed by **Luthra &** sattar, 1934

1 In this method seeds are soaked **in water for 4-5 hours,** and dried in sun in the month of May —June by the keeping on cemented floor or metal- sheet.

1 This method is used to control loose smut of wheat anti" barley.

Unit -3

Classification of plant diseases

1. **Bacterial diseases:**
   - **Phylum Proteobacteria** is the biggest phylum containing the gram negative bacteria e.g. *Agrobacterium, Rhizobium, v it,,,,ymnas Pseudomonas, Erwinia, Serratia etc.*

SN	Common name	Causal bacteria	Vector
I	**Citrus canker**	*Xanthomonas curl*	
2	Black rot of crucifers	*Xanthomonas compestris*	
	Bacterial blight of rice	*Xanthomonas oryzae*	-
-4 -	Angular leaf spot/black *arm* of cotton	*Xanthomonas malvacearum*	

k t Pr.'1: %f%la' .

5	Greening disease of Citrus	*Canditatus Liberobacter* (former *Ml.,0s)*	Psy !lids, *Diaphorina Mil*
6	Fire blight of apple/pear	*Erwinia amylovora*	-
7	Scab disease of potato	*Streptomyces scabies*	-
8	Red stripe of sugarcane	*Pseudomonas rubrineans*	-
9	Ratoon stunting disease of sugarcane (RSD)	*Clavibacter xyll*	*Mechanical transmission*
10	Yellow vine of cucurbits	*Serrata niarcescens*	*Squash bug, /Masa tritis*
11	Corn stunt	*Spiroplasma kunkelii**	*Dalbulus maidis*

*Fastidious vascular -colonizing bacteria

2. Mvcoplama diseases:

SN	Name of disease	Host plant	Vector
	Yellow dwarf disease	Rice	GLH: *Nephoteilix virescens*
	Phyllody	Sesame	Leafhopper: *Orosius albicinctus*
	Little leaf	Brinjal	Leaf hopper: *Cestius phycitis*
	Grassy shoot	Sugarcane	Aphids:
	Purple top roll	Potato	Leafhopper:
	Sandal spike disease	Cardamom	Leaf hopper: *Jassus indicus*

3. Viral diseases:

Definition of virus: Viruses are elementary particles that posses some properties of living system, such as having a genome and being able to adapt to changing environment (by ICTV).

I SN	Host plant	Viral disease	Vector
	Wheat	Streak mosaic	Eriophyid mite: *Aceria tulipae*
	Maize	Mosaic	Sorghum bug: *Peregrinus maidis*
	Rice	Tungro disease	GLH: *Nephotettix virscence*
	Rice	Grassy stunt	BPH: *Nilaparvata Ivens*
	Groundnut	Rosette virus	Aphid: *Aphis craccivora*
	Groundnut	Bud necrosis	Thrips: *Frankliniella scultzei*
	Pigeon pea	Sterility mosaic	Eriophyid mite: *Aceria cajani*
	Bhindi	Yellow vein mosaic	Whitefly: *Bemisia tabaci*
	Tomato	Leaf curl	Whitefly: *Bemisia !abaci*
	Chili	Leaf curl	Thrips: *Scirtothrips dorsalis*
10	Chilli	Mosaic	*Whitefly: Bemisia tabaci*
10	Potato	Potato leaf roll	Aphid: *Myzus persicae*
11	Banana	Bunchy top	Aphid: *Pentalonia nigronervosa*
12	Citrus	Tristeza	Aphid: *Toxoptera auranta*
	Papaya	Mosaic	Aphid: *Aphis craccivora*
	Cardamum	Kattee/Foorkey	Aphid: *Pentalonia nigronervosa*
	Cotton	Leaf curl	*Whitefly: Bemisia tabaci*

	Cow pea	Mosaic	Aphid: *Aphis craccivora*
	Mango	Malformation	Bud mite: *Aceria mangiferae*

Unit -4

Crop Diseases

Rice

1. **Blast (or rotten neck): *Pyricularia oryzae***
   - Most severe disease of rice also called as **rich men's disease.**
   - **Air borne** disease, conidia spread by wind cause secondary infection.

Symptoms:

- Brown spindle **eye boat** (spindle) shaped lesion on leaf, and leaf sheath.
- At the end of season **rotten neck** or collar rot symptoms appear.
- The infected pedicels result in non production of seeds is called ***blanking.***

Management:

- Seed treatment with Thiram @ 2.5 g/kg of seeds
- Spray **Mencozeb @ 0.3 %** on standing crops

3. Bacterial leaf blight of rice (BLB): ***Xanthomonas oryzae***

Symptoms:

- Initially 'blighting starts from tip of leaves to the base'.
- **Bacterial ooze** appears on the surface of legions.
- Later **`Kresele** (seedling wilt) occurs plant withers and dry **up.**

Management:

- Seed treatment with **Streptocyclin 0.015 %**
- **3-** 4 spray of Agrimycin 100g + 500g of copper oxychloride in 500 liter water/ha.
- Spray of **Bacteromycin @** 25 g/ha.

4. Brown leaf spot: ***Helminthosporium oryzae.***

- This disease is responsible for The Great Bengal Famine in 1943.

Symptoms:

- Many dark brown spots on upper surface of leaves
- This disease is severe on **potash deficiency soils.**

5. Khaira disease:

- Due **to zinc** deficiency
- Usually in nursery chloratic or yellow patches at leaf base *on* both sides of midrib

Management:

- Spray *(4)* 5 kg **ZnSO4/ha**

6. Bakanae disease:

- Foot rot or Bakanae "disease ***Gibberella fujikorai*** isolated by a Japanese scientist **Kurasova.**
- This disease is also known as 'foolish **seedling disease'.**

7. **Pan Sukh: Dry physiological disease.**

- **Management:** drain excess water, apply **ammonium sulphate @** 15-20 kg/ha.

8. Tungro disease: Rice **Tungro virus** ***(NET ento-2013)***

- Vector is: **Green Leaf Hopper** *(Nephottetix virscence)*
- The rice tungro is unique disease which is caused by two viruses, as RNA virus (RTSV), and a DNA virus (RTBV).

8 Stunting of plants and leaf yellowing are two main symptoms of tungro.

Other minor diseases of rice:

- Sheath blight: ***Rhyzoctonia solani***
- Grassy stunt: **Viral** (vector **`13PH'** *Nilaparvata 'wens)*
- *Yellow* dwarf: Due to ***Phytoplasma***
- Udbatta disease: Due to fungus ***Ephelis oryzae'***

Wheat

1. Rust,

4' Brown/leaf rusts: *Paccinia recondita tritici*

- *It's* most widespread and most damaging in our country.

- It is **earliest in appearance on wheat in India.**

Symptoms:

- Bright orange, uredinial pustules, scattered mainly on leaves.

b. Yellow or stripe rust: ***Puccinia striformis:***

- The yellow rust is major disease in N.W. part of country.

Symptoms:

- Lemon yellow pastules develops in a rows on leaf, leaf sheath, and glumes.

c. Black/stem rust: ***Puccinia graminis tritici***

- Known as **'Killer'** disease of wheat
- Because of late appearance the damage is less than other rusts
- Severe in Southern, Central and Eastern India

Symptoms:

- Elongated brown pustules of uredinia appear on stem, leaf sheath and leaves but stem often most severally affected.

Management of rusts:

- Avoid late sowing
- Use of resistance varieties
- Use high dose of potassic fertilizer
- After appearance of symptoms spray of Mencozeb @ 2 kg/ha
- Dusting of Sulphur @ 25 kg/ha is effective against all three rusts infestation.

2. Karnal bunt/partial bunt: ***Neovossia indica***

- time reported in Karnal (PB) by **Mitra (1931)**
- Called as **'Cancer'** of wheat and it is new emerging disease at International level.
- Many countries have imposed restrictions to import of wheat from diseased area (quarantine importance disease).

Symptoms:

- Infection occurs at flowering stage by air -borne spordia.
- Few grains are partially converted into **black sooty powder.**
- Rotten black powder gives a **foul smell** due to the presence of **tri-methyl-amine.**
- The prepared flour is of dark colour and gives a **fishy smell.**
- Disease is seed, soil and air borne

vlanagement:

- It is soil, seed and air borne disease hence grow resistance varieties only option
- Avoid excessive irrigation particularly at flowering.
- Seed treatment with Agrosan-GN (PMA) @ 2.5 gm/kg seeds

3. Loose smut: ***Ustilago nuda tritici***
   - Internally seed borne disease

Symptoms:

- Early emergence of heads
- Entire 'ear' except the rachis and awns, are smutted
- Initially the spore masses are covered by a silvery membrane.
- Later production of **black powder** in place of grains.

Management:

- Seed treatment with **vitavax @** 2.5 g/kg of seeds
- Solar heat treatment of seeds: given by **Jensen (1888)**
- Hot water treatment: 54 °c for 30 minutes.
- Roguining of diseased plants

4. Powdery mildew ***(Erysiphe graminis***
   - White powdery growth of fungus on the upper surface of leaves.
   - It managed by sulphur dusting @ 25kg/ha.
5. **Tundu** disease/sehu/yellow ear rot disease: ***Corynebacterium tritici* + *Anguina*** *tnitici*

Symptoms:

- Curling of affected plant leaves
- Bright **yellow slimy** ooze on leaves and inflorescence
- Agglutinated inflorescence

Management:

- Floatation of seeds in **20 % salt solution.**
- Roughing

6. **Other diseases of wheat:**
   a. Flag smut: ***Urocystis tritici***
   b. Hill bunt: ***Tilletia foetadalearies.***
   c. Ear—cockle of wheat: due to ***Anguina Oda*** It is managed by seed floatation in **20% salt solution** before sowing.

Barley

1. Covered smut: ***Usti!ago hordei***

Symptoms:

- Smutted head
- Grains replaced by black agglutinated spore masses.

Management:

- Externally seed borne hence easy to control,
- Seed dressing with Agrosan GN @ 2.5 g/kg seeds.

2. **Loose smut:** *Ustilago nada,* same as wheat
3. Powdery mildew: ***Erysiphe graminis*** var. ***hordei***

Symptoms:

- **Cottony growth** on both the leaf surface

Management:

- Spray of sulphur fungicides e.g. **Karathane**

reari male

.1. Downy mildew/green ear disease: ***Sclerospora graminicola***

- Ear transformed into **green leaf like** or leafy whorl type structure.

Management:

- Roughing of diseased plant
- Crop rotation about 4-5 year
- Seed treatment with **Apron S.D. @** 6 gm/kg seed before sowing.
- Spray **Mencozeb @** 2kg/ha 21 days after sowing.

2. Ergot: ***Claviceps fusiformis:***
   - First appear on the ears in the form of honey like pinkish liquid, **Sclerotia**
   - Later on pinkish liquid appear as **brown to black.**

Management:

- Avoid late planting.
- Seed treatment with Captan/Thiram @ 3g/kg seeds
- Seeds are deep in **20 "A) salt solution** and floating ***seeds*** should be collected and destroyed.

- At the time of ear emergence two spray of Mencozeb **kg/ha,** at 3-3 days interval A 2

3. Smut: ***Tolyposporium penicillariae***
   - Affected kernels become green and larger in the beginning but later turn to **black son.**
   - Seed treatment with Thiram @ 3g/kg seeds
   - Spray vitavax @ 0.25 %.

Maize

1. **White bud of *maize:* *Zn*** *deficiency*
   - Apical portion of leaf becomes white.
   - Apply $ZnSO_4$ @ 20-25 kg/ha at sowing time.
2. Charcoal rot: ***Macrophomina phaseoli***
   - Avoid water stress after the flowering of the crop.
3. Seed Rot/Seedling Blight: ***Pythium aphanidermatum.***

Gram diseases:

I. Fusarium wilt: ***Fusarium oxysporium*** f.v. ciceri
   - Soil borne
   - Most serious in central India.

Symptoms:

Stunted growth;
Roots turn black and ultimately decomposed.
Yellowing of leaves
Withering of plants and main root turns black.

Management:
- Avoid early planting (early sowing of gram protect the crop from H. armigera but severe infestation of Fusarium wilt)
- Grow resistance var. i.e. ***Avrodhi***
- Seed treatment with Bavistin 2g/kg
- Crop rotation and deep sowing

2. Ascochyta blight: ***Ascochyta rabid.***
   - Air borne
   - Most potential disease of North West plains
   - All plant parts except roots are affected

Sorghum

I. Downy mildew: *Sclerospora soghi*

Symptoms:

- **Downey white growth on lower surface with yellowing on upper surface on young leaves i.e. chlorosis at downy spot**

Management:

- **Seed treatment with Agrosan GN**
- **Spray Mencozeb @ 0.2 %**

2. Other:

- **Grain smut: *Sphacelotheca sorghi* (RPSC-AO exam -2012)**
- **Leaf rust: *Puccinia purp urea***
- **Head smut: *Sphacelotheca relliana*, portion of entire floral structure transformed into smutted galls**
- **Long smut: *Tolyposporium enrenbergii***

Arhar

1. Fusarium wilt: *Fusarium oxysporium* f. sp. udum

- **Most destructive soil borne fungal disease wilting of leaves and plants**

Management:

- **Mixed cropping and crop rotation, no chemical control found effective**

2. Sterility mosaic: sterility mosaic virus

- **Vector of sterility mosaic is, Eriophyid mite: *Aceria cajani***
- **It renders the plants sterile by inhibiting flower formation.**
- **Due to viral infection the plants grow luxuriantly, and the disease is called *green plague.***

Sojbeart

1. Yellow mosaic: due to yellow mosaic virus

- **Vector is *Bemisia tabaci* (whitefly)**
- **Foliar spray of Thiomethoxam @,60 gm a.i. /ha**

2. **Charcoal rot:** ***Rhizoctonia bataticola***
   - **Reddish black to brown necrotic lesion at crown portion**
   - **Seed treatment with Carbendazim, summer plough ing and crop rotation.**

Groundnut

I. Tikka disease: ***Cercospora personata & C. arachidichola***

Symptoms:

- **Small dark brown spots and pre mature leaf shedding.**
- **In case of** *C. persona/a,* **brown spots are regular and not more than 0.6 in diameter but in** *C. arachidichola,* **there are irregular spots of larger diameter.**

Management:

- **Spray Bavistin @ 0.3%**
- **Spray Mencozeb @ 1.5 kg/ha 40 days after sowing**

2. **Collar rot & dry root rot:** ***Aspergillus niger***
   - **It produce** ***Aflatoxin*** **in stored kernels.**
   - **Symptoms: attack at seedling stage at the base, black spores are seen at root**

Management:

- **Seed treatment with Mencozeb 3g or Bavistin 2g/kg of kernels**
- **Soil drenching with Bavistin 0.3 %**
- **Application of** ***Trichoderma viridae*** **@ 4 kg/ha mixed with 15-20 kg well rotted FYM and subsequently irrigate the field (it has antagonistic effect on pathogenic fungi).**

MiLisfard

1. **White rust blister:** ***Albugo candida***

Symptoms:

- **White or yellow pustules variable sizes & shapes on lower surface of leaf**
- **Infection covers all parts except roots.**

Management:

- Spray Blitox -50 @ 1.5 kg/ha at 15 days interval.
- Seed treatment with Apron 35 SD @ 6 g/kg seeds.
- 2 -3 spray Mencozeb @ 2 kg/ha at 20 days intervals.

2. Alternaria blight: ***Alternaria brasicae***
    - **Symptoms:** Concentrate black spots on leaves, stem and pods
    - **Management:** Spray Dithane M-45 @ 2kg/I 000 liter water at 15 days intervals starting from 40-45 days after sowing.
3. Downy mildew: ***Pernospora brassicae***
    - Yellow & irregular spots on upper surface & white growth on under surface of leaves malformed inflorescence.

Sugarcane

1. Red rot: ***Collectotrichum falcatum***
    - Most destructive disease in both tropical and subtropical Ind ia

Symptoms:

- Typical symptoms of red rot are seen inside the stalk i.e. reddened pith which is responsible for quick decline of many of the sugarcane varieties.
- Alcoholic smell from field

Management:

- Sets are deep in **0.25% of mercurial compounds like Agallol or Aretan for five minute**

2. Grassy shoot of sugarcane: **Mycoplama**
    - Symptoms: Excessive tillering, sprouting of lateral buds.
3. **Smut: *Ustilago scitaminea***

    it is also known as `culrnicolous' smut of sugarcane because it affects the stalk of cane.

    Severe from April to July, 10% loss in juice

Symptoms:

- **Along black whip like structure at the apex of the stalk also known as '*whip smut*' .**

4. **Red stripe: *Xanthomonas rubriliens***

- Long narrow red stripe appear on leaf, only leaves and top shoots are affected.

5. RSD (Ratoon Stunt Disease of sugarcane)
   - Caused by Clavibacter xyli
   - It is called **`ratoon stunting'** because the disase is more severe on ratoon crops than on 'plant cane' crop.

Other diseases:

- Gummosis: ***Xanthomonas vasculorum:*** the fibro-vascular becomes red
- Grassy stunt disease caused by **Mycoplama** vector is rice BPH.
- Sett rot or pineapple disease: ***Certostmella paradoxa.***

rotat •

1. Late blight: ***Phytophthora infestans***
   - It is most destructive disease of potato and tomato also.
   - Symptoms appear late in season, at the flowering stage.
   - Bright brown spots on leaves and irregular patches starts from leaf tip, later turned in brownish black patches.
   - First ground leaves show symptoms; in favorable condition entire vegetative parts are killed within a day hence called ***blight.***

Management:

   - Foliar application of copper oxychloride @ 1.5 kg/ha through spaying
   - Spray Mencozeb 2.0 kg/ha.2-3 sprays at 15 days interval.

2. Early blight: ***Alternaria solani***
   - It occurs earlier than the late blight, so named ***early blight***
   - Concentric ring or ***'target board'*** appeared on leaf lamina is most characteristic symptoms, spots are irregularly distributed.
   - Spray Mencozeb @ 0.2%

3. Black scurf: ***Rhyzoctonia solani***

- **Symptoms: surface of tubers covered with black incrustations (Sclerotia of pathogen), growing tips of tuber sprouts are killed.**

4. **Wart:** ***Synchytrium endobioticum***
   - **Appearance of tumors or warts on tubers, stems** *and* **stolons.**
5. **Black heart: Due to oxygen starvation.**
6. **Scab:** ***Streptomyces scabies***

Seasart •

1. **Phyllody: My-coplasma**
   - **Transmitted by leaf hoppers**

Symptoms: Green leafy floral parts and profuse branching

Management: Spray Metasystox 1 ml/lit water.

Cottorb

1. **Bacterial blight/angular leaf spot/black arm:** *Xantomonas campestris* ***pv.malvacearum***
   - **Most serious disease of cotton in India**
   - **Angular and water soaked lesion on leaf & stem.**
   - **On the stem develops peripheral cracks called** ***'black arm'*****.**

Management:

- **Spray a mixer of Streptocyclin + Copper oxychloride 50 + 250 g/ha**
- **Seed treatment with Agrimycin**

2. **Tirak/bad opening of bolls: Physiological disorder**
   - **Premature defective opening of bolls & shedding of leaves**

Management:

- **Follow late sowing**
- **Apply extra water at flowering & fruiting in sandy soil.**

3. **Fusarium wilt:** ***F. monilliform*** **sp. vasinectum.**
4. **Stenosis/small leaf: Viral**
5.

Tomato

1. Late blight and early blight: Fungal disease.
    - Burnt like appearance on leaves

Management:

- Spray of Copper oxychloride @ 2 g/liter or Mencozeb @ 2g/liter
- Spray Bacteriomycin @ 0.2 g/liter of water

2. Leaf curl: Viral
    - Transmitted by white flies

    Management:

    - Acephate 1.5 ml/liter
    - Acetamiprid @ 60 g a.i. /ha
3. Blossom end rot: **Ca deficiency**
4. **Fruit cracking: Boron deficiency.**

Brinjail

1. Phomopsis blight/fruit rot: ***Phomopsis vexan***
    - Soft & watery soaked on fruit, blight on foliage, fruit rot
    - Seed treat with Carbendazim @ 1 g/kg of seed
    - Spray Bavistin 0.05 %
2. Little leaf of brinjal: **Mycoplama**

CorSiCEIra

1. Damping off: ***Pythium aphaniderntatum lphytoplahora sp.***
2. Anthracnose/ripe rot die back: ***Collectotrichum capsici***
3. Leaf curl: **Viral**
    - Downward cupping/curling of leaves
    - Transmitted by **thrips and aphids**
    - Managed by seed treatment with **Acetamiprid @** 45 gm a.i. /ha.
    - Spray of Acephate @ 1.5 ml/liter with Streptocyclin @ 0.15 gm/liter.

Crucifers

1. White blister same as **mustard**
2. Browning of cauliflower: **Boron deficiency**
   - Brown curd, hollow stem
   - Apply Borax @ 10-15 kg/ha in soil or spray 0.2%
3. Whiptail of cauliflower: **Mo deficiency**
   - Thick, green & leathery leaf and no curd formation.
   - Apply 1-2 kg sodium or aluminum molybdate
4. Club -root (finger & toe disease): ***Plasmodiphora brassicae***
   - Formed club -shaped roots.

Banana

1. Panama wilt: ***Fusarium oxysporium*** var. Cubans
2. Bunchy top: Virus
   - Vector is aphid: ***Pentalonia nigronervosa.***

Citrus

1. Citrus canker: ***Xanthomonas compestris*** p.v. ***citri***
   - Small brown corky outgrowths on leaves, twinges and fruits.
2. Die-back/wither tip: ***Collectotrichum gloeosporiodides***
3. Gummosis: ***Phytophthora palmivora***
   - Ruptured lengthwise bark, exudes gum
4. Greening disease: ***Candidatus Liberobacter***
   - a gram negative, walled phloem -colonizing bacteria is responsible for the destructive citrus -greening disease (earlier known as mycoplama disease).
   - In China called as **citrus Huanglongbing** (HLB) or **Yellow dragon disease.**
   - Transmitted by vector asian citrus psylla: ***Diaphorina curl***
   - Drench with Tetracycline @ 500 ppm

S. Tristeza: **viral**
   - Vector is aphids: ***Toxoptera citricida***

Important points:

- Father of nematology: H.C. Bastian.
- Father of American/modern nematology: N.A. Cobb
- Ilyperplasia (abnormal increase in the number of cells), symptoms formed b., ***Meloidogyne***
- Hypertrophy (abnormal increase in the size of cells of a tissue) these symptoms formed by: ***Heterodera***
- **Mentake** disease of rice is caused by: **Rice root nematode.**
- The entire names of nematode corrected by **Filipjev** 1936.
- Root lesion nematode, ***Pratylenchus coffee*** is a serious pest of coffee in S. India.
- Borrowing nematode ***Rodopholus sitnilis'*** cause severe damage to fruit crops, spices and it.s responsible for ***'spreading decline'*** of citrus in Florida.
- Citrus nematode cause 'slow **decline & die back** 'of citrus.
- Reniform nematode is as second important nematode of vegetables after root -knot.
- **Curvature** of nematode body rs always towards **ventral** side except in case of **Dorsella** which curved in a 'C' shape towards dorsal side.
- All the natural openings of nematode are situated in ventral **side**
- **Amphids:** Paired chemosensory organ, located near lip region.
- **Deirid:** are paired structures apposite to excretory pore and are **mechanoreceptors** in function.
- **Circulator),** and **respiratory** system are absent in nematodes. ***(JRF-2011)***
- Number of moulting in nematode generally four (it means nematode have four larval stages): ***JRF- 2011***
- In plant parasitic nematodes the first molt (J1) occurs within the eggs and **stylet** bearing 2" stage larvae (J2) are released.

- ***Anguina tritici*** undergoes **quiescent** in J2 for up to **28.32 Years.**
- **In *Ditylenchus dipsaii*** the **J4 (fourth)** stage undergoes quiescence.

  Majority of the plant pathogenic nematodes belong to class-***Secernentea.* and order *Tylenchida.***
- **In Tylenchids cuticle is marked with transverse** striation known **as *striae*** these are deep in criconematidae and called **spine/scale, and are useful** for taxonomic importance.
- Only hypodermis/Epidermis is **metabolic active** layer.
- In **tylenchids:** Present **stoma or baccal cavity or stylet,** hence tylenchids named **stomostylet,** it used for piercing into plant cells.
- Stomostylet developed from fusion of walls of **baccal cavity.**

  In some nematodes rectal glands **three in female** and **six in males** are present: they are responsible for production of **gelatinous matrix** in which eggs are laid. It is normall} feature of ***Dorylaintida*** but it has also been reported in ***Meloidogyne.***
- ***Aphelenchoides sp.*** associated with strawberry disease known as **'spring crimp'** and **'summer crimp'.**

  Root rots" cause on potato tuber by: ***Ditvlenchus destructor".***
- Lesion & necrosis:" caused by ***Pratylenchus & Rodopholus***

First journal of nematology in the world was: ***Nematologia***

Unit -1

Nematologv

Study of free living and plant pancAtic nematodes is known as ***nentatology.***

Nematode: It derived from two Creek worlds:

- *Nema* =- Thread
- *Oides* = ike

Means thread like organisms also known as **round worms** because round in cross section.

- Nematodes are **pseudocoelomate:** only ectoderm is linked with the mesoderm while it is not lined to endoderm or alimentary canal of nematode.

Unit -2
Helminthology

Study of nematodes which are **parasitic** exclusively on **man** and **domesticated animals** is known as ***Helminthology.***

***Animal* parasitic nematodes:**

SN	Nematode	Disease
1	*Placenta gigentissima*	It is largest APN Found in **whale fish**
2	*Dracunculus medineusis*	**Guinea worm,** cause Naru **bala'** disease in human
3	*Wucheraria bancrofii*	*Cause 'Elephantiasis'* or **Filariasis** disease in man. ***(JRF Erik) 41)*** The vector for **`Filariasis'** disease is ***Aedes agypti. (RPSC-A2,10-09)***
I 4	*Ascaris lumbricoides*	*Known as* **round worms,** intestinal parasite of human
5	*Enterobius vermicularis*	It causes severe itching in anal area particularly while childerens are sleeping.
6	*Onchocera volvulus*	It causes onchoce rciasis' or river blindness, commonly in Africa, transmitted by black fly. ***Sin:Whim sp.***

tinit -3
History of nematology

1594. **First time PPN mentioned by William Shakespeare** in his **'Love's Labor Lost'** act **IV**, Scene -3 and wrote in 'Sowed **cockles reaped no corn'.**

1743: **J.T. Needham:** discovered first PPN ***Anguina tritici*** and it was named as *'Vibrio* ***tritici***

1855: **Berkeley,** reported root knot nematode ***(Meloidogyne spp.)*** from roots of green house cucumber in England.

1857: **Kuhn** reported stem & bulb nematode ***Di0,1enchus dipsaii.***

1859: **Schacht, reported sugar** beet cyst nematode ***(Heterodera schachtii).***

1865: **H.C. Bastian, he** known as **Father of Nematology and wrote monograph of the *Anguillulidae***

1871: **Kuhn** first experimented CS_2 for control of Sugar beet cyst nematode.

1884: **J.G. Deman,** gave **"Biometry'** and taxonomic monograph **(Morphometry).**

1907: **N.A. Cobb,** known as **Father of American** (modern) **Nematology.**

1933: **Tom** Godey: He published two books.,

1. **Plant parasitic nematodes and disease they cause** in 1933.
2. **Soil and fresh water nematodes** in 1951.

1937: Chitwood & **Chitwood** wrote a book: ***An Introduction to Netnatology'.***

1943: **Carter** discovered nematicidal properties of **DD.** ***(JRF- 09)***

1945: Christie, discovered nematicidal properties of **EDB.**

1958: Hewitt, Raski and Goheen, first reported the **transmission** of viruse by nematode ***(Xiphinema index)*** transmitting .grape vine fan leaf virus disease in USA.

1961: G. Thorne wrote book *'Principle* ***of Nematoloe*** known as Bible of nematology).

History of Nematology in India:

1901: **Barber** first reported PPN **'root knot' (Meloidogyne)** infesting tea in Kerala.

1913: **Butler,** reported **Ufra"** disease of rice caused by ***Di671enchus angustus*** from Bengal.

1919: **Milne,** reported ***Anguina tritici*** (seed gall) of wheat in Punjab.

1936: **Dastur,** reported **white tip disease** of rice by ***Aphelenchoides besseyi'.***

1958: **Vasudeva** reported **Molya disease** of wheat ***(H. anenae)*** from **Neem ka Thana,** Sikar, Rajasthan, later by **Sesadhari (1959).**

1961: **Siddiqi,** reported **citrus nematode** from **UP (Aligarh).**

1961: FGW Jones reported potato cyst *(Globodera rostochiensis)* nematode from Nilgiri **(TN).**

1966: Division of Nematology established at **JAR!,** New **Delhi.**

1969: **Nematological Society of India** was founded at **IARI.**

1971: First time **Indian Journal of Nematology published.**

1977: All India Co-ordinate Research Project **(AICRP) on** Nematode pests of crops and their control started.

Unit -4
Classification of nematodes

- Phylum = **Nematoda**

Class: Two important classes: **Secernentia** and **Adenophorea.**

A. Secernentia: (phasmida)

- Phasmids present
- Caudal gland are absent

Class secernentia has two orders, namely tylenchida, aphelenchida.

1. Order: Tylenchida.

- **Tylenchida** is highly evolved & sedentary parasite in nature.
- It includes sub -order **tylenchina**

- Tylenchina is having super families of: Tylenchoidea, Haplaimoidea and Heterodoidea

a. **Tylenchoidea:**

Families: Tylenchidae (eg. *Tylenchus, Rotylenchulus)*

: Tylenchorhynichidae (eg. *Tylenchorhynchus)*

: Anguinidae (eg. *Anguina)*

b. **Haplolaimoidea:**

Families: Pratylenchidae (eg. *Pratylenchus)*

: Haploimidae (eg. *Haplolaimus)*

c. **Heterodoidea:**

Families: Heteroderidae (eg. *Heterodera, Globodera)*

: Meloidogynidae (eg. *Meloidogvne)*

B. **Class: Adenophorea (aphasmida).**

- Phasmids absent
- Caudal glands are present

1. **Order: Dorylaimida.**

Super family: Longidoroidea

Family: Longidoridae (e.g. *Longidorus)*

: Xiphinematidae (e.g. *Xiphinema)*

Super family: Trichodoroidea

Family: Trichodoridae (e.g. Trichodorus, Paratrichodorus)

Unit -5

Parasitism of nematodes

1. **Ectoparasite:** Living and feeding on a host from outside.
   - **Migratory** parasite eg. ***Xiphinema** (.1RF-2010), **Longidorus***
   - **Sedentary** e.g.: *Hemicychophoro.*
2. **Semi-endoparasite:**
   - Migratory e.g. *Haplolaimus, **Tylenchorhynchus.***
   - Sedentary e.g. ***Rotylenchulus, Tylenchulus.***
3. **Endoparasite: Enters the host tissue and feeds from within.**
   - **Migratory e.g. *Prtnylenchus, Rodopholus.***

- Sedentary e.g. ***Meloidogyne, Heterodera.***

4. Both Ecto and Endo parasite:

- Ditylenchus
- Aphelenchoides
- Anguina

Unit -6

Important plant parasitic nematodes:

1. Seed _alli **Par** uewatoue or wneat: *Anguma* ***tritici***
2. Tundu/ Sehu or yellow ear rot of wheat: ***Anguina*** + ***Clavibacter tritici.***
   : **(Yellow slime** or gum on leaves is major symptoms of Tundu)
3. Cereal cyst nematode: ***Heterodera avenae.***
4. Root knot nematode: ***Meloidogyne spp.***
5. Citrus nematode: ***Tylenchulus semipenetrans.***
   : (Formation of 6-10 cortical cells, known as **'nurse cells'** is specialized symptoms, cause slow decline or citrus decline of citrus).
6. Reniform (pulse) nematode: ***Rotylenchulus reniformis.***
7. Stem & bulb nematode: ***Ditylenchus dipaci.***
   : **('Onion bloat'** in onion is major symptoms of ***D. dipsaii)***
8. Stem nematode of rice: ***Ditylenchus angustus.***
   : (Cause **`Ufra disease'** of rice)
9. Potato root nematode: ***Ditylenchus destructor.***
10. Mushroom nematode: ***Ditylenchus mycelophagus.***
    : (it reported as **First mushroom** nematode)
11. Bud and leaf nematode (foliar): ***Aphelenchoides sp.***
    : Rice leaf or white tip nematode: ***Aphelenchoides*** *besseyL*
12. Coconut red ring nematode: ***Rhadenaphalenchus cocophilus.***
    : (Vector for this nematode is ***palm*** weevil: ***Rhyncophorus feruginonsis).***
13. Potato cyst nematode: ***Globodera rostochiensis.***

: (a characteristic symptom Syncytiunf is developed)

14. Root lesion nematode: ***Pratylenchus sp. (JRF-2011)***

: (also referred as 'Meadow' nematode)

15. Rice root nematode: ***Hirschnynniella sp.***

: Cause 'Mentek **disease'** of rice. ***(JRF-2011)***

16. Burrowing nematode: ***Rodopholus sp.***

: Infective stage: ***all***

17. Blackhead disease, rot root or rhizome root of banana: ***Rodopholus similis*** (also cause **'Yellow pepper'** disease in black pepper),

18. Spreading decline of citrus: ***Rodopholus citrophilus.***

19. False root knot nematode: ***Naccobus sp.***

20. Stunt or stylet nematode: ***Tyknchorhynchus sp.***

21. Ring nematode: ***Criconema sp.***

22. Pin nematode: ***Paratylenchus sp. (JRF-2011)***

23. Needle nematode: ***Longidorus sp. (JRF-2011)***

24. Dagger nematode: *Xiphinema index. (JRF 2011)*

25. Stubby **root: *Trichodorus sp.***

27. Lance nematode: *Haplolaimus sp.* ***(JRF- 2011)***

Unit -7
Common crop nematodes

1. Seed gall/ear cockle nematode: ***Anguina tritici***

First reported by J.T. Needham, 1743.

He called Vibrios; name *Angelina* given by Filipjev in 1936.

In India first reported by **Milne from Punjab in 1919.**

This nematode cause **epidemic in Bihar, IVEP where** the farmers burnt the standing crop of wheat.

This **nematode association** with a bacterium ***Clavibacter*** (Corynebacterium) ***tritici*** is caused **yellow ear rot** or **Tundu** disease of wheat.

vr **The seed galls have 3000-12000 second stage juveniles (J2) in a quiescent stage.**

1' It first feeds as **ectoparasitically &** after three moults it becomes **endoparasitic.**

.4 Some species of ***Anguina*** produces galls in leaf surface for e.g. ***A. tumafaciens*** on ***Cynodon transvalense.(JRF41).***

Symptoms:

- Seedling leaves are **twisted** and **crinkled.**
- Seedling may **stunted** and **die.**
- Plant show **profuse tellering** and infested plant produce ears almost 30-40 days before healthy plants.
- Finally seeds are replaced by ***galls.***
- The most important character of this nematode is the conversion of grains in to ***cockles or galls.***

Management:

- **Salt floatation: Use of 20 % salt** (brine) solution for washing of seeds is very effective control method.
- Hot water treatment: **54 °C for 10 minutes.**
- **Crop rotation** also useful method to escape infestation of nematode.
- **No resistant variety** of wheat are found against this nematodes

2. Cereal cyst nematode: ***Heterodera avenae***

.4 Cause **"Molya disease'** in wheat and barley.

- ***Heteros*** = different and ***deras*** = skin means different types of skin & **lemon shaped** female.

.4 Females have ***zig-zag pattern*** or lace like pattern on body known as ***cyst wall pattern.***

,7 **Cyst nematodes:** Includes genus, ***Heterodera*** and ***Globodera*** both have **unique character** of retention eggs & larvae within mature female body which turn into brown or black hard body after its death; that why known as ***cysts.***

- Pigeonpea cyst nematode ***(H. cajam)*** also infest other pulses

1 ***Heterodera oryzicola*** (paddy cyst nematode) serious pests of rice in Kerala, Orissa, Haryana in upland rice growing areas.

Damage:

- J2 is infective stage
- ETL = **3 eggs/g of soil.**

Management:

- Crop rotation with mustard, chick pea is effective control method.
- Deep ploughing is destroyed quiescent eggs of nematodes.
- Grow resistant varieties e.g. for wheat: **Raj MR -1**
- For barley: **RD 2052,** RD-2035and **Rajkiran.** ***(JRF-11)***

3. Potato cyst nematode: ***Globodera rostochiensis.***

- Golden nematode of potato first reported by **FGW Jones** in 1961 from Nilgiri Hills (TN).
  It feed pericycle cortex with results formation of nurse cells i.e. ***Syncytium*** develop which provides nutrients to female throughout development.

Management:

- **Legislative methods: Domestic quarantine** was introduced against **Globodera,** not carry infested potato tubers without phytosanitory certificate issued from **Nilgiri to other part** of country. ***(JRF-06)***
- **Resistant variety: Kufri swarna** is resistant to ***Globodera sp.***
- **Fumigants: Methyl bromide** exposer for 5-6 hrs.

4. Root -knot nematode: ***Meloidogyne spp.***

Means **melon or apple** shaped female.

First reported by **Barkley 1855** from **cucumber.**

- In India it reported b) **Barber in 1901** on tea (Kerala).
  In meloidogyne the ***Perineal pattern*** present on **vulva -anus area** which is helpful in **species identification** ***(JRF-07)***

1 Eggs lay in gelatinous matrix (200-500 eggs).

V Sex **differentiates** in late second juvenile stage (J2).where the genital primordial is 'V' shaped in female and shaped in male.

1 Second -stage juvenile (J2) is infective stage in Meloidogyne. ***(JRF -11)***

1 *'Spike tail'* in Meloidogyne: it is succeeding moulting of second, third avw-i Li stage juveniles ot *Meloidogyne spp.*

1 ***Sexual reversal:*** In ***Meloidogyne*** some time under adverse conditions male changed in to female.

Classification:

- ***M. incognita:*** Present throughout India **on vegetables.**
- ***M. exigua:*** **Found on coffee in Karnataka.**
- ***M. hapla:*** **Restricted to temperate parts (on hilly** area).
- ***M. arenaria:*** It is a serious pest of **ground nut** in Gujarat. ***(JRF-11)***
- ***M. brevicauda:*** Found on tea in Assam
- ***M. graminicola:*** Found on rice in eastern part of country ***(JRF-2010)***

Symptoms:

- The reaction to the entrance of the larvae is the development of ***hypertrophy*** (enlargement of cell size) of cortical cells and formed *'Giant cell* from which it derives food.
- Nematode secrete protease enzyme results break down protein into amino acid **(tryptophan)** which is a **'precursor of IAA'** is important and responsible for creating hormonal imbalance at site of reaction. Due to excess IAA formation at feeding site cause ***gall/knot*** on **roots.**

n;ffpr,-•nise between **root knot** and **rhizobium nodules:**

Root knot	_Rhizobium nodules
In case of meloidogyne infestation root knots are hard in consistency and deep seated They don't easily rubbed off	Rhizobium nodules are spongy consistency, found along side of roots as side appendages Soft and can be easily detached from roots

Management:

- Deep ploughing.

Grow resistant varieties:

- For tomato **Hissar !alit, SL- 120**

- For brinjal: **Black beauty, Neelkantha.**
- For: chilli: **Pusa jwala.**

Biological control of *Meloidogyne:*

- Fungus: ***Paecilomyces lilaeinus***
- Bacteria: ***Pasteuria penetrans***
- Both have been reported as promising biocontrol agent.
- ***Bt. Kurstaki:*** also effective against *Meloidogyne spp.*

5. Citrus nematode: ***Tylenckulus semipenetrans***

Reported by **Cobb** 1912 (USA).

- In India by Siddiqui 1961 (UP).

At feeding site formed *6-10* ***nurse cells. (JRF-11)***

Cortical feeder as sedentary semi-endoparastic.

Symptoms:

- Slow decline/citrus decline and die back. ***(JRF -2011)***

6. Reniform nematode: ***Rotylenchulus reniformis***

- Mature female is **'Kidney shaped'.**

Reported by **Linford** and **Oliveria** from USA in 1940.

- In India by **Seshadhari & Shivkumar** 1963 on cotton.

Two races:

- **Race 'A':** Multiply on cow pea, castor & cotton.
- **Race 'B':** Reproduces only on cowpea. ***(JRF-11)***

7. Stunt or stylet nematode: ***Tylenchorhynchus spp.***

Migratory semi-endoparasite

- ***Tylenchorhynchus brassicae:*** Feeds on **Cruciferae.**
- ***T. brevilineatus:*** Cause **`Kalahasti disease'** in ground nut in **AP.**
- ***T. vulgaris:*** Feeds on **cereals.**
- ***T claytoni:*** **Known** as **'tobacco stunt'** nematode.

8. Stem & bulb nematode: ***Diolenchus sp.***

- ***Nemawool:*** A frothy substances secreted through saliva of pre adult (.14) nematode responsible for quiescent in ***Ditylenchus.***

a. Rice stern nematode: ***Ditylenchus angustus***

v **In India only** ***D. angustus*** is reported.

- It is reported by **Butler, 1913**

1 It causes **`Ufra'** disease

Infestation mainly in deep water paddy.

Symptoms:

- **Twisting of leaf &** leaf sheath.
- The symptoms of **Ufra** are well noticed in **two months old crops.**

b. Stem and bulb nematode: ***Ditylenchus dipsaii***

V By infestation of this nematode onion suffers heavy losses as it cause **"onion bloat"** disease.

c. Potato rot nematode: ***Ditylenchus destructor***

It found in temperate region of Europe & N. America

Cause **'rots'** on potato roots.

d. Mushroom nematode: ***Ditylenchus myceliophagus***

This nematode was first reported that to cause damage on **mushroom**

It is also found in India.

Leaf and bud nematode: ***Aphelenthoides sp.***

Also known as **foliar nematode**

a. White tip or rice leaf nematode: ***Aphelenchoides besseyi***

This nematode associated with **serious epidemic of rice in MP.**

- It feed **actoparasitically**
- Humidity favors infestation.
- This is **seed borne** nematode

b. Chrysanthemum/foliar nematode: ***Aphelenchoides ritzemabosi***

Known as **Spring crimp** or straw berry nematode

c. ***Aphelenchoides composticola:***

- Important nematode of mushroom and known as mycophauus nematode

10. Red ring nematode: ***Rhadinaphelenchus cocophilus***

,f Cause serious disease of coconut palm is called 'red -ring'.

This nematode is transmitted mechanically through palm weevil, ***Rhynocophorus palmarum.***

11. Root lesion nematode: ***PraVlenchus sp.***

- Also referred as **'Meadow nematode'.**

12. Rice root nematode: *Hirschrmunniella sp.*

This nematode responsible for causing **`Mantek'** disease of rice in 1949

I **Infective stage: all Juveniles (J) and** adult also. ***(JRF-2011)***

- It can be managed by soil treatment of Carbofuran @ 4kg a.i/ha before sow ing.

13. Burrowing nematode: ***Rodopholus sp.***

a. Root and rhizome rot of banana : ***Rodopholus similis***

It is commonly found in India.

Other names are 'banana **decline' and 'black head disease** 'of banana.

- This nematode also helpful in causing **panama wilt** of banana in association with fungus ***Fusarium oxysporium*** var. ***cube use***

It is caused 'Yellow **disease'** of pepper.

b. *Rodopholus citrophilus:*

Responsible for causing 'spreading **decline'** of citrus in Florida, USA

14. False root knot nematode: ***Naccobus sp. (JRF-11)***

Develops **hypertrophy**

15. Ring nematode: ***Criconema sp.***

It has large annuli.

16. Pin nematode: ***Paratylenchus sp.***

This is **smallest** plant parasitic nematode with size of < 0.5 MM.

17. Dagger nematode: ***Xiphinema sp.***

- Presence of characteristic **sword** like stylet

It transmit ***fan* leaf virus** of grape virus.

Unit -8

Management of nematodes

1. Chemical control:

A. ,Fumigants: e.g. DD- a mixture of dichloropropane and dicbloropropene, EDB-ethylene dibromide. MBr-methyl bromide, Nemagone (DBCP dibromocbloropropane)

B. Non -fumigants: are grouped in to:-

(I) **Carbamates:-** Aldicarb (Tern 1k), Carbofuran (Furadan), 0\y myl (Vydate), Metharn sodium (Vapam).

(ii) **Organophosphate:-Thionazin** (Nemaphos),Phorate (Thimet), Phenamiphos (Nemacur)

2. **Physical control:** Use of Heat, hot water treatment (54 C for 10-15 min.) irradiation, Osmatic pressure and ultrasonic.
3. **Regulatory methods:** such as adoption of legestive quarantine regulations e.g. potato tubers used as seed materials restricted use from Nilgiri hills (TN) to other part of country.
4. **Biological control:** ***Fungus-Paecilomyces*** *lilacinus (Oviparusite). Bacteria: Pus/curia penetrans (larval parasite:).*
5. **Cultural methods:**

a. **Crop rotation: It** is effective for ***Molya disease*** control by orowino of mustard and gram.

b. **Trap/Antagonistic crop:**

Mustard: contains Ally, isothioc)nate toxic for **cyst** nematode.

Marigold: contains **a- terthienyl,** reduce population *of Paralvlenchus, Rotylenchulus*, and *Meloidogyne spp.*

c. Flooding: kills nematode by asphyxiation.

d. Propogation through healthy planting material.

e. Soil solarization: in summer it is effective by 2-3 cross deep ploughing or use of plastic sheet for solarization.

Unit -9

EPN (Entomopathogenic nematode):

- Nematode families of Steirnematidae. heterorhabditidae have potential as biocontrol agents. Because these are ***Entontopalhogenic*** *nematode* and are facultative parasites they associated with symbiotic bacteria eg. [he *Xenorhabihrs* *bacteria* associated with ***Steinernema*** and the ***Photorhabdus bacteria*** *is associated with nematode* ***Heterorhabditid.***

- Eg. ***Heterorhabditis indicus*** used against ***Holotrichia serrata.***

EPN Products:

- In India a commercially formulation *"Ecomax"* is available, it's prepared from nematode ***S. carpocapsae*** and ***H. bacteriophora.***
- The product of ***Neoplectana carpocapsae*** with bactria ***Achromobacter nematophilus*** is commonly named as **DD-136.** It is also available in several labs under the Trade name of ***'Black Commando'.***

Unit -10

Virus vector nematodes

I. NEPO viruses: Nematode -transmitted Polyhedral viruses.

- Tomato black ring (TBR): ***Longidorus sp.***
- Raspberry ring spot: ***Longidorus elogatus***
- Grapevine fan leaf ***(JRF-07): Xiphinema index.***
- Tobacco/tomato'ring spot: ***Xiphinema americana***

2. **NETO: Tobraviruses:**

- Tobacco rattle virus: ***Trichodoras similis. (JRF-04)***
- Pea early browning: ***Trichodorus sp.***

Unit -11

Some terms

Mesentron of nematodes:

- **Initima** (cuticular lining) is absent and line finger like projection known as **microvilli** present around lumen.
- Microvilli **increases the surface area** of intestine and'are both secretary & absorptive in function.

Cloaca:

- It provides structure like spicules, gubernaculums (both are skelerotized plates). In male these copulatory structure are used for open the vulva to transfer of sperm.

Female ovaries:

- **Monodelphic:** Only one ovary is functionally.
- **Didelphic:** Two ovaries are functionally.

Male testis:

- **Monorchic:** Only one testis is present
- **Diorchic:** Two testes are present.

Voltinisms: refers to number of generations in a year

1. **Multivoltine nematodes:** many generations are completed in a year. Examples are: ***Meloidogyne, Pratylenchus, Rotylenchulus and Tylenchulus sp.***
2. **Univoltine:** only one generation is completed in a year. e.g. ***Anguina* tritici** and In ***Heterodera:*** only ***Heterodera avenae*** is univoltine.

Important points:

V Father of plant tissue culture: ***G. Haber land***

1 Father of Botany: ***Theophrastus***

Father of Zoology: ***Aristotle***

Father of Genetics: ***G.J. Mendel***

The longest mitotic phase is: ***Prophase***

Segregation occurs during: ***Meiosis only***

The most abundant form of RNA is known as: ***t- RNA (80%)***

Bacteriophages are: ***Single strain DNA (virus)***

In mitochondria found **only 70** s types of: ***Ribosomes***

Alternative form of a gene is known as: ***Allele***

• Tift 60 is an important source of male sterity in: ***Sorghum***

Often cross pollinated crops are: ***Cotton, sorghum***

The theory of inheritance was proposed by: ***G. Mendel***

The shortest phase of all the mitosis phase is: ***Anaphase***

The site of protein synthesis is: ***Ribosome***

Physical basis of life is: ***Protoplasm***

Onion is a modified form of: ***Leaf***

Onion & garlic are example **of:** ***Bulb***

Edible part of apple: ***Thalamus***

Edible part of mango: ***Mesocarp***

Edible part of coconut: ***Endosperm***

An agent that causes gene mutation mutation is called as: ***Mutagen***

,(Most mutant tolerant are: **Polyploids**

Characters which express in one sex only is: ***Sex limited traits***

•⁄ RNA synthesis is in which organ: ***Nucleolus***

V The inflorescence of banana is known as: ***Spud&***

The theory of natural selection was proposed **by:*****Charles Darwin***

The theory of acquired characteristics was proposed by: ***Lamarck***

Single gene affecting more than one character is known as: ***Pleiotropy***

Garlic & turmeric are examples of modified stem of: ***Rhizome***

The structure of chromosome can be best observed during: ***Metaphase***

- Ribosomes are small cellular particles which are the sites of: ***Protein synthesis***

Closest form of inbreeding possible in self- incompatible sp. is: ***Sib- mating***

•(Physical chromosomal exchange (crossing over) takes place in: ***Pachytene***

- Re -discovery of Mendel laws in 1900 by: ***de Vries, Carl Correns & tschemark***

.7 **Only about 0.1%** of the induced mutations are useful in crop improvement.

- The enzymes associated with Krebs cycle are also present in the: ***Matrix***

Life was first originated in water the theory of genes in the chromosomes was introduced by: ***Morgan***

1' **In 1944,** Avery, Mac Leod and McCarty demonstrated that DNA was the genetic material.

I In CAM plants transpiration is negligible since stomata are closed during the day.

1 Examples of prokaryotes: *cells of* ***Mycoplama, Bacteria and Blue green algae.***

1 Cytoplasm: includes all the structures of outside the nucleus.

1 Protoplasm: ***Cytoplasm + Nucleus.***

Centrosome is present only in animal cell.

1 Openings are left at plants between the adjacent cells known as ***plasmodesma*** and thread like lining between two cells is known as ***Plasmodesmata.***

v A common crop of natural auto-tetraploids grown in India *is:* ***Potato***

Cell wall of fungi is chiefly made up of: ***Chitin***

Plant showing less than 5% cross pollination is considered as: ***Self pollinated***

- A variety resistant to more than one race of pathogen is due to: ***Horizontal resistance***

1 Type of male sterility used in hybrid seed production in pearl millet: ***Cytoplasmic genetic male sterility***

V An individual having both male and female reproductive organs is known as: ***Hermaphrodite***

1 Aseptic conditions means: ***Pathogen free environment***

In 1900, potato moth ***(Phthorimaea operculella)*** came in to India from: ***Italy***

- ***Pedigree:*** record of ancestry of an individual selected plant for its various generations

1 The study of interactions between antigens and antibodies is called: ***Serology***

1 Transfer of genetic material from one cell to another cell by means of viral vector: ***Transduction***

- NaOH test used for testing the: Karnal bunt disease of wheat.

▪ **PCR techniques provides: Several copies of specific DNA sequence**

Science of identifying the sequence of DNA in species: *Genomics*.

1 The lines are homozygous and homogenous in nature called *as: Pure line*

1 Autotriploidy found in: *Banana*

1 If the development of fruit without fertilization the process called: *Parthenocapry*

I Repeated crossing of hybrid progeny back to one of its parents called: *Back cross*

The *Tifi 23-A* and *Kafir- 60* are the important sources of male sterility in pearl millet and sorghum respectively.

Ethidium bromide has been found effective in inducing cytoplasmic male sterility in pearl millet and barley.

sN	Organ	Discovered/Named by
1	Living cell	Antony von Leeuwenhoek 1723
2	Cell wall	Robert Hook, 1665
	Nucleus	Robert Brown, 1851
	Nucleolus	Fontana, 1781, seen nucleolus But termed by Bowman, 1840
	Cell theory	Scheleiden & Schvvann 1839
6	Mitotic cell division	Fleming 1879
7	Meosis	described by van Beneden in 1883
8	Plasmodesmata	E. Strasburger, 1901
9	Protoplasm	J. E. Purkinje 1840
10	Protoplast	Hanstein, 1880
11	Plasmalemma	J.Q. Plowe 1931
12	Unit membrane concept of cell membrane	David Robertson 1962
13	Fluid mosaic model	Singer & Nicholson, 1972
14	Endoplasmic reticulum	K. R. Porter, 1945
15	Plastid	E. Haeckel, 1865
16	Ch lorop last	A.F.W. Schimper
17	Mitochondria	C. Benda, 1867
18	Golei body	Camilo Golei
19	RNA discovered by	Palade 1955
20	Ribosome	First time reported by Palade 1953 But named by Haguenau in 1958)
21	Lysosomes	De Duve
22	Centrosome	T. Boveri
23	Chromosome, observed by	E. Strasburger, 1875
24	Term chromosomes given by	Waldeyer, 1888
25	Double helical structure of DNA was given by	Watson & Crick 1953
26	Re ,mbinant DNA technology/DNA sequencing	Berg, Gilbert & Anger

27	Term linkage & sex determination	Batson --
28	Linkage theory	**T.H.** Morgan in 1910
29	Term pure line, phenotype & genotype	W. Johannsen
30	Chromosomal theory of heredity	T. Morgan
31	X-ray as physical mutant by	Muller
32	Bacterial transformation	Avery, Mac leod & McCarty
33	First inter -specific cross was made by	Thomas Fairchild
34	Centers of origin were first given by	Vavilon
35	Term heterosis was coined by	Shu11,1914
36	RNA was first synthesized by	S. Ochoa in 1969
37	The term genetics was coined by	W. Bateson
38	One Gene one Enzyme Hypothesis	Beadle and Tatum in 1914
39	Operon Hypothesis	Jacob and Monod in 1961
40	Mutation first defined by	Hugo de vries

Pre-mendelian heredity theories:

- Theory of **Epigenesis:** ***Wolf, 1738-94***
  Theory of acquired character: ***Lamarck, 1744***
- ./ Theory of pangenesis: ***C'. Darwin, 1809***
- */ Germ plasm theory: ***Weisman, 1889***
  Chromosomal theory of inheritance: ***Sutton & Boveri, 1903***

Organism used in genetics:

- Bacteria: ***E. coli***
- Fungi: ***Neurospora crassa***
- Insect: ***Drosophila melongester***
- Plant: ***Maize, Pea***

Unit -1
The Cell

Cell: is the structural and functional unit of all living organisms, except ***viruses.***

The size of cells:

- The smallest cell size ranges from 0.2 to 5.0 µ (microns) in bacteria to up to largest 75 mm in the case of ostrich eggs.

Cell Structure:

1. Cell wall:

- Plant cells are surrounded by a ***nonliving*** and rigid coat called cell wall. It secreted & maintained by protoplasm.
- The main functions of cell walls are to provide plant cells a definite shape, mechanical support and strength to tissues and organs.

Cell wall is differentiated into three parts:

a. Middle Lamella: The walls of immediate neighbour cells are joined by middle lamella. This is composed mainly of ***pectin*** (mainly in the form of Ca^{2+} & Mg2 salts).

b. *Primary cell wall:* It is deposited after the formation of middle lamella. Its main constituents are ***hemicelluloses*** (53 %) and cellulose (30 %). Cells in meristematic tissues contain only' primary cell wall.

c. ***Secondary cell wall:*** It is the inner most layer of wall. It composed mainly of ***cellulose.***

2. **Plasma lemma or cell membrane:**

- The membrane enclosing cytoplasm of a cell is known as *plasma lemma or plasma membrane.*
- It composed of lipid (60 cY0) and proteins (40 %).
- It acts as a permeability barrier, and acts as vehicle for the transport of substances from one organelle to another.

3. **Cytoplasm:**

- The substances, except nucleus, surrounded by the plasma ° lemma is known as ***cytoplasm.***

It may contain the following structures:-

a. **Endoplasmic Reticulum:** An extensive network of membrane.. enclosed spaces are known as *endoplasmic reticulum* (ER).

- ER is not found in RBCs, eggs or embryonic cell and prokaryotic cells.
- ER is grouped in to two categories:

(i) ***Smooth ER:*** Both outer and inner are regular and smooth. No protein synthesis is takes place in smooth ER. It provides the structural base for synthesis of certain type of steroids i.e. ***Cholesterol, progesterone*** *and* ***testosterone.***

(ii) ***Rough ER:*** The outer surfaces of membranes have a rough appearance due to the attachment of ribosomes. The rough ER is mainly composed of cisterns and is found in cells actively involved in **protein synthesis.**

Functions:

- It provides the structural base for synthesis of protein
- Provides channel for the transport of materials among cell organelles.

b. **Ribosomes:** These are particles of about 200 A in diameter and are composed of RNA and protein.

- Ribosomes are synthesized and assembled in ***nucleolus.***
- Ribosomes are site *of protein* ***synthesis.***

On the basis of their sedimentation ribosomes are classified in to:-

(i) ***80 S sizes:*** In plants, they dissociate into **60 *S*** and **40 *S*** subunits.

(ii)70 ***S size:*** They are made up of **50** *S* and **30** *S* subunits (Found in mitochondria and plastid).

Structural differences between eukaryotic and prokaryotic cells

SN	Eukaryotic cells	Prokaryotic cells
1	All membrane -bound structures eg. ER, Mitochondria, Golgi bodies, Lysosomes,, Vacuoles etc. are present.	All membrane bound structures are absent.
	True nucleus is present	Nucleus lacks nuclear membrane
	Nucleolus is present in the nucleus	Nucleolus is absent

4	Both 70 *S* and 80 *S* ribosomes are present	**Only 70** S type of ribosomes are present
5	Cytoplasm has microtubules	Cytoplasm doesn't have any microtubules
6	Eg. Cells of higher plants and animals	Eg. Bacterial cells, fungi etc.

c. **Golgi body: Also** called ***endomembrane system*** because it associated with ER & Lysosomes. Provides site of synthesis of lytic enzymes and supports cell wall formation.

d. **Lysosomes:** Produced from the Golgi complex and are site of hydrolytic enzymes (mainly ***acid phosphatise).*** Lysosomes common in animal cell but also present in plant cell. Main function of Lysosomes is autolysis; known as ***suicidal bags*** (digest cell itself).

e. **Peroxisome:** Mainly occur in photosynthesing cells of higher plants and concerned with *glycolate metabolism* or ***photorespiration*** of C_3 plants.

f. Spherosomes: These are site of hydrolytic enzymes and are found in plant cells only; they don't occur in animal cells. Contains upto 98 % lipid; their function may be in *lipid storage*.

g. **Glyoxysomes:** Concerned with ***glyoxylate metabolism*** and help in conversion of lipids of germinating seeds into carbohydrates.

h. **Vacuole: plant** cells have one or more vacuoles of variable size. It contains cell sap and large part of cytoplasm upto 90 % is occupied by a large vacuole. Vacuoles are surrounded by a unit membrane; the membrane is referred to as ***tonoplast.***

i. **Centriole:** these are confined to animal cells. And aren't found in plant cells.

4. Mitochondria:

- These are site of **krebs cycle** and **electron transport chain.**
- Originated by fusion of pre-existing mitochondria. An average cell may have 200 to 800 mitochondria.
- Mitochondria are surrounded tty two concentric unit membranes; named outer membrane and inner membrane.

- The respiratory complex contains three large enzyme complexes (i.e. NADH dehydrogenase complex, b -c l complex and cytochromes oxidase complex) these enzyme complexes are embedded in the inner membrane.
- The infolds of inner membrane are known as ***crystae***
- The crystae grei..ly increase the area of inner membrane and have oxysomes known as electron transport particles (ETP).
- The space on the inside of the inner membrane is known as ***matrix.*** It contains a variety of transport proteins that make it selectively permeable to molecules metabolized in the matrix. In addition to proteins it carries out the oxidation reactions of respiratory chain, i.e. the electron transport chain and ATP synthesis in the matrix. The respiratory chain carries out oxidative phosphorylation that generates most of the ATP in the animal cells, so it named as ***power house of cell.***

5. **Chloroplasts:**
   - Actual **site of photosynthesis.**
   - Chloroplast contains ***chlorophyll*** which imparts the characteristic green colour to plants.
   - The membrane free space enclosed by membranes of chloroplast is referred to as ***stroma.***
   - Within the stroma are embedded about 40-80 ***grana.*** Each granum contains 5-25 flat cisternae stacked on top of each other are called ***thylakoids.*** It has quantosome with 250-300 photosynthetic units.

In addition to chloroplast, plant cells contain two more type of plastids called as:

a. **Leucoplasts;** are colour less plastid and function in the storage of starch, protein and fats.
b. **Chromoplasts;** contain pigments other than chlorophyll e.g., phycocyanin, phucoxanthin etc.

6. **Nucleus:**
   - Nucleus contains ***chromosomes*** which control functions of cell by having almost all the genetic information of a cell.

- It produces ribosomes, tRNA, mRNA, and certain other RNAs.

Unit -2

Cell division

- The process of formation of new cells from the pre-existing cells is referred to as **cell division.**

Two types:

1. **Mitosis:**
   - Cell division in which one cell gives rise to two cells of genetically identical to the cell which produced them eg. occurrence in somatic cells responsible for vegetative growth.
2. **Meiosis:**
   - Cell division in which one cell with two set of chromosomes gives rise to four cells with one set of chromosomes each eg. its occurrence in **gamete formation** and responsible for sexual reproduction.

1. **Mitosis:**
   - It is the process by which a cell divides into two daughter cells, each having a nucleus with sets of chromosomes exactly identical to the parent cell.

Cell cycle:

- Divided in to **Interphase, Mitosis** and **Cytokinesis.**

A. Interphase:

It is the **longest** stage of cell cycle.
Further divided into three sub stages.

a. G1(first gap):
   - Pre -DNA replication phase
   - Protein & RNA synthesis takes place

b. S **(synthesis, DNA):**
   - DNA synthesis takes place

c. 6 2 (second gap):
   - Post -DNA replication phase
   - **RNA & protein particularly** component of microtubules synthesis.

B. Mitotic phase:

a. Prophase:

- In mitotic cell division small sub units of prophase are absent.
- Appearance of definite thread -like structures in nuclei.
- Chromosomes become condensed.

b. Metaphase:

- Disappearance of nucleolus.
- Appearance of spindle apparatus.
- Chromosomes arranged in *equatorial plate*.
- a Shortest and thickest state of chromosomes.
- Chromosomes are clearly visible at metaphase.

c. Anaphase:

- Chromatids separate at centrosomes and move towards opposite sides.
- *Smallest* form of mitosis.

d. Telophase:

- Nucleolus reappears.

C. Cytokinesis:

•7 It is complete by the end of Telophase.
At the equatorial plate, membranous elements of ER and products of Golgi bodies organize into the phragmoplast gives rise to cell plate and subsequently to middle lamella.

2. Meiosis:

- Meiotic cell division was first described by van Beneden in 1883 in the round worm.
- Meiotic division of one somatic (2n) cell gives rise to four haploid (n) daughter cells.
  The reduction in chromosomes number of the daughter cells is mainly due to a single S phase followed by two successive nuclear divisions.

I Hence, during meiosis chromosomes replicate only once. while the nuclei divide twice.

I **Meiosis** takes place during gamete/spore formation. Therefore it is confined to reproductive cells.

First meiotic division:

1 **Results** in reduction of chromosomes numbers to just half of the mother cell

1 It is also referred to as ***reductional division***

1 It consists of four different phases as:

A. First prophase:

- This stage is the longest in duration and divided into **five sub stages.**

a. **Laptotene:**

- Chromosome condensation so that they visible as fine threads.
- RNA synthesis

b. **Zygotene:**

- The main event is ***synapsis;*** pairing between homologous chromosomes.

c. **Pachytene:**

- The main events that occur during Pachytene are as follows.

(i) ***Bivalent:*** Haploid (n) pair of chromosomes

(ii) ***Tetrad:*** Each bivalent has four chromatids as strands, hence bivalents are said to be in four strand or ***tetrad stage.***

(iii)Crossing ***over:*** Interchange of parts between non sisters chromatids of chromosomes during meiotic prophase.

d. **Diplotene:** in this stage occurs chaismata.

- ***Chaismata:*** attachment of homologous chromosomes to each other.

e. Diakinensis:

- It begins after complete termilization of chaismata.

Unit -3

Chromosome: structure and function

- V Chromosomes were first described by Strausberger in 1875.
- V The term chromosome was first used by Waldeyer in 1888.
- V Chromosomes number can be counted with relative case onh during mitotic metaphase.

Somatic chromosomes numbers of common plants and animals:

S N	common name	Botanical name	Chromosome number
1	**Plants**		
	Barley	*Hordeum vulgare*	*14*
	Tomato	*Lycopersicon esculentum*	24
	Onion	*Allium cepa*	16
	Tobacco	*Nicotiana tabacum*	48
	Rice	*Oryza sativa*	24
	Bajra	*Pennisetum americanum*	14
	Pea	*Pisum sativum*	14
	Rye	*Secale cereale*	14
	Potato	*Solanum tuberosum*	48
	Jowar	*Sorghum bicolor*	20
	Maize	*Zea mays*	*20*
2	**Animals**		
	Honey bee	*Apis mellifera*	32
	Roundworm/ Horse neinatode	*Ascaris megalocephala Univale/* Parascaris equorum	2
	Fruit fly	*Drosophila melanogaster*	8
	Man	*Homo sapiens*	46
	House fly	*Alusca domestica*	12
	Rat	*Rat/us norvegicus*	4/

Genetic materials:

1. **Chromatin:** It is composed of DNA, protein and RNA.
2. **Histones:** Constitute about 80 % of the total chromosomal proteins.
3. **Chromosomes:** Composed of nucleic acid (DNA or RNA)

4. **Nucleic acid:** Contains many nucleotides
5. **Nucleotides:** It consist of nucleoside and phosphoric acid.
6. **Nucleoside:** Contains sugar + nitrogenous base
7. **Nitrogenous base:** Two types Purine (A, G) and pyramidene (T, C or **Uracil** in RNA).

1. **RNA (Ribose Nucleic Acid):**
   - **It** is found in cytoplasm as well as in nucleus.
   - It is generally involved in protein synthesis and act as genetic material for all plants viruses (e.g.TMV contains ss-RNA) except cauliflower mosaic viruses which contain ds-DNA.

Types of RNA:

a. Messenger RNA (m-RNA):
- It carries the genetic information present in the DNA.
- Forms about 5-10% of the total RNA present in Cell.

b. Transfer RNA (t -RNA):
- Also known as soluble RNA (s -RNA)
- It carries amino acids to the site of protein synthesis.
- It forms 10-15% of total RNA present in cell.

c. **Ribosomal RNA (r-RNA):**
- Most stable type of RNA and is found associated with ribosome.
- It forms about 80% of the total cell RNA.

2. **DNA (De-oxy ribose Nucleic Acid):**
   - It is a double stranded helix made up from many nucleotides.
   - DNA is present in nucleus, mitochondria and chloroplast.
   - It encode genetic information, serve as the template for DNA replication and transcription.

Unit -4
Chromosomal aberration

- Any change which alters the normal structure of a chromosome is known as structural chromosomal aberration.

Types of structural changes:

a. Deletion (deficiency):

- Loss of a segment of a chromosome.
- It plays an important role in species formation and releasing variability through mutations.
- Deletions are important cytological tools for mapping genes.

b. **Duplication (repeat):**

- A chromosome segment present in more than two copies in the same nucleus.
- It results in addition of one or more genes to a chromosome.
- Duplications are less harmful than detection.
- They don't reduce the viability of an individual
- Duplications lead to addition of some genes in population.

c. **Translocation:**

- One way or reciprocal transfer of segments between non homologous chromosomes is known as translocation.
- Translocation alters the chromosome size, chromosome number thus play important role in the formation of species
- They are useful tools in breeding programmes for transfer of **desirable characters** from one species to another.
- **Phenotype effect** of translocation in *human Down syndrome* **(Mongolism)** can arise in the progeny of an individual heterozygous for a translocation involving chromosomes number **21.**

d. Inversion:

- It refers to structural change in a chromosome in which a segment is oriented in a reverse order.
- Gene order is changed in the inverted segment of a chromosome.

Unit -5

Genome

- A basic or monoploid set of chromosomes of an individual is called **genome.**

Monoploid:

- Contains a single chromosome set and are characteristically sterile.
- A monoploid can be haploid but all haploid can't be monoploid.

Haploid: Single set of chromosomes (denotes by 'n')

Uses **of haploids:**

- Used for development of pure lines
  Disease resistance
- Development of inbred lines and
1 Production of aneuploid

Polyploidy:

- Presence of more than two genomes in an individual is known as polyploidy.
- It is of two types:

1. **Auto polyploidy:**

   If all the genomes present in an individual are identical, it is called ***autopolyploid.***

   In many species, auto polyploids show an increase in vigour and size this phenomenon is known as' ***gigantism.***

   I It includes auto triploids (3X), tetraploids (4X), penta (5X) and other polyploidy.

a. **Autotriploids:**

- Having three set of homologues chromosomes.
- Autotriploids are generally ***highly sterile*** due to defective gamete formation. But triploids of some species are **highly fertile** eg. spinach *(Spinacea aleracea).*
- Triploids are useful only in those plant species which propagate asexually like **banana, sugarcane,** and **apple.**

(i) Banana: Mostly cultivated varieties of banana are triploids and seedless.

(ii)Water **melons:** The **triploid** water melons are seedless and have been commercially grown in Japan.

(iii) **Sugar beets:** produce larger roots and more sugar contents than diploids.

b. Autotetraploids:

- They have **four copies** of the same species.
- Tetraploids are usually very stable and fertile because pairing partners are available during meiosis.
- E.g. Rye, **grasses,** alfalfa, berseem (var. Pusa giant), groundnut and **potato** are well known example of autotetraploids.

2. **Allopolyploidy:**

- Allopolyploids contain two or more distinct genomes, which are derived from different species.
- Allopolyploidy can be developed by interspecific crosses and fertility is restored by chromosome doubling with **colchicine** treatment.
- It found in about **50 %** of crop plants.
- Polyploidy is mainly induced treatment with a chemical known as ***Colchicine.***
- Examples of Polyploids i.e. wheat; the common bread wheat ***(T. aestivum)*** is an ***allohexaploid*** and tobacco, brassica, cotton etc, are ***allotetraploid.***

3. **Aneuploids:** a loss or gain of one or few chromosomes as compared to the somatic chromosome number of a species is known as *aneuploidy.*

Aneuploids are following types:

a. **Monosomic:**

- An individual lacking one chromosome from a diploid set is called ***monosomic*** and this condition is known as *monosomy.*
- Monosomic = ***2n — 1***
- Double monosomic = ***2n -1* - 1**

b. Nullisomic:

- The absence of a chromosomes pair from a diploid set is termed as ***nullisomic.***
- Nullisomics = ***2n* - 2**

e. **Trisomics:**

- **An individual having one extra chromosome in the diploid set of chromosomes known as *trisomics*.**
- **Trisomic = 2n + 1**

f. Tetrasomics:

- **An individual having one pair of extra chromosome in diploid complement is known as *tetrasomics*.**
- **Tetrasomics = 2n +2**

Aneuploidy in man:

- **One of the common syndromes associated with aneuploidy is the *Down's syndrome*.**
- **It is due to the trisomy for chromosome 21.**
- **It is also known as *'mongolism'* suffered persons have short stature about 120 cm.**

Unit-6

Classical genetics

1. **Alleles: The various forms of a gene are called alleles.**
2. ***Gamete:* Gamete refers to a sexual unit.**
3. **Contrasting characters: The individual plant features with marked phenotypic difference are known as contrasting characters or traits e.g. Red and white flower colour, yellow and green seed coat colour.**
4. **Back cross: The crossing of F1with one of its parents is called *back cross*. Back cross play important role to development disease resistance in plants**
5. **Test cross: Crossing of F1 with of its recessive parents is called *test cross*.**
6. **Top cross: A cross between an inbred line and an open pollinated variety also known as *inbred varieties cross*.**

Mendalian laws:

1. **The Law of Segregation:**
   - **The two alleles of a gene present in the Fi do not contaminate each other; they separate and pass into different gametes in**

their original form producing two different types of gametes in equal frequencies.

- The term ***'Law of purity of gametes'*** also used to describe this law.

2. **Law of independent assortment:**

- This law states that when two pairs of gene enter in F1 combination, both of them have their independent dominant effect.

Gene:

- Smallest and functionally part of genetic material.
- An alternative form of gene called **allele.**

Allele:

- When a gene has two alternative forms called alleles.

Multiple allele:

- The many allele of a single gene are called ***multiple alleles***
- In the case of multiple alleles, only the monohybrid ratio is observed in the F_2 generation.
- These control same character
- No crossing over in the multiple allelism.

Example of multiple allele:

- **Fur colour in rabbits**
- **Wing type in drosophila**
- **Eye colour in drosophila**
- **AB & 0 blood group in human**

Pseudo alleles:

- Govern different expression of the same character.
- They exhibit cis -trans position effect.

Types of gene interaction:

- Typical di -hybrid ratio for a single trait: **9:3:3:1**
- Duplicate gene action: **15:1**
- Complementary gene action: **9:7**
- Supplementary gene action: 9:3:4
- Inhibitory gene action: ***3:3***
- Masking gene action: 1 2:3: 1

- **Polymeric gene action: 9:6:1**
- **Additive gene action: 1 :4:6:4: I**

Antigen:

- **An antigen is a molecule of immunogenic, which specifically interacts with an antibody**

Antibody:

- **An immunogen is a molecule, which when introduced into the system of an animal, induces the production of a class of proteins, known as antibodies.**
- **Antibodies belong to a class of proteins called *immunoglobulins*.**

lir

Unit -7

1. **Mutation:** Sudden heritable changes in the characters of organisms are called ***mutation.***
2. **Mutants:** The individuals showing these heritable changes are known as ***mutants.***
3. **Mutagens** Agents, both chemical and physical, increase the frequency of mutations several -fold are called ***mutagens.***

Examples commonly used mutagens:

SN	Class	Mutagens
I.	**Physical** mutagens	
	toning radiations	**a -rays, n -rays, y -rays (14C, ◦ CO), & x-rays**
	Non- ioning radiations	**UV rays**
2.	**Chemical mutagens**	
	Alkalating agents	**Mustard gas, EMS, MMS, EES**
	Base analogues	**5-Bromouracil**
	Acridine dyes	**Acriflavin**
	Deamination agents	**Ethium bromide**

Note: -The rate of spontaneous mutation is very low generaiiy ranges iu -4 — ru Lot **eukaryotes and** le—le **for prokaryotes.**

Linkage

- **All the genes on** a chromosome are said to be linked to one another and belong to the linkage group.

- The phenomenon of inheritance of linked genes in same linkage group is called ***linkage.***
- It opposites to **crossing over.**

Phases of linkage:

a. **Coupling:** Linkage between two or more either dominant (AB) or recessive (ab) allele is referred to as ***coupling.***

b. Repulsion: Linkage of dominant allele with that of recessive allele (Ab or aB) is known as ***repulsion.***

Detection of linkage:

- **Test cross** is the most common method of detecting the linkage.

Interference (Muller):

- Tendency of one crossover to reduce the chance of another crossover in its adjacent region.

Coincidence (Muller):

- It explained the strength or degree of interference.

Sex **determination:**

- It utilizes various genetically concepts to decide whether a particular individual will develop into male or female sex.
- Sex determining genes are present on both **x -chromosomes** as well as autosomes.

Sex -linked characters:

- The characters for which genes are located on sex chromosomes are known as ***sex—linked traits.***
- Such genes are called sex linked genes, and linkage of such genes is referred to as ***sex linkage.***

Main features:

a. **Location:** Sex —linked genes are located on X chromosomes only.

b. **Number:** In diploid organism, each homogametic sex (xx or zz) has two copies of linked alleles.

c. **Expression:** In homogametic sex, a recessive gene can express. In heterogametic sex, a recessive allele can express.

d. **Transmission: Sex linked genes are transmitted from female to male and not from the male, because males receive their x chromosome from the female only. Sex linked genes are first inherited from male to female in the first generation and then back to male in the second generation. This type of inheritance in which a sex linked gene is inherited from grandfather to grandson through daughter is called *cris-cross inheritance.***

Sex linked characters:

a. **In drosophila (white eye, vermilion eye).**

b. ***Hemophilia* is the well known example of sex linkage in human. In case of a marriage between hemophilic woman and normal man, the disease will be transmitted to 50% of the sons even if the gene is in heterozygous condition in the carrier.**

c. **The *colour blindness* is another example of sex linkage in humans. Sons from the marriage between colour blind man and normal woman will be normal, but daughters will carry such genes in heterozygous condition. Marriage of such carrier girl with colour blind boy will yield children in which both male and female children will be colour blind each in 50% cases.**

Sex limited characters:

- (**The characters which are expressed in one sex only are referred to as *sex limited characters.* E.g. breast development in woman and beard in man.**

Protein synthesis

Involve two main processes:

I. Transcription/tenalism:

- **The process of synthesis of messenger RNA from a DNA template is known as *transcription.***

- It takes place during interphase and continues up to prophase of cell division.
- **DNA** (Transcriptase + Transcription ions) **m-RNA**

Reverse transcription:

- Formation of DNA from mRNA is known as ***reverse transcription***
- **m-RNA** **DNA**

2. **Translation:**

- The process of protein synthesis from information in m-RNA is known as ***translation.***
- **DNA** mRNA(transcription) **Protein** (translation)

Cytoplasmic inheritance:

- Most of phenotypic characters are controlled by genes present in the chromosomes. but some characters expressed by factors present in the cytoplasm. These factors lying in the cytoplasm are called ***plasmagenes.***
- The transmission of characters controlled by plasma genes is called ***Cytoplasmic inheritance.***
- The first case of Cytoplasmic inheritance was reported by **Correns** in 1909 in four 0" clock *(Mirabilis jalapa)* for leaf colour.
- It is used for development of **Cytoplasmic male sterility** (CMS) lines in several crops like **maize, pearl millet, sorghum, cotton** etc.

Unit -9
Plant breeding

Contributions of breeders:

I. Thomas Fairchild (1717):

- Developed first inter -specific hybrid between sweet william and carnation species of ***Dianthus***

2. Rimpu (1890):

- Made first inter -generic cross between bread wheat *(T. aestivum)* and rye *(Secale cereal)* to give birth of ***Triticale.***

- **DT -46** is the variety of triticale

3. **Jones, D.F. (1917):**
   - Made **double cross** in maize
   - Used genetic male sterility in the development of maize hybrid.
4. **Vavilon, N.I.:**
   - The center of origin given by: **Vavilon**
   - Identify **8 main centers** and **3 sub centers** of crop diversity.
5. **Nagaharu, U (1935):**
   - Tetraploids species of Brassica using a triangle which is popularly known as *U's* ***triangle.***
6. **Harrington, J.B. (1937):**
   - Proposed mass pedigree method of breeding which is a modification of pedigree method.
7. **Flor, H. H. (1956):**
   - He developed the concept of gene for gene hypothesis in flax for flax rust caused by ***Malampsora lint.***
8. **Vander Plank, J. E. (1963):**
   - Developed the concept of vertical and horizontal resistance.
9. **Donald, C.M. (1968):**
   - Crop Ideotype working with wheat. **(RAS-09)**

Breeding methods:

1. **Pure line selection** (by Johansen):
   - Refers to the homogenous progeny of a self pollinated homozygous plant.
   - Development of new variety through identification and isolation of single best plant progeny is known as ***pure line selection*** or individual plant selection.
   - This method is commonly used in **self pollinated** species e.g. **Wheat, barley.** ***(RAS-09)***
2. **Mass selection:**
   - Refers to a method of crop improvement in which individual plants are selected on the basis of phenotype from a mixed

population, their seed are bulked and used to grow the next generation.

- This is one of the **oldest methods** of crop improvement.
- Mass selection is applicable to **both self and cross pollinated** species but mostly for cross pollinated crops.
- E.g. Maize, pearl millet, mustard & often cross pollinate crops like cotton, sorghum etc.

3. **Clonal selection:**
   - Progeny of a single plant obtained by asexual reproduction is known as ***clone.***
   - Crops which are propagated asexually or by vegetative means are known as asexually propagated or vegetative propagated or clonal crops.
4. **Pedigree method:**
   - Pedigree refers to record of the ancestry of an individual selected plant.
   - Pedigree breeding is a method of genetic improvement of self pollinated species in which superior genotypes are selected from segregating generations and proper record of the ancestry of selected plants are maintained in each generation.

Applications:

- It is widely used for the improvement of self pollinated species for development of new varieties, while in cross pollinated species it is used for development of inbred lines.

5. **Bulk breeding methods:**
   - Selection refers to selection procedures in which the segregating population of self pollinated species is grown in bulk plot.
   - This method is also known as **mass or population method.**
   - This method is used for the **genetic improvement of self pollinated** crop plants.
6. **Backcross method:**
   - Backcross refers to crossing of **F1 with either of its parents.**

- When the F1 is crossed with homozygous recessive parent, it is known as **test cross.**
- Back cross method is applicable in all three groups of crop plants, viz, self pollinated, cross pollinated and asexually propagated.
- Backcross method has been widely used for the development of **disease resistance varieties** in both self and cross pollinated species of wheat and cotton.
- It has also been used for inter -specific gene transfer *and* development of multiline varieties in self pollinated species.

7. **Recurrent selection:**
   - As reselection generation after generation with interbreeding of selects to provide for genetic recombination
   - It was originally developed as a method of breeding cross pollinated species, but now it is also used for self pollinated species.

7 1 z w i i m
.a

Unit -10
Seed technology

Seed:

- **Botanically seed** is a **fertilized ovule** consisting of intact embryo, stored food and seed coat which is viable and has got the capacity to germinate.
- **Indian seed act passed in: 1966**
- **National Seed Corporation in: 1963**

Types of pure seeds:

a. **Breeder/nucleus seed:**
   - Such seed are produced directly under the supervision of **plant breeder.**
   - It possessed all the required genetic characters and **99.9% genetically pure.**
   - Breeder seed is used to **produce foundation** seed.
   - It has **golden yellow** colored tag.

b. **Foundation seed:**

- **It's progeny of breeder seed.**
- **Known as mother seed and it is the source of registered and certified seed classes.**
- **It is genetically 99.9%% pure. However, physical purity of 98% is permissible.**
- **Production of foundation seed is the responsibility of national seeds corporation.**
- **It is produced on government farms, at experiment stations, apiculture universities or on cultivator's field under strict supervision of research scientists and expert from seed certification agencies (SCA).**
- **White tag is denotes for foundation seed.**

Registered seed:

- **Produced from Foundation seed or registered seed itself.**
- **It has satisfactory genetic identity and purity.**
- **In India it is generally omitted and certified seed is produced directly from foundation seed.**
- **It has purple/orange tag.**

Certified seed:

- **Progeny of registered seed, foundation seed or Certified seed itself.**
- **It has satisfactory genetic identity and purity.**
- **It is approved and certified by the state seed certifying agency**
- **It denoted by blue tag.**
- **It is available for general distribution to farmers for commercial crop production.**

Viability of seeds:

- **Seeds viability is defined as the capacity of the seed to remain capable of germination for some specific period of time.**

Seed viability tests:

a. **Potassium permanganate method:**
   - **It's qualitative test to find out whether seeds are viable.**

b. **Tetrazolium chloride test:**

- Known as **biological** test
- Seeds are soaked in 0.5-2% solution of **2, 3, 5, triphenyl tetrazolium chloride.**
- The viable or living seeds take **bright red** coloration and the colour becomes more intense in the embryo.
- It is a **quickest** method of viability test.

c. **Grodex test:**

- Grodex is a seed germination indicator
- **It's** a brand name of **triphenyl tetrazolium bromide** in powder form.

Isolation distance:

- Isolation of seed crop is essential to avoid genetic & physical impurities.

Minimum isolation requirements of some crops:

Crops	**Minimum isolation distance (in m)**	
	Foundation seed	**Certified** seed
Self pollinated crops like rice, **wheat,** barley, oat	3	3
Pearl millet hybrid	**1000**	200
Maize, sorghum	**400**	200
Cotton hybrid	**50**	**30**
Groundnut, Soyabean	3	3
Rapeseed & Mustard	400	200
Cucurbits	800/1000	400/500
Okra	400	200
Tomato	**50**	**25**
Oni on	1000	1000

Real value of seed:

- **Real Value =** $\frac{\text{Purity \% x Germination \%}}{100}$

- It's percentage of germinability of percentage of purity of seed lot of a crop plant.
- It is expressed in percentage and also known as utility percentage of seed.
- Impurity percentage is called Dockage.

Genetic purity:

- " • Genetic purity is required 100% as far as an impurity by seeds of other varieties of same crop is concerned but in case of impurity by seeds of other crop species; it is permitted up to 0.1% only in foundation seed and 0-0.5% in other seeds.
- Seed index: Weight of 100 seeds (seed index used in case of bold seeds like gram, maize).
- Test weight: Weight of 1000 seeds (wt. of small seeds like rice, wheat etc.).
- Seed quality index: It is the vigor of seed germination.
- Germination percentage in maize is: 90 % (highest in field crops)
- In cotton germination percent is: 65 % (lowest among field crops)

Seed dormancy:

- Unability of viable seed to germinate even under optimal conditions provided for germination.

Breaking of dormancy:

1. Scarification: Process of breaking/softening the seed coat to make it permeable to water and gases.
   KNO_3 (1-3 %): Strongest dormancy breaker.
   ./ Thiourea: Mainly used in case of potato.
2. Stratification: Seeds are subjects to temperature treatment (chilling temperature).
   v E.g For chilling treatment: Seeds should be kept 2-8 "C for 12-24 hours.

Seed plot technique of potato:

- Developed by Pushkarnath *et. Al.* in 1967
- It is a technique of multiplication of disease free (Virus free) seed in Northern plains of country
- The viruses are transmitted by aphids.

- **Nucleus seed of potato** is produced during April to August when aphid population is low in hills. It is brought to plains and is stored in cold -storage for planting the seed crop in October.

Other categories of seeds:

1. **Orthodox seeds:**
   - Seeds remain viable for long time at low temperature and low moisture content. They don't lose their viability at low temperature e.g. Seeds of cereals.
2. **Recalcitrant seed:**
   - Seeds don't remain viable for long time at low moisture & low temperature, because they show very drastic loss of viability with decrease in moisture content below 12-14%.
   - E.g. Mango, coconut seeds

Seed Act:

- **The seed Act** was enacted by the parliament on 29.12.1966 and the seed rule were notified in 1968.
- This act came into force throughout the country on **2" Oct. 1969.**
- Seed was declared as an **essential commodity under the Essential Commodity Act 1955.**

Seed production agencies:

a. **National Seed Corporation** (NSC): it was registered in **1963** having objectives of:
   - To promote development of a seed industry in India.
   - To produce and supply foundation seeds of various crops

b. **State Seed Corporation (SSC):** it concerned with;
   - Production and supply of certified seed
   - To reduce the work load of **NSC.**

Agmark:

- According to Agriculture Production Act 1937
- It's used **National mark** to express **quality/Purity** of agriculture and animal (dairy) **products.**
- Central laboratory of agmark is situated at: **Nagpur.**

Terminology

1. ***Genetics:*** The branch of biology concerned with the study of heredity and variation
2. ***Eugenics:*** The application of principles of genetics for the improvement of humankind.
3. ***Gene pool:*** The sum total of all the alleles present in the breeding or reproductive members of a random mating population.
4. ***Gene frequency:*** The proportion of one allele relative to all the alleles of a gene in a Mendelian population.
5. ***Cytogenetics:*** Concerns with the study of various aspects of chromosomes and their effects on the development of characters of organisms
6. ***Genome:*** A complete set of chromosomes of a diploid species
7. The first artificial hybrids in plants were produced by **Thomas Fairchild** in 1717 when he crossed ***sweet William*** with ***carnation.***
8. ***Euphenics:*** Deals with the control of hereditary diseases especially inborn errors of metabolism.
9. ***Epistasis:*** When one gene affects in any way the expression of another gene, the phenomenon is called ***epistasis.***
10. ***Genomics:*** **It refers to the study of the structure and function of entire genome of an organism.**
11. ***Biodiversity:*** **Refers to the total variability present within and among species of all living organisms and their habits**
12. ***Acclimatization:*** **Refers to adaptation or adjustment of an introduced variety to the new environment.**
13. ***A -line:*** Means the male sterile parent used in crossing to develop a new hybrid seed. it is the male sterile line.
14. ***B -line:*** **It** is the fertile counter parent of the 'A' line, it is also called the maintainer line.
15. ***R -line:*** It is an inbred line which when crossed with a male sterile strain, the resultant hybrid is male fertile.
16. ***In vitro:*** biochemical process taking place in a test tubes (in lab.)

J7. ***In vivo:*** biological process taking place in a living cell or organism.

18. ***Cris -cross inheritance:*** Inheritance of sex linked genes from grandfather to grandson through daughter.

19. ***Gene cloning:*** Isolating a gene and process of producing identical copies is known as ***gene cloning.***

20. **Electroporation:** A technique uses electric discharge to produce pores on cell membrane for intake of recombinant DNA.

21. **Heterosis: Heterosis:** The superiority of F1 in one or more character over its parents known as Heterosis/hybrid vigour.

22. **Heterobeltosis:** When F1is found superior to either parents

23. **Allogamy/cross pollination:** Pollen grains from flowers of one plant transferred to receptive stigmas of flower of another plants.

24. **Self pollination/autogamy:** Pollen grains from an anther fall on receptive stigma of the same flower.

25. **Chasmogamy:** Flower opens, but only after the pollination has taken place e.g. **Moong**

26. **Cleistogamy: Flower does not open at all, ensuring complete self pollination e.g. Wheat, cereals.**

27. **Geitonogamy:** Pollen **grains from flowers of one plant fall on the receptive stigmas of other flower of the same plant e.g. Maize**

28. **Monoecious:** Male and female **reproductive structures are found on the same plant but in separate flowers e.g. Maize**

29. **Dioecious:** Male and female **reproductive structures are found on separate plants e.g. Papaya, date palm**

30. **Pseudo-heterosis: Superiority of F1over its parents in vegetative growth, but not in yield and adaptation also called *Luxuriance.***

31. **Inbreeding: Mating between closely related individuals such as selfing and sub -mating.**

32. **Inbreeding depression: Loss or decrease in vigour and fitness as result of inbreeding.**

33. **Three way cross hybrid: The hybrid progeny between a single cross and an inbred *viz.* (A x B) x C.**

34. **Double cross hybrid:** I he hybrid progeny from a cross Wes* tvw single crosses *e.g.* (A x B) x (C z

35. **Top Cross:** A cross betucen an inbred line and an ope. pollinated variety. Also knovsn as inbred sarieties cross.

36. **Synthetic varieties:** A variety %Ouch is desekved by mating in all possibk conibmations a number {If inbred lines with good general combining ability and filming the 'evil of I crotses in equal quanhit i mkt-1rd to as c% ntbdk: saricrs (first in main)

37. **Conipissitc saris -tics:** In c•voss pollinated ropt. 4 %and" developed by mixing he seed of ‘ittitltis genotypes IA Pilch art similar in maturity. height. wed sire, wed colour, etc Or the mixture of genotypes from several sources that is maint.sincd in bulk from oric fenerithon to the next is referred to as conipiride variety c g 9ay, Nmber,, Shakti and Prisms sarieties of friai.te

O. PLANT PHYVOLOGY

Important points:

- Theory of evolution was given by: ***Charles Darwin.***
- Photo -respiration is: ***Energy spending process.***
- Mass flow is affected by: ***Transpiration.***
- Conversion of fat to sugar occurs in: ***Glyoxysomes.***
- Photorespirat ion occurs in: ***Chloroplast.***
- Photosynthesis in an: ***Oxidation —reduction process.***
- Photo system II **is absent in:** ***C4plants.***
- Conversion of fat into carbohydrate is in: ***Glyoxylate cycle.***
- Precursor of IAA is: ***Tryptophan.***
- Father of plant physiology is: ***Stephen hales.***
- Cobalt as a **constituent of:** ***Vit. B12***
- **Law of tolerance introduced by:** ***Shelford***
- **Glycolysis occurs in the part of cell:** ***Cytoplasm***
- **Krebs cycle & ETC occurs in:** ***Mitochondria***
- Final product of Glycolysis is: ***Pyruvate***
- **Light or hill reaction takes place in:** ***Grana of chloroplast***
- **Dark reaction or Calvin cycle takes place in:** ***Stroma of chloroplast***
- **Most abundant protein in the world:** ***Rubisco***
- **One molecule of glucose is produced:** ***686 Kcal.***
- **Highest water use efficiency order:** ***CAM > C4> C3***
- **Kranz type leaf anatomy found in:** ***C_4 plants***
- **Calvin cycle & hatch- slack occurs in:** ***Chloroplast***
- **Photosynthetic rate highest in:** ***C_4 plants***
- **Glucose is a type of sugar:** ***Monosaccharide***
- **Sugar which is sweetest among all sugars:** ***Fructose***
- **Examples of disaccharides are:** ***Maltose, lactose, sucrose***
- **Non reducing sugar:** ***Sucrose***
- **Sugar found in germinating seeds:** ***Maltose***
- **Lactose (milk sugar) is a combination:** ***Glucose + Galactose***
- **Term protein was coined by:** ***Moulder in 1840***
- **The term enzyme was coined by:** ***W. Kutins***

1 **Lock & key model was proposed by:** ***Fisher***

V **Term vitamin was proposed by:** ***Funk***

1 **Bond that joins amino acids:** ***Carboxyl***

1 **Kranz anatomy was shown by which group of plants:** ***C_4 plants***

1 **Who used the term *Florigen* for a flowering stimulus hormone:** ***M. Chailakyan***

V **Mineral element which is involved in stomatal movement is:** ***K.***

1 **Light reaction of photosynthesis takes place in:** ***Thailakoid***

V **Breaking of seed dormancy by low tempreature treatment of moist seeds is termed** ***as: Stratification***

1 **RNA synthesis takes place in:** ***Ribosomes***

V **This is essential factor for germination of seed:** ***Air***

1 **Soaking up of water by dry substances due to hydrophilic colloids** ***is: Imbibitions***

I **Shrinkage of protoplasm due to outward flow of water in a hypertonic solution:** ***Plasmolysis***

1 **The effect of global warming is somewhat good on C_4 plants because they** ***efficient user of M-***

I **Emerson & Lewis (1943): They observed that quantum yield declined sharply at wavelength greater than 600 nm in red zone also called** ***red drop.***

,./ **The red spectrum (wavelength of 580 nm to 680 mu) of light which is the most *effective* for inducing flowering in both short day and long day plants.**

1 **Otto Warburg 1920: found that photosynthesis in algae was inhibited by 02. This occurs in all C_3 plants and this effect is known as** ***Warburg effect.***

1 **The light intensity, at which the photosynthetic intake of CO2 is equal to the respiratory output of CO2, is called** ***compensation point.***

I Therefore net photosynthesis is zero at the compensation point.

I The cold treatment to a plant bud or seedling in order to fulfill a specific low temperature requirement (especially for cool loving plants) is known as: *Vernalisation.*

I The term *"vernalisation"* was coined by: *T.D. Lysenko.*

1 Translocation of water and nutrients from roots to above ground parts of plants takes place through: *Xylem.*

1 Mineral deficiency in plants can be quickly corrected by: *Foliar spray*

In water molecule angle between $_{H2}$ and 02 molecules is: */05°*

1 The total amount of water present in the soil is called as: *Holland*

1 Mass flow/pressure flow theory for the movement of food was given by *Munch.*

'7 Most abundant chemical present in the cell wall is: *Lignin*

I Accumulation of hormone during stress is: *Proline*

1 Photorespiration occurs in $_{C3}$ plants in: *Light only*

I Nutrient evolved in the biosynthesis of IAA is: *Zn*

Types of protein:

Proteins	Presence
Collagen	Muscles
Keratin	Hair & nail
Fibroin	Silk
Elastin	Insect wings
Regulatory	Enzymes

Plant avsioloor

- Plant physiology is the study of vital or **functional** activities of plants.

1. Diffusion:

- Means to spread or to **disperse in all directions.**
- The movement of the molecules of gases, liquids and solids from the regions of **higher concentration to the regions of lower concentration** until a equilibrium is reached among molecules throughout the available space is known as ***dijfusion*** e.g. ***Spreading of scent molecules in rooms.***
- **Other examples of diffusion are:**

States of diffusion:	**Formed**
• **Gas into liquid:**	***Foam.***
• **Liquid into gas:**	***Clouds*** (vapor).
• **Solid into gas:**	***Smoke.***

2. Osmosis:

- **It is a special type diffusion of liquids though *a semi permeable membrane.***
- **Means diffusion of liquids from lower concentration of solution to higher concentration through *semi -permeable membrane.* Osmosis occurs only in liquids.**
- **Plasma/cell membrane is a semi -permeable membrane e.g. *Swollen of Kismis in water.***
- **In a pure solvent, the value of osmotic potential is zero.**

a. Endo osmosis: The solvent of lower concentration is enter inside the cell is called *endo-osmosis.*

- **Eg. Raisins *(Kismis)* swell in water due to endosmosis.**

b. Exo osmosis: The out ward movement of solvent from higher concentration medium is called *exo-osmosis.*

- **E.g. In pickles salt** act as **exo-osmosis on bacterial cells and killed microbes.**

3. Plasmolysis:

- Plasmolysis is the **shrinking** of protoplasm due to outward flow of water in a **hypertonic** solution.
- If a plasmolysed cell is kept in pure water, the cell attains their original shape and size due to endosmosis. This phenomenon is called ***de-plasmolysis.***
- E.g. Excessive use of **fertilizer** in the soil kill the plant due to plasmolysis.

4. **Diffusion pressure deficit** (DPD):
   - It is also called ***suction pressure.***
   - It is the force per unit area by which water enters into a cell.
   - DPD = OP - TP(WP)

Where,

- **OP =** Osmotic pressure
- TP = Turgor pressure
- WP = Wall pressure

- When water enter in a cell, due to swelling a (outward) pressure exerted by the cell solution on the cell wall is known as ***turgor pressure.***
- When water enters in cell, the cell wall exert an opposite (inward) pressure on cell membrane is called ***wall pressure.***
- Water potential is **always negative** and the maximum value is zero.

5. **Solutions:**
   a. **Hypotonic solution:** means **low concentrate** solution.
   b. **Hypertonic solution: Strong** or higher concentrate.
   c. **Isotonic:** Neither weak nor strong solution e.g. ***eye drops***

6. **Imbibitions:**
   - The adsorption of water by dry woody substances due to hydrophilic colloids is called ***imbibitions.***
   - **E.g. Absorption of water by dry woods.**

Water relation

Absorption of water by plants:

- The absorption of water takes place in the terminal portion of roots i.e. ***root hairs.***
- Root hairs are more developed in xerophytes and absent in hydrophytes.

Types of absorption:

a. **Active absorption:** Water is absorbed due to activities of roots and metabolic energy is spend in non osmotic active absorption. only a small portion of water is absorbed by active absorption.

b. **Passive absorption:** Passive absorption is controlled by activities of areal parts i.e. shoots, leaves of plants due to pressure exerted by transpiration, hence energy is not required. Plant absorbs most of water by passive absorption.

Ascent of cell sap:

- **The upward movement of water from stem base to tree top is called 'ascent of sap'.**

Mechanism of ascent of sap:

a. **Vital theories:**

(i) Relay or clambering pump theory: given by Godlewski 1884.

(ii) Pulsation theory: given by Sir J. C. Bose (1923).

b. Root pressure theory:

- **It coined by Stephan Hales (1727).**
- **The hydrostatic pressure developed due to the accumulation of water absorbed by the roots called *root pressure.***
- **It measured by *manometer*.**

c. Physical theories:

(i) Capillarity theory: Boehm 1809: He stated that water rises in narrow tubes due to surface tension.

(ii) Imbibitional theory: According to Sachs 1878, imbibitions activity of cell walls of xylem is responsible for ascent of sap.

(iii) Cohesion and adhesion theory/transpiration pull theory:

- **This theory was propounded by Dixon & Jolly 1894**
- **This theory is most accepted theory.** •

Loss of water in plants:

a. Transpiration:

- **The loss of water in the form the living aerial parts of the plant in the form of water vapour is termed as *transpiration.***
- **Transpiration is a necessary evil.**
- **It cooled down the leaf surface of plants.**
- **Nearly 99% of the water absorbed by the plants is lost in transpiration.**
- **It is a vital and unavoidable phenomenon of plants.**
- **Transpiration is** regulated by stomata activities.
- The principle organ of transpiration is **leaf.**
- Again foliar transpiration is of two **types viz. Stomata!** (80-90 %) and cuticular (up to 20 %).

(i) **Stomata:**

- **These are specialized epidermal cells** which are distributed all over leaf surface but in case of terrestrial plants, mainly on lower surface of leaves, therefore approx. 97% of transpiration takes place from the **lower surface** in such plants.
- Each stomata has two **kidney shaped guard cells, inner** wall of guard cell is thick and outer wall is thin.

Mechanism of stomata opening and closing:

- **Opening and closing of stomata are due to its turgidity and flaccidity** respectively. Means stomatal movement is governed by ***Turgor pressure.***
- **When T.P. of guard cells increases, stomata are opened and when decreases, stomata are closed.**
- **Rate of transpiration is determined by *Photometer.***

b. Guttation:

- **Term is** given by ***Burgerstein***

- The exudation of water with salt and minerals through hydathode is called ***Guttation.***
- **Hydathode:** a structure present at tips of veins of leaves.
- It is caused due to ***root pressure***
- Guttation normally occurs at **night.**

Unit -3
Photosynthesis

1. Photosynthetic pigments:

a. Chlorophylls pigments:

- Chlorophylls occur **in the grana plastid** and are associated with the **thylakoids membrane.**
- The centre of the **porphyrine ring** of chlorophyll A & B contains a single atom of **magnesium** (Mg).

Chlorophyll pigments are two types:

(i) **Chlorophyll 'a':**

- Empirical formula is **C55 H720 5N4 Mg.**
- Occurrence is universal in green plants.

(ii) **Chlorophyll 'b':**

- Empirical formula of Chlorophyll '13' is **C55H70 0 6 N4 Mg-**
- It present in higher plants and in green algae but absent in red algae.

b. **Carotenoids pigment:**

- Carotene and xanthophylls are together called *`Carotenoids'*.
- It belongs to large group of compounds called ***terpenoids.***
- These are fat soluble **yellow pigments.**
- Carotenoids are located in **chloroplast** and **chromoplast**

(i) Carotene:

- Orange -yellow coloured having empirical formula **C40 H** .
- It is abundant in roots of carrot hence the name **carotene**
- **Its** most common form is **n -carotene.**

- pn -carotene is the precursor of Vitamin A.
- It's quickly oxidized in air hence the rapid change of colour takes place in the scalped carrot.

(ii) **Xanthophylls:**

- It's **more abundant than carotenes** having yellow to brown colour.
- Empirical formula is $C_{40}H_{56}O_2$
- It is also called ***carotenol.***
- The principal yellow pigment of maize is ***zeaxanthin.***

c. **Anthocyanin:**

- It is a **purple** pigment
- Soluble in water hence it occurs in **solution form** in the water of the cells.
- **It doesn't take** part in photosynthesis
- It is present in **sugar beet, apple**

2. Photosynthesis/CO2 assimilation/food production:

Definition:

- The formation of carbohydrates from utilizing CO2 and water by illuminated green cells and 02 liberated as by product is called ***photosynthesis.***

$$6CO_2 + 6H_2O \xrightarrow{(Light + Chlorophyll)} C_6H_{12}O_6 + 6O_2$$

- Reaction of the light phase is light sensitive hence called ***photochemical reaction.***
- **Source of oxygen** during photosynthesis is ***H20***
- The conversion of light energy in to chemical energy i.e. ATP is called ***Rhotophosphorylation'.***
- The breakdown of water molecule I-120 into hydrogen and oxygen by light energy is called as ***Photolysis*** of water.

It has two phases' viz, **light phase** and **dark phase:**

a. **Light reactions:**

- The site of light reaction is **grana** and dependent on pigment.

(Chloroplast)

- **Light + 1120** **0 2 released**

Emerson effect:

- Green plant exposed to monochromatic light i.e. wavelength **greater than 680 nm** in **red zone** this prolonged duration of red zone decreased the rate of photosynthesis (i.e. decrease in quantum yield) this effect is called **red drop.**
- The quantum yield produced by the mixed light was greater than the total yield got from the two beams of light used separately. This enhancement effect is known as ***Emerson effect'.***

b. Dark reaction:

- **Dark phase of photosynthesis i.e. CO2 fixation:**
- The reactions of the dark phase are temperature sensitive and **don't requires light.**
- This is purely chemical reaction and called ***Blackman reactions*** on the name of F.F. Blackman who first demonstrated its existence.

(i) **Calvin cycle/C3-cycle:**

- **This is predominantly found in wheat, rice,** barley, pulses, **soyabean, cotton, sunflower** etc. and such plants are called C_3 **plants** because in the Calvin cycle, first stable **product is (PGA)** C_3 **compound (having three number of carbon in a compound).**

Blackman's: law of minimum or low of limiting factor:

- CO2 (Light, ATP + NADH2) Reduction in CH20
- If light intensity is increased by twice **but CO2-concentration** is constant, there will be no increase in photosynthetic rate.
- It means CO2 acts as a limiting factor because its concentration is available in minimum quantity.

(ii) **Hatch & slack cycle/C4cycle:**

- **It is found in sugarcane, maize, sorghum, bajra** etc. *such* plants are called C_4 **plants.**
- C_4 plants have "**kranz** anatomy" in leaves.

.66621160 4 , ' 6

111111111111E0ok.tiss

- 1st stable product is 4 carbon compound Oxalo-acetic acid **(OAA)** or malic acid, hence the name C4-cycle.
- PEP carboxylase has high affinity for CO_2 and hence C_4 plants are able to absorb CO_2 strongly from a much lower CO_2 concentration than the C_3 plants.
- Thereby resulting higher rate of photosynthesis.
- Most of **weeds are C_4 plants.**
- C_4 plants lack **photo respiration,** hence photosynthetic rate is higher.

(iii) **Crassulacean acid metabolism (CAM):**

- **All** CAM plants have **succulent habit.**
- Such plants have also the **capability of fixing the CO_2** lost in respiration.
- Such plants behave like C_4 plants **during the night and as C_3** plants during the day.
- These plants have slowest **photosynthetic rates.**
- **In CAM plants open the stomata during the night and closed** at **day time.**
- **E.g. Onion, Garlic, Sisal, Lilli and plant** of family **crassulaceae (eg. cactus, pine apple).**

Difference between C3, C4 and CAM plants:

S.N	Particulars	C_3 Plants	C_4 Plants	CAM Plants
1	Site of the cycle i.e. leaf structure	Mesophyll	Mesophyll and bundle sheath cell i.e.kranz anatomy	Mesophyll and vacuole
2	ist stable compound	PGA (3-carbon)	OAA or Mallic acid (4-C)	Both
3	CO_2 acceptor	RuBP	PEP	PEP
4	Dark reaction through	Calvin cycle	Hatch & Slack cycle and Calvin cycle	
5	Compensation point (CO_2	50 ppm	1-5 ppm	

	concentration)			
6	Photosynthetic rate	Medium	**High**	Slow
7	Biomass production	Medium	High	Low
8	Light saturation point	Low	High	Medium
9	photorespiration	**High**	Low	Low
10	Water use efficiency	**Low**	**medium**	**High**
11	Transpiration rate	**High**	Medium	Low

Urkit-4
Respiration

1. **Photorespiration/glycolate pathway:**
   - Krtokov (1963) introduced the term photorespiration to refers to the release of CO_2 in respiration in presence of light.
     In photorespiration high conc. O_2 induced by high light, checks the production of two molecules of PGA and forms glycolate instead of one molecule of PGA.
   - H_2O_2 is formed.
     Known as **C_2cycle** (2 -carbon compound; glycolate)
   - Don't formed **ATP** (energy) hence;
     This is **energy consuming/harmful** process.
     It occurs between ***chloroplast, peroxysomes*** and ***mitochondria.***
2. **Respiration:**
   - The energy is released by the oxidation of various photosynthetic products especially carbohydrates by the process called ***respiration.***

$C_6H_{12}O_6$ 11. **CO_2 + H_2O** + 686 kcal

Mechanism of respiration:

I First and common stage in respiration is called **glycolysis or EMP pathway.**

1 One molecule of glucose gives: two molecules of pyruvic acid.

Hence, end product of glycolysis is pyruvic acid.

- It occurs in cytoplasm under anaerobic condition.

Acetyl Co —A: link molecule between glycolysis and Krebs cycle.

V 2 molecules of **pyruvic acid** and further will be **oxidized** through link and Krebs cycle

- Two molecule of NADH2: further will be used for electron transport system to release H20

Net production: 2 **ATP in glycolysis.** But two molecules of NADH2 will be oxidized aerobically to yield 6 molecules of ATP.

Thus total molecule of ATP through glycolysis in *presence* of 0 2 will be **eight** instead of **two.**

Both **ETS & Krebs cycle** (citric acid/TCA cycle) takes place in **mitochondria** under **aerobic** condition.

Energy released during respiration:

During the break down of one molecule of glucose, **Net 36 ATP** molecules are formed.

3. Respiratory quotient:

- **R.Q.** is the ratio of the volume of CO_2 released to the volume of O_2 absorbed in the respiration.
- It is also called **respiratory ratio**
- R.Q. = Volume of released CO_2/volume of absorbed O_2

R.Q. values of some products:

- Fat: 0.7
- **Protein: 0.8-0.9**
- **Carbohydrates: 1.0**
- **Succulents: 0**
- **Organic acid: >I or 1.33**

Photoperiodism

- **Response of plant to day light period** specially **flowering behaviour** is called photoperiodism.
- The term photoperiodism was coined by **Garner and Allard (1920).**

They classified plants into three categories:

a. **Short day plants:**
   - Such plants require the day length **less than 12 hours** for flower initiation..
   - E.g. **tobacco, soybean, rice,** generally **kharif** crops and many tropical plants.

b. **Long day plants:**
   - Such plants require **more than 14 hours** day light for flower initiation.
   - E.g. **wheat, barley, sugar beet, castor,** generally **Rabi** crops

c. **Day neutral plants:**
   - Such plants are **unaffected by the day length** e.g. **maize, tomato,** buckwheat, **sunflower, cotton, cucumber** etc.

11. ArirtICULTURE EXTENVON

Extension: Derived from two Latin words.

Ex		Out
Tens is	=	Stretching.

Education:

- Production of desirable changes in human behavior through gaining desirable knowledge, attitude and mental/manual skill is called education.

Classification of communication:

- According to use and nature of contact:

I. Individual contact method:

I Contact is *face* to face or person to person.

It is very effective in teaching, quantum of feedback available is very high but slow communication

- Eg. **Farm** and home visit, personal contact, telephone call, office call, personal letters and result demonstration.

2. **Group** contact methods:

A group of 2-30 persons

Nt Group is usually formed around common interest.

I Face to face contact.

- Eg. Symposium, discussion, lecture, tour and field days, method demonstration, conference, school, seminar.

1

3. Mass contact:

- More than 30 persons

I7 It is more useful for making people aware of the new agricultural technology quickly.

- Eg. Bulletins, leaflet/booklet/folder, newspaper, journal, magazine, exhibition, television, radio, fairs, posters, cinema. drama & songs.

imp,' talla r ...w .---- ... ...nip/4s and associated persons:

SN	Project	Associate person/year
1	Gurgaon project	F.L. Brayne, 1920
	Shantiniketan	Ravindra Nath Tagore, 1921
	Rural reconstruction	Daniel Hamilton

	Marathondom	Spencer Hatch, 1921
5	Sewagram	M.K. Gandhi, 1929
6	Etawa Pilot project	Albert Mayer, 1948.
7	Nilokheri Experiment	S.K. Dey.
	Majdoor Manjil	S.K. Dey 1947
9	Firka Development	T. Prakashan 1946
10	Community Development	S.K. Dey, 2 Oct. 1952
11	National Extension Service	2 Oct. 1953
12	Indian Village Scheme	S.N. Gupta
13	Young Farmer Association	P. Deshmukh
14	Father of Extension	Leagnes
15	National Demonstration: Scheme	Kalwar and Subramanian
16	Model village given by	Hamilton 1903
17	IADP (Intensive Ag. District Programme):	1960
18	IAAP (Intensive Ag. Area Programme)	1964
19	HYV Programme	1966
20	Green revaluation	1966-67
21	DPAP (Drought Prone Area Programme)	1970
22	T& V (training and visit programme)	1974, by Daniel bonor 1974
23	CADP	1974
24	IRDP	1979
25	IRDP, TRYSEM, DWCRA SITRA etc merged into	SGSY, 1999
26	Lab to land program	1, June 1979
27	Establishment of MANAGE	Hyderabad ,1986
28	Nationalization of bank	1969
29	Extension is a	Two way flow of message
30	Programme known as package	IADP

programme

311 Concept of demonstration | Dr. Seaman A. Knapp

Important facts:

- National Rural Employment Guarantee Scheme started in: ***Feb. 2006***
- The role of extension education in India is performed by: ***State Agriculture University***
- The person acting as a connecting link between higher department official & farming community, known as: ***Village extension worker***
- A demonstration which shows the value or worth of the new practice is: ***Result Demonstration***
- A process of initiating a conscious and purposeful action is called as: ***Motivation***
- Agriculture extension worker is: ***A messenger men***
- Extension teaching is: ***Horizontal***
- Institutionalized, chronologically graded and hierarchically strucatured education system is: ***Formal education***
- Sensory situation is more in: ***Inter -personal communication***
- Over—adoption may due to: ***Insufficient knowledge***
- Farm management is an: ***Intro jarm science***
- Farmers obtain short term loans from: ***Central co-operative bank***
- The most effective approach for personal contact is: ***Telephone calls***
- The accepted ways of eating, meeting folks, wooing, training the young, supporting the ages etc are called: ***Customs***
- Which is audio-visual aids: ***Puppet show***
- The most influence type of demonstration is: ***Method demonstration***

Training and visit (T & V) system was first introdced in the state of: ***Rajasthan***

The constitutional 73rd amendment act, 1992 come in force to provide constitutional status to the panchayati raj system in the year: ***1993***

- Which one is a non formal education: ***Agricultural extension education***

The two important principles of extension education are: ***Participation and leadership***

Cooperative society is basic institution for: ***Socio-economic growth of villagers***

Categories of (new innovation) adopter:

- **Innovators:** Adopt immediate (2.5% of total population)
- Early adopter: **13.5 %** population
- Laggards: **16%** adopted **last.**

1
Pu

12,0 AGkICULTURE ECONOMICS

Theories in economics:

• Theory of **profit:**	**A. Walker**
• Modern theory of interest:	**Hicks -Hansen**
• Population theory:	**Malthus**
• Theory of inflation:	**A.P. Lerner**
• Theory of absolute advantage:	**Adam Smith**

Types of farmer (according to land holding):

• Marginal farmer	Less **than 1 (ha.)**
• Small farmer	1-2
• Medium farmer	2-4
• Large farmer	**More than 4 ha**

Finance according to period:

• **Loan**	**Term (years)**
• Short term/ crop loan	**1 to 1.5**
• Medium term	1.5 to 5
• Long term	5 to 30 years

Farm efficiency measures:

- Net capital ratio = **Total assets/Total liabilities**
- Working capital = Working assets + Current assets

  Intermediary liabilities + current liabilities

- Debt Equity Ratio = Differed Liabilities/Net Worth
- Production efficiency = Yield per acre/Yield of locality x 100
- Operating cost ratio = Total operation cost/Total profit
- Rate of capital turn over= Gross income/Total farm income x

  100.

Difference between:

[Production economics	**Farm management**
Macro approach	Micro approach
._Inter farm science	lntra farm science
Decisions are made for aggregate [2:esources of nation	Decisions are taken for individual farm

Variable cost	**Fixed cost**
Known as cost of variable inputs	Known as **sunk cost**
It is always in cash	It may be cash and non cash both
It vary with level of output	It doesn't change with level -On out put

Isoproduct curve:

- It is curve of **two input** combinations which have same output.

Indifference curve:

- **It** is a curve which shows combitinations of **two commodities** which derive **equal** satisfaction to the consumer.

Agricultural credit:

- **Short term loan:** For the purpose of purchasing seeds, fertilizers and for meeting out family requirements
- **Medium term:** To purchase agricultural equipments, animals, and land improvement equipments e.g. Tractor.
- **Long term:** To purchase land, farm buildings and expensive agricultural equipments and for repayment of old loan.

Diversified farming:

- A farm on which the income from a single product is less than 50 % of total

Specialised farming:

- A farm on which the income from a single enterprise is more than or equal to 50%.

Marketable surplus:

- Portion of total produce in stock which the farmer is willing to sell
- Total production - total requirement
- Marketable surplus — marketed surplus only under **ideal** condition.

Marketed surplus:

- Quantity of the produces **actual** sale is the market at particular time for sale.

Types of assets:

- Fixed assets: Difficult to convert in cash e.g. **land, buildings**
- Working assets: **Farm machinery, equipments**
- Current assets: More liquid e.g. **seed, fertilizer, cash, live stock**

Important points:

Family is the basic unit of: ***Civilization***

Village is the basic unit rural: ***Society***

Cooperative movement was started in India: ***1904***

- Father of co-operative movement in India was: ***F Nicholson***

In farm production capital is the: ***Passive factor***

Labour in farm management is an: ***Active factor***

The agricultural produce Act was passed in: ***1937***

- **AGMARK** established in the year: ***1937***

Planning commission established in: ***1950, March***

VAT (value added tax) is an: ***Indirect tax***

Agriculture year: ***June** to **31' May***

Financial year: *1'* ***April** to **31' March***

Demand for luxurious good is: ***More elastic***

Demand for necessary commodities is: ***Inelastic***

One of the important fixed cost on farm is: ***Land rent***

The demand of agricultural products in general is: ***Inelastic***

The price elasticity of demand for **'food' is:** ***Relatively inelastic***

- Indian economy is concerned with: ***Mixed type***

The period of 11*th* five year plan in India is: ***2007-2012***

Risk is minimized in: ***Diversified farming***

Short term credit facility is given for the purpose of: ***Crop productoin***

Finance is provided by land development bank: ***Long term loan***

Retail markets are considered to be: ***Perfect market***

Most important component in farm management is: ***Farm budgeting***

When marginal utility is zero, total utility is: ***Maximum***

Principle of Equi-marginal returns is applied when: ***Resources are limited***

At present, the farming system of India has become: ***Market oriented***

The U" shape of cost curves could be best explained by the law of: ***Variable properties***

NABARD established in 12, July, 1982 with the recommendation of: ***Shivaraman committee***

A market structure with a large number of firmes selling differentiated product is called: ***Perfect competion***

I Most important principle if farm management is done is: ***Low of diminishing return***

V. The cost of production of the crop can be minimized by using economic principle: ***Principle of least cost combination***

The apex body for institution finance for agriculture in India is: ***NA BARD***

The national centre for agricultural economics and policy research is located at: *New* ***delhi***

According to law of diminishing return the economically relevant zone is: ***Zone-ll***

Principle of Equi-marginal return is applied when: ***The prices o pesource is high***

Law of dimising returns are operates when: ***One input are variable***

Indian economy is a type of economics: ***Mixed economics***

Father of economics: ***Adam Smith***

The share of capital is referred as: ***Interest***

In economics, anything that can satisfy a human want is called as: ***Goods***

- In economics cash is a: ***Working capital***

All possible combination of two inputs capable of producing same level of output refer as: ***Isoquant***

- All possible combination of two inputs which can be purchased with a given amount of fund refer as: ***Isocost line***

The time gap between investment and return is: ***Gestation period***

Risk bearing ability depends on: ***Net worth***

When total utility is maximum then marginal utility is: ***Zero***

- Stage I of production is also called the stage of: ***Increasing return***
- In the case of fruits and vegetables the marketed surplus is nearly: ***80 %***

The income elasticity of demand for inferior goods is: ***Negative***

- The income elasticity of demand for giffen goods is: ***Negative***

In the monopoly market there is: ***One seller of the produce***

When there is a only one buyer of the product, the market is termed as: ***Monopsony market***

There is a large number of buyers and seller and they have perfect knowledge of demand, supply and prices termed as: ***Perfect market***

- Markets in which business is done in accordance with the rules and regulations is called: ***Regulated market***

The cost involved in moving the product from the point of production to point of consumption is called: ***Marketing cost***

Balance sheet of farmers exhibit the: ***Financial position of a farmer***

Finance management at farm level is called as: ***Micro finance management***

As per the RBI norms, 18 per cent of the Net Bank Credit should be deployed in agriculture

- In India marketed surplus is greater than the marketable surplus
- ***Land*** rent is an example of: ***Fixed cost***
- Sales tax is an example of: ***Indirect tax***
- Through cooperative both members and non members are benefited through: ***Cooperative***
- B: C ratio = ***Gross return /Total cost***
- The most common method exists in regulated market is: ***Open auction system***
- The technique which protect the traders from extreme falls in price is known as: ***Hedging***
- Storage function creates: ***Time utility***
- When one enterprise neither adds nor hinders the production of another enterprise, the enterprise relationship is known as: ***Supplementary***
- The percentage expenditure on luxurious commodities increases as income increases
- The market in which permanent or durable commodities are traded: ***Secular market***
- Crop farming and milk production is an example of: ***Complementary enterprise***
- In WTO, non -actionable subsidies like those on agricultural research, plant protection chemicals and subsidies for ecologically fragile zone are counted under: ***Green box***
- Limited permission on subsidies like those on electricity, irrigation, fertilizers for the purpose of agricultural production are counted under: ***Blue box***
- Agriculture produce (Grading and Marketing) Act was passed in the year: ***1937***
- Co-operative credit societies act was passed **in:** ***1904***
- **In India when co-operative movement in agriculture sector started:** ***1904***

I The analytical concept -cum criterion developed recently to compare the overall development of countries is: ***Human Development Index (H.D.I)***

The Human Development Index quoted in World Development Report is a quantitative measure of a country's: ***Standard of living, educational opportunities and Longevity of citizen.*** (RAS-pre 2013)

13. STAPSTICS

1 Father of vital statistics was: ***Captain John Grant.***

1 The purpose of randomization in field experiment is to: ***Control variance***

1 Unit less measure of dispersion is: C*V.*

1 Coefficient of Variation is computed by: ***(S.D./Mean)x 100***

1 Critical Difference (CD) is calculated by: ***Ni(2 MSE/r) x t***

1 Expression for degrees of fredom in RBD is: ***(n-1) (r-1)***

The range of probability lies between: ***0 to 1***

I Minimum degree of freedom for error in ANOVA is: ***12***

1 T' test is applicable when number of treatments is: ***2***

• Goodness of test is used for distribution of: ***Chi square test***

1 The first step of summarizing the data is: ***Classification***

Probability of impossible event is always: ***Zero***

1 To find the average height of plants we should use: ***Arithmetic mean***

1 When sample size is small and S.D. is unknown use: ***T' test***

For testing the significance of correlation coefficient use: ***T' test.***

1 Latin square design is suitable for comparing: ***5 to 12 treatments***

I In the field experiments the commonly used design is: ***RBD***

The regression coefficient lies between: -00 ***to +0o***

1 The correlation coefficient lies between: -1 ***to +1***

1 The student t" test was discovered by: ***W.S. Cosset***

1 The value of X2(chi square) always lies between: *0 to* 00

Most commonly used measure of central tendency is: ***Arithmetic mean***

1 Measure of dispersion which is considered as best: ***Standard deviation***

1 Which is not a measure of dispersion: ***Coefficient of variation***

1 The value of standard deviation may vary between: *0 to* 00

1 Correlation is used to analysis the behavior of: ***Two or more variable.***

- The RBD is available for a wide range of treatments: ***2 to 24***
- If observed frequency is equal to expected one than: ***The value of x2 static is zero***
- To getting the higher precision is required: ***Larger samples***
- F" test can be used for testing the significance of: ***Several differences***
- The minimum sample size for using x2 test should be: ***50***
- To find the average size of shoes sold in the market we should use: ***Mode***
- To present the whole data by only single value we used: ***Measure of central tendency***
- During the experimentation, the some lost information can be get by: ***Missing plot technique***
- Two study effect of two or more factors requiring different plot sizes: ***Split Plot Design***
- In industries for quality control, the most important measure of dispersion: ***Range***
- If all the variate values are negative the standard deviation will be: ***Positive***
- Under the assumption for analysis of variance, the parent population should be: ***Normal***
- The analysis of variance technique is used for: ***Comparing the means of more than two populations***
- The design where number of replication is equal to number of treatments: ***Latin square design (LSD)***
- For testing the independence of two attributes, the test used is: ***x2 test***
- Correlation of continuity in 2 x 2 contingency table should be used when expected frequency of any cell is: ***Less than 5***
- When two variable moves in the same direction correlation is said to be: ***Positive***
- When two variables moves in the opposite direction correlation is said to be: ***Negative***
- In the case of perfect negative correlation the coefficient of correlation will be: **-/**

Probability of any event is a number lying between: ***0 to I,*** but not practically *zero*

In describing the amount of variation in a population & measure often used is: ***Coefficient of variation***

If the fertility variation in the field is in two directions at right angles, which of the experimental deign is suitable: ***LSD***

Arithmetic mean is most commonly used because: ***It is based on all observations***

To testing the homogeneity of correlation coefficient used: ***Chi square test***

To reduce the experimental error with heterogeneous material are used: ***More replication & use of local control***

The lack of homogeneity in the size of distribution is called: ***Dispersion***

Such measure of dispersion which is affected least by fluctuation of sampling: ***Standard deviation***

V If the kurtosis of a distribution is less than 3, then it is called: ***Platykurtic curve***

V The number of independent constraints in the set of observation is called: *Degree* ***offreedom***

The test whether theory fits well in practical can be judged by: ***Chi square test***

For testing a single proportion of the population test is used when the sample size is large: *Z- test*

The correlation between price and demand of a commodity is: ***Negative***

Statistics:

Definition: By statistics we means aggregates of facts affected to a marked extent by multiplicity of causes, numerically expressed, enumerated or estimated according to reasonable standard of accuracy collected in a systematic manner **for** a predetermined purpose and placed in relation to each other.

Variable:

- A characteristic/phenomenon which may take on **different** values i.e. **rainfall records,** birth, **death rates etc.**

Variables are **two types:**

1. **Continuous variable:** Quantities which can take **any numerical** value within certain range e.g. Plant height, yield etc.
2. **Discrete/discontinuous variable:** can take only **integer** values.

Variate:

- A single **observation** or measurement.

Central tendency:

- A value of the Variate which thoroughly representative of the **series** or the **distribution** as a whole is known as **central tendency.**

Measurement of central tendency:

1. **Arithmetic mean:**
   - Most **commonly** used measure of central tendency, only measure of **practical** importance.
   - It is regarded as the **best** of all the averages.
   - It is rigidly defined and based on all the observations.
2. **Median:**
   - The value of the **middle** most when items are arranged in either ascending or descending order of their magnitude
   - E.g. 3, 6, 9, 5, 4, 7, 8 put in ascending order = 3, 4, 5, **6, 7,** 8, 9.
   - Median is = **6**
   - Median is used for **qualitative** data such as **intelligence. ability, honesty** etc.
3. **Mode:**
   - Value of the Variate which occurs most frequently or whose **frequency** is maximum
   - E.g. 4, 7, 6- 5, 4' 6, 4
   - Mode = **4**
   - It used for model size of shoes, size of readymade garments and in business/meteorological fore casting.
4. **Harmonic mean:**
   - **It** is the reciprocal of the arithmatic mean
   - Used to find **average speed,** distance and rate.

Empirical relationship between mean, mode and median arc:

a. In a **symmetrical** distribution: Mean = Mode = Median.

b. In a **skewed** distribution/asymmetrical distribution: Mean - Mode = 3(Mean-Median).

Measures of dispersion:

- Variation of the variable about the central value

Two types of measures of dispersion:

A. Absolute measures:

1. Range:

- It is **simplest** measure of dispersion.
- Range = Largest value — Smallest value.

Properties of range:

- Coefficient of range = L - S/L + S
- Quartile range = Q3 - QI
- Coefficient of quartile range = Q3- Qi/Q3+Qi

2. **Mean deviation:**

- M. **D.** = **Z(X,-X)**

3. Standard deviation/root mean square deviation:

- It is defined as the **square root** of the **arithmetic mean.**
- Given by **Karl Pearson, 1823** denoted by Greek word ***sigma*** ***(0).***
- S. D. = V **variance**
- It is most commonly used measure of dispersion

4. Variance:

- Term **variance** proposed by **R.A. Fisher.**
- **Square root of standard deviation** known as ***variance***

B. Relative measure of dispersion:

1. Coefficient of variation (C.V.):

- Given by **Karl Pearson.**
- Most commonly used measure of relative variation.
- C.V. = a/x or **S.D./Mean**
- If standard deviation is expressed as % of mean is known as C.V.
- If value of C.V. is **greater** it means more **variability** or less homogeneity, if values of C.V. less means vice versa.

1. **Standard error of mean:**

- **SEM** defined as the **S.D.** of the **sampling distribution** of **means.**
- It gives idea about **variability** of given data or sample.

Moment:

- Force x distance.
- The moment in statistics are used to describe the various characteristics of frequency distribution like central tendency (µ I), variance (µ 2), skewness (µ 3) and kurtosis (II 4).
- In a symmetrical distribution all odd moments i.e. µ1, µ3, µ5 would always be **zero** because positive deviation & negative deviation of symmetry are exactly balance or **equal.**

Difference between **raw** moment and **central** moment:

Raw moment or arbitrary mean	**Central moment** or central mean
It is denoted by fer	It is denoted by **pr**
Calculated about any point	Calculation about **mean** only & take more time
- I' row moment about point A = 0 is equal to **mean**	1st central moment always zero
Raw moment will be changed of origin	Central moment aren't changed of origin

Note:

- Usually calculation of central moment takes the more time due to reason that mean may not be in whole number therefore calculation of the central moment first we calculate raw moment and with help of the formulae we calculate central moment.

Raw moment:

- The **r** th moment about arbimatary mean **"A"** is defined as:

I/N F (XI - AY

Central moment:

- **The rth** moment about mean (x) is defined as:

t1= 1/N 1Fi (X1-X) r

1. Value of PO=

• I N ZFE (X i-X)° = I

- The 0th central moment is always **one.**

2. Value of 1st central moment:
   - 1t,= UN IF, (Xi-X) I = 0
   - The first central moment is **always zero,**
   - Whereas" raw moment is **not zero.** It is **equal** to mean.
3. Value of 2"d central moment:
   - [12= UN IF, (X1-X) 2= 432 (variance)
   - 2" central moment gives an idea about measures of **dispersion.**
4. Value of **3rd** central moment:
   - uI = 1/N yF, **(X1-X)** = measure the **skewness.**
   - ui gives an idea either curve is symmetrical or not.
5. Value of 41h central moment:
   - 114= **UN IF,** (X1-X) 4= kurtosis.

Skewness:

- There are two type of frequency distribution:

L Symmetric frequency distribution:
   - Mean = Median = Mode.

2. Asymmetrical frequency distribution:
   - Mean Median# Mode.
   - Quartiles are not equi distant from median.
   - Q3— Md Md — Q1
   - Curve is more inclined in one side than other.
   - The sum of positive deviation from median is not equal to the sum of negative deviation from the median.

Definition:

- Skewness may be defined as departure from symmetry or lack of symmetry of frequency distribution is known as **skewness.**

Skewness is two types:

1. **Positive** skewed frequency distribution:
   - A distribution or **skewness is said to be positive if the frequency curve has a longer tail on the right hand** side as compare to left hand side.

- Positive skewness = Mean > Median > Mode.

2. Negative skewness:

- **The frequency curve is more inclined to the left hand side as compare to right hand side.**
- **Negative** skewness = Mode > Median **or Mean < Median < Mode.**

Measures of skewness:

a. **Prof. Karl Pearson coefficient of** skewness:

- SK= $\frac{\text{Mean—Mode}}{\text{SD}}$

b. **Based on moments:**

- Skewness (0,) =1132/ ft23
- yi or r = Pi 2
- kurtosis (132) = p.4/µ2
- y2=13-3

For symmetric distribution:

- PI = 0
- 132 = 3
- Skewness = 0

Kurtosis:

- Refers to degree of **flatness** or **peakness** of the frequency curve.

Three types:

- Leptokurtic (narrow peak/base): 132 > **3**
- Mesokurtic (normal curve): 132 = **3**
- Platykurtic (flat peak/broad base): 132 < **3**

Distribution: Theoretical distributions are two types.

a. **Discrete** distribution:

- X can take only integer values like 0, 1, 2, 3, - - - - - -
- Eg. **Binomial distribution, Poisson distribution**

b. **Continuous** distribution:

- X can take **all possible** values in a given range.
- E.g. **Normal distribution.**

1. Binomial distribution:

- Given by **James Bernoulli** in 1700 A.D.

- Bernoulli trial: a trial is known as Bernoulli trial if it has only two out comes namely success and failure with probability **p** and **q** respectively.
- **p + q =** ı

Definition:

- A random variable "x" said to have binomial distribution if it assumes only non -negative values and its probability mass function is given by:
- p (x) **otho pX.** n- x
- **X = 0 ,** , 2, - - - - -
- n = number of trial
- x = number of success of n trial
- p = probability of success
- q = probability of failure or **(1-p)**
- p + q = 1 (B.D. represent by 1)
- **n p** are the parameters of B.D.

Properties of B.D.:

- Arithmetic mean (11.1) of B.D = np
- Variance (II ,) of B.D. = npq
- Skewness (µ3) = npq (q -p)
- Kurtosis (p4) = npq (1 + 3 (n-2) p q
- Standard Deviation = 4npq
- In case of B.D = **Mean** > **variance.** ***(JRF-07)***

2. **Poisson distribution:**

- Discovered by **S.D. Poisson**

Definition:

- It is a limiting case of B.D such that
- N tends to Go
- p tends to zero
- and np = m

Therefore a variable x" is said to follow a Poisson distribution if it assumes only **negative** values and its probability mass function is given as:

- P (x) e XI

X

Here,

X is called the parameter of P.D

X. is always greater than zero.

X = number of success

- e = 2.718

Examples of P.D:

- Number of deaths from a disease
- Number of defective materials
- Number of wrong calls receives in a month.

Properties of P.D:

- Mean (p i):
- Vafiance (p,):
- 1.0:

"

- **In case of P.D: Mean = Variance.** ***ORE -09)***
- P.D is useful in theory of games, waiting time, problems of business.
- P.D tends to normal distribution when A tends to 00

Coefficient of P.D:

- **131=** 1/
- 132= 3+1/A

3. **Normal distribution:**

- Discovered by **de- Moivre** in 1733 also called *Gaussian*

(A011)1111011.

Definition:

- A random variable x" is said to have a normal distribution with parameters **mean** and **variance** and its probability density function is defined as:

e-ṗ -(x-107)

P (x) =

a

Properties of normal distribution:

- The curve of normal distribution is bell shaped
- It is symmetric about the mean
- Mean = Mode = Median (are equal).
- Quartiles are equi distance from median: *Q3-Q2 = Q2- 0*
- Coefficient of skewness for normal distribution is: *Zero*
- Coefficient of kurtosis for normal distribution is: 3
- Range of normal distribution is from: -00 *to* +00
- But practically range equal to *6a*
- Mean deviation about mean: *4/5a*
- Quartile deviation: *2/3a*

Importance of normal distribution:

- It has got a large application in statistics quality control and important area of statistics used in industries for setting control limit.

Correlation:

- It studies the **relation** or association between two variables.
- Two independent variables are **uncorrelated.**
- The measurement of correlation is called the **correlation co-efficient** (r) or correlation index, which summarizes in one figure the direction & degree of correlation.
- **Range of correlation** are varies between **+1** to **-1.**

Types of correlation:

a. Positive/negative:

- If both the variables are varying in the **same direction** i.e. one is increasing the other also increasing and vice versa than it is known as **positive correlation.**
- If both the variables are varying in **opposite direction** i.e. as one variable increasing the other is decreasing and vice versa than it is known as the **negative correlation.**

b. **Simple, partial and multiple correlations:**

- **Simple** correlation: when only **two variables** are studied.
- **Partial** correlation: **More than** two variables are studied but consider only two to be influencing each other, the effect of other influencing variable being kept constant.

- **Multiple** correlations: **three** or more variable are studied simultaneously.

c. **Linear** and **non linear** correlation:

- If the amount of change in one variable **tends** to bear a constant ratio to the amount of change in the other variable is known as ***linear correlation.***
- If the amount of change in variable **doesn't** bear a constant ratio to the amount of **change** in other variable is known as ***non linear*** *correlation.*
- In the **most of** the practical situations we find a **non linear** relationship between variables.
- Absence of any **relationship** between the variable the value of correlation coefficient will be **zero.**

Regression:

- Term regression first used by **Sir Francis Galton** in 1877.
- The regression analysis is a mathematical average relationship between **two** or **more** variable. Relation may be linear or non linear.
- Original line of regression = y = a + bx
- Range of regression is varies between: + oo **to - oo**

Transformation of data:

- When the data do not follow the normal distribution the variate x_i be transformed to some new variate say f(x1) in such a way that f(x) is normally and independently distributed with mean (N) & Variance (a^2)

Types of transformation:

a. **Square root transformation:**

- Used when countable data have **small** values between 0-10 & when data follow Poisson distribution.
- It is also used for percentage data when all values are > **80 %.**
- E.g. Transformation = N X

b. **Logarithmic transformation:**

- Used when variation in the countable data is **large** and values are also large.
- E.g. Transformation = **log x** or log x+1

C. **Angular or aresine transformation:**

- Used for data following binomial distribution and when data are in percentage based on count values.
- The percentage are transformed the degree.
- E.g. **Sin = p/100**

Hypothesis:

- Any **statement** about the population parameter.

Test of hypothesis:

a. **Null hypothesis:**

- A statement about parameters which to be rejected afier testing is known as null hypothesis.
- Given by **R.A. Fisher**
- It is denoted by 11-10
- It is the hypothesis of **no difference.**

b. **Alternative hypothesis:**

- This is the hypothesis contrary to the null hypothesis.
- Denoted by 111.

Types of error:

a. **Type t" error:**

- It denoted by **Alfa (a).**
- Rejecting **Ho** when it is true or accepting H1 when it is false.

b. **Type 2"d error:**

- Denoted by Beta (0)
- **Accepting** Ho when it is false, **rejecting** Hi when it is true.
- It is more severe than type I error.

Level of significance:

- The maximum probability of committing type I error is known as level of significance denoted by **Alfa**
- Generally we take **5% (field** ex.) or 1% level of significance.

Degree of **freedom:**

- It is difference in total number of items (n) & linear constraints.
- **D.F. =** N- Total number of constraints.

" D.F. — N -K (total no. of constraints)

fest sionTeance:

a. **Chi-square (x2) test:**

- First used by **Karl Pearson (** 1900)

- It is used for **enumerated** or non parametric/qualitative data in **Mendelian** or population genetics.
- Range: o to oo
- X2 = Doi - e1) 2/e1

Conditions for applying x2 test:

- Total sample size > **50**
- Expected frequency of each and every class should not be **less than 5.**
- The sample observation should be independent.

Application of Chi-square:

- To test the goodness of fit
- For testing the hypothesis about the ratios for various classes
- Testing the independence of two attributes
- For detection of linkage
- To study gene frequencies in population genetics
- Test of significance of difference between two mean:

b. Z test/ student **z test:**

- Given by **R.A. Fisher.**
- Used when sample size is **large > 30.**

c. Student t- test:

- Given by **WS Gosset 1905**
- Used when the sample size is **small (<30).**

Basic principle of field experimentation:

a. **Replication:**

- **Repetition** of treatment under investigation is known as **replication** so that each treatment experiences every type of environment in the field.
- It increases precision, to estimate experimental error.

b. **Randomization:**

- **Allocation** of treatment to the various experimental units by a random process
- It is **minimizes** the random variation.

C. **Local control/error control:**

- The process of **dividing** the experimental material into different groups called **blocks** to make them areiner **homogenous** is known as local control/error control.

- It **reduce** the experimental error hence make the test of significance more **powerful.**

Treatment:

- The objects of comparison which an experiment has to try out in the field or elsewhere for assessing their values are known as **treatment**
- **E.g. Varieties, manures, cultivation practices,** methods of **seed treatment, insecticides** etc are treatments used in case of **field experiment.**

Experimental unit:

- The group of **material** to which a treatment is applied in a single trial of treatment.
- E.g. A plot of land, a **patient** in hospital etc.

Experimental error:

- The **variation** in the data due to uncontrolled factor is known as experimental error.

ANOVA:

- Analysis of **variance**
- The concept by **R.A. Fisher**
- **It** is a statistical **technique of partitioning the total variation into component** variations & computing them **by F test.**

Experimental design:

- **A local structure** of an experiment that helps in obtaining results with some precision.

a. **CRD (completely randomized design):**

- **It** is regarded as **one way** classification and **no way** control or elimination
- " **Applied when the experimental material is limited and homogenous, such as the soil in Pot** experiments.
- This provides the **maximum** number of degree of freedom for error, for a **given number of treatments as compared to other design.**
- **Local control not** used in **CRD.**
- **Error degree of freedom in CRD: N -n2**

b. RBD (randomized block design):

- **Two way classification and one way** control

- This design appropriate when the fertility gradient in the field is in **one direction** only
- It is used up to **20 treatments** without appreciable loss of efficiency.
- In RBD the most number of blocks must be **equal** to the number of replications fixed for ceach treatment.
- The number of plots in each block should be equal to the number of treatments.
- It provides more accurate results than CRD due to **formation** of homogenous blocks.
- It is **most commonly** used design in field experiment.
- This design **utilizes** all the three basic principles of field experimentation.
- Error degree of freedom in RBD: **(n-1)** x **(r-1).**

c. LSD (Latin square design):

- Three way classification two way control of error
- The term **square** has been used in LSD because the number of **rows and columns are equal.**
- This design used when fertility gradient is in **two directions.**
- Suitable for **5-8** treatments or from **5-12 at the most**
- Because the minimum error degree of freedom should be **12**
- **Shouldn't** be used for **less than 5** treatments
- Number of **replications =** Number of **treatment.**
- Number of **rows =** Number of **column =** Number of **treatments.**
- **Randomization** of treatments is done in such a way that each treatments occurs once and only once in **each row** and each **column.**
- Error degree of freedom in LSD: **(n-1) x (n-2)**

d. SPD (split plot design):

- A lay out in which one set of treatments is **assigned** to **large plots** called **main plots in** to which a replicate is divided and **another set** of treatments to **sub divisions** of the main plots called **sub plots** is termed as a **split plot design.**

This design used under following condition:

(i) When factors of the different nature are to be tested in same experiment that is level of one factor require larger area as compared to other factor eg. **Depth of ploughing** and **nitrogen levels, date of sowing** and **varieties,** varieties and nitrogen level, irrigation level and varieties.

ii) When all factors aren't important

(iii) When the levels of one factor produce larger differences as compared with the levels of other factor.

(iv) When we want to study one factor with **higher precision** as compared to other factor and take it in sub plots.

e. **SrPD (strip plot design):**

- This design is used when both the factors **require** relatively **large** area.
- In this case **sub plot** treatment is applied **in strips** instead of randomizing in each unit.
- In this design number of error is **equal** to the number of plot size.

Confidence limit:

- The **range** w ith in which the true **populations mean** lies is called confidence limit or **fiducially limit.**

Biometry:

- The application of statistical concepts and procedures to study of **biological problems.**

.7 Total livestock [redacted]

Share of world li . **t.tict(population** in India: ***15 %***

.4 Cattle population in India: ***205 millions***

.1 Buffalo population: ***84***

Cattle disease that is co;nguniCated to man is: ***Anthrax***

Cow's milk is **light yellow** or ***creamy*** in colour due to: ***Carotene***

- The milk is white in colour due to presence of: ***Casein***

The carbohydrate or sugar constituent of the milk: ***Lactose***

Milk is deficient in element: ***Iron***

V Milk production is maximum in: ***Uttar Pradesh***

- The state which is second in milk production is: ***Rajasthan***
- Fat globule in the milk are in the form of: ***Emulsion***
- Protein present in the milk in the form of: ***Colloidal***

Lactose and Minerals are present in milk in the form of: ***Solution***

- Milk is the poor source of: ***Iron and Vitamin C***

India **ranks first** in production of: ***Carpet wool***

Best crop for silage making is: ***Maize***

Temperature of artific:.. vagina: ***42 °C***

First clone of adult **(sheep)** animal: ***Dolly***

In India wool production is maximum in: ***Rajasthan***

Disbudding in calf of newborn is done at the age of: ***4-10 days***

Swelling due to the **collection** of gases in **rumen** of the animal is: ***Bloat***

Protein content in colostrums of cow is 12.8% & in buffalo colostrums is: ***21.4%***

- Generally ruminant have ***four chambers*** stomach eg. cattle, sheep, goat, Seer except ***camel*** that has ***three chambered rumen.***

Milk is rich source of **Calcium, Phosphorus** and excellent source of ***vitamin A.***

India's first position **world milk production**, total **buffaloes, wool production au.** ***cattle production.***

- The world's first in vitro fertilized buffalo calf **is: Pratham**
- The most commonly used cryoprotectant for freezing of semen: ***Glycerol***
- ***Collagen*** is the main proteins of skin/connective tissues
- Canabalism is seen in poultry due to: ***Sodium chloride deficiency***
- Cracked feet in poultry is caused by: ***Deficiency of biotin***
- Degnala and Alkali diseases are caused due to toxicity of: ***Selenium***
- Crazy chick disease is caused by deficiency of: ***Vitamin E***
- Breed of poultry is excellent for broiler purpose: ***Plymouth Rock***
- A pregnant cow doesn't come in heat due to presence of: ***Corpus luteum***
- Animal protein factor is known as: ***Cobalamine***
- Fat content in double tonned milk is: ***1.5 %***
- Hay can be stored if moisture per cent below: ***16 %***
- Legal standard for solid not fat (SNF) in cow milk is: ***8.5 %***
- Let down of milk in cow is due to: ***Secretion of atytoxine***
- Milk lipid is: ***lecithin***
- Scientific castration is done by using an instrument known as: ***Burdizzo castrator***
- Only essential fatty acid of poultry is: ***Linolic acid***
- Glucose + Glucose = ***Maltose***
- Glucose + Fructose = ***Sucrose***
- Glucose + Glactose = ***Lactose (Milk** sugar)*
- Sulphur containing vitamins are: ***Thiamine and Biotin***
- Sulphur containing amino acids are: ***Cystine, Cysteine and Methionine***
- The best way to prevent fatal septicaemia in young calves is to make sure that they get: ***Colostrums***
- The biggest compartment of ruminant stomach is: ***Raman***
- The boiling point of milk is: ***100.17 °C***
- The main storage polysaccharide in animal cells is: ***Glycogen***
- ***Casein*** constitute about 80 % of the total protein present in milk

The most variable constituent of milk is: ***Fat***

V The process of dehorning is accomplished by applying: ***Castic potash***

The poultry specially raised for meat production is known as: ***Broiler***

The protein which can't be digested: ***Elastin***

V Which is used for treatment of oxalate poisoning: CaCo3

V Freshly drawn milk has a pH value of: ***6.5-6.7***

The disease in which animals aborts or gives birth to a dead or weak calf is known as: ***Brucellosis***

• The deficiency of manganese in poultry causes: ***Perosis***

Parakeratosis is caused by the deficiency of: ***Zinc***

Oxidation of fat is called: ***Beta oxidation***

Protein which is soluble in water and heat coaguable is: ***Albumin***

Pasteurization:

- **It** is done to kill all the **pathogenic** and **most of** the **non-pathogenic** bacteria eg. ***Clostridium botulinum.***

Methods:

- **Low Temperature Long Time** (LTLT): Exposing of milk at **61-63 °C** for **30** minutes.
- **High Temperature Short Time** (HTST): About **71-76.6** °C for **15** seconds.
- **Ultra High Temperature (UHT): 148** °C **1-** 5 seconds or **149** °C for **0. 5** sec. Followed by rapid cooling by **10** °C or below.

Common terms in live stock production:

Details	**Cattle**	**Buffalo**	**Sheep**	**Goat**	**Pig**	**rOtIltry**
Group	**Herd**	**Herd**	**Flock**	Flock	Drove, herd	**Flock**
Adult male	Bull	Buffalo bull	Ram	I3uck	Boar	Cock
Adult female	Cow	Buffalo	**Ewe**	**Doe**	**Sow**	Hen
Young male	Bull calf	Buffalo Calf	Male lamb	Male kid	Boarling	Cockrel
Young female	Heifer calf	Heifer calf	Female lamb	Female kid	Female pielet	Pullet
New bom	Calf	Buffalo calf	Lamb	Kid	Piglet	Chick

Meat	Beef, calf-veal	Buffin	Mutton	Chevon	Pork	('hicken
Casted . male	Bullock	Bullock	Weeder	Buck	Hog. stage	Capon
Mating	serving	Serving	'nipping	Serving	Coupling	Serving
Parturition	Calving	Calving	Lambing	Kidding	Farrowing	Hatching

Body temperature and gestation period of domesticated animals:

Live stock	Body temperature		Gestation period (days)
— ,	(℃)	et")	
cow	38.5	101.5	282
Buffalo	37.5	100	310
Goat	39.1	102.5	148
' Sheep	38.9	102	150
Camel	-		390-410
Pig	' 39.2	102.6	114
Hen	_ 41.7	107	-

Reproductive cycle of domestic animals:

Animals	Puberty (females) (in months)	Oestrous cycle (days)	Period of heat
Cattle	30-42	21 days '	18 hours
Buffaloes	30-42	21	27 hours
Goat	15-18	18-21	2-3 days
Sheep	18	15-18	1-3 days
Camel	36-48	14	-

Composition of milk (% by weight)

Species	Water	Fat	Protein	Lactose
Cow	86.61	**4.14**	3.58	4.96
TBuffalo	82.76	7.38	3.60	**5.48**
I Goat	87.00	4.25	3.52	4.27
Sheep	79.50	**8.50**	**4.00**	4.30

Nutrient:

Carbohydrate

- Protein

Fat

- Conversion of milk into curd

Bacterial fermentation

Streptococcus lactis

Bacillus subtilis

Pseudomonas fra2i

Lactobacillus thermophillus

Classification of cattle breeds in India:

SN	Breed name	Native of	Features
A	**Dairy breed**		
1	**Sahiwal**	Montgomery (Pakistan)	**Highest and sweetest milk producing** cow breed
2	Gir	Kathiawar (Gujarat)	In Rajasthan found Ajmer & Bhilwara districts
3	Sindhi	Karachi (Pakistan)	Red brown in colour
B	**Draught breed**		,
1	Malvi	Malwa (MP)	-
2	Nagori	Nagaur (Rajasthan)	Superior among drought breeds
3	Amaratmahal	Mysore (Karnataka)	- ,
C	**Dual purpose** breeds		
1	Hariana	Hissar/Rahtak (Haryana)	Best dual purpose breed
2	Kan krej	Kutchh (Gujarat)	Highest body weight in Indian cows
3	**Rathi**	A I war (Rajasthan)	Found in Bikaner & Ganganagar districts of Raj
4	**Tharparkar**	Sindh (Pakistan)	In Rajasthan found Jaisalmer & Jodhpur dist.

	Ongole	Guntur (Andhra Pradesh/KR)	Pure white in colour
	Mewati	Kosi (Mathura)	Al war and Bharatpur districts of Rajasthan
	Hariana	I-Iissar/Rahtak (Haryana)	Best dual purpose breed
	Kankrej	Kutchh (Gujarat)	Highest body weight in Indian cows

Exotic cattle breed:

- **Jersey:** Native of **English Chanel** (highest. fat % in exotic breeds)
- **Holestein Friesian:** Native to **Holland,** Heaviest exotic breed, highest milk producing cow in the world (5000-6000 litre/year)
- **Frieswal** (Holstein x Sahiwal): Highest milk yielding breeds (14 lit/day)
- **Brawn Swiss:** Native of **Switzerland**

Hybrid developed form **NDRI, Karnal:**

- **Karan Fries:** (Friesian x Tharparkar)
- **Karam Swiss:** (Brown Swiss x Sahiwal)

Buffalo breeds:

SN	Name of breed	Native of place	Features
	Murrah	Southern Punjab	Best in milk, 7% Fat. ***Jet black*** coloured body coat
2	**Bhadawari**	Agra (UP)	Highest Fat % (13 %), ***Copper coloured*** body coat
3	Zaffrabadi	Kathiawar (Gujarat)	
4	Nil Ravi	Pakistan	White eyes known as ***'Wall eyes'***
5	Mehsana	Baroda (Gujarat)	
6	Surati	Baroda (Gujarat)	***Sickle shape horn*** is characteristic feature
7	Godavari	Andhra Pradesh	

Common diseases of cattle:

- **Mastitis:** **Inflammation of udder**
- **FMD:** **Viral disease**
- **Riderpest:** **Viral, known as cattle plague**
- **Anthrax:** **Bacterial disease, it is called Spleenic fever**
- **Cow pox:** **Viral disease.**

Sheep breeds:

SN	Region	Breed name	Native	Remarks
1	**Himalayan**	**Gaddi, Rampur-bushier, Bhakarwal**	**Jammu Kashmir**	**Fine quality** wool *Loei* is obtained from Bhakarwal
2	**Western**	**Lohi**	**Pakistan**	**Largest** Sheep
		Bikaneri/Pugal	**Rajasthan**	**Best Carpet** wool
		Manvari	**PB&RJ**	Black face
		Jaisalmeri	**Rajasthan**	Desert breed
		Malpura	Tonic, Rajasthan	Suitable for meat
		Chokla	**Shekhawati** region	Known as **'Merino'** of Rajasthan
3	**Southern**	Deccani	**MH, KN, AP**	**Good for mutton, fit** for weaving ***kambal***
		Nel lore	Andhra Pradesh	**Tallest** breed
		Mandya	Karnataka	**White** in colour
4	**Eastern**	Shahabadi	Muzaffarnagar **(UP)**	Best wool producing breed **in India.**
		Hisardale	Developed at **Hissar**	Cross of **Bikaneri x Merino**

Exotic breeds of sheep:

Merino:

- Native of Spain
- **Fine wool** breed
- About **80%** of wool that is produced in the world comes from Merino and its crosses.

Rambouillet: *(RPSC, A0-09).*

- Native of **Spain**
- Dual purpose breeds.

Diseases of sheep:

- **Anthrax:** caused by Bacteria **(contangious** to man).

- **Stiff lamb disease:** caused by **Vitamin E** deficiency.

Goat Breeds of India:

Pashmina used in winter clothes is obtained from the animal: **Goats.**

Morocco: fine **leather** is prepared from **uoat** skin.

SN	Name of breed	Native place	Features
1	**Jamunapari**	Etawa (UP)	Dual purposes breed. Pendulated curved long ears, **'roman nose'** and thick long hairs on hind legs are major characters
2	**Barbari**	Somali (Africa)	**Dairy breed,** suitable for **towns and cities.** Usually give birth **two kids (twins)** in one parturition
3	**Beetul**	Gurdaspur (PB)	Resembles as **`Jamunaparr.** Presence of **beard** in male
4	**Black Bengal**	Western Bengal	**Excellent for meat** ***(RPSC, AO-09)*** ***:***
5	**Marwari**	Marwar (Raj)	Disease resistant breed
6	**Sirohi**	Sirohi (Raj)	Dual purpose breed

Exotic breeds of dairy goat:

Angora:

- **Native of Turkey**

Alpine:

- **Europe (milk breed)**

Anglo-Nubian:

- It is cross between Jamunapari and Nubian (England).
- **Known as 'Jersey cow'**

Saanen:

- Native of Switzerland; presence of **beard** in **both** the sexes is **the characteristic feature.**
- This breed is also known as **Queen of Goats.**

Toggenberg:

- **Chocolate colour**
- **Hornless breed**
- **Native of Switzerland.**
- **Milk breed**

Swine:

- **Salted smoked meat of Pig is known as Bacon.**

Exotic Breeds of swine:

- **Lind race: white in colour: native of Denmark.**
- **Duroc: red in colour: native of USA.**
- **Yorkshire: white in colour: native of U.K.**

Viral diseases of cattle:

- **Swine fever** — **Pox**
- **FMD** — **Plague**
- **Blue tongue** — **New castle (Ranikhet)**
- **Leucosis** — **Rinderpest**
- **Marek' s** — **Bronchitis**

Fungal diseases:

- **Bronchomycosis** — **Ringworm**
- **Brooder pneumonia** — **Aflatoxicosis**

Protozoa diseases:

- **Coccidiosis** — **Anaplasmosis**
- **Theileriasis** — **Trypanosomiasis (surra)**

Bacterial diseases:

- **Anthrax** *(Bacilus anthrasis)* **Black quarter**
- **Brucellosis** — **Mastitis**
- **(P. maltocida)** — **Pneumonia**
- **Tuberculosis** — **Cholera**
- **Typhoid**

rvj

Poultry breeds:

SN	Name	Native	Features
1	**Rod Island Red**	**America**	**Dual purpose breed, produce 100 eggs/year**

2	**White Leghorn**	Italy	Highest eggs production breed in world, 220 eggs/year
3	**Red Cornish**	England	Famous in America for meat
4	**Plymouth Rock**	America	Produce best quality meat
5	Aseel	UP	Famous for **fighting sports**
6	**Kadaknath**	-	**Black** coloured meat

- A medium sized **egg** contains **6.0 g protein, 6.5 g CaCO3, 14 g Vitamin.**
- **Andhra Pradesh** has largest number of poultry and is the largest producer of eggs in India.
- Colour of egg yolk is due to the pigment: **Xanthophyll.**
- Usually internal quality of eggs can be determined by: **Candling.**
- In our tropical climate necessary to construct poultry house **East to West** in order to **avoid** sun ray directly falling into the shed and heating up of the shed.

Important disease of poultry:

- **Bacterial** diseases: Fowl Cholera, **Diarrhea**
- **Viral** diseases: **Ranikhet,** Marek's disease
- **Protozoal** disease: **Coccidiosis**

Nutritional diseases:

- **Nutritional roup:** Vitamin **A** deficiency
- **Rickets:** Vitamin **D** deficiency
- **Curled toe paralysis** **itatnin $_{B2}$** deficiency

Fish production:

1' India is the **second** largest fish producer from **inland** sources after **China.**

Maximum fish production is in **West Bengal.**

./ Maximum **marine** fish production is in **Gujarat.**

Largest contributor in agricultural **export:** **Marine products.**

Terminology:

I. **Alveolus:** A small structure in mammary glands in which milk is manufactured by female.

2. **Anorexia:** Lack of appetite.
3. **Biological value:** Percentage utilization protein within animal body.
4. **Crude fiber:** Composed of cellulose, hemi cellulose, etc. it is high in forage and other poly saccharides and low in grain.
5. **Culling:** The separation of diseased animals from healthy animals.
6. **Casting:** Throwing the animals on the ground
7. **Docking:** Removal of tail in sheep.
8. **Flushing:** Feeding extra concentrates to pregnant sheep is known as ***flushing.***
9. **Dehorning:** Suppression of emerging horn in goat at an age of 10 days.
10. **Mohair:** The hair of Angora breed of goats, soft white wool in great demand for clothing.
11. **Pashmina:** The undercoat of Kashmiri goats, soft wool in great demand for clothing.
12. **Pica:** An appetite for materials not usually considered to be food such as is observed in phosphorus deficient animals; a deprived appetite.
13. **Puberty:** The period of life at which the reproductive organ first become functional. This characterized by estrus and ovulation in the female and semen production in the male.
14. **Surra:** Common disease in camel caused by protozoa.

Surahee's Best Seller Agri-Competition Book

1. Agronomy Treatise
2. Agri -Scan
3. A Competitive (Bookof Agricutature
4. Vegetabk Science -fl Guide
5. Compkte Agricurture (14 gandi)
6. Objective Agriculture Encyclopedia-Part-I
7. Objective Agriculture Encyclopedia-Part-II
8. Plant Pathology an ov[illegible]

Published by:
Surahee Publications, Jaipur