



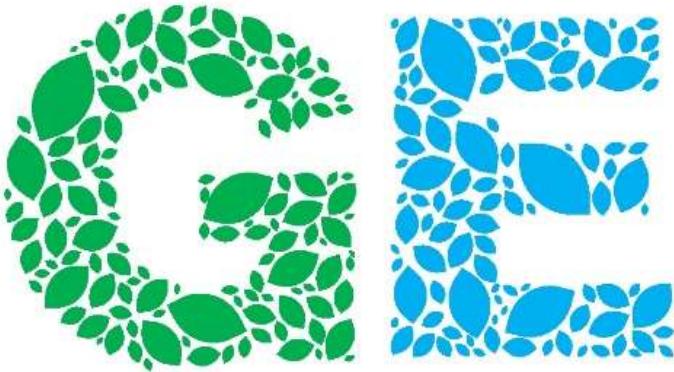
"We plant seeds of SUCCESS"

Licensure Examination in

Agriculture Reviewer

(Lecture Manual and Review Questions)

CROP SCIENCE



Green Empire PH is an online support group providing basic knowledge in agriculture especially to those who are planning to take the Licensure Examination in Agriculture in the Philippines.

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CROP SCIENCE

I. AGRICULTURE AND CROP SCIENCE

A. The Concept of Agriculture

- ✓ Systematic raising of useful plants and livestock under the management of man
- ✓ Purposeful work through which the elements of nature are harnessed to produce plants and animals to meet human needs.
- ✓ Broad industry engaged in the production of plants and animals for food and fiber, the provision for agricultural supplies and services and the processing, marketing and distribution of agricultural products

B. World and Domestic Food Situation and Production Centers

- The world population is expected to increase by 2.6B over the next 45 years from 6.5B today to 9.1B in 2050. Much of the increase will be from developing countries. The population in developing countries will increase from 5.3B to 7.8 B in 2050.
- Great pressure is being placed on agricultural lands hence, it is imperative to increase current levels of food production to provide an adequate supply of food to increasing population
- Arable land is not suitable for agriculture of the world's total land area of 150 M km². Arable land comprises 10% of the total; permanent crops are 1%; meadows and pastures, 24%; forest and woodland, 31%. The remaining 34% is land surface that supports little or no vegetation: Antarctica, deserts, mine sites, urban areas.

- Rapid population growth in most developing countries had greatly reduced the arable land per capita. It is estimated that by 2050, the amount of arable land will be just over one-tenth of a hectare per person, from 0.50 ha in 1961.

C. Philippine Population, Food Supply and Agriculture

- In 2009, the Philippine population was 92.23M.
- The annual population growth rate from 2000-2007 is 2.04%.
- About 32% of the country's total land area constitutes the agricultural land.
- At constant prices, the agriculture and fishery sector had 3.23% growth in 2008. The average annual rate of increase was 3.98% for the period 2006 to 2008.
- The share of agriculture in the gross domestic product (GDP) in 2008 is 18%.
- Presently, the increase in food supply is about 2% per year which is just enough to keep up with population increase. About 20% of this increase is the result of expansion of new production areas. The remaining 80% is due to technological advances in production like improved irrigation, crop protection, better cultivars, improved crop nutrition, post-harvest handling etc.

D. State of Philippine Agriculture

Agriculture and Fisheries Modernization Act (AFMA) or Republic Act 8435

- Mandated the modernization of the country's agriculture sector
- Signed into law in 1997

E. The Concept of Crop Science

Science – systematically accumulated and tested knowledge.

Plant – any organism belonging to the Kingdom Plantae, typically lacking active locomotion or obvious nervous system or sensory organs and has photosynthetic ability.

Crop – domesticated/cultivated plants grown for profit. It usually connotes a group or population of cultivated plants.

Crop Science – It is concerned with the observation and classification of knowledge concerning economically cultivated crops and the establishment of verifiable principles regarding their growth and development for the purpose of deriving the optimum benefit from them. It is divided into areas as follows:

- a. **Agronomy** - deals with the principles and practices of managing field crops and soils
- b. **Horticulture** – deals with gardens and plants within an enclosure. It includes :
 - i. **Pomology** (fruits)
 - ii. **Olericulture** (vegetables)
 - iii. **Floriculture** (flowers)
 - iv. **Nursery management**
 - v. **Landscape gardening**

G. Crop Production as a Science, Art and Business

- Its science is derived from the adoption or application of the basic sciences of chemistry, mathematics, physics, and from various applied sciences like physiology, meteorology, anatomy, plant breeding etc.
- It requires skills to produce crops even with little or no scientific training.
- Plants are not grown simply to satisfy the needs of man but to realize some profit in the process of production

Agricultural research in the Philippines has been established through schools and research centers, in both private and public sector. These are:

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1. State colleges and universities offering degrees in agriculture
2. Department of Agriculture Research Networks
3. National commodity research centers
 - ✓ **FIDA**- Fiber Industry Development Authority
 - ✓ **NTA**- National Tobacco Administration
 - ✓ **PhilRice**– Philippine Rice Research Institute
 - ✓ **PCA** – Philippine Coconut Authority
 - ✓ **SRA** – Sugar Regulatory Administration
 - ✓ **PRCRTC** – Philippine Rootcrops Research and Training Center
 - ✓ **NPRCRTC** – Northern Philippines Rootcrops Research and Training Center
 - ✓ **NARC** – National Abaca Research Center
4. Specialized discipline-oriented research centers
 - ✓ **IPB** – Institute of Plant Breeding
 - ✓ **NCPC** – National Crop Protection Center
 - ✓ **NPGRL** – National Plant Genetic Resources Laboratory
 - ✓ **PHTRC** – Postharvest Horticulture Training and Research Center
 - ✓ **BIOTECH** – National Institutes of Molecular Biology and Biotechnology
5. Private seed companies
 - ✓ East West
 - ✓ Monsanto
 - ✓ Pioneer
 - ✓ Syngenta
 - ✓ Allied Botanicals

Major international research organization mandated to do research and development in crop species important to food and agriculture include the following:

- ✓ **IRRI** – International Rice Research Institute (Philippines)

- ✓ **CIMMYT** – Centro International de Mejoramiento de Maize y Trigo (Mexico)
- ✓ **CIP** – Centro International de Patatas (Peru)
- ✓ **ICRISAT** – International Center for Semi Arid Tropics (India)
- ✓ **CIAT** – Centro de International de Agricultural Tropical (Colombia)
- ✓ **ICARDA** – International Center for Agricultural Research for Dry Areas (Syria)
- ✓ **IITA** – International Institute for Tropical Agriculture (Nigeria)
- ✓ **ICRAF** – International Center for Research on Agroforestry (Kenya)
- ✓ **AVRDC** – Asian Vegetable Research and Development Center (Taiwan)
- ✓ **Biodiversity International** – for International Plant Genetic Resources Institute (Italy)

II. CLASSIFICATION OF CROPS

- Crops are classified for order and organization. Agricultural crops are diverse in nature hence classification of a crop is very helpful.
- Crops are classified for logical naming. A crop can be identified by its common name which varies from one locality to another or by its scientific name which is constant worldwide.

A. Systems of Classification

- a. **Artificial system**– based on convenience in which a structure or feature serves as a basis of grouping
- b. **Natural system**– uses the most prominent and most peculiar morphological structure of the plant with the intention of grouping together those crops which are most familiar in a number of structures

- c. **Phylogenetic system** – plants are classified according to their evolutionary status

B. General Classification of Crops

i. According to growth habit

- a. **Herbs** – succulent plants with self-supporting stems, with soft stems
- b. **Vines** – succulent or woody plants without self- supporting stems
- c. **Shrubs** – may have several main branches with no trunk and rarely grows higher than 5 meters
- d. **Trees** – with single central stem to which branches are attached, usually taller than shrub

ii. According to life cycle

- a. **Annuals** – complete their cycle in 1 year or less.
eg. Squash
- b. **Biennials** - plants ordinarily require 2 years or at least part of 2 growing seasons with a dormant period between growth stages to complete their life cycle.
eg. carrot, cabbage, celery
- c. **Perennials** – plants that do not die after flowering but live from year to year
eg. Asparagus

iii. According to mode of reproduction

- a. **Sexual** – plants that develop after undergoing processes of meiosis and fertilization in the flower to produce a viable embryo in the seed
- b. **Asexual** – plants that are produced by any vegetative means not involving meiosis and the union of gametes.

iv. Special types:

- a. **Parasites**- parasitic, sucking roots
- b. **Epiphytes**- grow upon other plants (orchids) but not parasitic

- c. **Saprophytes**- grow in places rich in decaying organic substances

C. Classification of Crops Based on Purpose

1. **Cereals/grain crops** – grown for their grains
Examples: rice, corn, wheat, sorghum

2. **Legumes** – for pods and seeds
Examples: cowpea, mungbean, sitao, peanut

3. **Root crops** – for enlarged roots/ tuberous roots
Examples: cassava, ubi, arrow root

4. **Fiber crops** – grown for their fibers used in textile, cordage, twines, sacks, bags etc.
Examples: cotton, ramie, kenaf, jute

5. **Oil crops** – grown for their oil content
Examples: soybean, peanut, sunflower, castor, coconut

6. **Sugar crops** – grown for their sugar content
Examples: sugarcane, sugar beet

7. **Pasture/Forage crops** – used for roughage source for animals
Example: para grass, napier grass, ipilipil, *Stylosanthes*

8. **Beverage crops** – used for brewing non-alcoholic drinks
Examples: coffee, cacao, tea

9. **Spices, condiments, essences** – used to provide special flavor, scent, and color to food, perfumes, soaps and body dressing

Example: black pepper, vanilla, citronella, ilang-ilang, annatto

10. **Latex and resins** – used for extracting sap from the trunk/stem

Examples: rubber, chico, pili, rimas, papaya

11. **Medicinal and poison crops** – with curative, laxative and pesticidal properties

Example: lagundi, sambong, tobacco

12. **Vegetables** – usually eaten with staple crops, further classified according to similarities in the method of culture

- a. Root – radish, carrot
- b. Leafy – spinach, lettuce
- c. Stem – celery, asparagus
- d. Flowers – squash, katuray
- e. Fruit – okra, tomato, eggplant

13. **Fruits** – edible botanical fruits usually used for dessert which may be eaten raw, cooked or in processed form.

Example: pineapple, cashew, mango

14. **Ornamentals** – plants cultivated mainly for their aesthetic value, further classified according to their special uses.

- a. **Cutflowers**– grown for its flowers
Examples: roses, orchids

- b. **Cut-foliage**– foliage provides background in floral arrangement

Examples: ferns, fortune plant, palmera

- c. **Flowering pot plants** – plants grown in containers for their flowers usually used for display

- Example: poinsettia
- d. **Landscape plants**- for landscaping purposes
Example: blue palm, white grass, song of india
 - e. **Foliage plants** – for attractive foliage, maybe grown indoor or outdoor for decoration
Example: begonia, philondendron
 - f. **Turf** – used in lawns or greens
Examples: Bermuda grass, carabao grass, blue grass

D. Special groups

- 1. **Green manure** – a crop that is plowed under while still green and growing to improve the soil (eg. sesbania)
- 2. **Cover crop** – any crop grown to provide soil cover, prevent soil erosion by wind, or water, improve soil and control weeds (eg. centrosema)
- 3. **Companion crop** – crop sown with another crop and harvested separately. The combination benefits either or both of the crops.(eg. ipilipil planted with black pepper)
- 4. **Trap crop** – a crop which is planted to protect the main crop from pests by attracting the pest to the crop itself and later destroying it. (eg. main crop is rice and sweet potato is planted to trap some rats)
- 5. **Catch crop** – a short seasoned crop grown immediately after the failure of the main crop to utilize residual resources (eg. rice is the main crop but may have been destroyed by typhoon therefore pechay or mustard is planted immediately).

- 6. **Soilage** – grasses that are grown, cut and directly fed to animals
- 7. **Silage** – grasses grown, cut, fermented, and preserved before being fed to animals

III. THE NATURE AND COMPOSITION OF PLANTS

A. The Plant Cells: Parts and Functions

Cell

- The smallest structure in the universe capable of growth and reproduction
- The basic unit of every living organism.
- An autonomous living system capable of independent existence and propagation
- Fundamental morphological unit of plant body.

Differences between plant and animal cells

- a. Plant cells contain chloroplast(s) that carry out photosynthesis
- b. Plant cell is surrounded by a rigid cell wall. Each walled cell and its adjacent wall are cemented together by middle lamella.
- c. Plant cells develop a large central vacuole
- d. Animal cells contain centrioles and lysosomes that involved in cell division and digestion, respectively. Embryonic cell can migrate from one location to another.

Plant cell has three main components:

- A. Cell wall
- B. Cytoplasm
- C. Nucleus

i. **Cell wall**

- Provides mechanical protection and rigidity to the plant cell
- Consists of cellulose that overcome pressure due to its elastic property
- Composed of cellulose, hemicellulose, pectic substances, organic and inorganic substances, lignin, enzymes, protein and water.

Three layers of Cell wall:

1. **Middle lamella** (where pectin cements adjacent cells together);
2. **Primary wall** (thin, not rigid, stretched as the cell grows, layer formed before and during growth of the plant cell, consists of cellulose microfibril, have primary pit fields, thin areas that transversed by numerous protoplasmic strands called plasmodesmata)
3. **Secondary wall** (rigid, thick, formed after cell completes growth)

ii. **Cytoplasm**

- All living matter of the cell apart from the nucleus
- Gel-like material or fluid in which the cell's organelles and internal membrane system are suspended
- Distributes substances absorbed from outside and released by the nucleus and other organelles (through cytoplasmic streaming/cyclosis - flowing movement of cytoplasm)

Cytoplasm consists of the following:

1. **Plasmalemma/plasma membrane** - has selective permeability

Functions:

- Allows some substances to cross easily and completely block substances
- Accumulates the ions or the molecules in the cytosol through the action of transport proteins that consumes metabolic energy
- Coordinates the formation of cell wall microfibrils

2. **Endoplasmic Reticulum**

- flattened disks or tubular sacs

Types:

- Rough endoplasmic reticulum (with numerous ribosomes)
- Smooth endoplasmic reticulum (lack ribosomes)

Functions:

- Rough ER - involved in the synthesis of lipid
- Smooth ER - involved in the synthesis of membrane proteins and secretory proteins

3. **Golgi Apparatus** - collective term for all dictyosomes (consists of stack of flattened hollow disks called cisternae) or golgi bodies

Functions:

- Involved in the synthesis of polysaccharides and glucose units for cell wall formation.
- Secretes protein and carbohydrates from the cell to the exterior part (Ex. nectar coming out from the flower)

4. **Mitochondria** - small cylindrical organelles enclosed by two-unit membranes:

- a. **Outer membrane**-permeable for smaller particles,contains the respiratory chain component and enzymes for the synthesis of ATP.
 - b. **Inner membrane**- impermeable and folded into numerous cristae
Function:sites of respiration (energy source for plants body maintenance, growth and development).
5. **Plastids** - differentiated into system of membrane (2 units) and ground substance, the stroma.
Types:
- a. **Chloroplast**
Function:
 - site of photosynthesis
 - involved in amino and fatty acids synthesis
 - provides space for temporary storage of starch.
 - b. **Chromoplast** - responsible for the yellow, orange or red colors of many flowers and other parts of the plants
Function: Attracts insects and other animals
 - c. **Leucoplasts** - nonpigmented plastids but once exposed to light, it may develop into chloroplasts
 - Amyloplast - starch
 - Proteinoplast - proteins
 - Elaeoplast- fats and oils
6. **Microbodies** - spherical organelles bounded only by one membrane, about 0.5 to 1.5 micrometer in diameter.
Function:
- Peroxisomes (terms to some microbodies) play an important role in glycolytic acid metabolism associated with photorespiration.

- Lyoysomes (other microbodies) contain enzymes needed for the conversion of fats into carbohydrates during germination in many seeds.
7. **Cytoskeleton** - an organized cytosol into a three-dimensional network of fibrous protein.
Types:
- i. **Microtubules**
 - Long, thin, cylindrical structures about 24 nm in diameter and of varying lengths.
 - Each is made up of sub units of the protein called tubulin

Function:

 - a. Involved in the orderly growth of the cell wall, especially the control of cellulose microfibrils alignment.
 - b. Formation of cell plate (the initial partition of dividing cell)
 - c. Involved in the movement of flagella and cilia in which microtubules are important components of it.
 - ii. **Microfilaments** - consist of two actin chain (similar to that of muscle tissue) that maintains in a helical fashion:
Function:
 - play a causative role in cytoplasmic streaming
8. **Ribosomes** - small particles about 17-23 NM in diameter containing an equal polyribosomes or polysomes.
9. **Vacuoles** - enclosed by a unit membrane called tonoplast
 - dumping house of the cell, contains water and other substances

Functions:

 - Absorb toxic products
 - Stores various metabolites

- Breakdown macromolecules and the recycling of their components within the cell.

iii. Nucleus - contain the genetic information indispensable for the cell's life and metabolic function.

Function

- Controls the activities of the cell by determining which protein molecules are produced and when they are produced.
- Stores the genetic information

B. The Anatomical Regions of a Plant Body

- The plant body is composed of three organs: leaf - for photosynthesis; stem - for support; and root - for anchorage and absorption of water and minerals.
- The flowering plants (angiosperm - 250,000 species) cover almost the earth's vegetation.
- The seed contains embryo and cotyledon (endosperm) which are protected with a seed coat.
- The seed grows under favorable condition (moisture, temperature, oxygen and sometimes light).
- From the embryo, the root and shoot develop.
- The seedling grows due to cell division in the meristematic tissues.
- After juvenile stage, plant produces flowers and fruits (after pollination and fertilization).
- Fruits contain seeds thus completing the life cycle of the plant.

Tissue - Composed of cells usually similar in structure and function.

- It is simple if it contains one cell type
- It is more complex if it is made up of several types of cells.

Organ - composed of several tissues with distinct structures and functions

System - composed of interacting organs that coordinate as a functional complex in the life of the organ.

i. Plant tissues and tissue system

1. Meristematic tissue - part of plant where cell division (mitosis) or production of new cells occurs.

a. **Apical meristem** - tip of stem and roots (shoot or root apical meristem); give rise to primary meristem

b. **Lateral meristem** - stem and roots

b1. Vascular cambium

b2. Phellogen (cork cambium)

c. **Intercalary meristem** - internodes and bases of young leaves

2. Permanent tissue - derived from meristems which have attained maturity form thus perform their specific function or functions.

a. **Epidermis**

- Outermost layer of cells of the primary plant body
- Contain stomata, trichomes (appendages)

b. **Parenchyma**

- Found in the cortical regions of stems and roots and in the mesophyll of the leaves.

- These are living cells that have diverse functions ranging from storage and support to photosynthesis and phloem loading.

- Apart from the xylem and phloem in its vascular bundles, leaves are composed mainly of parenchyma cells.

- Some parenchyma cells, as in the epidermis, are specialized for light penetration and focusing or regulation of gas exchange.

c. Collenchyma

- Thickened tissue found in the cortex of the stem and petioles or along the veins of the leaves.
- Collenchyma cells are alive at maturity and have only a primary wall.
- These cells mature from meristem derivatives that initially resemble parenchyma, but differences quickly become apparent.

d. Sclerenchyma

- Sclerenchyma cells (from the Greek *skleros*, *hard*) are hard and tough cells with a function in mechanical support.
- Scattered throughout the plant, found in both primary and secondary tissues.

Types of Sclerenchyma

- Fibers - known as bast fibers
 - long, thin cells with very thick walls often dead at maturity
- Schleroids or stone cells - similar with fibers thick wall and lignified; may be living or dead at maturity.

e. Cork

- Outermost tissue; impregnated with suberin (waxy substance)

ii. Complex Permanent tissue / Types of vascular tissues

1. Xylem

- Conduct water and mineral salts upward the plant body
- Consist of **tracheids, vessel membrane xylem fibers, and xylem parenchyma**.

2. Phloem

- Distributes the dissolved food materials between the source and sinks:

- Consists of:
 - Sieve tube element** - chief food conducting element
 - Companion cells** - parenchyma cells always found besides the sieve tubes; moves food in and out of the sieve-tube member.
 - Phloem parenchyma** - like ordinary parenchyma cells
 - Phloem fibers** - like sclerenchyma cells

iii. Major plant tissue system

1. Ground

- This packing and supportive tissue accounts for much of the bulk of the young plants
- It also functions in food manufacture and storage
- It contains three main cell types: parenchyma, collenchymas, and sclerenchyma

2. Dermal tissue

- This is plant's protective outer covering in contact with the environment
- It facilitates water and ion uptake in roots and regulates gas exchange in leaves and stems

3. Vascular tissue

- Together the phloem and xylem form a continuous vascular system throughout the plant.
- This tissue conducts water and solutes between organs and also provides mechanical support

C. Plant organs

i. Root

Regions of the Root

- **Root cap** – protects the tender apex (absent in aquatic plants)
- **Region of cell division**– 1 to few mm above the root cap; have small cells with thin walls, dense with protoplasm; undergo repeated cell division (meristematic region)
- **Region of elongation** – lies above meristematic region; extends to 1-5 mm; undergo rapid elongation and enlargement; responsible for growth in length of the root
- **Region of maturation** – lies above meristematic region of elongation, this region produces root hairs

Types of Roots

1. Tap root system

- primary root grows vertical downward
- branches grows downward or horizontally outwards

Functions

- absorb water, mineral, salts from soil, anchorage

2. Adventitious root system

- Roots that grow from any part of the plant of the plant body other than radicle

3. Fibrous root system

- In monocots (with all adventitious roots)

4. Foliar root system

- From leaves mainly petiole or vein (spontaneous or due to injury)

ii. Stem

– supporting and conducting organ initially developed from the epicotyl

Major parts: **Bark, pith and wood** (composed of xylem made up of vessels, fibers, and parenchyma cells)

Types of stem:

- ✓ **bulb** – short, erect underground stem
- ✓ **culm** – flowering stem of grasses and sedges
- ✓ **offset** – like runner originates from leaf axil as a short and thickened branch away from the mother plant
- ✓ **rhizome** – horizontal underground stem
- ✓ **runner or stolon** – indeterminate aboveground stem with internodes and new plantlet at the tip
- ✓ **sucker** – shoot arising below the ground from old stem
- ✓ **tendril** – slender coiling branch for climbing
- ✓ **tiller** – shoot produced from the base of the stem or culm
- ✓ **tuber** – thick storage underground stem
- ✓ **corm** – enlarged solid fleshy base

Forms

- Erect or strong stems:

Unbranched; erect; cylindrical; stout; slim jointed stem with solid nodes and hollow internodes

- Weak stems:

Weak trailing stem- on ground without rooting at the nodes

Creeping stem- runner, stolon, offset or sucker

Climbing stem- attaches or climbs objects (vines)

iii. Leaf

Functions

- Food manufacture (PS)
- Exchange of gases (PS and RN)
- Evaporative of water (Transpiration)

Parts of Leaf

- **Leaf base** – part attached to stem
- **Petiole** – stalk of leaf
- **Leaf blade or lamina** – green expanded portion of the leaf

Leaf Venations:

- **Reticulate** – network-type of veins
- **Parallel** – veins parallel to each other

***iv. Flower* – reproductive structure of flowering plants**

Major parts:

- a. calyx – lowermost whorl of modified leaves, also known as sepals
- b. corolla – whorl of petals above the sepals
- c. gynoecium or pistil – group of carpels in the center or at the top of the flower
- d. gynophore – stipe of a pistil or carpel
- e. pedicel – stalk of a flower
- f. perianth – combined calyx and corolla
- g. petal – a unit of corolla
- h. sepal – a unit of calyx
- i. stamen – male sporophyll within the flower

Complete Flower- has all four parts of the flower (sepals, petals, pistil and stamen)

Incomplete Flower- A flower lacking sepals, petals, pistil or stamen

v. Seed

– a ripened ovule which when shed from the parent plant consist of embryo and stored food supply both of which are enclosed in a seed coat or covering.

Dicotyledon – embryo lies within an axis of two cotyledons

Monocotyledon – consist of seed coat, endosperm and embryo

Parts of a seed:

- j. **Embryo** – developing plant still inside the seed. The embryo has cotyledons (embryonic leaves), a root cap, a food source and a plumule (shoot)
- k. **Hilum** – the scar on a seed coat at the location where it was attached to the plant's stalk during development
- l. **Micropyle** – the small pore in a seed that allows water absorption
- m. **Root (Hypocotyl)** – the part of the stem of a sprouting plant that is above the root and below the stalk of the cotyledon (seed leaves)
- n. **Seed Coat (Testa)** – seed coat is the outer, protective layer covering the seed
- o. **Seed leaf (Cotyledon)** – the embryonic leaf within a seed
- p. **Plumule**– the shoot of an embryo

Types of seed:

1. Orthodox

- Dries out naturally on mother plant to a low MC ($\leq 20\%$)

- Can be dried to low MC (<5%) without damage
- Can be stored at low temperature
- Ex. rice, corn, beans, vegetable seeds, pili, etc.

2. Recalcitrant

- Do not dry out normally on mother plant, shed in moist condition (50-70%MC)
- Seed larger than orthodox-embryo is only 15% of the orthodox
- Killed if MC is reduced below critical values (12-30%)
- Susceptible to freezing (below 0°C) or chilling (10-15°C)
- Ex. seeds of aquatic species, large seeded species, wild rice, tropical fruit crops, jackfruit, cacao, rambutan, lanzones, etc.

3. Intermediate

- Can withstand desiccation to about 10-12% MC and can be stored under hermetic condition
- Lose viability more rapidly at low temperature (<10 °C) than at warm temp (12-21 °C)
- Ex. coffee, oil palm, papaya, citrus sp., star apple, chico, etc.

vi. Fruits

- It is a mature, ripened ovary.
- Contain the seed (*ripened ovules*) and pericarp (*the tissue that surrounds the seeds*)

a. Simple fruit

- One fruit develop from single ovary of a flower with or without accessory parts. Ex. Corn, Peanut

b. Aggregate fruits

- Collection of simple fruit developing from apocarpous pistil of a flower. Ex. Strawberry

c. Multiple or composite fruits

- develop from a number of flower from an inflorescence. Ex. Pineapple, Peach fruit

Types of fruits

1. Fleshy fruit are juicy.
 - a. **Berry** - has an entirely fleshy ovary. Ex. tomatoes, dates, blueberries, bananas, peppers, and cranberries.
 - b. **Hesperidium** - have a leathery rind. Examples include oranges, grapefruits, lemons, and limes.
 - c. **Pepo** - is a type of fruit defined by hard rind and a fleshy inner matrix. Ex. watermelons, cantaloupe, squash, and pumpkins.
 - d. **Drupe** - is a fruit with a fleshy exterior and a single hard, stony pit surrounding the seed. Ex. cherries, peaches, olives, mango, raspberry, coconut, plums.
 - e. **Pomes** - have a fleshy exterior and a center with papery carpels. Apples and pears.

2. Dry fruits may be indehiscent or dehiscent.

- a. **Indehiscent fruits** - are those that do not split open at maturity and are usually one- or two-seeded.

1. **Achene** - is a single-seeded fruit with seed attached at only one place to the pericarp.
 - Ex Sunflower, strawberry, buckwheat.

- 2. **Caryopsis** - a fruit is similar to an achene; however, the pericarp sticks or clings to the seed.
 - Ex. Corn, rice, barley, rye, amaranth, sorghum, oat, and wheat.
- 3. **Samara** - is usually single-seeded with a membranous wing.
 - Ex. maple, elm, and ash.
- 4. **Nut** – is a hard, one-seeded fruit.
 - Ex. Oak, walnut, filbert, and hickory.
- 5. **Uricle**- is like an achene, but the ovary wall fits loosely around the seed.
 - Ex. Finger millet and pigweed.
- 6. **Nutlet** - is a small version of a nut.
 - Ex. Birch and hornbeam.

- b. **Dehiscent fruits** - are fruits that split open upon maturation.
- 1. **Legume** (pod)- is composed of a single carpel and has two longitudinal sutures.Ex. Soybeans, green beans, and peas.
 - 2. **Follicle**- is composed of a single carpel and splits open along one suture. Ex. Milkweed.
 - 3. **Capsule**- is composed of more than one carpel that are united and form many-seeded fruits.Ex. Okra and cotton.
*silique.- a specialized form of capsule n the mustard

4. **Pyxis**- is a type of capsule with a lid that falls from the fruit. Ex.purslane.

Parthenocarpy

- Greek *parthenos*, virgin and *karpos*, fruit
- literally means virgin fruit
- The production of fruit without fertilization. Fruit is therefore seedless
- Ancient origin – oldest parthenocarpic fig first grown at least 11,200 years ago.

Types of Parthenocarpy

- ✓ **Stimulativeparthenocarpy**
 - Pollination or other stimulation is required for parthenocarpy
 - Banana and watermelon
- ✓ **Vegetative parthenocarpy**
 - Do not require pollination or other stimulation to produce parthenocarpic fruit
 - Cucumber, citrus and pineapple

IV. PLANT LIFE PROCESSES

A. Photosynthesis

- Manufacture of sugars and its precursors by green plants in the presence of light and chlorophyll.
$$6\text{CO}_2 + 12\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O}$$
- Carbon dioxide is taken from the air through the stomata, while water is absorbed from the soil by the roots and is transported in the xylem to sites of photosynthesis

- The main organ for photosynthesis is the Leaf; the main organelle involved is the Chloroplastid.
- The features which make the leaf an ideal organ for photosynthesis are:
 1. Its typically expanded form
 2. It's usually perpendicular angle to incident light
 3. Its extensive internal surface with an efficient vascular system for channeling the various reactants and end products of photosynthesis
 4. Its pigment for light absorption

Chloroplast

- Are usually lens-shaped bounded by a double membrane
- The inner membrane invaginates parallel to the surface and becomes organized into specialized cytoplasmic body consisting of a stack of thylakoids called granum which are embedded in a proteinaceous matrix called the stroma.

Chlorophyll

- Principal pigment in photosynthesis located in the partition between two adjacent thylakoids
- Chlorophyll a occurs in all higher plant, but other isomers like chlorophyll b, c, d etc may also be found
- In higher plants, the two main isomers are chlorophyll a and chlorophyll b in ratio of 3:1
- Its basic unit is the porphyrin ring system, a structure made up of four simpler pyrrole nuclei joined by carbon linkages.

The center of porphyrin is occupied by a single magnesium atom.

Significance of Photosynthesis:

1. Photosynthesis converts light energy into chemical energy in the form of organic nutrients
2. Photosynthesis supplies oxygen to the atmosphere
3. Photosynthesis produces food.

Component Reactions of Photosynthesis

1. Light/ Light Dependent/ Photochemical Phase

- Light energy are harvested by two photosystems
- Oxidation of water and generation of NADPH and ATP by the chloroplast thylakoids
- The lights induce the splitting of H_2O to produce oxygen and the NADPH and ATP (reducing power).
- Rapid process and requires the presence of light.
- Composed of:
 - a. Non- cyclic photophosphorylation
 - b. Cyclic photophosphorylation
- The end product of light reaction, ATP and NADPH are used to fix CO_2 .

2. Dark or Light Independent/Biochemical or CO_2 assimilation phase or photosynthetic carbon reduction cycle

- Primary process by which inorganic carbon is converted to organic compounds
- Use of reducing power to reduce CO_2 to carbohydrates and water
- Occur both in the presence or absence of light

- Slow process
- Use the products of light reactions, ATP and NADPH

The fixation or reduction of CO₂ into carbohydrates can occur via three pathways:

a) Calvin Benson Cycle/ Reductive Pentose Pathway

- Fixation and reduction of one molecule of CO₂ requires three molecules of ATP and 2 NADPH (coming from light reaction)
- Occurs in the mesophyll cell chloroplast
- CO₂ acceptor is RUBP
- RUBP carboxylase enzyme is needed
- the first product is 3-PGA

b) C₄ or Hatch Slack Pathway

- Occurs in the mesophyll cell
- CO₂ acceptor is PEP, catalyzed by PEP carboxylase enzyme
- Products are 4- carbon organic acids (oxaloacetic acid at the mesophyll cells)
- The oxaloacetic acid is converted to malate and aspartic acid
- Malic acid is decarboxylated to produce CO₂
- The 3-carbon compound goes back to the mesophyll cells
- The CO₂ released enters the calvin cycle for sugar/starch production
- The 3- carbon compound combined with 1- carbon from the atmosphere to form again into 4- carbon compound

c) Crassulacean acid metabolism (CAM) pathway

- Found in succulent plants (cactus, pineapple)
- During the night, CO₂ is fixed
- During the day, malic acid is decarboxylated where CO₂ is fixed through the C₃ pathway

Table 1. General Characteristics of C3, C4 and CAM plants

	C3 plants	C4 plants	CAM plants
Crop examples	Typically temperate species eg. spinach, wheat, potato, tobacco, sugarbeet, soybean, sunflower	Typically tropical or semitropical species eg. corn, sugarcane, amaranthus, sorghum; plants adapted to high light, temperature, and semi-arid environments	Typically xerophytic species. eg. cacti, orchids, agave, bromeliads, and other succulents
Biomass Production	Moderately productive; 30 tons per hectare is possible for sunflower	Highly productive; 80 tons per Hectare is possible for sugarcane	Very poor productivity
Leaf anatomy	Lack Kranz-type anatomy and peripheral reticulum; only one type chloroplast	Kranz type anatomy and peripheral reticulum are essential features	Lack Kranz-type anatomy and peripheral reticulum; only one type chloroplast
Initial CO₂ acceptor	Ribulose-1,5-bisphosphate (RuBP), a 5-C sugar	Phosphoenol pyruvate (PEP), a 3-C acid	PEP in the dark and RuBP in the light
First stable product	3-phosphoglycerate (3-PGA), a 3-C compound	Oxaloacetate (OAA), a 4-C compound	OAA in the dark and 3-PGA in the light
CO₂ fixation	Only one CO ₂ fixation pathway	Two CO ₂ fixation pathways are separated in space	Two CO ₂ fixation pathways are separated in time
Glycolate synthesis	High	Low	Low
Water-use efficiency/salinity tolerance	Low	High	High
Light saturation	At about 1/5 full sunlight	Do not readily photosaturate at high light density	Do not readily photosaturate at high light intensity
CO₂ compensation point	High	Low	High affinity for CO ₂ at night
Stomatal opening	Open stomata by day	Open stomata by day	Open stomata by night

Factors affecting photosynthesis

1. Internal

- a. Enzymes - biological catalysts/ agent of life
- b. Genetic factor - chlorophyll, kind of plant, etc.
- c. Leaf age
- d. Demand of sinks for photosynthates
- e. Water content of the plant
- f. Amount of plant regulates

2. External

- a. Light
 - Quality
 - Intensity
 - Duration
- b. CO₂ and H₂O availability
- c. Temperature
- d. Wind velocity

B. Respiration

- Defined as an enzyme-catalyzed reaction involving the transformation of organic substrate into carbon dioxide and water accompanied by the release of energy.



Stages of Respiration

1. Glycolysis

- Occurs in cytoplasm
- Partial oxidation of a glucose molecule (6-C) yields two molecules of pyruvic acid (3-C). In the process substrate phosphorylation of the sugar molecule results to a net production of 2 ATP

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2. Krebs Cycle

- Pyruvic acids produced in the cytosol during glycolysis are imported into the mitochondrial matrix which is the site of Krebs cycle.
- Pyruvic acid is first oxidized to acetyl co-enzyme A and subsequently converted to CO₂.
- For every glucose molecule (2 pyruvic acids) entering the mitochondrion, the Krebs cycle generates 6 NADH and 2 FADH₂ and yield 2 ATP via substrate level phosphorylation.

3. Electron Transport System (ETS)

- Occurs in the inner mitochondrial membrane.
- NADH (from glycolysis and Krebs cycle) and FADH₂ (from Krebs cycle) are oxidized to yield ATP.
- ATP is generated in ETS via oxidative phosphorylation

Factors Affecting Respiration:

1. Age and Tissue type

- large, young tissues respire more strongly than old
- developing tissues respire more than mature ones
- tissues undergoing metabolic processes respire more than resting tissues

2. Temperature

- enzymes activity doubles for every 10°C rise in temperature within certain limits
- more rapid breakdown of respiration as temperature increases above 35°C due to destruction of enzymes by heat

3. Oxygen

- presence of oxygen is essential for oxidative metabolism

4. CO₂

- high level (higher than normal atmosphere) inhibits respiration
- high concentration causes the stomata to close

5. Physiological status of plant or plant Parts

- Dormant state respire less than active parts of the plant.

6. Moisture Content of Tissues

- Seeds with higher moisture content respire more than seeds with drier tissues

C. Transpiration

- Is the loss from plants in the form of water vapor. This evaporative process is dependent on energy, the heat of vaporization (539 cal per gram) which is required to convert water from liquid state to gaseous state
- Considered as "necessary evil"
 - a. it keeps cells hydrated
 - b. it maintains favorable turgor pressure for the transport of nutrients absorbed by the roots from the soil
 - c. it serves as a cooling process

Types of Transpiration

1. Cuticular transpiration

- Loss of water through the epidermis which is usually covered with a cuticle. In some temperate plants, about 5-10% of the water lost from plants maybe lost by this pathway

2. Lenticular transpiration

- Loss of water through numerous pores in the outer layer of a woody plant stem, called lenticels. In deciduous species and in some fruits, water loss through lenticels maybe quite substantial

3. Stomatal transpiration

- Loss of water through the stomata which can account as much as 90% of the water loss from plants

Two-stage process

- a. Evaporation of water from the moist cell walls into the substomatal air space
- b. Diffusion of water vapor from the substomatal space into the atmosphere.

Factors affecting transpiration

1. Relative humidity
2. Temperature
3. Wind velocity
4. CO₂ concentration- higher concentration will close the stomata
5. Light intensity
6. Morphology of leaf stomatal modification

D. Translocation

- A long-distance transport of photoassimilates
- Transport of solutes by the roots to the other parts of plant passing the dead conduits or dead xylem vessels (apoplastic transport)
- Transports of photosynthates in living conduits or phloem vessel (symplastic transport)
- Transport of solution from the roots to the upper parts through the xylem of the stem (transpirational stream)

transpiration or loss of water in plant is the cause of the movement.

- Tissues involved are the phloem and the xylem
- Sucrose is the main photosynthates being translocated.
- The translocation is from the sources to the sinks

Source- an organ or tissue that produces more assimilates than the requirement of the said organ for its own metabolism and growth exporter organ

Sink - importer or consumer of assimilate

Factors affecting translocation

1. Temperature - rate of translocation increases with temperature to a maximum and then decreases due to hazardous effect of high temperature
2. Light - CO₂ assimilation increases as light intensity increases.
3. Metabolic inhibitors
4. Concentration gradient
5. Mineral deficiencies - sucrose movement can be aided by boron.
6. Hormones - associated with the active parts, hence growing parts (sinks) greatly influence translocation

E. Assimilation

- The process of utilizing food (photoassimilates and other solutes) for growth
- During the early stage, food substances are converted into simpler compounds (enzymes are needed, nutrients are necessary for normal action of enzymes) and used as building blocks for more complex substances
- During the later stage, simple and complex compounds are integrated into the living substances of the cells.

There are a number of factors which determine assimilate partitioning in a crop:

1. **Sink strength.** The ability of a sink to accumulate assimilates is called sink strength. It is a function of sink size and sink activity.
2. **Proximity of the sink to the source organ.** Assimilates move preferentially toward sink leaves above and in line with the source leaf. Lower mature leaves feed mainly the roots, the higher mature leaves feed mainly the young leaves and the shoot apex.
3. **Stage of development.** Developing flowers and fruits become dominant sinks during the reproductive stage of a crop. On the other hand, storage roots used as planting materials export assimilates to developing vegetative tissues.
4. **Nature of vascular connections between source and sinks.** Each leaf is connected to the main vascular system of the stem by a vascular trace, which diverts from the vascular tissue of the stem into the petiole.

V. GROWTH AND DEVELOPMENT

Development

- Denote the attainment of size by virtue of growth and architectural style by the concomitant process of morphogenesis.
- Has three interrelated aspects, namely: growth, differentiation, and organization.
-

Growth

- Is an irreversible time change generally accompanied by an increase in size, weight or mass.

Differentiation

- Is the outward sign of selective gene action, the reflection of change in the cell's biochemical program as a consequence of the release of information encoded in one-dimensional sequences.

Organization

- Orientation and integration of the differentiated cells in space together with regulated growth with the consequent attainment of form and structure of the complete organism.

Correlation

- Regulatory effect exerted by one part of the plant on the growth and development in another part

Endogenous rhythm

- Recurring events or oscillations with properties not directly reflecting environmental fluctuations
 - a. Annual – reoccur every year
 - b. Lunar – reoccur every new moon
 - c. Circadian – recur every 24 hours

Plant movements

- May exhibit movement of some organs in response to environmental stimuli.

Three steps in plant movement:

1. **Perception** – involves recognition of the environmental stimulus by the plant
2. **Transduction** – involves biochemical and biophysical changes which occur in response to perceived stimulus
3. **Response** – shows the changes in the organ affected by the perceived stimulus

Two categories of plant movements

1. **Tropic movements (tropisms)** – direction of the environmental stimulus determines the direction of the movement
 - a. **Phototropism** – response to light
 - b. **Gravitropism** – response to gravity
 - c. **Solar tracking** – flat blade of the leaf is always at nearly right angle to the sun throughout the day
2. **Nastic movements** – movement maybe triggered by an internal timing mechanism (biologic clock) and the direction of the stimulus may not determine the direction of movement.
 - a. **Hyponasty** – bending up of leaves
 - b. **Epinasty** – bending down of leaves
 - c. **Nyctinasty** – folding of some leaves in response to light which usually assumes a rhythmic pattern because of its interaction with the biological clock
 - d. **Hydronasty** – the folding and rolling of leaves in response to water
 - e. **Thigmonasty** – response to touch or mechanical stress
 - f. **Seismonasty** – response to shaking without contact to the organism

Crop Adaptation

1. **Morphological adaptation** – exemplified by the presence of metamorphosed or specialized organs which performs non-typical functions. Example: pneumatophores or modified roots of certain trees growing in marshes which serves as "breathing" organs
2. **Physiological adaptation** – exemplified by the closing of stomates of many bromeliads during the day to help conserve water as well as the abscission of leaves in deciduous plants to reduce the evaporative surface area thereby conserving moisture and lowering of compensation point.
3. **Biochemical adaptation** – biochemical changes with some bearing on certain survival mechanisms such as the increase in proline and abscisic acid and osmolytes in plants during period of moisture stress to regulate increased water-holding capacity of tissues for moisture as well as stomatal closure to conserve water.

VI. PLANT GROWTH REGULATION

Phytohormones

- Organic substances other than vitamins and nutrients which are active in very minute (often $<2\mu M$) amounts
- Formed in certain parts of the plant and which are usually translocated to other sites where they promote, inhibit, or otherwise modify physiological, biochemical and/or morphological processes

- In general, PGRs are promotive at relatively low concentrations but become inhibitory at relatively higher concentrations
- Endogenous PGRs are called plant hormones or phytohormones

1. Auxin

- Generic term applied to growth regulators with the special capacity to promote cell elongation.
- Naturally occurring auxins are the indole-auxins represented by indole-3-acetic acid (IAA)
- IAA is synthesized from the amino acid tryptophan primarily in actively-growing tissues. It is also produced in mature leaves and root tips, although at much lower concentrations
- IAA transport is cell to cell and is polar in nature. The basipetal transport to the root and acropetal transport to the upper organs involves vascular and non-vascular tissues.

Effects

- a. Promotes cell enlargement and cell division in the cambium in tissue culture
- b. Stimulates differentiation of phloem and xylem
- c. Stimulates root initiation in cuttings
- d. Induces ethylene biosynthesis at supra-optimal concentration
- e. Mediates the tropic bending responses of shoots and roots to gravity, light and touch
- f. Promotes apical dominance
- g. Delays leaf senescence and leaf and fruit abscission
- h. Promotes fruit setting and fruit development in some plants

- i. Can also delay fruit ripening but may promote flowering in some plants (Ex. bromeliads)
- j. Induces femaleness in dioecious flowers (via ethylene)
- k. Induction of parthenocarpic (seedless) fruit development (Ex. tomato)
- l. Popularly used as herbicides (Ex. 2,4-D, 2,3,5-T [agent orange], dicamba etc)

2. Gibberellic acid (GA)

- Belong to a family of compounds based on the ent-gibberellane structure
- GAs are synthesized from mevalonic acid in 1) elongating shoots, 2) young leaves of developing apical buds, 3) developing seeds and fruits, and 4) apical regions of the roots
- The major conduit for the non-polar transport of GAs is the phloem

Effects

- a. Stimulates stem elongation (may reverse physiological and genetic dwarfism in plants)
- b. Promotes bolting (rapid elongation of floral stem) in long day plants
- c. Induces germination of seeds that normally require a cold treatment (stratification) or light (positively photoblastic seeds)
- d. Stimulates *de novo* synthesis of α - amylase in germinating cereal grains
- e. Promotes fruit set and fruit growth in some fruits (Ex. grapes)
- f. Induces maleness in dioecious flowers of some species.

3. Cytokinin (CK)

- Adenine derivatives which have the capacity to induce cell division in tissue culture.
- The most common CK base in plants is zeatin, the first natural CK which was isolated from corn endosperm.
- Synthesized through the biochemical modification of adenine.
- The major site of CK biosynthesis is at the root apical meristem although seeds (embryo) and developing leaves have been shown to produce significant amounts of CK as well
- CK produced in the roots is transported to the upper organs via xylem.

Effects

- a. Regulates morphogenesis in cultured tissues (in synergy with auxin)
- b. Releases lateral buds from apical dominance
- c. Delays leaf senescence
- d. Promotes cotyledon and leaf expansion
- e. Promotes nutrient mobilization
- f. Enhances stomatal opening in some species
- g. Enhances accumulation of chlorophyll as it promotes the conversion of etioplasts into chloroplast

4. Ethylene

- Only phytohormone occurring in gas state
- It is an unsaturated hydrocarbon synthesized from the amino acid methionine (primary precursor) in many tissues in response to stress

- Ethylene does not seem to be essential for normal vegetative growth but it is the only hydrocarbon with a pronounced effect on plants
- Synthesized in most tissues in response to senescence and stresses
- Being a gas, ethylene moves by diffusion from the site of biosynthesis.

Effects

- Promotes ripening of climacteric fruits
- Induces epinasty
- Induces lateral cell expansion
- Formation of adventitious roots
- Induces flowering in pineapple and other bromeliads
- Enhances flower, fruits and leaf senescence
- Induces femaleness in dioecious flowers of some species
- Promotes shoot and root growth differentiation
- Releases tissues/organs from dormancy
- Promotes leaf and fruit abscission
- Enhances flower opening in some species

5. Abscisic acid (ABA)

- Synthesized from mevalonic acid in mature leaves particularly in response to water stress. Seeds are also rich in ABA which may be imported from the leaves or synthesized in situ.
- ABA is exported from leaves in the phloem. There are some evidences that ABA may circulate to the roots in the phloem and then return to the shoots in the xylem

Effects

- Counteracts the effect of gibberellins on α-amylase synthesis in germinating cereal grains

- Enhances stomatal closure (eg. during water stress)
- Promotes leaf senescence
- Promotes storage protein synthesis in seeds
- Induces transport of photosynthates towards developing seeds and its subsequent uptake by growing embryos
- Induces and/or maintains dormancy in seeds and buds

VII. CONCEPTS RELATED TO PLANT GROWTH

Liebig's Law of Minimum

- The growth in lowest supply (climatic, edaphic, biological or genetic) sets the capacity for yield.
- This law is otherwise known as the "barrel" concept. If a barrel has staves of different heights, the lowest one sets the capacity of the barrel.

Blackman's Theory of Optima and Limiting Factors:

- When a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the slowest factor.

Mitscherlich Law of Diminishing Return

- When plants had adequate amounts of all but one limiting element, the growth response was proportional to the limitation element.
- Plant growth increased with additional increments of a limiting factor but not in direct proportion
- The response is curvilinear contrary to Blackman's concept of linear response.

VIII. PLANT PROPAGATION

A. Sexual Propagation

- Most common method by which plants reproduce in nature
- Most efficient and widely used method for cultivated crops. Seeds arise from the fusion of male and female gametes to form a single cell (zygote) within the ovule of a flower

Seed Germination

- Series of events which take place when dry quiescent seeds imbibe water resulting in an increase in metabolic activity and the initiation of a seedling from the embryo
- Resumption of embryo growth

***Epigenous germination** – hypocotyl elongates and brings cotyledons above ground

***Hypogenous germination** – epicotyl emerges and the cotyledons remain below soil surface

Seed storage: Behavior Categories

Seed dormancy

- Physiological or physical condition of a viable seed that prevents germination even in the presence of otherwise favorable germination conditions.

Seed Quiescence

- Condition in which seed cannot germinate because of unfavorable condition.

Types of Dormancy

- a. Primary

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- Exogenous or coat-imposed dormancy – essential germination components not available
 - Endogenous dormancy – caused by environment during seed development and maturation
- b. Secondary
- Imposed by: temp, light/darkness, abnormal amount of water; chemical and gases

Dormancy Technology

- a. **Ecodormancy** – due to one or more unsuitable factors in the environment with non specific effect
- b. **Paradormancy** – due to physical factors or biochemical signals originating externally to affected structure
- c. **Endodormancy** – regulated by physiological factors inside affected structure

Hastening Seed Germination/ Breaking Dormancy

Scarification

– Is any treatment that removes the seed coat or alters it, making it more permeable to water and air. This can be done mechanically by rubbing into a rough surface or the use of chemicals such as hydrogen peroxide and muriatic acid.

- a. **Physical scarification** – soaking in water (tap, hot or boiling water) for a specific period of time
- b. **Mechanical scarification** – piercing, rubbing on sand paper, filing, grinding with abrasives
- c. **Chemical scarification** – treatment with sulfuric acid and organic solvents

Stratification – Is the placement of seeds between layers of moist sand, soil, or sawdust at high or low temperature so the action of water and high and low temperature will soften the seed coat.

Vernalization

- Seed treatment to cold temperature prior to germination.

Embryo culture

- Aseptically removing the embryo from the seed and placing it in a sterilized culture medium to germinate

B. Asexual Propagation

- involves reproduction from vegetative parts of plants and is possible because the vegetative organs of many plants have the capacity for regeneration.

1. Propagation by apomictic embryos

- **Apomixis** – from the Greek Apo, meaning "away from," and Mixis, which means "mingling"
- The production of viable seeds without pollination
- Involves the development of embryos containing the same genetic information as the mother plant and which are in effect clones
- Parthenogenesis in animals
- Reproduction of embryo without meiosis and fertilization; embryo arise from vegetative cells within the ovule

Types:

✓ **Obligate Apomitic :**

- A plant which reproduce only by asexual reproduction. Ex. Lanzones, Mangosteen

✓ **Facultative Apomitic:**

- A plant which reproduce either sexually or asexually. Ex. Mango, Citrus

2. Separation and Division

Separation-involves separating naturally detachable organs from the mother plant

Division- procedure wherein specialized vegetative structures are cut into sections→**modified organs** which may be separated and /or divided:

- **Bulb** – a specialized underground organ consisting of a short, fleshy, usually vertical system axis (basal plate) bearing at its apex a growing point or a flower primordium enclosed by thick, fleshy scales Ex. tulips, lilies
- **Bulbil** – aerial plantlet formed on the axil of the leaves or flower stalk Ex. agave
- **Corm** – a swollen base of a stem axis enclosed by the dry - scale leaves Ex. banana, gladiolus, gabi
- **Cannel** – miniature corm which develop between old and new corms
- **Crown** – pan of a plant at the surface of the ground from which new shootsh are produced Ex. aster, Shasta daisy
- **Offset** – (syn. Offshoot) a characteristic type of lateral shoot or branch which develops from the base of the main stem in certain plants (a shortened, thickened stem of rosette-like appearance) Ex. *Pistia* sp.
- **Pseudobulb**- specialized storage structure consisting og an enlarged, fleshy section of the stem made up one to several nodes Ex. *Cattleya* sp.
- **Rhizome** – a specialized structure in which the main axis of the plant grows horizontally at or just below the ground surface Ex. banana, bamboo, sugarcane.

- **Runner** – a specialized stem in which develops from the axil of the leaf at the crown of a plant, grows horizontally along the ground, and forms a new plant at one of the nodes Ex. strawberry, black pepper
- **Slip** – leafy shoot originating from axillary buds borne at the base of a plant or peduncle of the fruit Ex. pineapple, cabbage
- **Stolon** – special modified stem, produced by some plants, that grows horizontal to the ground, Ex. Bermuda grass
- **Sucker** – adventitious shoot that arise from the underground stems below the ground Ex. banana, pineapple
- **Tuber** – a modified stem structure which develops below ground as a consequence of the swelling of the subapical portion of the stolon and subsequent accumulation if reserve materials
- **Tuberous root** – thickened root which contain large amount of stored foods Ex. cassava, sweet potato

3. Cutting – a portion of a stem, root. Or leaf is cut from the parent plant, after which this plant part is place under certain favorable environmental conditions and included to form roots and shoots, thus producing a new independent plant.

Types:

- **Root cutting** – Ex. breadfruit, Apple
- **Stem cutting** – Types: hardwood, semi-hardwood, softwood, herbaceous cutting Ex. cassava, malunggay, coffee, rose
- **Leaf cutting** – Ex. snakeplant, begonia, African violet
- **Leaf-bud cutting** – Ex. black pepper, vanilla

4. Layering – a propagation method by which adventitious roots are included to a form on a stem while it is still attached to the parent plant

Types:

- Simple layering
- Air layering or marcotting
- Compound or serpentine layering
- Mound or stool layering
- Trench layering

5. Grafting – connecting parts of plants together in such a manner that they will unite and continue their growth as one plant

- Scion** – short piece of detached shoot with one to several dormant buds and which is to become the upper portion of graft combination
- Rootstock** – lower portion of graft which develops into the roots system of the grafted plant
- Interstock** – a piece of stem inserted between scion and rootstock (to avoid any incompatibility between scion and rootstock and /or to take advantage of its growth controlling properties)

Types of Graftage:

- Approach Grafting or Inarching** – selected shoots of the desirable plant are grafted with the stem of the stock grown in individual containers while the scions are still connected with the mother plant.
- Topworking** – this method of grafting is usually used in changing the top of established inferior plants into more desirable ones.

3. Splice Grafting – In this method, the detached scion used is leafless, usually with terminal leaf bud or well-developed dormant bud.

4. Cleft Grafting – a detached scion is directly grafted on top of the stock as in splice grafting, except that the types of cuts used vary.

5. Side Grafting – In this method of grafting, the basal portion of a detached scion is joined at the side of the trunk of the stock.

6. Bark Grafting – This method is especially useful in grafting a detached scion on a stumped stock whose stem is much larger than that of the scion.

6. Budding – an asexual propagation that like grafting, which involves joining 2 plant parts such that the size of the scion is reduced to only one bud and a small section of bark, with or without wood

Types of Budding:

1. Patch Budding – this type of budding is usually used in species having a thick bark which can be separated easily from the wood.

2. Shield or T-budding – this is usually made on an actively developing stem whose bark can be readily separated from the wood.

3. Chip Budding – this method of budding is used where the bark of the stem adheres closely to its wood, which may occur naturally to some species or arising from growing conditions.

7. Inarching (approach grafting) – an asexual propagation technique in which plants are made to unite while growing on their roots

8. Tissue culture techniques other than embryo culture – can be started from a variety of plant parts which have cells capable of dividing, Ex. shoot-tip culture; meristem culture and endosperm culture

IX. FACTORS AFFECTING CROP PRODUCTION

Crop production can be viewed from two properties

- 1 – at the CROPS level
- 2 – at the SYSTEMS level

Crop production at the crop level:

In the form of an equation:

$$Y = f [(G + E + (G \times E))]$$

Where: Y = yield

G = genotype

E = environment

G × E = interaction of genotype and environment

Genotype and Environment

- **Genotype** – Genetic design of a plant which dictates the ceiling of how much a variety / cultivar can yield.

- Genes controlling a character (yield, plant height, taste, color, etc.)
 - Varies among and even within species
 - Sets the ultimate limit for plant variation
- **Environment** – Any factor external to the plant that influences its growth and development.
- May be biotic or abiotic; examples are climate, soil, topography, pest and diseases

G x E Interaction

*A high yielding variety grown under poor environment will have low yield.

*A low yielding variety grown in optimum (good) environment will still have low yield.

- An ideal genotype therefore is one that has a wide range of environmental
- An optimum environment is one that poses a minimum of constraints to crop growth and development
- Through G x E interaction, some particular elements of the environment may draw varying responses from different genotypes.

Practical implications:

1. Develop management practices that can remove or avoid environmental constraints.
2. Continuously assess G x E interaction
3. Need for continuous development of improved varieties

In a production system:

- Inputs – controllable, manageable resources such as seeds, fertilizers, pesticides, etc.
- Output - yield
- Environment – uncontrollable factors external to the system
- System – component crops, processes and activities

Practical implications:

1. Man (management has only partial control of the system).
2. Certain factors / conditions are given to which the system has to fit or adjust
3. The design of the system emanates from man (his needs, objectives, knowledge and capabilities)

X. ENVIRONMENTAL FACTORS

- Includes CLIMATIC or above-ground factors and EDAPHIC or soil factors (abiotic factors)
- Also includes pests and beneficial organism (biotic factors)

Abiotic factors

A. CLIMATIC FACTORS

a. Climate

- The seasonal pattern of a particular place occurring from year to year.
- A composite of day to day weather conditions described in averages and variability

b. Weather

- A momentary state of the atmosphere brought about the combination of elements, Ex., temperature,

- pressure, moisture content, air movements, radiation, etc.
- Day-to-day changes of the state or condition of the atmosphere

c. Macroclimate

- The climatic environment one meter above the plant canopy

d. Microclimate

- Generally refers to the climatic environment one meter below the canopy in the case of tall plants or the climate within the leaf canopy for short (below one meter) plants.

The Climatic Elements:

1. Precipitation – is any form of water particles falling on the ground in liquid or solid form (rainfall, hail, snow, etc.)

Role of water in plants

- As a reactants in many biological reactions
- Enters into the structure of biological molecules
- Serves as medium of transport of nutrients and other substances
- Helps regulate plants temperature

Categories of plants based on need for moisture

- Xerophytes** – desert plants
- Hydrophytes** – aquatic plants
- Mesophytes** – land plants; most economically important plants

Factors affecting amount of distribution of rainfall

- *Topography* influences the amount and distribution of rainfall
- *Mountain ranges* present barriers to clouds, causing them to rise to higher elevations and generally colder temperatures causing vapor to condense and water to fall on the windward sides as the clouds pass over, leaving the leeward side relatively dry. Examples are Los Banos in Laguna and Sto Tomas in Batangas. Sto. Tomas is drier than Los Banos due to the presence of Mt. Makiling.
- *Air circulation patterns* affect the seasonal distribution of precipitation

Rain formation requires

- High relative humidity (RH)
- Sufficiently low temperature (below condensation point)
- Condensation nuclei
- Sufficiently low pressure

Drought – insufficiently low of rainfall/moisture which seriously affects plant growth.

- **Absolute drought** – 29 consecutive days without rainfall of at least 0.25 mm.
- **Partial drought** – 15 consecutive days without rainfall of at least 0.25 mm.

2. Temperature

- The degree of hotness and coldness of a body
- Every chemical, physiological and biological process in plants is influence by temperature.

Three (3) cardinal temperatures:

- a. **Minimum temperature** – that temperature below which the velocity of the reaction becomes zero, due to the deactivation of enzymes.

- b. **Optimum temperature** – temperature where the velocity of the reaction is at maximum.
- c. **Maximum temperature** – that temperature above which the velocity of the reaction becomes zero, due to the desaturation of enzymes.

Temperature of the environment depends upon:

- a. **Solar radiation** – vertical rays are more energy efficient/unit area than oblique rays (in polar regions).
- b. Surrounding land masses or bodies of water.
- c. **Altitude** – for every 100 meter rise in elevation, there is a 0.6 °C decrease in temperature.

In the Philippines:

- High elevation – 13.2 – 24.6 C
- Low elevation – 23.3 – 31.5 C

Classification of crops according to temperature requirement

- a. **Cool season crops** – Ex., cole crops like cabbage, broccoli, cauliflower
- b. **Warm season crops** – Ex., rice, banana
- c. **Tropical** – Ex., coconut
- d. **Sub-tropical** – Ex., citrus

Effect of temperature on crops:

- Vernalization requirement of certain crops for flowering (Ex., celery seed exposed to 4.4 – 10 C for 10 days under imbibed condition)
- Effect on crop maturation (crops mature faster in hotter environments than in colder ones)

3. Wind or air in horizontal motion

- Normal wind speed in the Philippines = 7.2 km/hr

- At 30 km/hr = leaf tearing may already occur especially in banana and abaca

Effects of wind in plants:

- a. Increase transpiration
- b. Destructive effects of strong winds, typhoon (Ex., crop lodging, grain shattering)
- c. Sterility due to loss of pollens
- d. Disease spore dispersal
- e. Reduced CO₂ levels especially in enclosed spaces
- f. Affects plant form
 - ❖ Air circulation in the atmosphere results from the sun's radiation falling more directly on the tropical regions than on polar regions, the warmer air rises and flow forward the poles, cools and sinks as cold polar air and then returns toward the equator as ground flow
 - ❖ The interactions cause the establishment of regions, large and small, each with a different climate.

4. Solar radiation or light – energy given out by the sun through radiation

Three aspects important to plants

1. **Light intensity** – expressed in foot-candle or lux.
 - Plants are generally spaced so that maximum leaf area is exposed to sunlight
 - Some plants do not require high light intensity (shade-loving) because they have low light saturation point.
 - Some plants require subdued light to survive. Ex., some ornamentals
2. **Duration or day length** – expressed in hours per day

3. **Wavelength** – expressed in Angstrom or nanometers or identified by color
 - Not all wavelengths of light are equally effective
 - In Photosynthesis – red and blue wavelength
 - In photoperiodism – far red and red wavelength

Effect of light on plants:

- a. **Photoenergetic effect** - direct effect on photosynthesis (intercepted radiation is important)
- b. **Photocybernetic effect** – effect on plant development (light quality is rather important than quality of light)
- c. **Photoperiodic effect** (response)- plant response as conditioned by daylength

Classification of plants according to light intensity requirements

a. **Heliophytes**

- Sun loving
- Light saturated at about 5000 foot candles
- Examples: banana, chrysanthemum, corn, cowpea, cucurbits, eggplant, papaya, peanut, sugarcane.

b. **Sciophytes**

- shade loving
- light saturated at about 500 foot candles
- examples: ginger, African violet, ferns, philodendron, coffee

Plants belonging to the intermediate group may be converted through acclimatization into either heliophytes or sciophytes

Classification of plants according to photoperiodic response

- a. **Day neutral** – will flower over a wide range of daylength
Examples: banana, citrus, coconut, corn, tomato
- b. **Short day plant** – requires a dark period exceeding some critical length to induce flowering
Examples: coffee, kenaf, lima bean, rice, sesame, soybean, winged bean
- c. **Long day plant** – inhibited from flowering when the dark period exceeds some critical length
Examples: aster, castor oil, onion, radish

5. Relative humidity

- proportion/amount of moisture in the air
- low relative humidity and high temperature will result to high evapotranspiration
- high relative humidity and high temperature will result to low evapotranspiration

1. Gaseous Environment

- **Carbon dioxide** – critical in enclosed environments like greenhouses
- **Air pollution** – toxic substances like lead, sulfur dioxide, carbon monoxide, HF

2. **Cloudiness** – cloud including smog and fog affect the amount of radiation received by plants. Most solar radiation is reflected by clouds.

Climatic Stresses:

a. **Typhoon and weather variations**

- Typhoon – strong winds with speed greater than 21 kph

b. Ozone Destruction

- Ozone – protective shield against the harmful UV rays; it is 6-30 miles above the earth
- Harmful effects:
 - i. Depressed photosynthesis
 - ii. Reduced levels of seed protein, lipids and carbohydrates

c. Global warming

- Increased concentration of carbon dioxide in the atmosphere
- CO₂ concentration might double to around 600ppm in 30-75 years
- Methane gas contributes to global warming

d. El Niño/ La niña

- El Niño phenomenon happens when there is a periodic ocean-warming and atmospheric disturbance characterized by deficient rainfall or prolonged drought in some areas, while heavy rains, storms or hurricanes occur in other areas of the globe
- Climatic indicators of El Niño in the Philippines include:
 - a. Delayed onset of the rainy season
 - b. Early termination of the rainy season
 - c. Weak monsoon activity
 - d. Weak tropical cyclones activity

Effects of El Niño

- i. Fish kill especially cold water fish-tuna and milkfish catch declines
- ii. Decrease in yield for most crops

iii. Human death

e. Acid Rain**f. Lahar****B. EDAPHIC FACTORS**

➤ Refers to the soil as a factor in crop production

Soil

- a mixture of organic and inorganic materials which developed on the earth's surface through weathering process of rocks and minerals and whose properties are conditioned in various degrees by the influence of climate, living organisms, and topography acting on the parent material over a period of time
- serves as a medium of plant growth (physical support for anchorage of plant roots; water and nutrient supplier)
- considered a non-renewable resource because it takes about a hundred years for natural processes to form an inch of soil
- a natural body with dimensions of thickness and width with indistinct horizontal boundaries enabling it to blend with other soils and vertical boundaries of the air above it and the unweathered rocks below it

Soil Properties in relation to Crop Production**1. Soil Texture**

- Relative proportion of sand, silt and clay in a particular soil
- The ranges of diameters of the three separates are: sand (2.0- 0.05 mm), silt (0.05-0.002 mm), and clay (<0.002 mm).

Comparison between sand and clay separates.

Sand	Clay
Low total porosity (more macropores)	High total porosity (more micropores)
Low water holding capacity (droughty)	High water holding capacity
Very good aeration	Poor aeration and drainage
Easy to till ("light" soil)	Difficult to till ("heavy" soil)
Non sticky and non plastic when wet	Very sticky and plastic when wet
Low nutrient holding capacity (less fertile)	high nutrient holding capacity (more fertile)

2. Soil Structure

- refers to the clustering of the soil particles into characteristic aggregates of various sizes, shapes and stability

Structural classes based on the shapes of the aggregates

- a. **Prismatic structure** : pillar-like with level tops
- b. **Columnar structure** : pillar-like with rounded tops; like prismatic structure, commonly occur in subsoils and in soils of arid and semi-arid regions

- c. **Blocky structure** : cube-like and has more or less sharp edges and the rectangular faces are distinct
- d. **Sub-angular blocky structure** : has edges which are more or less rounded; like the blocky structure, typical in clayey subsoils particularly in humid regions
- e. **Platy structure** : has disc-like aggregates; commonly found in virgin soils and subsoils; generally make the soil poorly drained
- f. **Spheroidal structure** : rounded aggregates which are more porous; characteristic of surface soils especially those high in organic matter content
- g. **Granular / Crumb** : resembles cookie crumbs; commonly found in surface horizons where roots have been growing

Importance of Soil Structure to Crops:

- a. Influences the infiltration of water through the soil
- b. Influences soil aeration which is critical during seed germination and seedling emergence

3. Bulk Density

- The mass (dry weight) per unit volume of soil
- Mathematically, $B.D. = W_s / V_t$
- where: B.D. = bulk density in g/cm³
 - o W_s = oven-dried weight of soil in g
 - o V_t = total volume of soil clod in cm³ (includes solids and pore spaces)
- A measure of degree of compaction of the soil and an indicator of porosity

- The more compact the soil, the higher is the bulk density value and the less porous it is.
- The range of bulk density values for sand and sandy loam soils is 1.20 to 1.80 g/cm³.
- The range of bulk density values for clay, clay loam and silt loam is 1.0 to 1.60 g/cm³.

Interpretation of some bulk density values	
1.0 to 1.3 g/cm ³	Normal soil
> 1.3 g/cm ³	Compacted soil, poor soil structure
< 1.0 g/cm ³	Very loose soil

Soil Chemical Properties

1. Soil pH

- The most favorable pH for growing most agricultural plants is between pH 6 and pH 7 because at this range the availability of the nutrients and activities of beneficial microorganisms are at maximum.
- The range of pH in the Philippines is from pH 5.5 to pH 6.5.
- When the pH is too low (< 5.0, strongly acidic)
 - nutrients particularly Ca, Mg, K, P, Mo, N become less available to plants
 - N release may also be hindered when the symbiotic nitrogen fixation and nitrification are inhibited
 - Fe, Al, and Mn become more soluble to the point of toxicity

- P becomes complexed into insoluble forms with Fe and Al
- P can also be precipitated as insoluble manganese phosphate compounds when the soil is rich in manganese oxides
- Soils also become acidic when the bases are leached out and replaced by H⁺ ions Ex. old soils in the humid tropics
- Soil acidity may also develop from the decomposition of organic matter due to the formation of organic acids like fulvic acid, humic acid and carbonic acid.
- When pH is too high (>8.0, strongly alkaline)
 - Most micronutrients (except Mo) become unavailable at high pH
 - Iron deficiency commonly develops
 - P becomes complexed with calcium as precipitates of calcium hydroxyapatite or calcium phosphate dehydrate
 - K also competes with the now abundant Ca for plant absorption

2. Cation Exchange Capacity (CEC)

- the ability of the soil to adsorb and exchange cations with those in the surrounding soil solution as well as with the plant roots
- the sum of all adsorbed cations per unit amount of soil
- commonly expressed as milliequivalent per 100 g of soil (me/100g) or cmol/kg soil
- reversible, instantaneous, and stoichiometric process
- typical values ranges from 10 me/100 g to 30 me/100 g
- increases with increasing amount of clay and organic matter

3. Soil Organic Matter (SOM)

- refers to the totality of all carbon-containing compounds in the soil derived from either plants or animals
- Organic constituents of plants:
 - i. Cellulose (15 – 60%)
 - ii. Hemicellulose (10 – 30%)
 - iii. Lignin (5 – 30%)
 - iv. Water-soluble fractions: amino sugars, amino acids (5-30%)
 - v. Proteins
 - vi. Fats, oils and waxes
- Accumulation is affected by temperature, soil moisture, vegetation, soil texture, and cropping system
- Cultivated soils contain an average of 2 to 3% organic matter.
- Organic matter declines when the soil is cultivated because of the enhanced oxidation and microbial activity brought about by the loosening of the soil.

Effects of organic matter to soil properties

Physical

1. enhances soil aggregation and aggregate stability
2. reduces plasticity, cohesion and stickiness of clayey soils
3. increases soil water retention, infiltration rate, water holding capacity and aeration
4. darkens soil
5. reduces bulk density and compaction

Chemical

1. increases CEC of soils
2. increases soil buffering capacity

- 3. increases nutrient availability through solubilization of minerals by organic acids and by chelation of metal ions
- 4. reduces Al toxicity by binding the Al ions in non-toxic complexes
- 5. increases soil native supply of N, P, S, etc
- 6. adsorbs pollutants such as Pb, Cd and Cu
- 7. inactivates toxin and pesticides

Biological

1. provides C and energy to soil organisms and thus increases their diversity and activity
2. enhances microbial functions such as N fixation, decomposition, and nutrient transformations

Soil Biological Properties

1. Soil organisms

- Composed of large and small plants and animals
- The larger organisms (insects, worms, moles, etc.) prepare the organic materials for further degradation by breaking them into smaller pieces
- The smaller organisms (bacteria, fungi, actinomycetes, algae, nematodes, protozoa) cause biochemical changes in the organic materials
- Roles:
 - Responsible for biochemical changes
 - Agents in the decomposition of plant and animal residues
 - Improve soil structure through aggregation

Biotic Factors

- All living elements in the environment that can affect crop production
 - a. **Beneficial organisms** – provides beneficial effects on crop production
 - b. **Pollinators** – important role in the preservation of species and in biodiversity conservation
 - c. **Decomposers** – a trophic level, usually consisting soil microorganisms specifically important in the maintenance of soil organic matter
 - d. **Natural pest enemies** – provide balance in a crop production system particularly in the control of pests
 - e. **Pests** – a collective term that includes pests, diseases, weeds, invertebrates and vertebrates

Genetic Factors

- Includes all factors internal to the plant
1. **Genotype** – the genetic design of a plant which dictates the ceiling of how much a variety/cultivar can yield
***Genome** – sets the ultimate limit for plant variation
 2. **Selection indices of major Philippine crops:**
 - a. The choice of variety is one of the most critical decisions in crop production
 - b. Technologies required in growing a certain crops are dependent on the characteristics of a particular variety especially growth characteristics, quality of the product and market acceptability

Genetically Modified Organisms

- The latest development in biotechnology in relation to crop improvement

- Transgenic crops: corn, tomato, soybean, cotton and potato
- Genetic engineering moves genes from one organism to another in ways that could never be possible in nature (Kuyek D., 2000)

Human Factors

1. Farmer's preference (crop type, variety)

2. Farmer's capability

- Depends on resources and knowledge of the farmer
- Most Filipino farmers are resource poor
- Our culture is very rich in indigenous knowledge particularly about farming

3. Management

XI. CROP IMPROVEMENT AND SEED SELECTION

Plant Breeding

- Science, art, and business of crop improvement for human benefit
- Improves quality, disease and insect resistance, change in maturity duration, agronomic characteristics, photosensitivity, synchronous maturity, non-shattering characteristics etc.

Activities in plant breeding:

1. CREATION OF VARIATION

- a. Naturally existing variability
 - **Domestication** – process bringing wild species under human management

- **Germplasm collection** – collection of a large number of genotypes of a crop species and its wild relatives
 - **Introduction** – taking a genotype or a group of genotypes of plants into new environments where they were not being grown before
- b. Creation of new variability
- **Hybridization** – crossing genetically dissimilar individuals
- c. Hybrid – the intermediate product of hybridization
- **Inbreeding** – mating of individuals related by ancestry; leads to production of homozygous individuals
 - **Inbred** – product of inbreeding hence consequently a homozygous individual
 - **Topcross** – cross between an inbred and an open-pollinated variety
 - **Testcross** – cross between a plant or line and a tester (tester may be an inbred, hybrid, synthetic, or open pollinated variety)
 - **Backcross** – a cross between a hybrid and one of its parents; also a breeding method based on repeated backcrossing of F1 (first generation offspring of a cross) and the subsequent generations to the recurrent parent usually to transfer a major trait controlled by one or a few genes from the donor (as the non – recurrent parent) and the recipient (as the recurrent parent)
- **Polycross**– open pollination in isolation among a number of selected genotypes arranged in a manner that promotes random mating
- **Reciprocal cross** – mating of two individuals in which each is used as the male parent and in one cross and the female parent in the other
- **Intraspecific cross** – crossing individuals belonging to the same species
- **Wide or distant cross**- crossing distantly related individuals
- **Introgressive hybridization** – repeatedly backcrossing interspecific hybrids to one of the parental species leading to the transfer of some genes from one species to another
- d. Heterosis of hybrid vigor – superiority of the F1 hybrid over its parents
- Mid-parent heterosis
 - Heterobeltiosis
 - Standard heterosis
- e. Combining ability – the ability of a genotype to transfer its desirable traits to its progeny
- **General combining ability** – average performance of a strain in a series of crosses
 - **Specific combining ability** – deviation from performance predicted on the basis of general combining ability of parent lines

- f. Inbreeding depression – loss of vigor due to inbreeding
- g. Mutation
 - Heritable change in an organism
 - Spontaneous – mutations occurring in natural populations
 - Induced – mutations artificially produced by treatment with certain physical or chemical agents or mutagens
- h. Chimera – an individual with one genotype in some of its parts and another genotype in other parts
- i. Polyploidization – increasing ploidy level to more than two identical or distinct genomes
- j. Genetic Engineering
 - Production of transgenic plants
 - Changing the genetic make-up of plants by direct introduction of genes from microorganisms, animals or other plant species; done when sexual hybridization between the recipient and donor is impossible
 - Steps:
 1. Identification of genes, construction of vectors
 2. In vitro plant regeneration system
 3. Gene introduction methods
 4. Molecular analysis
 5. Gene expression assays
 6. Stability and transmission analysis

2. SELECTION

- Identification of individuals or lines that are more desirable than others in a heterogeneous population
- a. **Natural selection** – change in gene frequencies from one generation to another because of differences in survival and reproductive abilities of parent genotypes in natural populations
- b. **Artificial selection** – change in gene frequencies brought about by man as is done in plant breeding where certain individuals or genotypes are not used as parent of the next generation

Modes of selection

- i. **Stabilizing or normalizing selection** – when adaptive individuals in the populations are selected under a constant environment through the years; keeps the population constant and eliminates the deviants; reduces the variability present in the population
- ii. **Directional selection** – change towards a particular direction due to changing environments resulting also in change of genetic contribution of the population; mode observed when breeders do artificial selection
- iii. **Diversifying or disruptive selection** – opposite of stabilizing selections; leads to either formation of subpopulations differing in their characteristics or

polymorphism in which each genotype is represented by a distinct phenotype.

Traits selected for:

- a. **Qualitative traits** – monogenic or oligogenic traits; show discrete or non-continuous variation, controlled by one of few genes, less influenced by environment
- b. **Quantitative traits** – polygenic, metric or measurable traits; show continuous variation, controlled by many genes, highly influenced by environment

Bases of selection

- a. Phenotype (P) can be accounted for by the genotype (G), the environment (E) and the interaction between genotype and environment (GxE).
- b. Components of phenotypic variance:
 1. **Phenotypic variance** – sum of genotypic variance, environmental variance and GxE variance
 2. **Genotypic variance** – sum of additive and non-additive types of gene action
 - *Additive – due to individual effects of genes
 - *Non-additive – due to intralocus and interlocus interactions

3. **Environmental variance** – effect of environment on the phenotype and estimated by measuring variation in a genetically uniform population growth in a certain location
4. **GXE interaction** – change in ranking and/or performance of genotypes when grown in different environments; estimated by computing variances of genotypes when grown in a number of locations which are environmentally diverse.

Heritability – a portion of the phenotypic variation among individuals that is due to genetic differences among them

- a. **Broad-sense heritability** – is estimated from the ratio of the total genetic variance to the phenotypic variance
- b. **Narrow-sense heritability** – is estimated from the ratio of the additive portion of the genetic variance to the phenotypic variance
- c. **Selection intensity** – the percentage of individuals selected in a population
- d. **Selection differential** – difference between the mean performance of genotypes selected from a population and the overall population mean
- e. **Gain from selection** – increase in mean performance of a population that is realized with each cycle of selection

3. EVALUATION

- Process of assessing the performance of newly developed lines of a crop through appropriate multi location trials and tests

- Sequences in the conduct of yield tests:
 - a. **Observational yield test** – may test separate groups of experimental lines; uses incomplete block design or triple lattice design with 2-3 replications in one location
 - b. **Preliminary yield test** – evaluation including a check variety using incomplete block design with 2-3 replications in at least 2 locations
 - c. **General yield test** – uses randomized complete block design with 3 replications in at least 3 locations
 - d. **Advanced yield test** – elite lines from general yield tests evaluated using randomized complete block design with 4-replications in 6-10 locations
- Superior lines are approved to be released as a variety by the National Seed Industry Council (NSIC); the variety must have passed the tests for distinctiveness (D), uniformity (U) and stability (S) or the DUS-test.

4. MULTIPLICATION

- Seed multiplication of an entry after it has been identified for release; the seed produced by the breeder after a strain is identified but before it is released as a variety is termed as the stock seed. The stock seed is known as breeder seed once the identified strain is released and notified.
- **Seed** – any propagating material used for raising a crop

Seed multiplication involves:

- a. **Seed production** – should observe proper isolation procedures to maintain genetic purity of the variety

- b. **Isolation** – separation of a population of plants from other genotypes with which they are capable of mating
- c. **Seed processing** – drying, cleaning and grading, testing, treating, bagging and labeling

Types of varieties

- a. **Hybrids** – first generation offspring of a cross between two individuals differing in one or more genes
- b. **Synthetics** – seed mixture of strains, clones, inbreds, or hybrids, maintained by open-pollination for a specified number of generations; the component units are propagated and the synthetic reconstituted at regular intervals
- c. **Composites** – mixture of genotypes from several sources, maintained by normal pollination
- d. **Inbreds** – a pureline originating by self pollination and selection
- e. **Multilines** – or blends; composite of isolines
- f. **Isolines** – lines that are genetically similar except for one gene
- g. **Open-pollinated variety** – variety maintained by natural cross pollination
- h. **Landraces** – farmer-selected cultivated forms

Hybrid seed production

- a. **3-line system** – male sterile line (A), maintainer line (B) and restorer line (R)

- b. **2-line system** – male sterile line, the expression of which is influenced by environment and any inbred variety as pollen parent
- c. **1-line system** – use of apomixis to produce the F1 seeds and maintain the genotype of the F1

5. DISTRIBUTION

- Classes of seeds
 - a. **Breeder seeds** – controlled by the originating plant breeder; starting point of all the subsequent classes of seeds; seeds obtained from uniform panicles by breeders; 100 percent pure
 - b. **Foundation seeds** – seeds produced from breeder seeds; source of registered and/or certified seeds; carry a red tag
 - c. **Registered seeds** - produced from foundation or registered seeds and carry a green tag
 - d. **Certified seeds** – produced from foundation, registered or certified seeds and carry a blue tag
 - e. **Good seeds** – produced from varieties not yet approved by NSIC

6. CONSERVATION OF GERMPLASM

- **Germplasm**– is the sum total of hereditary material or genes present in a species
- **Plant germplasm**- genetic source material used by plant breeders to develop new cultivars
- **Germplasm storage**
 - a. As seeds in cold/refrigerated rooms
 - b. Maintained as living plants in field or through slow growth in vitro
 - c. Cryopreservation or freeze-preservation

XII. SUSTAINABLE CROP PRODUCTION

SUSTAINABLE AGRICULTURE - an integrated system of plant and animal production having site specific applications that will, over the long term:

- satisfy human food and fiber needs,
- enhance environmental quality and natural resource base upon which the agricultural economy depends.
- make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls,
- sustain the economic viability of farm operations, and
- enhance the quality of life for farmers and society as a whole

Sustainability

– ability of a system to maintain productivity in spite of a major disturbance such as is caused by intense or large perturbation

- Capacity of a system to maintain output at a level approximately equal to or greater than its historical average, with the approximation determined by its historical variability.

Characteristics of Sustainable Agriculture

1. SA is flexible
 - No defined set of practices, methods, techniques/technologies or policies
 - recognizes local specificity
2. SA is experiential
 - does not impose a simple model or package
 - farmers and local communities must be able to adapt and allowed to change

- 3. SA is participatory
 - farmers are active participants
 - incorporates recent innovations originating from scientists, farmers or both
 - relies on continuous innovation by farmers and local communities
- 4. SA is proactive
 - forward-looking
 - concern of short and long-term sustainability
 - dynamic and innovative
- 6. Location specific
 - appropriate/practical technology
- 7. Resource-based
 - community-based management of resources
 - control of resources
 - enhanced/protect what is available or remaining
 - use of indigenous technical knowledge
- 8. Social equity
 - socially just and humane
 - enhance community participation and harmony
 - socially acceptable

Features/ attributes/ dimensions of SA

- 1. Continuously evolving
 - non-permanent
 - dynamic
- 2. Gender sensitive
- 3. Ecologically sound and friendly
 - environmentally/ecologically friendly farming practices
 - dynamic relationship between man and environment
 - improved standard of living for farmers without negative effects on the environment
- 4. Culturally appropriate
 - culturally sensitive
 - documentation, validation, promotion and use of indigenous knowledge system
- 5. Economically viable
 - economically viable system and practice
- 9. Holistic Approach
 - holistic/integrated
 - diversified farming
 - location specific
 - system with no leak
- 10. Enhances human values

Focus for action in sustainable agricultural framework:

- long term sustainability rather than short term benefits
- provide internal solutions to internal problems rather than external solutions to internal problems
- emphasis on management solutions to problems rather than merely on technological solutions to the problems
- responsive to feedback, belief in accountability and participatory, rather than detachment
- low rather than high external input
- emphasis on systems approach rather than on individual commodities and monoculture

- relies on available indigenous resources and self-reliance rather than capital intensive
- use of technologies that preserve and enrich the natural resource base rather than the use of technologies that exploit and destroy the natural resource base
- recognize location specificity of technologies, use of appropriate and indigenous technologies.

Biodynamic farming or biodynamic agriculture

- By spiritual insights of Dr. Rudolf Steiner that emphasizes on many of the forces within living nature, identifying many of these factors and describing specific practices and preparations that guide the decomposition process in manure and compost

Biological farming/ecological farming

- A system of crop production in which the producer tries to minimize the use of chemicals for the control of crop pests

Natural farming

- involves no tillage, no fertilizers, no pesticides, no weeding, no pruning and remarkably little labor by careful timing of seeding and combination of crops (polyculture)

Kyusei Nature Farming

- developed by Terou Higa of Japan which means saving the world, employs technology involving beneficial micro-organisms and inoculants to increase the microbial diversity, health and yield of crops

Permaculture

- or permanent culture was coined by Bill Mollison in 1970 which is a unique design that produce efficient low-maintenance integration of plants, animals, people and structure applied at the scale of a home garden, all the way to a large farm

Organic Farming

- was first used by Lord Northbourne, is a production system which avoids or largely exclude the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock additives

Regenerative agriculture

- a form of agriculture that aims to enhance regeneration of renewable resource to achieve a sustainable form of agriculture

Precision farming/agriculture/ Prescription Farming /Site Specific Management

- A management strategy that employs detailed site-specific information to precisely manage production inputs; to know the soil and crop characteristics unique to each part of the field, and to optimize production within small portions of the field that uses computers, telecoms and global positioning systems (GPS), etc.

XIII. FARMING SYSTEMS

Farm – is a highly organized integrated set of operation which exist in a complex of natural, social, political and economic environment

Farming system

- The manner in which a particular set of farm resources is assembled within its environment by means of technology for

- the production of primary agricultural products, excluding postharvest handling/ processing and marketing
- A farming pattern or mix of farming enterprises that a family allocates its resources (land, labor, capital) to efficiently exploit the existing environment (rainfall, soil properties, solar radiation, market, credit infrastructures, and service institution) for the attainment of the family's goal (increase income, improve quality of life, etc.)
- It is a complex inter-related matrix of soil, plants, animals, implements, power, labor, capital and other inputs controlled in part by families and influenced to varying degrees by political, economic, institutional and social forces that operate at many levels.
- It is the scientific integration of different interdependent and interacting farmenterprises for the efficient use of land, labor and other resources of a farm family which provides year round income to the farmers specially located in marginal zones.
- It represents an appropriate combination of farm enterprises viz. cropping system, livestock, poultry, fisheries, forestry and the means available to the farmer to raise them for increasing profitability.

Types of farming systems

- 1. Based on Enterprise Mix(es)** – monocropping or diversified farming (multiple cropping systems)
- 2. Based on the Dominant Crop(s)** which form the major enterprise (Rice-based, coconut-based, etc)
- 3. Based on Agro-environment**
 - Moisture regime/water source - rainfed or irrigated

- b. Topography – lowland or hilly farming (Ex. Agroforestry & SALT)
- c. Elevation/altitude – High land, Hilly Land, Low Land

4. Based on Use of Farm Inputs

- High External Input (HEI) FS – associated with modern agriculture (green revolution) characterized by the use of chemical fertilizers, pesticides & HYV seeds
- Low External Input (LEI) FS – biodynamic farming, permaculture, nature farming, etc. which are purest and pursue farming chemical free

5. Based on the Central or Unique Feature of the Farm

- Crop Centered FS
- Livestock Centered FS (ruminants, non- ruminants)
- Integrated Crop + Livestock FS
- Integrated Crop + Aquaculture FS
- Integrated Livestock + Aquaculture FS

6. Evolving Type of FS

- Recreational or hobby farming FS
- Agrotourism-oriented FS – farm resort & Open farm-farm level marketing

7. Specialized FS

- Production of high value cutflowers (anthurium, orchids, etc)
- Aquaculture – fingerlings production, aquarium fish, etc.

General Types of Farming Systems

- 1) **Lowland Farming System** – generally refers to crop or animals (including fish) production in paddy fields or swampy

areas, where there is a continuous or regular availability of water. Ex. lowland rice

- 2) **Upland Farming System** – refers to the growing of crops and/or animals in relatively flat or plain areas where water is not regularly available except through precipitation (rainfall) or irrigation.
- 3) **Agro-forestry** – involves the culture of crops and animals in any combination, together with a woody perennial. This includes areas whether flat or sloping.
- 4) **Highland Farming System** – this is oftentimes interchange with hilly lands, because of their similar topographic features, but this is concerned more on agricultural areas of higher elevation of at least 800-1000 m above sea levels. These are characterized with relatively lower temperatures throughout the year.
- 6) **Dry Farming or Dryland Farming System** – the practice of growing profitable crops without irrigation in areas which receive an annual rainfall of 500mm or even less

Dry land agriculture – the cultivation of crops entirely under rainfed condition, with three groups/classifications on the basis of annual rainfall

XIV. CROPPING SYSTEM

Cropping System

- Refers to the pattern or arrangement of crops in time and space, as well as the process of growing them.

Polyculture Farming System

- involves the mixture of annual crops with other annuals, annuals with perennials, or perennials with perennials, or perennials with perennials planted in spatial pattern

Cropping Pattern

- The yearly sequence and spatial arrangement of crops or of crops and fallows on a given area.

1. Monocropping

- a method of crop production in which only one crop is grown annually in the same parcel of land (perennial monoculture and annual crop monoculture)

*Monoculture – only one crop is grown in a given area throughout the year

Types of Monoculture

- a) Perennial monoculture – this involves the planting of trees especially on steep slopes and heavy clay soils. Rubber, ipil-ipil and coconut are suitable trees under this system.
- b) Annual crop monoculture – this system utilizes both upland and lowland annual crops like rice, corn and vegetables

2. Multiple Cropping

- growing of more than one crop on the same land in one year.

Types of Multiple Cropping

The intensification of cropping In time and space dimensions, is growing two or more crops on the same field in a year.

Sequential cropping – growing of two or more crops in sequence on the same field within a 12 month period, with the succeeding crop planted only after the preceding crop has been harvested such that a farmer managed only one crop at any time on the same field. A sequential cropping is denoted by a hyphen (-) between two succeeding crops.

Double cropping – growing two crops in sequence, seedling or transplanting one after the harvest of the other – also called sequential cropping

Triple cropping – growing three crops in sequence, seedling or transplanted one after the harvest of the other

Ratoon cropping – the development of a new crop without replanting from buds on the root system, stubble or stems of the preceding crops, a harvest not necessarily for grains. Rice under certain conditions can be a ratooned crop.

3. Intercropping

- It is the growing of two or more crops simultaneously on the same field such that the period of overlap is long enough to include vegetative stage. Intercropping is denoted by a (+) sign between any two crops grown simultaneously.

- The growing of two or more crops simultaneously on the same piece of land, base crop necessarily in distinct row arrangement, or with or without a row arrangement (row intercropping or mixed cropping).

- Includes alley cropping, strip cropping, contour cropping, paired row cropping, skip cropping, parallel cropping, companion cropping, multi-storey cropping, and synergistic cropping.

Major intercropping systems:

a. Parallel cropping

- cultivation of such crops which have different natural habitat and zero competition
- Ex. mungbean (30-35 days after sowing) + maize (50 days after sowing)

b. Companion cropping

- intercropping where the production of both intercrops is equal to that of its solid planning
- Ex. mustard/potato/onion + sugarcane

c. Multi-storey/Multilevel

- Cultivation of two or more than two crops of different heights simultaneously on a certain piece of land in any certain period
- Ex. sugarcane + mustard + onion/potato

d. Synergistic cropping

- The yields of both crops are higher than of their pure crop on unit area basis.
- Ex. sugarcane + potato

4. Relay cropping

- Growing of two or more crops together, but seedling or transplanting the succeeding one after flowering and before the harvest of the former crop. If the planting of the second crop is done before the flowering stage of the first crop, the cropping pattern is intercropping. Relay cropping is denoted with a slash (/) between crops.

Other types of Cropping Patterns

- **Strip cropping** – the growing of two or more crops simultaneously in separate plots arranged in strips that can be independently cultivated
- **Sorjan cultivation** – system of crop cultivation in parallel beds and sinks wherein lowland crops are planted in the sinks and upland crops are grown in beds. Two successive upland crops can be grown in beds during the year and the rice crops in the sinks.
- **Alley cropping** – the system follows an alternate succession of the strips or hedgerow croppings of perennial crops established along the contour of the slope and an open space or alley which is devoted to annual agricultural crops.

Limitations of Multiple Cropping

- a. **Allelopathy** – refers to the detrimental effects of higher plants of one species on the germination, growth or development of plants of another species.
- b. **Morphological differences** – the difference in form or structure of the component crops. The morphological difference is primarily related to “mutual shading” which in turn is directly related to photosynthesis.

SALT Cropping System

- can prevent soil erosion, improves soil fertility and provides a continuous income from diverse crops planted on the hilly land.

Agroforestry

- is a land-use system in which agricultural crops/and or livestock and forest trees are raised on the same land either sequentially through rotational use or simultaneous.

Crop rotation is the growing of different crops in a definite order of succession on the same land. The crops in rotation form a mutual and beneficial allelopathic relationship.

Low External Input Agriculture (LEISA)

- It is a low resource, resource-poor, undervalued-resource agriculture wherein properties of the physical environment and/or commercial infrastructure do not allow widespread purchased of inputs.

Integrated Farming Systems & Integrated Food & Farming Systems

- Included in this concept are the goals of finding and adopting integrated and resource efficient crop and livestock systems that maintain productivity that are profitable and protect the environment

XV. SITE CHARACTERIZATION AND EVALUATION

A Establishing a crop production enterprise

- a. Finding a suitable site
- b. Determining the suitable crop/s for that particular site
- c. Evaluating the socio-economic, biological, and physical conditions existing in the site

B Site selection – affects future decisions related to production costs, farm operations, transportation, etc.

C Socio-Economic Factors:

- a. Peace and order
- b. Manpower availability
- c. Market availability
- d. Farmers' preference
- e. Zoning and other regulations
- f. Land tenure situation

D Biological Factors:

- a. Crops planted
- b. Crop pests and diseases (see CROP PROTECTION manual)

E Physical Factors:

- a. Resources – water, tools and machines
- b. Soil – soil type, soil pH, NPK amounts (see SOIL SCIENCE manual)
- c. Topography – relief, elevation (see SOIL SCIENCE manual)

d. Climate:

- ✓ **Rainfall** – average in PH is 2553 mm; requires high relative humidity, temperature below condensation point, condensation nuclei, and sufficiently low pressure
- ✓ **Temperature** – range in PH at high elevations is 13.2-24.6°C; range in PH at low elevations is 23.3-31.5°C; for every 100 m increase in elevation, there is a corresponding 0.6 °C decrease in temperature; crops mature faster in higher temperatures

- Cardinal temperatures:

- **Minimum temperature**–temperature below which reaction velocity becomes zero due to deactivation of enzymes
- **Optimum temperature**– temperature at maximum reaction velocity
- **Maximum temperature**– temperature above which reaction velocity becomes zero due to desaturation of enzymes

- Types of plants based on temperature requirement:

- **Cool season crops**–cabbage, broccoli, cauliflower
- **Warm season crops** – rice, banana
- **Tropical crops**– coconut
- **Sub-tropical crops**– citrus

- **Vernalization**—exposure to low temperature as requirement for flowering

- ✓ **Wind speed**— average in PH is 7.2 km/hr; leaf tearing in banana and abaca at 30 km/hr

✓ **Solar radiation or light**

- Aspects of light important to plants:

- **Light intensity** – expressed in foot-candle or lux
- **Duration or daylength** – expressed in hr/day
- **Wavelength** – expressed in Angstrom or nanometer or identified by color; red and blue wavelength in photosynthesis, far red and red wavelength in photoperiodism

- Effect of light on plants:

- **Photoenergetic effect** – on photosynthesis
- **Photocybernetic effect** – on plant development
- **Photoperiodic effect** – plant response as conditioned by daylength

- Types of plants based on light intensity requirements:

- **Heliophytes** – sun-loving; light saturated at 5000 lux; banana, chrysanthemum, corn, cotton, cowpea, cucurbits, eggplant, papaya, peanut, sugarcane
- **Sciophytes** – shade-loving; light saturated at 500 lux; begonia, black pepper, coffee, ferns, ginger, philodendron

◦ **Intermediate group**

- Types of plants based on photoperiodic response:

- **Day neutral plant** – flowers over a wide range of daylength; banana, citrus, coconut, corn, tomato
- **Short-day plant**—requires a dark period exceeding a critical length to induce flowering; coffee, rice, sesame, soybean, winged bean
- **Long-day plant**—inhibited from flowering when dark period exceeds critical length; aster, castor oil, onion, radish

- ✓ **Relative humidity**— average in PH is 82%; increased incidence of pest and disease with higher relative humidity; increased incidence of wilting with lower relative humidity; high evapotranspiration due to low RH and high T°, low evapotranspiration due to high RH and high T°

XVI. CORONA CLASSIFICATION (Classification of Philippine Climate)

- **Type I. Pronounced wet and dry seasons** – dry from November to May, wet from June to October; Ilocos, Occidental Mindoro, Antique, Negros Occidental
- **Type II. No dry season with pronounced maximum rain period** – maximum rain period is from November to January; Bicol, Samar, Leyte, Surigao, Agusan, Davao

- **Type III. No very pronounced maximum rain period with short dry season lasting from one to three months** – dry from February to April; Cagayan, Nueva Vizcaya, Capiz, Cebu, Negros Oriental, Masbate, Mt. Province
- **Type IV. No pronounced maximum rain period and no dry season** – rainfall is distributed throughout the year; Isabela, Bohol, Cotabato, Lanao, Zamboanga, Bukidnon; most fruits are best grown in a Type IV climate where rainfall is evenly distributed throughout the year

XVII. LAND PREPARATION AND PLANTING PRACTICES

Land preparation

- To provide a favorable soil environment for the germination and growth of a particular crop.
- It is done in accordance with the requirements of the crops, whether they grow under dryland or wetland systems. The two systems of land preparation and water management (wetland and dryland) have contrasting features in terms of its physical, biological and chemical nature of soils.

*Land is prepared by the process of tillage.

***Jethro Tull** is considered as the father of modern tillage

Tillage - is the manual or mechanized manipulation of the soil to provide a medium for proper crop establishment and growth.

Types of land preparation:

- **Lowland/wetland preparation** – soaking, plowing, harrowing, leveling
- **Upland/dryland preparation** – plowing, harrowing/rotavation, leveling

Tillage and planting equipment

- **Plow** – animal-drawn moldboard, tractor-drawn moldboard, disc
- **Harrow** – disc, comb-tooth, spike-tooth
- **Rotavator**
- **Furrower** – animal-drawn ('lithao'), tractor-drawn
- **Planting hole digger**
- Characteristics of a well-prepared upland field:
 - Soil is granular, friable, and compact enough to allow contact between seed and soil
 - Sufficient moisture for germination and subsequent growth
 - Level field to avoid water accumulation
 - Free from weeds
- Differences in terms of physical changes between upland and lowland land preparation:

- **Upland** – no flooding, no puddling, macro- and micropores are maintained, water drains easily if there is no plowpan, tillage is easy especially at field capacity
- **Lowland**–flooding involved, puddling involved, macropores are lost while micropores are maintained, plowpan is formed, tillage is hard when soil is dried
- Differences in terms of chemical changes between upland and lowland land preparation:
 - **Upland** – root zone is well-aerated, aerobic organisms are present, no reduced zone, pH is stable, high N mineralization, P, K, Si, and Mo are less available, Cu and Zn are not affected, less generation of gases (i.e. carbon dioxide, methane, nitrous oxide, hydrogen sulfide) and organic acids
 - **Lowland** – thin oxidized layer and reduced layer in root zone, aerobic and anaerobic organisms are present, increase in pH in acid soils and decrease in pH in alkaline soils, slow N mineralization, P, K, Si, and Mo are available, Cu and Zn are reduced, generation of gases and organic acids
- Types of Tillage Operations:
 - **Primary tillage** – the most aggressive tillage operation; undertaken when the soil is wet enough to allow the field to be plowed and strong enough to give reasonable levels of traction; after the crop harvest or at the beginning of the next wet season; includes the plowing operation which is opening of the compacted soil with the help of different plows
 - **Secondary tillage** – any working completed after primary tillage; shallower and less aggressive; includes the operations performed after plowing such as leveling, discing, and harrowing
 - **Seedbed preparation** – for germination of seeds; carried out by using hand tools or implements like harrow, rollers plank, and rider
 - **Inter tillage** – carried out in the standing crop; after sowing or planting and prior to the harvesting of crop plants; includes gap filling, thinning, weeding, mulching, top dressing of fertilizers, hoeing, etc.

Forms of Tillage Operations

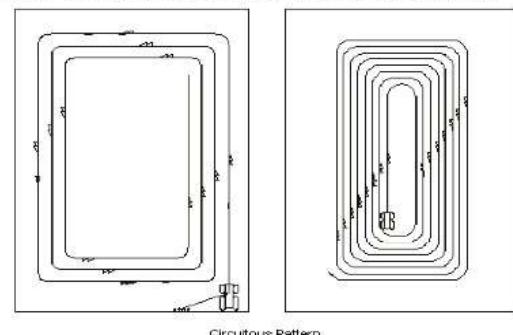
1. **Conventional tillage** – results in a residue-free soil surface at planting time
2. **Conservation tillage** – It is a basic tillage strategy that entails practices in which some crop residue remains on the soil surface after the operation. It maintains residue from previous crop on soil surface. The chief goals of conservation tillage are: 1) to reduce soil erosion and 2) conserve moisture.

The common types of conservation tillage include:

- a. **No tillage or zero tillage.** A system of cropping whereby a crop is seeded directly into a seedbed not tilled since the harvest of the previous crop.
- b. **Mulch tillage.** A system that leave crop residue to serve as mulch, as in stubble-mulch tillage that aims to conserve moisture and to protect the soil from wind and water erosion by leaving crop residues on the soil surface.
- c. **Strip tillage.** It is also called strip-till or zone tillage. It entails the disturbance of narrow strips in the soil where seeding is done. The interrow zone remains undisturbed and covered with crop residue.
- d. **Minimum tillage.** It involves considerable soil disturbance but to lesser extent than conventional tillage. Some crop residue is left on the soil surface. Minimum tillage is also called reduced tillage.
- e. **Ridge tillage.** A small band of soil on the ridge is tilled. The soil from the top of the ridge is mixed with crop residue between ridges. The debris reduces soil erosion and increase water retention.

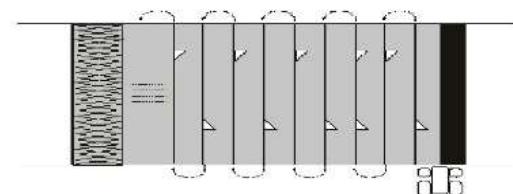
Tillage patterns - reduce the time spent in non-productive work; minimize the number of turns and maximize the length of the tillage runs

- **Circuitous pattern** – used with moldboards, discs, and offset discs; most animals are accustomed to working; ends up with a large cut out furrow in the center – difficult to drain and get an even depth of cultivation



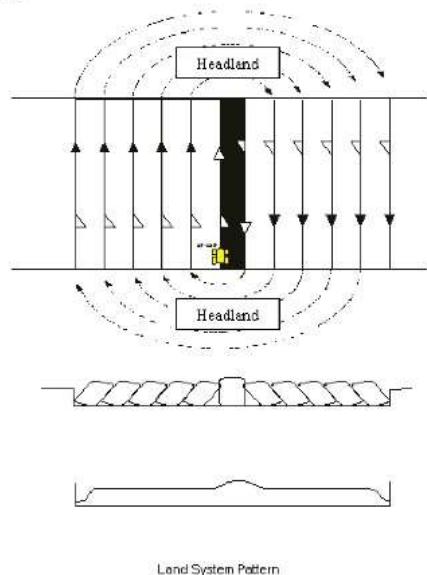
Circuitous Pattern

- **Up and back/Headland pattern** - runs parallel to each other; used for tined implements, rotavators, harrows, and reversible plows; most field efficient system and if equipment is correctly set up and operated, it should not leave furrows in the field



Headland Pattern

- **Land system** - plowing to begin in the center of the field and works out to the edges; requires measurement of the field to establish the center point; used with all types of plows



XVIII. PLANTING MATERIAL, SELECTION AND PREPARATION

Definition of Terms:

Planting materials – seeds, setts, seed pieces, propagules

Seeding rate – number of seeds to be planted in a given hill or linear meter

Population density – the amount of seeds planted in a given area

Furrows – an opening in the soil where the seeds are planted

Basal fertilizers – fertilizer materials before the seeds are placed.

Planting materials for row planting

1. Seeds: All grain crops (legume and cereals), forage grasses and legumes; fiber crops (jute, ramie, and cotton)

2. Vegetative materials:

Stem cuttings - sugarcane, sweet potato, cassava, forage grasses

Tubers – Irish potato, yams

Bulbs – multiplier onions, garlic

Corms – taro (gabi)

Rhizomes – ramie, ginger

SEXUAL PROPAGATION AND NURSERY PRACTICES

Types of flowers:

- **Staminate** – male, only stamens
- **Pistillate** – female, only pistils
- **Hermaphroditic** – perfect, both stamen and pistil
- **Monoecious** – staminate and pistillate flowers on the same plant, e.g. cucurbits
- **Dioecious** – staminate and pistillate flowers on different plants, e.g. papaya

- **Andromonoecious** – perfect and staminate flowers on the same plant, e.g. muskmelons

Breeding methods:

- **Naturally self-pollinated**

Beans, peas, lettuce, tomatoes

Not absolute; crossing usually occurs

- **Cross-pollinated**

Crucifers (cabbage, cauliflower, radish),

Root crops, carrots, beets, parsnips, onions

Others like sweet corn, spinach, asparagus

- **Partially cross-pollinated**

Eggplants, peppers, celery, cucurbits (squash, pumpkins, muskmelons, cucumbers, watermelons)

Hybrid vs. Open-Pollinated Cultivars:

- **Hybrid** - product of controlled pollination of 2 or more genetically distinct parental inbred lines; superior; crop uniformity; time-consuming; expensive
- **Open-pollinated** - self/cross-pollinated; strict artificial isolation; less expensive

Seed Quality and Characteristics:

- True-to-type
- High germination percentage
- High vigor
- No dormancy
- Free of foreign matter
- No disease or insect contamination

Seed classes:

- **Breeders seed** - initial source of cultivar produced by the plant breeder
- **Foundation seed (white tag)** - progeny of the breeder's seed and handled to maintain the highest degree of purity
- **Registered seed (purple tag)** - progeny of foundation seed for the production of certified seed
- **Certified seed (blue tag)** - final product produced by seed company or growers for commercial sale to crop producers

* **Good seeds** – seeds produced from certified seeds which are widely available at village levels.

Seed performance:

- **Seed vigor** - rapid, complete, and uniform seed germination
- **Seed enhancement** - to improve seed vigor; chitting - shorten time between sowing and seedling emergence, under ideal conditions until radicle emergence, sowing/transplanting in moistened media
- **Osmoconditioning/Seed priming** - improves seedling vigor, germination rate, and uniformity; involves seed imbibition in a temperature-controlled, dilute, aerated solution of an organic or inorganic osmoticum; all seeds will have exactly the same moisture content; seed metabolism is stimulated
- **Use of coated or pelleted seed** - small-seeded vegetables like tomatoes can be handled and singulated in precision seeders more efficiently; thick layer of diatomaceous earth,

- montmorillonite clay, sand, etc. with a binder around seeds to increase size and uniformity; increased pestilence protection when fungicides/insecticides are incorporated
- **Use of synthetic seeds** - disease-free plant tissue, somatic embryos produced aseptically in vitro; embryos can be removed from the culture media and encapsulated in synthetic gels that replace endosperm and seed coat; chemicals for protection against pestilence can be incorporated in this gel

Transplanting vs. direct seeding:

- **Transplanting (plugs)** - extend a short growing season for late-maturing crop; improve land-use efficiency; save cost of expensive hybrid seed; force crop production for an early market; assure complete stand and crop uniformity
- **Direct seeding** - most economical; not satisfactory seed germination

Hardening - acclimatization or adaptation to the harsher field environment by withholding moisture and reducing temperature for 7-14 days prior to transplanting; slows or retards seedling growth and allows accumulation of carbohydrates

Planting methods:

- **Crops that are usually transplanted** - cabbage, pepper, broccoli, cauliflower, celery, tomato, lettuce, eggplant

- **Crops that are usually direct-seeded** - melons, bitter gourd, cucumber, beans, kangkong, hybrid onion, sweet corn
- **Crops that should be direct-seeded** - radish, turnips, carrot, beets; crops are never transplanted because the tip of their taproots may be damaged in the process, resulting in forked roots

Planting depth:

- Too deep will exhaust energy reserves before reaching the soil surface
- Too shallow will not able to reach soil moisture, dry out and die
- Not deeper than 10x the diameter of the seed
- Epigeal emergence (soybean) are prone to crusting than hypogea emergence (corn)
- Seeds are sown deeper in sandy than clayey soils

Seeding methods:

- **Broadcasting** - even spreading of seed on top of seedbed; manual or mechanized
- **Drilling** - depositing seed in a row at a uniform depth in a seedbed using equipment; greater seeding precision

Methods of Raising Rice Seedlings

1. **Wetbed method** – seeds are sown raised beds with continuous irrigation water and seedlings are ready for transplanting in 25-30 days

- Dapog method** – pre-germinated seeds are sown in cemented or puddle soil covered with banana leaves or plastic sheet. Seedlings are ready for transplanting in 10-14 days.
- Dry-bed method** – It is only applicable for rainfed areas wherein seedbeds are prepared followed by sowing of seeds. Seedlings are ready for transplanting in 20-40 days.

ASEXUAL PROPAGATION AND NURSERY PRACTICES

✓ Natural Vegetative Propagation

- Vegetative propagation by roots** - tuberous and develop adventitious buds which grow into leafy shoots called slips; radish, carrot, dahlia, tapioca
- Vegetative propagation by stems** - aerial weak stems like runners and stolons, when touch the ground, give off adventitious roots; when the connection with the parent plant is broken, the portion with the newly struck roots develops into an independent plant
 - Bulbs - onion
 - Corms - colocasia
 - Offsets - Eichhornia
 - Rhizome - banana, ginger
 - Stolons - strawberry
 - Tuber – potato
- Vegetative propagation by leaves** - Bryophyllum plantlets are produced from the notches of the margin of intact leaves, still attached to the parent plant; in

other species of Bryophyllum, the leaves must be detached or injured before plantlets arise

- Vegetative reproduction from reproductive organs** - in Agave, the flower bud becomes modified structures called bulbils; bulbils are fleshy storage food in the floral leaves and drop from the parent plant to the ground, give out adventitious roots, and develop into new plants

✓ **Artificial Vegetative Propagation**- combining the good qualities of two different varieties; propagating the desirable variety of plants economically, with the least attention and in a comparatively shorter time

- Cutting/cuttage** – a missing organ is allowed to regenerate on detached vegetative part so that a complete plant is formed; types of cuttings are root cuttings, stem cuttings, and leaf cuttings
- Air layerage/Marcotting**– rooting a shoot or branch which is still attached to the mother plant, and then later separating the rooted shoot or branch to become a new plant
- Graftage**– joining of two plant parts with the objective of having the parts united so they can continue to grow as one; rootstock (root system) and scion (shoot system)
- Separation** – using naturally detachable organs from the mother plant as planting materials; applicable for plants having modified organs
- Division** – cutting the modified organ into sections or pieces with each piece having at least two buds

- **Tissue culture** - a small amount of tissue from a suitable part of the parent plant is excised and grown on a nutrient medium under aseptic conditions; the tissue then develop into an undifferentiated mass of cells called callus; a small portion of the callus tissue is transferred to another suitable nutrient medium where they develop and differentiate into small plantlets; these plantlets on being transplanted in pots or soil, develop into mature plants

XIX. PLANTING PRACTICES

I. Seed Analysis/Testing

- It is a procedure for gathering pertinent information about a seed, its capacity for establishing a stand of seedlings.

Methods of seed viability testing:

a. Standard Germination Test

i. Rug doll method or rolled-towel test

- Seeds are arranged in rows and rolled up. The rolled material is placed in a germinator at 90% RH at 26°C for 16 hour, then another 8 hours at 30°C for one to several weeks.

ii. Seedbox method

- Seeds are sown in previously sterilized soil.
-

iii. Petri dish method

- Seeds are placed in absorbent material in the dish.

b. Tetrazolium Test

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- It is a colometric test in which the biochemical reaction causes the test solution to change color under certain conditions. Respiring and viable seeds will change color to red; dead or non-respiring seeds remain colorless.

II. Seed Purity Test

Seed Purity is the percentage pure seed (only the seed of the desired kind without contaminants) in the sample tested.

XX. SPECIAL PRACTICES IN CROP PRODUCTION

- **Windbreak**—rows of trees or shrubs that protect crops from strong winds
- **Shading**—required for normal growth and development for sciophytes
- **Hardening**— exposing young plants slowly to the outdoor environment
- **Pricking**— transfer of seedlings from overcrowded container to another container
- **Rouging**— removal of off-type or diseased plants
- **Mulching**— placing mulch (a protective layer made of either organic or inorganic material) over the soil
- **Pruning**—removal of plant parts to attain a specific objective (preventive, formative, corrective, rejuvenative)

Types of Pruning:

1. Heading-back

- the cuts are made at the terminal portion of the plant capitalizes on what is known as "apical dominance"

2. Thinning-out

- the complete removal of any number of branches.
- the remaining branches retain their apical dominance, suppresses the development of the lateral buds and grow into sturdy boughs.

- **Fruit thinning**—removal of some fruits to minimize inter-fruit nutrient and assimilate competition
- **Deblossoming**—removal of flowers on the young woody plants to have full canopy development
- **Ratooning**—growing of a new crop out of the shoots arising from the previous crop
- **Desuckering**—removal of unnecessary suckers from the base (mat) of banana or abaca
- **Training**—bending, twisting, and tying of plants to support structures
- **Trellising**—providing structural support to plants so that stems, leaves, or fruits are kept away from the ground and plants are more exposed to sunlight; arbor or overhead type, fence type, pole type, T-type, A-type, teepee type
- **Propping**—providing support to bunches or stalks which tend to bend due to heavy load of fruits; single pole, double pole, cable propping

- **Fruit bagging**—wrapping fruits either individually or as a group with newspaper, jutesack, or PEB to prevent damage from pests, diseases, and strong wind
- **Latex stimulation**—use of Ethrel to stimulate latex production of old rubber trees
- **Flower induction**—hacking (wounding trunk of mango tree to release ethylene); smudging (smoky fire below mango tree canopy); potassium nitrate (Carabao, Pico, and Pahutan mango cultivars); calcium carbide or Ethrel (pineapple)
- **Pollinators**—increase percentage of seed setting
- **Control of sex expression**—maleness (long days, high temperatures, gibberellins); femaleness (short days, low temperatures, auxin and ethylene)
- **Distance isolation**—maintain genetic purity and avoid seed variability especially in cross-pollinated plants
- **Time isolation**—at least 3 weeks difference in time flowering

XXI. WATER MANAGEMENT

- **Water** - essential and critical input in crops at all stages; the medium with which nutrients are absorbed by plants
- **Methods of irrigation:**
 - **Surface irrigation** - water is allowed to pass through the soil surface towards the root zone of the plant
 - a. **Furrow method** - done through the furrows with uniform; applicable in gentle slope and soils with high water-holding capacity
 - b. **Basin method** - water is directly applied on soil surface over the root zone forming some sort of a

basin; can be done on hilly lands with 60-70% efficiency

- **Sprinkler system** - uses water more efficiently since water is applied in small droplets, requires smaller volume of water, and adopted in various slopes and soils; 70-80% efficiency
- **Drip system or trickle method** - delivers water through a network of pipes attached to the drippers or nozzles which efficiently regulate the flow of water directly into the root zone; can be combined with fertilization (fertigation) and pesticide application; requires water filtration system to avoid clogging of nozzles and high capital investment; most efficient (80-90%)

Managing soil moisture:

- If water is limited, select crops that will grow well under drier conditions (mungbean, cassava, eggplant).
- Select short-term vegetable crops that can be grown near a source of water such as a water well, the drain from washing areas or a water tank.
- Where feasible and affordable, use drip irrigation systems (such as the bucket system) to maximize water usage efficiency.

Managing soil moisture in the dry season:

- Above the soil surface:
 - Cover the soil around plants with a mulch of leaves, cut grass or rice straw.
- If plastic mulch is used, only silver-coated ones should be applied since black mulches heat up too much and can cause burning of stems and other plant parts.
- Provide young plants with shade to keep them cool.
- Remove weeds because they compete with the plant's moisture intake.
- Below the soil surface:
 - Incorporate compost or organic material in the soil. One large sack of composted organic material should be sufficient for an area of about 10m². Use one sack at the start of the wet season and one sack at the start of the dry season.

Managing soil moisture in the wet season:

Above the soil surface:

- Plant crops in high beds to improve aeration and to avoid water logging.
- Plant crops that like to grow in wet areas, such as taro and kangkong.
- Use coconut fronds or other materials to protect young plants and those with tender leaves from heavy rain.
- Grow vine plants up on to a trellis.

XXII. SOIL FERTILITY MANAGEMENT

Crop Nutrition – very important contributing factor to increase production nutrient should be present in proportionately balanced condition, and if any one elements is lacking, it should be made available in the soil.

Fertilizer Application Methods

1. **Broadcast**– application of fertilizer be done at final harrowing, done either by hand or with the use of a “cyclone spreader”
2. **Band application** - fertilizer is applied in a strip 2-3 cm beneath and to the side of the location of the seed during seeding.
3. **Sidedressing and Topdressing**
Sidedressing – placement of fertilizer along the rows near the base of the plant
Topdressing – N fertilizers are applied to juvenile crops wherein fertilizer is broadcast over the growing plants
4. **Localized placement** – placement of fertilizer-centered mudballs in flooded soils wherein one mudball (urea) is plunged 10-12 cm deep for every four rice placed spaced at 20 x 30cm which are applied immediately after transplanting
5. **Foliar application** – involves dissolving the fertilizer material in water and applying it as a spray to plants which is effecting in correcting trace element deficiency at critical stages of the crop.

Other sources of nutrients:

1. **Organic fertilizers** (compost) 1-7%N, 2-13%P₂O₅ and 1-10% K₂O from plant and animal sources.
Trichoderma harzianum – speed up decomposition of compost materials (1 ton of compost material needs 10 kg of Trichoderma inoculum)
2. **Green manure** – biomass produced by a N-fixing legume crop, plowed under at ear flowering time to serve as source pf nutrient to the succeeding crop
3. **Azolla**(*Anabaena azolla*) – water fern that grows symbiotically with blue-green algae; can produce 30T/ha in one growing season equivalent to 150 kg of N/ha

Liming – application of lime to correct soil acidity; Ideal pH range is from **6.0 -6.5**

Mineral Nutrition

An element is considered essential if it satisfies all the criteria below:

1. There is a positive requirement of the element for normal growth or reproduction, or to complete the plant's life cycle.
2. The function of the element cannot be replaced by another.
3. The element has direct or indirect function in plant metabolism

Decline in Soil Fertility

1. **Soil erosion.** Soil erosion is the physical loss and displacement of the fertile topsoil which can be categorized into four types:
 - a. **Geological erosion.** It is a natural erosion process that leads to soil formation and processes that maintain the soil in a favorable balance suitable for crop growth
 - b. **Wind erosion.** This is caused by extreme wind speeds
 - c. **Water-borne erosion.** This is caused by rainfall and runoff (emitted interflow and overflow)
2. **Crop removal**
3. **Conversion of nutrients to unavailable forms**
 - a. Combination with other elements forming insoluble forms
 - b. Microbial mediated transformations
 - c. Volatilization
 - d. Leaching

Nutrient uptake mechanism:

1. **Passive** – ions move with water without metabolic involvement; the characteristics of the apoplast (non-living) path determines the rate of passive uptake of nutrients; transpiration creates the force necessary for the ascent of sap
2. **Active** – ions cross the plasmalemma with the involvement of metabolic energy from ATP and ions move from one cell to another through the plasmodesmata; this type of uptake moves ions from a region of lower concentration to a region of higher concentration

Factors affecting nutrient uptake:

- a. **Availability of nutrients** – partly determined by the pH of the solution; some nutrients are chemically bound at low or high pH forming insoluble compounds

- b. **Stage of growth and development** – uptake varies depending on the demand by growth rate; at late stage of development, the uptake of nutrients declines due to the declining demand and also due to remobilization of certain elements.

(for more information, see SOIL SCIENCE manual)

- 17 essential nutrients/elements – C, H, O, N, P, K, Ca, Mg, S, Fe, Mn, B, Cu, Zn, Mo, Cl
 - **Macronutrients** – C, H, O, N, P, K, Ca, Mg, S
 - **Micronutrients** – Fe, Mn, B, Cu, Zn, Mo, Cl, Ni
- Calculation of fertilizer requirement based on nutrient recommendation
 - **Weight of nutrient (kg N or P or K / ha)** = Weight of fertilizer x (%nutrient/100)
 - **Weight of fertilizer (kg fertilizer / ha)** = Weight of nutrient / (%nutrient/100)

The following is a table of common forms and known functions of the essential elements (adopted from Opik and Rolfe, 2005)

Nutrient	Form(s) Commonly Adsorbed by Plants	Functions
Carbon (C)	CO_2 , CO_3^{2-} , HCO_3^- ,	Constituent of all organic molecules
Hydrogen (H)	H_2O	Constituent of all organic molecules
Oxygen (O)	O_2 , H_2O , CO_2	Constituent of all organic molecules
Nitrogen (N)	NO_3^- , NH_4^+	Integral component of proteins, enzymes, and nucleic acids
Phosphorus (P)	H_2PO_4^- , HPO_4^{2-} , PO_4^{3-}	Component of nucleic acids, phytin, coenzymes, adenylases; regulatory function of synthetase reactions
Potassium (K)	K^+	Osmoregulation; activator of certain kinases, synthetases, lyases; required for protein synthesis; integral components of proteins, sulfolipids, S-coenzymes, S- and Fe-S proteins
Calcium (Ca)	Ca^{2+}	Component of pectates, regulatory protein (calmodulin); regulates ion transport, senescence, membrane permeability, activator of numerous enzymes
Magnesium (Mg)	Mg^{2+}	Integral component of chlorophyll, Mg-ATP, activator of phosphorylation, RuBP carboxylase
Sulfur(S)	SO_4^{2-}	Constituent of several coenzymes, vitamins essential for metabolism, and two amino acids
Iron (Fe)	Fe^{2+}	Components of Fe- and Fe-S proteins, cytochromes, and ferrodoxins
Copper (Cu)	Cu^{2+}	Activator of several oxidases and lignin synthesis
Zinc (Zn)	Zn^{2+}	Activator of carbonic anhydrase, alkaline phosphatase, hexokinase, and alcohol dehydrogenase
Manganese (Mn)	Mn^{2+}	Activator of amino peptidases; activator of photosynthetic evolution of oxygen (Hill reaction)
Molybdenum (Mo)	MoO_4^{2-}	Component of nitrate reductase; essential for nitrogenase in bacteria for N_2 fixation
Boron (B)	H_3BO_3	Possibly cis-diol-type borate complexes with proteins; enzymatic regulation of growth and development
Chlorine (Cl)	Cl^-	Activator of photosystem II; participates in electron transport in chloroplast
Nickel (Ni)	Ni^{2+}	Integral component of urease enzyme

XXIII. HARVESTING AND POSTHARVEST OPERATIONS

Harvesting

- The separation of the economic yield (whether the whole plant biomass or the portion of the whole plant biomass when crops have reached highest or optimum level of productivity (physiological maturity onwards)
- It refers to cutting or collecting of crops from the field which can either be done by hand, harvesting tools machines, etc depending on the technical and economic factors.

Postharvest handling – refers to the movement of farm products or operations through which the commodities undergo from harvest to possession by the final consumer

Harvesting -- packing house (sorting/grading, cleaning, or primary processing, packaging, etc) -- transport -- storage -- marketing -- consumer

Postproductiontechnology –practices and operationsfrom harvesting to consumption; aim is to deliver good quality products

Primary processing - original plant part can still be recognized

Secondary processing– conversion of produce into more stable forms that can no longer be changed into other forms

Types of secondary processing:

- **Heat sterilization**– canning

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- **Dehydration** – dried fruits and vegetables
- **Fermentation**– pickling, wine making, vinegar making
- **Freezing** – frozen fruits and vegetables

Postharvest handling

Types of crops based on postharvest characteristics:

- **Durables** – low moisture content (less than or equal to 14%); corn, rice, mungbean
- **Perishables** – high moisture content (80-95%); fruits, vegetables, ornamentals

Kinds of packages:

- **Flexible** – burlap or gunny sacks, mesh or net bags, PEBS, palm leaves, sacks of woven plastic fabric
- **Rigid and semi-rigid**–bamboo and rattan baskets, wooden crates, cartons, wood-paper laminated container, plastic crates, foamed plastic boxes

Shelf-life of perishables can be prolonged by:

- **Cold storage**
- **Evaporative cooling**–perishables give off heat during respiration and when a source of heat is within the vicinity, heat given off is used in evaporating water resulting in a drop in temperature and increase in relative humidity
- **Modified atmosphere (MA) storage**–respiration of the produce modifies the atmosphere; uses any of low density

polyethylene (LDPE), polyvinyl chloride (PVC), polypropylene (PP), waxes, temperature-compensating packages, and vacuum or hypobaric packaging

- **Controlled atmosphere (CA) storage** –the supply and level of carbon dioxide and oxygen are manipulated through gas generators and appropriate control devices in properly designed storage structures

Biological factors involved in deterioration:

- Respiration
- Ethylene production
- Compositional changes
- Transpiration or water loss
- Condition of crops
- Growth and development

Environmental factors involved in deterioration:

- Temperature
- Relative humidity
- Atmospheric Composition
- Ethylene
- Light
- Sanitation

Classification of Rs patterns:

- **Climacteric** - harvested at optimum maturity and ripened after harvest; show dramatic changes after

harvest; apple, avocado, banana, mango, peach, pear, plum, tomato

- **Non-climacteric** - continuously declining rate of respiration from maturation to the end of senescence; no burst of Rs during postharvest; harvested ripe and ready for consumption; bell pepper, cherry, citrus, grapes, pineapple, snap bean, strawberry, watermelon
- **Maturity indices** - signs or indications of the readiness of the plant for harvest; used to determine maturity and predict harvest date; used to assess quality of crop; ensure sensory quality (flavor, color, aroma, texture) and nutritional quality; ensure an adequate postharvest shelf life; facilitate scheduling of harvest and packing operations

Age-related/Phenological

Number of days from planting to maturity

- Days from flower induction (mango)
- Days from anthesis (durian, beans)
- Days from shooting (appearance of false hands in banana)
- Heat units/growing degree days (GDD)

Morphological

- Change in peel color (pineapple, lanzones, tomato)
- Change in pulp color (mango, tomato)
- Drying of plant part (banana, onion, ginger, potato)
- Flattening of eyes (pineapple)

- Development of abscission zone (melon, durian)
- Greater prominence of netting (melon)
- Appearance of bloom (mango, grapes)
- Increase in size (eggplant, cucumber)
- Fullness of pods (cowpea, peas, snap beans)
- Change in shape (banana, mango)
- Compactness of curd/bud (cauliflower, broccoli)
- Bud opening (roses)
- Bud opening change in angularity of fingers
- Appearance of corky spots (banana)
- Development of waxy layer on the epidermis (plum, grape, melon)
- Formation of gel-like material surrounding the seeds (tomato)
- Prior to tip opening (asparagus)

Other post-harvest Terms:

Degreening

-process of hastening the peel color change from green to orange or yellow of citrus fruits which have attained full flavour and aroma.

Vapor Pressure treatment

- pressure exerted by water vapour in a given space or atmosphere
- mangoes exported for Japan will undergo into this treatment

Aril

- the fleshy edible pulp adhering to seeds of fruits as in rambutan, durian and lanzones

Commercial maturity of a commodity

- the stage of growth when a commodity has developed sufficient desirable characteristics to make it marketable or desirable for its intended purpose.

Curing

-process of toughening and self-healing of bruises and skinned areas in root and tuber crops or the rapid closing of the neck of bulb crops under favorable conditions.

Dehaulming

-cutting or killing of potato vines a week before harvesting

Fumigant

- chemical which at required temperature and pressure can exist in the gaseous state in sufficient concentration to be lethal to a given pest organism.

Grading

- the process of classifying into groups according to a set of recognized criteria of quality and size , each group bearing an accepted name and size grouping.

Horticultural Maturity - commercial maturity

Internal breaking of mango

- white starchy area in the middle portion of the pulp near the seed of a ripe fruit, sometimes with air pockets in the middle of the starchy areas.

Precooling

-Strictly, precooling means the rapid cooling (48 hr. or less) of a commodity to a desired transit or storage temperature soon after harvesting before it is stored or move in transit.

Shelf life

-post-storage market life.

Sorting

-the process of classifying of commodity into groups, designated by the person classifying the produce either according to a set criteria or whatever criteria he may desire.

Standardization

-the process of formulating and issuing grade standards in the country or industry.

Vascular streaking

-browning of tissues about a centimeter below the peeled surface of a cassava viewed cross-sectionally.

Waxing

-is the application of a thin film of surface coating to fruits and vegetables

-the coating may or may not be wax but usually the term wax is used synonymously with surface coatings or protective skin coating.

Water Elimination

- refers to the drying of surface moisture after washing or waxing or when commodities are harvested wet

Topping

- leafsheaths are removed in abaca

Tuxying

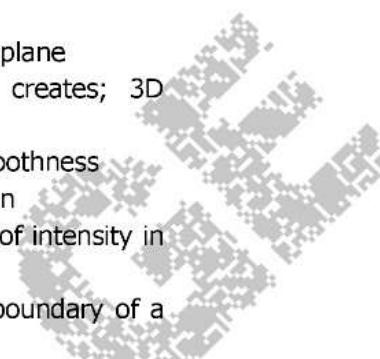
- is the separation of the strong mechanical bundles from the weaker fibrovascular bundles.

XXIV. FARM ENTREPRENEURSHIP

- **Breakeven yield (BEY)** = Total cost / Unit price
 - Farmer needs to produce the BEY to cover production costs. Yield below BEY implies loss while yield above BEY implies profit.
- **Cost to produce a kilogram (Cost/kg)** = (Total cost/ha) / (Yield in kg/ha)
 - With the same total cost and if yield is higher, unit cost proportionally decreases.
- **Return on investment (ROI)** = (Total income or gross return) / (Total cost excluding interest expense) where **Total cost or gross return** = Yield x Unit price
 - ROI is a ratio that indicates how much the return per unit cost is. An ROI of P2.25 means that P1.25 was earned for every P1.00.

XXV. TROPICAL LANDSCAPING

- **Landscaping**—the art and science of selecting, arranging, and growing plants together with the landscapes for aesthetics, privacy, and pleasure
 - Major phases:
 - **Landscape design**
 - **Landscape implementation**
 - **Landscape maintenance**
 - Basic elements of landscape design:
 - **Line**—extending many points on a plane
 - **Form**—outline that an object creates; 3D effects
 - **Texture**—visual roughness or smoothness
 - **Color**—visible pattern of the design
 - **Light**—allows us to see a variety of intensity in colors, textures, lines, and shapes
 - **Volume or space**—defines the boundary of a landscape
 - Basic principles of landscape design:
 - **Balance**—illusion of equilibrium around a real or imaginary central axis
 - **Unity**—arrangement of planes that will produce a single, harmonious design
 - **Repetition**—using the same size, color, texture, or form of material
 - **Sequence**—transition from one area to another



- **Contrast/Variety**— break monotony due to too much repetition
- **Emphasis**— focus on dominant or accent features
- **Scale and proportion**— relative size of plants and objects with a particular reference
- **Harmony**— pleasing relationship of objects within a landscape
- Plants used in landscaping:
 - **Ground covers**— plants used to cover the ground to minimize erosion
 - **Edging plants**—low growing plants used to define pathways and shapes of planting areas
 - **Specimen plants**— plants of special beauty or unusual quality grown to be exhibited alone
 - **Accents/Focal point**—one or more plants used as prominent features in the garden
 - **Barriers/Screens/Hedges**— plants that provide security and privacy
 - **Foundation plants**— dense shrub grown near or along a building

XXVI. RECOMMENDED VARIETIES OF CROPS

In the Philippines, there are a number of public institutions and private seed companies that undertake research and development relating to varietal improvement of major crops. To rationalize the release of varieties emanating from different sources, a system of coordinated ecological trials has been in operation since 1955 under the aegis of the Philippine Seed Board (PSB) now renamed as the national Seed Industry Council (NSIC).

The recommended varieties of crops are only those that have been grown widely in the country which include the following:

A. Cereals

1. Rice: The breeding institutions are IRRI, UPLB, DA-BPI and DA-Philrice.

a. lowland varieties: C4-63 (G), BPI-76 (NS)

IR 36, IR 42, IR 64, IR 66 (with salinity tolerance)

PSB RC-2, PSB RC-4, PSB RC-6, PSB RC-8, PSB RC-10, PSB RC-12, PSB RC-14

b. lowland F1 hybrids: PSB RC-26H, PSB RC-72H released by PhilRice

c. lowland glutinous varieties: IR 29, IR 65

UPL Ri-1, UPL Ri-3

d. rainfed lowland: IR 46, IR 52

UPL Ri-2

e. upland varieties: C-22

IR 45

UPL Ri-5 (with acid sulfate tolerance), UPL Ri-7

PSB RC-1, PSB RC-16 (Ennano)

2. Maize: The institutions involved in varietal improvement are IPB-UPLB, DA, and USM. The major private companies are: Pioneer Overseas Corp-Phil, Cargill Phil, Inc., Ayala Agricultural Development Corporation, BM Domingo and Co., Inc. or Corn World Breeding System Corp, and Asian hybrid Corporation.

a. open-pollinated varieties: yields 5-6 tons per hectare

i. Yellow flint corn: IPB Var 1 (Ginintuan), IPB Var 5, IPB Var 7

- BPI LG Comp 1
USM Var 3, USM Var 5, USM Var 7
IES Cn 3
- ii. white flint types: IPB VAr 2 (Tanco White), IPB Var 4
USM Var 10, USM Var 12
IES Cn 6
CMU Var 2
- b. F-I hybrids: Pioneer 3228
SMC 305, SMC 301
IPB 911 (single cross), IPB 947 (3 way cross), IPB 9204 (3 way cross), IPB 921 (PSB 93-37), IPB 919 (PSB Cn 93-36),
IPB 913 (PSB Cn 92-24), IPB 929 (PSB Cn 93-38)
PSB Cn 93-42, PSB Cn 93-43, PSB Cn 93-44, PSB Cn 93-45, PSB Cn 93-46, PSB Cn 94-54, PSB Cn 94-55,
PSB Cn 94-56, PSB Cn 94-57, PSB Cn 94-58, PSB Cn 94-59, PSB Cn 94-60,
FE 817, FE 820, FE 326, FE 325
BS 9754, BS 9881, BS 9889
TCT 961, TCT 311, TCT 393, TCT 377, TCT 1133
C-838, C-909, C-4043
AG 5355, AG 8351, AG 8353, AG 8360, AG 8362
P-30J32, P-3013, P-3B29, P-30A10, P-3013, P-3023, P-3014
CW 59, CW 208
- c. Sweet corn: PSB Cn 93-48 (3 way hybrid), PSB Cn 93-49 (sweet and waxy) or DLU Pearl Sweet, PSB Cn 94-52, PSB Cn 94-53

3. Tropical wheat: yields 1.6-1.8 tons/ha as grown in Northern Luzon
Trigo 1, Trigo 2, Trigo 3

4. Sorghum: UPL S-5 (Cosor 5)
PSB Sg 93-01 (USMARC 104), PSB Sg-02 (IES Sor 1), PSB Sg 94-02 (IES Sg 2)

B. Sugarcane: The agencies involved in the breeding work are the Sugarcane Regulatory Administration (SRA) and the Victorias Milling Corporation (VMC).

Phil 66-14, Phil 56-226, Phil 72-70, Phil 78-1440, Phil 8361, Phil 8477
SRA 77-79, SRA 80-13, SRA 85-83,
VMC 71-39, VMC 71-238, VMC 73-229

C. Root and tuber crops: with VisCa, IPB-UPLB

- 1. Cassava:** UPL Cv 3 (Sultan 1), UPL Cv 4 (Vassourinha), UPL Cv 5 (Sultan 2), UPL Cv 1 (Datu)
UPL Cv 2 (Lakan 1), Lakan 2, Lakan 3, Lakan 4
PSB Cv 8, PSB Cv 9, PSB Cv 10
- 2. Sweet potato:** UPL Sp 1 (Kinabakab), UPL Sp 3 (Tinipay), UPL Sp 5 (G 113 -2b), UPL Sp 2 (G 50-1a), UPL Sp 4 (Cambel),
UPL Sp 6 PSB Sp 16 (VisCa), PSB Sp 17 (VisCa)
- 3. Taro (Gabi):** PSB Vg 2, PSB Vg 3
- 4. Yam (Ubi):** PSB Vt 2, PSB Vt 3

D. Grain legumes

- 1. Mungbean:** MG 50-10A
UPL Mg 1 (Pag-aso), UPL Mg 3 (Pag-aso 3), UPL Mg 5 or Pag-aso 5 (for dry, wet, and post rice planting)
UPL Mg 7 (Pag-aso 7), UPL Mg 9 (Pag-aso 9), UPL Mg 11 (Pag-aso 11)
BPI Mg- 9 (Taiwan Green)
- 2. Peanut:** UPL Pn 2 (Mekong), UPL Pn 4 (Biyaya 4), UPL Pn 8 (Biyaya 8), UPL Pn 10 (Biyaya 10), UPL Pn 12 (Biyaya 12),
UPL Pn 14 (Biyaya 14)
BPI Pn 9
- 3. Soybeans:** UPL Sy 4 (Tiwala 4), UPL Sy 6 or PSB Sy 2 (Tiwala 6), UPL Sy 8 (Tiwala 8), UPL Sy 10 (Tiwala 10)
BPI Sy 4
PSB Sy 3 (La Granja)

E. Fiber crops

- 1. Cotton:** UPL Ct 1 (Batac 1), UPL Ct 2 (Batac 2), UPL Ct 3 (Batac 3), UPL Ct 4 (PSB Ct 6)
CRDI-1
- 2. Kenaf:** UPL K-1

F. Vegetables: The breeding institutions are: IPB-UPLB, DA, East-West-Phil, Kaneko Seeds-Phil.

1. Pole sitao: UPL PS 1 (Sandigan), UPL PS-2 (Ana), CSL 15 (PSB PS-3), BPI PS 3
2. Bush sitao: UPL BS 3 (Sumilang), PSB B2-2, CBL 3 (PSB BS-1)
3. Bitter gourd: Makiling, Sta. Rita, Jade Star, F1 Mayon
4. Bottle gourd: Tambuli
5. Cowpea: UPL Cp 1 (Sagana), UPL Cp 3, UPL Cp 5 (Magbunyi), UPL Cp 7, UPL Cp 9 (Juliet), BPI Cp 4, BPI Cp 3
6. White potato: T-204 (Banahaw), Arka, Siro, Kennebec, Up-to-date, Conchita, Cosima
7. Cabbage: F-1 KK Cross and F-1 KY Cross (heat tolerant), Marion market, F-1 Princess #39, F1 Stone Head, YR Summer 50
8. Tomato: UPL Tm 1 (Marikit), UPL Tm 2 (Marilag), UPL Tm 6 (Maligaya), Improved Pope
9. Eggplant: UPL Eg 11, Dumaguete Long Purple, Dingras Multiple Purple #1, EG Long Purple
10. Onion: Red Globe, Excel, Yellow Granex
11. Cauliflower: Early Patna
12. Chinese Cabbage: Esperanza, Corazon, Reyna Elena
13. Cucumber: UPL Cu-1 (Pilipina), UPL Cu 6 (Pilmaria), UPL Cu 2 (Pinagpala), Explorer, Panorama
14. Garlic: Ilocos Purple Shank, Ilocos White Shank, Batangas Strain
15. Lima Bean: Kentucky Wonder, Habas, Sugar Mammoth
16. Honey Dew Melon: Tan Dew, Honey Dew
17. Pechay: Black Behi
18. Watermelon: Sugar Baby
19. Lettuce: Dennis Red, Presidente, Bravo, Vanguard, Simpson

G. Fruit crops

1. Avocado: Cardinal, De Leon 1, Lopena
2. Banana: Lakatan, Bungulan, Latundan, Saba, Cavendish
3. Cashew: Magbayto (Acc.No. 1851), Makiling (UPL Cs-1), Guevarra (Acc.No.1849)
4. Chico: Lamao (UPL Ch 1), Gonzales, Pineras (UPL Ch 2), Ponderosa (UPL Ch 4), Sao Manila (UPL Ch 3)
5. Citrus:
 - a. Mandarin: Ladu, Batangas, Calamandarin, King

- b. Orange: Hamlin, Valencia
 - c. Pumelo: Amoy Mantan, Fortich, Siamese, SinuwiLuk
- 6.** Guyabano: Dulce(UPL Gn 1), Katasim (UPL Gn 2)ah
- 7.** Mango: Carabao(UPL Mg 1), Pico (UPL Mg 2), Nam Doc Mal (UPL Mg 3), Ah Ping (UPL Mg 4), Pope (UPL Mg 5), Otts (UPL Mg 6), Fairchild (UPL Mg 7), Kachamita
- 8.** Papaya: Cavite, Solo, Sinta
- 9.** Pili: Katutubo (Acc.No. 024), Oas (Acc.No. 45), Mabunga (Acc.No. 46), Ibalon (Acc.No. 36), Mayon (Acc.No. 25), Isarog (Acc.No. 27)
- 10.** Pineapple: Cayenne, Queen
- 11.** Rambutan: Maharlika (UPL Rm 1), Seematjan (UPL Rm 2), AtjehRaplah (UPL Rm 3), Llenez, Seenjonja

H. Plantation Crops

- 1.** Coconut: Typica, Javanica, Nana
- 2.** Coffee: *Coffea Arabica* L., *C. robusta* Linden, *C. excelsa*A.Chev, *C. liberica* Bull ex Hlem
- 3.** Cacao: Criollo, Forastero, Trinitario

XXVII. BUREAU OF AGRICULTURAL STATISTICS DATA

Volume of Production by Region

Unit: Metric Tons

Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)

	Abaca	Cacao	Cashew (ripe fruit with nut)	Coconut (with husk)	Coffee (dried berries)	Coffee Arabica (dried berries)	Coffee Excelsa (dried berries)	Coffee Liberica (dried berries)	Coffee Robusta (dried berries)	Cotton
NCR	0	0	0	0	0	0	0	0	0	0
CAR	13.03	21.12	1.2	1078.78	5464.82	548.34	84.05	16.56	4815.87	..
ILOCOS REGION	..	39.19	718.7	40482.32	84.14	23.71	15.94	..	44.49	4.08
CAGAYAN VALLEY	..	69.21	29.59	70426.45	766.95	151.26	104.18	6.69	504.82	..
CENTRAL LUZON	113.25	44.8	5968.47	179360.22	1705.3	5.37	34.97	3.26	1661.7	..
CALABARZON	15.07	19.46	44.39	1434803.72	5237.66	65.48	586.87	99.16	4486.16	..
MIMAROPA	120.98	65.61	138873.91	779134.54	183.04	4.87	33.19	20.48	124.5	..
BICOL REGION	24077.96	34.21	3.99	1255507.48	325.49	75.88	1.15	4.12	244.34	..
WESTERN VISAYAS	1741.29	62.56	546.44	470652.72	4938.47	848.77	1.47	155.95	3932.28	21.44
CENTRAL VISAYAS	414.57	57.05	35.98	458992.52	235.13	27.8	..	0.8	206.53	3.47
EASTERN VISAYAS	16597.42	95.86	..	1623585.95	128.33	41.49	26.43	7.85	52.56	..
ZAMBOANGA PENINSULA	589.54	103.51	5.55	1743791.81	961.08	404.99	108.94	4.3	442.85	..
NORTHERN MINDANAO	2243.88	196.31	10.08	1816577.68	5334.81	379.4	297.57	..	4657.84	..
DAVAO REGION	7268.63	3844.3	39.39	2275979.56	12388.99	2384.85	1601.73	81.62	8320.79	..
SOCCSKSARGEN	953.65	79.1	9.38	1040610.03	28891.37	11984.53	612.61	2.56	16291.67	26.35
CARAGA	5827.89	57.84	1.6	834917.16	1497.16	..	10.1	..	1487.06	..
ARMM	4974.44	85.46	..	1327298.98	10491.17	1646.79	1397.63	159.9	7286.84	..

Volume of Production by Region**Unit: Metric Tons****Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)**

	Oil Palm (fresh fruit bunch)	Pili Nut	Rubber (cuplump)	Sugarcane	Tobacco	Tobacco Native	Tobacco Virginia	Chrysanthemum	Gladiola	Orchids	Roses
NCR	0	0	0	0	0	0	0	0	0	0	0
CAR	12895.22	963.53	10.1	944.32	1419.59	739.64	..	1475.7
ILOCOS REGION	19320.45	37111.44	4075.73	27267.38	0.46	..	109.26	19.46
CAGAYAN VALLEY	491468.09	12889.27	5518.66	16.75	17.79	21.54	66.51	42.46
CENTRAL LUZON	996969.63	32.78	66.16	37.06
CALABARZON	..	62.53	72.36	1783985.43	41.26	46.25	97.89	41.9
MIMAROPA	14283.27	1.02	59.26	..	1539.6	1.6	41.59	6.01
BICOL REGION	..	7080.93	..	259311.43	56.65	5.41	355.44	11.74
WESTERN VISAYAS	..	83.91	..	13886059.8	162.73	162.73	..	12.48	4.64	146.92	35.26
CENTRAL VISAYAS	34405.98	0.33	9.16	2054460	9.57	9.1	0.47	684.94	96.1	18.04	236.71
EASTERN VISAYAS	..	1004.46	..	318296.69	12.55	12.55	..	10.01	1.58	35.7	28.96
ZAMBOANGA PENINSULA	195357.03	294.7	15.94	15.94	..	33.04	0.89	40.79	44.01
NORTHERN MINDANAO	35180	3.21	11261	3496229.75	935.6	919.1	16.5	62.83	38.38	97.36	282.71
DAVAO REGION	2974.99	5.68	8240.8	438231.38	17.41	17.41	..	166.73	57.79	177.05	93.7
SOCCSKSARGEN	143673.5	0.8	172953.92	735087.45	36.94	36.94	..	50.3	0.97	38.68	66.41
CARAGA	136370.7	..	10030.83	0.75	1.38	1.38	..	3.32	0.47	10.52	13.27
ARMM	106527.7	..	46833.34	92209.41	24.25	24.25	..	1.8	..	10.65	2.5

Volume of Production by Region**Unit: Metric Tons****Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)**

	Banana	Banana Cavendish	Banana Lacatan	Banana Saba	Calamansi	Durian	Lanzones	Mandarin	Mango	Mango Carabao
NCR	0	0	0	0	0	0	0	0	0	0
CAR	27194.63	..	4829.33	9552.81	417.78	..	38.5	845.54	3421.81	3283.32
ILOCOS REGION	43478.88	..	944.27	21451.93	3437.02	..	2.59	11.94	260524.2	221046.9
CAGAYAN VALLEY	360395.5	221.67	40642.86	255377.2	7055.43	42.03	47.83	6821.6	47782.39	36998.97
CENTRAL LUZON	58917.15	..	13169.07	29128.29	10396.38	2.25	11.19	725.2	70500.44	56565.55
CALABARZON	117974	941.5	8471.78	77558.71	13855.33	52.02	1675.14	4170.07	54291.28	36265.57
MIMAROPA	158671.4	..	29176.3	98915.44	88747.51	15.86	160.68	376.53	10161.65	6552.73
BICOL REGION	83352.58	..	3926.88	43196.36	2111.94	..	8.07	843.96	1532.35	263.53
WESTERN VISAYAS	332761.6	1487.98	19696.11	203869.7	5289.92	151.36	471.3	53.56	47948.54	43994.22
CENTRAL VISAYAS	190699.6	1292.91	17510.61	123176.1	1092.61	6.5	78.27	52.44	71583.58	65635.06
EASTERN VISAYAS	259095.4	151.33	14621.95	169426.8	2224.18	9.69	158.39	28.5	847.52	437.73
ZAMBOANGA PENINSULA	259188.2	599.82	55743.73	138878.3	6988.7	558.46	83.98	1.41	92445.04	74043.31
NORTHERN MINDANAO	1735977	1120311	167312.6	295655.7	1341.31	2164.55	5519.14	71.01	44694.58	41756.39
DAVAO REGION	3164641	2392320	203899.4	487433.1	8135.73	70063.66	581.1	1216.05	32171.54	26920.61
SOCCSKSARGEN	1185492	520618.2	229323.5	356727.4	7364.99	4795.57	456.9	48.04	55051.89	43896.34
CARAGA	208303.2	45252.67	18283.02	101025.4	4194.08	1483.1	195.21	9.68	15562.1	12044.86
ARMM	459606	146876.1	102442.7	145612.7	1406.61	11866.59	25718.58	4.3	7680.2	2156.86

Volume of Production by Region**Unit: Metric Tons****Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)**

	Mangosteen	Orange	Papaya	Pineapple	Rambutan	Tamarind	Watermelon	Asparagus	Ampalaya	Broccoli
NCR	0	0	0	0	0	0	0	0	0	0
CAR	..	842.32	1627.37	770.61	46.45	13.88	372	..	490.71	1948.35
ILOCOS REGION	..	22.43	3456.37	196.17	88.1	2577.35	23864.84	..	9844.07	..
CAGAYAN VALLEY	..	635.3	1999.04	31140.79	363.81	1438.21	11483.18	..	6869.89	15.23
CENTRAL LUZON	..	22.19	3918.89	1456.9	64.35	1573.01	7537.5	1.95	25140.79	..
CALABARZON	53.9	19.01	9231.61	88238.66	2925.64	112.3	2754.77	..	24194.13	1.15
MIMAROPA	1.16	7.5	4057.03	364.2	380.99	188.85	2644.37	..	872.38	..
BICOL REGION	..	920.57	9628.04	124960.8	28.01	164.74	5421.33	..	3095.09	..
WESTERN VISAYAS	22.89	21.31	6026.4	16258.03	181.95	72.36	66493.86	1.87	2634.9	7.5
CENTRAL VISAYAS	10.88	5.55	6427.65	5379.82	55.27	137.37	995.54	4.09	3721.01	222.01
EASTERN VISAYAS	..	99.76	2912.1	7485.2	24.2	42.49	721.31	..	1182.14	..
ZAMBOANGA	24.64	37.39	5247.1	1839.68	190.55	156.63	532	..	3618.8	..
PENINSULA										
NORTHERN MINDANAO	66.6	98.87	30107.6	1341569	334.04	21.47	1502.85	..	2828.1	820.55
DAVAO REGION	302.3	644.32	10335.21	28078.67	946.51	1043.06	874.53	..	2607.76	8.06
SOCCSKSARGEN	710.31	100.78	67622.82	806076	1600.07	235.9	1761.14	3205.04	1606.59	1.61
CARAGA	62.79	20.45	1057.33	3542.23	194.72	1	2943.33	..	851.33	..
ARMM	2047.56	13.85	2606.74	1065.39	15.15	0.7	46.7	..	305.27	..

Volume of Production by Region**Unit: Metric Tons****Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)**

	Cabbage	Camote	Carrots	Cassava	Cauliflower	Eggplant	Gabi	Garlic	Ginger	Gourd	Habitchuelas	
NCR	0	0	0	0	0	0	0	0	0	0	0	0
CAR	99957.6	15560.27	60038.42	11621.16	5206.66	891.53	4856.58	12.55	940.15	1292.8	8119.79	
ILOCOS REGION	3159.7	14954.91	1.3	17274.43	4812.07	78136.14	3229.36	5718.22	880.31	10774.43	350.24	
CAGAYAN VALLEY	1164.88	9853.22	592.75	77689.31	236.58	20450.44	15816.53	267.15	5204.55	11527.29	2773.22	
CENTRAL LUZON	..	31027.21	..	18681.84	25	19358.05	6975.68	316.7	1177.74	9730.8	45.78	
CALABARZON	797.44	31609.05	33.38	49934	2.8	36666.55	6175.27	235.36	3912.95	27749.77	191.15	
MIMAROPA	28.64	15143.64	3	16705.3	3	3444.46	4126.85	2010.2	530.42	559.48	..	
BICOL REGION	239.07	94880.68	21.5	113789.7	..	7882.18	11685.32	..	326.99	3416.69	871.46	
WESTERN VISAYAS	451.26	44711.16	139.09	62560.37	72.55	16050.98	4892.34	79.56	1408.81	2504.96	138.62	
CENTRAL VISAYAS	8518.61	32814.13	3908.73	90697.63	133.61	8787.51	6388.72	..	1850.99	3239.3	1354.2	
EASTERN VISAYAS	149.44	117849.2	11.92	90331.26	..	2316.34	22900.08	4.01	2174.37	3480.02	397.28	
ZAMBOANGA PENINSULA	534.25	20201.59	227.22	52310.18	5.3	3264.07	1550.43	..	673.07	4152.28	138.75	
NORTHERN MINDANAO	6296.84	34119.01	1244.45	601288.5	1022.04	4534.69	3074.45	..	5976.68	3525.2	611.49	
DAVAO REGION	4144.19	18597.32	1389.99	15968.61	102.79	6885.98	3256.69	..	1120.68	3226.67	146.04	
SOCCSKSARGEN	1531.91	10802.76	488.61	89868.15	154.55	7082.37	4989.43	..	775.18	1510.63	245.03	
CARAGA	11.24	29434.16	1.38	17699.89	1.8	3473.96	11253.23	..	213.4	904.69	31.54	
ARMM	459.46	6171.27	..	1035107	..	659.7	1014.79	..	1005.89	845.38	4.43	

Volume of Production by Region**Unit: Metric Tons****Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)**

	Kangkong	Lettuce	Mongo	Okra	Onion	Peanut	Pechay Chinese	Pechay Native	Radish	Squash Fruit	Stringbeans
NCR	0	0	0	0	0	0	0	0	0	0	0
CAR	8.18	1283.4	134.05	47.33	..	125.51	45058.38	4063.53	1462.53	6286.07	509.89
ILOCOS REGION	3431.65	..	11473.16	1697.99	39770.05	11431.65	2.2	2256.1	69.52	17352.19	12003.93
CAGAYAN VALLEY	2383.89	1.36	8452.1	5452.35	7208.27	3973.43	156.49	5512.41	136.02	34746.93	17343.27
CENTRAL LUZON	1000.59	..	3297.74	10798.51	73911.12	1744.44	..	2865.88	500.82	25730.11	36668.45
CALABARZON	6150.8	218.56	106.8	1851.9	390.4	523.4	164.94	6929.71	2997.88	38844.52	5511.36
MIMAROPA	2056.83	5.5	719.41	258.44	12589.79	1272.9	..	539	158.64	1737.42	1555.27
BICOL REGION	4467.61	..	180.67	1870.13	..	868.53	..	13987.86	198.02	34300.33	12342.58
WESTERN VISAYAS	8472.29	35.15	2512.9	1633.22	230.65	2114.59	..	1784.22	831.55	14396.15	9527.8
CENTRAL VISAYAS	1621.48	604.54	574.63	1596.95	5.16	1014.43	3570.02	1223.56	993.69	12287.13	2912.06
EASTERN VISAYAS	8473.08	0.63	181.64	879.67	..	572.43	1.56	838.34	7.76	2107.18	1744.24
ZAMBOANGA PENINSULA	5479.97	22.83	220.27	549.07	1.75	892.87	89.62	1619.13	357.44	6065.67	2151.24
NORTHERN MINDANAO	3569.06	1817.85	375.41	1823.55	..	2632.74	1992.45	1366.01	156.47	16106.35	2870.4
DAVAO REGION	4458.91	5.25	917.87	571.22	..	542.83	390.67	1301.56	1430.07	6422.12	12308.07
SOCCSKSARGEN	5517.05	44.76	487.67	544.61	62.72	674.2	371.87	576.35	432.84	2652.4	802.96
CARAGA	1390.18	..	151.87	503.52	..	124.47	..	705.53	3.03	2910.09	806.29
ARMM	16956.44	..	2634.55	36.74	..	580.51	..	393.14	90.67	1534.52	445.26

Volume of Production by Region**Unit: Metric Tons****Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)**

	Tomato	Ubi	White Potato
NCR	0	0	0
CAR	3897.95	166.28	100758.1
ILOCOS REGION	72017.12	296.76	..
CAGAYAN VALLEY	9458.19	1759.22	427.25
CENTRAL LUZON	22267.95	555.6	..
CALABARZON	18655.15	670.21	..
MIMAROPA	1523.59	539.63	..
BICOL REGION	3482.62	588.99	..
WESTERN VISAYAS	9054.27	664.42	..
CENTRAL VISAYAS	5040.42	5929.26	33.68
EASTERN VISAYAS	679.82	780.07	..
ZAMBOANGA PENINSULA	3011.29	265.05	..
NORTHERN MINDANAO	48934.4	940.92	6355
DAVAO REGION	4066.69	376.18	9511.42
SOCCSKSARGEN	4921.14	318.38	636.2
CARAGA	234.05	49.25	..
ARMM	410.48	312.75	..

TOP PRODUCING PROVINCES

Source: Bureau of Agricultural Statistics Website (Latest Data as of Feb. 27, 2015)

BENGUET: Chrysanthemum, Gladiola, Roses, Orange, Broccoli, Cabbage, Carrots, Cauliflower, Habituelas, Pechay Chinese, White Potato

ILOCOS NORTE: Tamarind, Garlic

ILOCOS SUR: Tobacco, Tobacco Virginia

PANGASINAN: Mango, Mango Carabao, Eggplant, Peanut

ISABELA: Tobacco Native, Mongo

NUEVA VISCAYA: Mandarin

BULACAN: String Beans

NUEVA ECIJA: Okra, Onion

BATANGAS: Gourd

LAGUNA: Rambutan, Radish

QUEZON: Coconut (w/ husk), Ampalaya

ORIENTAL MINDORO: Calamansi

PALAWAN: Cashew

ALBAY: Orchids, Pechay Native, Squash

CATANDUANES: Abaca

SORSOGON: Pili Nut

ILOILO: Watermelon

NEGROS OCCIDENTAL: Sugarcane

BOHOL: Ube

LEYTE: Camote

NORTHERN SAMAR: Gabi

BUKIDNON: Pineapple, Lettuce, Tomato

LANAO DEL NORTE: Ginger

DAVAO DEL NORTE: Banana, Banana Cavendish, Durian

DAVAO DEL SUR: Cacao

NORTH COTABATO: Rubber, Banana Lacatan, Banana Saba

SOUTH COTABATO: Cotton, Papaya, Asparagus

SULTAN KUDARAT: Coffee (dried beans), Coffee Arabica, Coffee Robusta

AGUSAN DEL SUR: Oil Palm (fresh fruit)

LANAO DEL SUR: Cassava

MAGUINDANAO: Kangkong

SULU: Coffee Excelsa, Coffee Liberica, Lanzones, Mangosteen

Review Questions in Crop Science

1. The botanical classification of agricultural crops is the grouping of plants according to morphological similarities and it was founded by this scientist
 - a. Pasteur
 - b. Leuwenhoek
 - c. Linnaeus
 - d. Hooke
2. Scientifically, the Grass family is the same as I, Graminae II. Poaceae III. Monocotyledonae.
 - a. I and III are True
 - b. I and II are False
 - c. I and III are True
 - d. II is False
3. Who was the Secretary of Agriculture when the Bureau of Agricultural Extension was established in 1953 together with the 4-H Club and Rural Improvement Club?
 - a. Rafael Alunan Sr.
 - b. Placido L. Mapa
 - c. Fernando Lopez
 - d. Salvador Araneta
4. The word cereal is derived from the name of the most important grain deity,
 - a. The Roman Goddess Venus
 - b. The Roman God of Soul
 - c. The Xeres God of Israel
 - d. The Roman Goddess Ceres
5. In Asia, the early civilizations have established around a diet basically consisting of:
 - a. Maize and peanuts
 - b. Sorghum and beans
 - c. Wheat and barley
6. A group of plants within a species that are distinguished by the same or similar characteristics
 - a. Clone
 - b. Genus
 - c. Variety
 - d. Species
7. What is not a species
 - a. Indica
 - b. Vulgaris
 - c. Carota
 - d. Mangifera
8. The enactment of this law replaces the Philippine Seed Board with the National Seed Industry Council beginning March 27, 1992
 - a. R.A. 7001
 - b. R.A.7308
 - c. R.A. 2000
 - d. R.A. 8435
9. Crops which have the following characteristics can be planted through direct seeding.
 - a. Seeds are difficult to germinate.
 - b. Seeds are expensive.
 - c. Seedlings cannot tolerate root disturbance.
 - d. Seedlings develop multiple tap roots.
10. Who was the first Minister of Agriculture when all cabinet departments were changed to ministries during martial law and established the 12 regional officers each headed by a regional director?
 - a. Arturo R. Tanco
 - b. Juan G. Rodriguez
 - c. Benjamin M. Gozon
 - d. Cesar Fortich

11. Who was the Secretary of Agriculture and Natural Resources when the Agricultural Marketing News Service which provides farmers and consumers regular prices of selected commodities was launched?
- Benjamin Gozon
 - Placido I. Mapa
 - Salvador Araneta
 - Jose Y. Feliciano
12. The synonym of family Leguminosae is
- Convolvulaceae
 - Fabaceae
 - Monocotyledonae
 - Pedaliaceae
13. Guttation in plants is through the _____
- Lenticels
 - Cutin
 - Leaves
 - Hydathodes
14. The people regarded now as the first agriculturists are the:
- American Indians
 - South American Indians
 - Cushites
 - Africans
15. Our region consisting of the Indochinese-Indonesian region is believed to be the center of:
- Coconut
 - Corn
 - Garlic
 - Potato
16. Corn originated in
- India
 - Philippines
 - China
 - Mexico
17. A national agency mainly involved in producing newly bred rice varieties
- IRRI
 - IPB
 - Philrice
 - NSIC
18. A cereal crop developed in CYMMIT and is a hybrid between wheat and rye
- Barley
 - Rice
 - Wheat
 - Triticale
19. 4. Smudging of mango trees induces flowering due to the production of this hormone
- Cytokinin
 - Gibberellin
 - Ethylene
 - Naphthalene
20. Analyze the following statements:
- I. The source of the oxygen gas released in photosynthesis is water,
II. The source of the electrons used to reduce NADP+ in the light reactions is chlorophyll.
- Both statements are correct.
 - Statement II is correct but statement I is wrong.
 - Statement I is correct but statement II is wrong.
 - Both statements are wrong.
21. The physical appearance of a plant with respect to a particular character.
- Ideotype
 - Phenotype
 - Genotype
 - Prototype

22. The Minister of Agriculture and Fisheries (MAF) who launched the Intensive Rice Production Program (IRPP) in 1984 was
- Salvador Lopez
 - Salvador H. Escudero
 - Salvador Araneta
 - Cesar Fortich
23. Who is the principal author of RA # 8435 otherwise known as the Agricultural and Fisheries Modernization Act (AFMA) of 1998?
- William D. Dar
 - Robert S. Sebastian
 - Senen C. Bacani
 - Edgardo J. Angara
24. The Philippines is an agricultural country with a land area of 30 million hectares. What percentage of this total area is agricultural land?
- 50% (15,000,000 ha)
 - 47% (14,100,000 ha)
 - 35% (10,500,000 ha)
 - 40% (12,000,000 ha)
25. An example of pulse crop is
- Tomato
 - Cowpea
 - Squash
 - Eggplant
26. Which is not under the family Leuminoceae
- Phaseolus lunatus
 - Vigna unguiculata
 - Lagenaria siceraria
 - Phaseolus vulgaris
27. Which does not belong to the group?
- Paragrass
 - Centro
 - Stylo
 - Siratro
28. Which is not an example of root crops?
- Sweet potato
 - Arrow root
 - Potato
 - Cassava
29. The center of origin of rice (*Oryza sativa*) is:
- India
 - Philippines
 - Africa
 - Mexico
30. Next to rice and corn, the top 5 crops of the Philippines include:
- Coconut, banana, abaca
 - Coconut, sugarcane, banana
 - Coconut, wheat, sugarcane
 - Coconut, coffee, cassava
31. Comparative advantage in agriculture means;
- Higher land area devoted to agriculture
 - Higher efficiency in resource use for agriculture
 - Higher yield of export crops
 - Higher yield of rice and corn
32. Which of these crops can be classified both as an agronomic and horticultural crop based on their uses under Philippine condition?
- Rice
 - Okra
 - Sorghum
 - Mungbean
33. An example of small fruit is
- Mango
 - Cashew
 - Rambutan
 - Pineapple
34. Which is not a cole crop?
- Brassica oleracea*

- b. *Brassica juncea*
c. *Raphanussativus*
d. *Cucumissativus*
35. Which among the choices is a variety of pili?
a. Mestizo
b. Mayon #2
c. Amarillo
d. Igorota
36. The technique of moving genes from one organism to another or putting them back in different combinations to produce an improved organism is known as:
a. Recombinant DNA
b. Genetic engineering
c. Biotechnology
d. Cloning
37. Plant propagation can be accomplished through several techniques. It is the implantation of a meristem from another plant to a plantlet or sterile plant in vitro.
a. Grafting
b. Budding
c. Microlayering
d. Micrografting
38. It is the process of preparing the soil for planting, thereby providing good physical, chemical and biological conditions that would permit optimum plant growth.
a. Secondary tillage
b. Land preparation
c. Primary tillage
d. Conventional Tillage
39. Seed sewing can be done in different ways. Planting the seeds by distributing them individually in the row is called:
a. Hill planting
b. Ridge planting
c. Drill planting
- d. List planting
40. The prime agricultural lands in the Philippines are generally located
a. Near forested areas
b. Near coastal areas
c. Near the hills and mountains
d. Around the main urban and high population density areas
41. In the implementation of the Comprehensive Agrarian Reform Law, a farm household cannot own a farm larger than
a. 3 has
b. 7 has
c. 10 has
d. 5 has
42. One of the principles of AFMA among others is
a. Exploitation of natural resources
b. Peace and order
c. Poverty alleviation and social equity
d. Industrialization
43. It refers to the ability to compete in terms of price, quality, and volume of agriculture and fishery products relative to those of other countries
a. Trade liberalization
b. Extension services
c. Competitive advantage
d. Global competitiveness
44. Which of these crops can be classified as an agronomic crops and horticultural crops based on their uses under Philippine condition?
a. Rice
b. Sorghum
c. Peanut
d. Mungbean
45. Analyze the statements:
I. Examples of family Cucurbitaceae are :
A. M. Charantia b. C. sativum c. C. Lunatus

- II. Examples of family Leguminoceae are:
- A. A hypogaea b. Cajanuscajan c. V. Radiata.
 - a. Statements I and II are correct
 - b. Statement I and II are not correct
 - c. Statement I is correct but Statement II is not correct
 - d. Statement I is not correct but Statement II is correct
46. Which among the crops does not fall under the family Solanaceae?
- a. P. Lunatus
 - b. S. Melongena
 - c. C. Annuum
 - d. L. Esculentum
47. An example of small fruit is
- a. Tamarind
 - b. Pineapple
 - c. Lanzones
 - d. Duhat
48. As a science, crop production is very much related to:
- a. Botany, soil science, breeding and genetics
 - b. Botany, biology, zoology
 - c. Soil science statistics, physics
 - d. Breeding and genetics, biology, animal science
49. The chlorophyll is commonly found in:
- a. Vascular bundies
 - b. Stomata
 - c. Mesophyll cells
 - d. Mitochondria
50. Light absorption by the leaf is lowest in:
- a. Red
 - b. Blue
 - c. Yellow
 - d. Green
51. In 1930s-1950s, photosynthesis investigation was intensified by:
- a. Detection of PGA as first product
- b. Use of carbon isotopes
 - c. Hatch and slack
 - d. Blackman
52. These are fruits borne on trees but which are enclosed by a stony structure
- a. Tree fruits
 - b. Small fruits
 - c. Nutt fruits
 - d. Soft fruits
53. Orchids are commonly used as
- a. Florist greens
 - b. Florist crops
 - c. Landscape plants
 - d. Vegetable crops
54. Dona Aurora is easily propagated through
- a. Marcotting
 - b. Grafting
 - c. Seedling
 - d. Cutting
55. Crossing over of genes on a chromosome occurs as a result of
- a. Sexual reproduction
 - b. Vegetative propagation
 - c. Clonal propagation
 - d. Self-pollination of a pure line
56. All are tropical crops except
- a. Pineapple
 - b. Mango
 - c. Sugarcane
 - d. Potato
57. The judicious removal of plant parts to control the growth of a plant physically.
- a. Trimming
 - b. Training
 - c. Topping

- d. Pruning
58. Post-harvest processing activities that do not change the structure of the commodity
- Secondary processing
 - Primary processing
 - Tertiary processing
 - All of the above
59. *Lansium domesticum* is a fruit produced in this municipality.
- Benguet, Mt, Province
 - San Marcelino, Zambales
 - San Mateo, Isabela
 - Paete, Laguna
60. Which of the following are not elements of weather?
- Temperature and wind
 - Atmospheric pressure and humidity
 - Typhoons and tornadoes
 - Precipitation and cloudiness
61. It refers to the process by which the economy is transformed from one that is predominantly agricultural to one that is dominantly industrial and service-oriented. Here, agriculture is the driving force that pushes for industry and services through the market it creates, the labor that it absorbs and the income that it generates which is channeled to industry and services.
- Resource accounting
 - Agricultural development
 - Rural industrialization
 - Farming system
62. One of the several WTO agreements deals on rules for trade and investment in ideas and creativity. The rules state how copyrights, trademarks, geographical names used to identify products and industrial designs should be protected when trade is involved
- Intellectual property
 - Policy review
 - Goods and services
- d. Settlement of disputes
63. It is the integration of the world economy that are influenced by such factors like rapid communication, market liberalization, and global integration of the production of goods and services
- Globalization
 - Export subsidies
 - Market access
 - Tarification
64. It is the application of indigenous and/or scientific knowledge in managing microorganisms or their parts, or of cells and tissues of higher organisms for used by humans for medical, agricultural, industrial and environmental applications.
- Biodiversity
 - Diagnostics
 - Biotechnology
 - Tissue and cell culture
65. The following are modern techniques in biotechnology except
- Tissue and cell culture
 - Bioinformatics
 - Vaccine technology
 - Diagnostics
66. It is generally the alteration, modification, or change of an organism's genetic or hereditary material to eliminate undesirable characteristics or to produce desirable new ones.
- Replication
 - Genomics
 - Bioinformatics
 - Genetic engineering
67. It is the transfer of desirable genes into organisms like production of genetically modified organisms (GMO), synthetic genetic engineering, application of recombinant DNA technology (gene splicing or crossing over from different sources).
- Transformation
 - Diagnostics

- c. Bioinformatics
d. Market-assisted breeding
68. It is a type of agricultural systems which is characterized by defined holdings with largely permanent field divisions. Semi-stationary housing predominates, with families having registered ownership of the land.
a. Shifting cultivation system
b. Fallow system
c. Systems with perennial crops
d. Grazing system
69. Which does not belong to the group of forage crops?
a. R. Communis
b. M. Atropurpureum
c. S. Humilis
d. P. Purpureum
70. Which does not belong to the Crucifer family?
a. B. Juncea
b. B. Oleraceae
c. B. Sinenis
d. B. Alba
71. The scientific name of bitter gourd is
a. Momordicacharantia
b. Citrulluslunatus
c. Luffaacutangula
d. Luffa cylindrical
72. The scientific name of watermelon is
a. C. Lunatus
b. C. Maxima
c. S. Edule
d. C. Sativus
73. The Kranz anatomy is found in the leaves of:
a. C₃ plants
b. C₄ plants
c. CAM plants
- d. Rice plants
74. C₃ plants have:
a. Only once CO₂ fixation pathway
b. Two CO₂ fixation pathways separated in space
c. Two CO₂ fixation pathways separated in time
d. Three CO₂ fixation pathways
75. An RQ value equal to 1 means:
a. Glucose is being respired
b. Fats is being respired
c. Anaerobic respiration is taking place
d. Aerobic respiration is involved
76. Cell turgidity in plants is maintained through:
a. Respiration
b. Osmoregulation
c. Translocation
d. Plasmolysis
77. Pigeon pea originated and is widely domesticated in this country
a. Australia
b. South America
c. India
d. Central Asia
78. A major cutflower of CAR
a. Strawberry
b. Aster
c. Orchids
d. Chrysanthemum
79. A major field crop in the Bicol Region
a. Garlic
b. Coconut
c. Abaca
d. Sweet potato
80. A major fruit in Western and Central Visayas
a. Onion
b. Mango

- c. Lanzones
 - d. Pineapple
81. Major field crop and vegetable in Southern Mindanao
- a. Corn and Potato
 - b. Rice and Pechay
 - c. Banana and roses
 - d. Corn and Cabbage
82. The World Commission on Environment and Development (WCED), which was formed by the United Nations in 1983, is better known as the Brundtland Commission. In April 1987, it issued this report which focuses on how development could be sustained
- a. Sustainable Development
 - b. Development and the Environment
 - c. Our Common Future
 - d. Conserving the Earth
83. In environment where water is scarce and expensive, and the soil which is sandy is porous, irrigation is best done by this method.
- a. Furrow irrigation
 - b. Overhead irrigation
 - c. Drip irrigation
 - d. All of the above
84. Leguminous crops can fix N from the atmosphere. Which is not under the family Leguminosae or Fabaceae?
- a. Phaseolus lunatus
 - b. Lagenaria siceraria
 - c. Vigna unguiculata
 - d. Phaseolus vulgaris
85. Properly dried seeds can be stored for a longer duration with high germination if this container is
- a. Paper bag
 - b. Jute sack
 - c. Sealed tin can
 - d. Plastic sack
86. A method of asexual propagation in which missing organs are allowed to regenerate or detach from the vegetative parts of the plant is:
- a. Marcotting
 - b. Budding
 - c. Cuttage
 - d. Grafting
87. It is a classification of farming systems based on type and intensity of rotation, water supply, cropping patterns and animal activities and degree of commercialization.
- a. Cultivation
 - b. Grassland
 - c. Collection
 - d. Fallow
88. It refers to duly registered associations or persons with a common bond of interest who have voluntarily joined together to achieve a lawful common social and economic end.
- a. Competitive advantage
 - b. Communal advantage
 - c. Rural advantage
 - d. Economic advantage
89. It refers to the manner of utilizing land, including its allocation, development, and management
- a. Land use
 - b. Land use planning
 - c. Land use plan
 - d. Land distribution
90. Which of the following does not belong to the classification of farming systems?
- a. Collection
 - b. Grassland utilization
 - c. Cultivation
 - d. Cropping system
91. The following are types of shifting cultivation systems, except:

- a. Intercropping system
 - b. Migration system
 - c. Vegetative system
 - d. Clearance system
92. Momordicacharantia and Sechiumedule, are examples of the family
- a. Cucurbitaceae
 - b. Moringaceae
 - c. Malvaceae
 - d. Compositae
93. The scientific name of durian is
- a. Duriozibethinus
 - b. Artocarpusaltillis
 - c. Durio discolor
 - d. Averrhoabilimbi
94. The scientific name of mangosteen is
- a. Garciniamangostana
 - b. Artocarpusaltillis
 - c. Durio discolor
 - d. Averrhoabilimbi
95. Mango's scientific name is
- a. Mangiferaindica
 - b. Artocarpusaltillis
 - c. Durio discolor
 - d. Averrhoabilimbi
96. The scientific name of lanzones is
- a. Duriozibethinus
 - b. Artocarpusaltillis
 - c. Durio discolor
 - d. Lansiumdomesticum
97. The main path of (movement of) inorganic substances in plants is:
- a. Roots
 - b. Xylem
 - c. Phloem
 - d. Leaves
98. Passive movement of water occurs:
- a. From a cell with high potential to cell with low potential
 - b. Only through a semi-permeable membrane
 - c. Through cytoplasmic streaming
 - d. From a cell with low potential to a cell with high potential
99. As autotroph, plants:
- a. Can directly use CO₂ to synthesize its food
 - b. Act as host to N₂ fixing bacteria
 - c. Obtain nutrients from the soil
 - d. Obtain nutrient from crop residue
100. Growth in plant usually takes in growth points such as:
- a. Flowers
 - b. Stems
 - c. Meristem
 - d. Branch
101. The mechanism in which plant growth is governed by some kind of "division of labor" among cell and different plant parts is called:
- a. Genome
 - b. Correlation mechanism
 - c. Endogenous growth rhythm
 - d. Exogenous growth rhythm
102. A major fruit in ARMM
- a. Mangosteen
 - b. Marang
 - c. Durian
 - d. Strawberry
103. Pearl millet is a major crop in and originated in this region of the world
- a. China
 - b. Australia
 - c. Southeast Asia
 - d. Africa

104. A major grass in Central Luzon
- Mungbean
 - Sugarcane
 - Millet
 - Sorghum
105. A system of land preparation involving plowing and harrowing under submerged condition
- Lowland
 - Upland
 - Dryland
 - Tillage
106. The lowland system of preparing the soil results in this physical change
- Soil structure and granulation are maintained
 - Macropores and micropores are maintained
 - Macropores are lost and only micropores prevail
 - Downward movement of water is normal and water drains easily
107. A system of land preparation where plowing and harrowing are done in dry or moist condition
- Lowland
 - Upland
 - Wetland
 - Tillage
108. This is the capacity of a cell cultured in vitro to regenerate into a plant.
- Potency
 - Micropropagation
 - Totipotency
 - Culturability
109. Carotenoids are present in the leaves to perform this role.
- Convert sunlight to ATP
 - Prevent photo oxidation of chlorophyll
 - Reduce NADP
110. The observable variation present in a character in a population is called
- Phenotypic variation
 - Dominance variation
 - Genotypic variation
 - Environmental variation
111. This refers to the increased genetic variability brought about by tissue Culture.
- Mutation
 - Somaclonal variation
 - Genetic variation
 - None of the above
112. This is a group of cells, tissues or plants derived from a single mother cell, tissue or plant through asexual means and is expected to be genetically identical
- Clone
 - Bud
 - Meristem
 - Scion
113. The mechanical manipulation of the soil from a known condition to a different desired condition,
- Primary tillage
 - Tillage
 - Soil tilth
 - Secondary Tillage
114. Collection is one of the conservation strategies of plant genetic resources. Which among the following is not a type of collection?
- In vitro collection
 - Core collection
 - Field collection
 - In situ collection
115. Which of the following is not a type of agricultural systems?
- Shifting cultivation system

- b. Fallow system
c. Farming system
d. Ley system
116. In grassland utilization as a classification of farming systems, the situation wherein farmers with a permanent place of residence send their herds, tended by herdsmen, for long periods of time to distant grazing areas is known as
a. Total nomadism
b. Partial nomadism
c. Semi-nomadism
d. Transhumance
117. Which of the following methods of crop improvement is not commonly used due to difficulty in identifying the change in the desired traits?
a. Plant introduction
b. Introgression
c. Selection
d. Hybridization
118. It is loosely defined as a wild species under the management of man which provides domestic types of plants that are superior in characteristics to the previously available material
a. Hybridization
b. Domestication
c. Introduction
d. Cultivation
119. The natural or artificial process which permits an increase in the proportion of certain genotypes or groups of genotypes in succeeding generation to isolate or separate the better strains or genotypes from the variety.
a. Selection
b. Hybridization
c. Introgression
d. Introduction
120. A classification of plants according to blooming habits wherein pollination occurs before flower opening. It is mostly self-pollination and limited cross-pollination
a. Dichogamous
b. Cleistogamous
c. Chasmogamous
d. Monoecious
121. This is the scientific name of rambutan
a. *Nepheliumlappaceum*
b. *Artocarpusaltilis*
c. *Durio discolor*
d. *Averrhoadomesticum*
122. The scientific name of wheat is
a. *Triticumaestivum*
b. *Oryza sativa*
c. *Zea mays*
d. *Saccharumofficinarum*
123. Plants that grow on live trees or dead trunks but do not depend on them for water and nutrients
a. Epiphytes
b. Xerophytes
c. Terrestrial
d. Bryophytes
124. *Pterocarpusindicus* Wild, the Philippine National Tree, represents a type of dry indehiscent fruit called
a. Achene
b. Schizocarp
c. Nut
d. Samara
125. Root hairs are uncutinized epidermal appendages located at the
a. Cell division region
b. Meristem region
c. Cell maturation region

- d. Cell elongation region that increase the water absorbing capacity of the root
126. Which is not a characteristic of dicotyledonous plants?
- Netted venation
 - Floral parts in 5's or multiple of 5
 - Tap root system
 - Distinct nodes and internodes
127. This phytohormone is also referred to as ripening hormone:
- IAA
 - Gibberelin
 - Cytokinin
 - Ethylene
128. The growth response of plants to the direction of light is called:
- Geotropism
 - Phototropism
 - Thigmotropism
 - Epinasty
129. The special cells that allow rice plants to adjust to varying levels of O₂ in the growth medium are called:
- Aerenchymacells
 - Bulliformcells
 - Phytochromecells
 - Chroplastcells
130. The G in equation Y=f[G+E+(G×E)] refers to:
- Growth
 - Genotype
 - Gender
 - Geotropism
131. An optimum environment for crop growth and development is one that:
- Poses a minimum of constraints
 - Has a wide range for crop adaptation
 - Does not interact with crops
- d. Free from pest and diseases
132. The seasonal pattern of atmospheric conditions in a particular occurring from year to year is called:
- Weather
 - Climate
 - Season
 - Summer
133. The Father of Modern Tillage
- Jethro Till
 - JethroTull
 - James Tull
 - John Tull
134. The greatest achievement of man in metallurgy during 3,000 BC which greatly improved tillage
- Development of plow
 - Selection and breeding
 - Use of farm tractor
 - Development and use of fertilizers
135. A unique component of lowland or wetland system of land preparation
- Plowing
 - Harrowing
 - Leveling
 - Flooding
136. Condition of the soil when puddled
- Percolation of water is sharply decreased
 - Drainage of water is normal
 - Soil clods are broken into smaller aggregates and particles
 - Plow sole or hardpan is absent
137. Soil moisture is a factor for good land preparation of upland fields. A practical indicator of a soil with ideal moisture content is
- Soil sticks on the moldboard plow
 - Field is level
 - Soil is non-friable

- d. Freshly cut surface should not glisten with moisture
138. An optional step necessary in opening new areas and in preparing the field after a prolonged fallow period
- Ridging
 - Plowing
 - Harrowing
 - Weeding
139. The most aggressive tillage operation
- Ridging
 - Plowing
 - Harrowing
 - Weeding
140. A method of planting the seed at the bottom of the furrow and is usually recommended during the dry season.
- Surface or flat-bed planting
 - List planting
 - Furrow planting
 - Hill planting
141. The general term for techniques that control the growth of plants in terms of shape, size, and spatial direction.
- Training
 - Pruning
 - Pinching
 - Trimming
142. The end of the development stage of a fruit or fruit vegetable when it has developed the ability to ripen normally after harvest
- Commercial maturity
 - Horticultural maturity
 - Physiological maturity
 - Botanical maturity
143. A stem of cropping in which as many crops as possible are grown on the same land within a year.
- Monocropping
 - Integrated farming
- c. Multiple cropping
- d. Sustainable farming
144. Assuming dry air and a sea-level air temperature of 30°C, the temperature on top of a 1000-meter-high mountain is
- 10°C
 - 30°C
 - 20°C
 - 40°C
145. Equity between the interests and rights of present and future generations is known as
- Intragenerational equity
 - Intergenerational equity
 - Both a and b
 - None of the above
146. Because irrigation water is applied in small amounts onto the soil without disturbing the surface, soil erosion and surface crustation are usually eliminated when using
- Flood irrigation
 - Drip irrigation
 - Furrow irrigation
 - Sprinkler irrigation
147. A basic type of hybrid crosses wherein a hybrid is crossed to one of its parents to improve lines or cultivars that excel in most desirable characteristics but lack one or a few
- Polycross
 - Top cross
 - Double cross
 - Backcross
148. It is a cross between an inbred and an open-pollinated variety
- Three-way cross
 - Double cross
 - Top cross
 - Backcross

149. It is the inability of a mature seed to germinate due to the absence of favorable environmental factors necessary for germination
- Quiescence
 - Imbibition
 - Dormancy
 - Physiological immaturity
150. The following are the main types of seed dormancy except:
- Innate dormancy
 - Induced dormancy
 - Enforced dormancy
 - Forced dormancy
151. A type of dormancy wherein the new embryo stops growing while still attached to the parent plant thus, preventing the seed from germinating viviparously even after the ripe seed is shed off or harvested
- Innate dormancy
 - Induced dormancy
 - Enforced dormancy
 - Forced dormancy
152. A method of breaking seed dormancy by scratching or chipping the seed thick coat with knives, files, sandpaper, etc. To increase the seed permeability to water and gases.
- Stratification
 - Scarification
 - Leaching
 - Pre-chilling
153. A portion of the axis of a plant embryo or seedling above the cotyledonary node which determines the kind of germination that a seed will have
- Radicle
 - Epicotyl
 - Hypocotyl
154. d. Plumule
154. It is a class of seeds intended for farmers' use after several tests and selections since they do not segregate anymore.
- Registered seeds
 - Certified seeds
 - Breeder seeds
 - Foundation seeds
155. Mangifera indica L. Our national fruit, is what type of fleshy fruit?
- Fibrous drupe
 - Berry
 - Fleshy drupe
 - Pepo
156. The increase in the girth of the stem of dicotyledonous plants is due to the division of a meristematic tissue called
- Protoderm
 - Procambium
 - Vascular cambium
 - Apical meristem
157. Water is translocated from the basal part of the plant, the root, to the upper parts, the stem, the leaves, the flowers or the fruits via two members of the conducting tissue namely
- Vessel and sieve tube
 - Tracheids and sieve tube
 - Tracheids and vessels
 - Vessel and companion cell
158. A flower that bears both reproductive structures, the pistil and stamen, is called
- Complete
 - Perfect
 - Determinate
 - Essential flower

159. The enlarged, fleshy root of some plants like *Daucuscarota*, *Ipomeabatatas*, *Raphanussativus*, etc. Is example of modified root doing the function

- a. Water absorption
- b. Anchorage
- c. Food storage
- d. All of these

160. Analyze the following statements:

1. The most colorful whorl of the flower is the petals and these attract insects for pollination.
2. Flowers that are inconspicuous are provided with mechanism responsible for attracting insects called showy or brightly colored leaves,

- a. Statement I is correct or true and Statement 2 is incorrect or false.
- b. Statement I is incorrect or false and Statement 2 is correct or true,
- c. Both statements are correct or true
- d. Both statements are incorrect or false

161. The most common type of cell and tissue in the plant body is

- a. Aerenchyma
- b. Sclerenchyma
- c. Collenchyma
- d. Parenchyma

162. Plant microclimate refers to the:

- a. Weather forecasters' local climate
- b. Complex of environmental variables to which plants are exposed
- c. Climate prevailing in a village
- d. Climate at the surface of the earth's atmosphere

163. Photocybernetic effect refers to the effect of sunlight on:

- a. Photosynthesis
- b. Plant development
- c. Plant response to daylength

d. Response to gravity

164. The effective wavelength for photoperiodism is:

- a. Red and blue
- b. Far red and red
- c. Ultra violet rays
- d. Gamma rays

165. Sciophytes are also known as:

- a. Sun loving plants
- b. Shade loving plants
- c. Day neutral plants
- d. Water loving plants

166. The net effect of the so-called greenhouse effect is:

- a. Cool temperature
- b. Excessive rainfall
- c. Excessive cloudiness
- d. High temperature

167. Most economically important crops are:

- a. Xerophytes
- b. Hydrophytes
- c. Mesophytes
- d. Halophytes

168. It is generally more rainy at:

- a. Mountainous area
- b. Low-lying areas
- c. Seaside areas
- d. Flat lands

169. A tillage practice where only necessary operations are performed

- a. Minimum
- b. Maximum
- c. Zero
- d. Upland

170. The final step in upland preparation where furrows or beds are prepared

- a. Ridging
 - b. Plowing
 - c. Harrowing
 - d. Weeding
171. A tillage operation undertaken in locations where crops are grown in aerobic soil conditions
- a. Primary
 - b. Secondary
 - c. Upland
 - d. Wetland
172. The type of planting material used for Chinese gabi
- a. Corm
 - b. Stem cutting
 - c. Rhizome
 - d. Bulb
173. A dessicant commonly used in seed storage to prevent further moisture absorption by seeds
- a. Silica gel
 - b. Carnauba wax
 - c. Freon
 - d. Liquid nitrogen
174. Preparation of planting materials for sugarcane involves the following activities
- a. Cut the basal portion of the stalk containing 3 nodes
 - b. Cut the top portion of the stalk containing 3 nodes
 - c. Cut the middle portion of the stalk containing 3 nodes
 - d. Cut the base of the stalk with a length of 25 to 30 cm
175. This institution exist to rationalize the release of varieties emanating from different sources
- a. Philippine Seed Board
 - b. Department of Agriculture
 - c. National Seed Industry Council
 - d. Asian Hybrid Corporation
176. Which does not belong to the group?
- a. Centrosema
 - b. Stylosanthes
 - c. Siratro
 - d. Paragrass
177. Which are not-included as rogues in seed production?
- a. Weeds
 - b. Plants that are genetically pure and conform with the standard of the variety intended for reproduction
 - c. Plants of other cultivars of the same species
 - d. Diseased plants of the same cultivar
178. Plants can be propagated using different techniques. Combining a root stock and a scion until they unite permanently is
- a. Cleft grafting
 - b. Graftage
 - c. Layerage
 - d. Cuttage
179. The leafy shoots originating from axillary buds borne at the base of the pineapple fruit are called
- a. Suckers
 - b. Slips
 - c. Runners
 - d. Crowns
180. The light reactions of photosynthesis involve Photosystem I and Photosystem II, each of which is characterized by a specific reactive molecule. The reactive molecule of Photosystem is
- a. P730
 - b. P680
 - c. P700
 - d. P660
181. The differential performance of genotypes in different environments is termed as
- a. Adaptation
 - b. Plant reaction

- c. GE interaction
d. Acclimatization
182. This method of genetic conservation conserves plants outside the natural habitat
a. Ex situ conservation
b. Cryopreservation
c. In situ conservation
d. None of the above
183. This is a standard procedure of testing whether a plant or plant tissue carries known diseases or not.
a. Quarantine
b. Disease tracing
c. Diagnostic
d. Disease indexing
184. It is a class of seeds whose genetic identity and purity of the variety are maintained. This type of seed is the source of all certified seed classes, either directly or through registered seed. It is issued with red tag.
a. Certified seed
b. Breeder seed
c. Foundation seed
d. Registered seed
185. A class of seed whose life span is prolonged with low seed moisture and temperature. They are called "drying tolerant" seeds.
a. Recalcitrant seed
b. Immature seed
c. Orthodox seed
d. Certified seed
186. Seed germination is affected by light quality as mediated by a phytochrome system. That kind of light that acts as an enzyme which initiates germination is:
a. Far-red light
b. Red-light
c. Ultra-violet light
d. Infra-red light
187. It is a product of two parents and thus, new seeds must always be produced for planting the next season through cross-pollination
a. Inbred rice
b. Cultivar
c. Hybrid rice
d. Purelines
188. It is the result of the union of male and female gametes which results in the formation of seeds and the creation of individuals with new genotype. This usually results in the increased vigor or growth of a hybrid progeny in relation to the average of the parent known as
a. Variety
b. Pedigree
c. Offspring
d. Heterosis
189. Which of the following is not a rice hybrid being recommended by the National Seed Industry Council (NSIC)?
a. PSB Rc 26 H (Magat)
b. PSB Rc 62 H (Makiling)
c. PSB Rc 72 H (Mestizo)
d. PSB Rc 76 H (Panay)
190. The stage in the life cycle of a seed when development is complete and the biological component necessary for all the physiological processes are active or ready to be achieved.
a. Seed germination
b. Seed emergence
c. Physiological maturity
d. Biological yield

191. It is a system of checking and guaranteeing various aspects of seed quality during the period seed is being multiplied and further handled.
- Seed selection
 - Seed certification
 - Seed processing
 - Seed production
192. The phloem tissue is found in the bark which is composed of
- Sieve tube, fibers, parenchyma and companion cell
 - Tracheids, vessel, parenchyma and companion cell
 - Sieve tube, vessels, parenchyma and fibers
 - Sieve tube, companion cell, fibers and vessels used in transporting the photosynthetic
193. The structure in plants located either at the upper, lower or both epidermis of the leaves responsible for exchange of gases is known as
- Root hair
 - Stomata
 - Crystal
 - Trichome
194. A type of sclerenchyma that is short and more or less cuboidal in shape that imparts gritty feeling when fruits containing them are eaten is called
- Fibers
 - Sclereids
 - Strings
 - Tracheids
195. Provided with tap root system in which the main root is capable of penetrating down the soil surface to seek water level and this explains why these plants are rather long lived, They are:
- Ferns
 - Monocots
 - Dicots
196. d. Mosses
196. A leaf is held to the stem by a petiole, a leaflet to the rachis by a petiolule, a solitary flower to the stem by a peduncle and a flower in a cluster by
- Pedicel
 - Filament
 - Style
 - Receptacle
197. The main cell type and tissue type comprising the whole plant body that performs the function of food production, storage and secretion is
- Collenchyma
 - Parenchyma
 - Clorenchyma
 - Schlerenchyma
198. The ultimate origin of all the primary tissues in the root and the stem is
- Protoderm
 - Ground meristem
 - Procambium
 - Apical meristem
199. The concept of basic and nutritious food being available accessible, affordable and stable in supply
- Food availability
 - Food security
 - Food safety
 - Food accessibility
200. An area is experiencing absolute drought if there no rainfall of at least 0.25mm in:
- 365 consecutive days
 - 29 consecutive days
 - 15 consecutive days
 - 5 consecutive days

201. Based on temperature requirement, rice is a:
- Cool season crop
 - Warm season crop
 - Sub-tropical crop
 - Semi-temperature crop
202. High relative humidity can cause:
- Plant wilting
 - Grain drying
 - High disease incidence
 - Breakage seeds
203. As a factor in crop production, edaphic factors refers to:
- Climate
 - Man
 - Soil
 - Microorganism
204. Tillability is difficult in:
- Heavy soil
 - Loamy soil
 - Light soil
 - Sandy soil
205. The desirable soil texture for crops is:
- Heavy soil
 - Loamy soil
 - Light soil
 - Sandy soil
206. The desirable soil structure for crops is
- Blocky
 - Granular
 - Columnar
 - Rectangular
207. GMO stands for:
- Genetically made organisms
 - Genetically modified organisms
 - Genetically mixed organisms
 - Genetically male organisms
208. The light reaction phase of photosynthesis takes place in the:
- Chloroplast
 - Thylakoid lamellae
 - Stroma
 - Chlorophyll
209. An agency actively doing breeding work in sugarcane varieties
- National Seed Industry Council
 - Institute of Plant Breeding
 - DLU Pearl Sweet
 - Victoria's Milling Company
210. The coat protein gene from the virus that causes the ringspot virus disease in papaya has been successfully transferred to papaya by
- IPB
 - Monsanto
 - USDA
 - Victoria's Milling Company
211. The first transgenic variety that was commercialized
- FlavrSavr Tomato
 - Bt corn
 - Golden Rice
 - Nusan
212. A recommended variety of cotton
- Biyaya 12
 - Batac 1
 - Sagana
 - Tiwala 4
213. Rice seedlings raised through Dapog method are ready for transplanting in
- 25 to 30 days
 - 10 to 14 days
 - 20 to 42 days
 - 40 to 0 days

214. The most common method of transplanting rice seedlings
- Square method
 - Triangular method
 - Nelder design
 - Rectangular method
215. A process that starts 7 to 10 days before transplanting of vegetable seedlings wherein gradual withholding of water is made
- Blocking
 - Hardening
 - Pricking
 - Spotting
216. A process done 7 to 10 days before transplanting of vegetable seedlings in which destruction of root system at transplanting time is minimized
- Blocking
 - Hardening
 - Pricking
 - Spotting
217. A method of growing transplants in vegetable production wherein the seedbed is fully exposed to sunlight
- Seedbed method
 - Seedbox method
 - Blocking
 - Spotting method
218. The tillage operation that does the initial cutting or breaking of the soil at its state where either a crop has been grown and harvested or simply a barren soil,
- Secondary tillage
 - Zero tillage
 - Primary tillage
 - Maximum tillage
219. Method of raising rice seedling where pre-germinated seeds are sown on cement or puddled soil covered with banana leaves or polyethylene plastic sheet. The raised seedlings are ready for transplanting in 10-14 days.
- Wet bed method
 - Dry bed method
 - Dapog method
 - Seedbed method
220. The process by which seeds with inhibitory substances are subjected to low-temperature treatment prior to germination to trigger the process of flowering later is called
- Hardening
 - Acclimatization
 - Vernalization
 - Scarification
221. Series of steps which include all those practices done after harvest either to prepare the commodity for the market or long-term storage.
- Packaging operation
 - Packaging house operation
 - Secondary processing operation
 - Handling operation
222. Application of system approach concept is based on a:
- Holistic approach
 - Scientific approach
 - Specific approach
 - Commodity approach
223. In crop rotation, the most critical factor to consider is:
- Proper combinations of crops
 - Proper intercropping
 - Right sequencing the growing crop
 - Proper mixing of crops
224. The temperature at which a biological process will take place at the fastest rate is:
- Cardinal temperature

- b. Minimum temperature
c. Maximum temperature
d. Optimum temperature
225. The attitude that regards the value of nature merely as a pool of exploitable resources to be used for the satisfaction of human wants is the
a. Profit attitude
b. Anthropocentric
c. Bio-centric-holistic attitude
d. None of the above
226. Which requires a longer irrigation interval?
a. Sandy soil
b. Well-structured soil
c. Loamy soil
d. Poorly structured clay soil
227. The competition among different parts of a plant for water, nutrients, light, etc. Is known as
a. Interplant competition
b. Interspecific competition
c. Intraspecific competition
d. Intraplant competition
228. It is defined as the spatial and temporal combination of crops in a given area and the management used to produce them.
a. Cropping system
b. Cropping pattern
c. Multiple cropping
d. Strip cropping
229. It is the growing of two crops in rapid sequence of succession planting one after the harvest of the former.
a. Relay cropping
b. Ratoon cropping
c. Intercropping
d. Sequential cropping
230. It occurs when the yield decrease is equal to the yield increase since the resources of the different species are exactly the same
a. Pure competition
b. Introgression
c. Selection
d. Hybridization
231. Biological diversity is the total variability within all the living organism and the ecological complexes they inhabit. Which of the following is not a level of biodiversity?
a. Human interference
b. Species
c. Ecosystem
d. Genetic diversity
232. Biological diversity includes the following except
a. Plants
b. Animals
c. Soil
d. Microorganisms
233. It is the successful management of the elements and resources of agriculture to satisfy changing human and development needs while maintaining the natural resource base and avoiding environmental degradation.
a. Crop production
b. Food production
c. Sustainable agriculture
d. Agricultural production
234. It is kind of reproduction in which sexual organs or related structures take part but fertilization does not occur hence, the resulting seed is vegetatively produced
a. Cloning
b. Hybridization
c. Introgression
d. Apomixis

235. A type of plant propagation wherein formation of adventitious roots or buds occurs before separation of the propagule from the parent plant.
- Grafting
 - Layering
 - Cloning
 - Inarching
236. Kangkong, ampalaya, and camote tops are easily chewed because of the absence of supporting and strengthening tissue called
- Parenchyma
 - Sclerenchyma
 - Cholenchyma
 - Sclereids
237. The smooth texture of the monocot stem is generally due to the absence of the porous swelling that facilitates gaseous exchange in this organ of the plant. This structure is called
- Pneumatophore
 - Lenticel
 - Stoma
 - Cuticle
238. An indication that corn and rhizome are stems although they are generally below the ground is the presence of
- Node and internode
 - Node and leaf sheath
 - Node and buds
 - Node and roots
239. Which is not a kind of parallel venation?
- Veinlets run on the same direction as midrib
 - Veinlets form an angle with the midrib
 - Veinlets originate from a common point and project like the fingers of a palm
 - Veinlets are perpendicular to the midrib
240. A strengthening tissue present in the plant that can be extracted and can be transformed into economic products like rope, jute sack, cotton balls or cloth is
- Aerenchyma
 - Sclereids
 - Collenchyma
 - Fibers
241. A condition exhibited by the plant bearing both pistillate and staminate flowers that may be derived from either the lateral or terminal bud is called
- Decisuous
 - Monoecious
 - Dioecious
 - Papilionaceous condition
242. In some plants like acacia trees, the outer covering especially of the older portion of the stem that breaks, separates and flakes off is the
- Phellem
 - Phellogerm
 - Cuticle
 - Epidermis
243. *Oryza sativa L.*, is the Filipino's staple food and it represents a kind of indehiscent fruit called
- Caryopsis
 - Schizocarp
 - Samara
 - Achene
244. In coconut, *Cocosnucifera L.*, the endosperm is classified into coconut meat and coconut water. The botanical term for the coconut meat is
- Liquid endosperm
 - Endocarp
 - Solid endosperm
 - Mesocarp

245. Several plants have the characteristic of becoming leafless during a year's growth. These plants that shed off their leaves are called
- Monoecious
 - Deciduous
 - Dioecious
 - Foliaceous
246. The products of the light reaction phase of photosynthesis are:
- O₂ and ATP
 - CH₂O and NADPH
 - ATP and NADH
 - ATP and NADPH
247. The process by ATP is formed when the electron donor is the synthesized PSI rather than the oxidation of H₂O in the light reaction phase of photosynthesis is known as:
- Oxidative phosphorylation
 - Photosynthetic phosphorylation
 - Cyclic photophosphorylation
 - Cyclic photodecomposition
248. According to the first Fick's Law of diffusion, the influx of CO₂ into the leaf is:
- Directly proportional to the size of stomatal opening
 - Inversely proportional to the CO₂ concentration gradient between the leaf and the air
 - Inversely proportional to total resistance
 - Directly proportional to the CO₂ concentration gradient between the leaf and the air, and inversely proportional to total resistance
249. The dark reaction phase (otherwise known as biochemical phase) of photosynthesis has been called as such because it:
- Does not take place during the day
 - Does not require light
 - Requires total darkness
 - Occurs inside the leaf
250. Rice is classified as C₃ species because its first stable product of photosynthesis is a 3-carbon acid known as:
- Pyruvic acid
 - Oxaloacetic acid
 - 3-phosphoglyceric acid
 - Phosphoric acid
251. The photosynthetic potential of a given species is fully expressed when the following environmental factors are optimum:
- Solar radiation and temperature
 - CO₂ concentration, solar radiation, and CO₂ concentration
 - Plant moisture status, solar radiation, and CO₂ concentration
 - Solar radiation, temperature, CO₂ concentration, and plant moisture status
252. Photosynthesis is usually low under drought conditions because:
- Water as an electron donor in the electron transport system is not available
 - Stomatal resistance to the diffusion of CO₂ into the leaf is high
 - The CO₂ concentration gradient between the air and the leaf is very wide
 - The photosynthetic apparatus is permanently damaged
253. The product of glycolysis in the higher forms of plants are:
- NADH and ATP
 - ATP and H₂O
 - NADH and H₂O
 - CO₂ and citric acid
254. The Krebs cycle takes in the:
- Chloroplast
 - Mitochondrion
 - Vacuole
 - Peroxisome

255. A variety of mango that bears oblong fruits with distinct beak at the apex
- Carabao
 - Pico
 - Maharrlika
 - Queen
256. A variety of papaya developed at the Institute of Plant Breeding which has excellent fruit qualities
- Solo
 - Cavite Special
 - Sinta
 - Kapoho
257. Planting material commonly used in pineapple
- Runner
 - Slip
 - Corm
 - Sucker
258. Breadfruit is propagated using this planting material
- Leaf bud cuttings
 - Sucker
 - Runner
 - Root cutting
259. Embryo culture technique in true-breeding Makapuno trees was developed by
- Dr. Emerita V. De Guzman
 - Dr. Estrelita V. De Guzman
 - Dr. Emerita B. De Guzman
 - Dr. Estrelita B. De Guzman
260. A system of spacing and arrangement in planting of perennial crops wherein seedlings are sown using square arrangement with an additional plant in the center
- Square arrangement
 - Quincunx
 - Triangular
261. These planting materials are derived from actively dividing and growing tissues and callus through test tube or bottle micropropagation techniques
- Plantlet
 - Stem cutting
 - Root cutting
 - Microplant
262. Seeds of mango, rambutan, citrus, etc which have initially high moisture content are called by this category
- Orthodox seeds
 - Recalcitrant seeds
 - Scarified seeds
 - Viable seeds
263. A native Abacca variety grown in Mindanao
- Maguindanao
 - Lausigon
 - Linlay
 - Tinawagang Puti
264. Generally, the most practical way of crop propagation
- Use of vegetative materials
 - Seed propagation
 - Transplanting
 - Micropropagation
265. Which is not a root crop?
- Sweet potato
 - Potato
 - Yam
 - Cassava
266. The scientist who formulated the "rules of thumb" in seed storage was
- Harrington
 - Collin
 - Taylor

- d. Van Daar
267. This is an example of a plant propagated by root cutting.
- Onion
 - Guava
 - Okra
 - Eggplant
268. Which of the following is a nut?
- Coconut
 - Pili nut
 - Peanut
 - Cashew nut
269. Many plants with tropical origin fix carbon using this pathway/cycle:
- C4 pathway
 - CAM pathway
 - C3 pathway
 - Calvin cycle
270. This is the ratio of genotypic variance to the total variance.
- Genetic advance
 - Repeatability
 - Heritability
 - Combining ability
271. Two of the most widely used antibiotics in plant genetic engineering are
- Ampicillin and kanamycin
 - Penicillin and kanamycin
 - Ampicillin and penicillin
 - Streptomycin and penicillin
272. The sterile plant with functional roots and shoots developed in vitro is known as
- Seedling
 - Plantlet
 - Embryo
 - Radical
273. Land preparation that is performed at relatively low moisture content, well below the saturation moisture level.
- Wetland or lowland preparation
 - Dry land or upland preparation
 - Secondary tillage preparation
 - Conventional land preparation
274. A process of transferring the seedlings from one container such as seedbox to another container before they are brought to the field.
- Pricking
 - Blocking
 - Hardening
 - Seeding
275. It refers to the visual impact of the total mass of an object such as or group of plants.
- Color
 - Form
 - Line
 - Texture
276. It is a genetically variant population originating through selection and propagation by individual farmers, or in small areas of geographic isolation.
- Landrace
 - Polycross
 - Hybrids
 - Multiple cross
277. Strictly speaking, it refers to a plant grown anywhere outside its natural range
- Endemic
 - Innate
 - Exotic
 - Inherent
278. The most recently evolved and most successful group of land plants in the world today.

- a. Angiosperms
 - b. Gymnosperms
 - c. Algae
 - d. Fungi
279. The young plant that develops inside the seed
- a. Seed coat
 - b. Embryo
 - c. Endosperm
 - d. Perisperm
280. The plant cell wall is made up chiefly of
- a. Glycoproteins
 - b. Cellulose
 - c. Hemicellulose
 - d. Pectins
281. The following movement of the cytoplasm which serves for efficient distribution of substances absorbed from outside of the cell and substances released by the nucleus and other organelles is
- a. Cytoplasmic streaming
 - b. Excretion
 - c. Intussusception
 - d. Secretion
282. Nectar is a fluid carbohydrate producer and secreted by the
- a. Dictyosome/golgi body
 - b. Nucleolus
 - c. Endoplasmic reticulum
 - d. Glyoxysome
283. Plastids that contain fats and oils.
- a. Chromoplasts
 - b. Chloroplast
 - c. Elaeioplasts
 - d. Amyloplast
284. The vegetative organs of the plant body include the roots, stem and
- a. Flowers
 - b. Seeds
 - c. Leaves
 - d. Fruits
285. A meristematic tissue where lateral roots of plants originate
- a. Vascular cambium
 - b. Epidermis
 - c. Endodermis
 - d. Pericycle
286. Water and minerals absorbed by the roots are transported to the different parts of the plant through the
- a. Vascular bundle
 - b. Xylem
 - c. Phloem
 - d. Stele
287. The pigment found in some plants that is soluble in water is known as
- a. Anthocyanin
 - b. Xanthophylls
 - c. Carotene
 - d. Lycopene
288. The transformation of one plastid to another like the transformation of leucoplast to chloroplast is manifested in the following instances
- a. Senescence of a green leaf
 - b. Greening of a potato tuber
 - c. Ripening of a fruit
 - d. Abscission of leaf
289. Crystals are metabolic waste products of the cell that could not be excreted and therefore stored in an organelle called
- a. Golgi bodies
 - b. Vacuole
 - c. Microbodies

- d. Microtubules
290. Based on habit, plants exist as tree, shrubs and vines, Vines cling to support or crawl on the soil surface and could not attain a vertical growth by itself because of the absence of
a. Permanent
b. Primary
c. Secondary
d. Mechanical tissue
291. Corn or Zea mays L., is a monocot plant that uses its terminal bud for the formation of the staminate flower and the lateral bud In the formation of the pistillate flower. Such condition exhibited by this plant is known as
a. Bioecious
b. Indeterminate
c. Determinate
d. Monoecious condition
292. The plant that is considered the tree of life simply because of the many uses of its stem, leaves and fruits is
a. Oryza sativa
b. Cocosnucifera L.
c. Zea mays L.
d. Musa paradisiaca L.
293. The tissue found in the root but not in the stem is known as
a. Endodermis
b. Pericycle
c. Epidermis
d. Pith which is the inner boundary line of the cortex
294. Analyze the following statements:
1. Terminal buds are necessary for the increase in the height of the plant as well as for fruit formation,
2. Lateral buds are necessary for fruit formation only,
a. Both statements are true
b. Both statements are false
c. Statements 1 is true, statement 2 is false
- d. Statement 1 is false, statement 2 is true)
295. Adjacent cell walls are cemented together by means of
a. Cell membrane
b. Middle lamella
c. Plasma membrane
d. Lipid membrane
296. Storage plastids store starch, oil and proteins are called
a. Aleuroplast
b. Elaioplast
c. Amyloplast
d. Leucoplast
297. The meristematic tissue found in the periderm responsible for the production of the cork and the parenchyma is
a. Phellem
b. Phellogen
c. Phelloderm
d. Exocarp
298. Assimilates and translocated via the:
a. Xylem tissue
b. Kranzanatomy
c. Phloem tissue
d. Epidermis
299. The ascent of the cell sap from the roots to the leaves of actively transpiring plants is driven largely by:
a. Water tension gradient
b. Water potential
c. Osmotic pressure
d. Low root pressure
300. Transpiration is a very useful process in plants because it is:
a. Involved in heat exchange between the leaves and the air
b. Essential in the distribution of essential elements in plants
c. Important in water and nutrient utilization
d. Needed in solubilizing organic compounds
301. Which of the following is/are not part(s) of the pistil?

- a. Ovary
b. Ovule
c. Pollen
d. Style
302. Which of the following is/are not considered as a berry?
a. Strawberry
b. Tomato
c. Bell pepper
d. Cherry
303. In the process of seed development the egg apparatus is composed of:
a. Egg cell + synergids
b. Egg cell + polar nuclei
c. Synergids+ antipodals
d. Synergids+ polar nuclei
304. In seed embryogenesis, the zygote which give rise to the embryo is formed by the fusion of:
a. Sperm cell + antipodals
b. Sperm cell + egg cell
c. Sperm cell + polar nuclei
d. Sperm cell + synergids
305. In a tetrazolium test, viable seeds will stain:
a. Red
b. Blue
c. Green
d. Yellow
306. Carbohydrate reserves of seeds will be hydrolyzed finally as:
a. Galactose
b. Fructose
c. Glucose
d. Cellulose
307. This type of dormancy is due to one or more unsuitable factors of the environment, which are non-specific in their effect. In seeds, this is equivalent to quiescence.
a. Paradormancy
b. Endodormancy
c. Ecodormancy
d. Chemical dormancy
308. Irrigation water is no longer needed at this stage of rice development
a. Seedling
b. Vegetative
c. Reproductive
d. Ripening
309. Rapid closing of the neck of bulb crops under favorable condition
a. Tightening
b. Curing
c. Drying
d. Healing
310. Microgametogenesis is a reproductive process in plants which results in the production of
a. Pollen grains
b. Seeds
c. Embryos
d. Spores
311. These are meristems found at the apices of the stem and the root mainly responsible for the increase in length of these plant organs are called
a. Secondary meristems
b. Intercalary meristems
c. Lateral meristems
d. Promeristems
312. Plant responses to seasonal variations in the length of day are collectively known as:
a. Vernalization
b. Photoperiodism
c. Circadian rhythm

- d. Morphogenesis
313. A water impounding earth-dam structure designed to collect rainfall and runoff water
- Tube well
 - Small farm reservoir
 - Diversion system
 - Rainfall
314. Annual crop losses due to weeds in Asia in 2001 have been estimated at
- 0%
 - 3%
 - 6%
 - 12%
315. The intercropping of cabbages and tomatoes is commonly adopted in vegetable growing areas because of:
- Allelopathy
 - Reduced incidence of diamond-back moth
 - Reduced incidence of diseases
 - Reduced cost of fertilizer
316. Which specific condition will a given non-photoperiodic variety of rice will flower and mature?
- Earlier in the Philippines than in China
 - Earlier in China than in the Philippines
 - At the same time in the Philippines and in China
 - Continuously flower in both countries
317. The shell of the coconut fruit is hard and stony, hence the fruit is classified as
- Samara
 - Drupe
 - Achene
 - Nut
318. The mature or ripened ovary of a flower is referred to as the
- Infructescence
 - Fruit
- c. Embryo sac
- d. Seed
319. Stomata are avenues for the exchange of gases in the leaves. When these avenues are located on both epidermis of the leaves, they are called
- Amphistomata
 - Hypostomaata
 - Epistomata
 - Mesostomata
320. Photosynthesis occurs also in other organs of the plant as specialized function. A modified stem capable of food production is called
- Mesophyll
 - Megaphyll
 - Cladophyll
 - Chlorophyll
321. Branch roots or secondary roots are produced due to the division of a meristematic tissue called
- Pericycle
 - Radicle
 - Hypocotyls
 - Stele
322. Photoreceptor involved in photoperiodism is:
- Phytochrome
 - Chlorophyll
 - Carotenoids
 - Flavins
323. These plants need to be supplied only with inorganic substances since they make their own organic substances:
- Heterotrophic organisms
 - Accumulators
 - Autotrophic organisms
 - Eukaryotic organisms

324. Reduction in the amount of green pigments in leaf, resulting to yellowing:
- Chlorosis
 - Necrosis
 - Autolysis
 - Dialysis
325. The type of weeds that are difficult to control mechanically or with the use of herbicides
- Broadleaves and grasses
 - Sedges and broadleaves
 - Grasses and sedges
 - Broadleaves
326. A beneficial effect of weeds
- May hinder cereal harvesting and contaminate seeds
 - Act as host to pathogens
 - Take up soluble nutrients on land not cultivated
 - Competition for light and nutrients
327. A broadleaf weed that is commonly known as "makahiya"
- Cyperusuraria
 - Mimosa pudica
 - Elusineindica
 - Amaranthus sp.
328. A wasp that parasitizes on the eggs of corn borer
- Trichogrammachiilonis
 - Trichogrammaevanescens
 - Trocogrammajaponicum
 - Bacillus thuringensis
329. A hymenoptera used against diamond backmoth in cabbage growing area in Benguet and Mountain Province
- Trichogrammachiilonis
 - Trichogrammaevanescens
 - Trocogrammajaponicum
 - Diadegmasemiclausum
330. This refers to the finite limits to the capacity of ecosystems and to the impacts that they and the earth as a whole can withstand without dangerous deterioration.
- Carrying capacity
 - Environmental capacity
 - Biotic capacity
 - Resiliency
331. The best method of irrigation to use in soils that are easily eroded is:
- Flood irrigation
 - Drip irrigation
 - Furrow irrigation
 - Sprinkler irrigation
332. Based on its uses this crop can be classified both as an agronomic and horticultural crop:
- Rice
 - Sorghum
 - Mungbean
 - Peanut
333. This best stored at this temperature: Orthodox seeds with 4% to 14% moisture content.
- Below 0°C
 - 0 .20°C
 - 15°C
 - 25°C
334. When male and female flowers are produced in the same individual plant, that plant is
- Nypogynous
 - Monoecious
 - Epigynous
 - Dioecious
335. The dry dehiscent fruit of peanut is classified as
- Grain or caryopsis
 - Silique

- c. Legume or pod
d. Nut
336. The basic unit of plant classification is the
a. Species
b. Order
c. Family
d. Genus
337. Double fertilization in plants, a process which leads to the formation of embryo and endosperm in a seed, occurs in
a. Flower-bearing plants
b. Vascular plants
c. Spore-bearing plants
d. All land plants
338. Fruits are derived from one flower with several ovaries
a. Aggregate
b. Simple
c. Multiple
d. Accessory
339. Analyze the following statements:
1. Endospermic or albuminous seeds contain endosperm for food storage
2. Corn and rice are two plants, whose seeds are classified as non-endospermic or exalbuminous
a. Both statements are correct
b. Both statements are incorrect
c. Statement 1 is correct, statement 2 is incorrect
d. Statement I is incorrect, statement 2 is correct
340. There are several agents that transfer pollen grains to hasten fruit development. Some flowers are pollinated by bats and these flowers are called
a. Hydrophilous
b. Entomophilous
c. Anemophilous
d. Chiropterophilous
341. Apical dominance is a phenomenon wherein lateral buds are dormant in the presence of terminal buds is effected by
a. Ethylene
b. Auxins
c. Gibberellins
d. Cytokinins
342. The study of how plants absorb, transport and assimilate inorganic ions is called:
a. Inorganic chemistry
b. Mineral nutrition
c. Translocation
d. Plant exudation
343. Which of the following is not a feature of an essential element?
a. The absence of the element makes it impossible for the plant to complete its life cycle
b. The deficiency is specific for element in question
c. The element is directly involved in the nutrition of the plant
d. The element can be substituted by another element of similar size
344. Which is not an example of a essential micronutrient?
a. B
b. Cu
c. Zn
d. K
345. The movement of substances against a concentration or chemical gradient is known as:
a. Passive transport
b. Chemical transport
c. Active transport
d. Membrane transport

346. An insecticide that became the most widely used and was first discovered in 1939 by Paul Mueller in Switzerland. The insecticide is now banned in the US and several countries in the world
- Carbamates
 - DDT
 - Pyrethroids
 - Organophosphates
347. Crops that were commonly used as alternative host plants for cotton bollworm. These crops are often intercropped with cotton.
- Tomato and maize
 - Tobacco and rice
 - Tobacco and maize
 - Cabbage and onion
348. A cultural or physical control of corn earworm
- Use of *Bacillus thuringiensis*
 - Spraying of Carbofuran
 - Detasseling
 - Application of *Trichogramma*
349. A common insect pest of grain legumes
- Thrips
 - Cutworm
 - Diadegma
 - White grub
350. Plants can be propagated in different ways. Inarching as one of the methods is also known as:
- Approach grafting
 - Marcotting
 - Layering
 - Saddle grafting
351. Analyze the following statements:
- I. The stem of a tree elongates by means of the apical bud.
II. The stem of a grass elongates by means of the intercalary meristem.
- Statement I and Statement II are both correct.
 - Statement I is correct but Statement II is wrong.
 - Statement I is wrong but Statement II is correct.
 - Statement I and Statement II are both wrong.
352. The required compounds for CO₂ fixation, namely, NADPH and ATP, are produced via
- Cyclic Photophosphorylation
 - Dark reactions
 - Non-cyclic photophosphorylation
 - Light reactions
353. Characters that are governed by several genes with small effects are known as
- Qualitative characters
 - Dominant characters
 - Quantitative characters
 - Recessive characters
354. This was the first genetically modified food crop produced in developed countries to delay ripening.
- Tomato
 - Watermelon
 - Eggplant
 - Soybean
355. The part of the living cell where metabolic energy, usually in the form of ATP is produced is the
- Mitochondrion
 - Ribosome
 - Chloroplast
 - Nucleus
356. Proteins are synthesized in the
- Mitochondrion
 - Ribosome
 - Chloroplast
 - Nucleus
357. The largest cytoplasmic organelle apart from the nucleus in plant cells is the

- a. Mitochondrion
 - b. Ribosome
 - c. Glyoxysome
 - d. Chloroplast
358. In contrast to animals, plant generally undergo indeterminate or unlimited growth primarily because
- a. They produce substances such as hormones that support continued growth
 - b. They possess meristematic tissues that continually produce new cells
 - c. Their cells persist throughout the life of the plant
 - d. Their cells continually enlarge and elongate
359. The cortex and pith tissues comprise the plant's
- a. Secondary tissue system
 - b. Vascular tissue system
 - c. Primary tissue system
 - d. Ground tissue system
360. Secondary growth of roots and stems of plants results primarily to an increase in
- a. Number of roots and stems
 - b. Size of roots and stems
 - c. Length of roots and stems
 - d. Adventitious roots and stems
361. Stomatal closure is not only due to deficiency of turgor pressure but also due to the action of hormones, It is effected by
- a. Ethylene
 - b. Cytokinins
 - c. Gibberellins
 - d. Abscissic acid
362. Senescence is yellowing of leaves due to maturity and it is due to a hormone called
- a. Ethylene
 - b. Cytokinins
 - c. Gibberellins
- d. Auxins
363. Short day plants are plants that bear flowers during the period of the year when nights are longer than daytime. The flowering of these kinds of plants is due to the action of the hormone
- a. Auxin
 - b. Ethylene
 - c. Abscissic acid
 - d. Cytokinins
364. The production of ethylene is due to the action or growth hormone known as
- a. Gibberellins
 - b. Auxins
 - c. Cytokinins
 - d. Abscission
365. Geotropism is responsible of the plants to gravity. This responsible is an effect of growth hormone called.
- a. Auxin
 - b. Cytokinins
 - c. Gibberellins
 - d. Ethylene
366. Which is not a feature of the Pfr form of the phytochrome:
- a. It is blue-green in color
 - b. It is convertible to Pr form
 - c. It is far-red light absorbing form
 - d. It is red-orange in color
367. Cultural control of fruit flies attacking mangoes in Guimaras
- a. Bagging
 - b. Releasing of sterilized male fruit flies
 - c. Using yellow sticky traps
 - d. Pruning
368. A method of land preparation where the soil is tilled at saturation point:
- a. Wetland or lowland preparation

- b. Dry land or upland Preparation
c. Primary tillage preparation
d. Conventional land preparation
369. When male and female flowers are produced in the same individual plant, that plant is
a. Nypogynous
b. Monoecious
c. Epigynous
d. Dioecious
370. Senescence is effected by ethylene but prevented by
a. Auxin
b. Stops
c. Cytokinins
d. Prevents ripening of these fruits
371. The natural termination of the functional life of an organ, organism or other life unit which is also regarded as the final phase in plant development:
a. Deterioration phase
b. Abscission phase
c. Senescence
d. Growth inhibition
372. Natural pyrethrum used as a botanical insecticide and which have been in the market for about 150 years was extracted from
a. Tobacco
b. Derris eliptica
c. Lonchocarpus spp.
d. Chrysanthemum cinerariaefolium
373. These are pathogenic organisms composed of nucleic acids and capable of altering a plant's metabolism by affecting protein synthesis
a. Viruses
b. Bacteria
c. Fungi
d. Nematode
374. To ensure high emergence, seeds must be viable enough. Which method is commonly used in testing seed viability?
a. Rag doll method
b. Petri-dish method
c. Seed box method
d. 78 hours
375. Flowering plants can be jewels of the landscape if they are planted in
a. Group
b. Random
c. C. Both a and b
d. D. None of the above
376. The dry dehiscent fruit of peanut is classified as
a. Grain or caryopsis
b. Siliques
c. Legume or pod
d. Nut
377. The basic unit of plant classification is the
a. Species
b. Order
c. Family
d. Genus
378. The white potato tuber is considered a stem because
a. It become fleshy and stores carbohydrates
b. It does not absorb water and minerals
c. It has xylem and phloem
d. It has nodes and internodes
379. Storing matured fruits in plastic bags
a. Enhances
b. Gibberellins
c. Delays
d. Abscissic acid
380. The foolish seedling growth is associated with what kind of growth hormone?

- a. Auxins
 - b. Gibberellins
 - c. Cytokinins
 - d. Ethylene
381. A type of senescence which is characterized by annual change in deciduous woody plants in which all the leaves die but the bulk of the stem and the root system remain viable:
- a. Whole plant senescence
 - b. Organ senescence
 - c. Sequential senescence
 - d. Leaf senescence
382. Phototropism is a growth response to unidirectional light which is probably influenced by a particular growth hormone:
- a. Abscissic acid (ABA)
 - b. Indoleacetic acid
 - c. Kinetin (Ki)
 - d. Gibberellins (GA)
383. A general management option for disease control involving planting of a resistant variety
- a. Exclusion
 - b. Immunization
 - c. Protection
 - d. Eradication
384. A cultural control method for disease adapted by local growers
- a. Regular weeding
 - b. Application of bacterial antagonist
 - c. Eradicant fungicides
 - d. Varietal resistance
385. A type of fungicide that cannot kill the fungi already established in the plant
- a. Protective fungicide
 - b. Eradicant fungicide
 - c. Systemic fungicide
 - d. Curative fungicide
386. A process of drying the surface moisture after washing or waxing fruits or when commodities are harvested wet.
- a. Wiping
 - b. Blowing
 - c. Airing
 - d. Water elimination
387. Hedgerow is critical in soil conservation. In hilly land farming, the most commonly used hedgerow crop is:
- a. Mahogany
 - b. Ipil-ipil
 - c. Eucalyptus
 - d. Rensonii
388. Wind direction varies according to season. An easterly wind blows in this direction.
- a. From east to west
 - b. From the equator to the east
 - c. From west to east
 - d. From the equator to the west
389. When a flower is imperfect, it means it is
- a. Irregular
 - b. Hypogenous
 - c. Unisexual
 - d. Bilateral
390. The inward rolling of monocot leaves as a means of avoiding excessive water loss occurs due to the activity of specialized cells in the epidermis called
- a. Bulliform cells
 - b. Silica cells
 - c. Subsidiary cells
 - d. Guard cells
391. The tissue of the leaf where the process of photosynthesis takes place is the
- a. Mesophyll
 - b. Hypodermis

- c. Epidermis
d. Vascular bundle
392. If the flowering of short day plant is controlled by a growth hormone, the flowering of long day plant is likewise controlled by growth hormones, the hormone responsible for this effect is
a. Auxins
b. Gibberellins
c. Cytokinins
d. Ethylene
393. Growth is also manifested in the increase in the girth of the trunk. This growth is due to the division of a meristematic tissue called
a. Cork cambium
b. Protoderm
c. Vascular cambium
d. Ground meristem
394. Tissues at the cell elongation region are
a. Protoderm, epidermis and cortex
b. Procambium, cortex and pith
c. Protoderm, ground meristem and procambium
d. Procambium, phloem and xylem
395. The growth response of plant to touch that is best exemplified by the coiling of tendrils in Cucurbits:
a. Thermotropism
b. Seismonasty
c. Thigmotropism
d. Thigmomorphogenesis
396. A characteristic response of roots and shoots such that they align themselves parallel to the direction of the gravity:
a. Degravitropic
b. Agravitropic
c. Orthogravitropic
d. Negative tropism
397. Leaf senescence like the other type of senescence can be promoted by the application of the growth hormone:
a. Cytokinin
b. Abscisic acid
c. Gibberellins
d. Auxin
398. A fungus used to control nematodes in white potatoes, bananas, and citrus
a. Fusarium sp.
b. Paecilomyces lilacinus
c. Burkholderia
d. Pythium
399. The virus disease that caused the collapse of a once thriving papaya industry in Cavite
a. Cadangcadang
b. PRSV
c. Sigatoka disease
d. AMV
400. A component of disease control which has been most successful but often does not hold very long since disease organisms develop new and more virulent strains which overcome it
a. Timely planting
b. Soil sterilization
c. Plant resistance
d. Biological control
401. A major disease of mango controlled by dipping newly harvested fruits in water heated at 52 to 55°C for 10 minutes, then cooling them in running water and air dried
a. Fruit flies
b. Anthracnose
c. Sigatoka
d. Cadangcadang

402. Sustainable agriculture is any practice, method, technique/technology, philosophy or system or production that makes agriculture attain this condition:
- Economically feasible, and. Ecologically sound
 - Socially just and humane
 - Culturally appropriate and grounded holistic science
 - All of the above
403. Drainage is the removal of excess water, To drain unstable soils, it is best to use this type of drains.
- Open drainage ditches
 - Tile drains
 - Mole drains
 - Subsurface drains
404. Fruits vary in color, size and shape. An example of small fruit is:
- Pineapple
 - Tamarind
 - Lanzones
 - Duhat
405. Some fruits develop even without pollination and fertilization. Such phenomenon, which produces seedless fruits is called
- Parthenocarpy
 - Apocarpy
 - Polyploidy
 - Apomixis
406. Seeds produced by fruits that develop in the absence of pollination and fertilization
- Parthenocarpic
 - Apomictic
 - Apocarpic
 - Polyploid
407. Seeds generally possess a nutritive tissue e.g. Endosperm to supply the growth of the embryo during germination. Some

- plants however produce endospermless seeds. An example of such plant is the
- Banana
 - Citrus
 - Orchid
 - Gumamela
408. Cork cells are derived from the division of the tissue called a. Cortex
- Cortex
 - Vascular cambium
 - Cork cambium
 - Phloem
409. The grand phase of growth is known as
- Logarithmic phase
 - Exponential phase
 - Linear phase
 - Declining phase
410. A tissue found only in the dicot but not in the monocot root and stem as well as dicot stem is
- Cortex
 - Endodermis
 - Phellogen
 - Epidermis
411. Senescence is the energy-requiring process brought about by the metabolic changes, one of this is the destruction of the pigments:
- Carotenoids
 - Xanthophyll
 - Anthocyanin
 - Chlorophyll
412. A variation movement cause by daily rhythms of light and dark resulting from changes in the turgor of motor cells in the pulvinus located at the base of each leaf:
- Nyctinasty

- b. Thermonasty
 - c. Seismonasty
 - d. Circumnutation
413. The bending or curvature (of an organ) caused by a differential growth when the adaxial or morphological upper side of an organ grows more rapidly than the abaxial or morphological lower side of the organ and is always associated with high ethylene concentration:
- a. Hyponasty
 - b. Thigmonasty
 - c. Epinasty
 - d. Thermonasty
414. Estimated losses of manual harvesting and threshing of rice in Southeast Asia in 2001 is
- a. 5 to 16%
 - b. 15 to 26%
 - c. 0 to 5%
 - d. 10 to 35%
415. A maturity index for amplaya ready to harvest
- a. Uniform refractometer brix reading from base to top of stalk
 - b. Change in color of fruit from deep to light green
 - c. Color of lower part of fruit turns creamy yellow
 - d. Tops begin to dry and topple
416. Peanut is ready for harvest when the leaves remain green, pods are full and firm, and at _____ days after planting
- a. 90-110
 - b. 60-70
 - c. 75-90
 - d. 110-120
417. Physical indices used as basis for harvesting a crop
- a. Based on manifest signs observable by sight
 - b. Determined by feel or touch, or sound when tapped
 - c. Determination of respiration rate
- d. Determining the number of days
418. The National Seed Industry Council (NSIC) (former Philippine Seed Board) implemented by a board. Who is not a member of the NSIC?
- a. Secretary of Agriculture
 - b. Director of the Bureau of Plant Industry
 - c. Crop Research Director, PCARRD
 - d. Director of Philmech
419. Plants can be propagated in many different ways. The easiest method of plant propagation is:
- a. Marcotting
 - b. Layering
 - c. Inarching
 - d. Cuttage
420. The flower of a squash which gives rise to a fruit is:
- a. Complete and perfect
 - b. Complete and Imperfect
 - c. Incomplete and perfect
 - d. Incomplete and Imperfect
421. The destruction of the chlorophyllmolecules due to strong light intensity is called
- a. Photolysis
 - b. Etiolation
 - c. Photo-oxidation
 - d. Decoloration
422. The mature or ripened ovule is botanically termed
- a. Fruit
 - b. Spore
 - c. Seed
 - d. Pollen
423. The thick fibrous portion or the husk of the coconut fruit is the
- a. Pericarp
 - b. Mesocarp
 - c. Exocarp

- d. Endocarp
424. In the xylem tissue of flowering plants, the major water-conducting cells are the
- Vessels
 - Seive tubes
 - Tracheids
 - Sieve cells
425. The veins and veinlets of leaves are relatively strong enough to support the weight of a fully expanded leaf because the vascular bundles in these veins are strengthened by
- Parenchyma cells
 - Collenchyma cells
 - Sclerenchyma cells
 - Aerenchyma cells
424. Is an irreversible increase in the size of the organism
- Development
 - Catabolism
 - Growth
 - Anabolism
425. This law states that additional farm inputs in excess of the required does not bring an increase in the amount of produce
- Limiting factors
 - Cytokinin
 - Optima
 - Ethylene
426. The hormone that inhibits organ formation is known as
- Auxin
 - Cytokinin
 - Gibberellin
 - Ethylene
427. The appearance of a plant with respect to a particular character
- Phenotype
 - Ideotype
 - Genotype
- d. Prototype
428. The organ movement such that the axis of the organ comes to the right angles to the direction of the gravitational field as exhibited by stolons of potato and strawberry:
- Heliotropism
 - Plagiogeotropism
 - Diagravitropism
 - Positive geotropism
429. The over-all shape of the plants is determined by:
- Allometric growth
 - Growth correlation
 - Apical dominance
 - Hormonal imbalance
430. Domestication of plants led to:
- Change in plant type and limited ecological adaptation
 - Narrower genetic variation and wider ecological adaptation
 - The disappearance of the natural habitats of wild plants
 - Increased genetic variation and limited ecological adaptation
431. The pattern of assimilate partitioning in plants varies:
- With stage of growth and development
 - With kind of fertilizer applied
 - Depending on the flux of solar energy
 - With total rainfall
432. A machine that completes harvesting operations by culling, conveying the cut materials into the threshing unit, threshing, cleaning of threshed material and conveying the grain to the grain container or into sacks in one pass
- Reaper-windrowers
 - Combine
 - Reaper-binder
 - Stripper-harvesters
433. Mechanical harvesting is not common in the Philippines due to the following crop constraint

- a. Low income of farmers
b. Small landholdings
c. Uneven ripening
d. All of the above
434. Visual indices used as basis for harvesting a crop
a. Based on manifest signs observably by sight
b. Determined by feel or touch, or sound when tapped
c. Determination of respiration rate
d. Determining the number of days
435. A postproduction operation involving the transfer of heat by conveying the water in the grain to vapor and transferring it to the atmosphere
a. Drying
b. Curing
c. Threshing
d. Milling
436. Peanuts and soybeans must be dried to a moisture content that is _____ to prevent grains from infection by *Aspergillusflavus* which produces which produces aflatoxin
a. Equal to 14%
b. Lower than 14%
c. Higher than 14%
d. 25 to 30%
437. It is traditional system of tilling the land which begins with a primary tillage operation followed by several secondary tillage operations.
a. Zero tillage
b. Maximum or conventional tillage
c. Minimum tillage
d. Secondary tillage
438. What is the germination percentage of corn, if 180 normal seedlings emerged out of 200 seeds sown?
a. 80%
b. 90%
- c. 85%
d. 95%
439. Straight lines give a feeling of rigidity and formality while curved lines radiate a feeling of
a. Gracefulness
b. Softness
c. Both A and B
d. None of the above
440. The application of a foliar coating to fruits and vegetables
a. Waxing
b. Artificial
c. Painting
d. All of the above
441. Land equivalent ratio (LER) is used to measure the yield advantage of intercropping. A LER value higher than 1.00 indicates:
a. Disadvantage of intercropping
b. Break-even point of intercropping
c. Advantage of intercropping
d. Intercropping is disastrous
442. The endodermis of roots contains a continuous band of suberin, a waxy substance deposited on the radial and transverse walls. This band is called
a. Endodermal Strip
b. Suberin Strip
c. Caspary Strip
d. Wall Strip
443. The collective term for all the sepals of a flower is
a. Androecium
b. Gynoecium
c. Corolla
d. Calyx
444. The petals of a flower are collectively termed
a. Androecium

- b. Gynoecium
 - c. Corolla
 - d. Calyx
445. The stamens of a flower are collectively termed
- a. Androecium
 - b. Gynoecium
 - c. Corolla
 - d. Calyx
446. The pistils of a flower are collectively termed
- a. Androecium
 - b. Gynoecium
 - c. Corolla
 - d. Calyx
447. The genetic constitution of an individual
- a. Genotype
 - b. Gametophyte
 - c. Phenotype
 - d. Ideotype
448. The observable variation present in a character in a population is called
- a. Phenotypic variation
 - b. Dominance variation
 - c. Genotypic variation
 - d. Environmental variation
449. The component of variation that is due to genotypic differences among individuals within a population is called
- a. Phenotypic variation
 - b. Dominance variation
 - c. Genotypic variation
 - d. Environmental variation
450. The differential performance of genotypes in different environments is termed as
- a. Adaptation
 - b. Plant reaction
- c. GE interaction
 - d. Adaptability
451. A plant showing tolerance mechanism of resistance to water deficit:
- a. Adjust its water absorption rate to maintain cell turgidity
 - b. Maintain relatively high stomatal conductance even if the water deficit progressing to a higher level
 - c. Rolls its leaves to reduce respiration
 - d. Extends its roots horizontally to explore soil moisture around the root zone
452. The following changes in plant are attributed to domestication except:
- a. Less of seed dormancy
 - b. Conversion from perennial to annual
 - c. Increased susceptibility to diseases
 - d. Increased environmental adaptation
453. Oxygen as one of the product of photosynthesis evolves from:
- a. The oxidation of H₂O
 - b. Photosynthesis of H₂O
 - c. The reduction of CO₂
 - d. The reduction of H₂O
454. Agriculture could have been initiated mainly due to chronic food shortage if:
- a. There was sedentary way of living
 - b. Grasslands and forests were present
 - c. Plant and animal diversity was limited
 - d. Fertile lands were available
455. The major product of respiration are the following:
- a. ATP, H₂O and NADH
 - b. CO₂ and ATP
 - c. NADH and ATP
 - d. H₂O, CO₂, ATP and NADH

456. To be given a license to operate a rice mill, milling recovery should not go below

- a. 62%
- b. 52%
- c. 42%
- d. 32%

457. Oil is extracted from this part of the corn kernel

- a. Endosperm
- b. Germ
- c. Testa
- d. Bran layer
- e.

458. Storage life of crops such as vegetables can be prolonged more effectively with this type of storage

- a. Evaporative cooling
- b. Clamp storage
- c. Cold storage
- d. Ventilated storage
- e.
- f.

459. In the Philippines, only a few commodities are stored in refrigerated facilities for an appreciable length of time. These commodities are

- a. Imported temperate fruits
- b. Temperate vegetables
- c. Spices such as tomato
- d. Coconut

428. Rapid cooling of produce soon after harvest within 48 hours or less to a desired transit temperature

- a. Cold storage
- b. Pre-cooling
- c. Processing
- d. Top icing
- e.
- g.

460. The commercial species processed for bast fiber are

- a. Maguey and pineapple
- b. Kenaf and jute
- c. Silk worm
- d.
- h.

d. Hemp and abaca

429. Given the relative humidity values below, in which condition that plant will need more water?

- a. 60%
- b. 80%
- c. 70%
- d. 90%

462. Some examples of external costs that are avoided in sustainable agriculture are:

- a. Soil erosion, pollution, lower food quality
- b. Loss of biodiversity, species/varieties/breeds, and indigenous knowledge
- c. Erosion of human health and social relationships
- d. All of the above

463. Drainage that removes excess water is important for this purpose:

- a. Better germination of seeds
- b. Healthy root system
- c. Timely land preparation and harvesting
- d. All of the above

464. A plant, like sineguelas, that loses its leaves during a certain time of the year before it bears fruit is a

- a. Seasonal plant
- b. Deciduous plant
- c. Evergreen plant
- d. None of the above

465. Insect activity is inhibited when seed moisture content is within this range:

- a. 45-60%
- b. Above 20-45% but below 45%
- c. 18-20%
- d. Below 8-9%

466. This is the mucilage or waxy materials surrounding some seeds and which causes physical dormancy.

- a. Exodermis
 - b. Sacro-testa
 - c. Seed coat
 - d. Sap
467. The plant organ mainly responsible for the transport of water, minerals and food to the various parts of the plant is the
- a. Xylem
 - b. Root
 - c. Phloem
 - d. Stem
468. The transfer of pollen from the anther to the stigma of a flower is termed
- a. Fertilization
 - b. Sporogenesis
 - c. Pollination
 - d. Reproduction
469. Growth in size or girth of stems and roots is due to the activity of lateral meristems. One such meristem is located between the primary xylem and primary phloem, and it is called
- a. Vascular cambium
 - b. Cork cambium
 - c. Ground meristem
 - d. Pericycle
470. The botanical term of wood is
- a. Secondary xylem
 - b. Cortex
 - c. Secondary phloem
 - d. Bark
471. To increase the roots surface area for absorption, roots, produce specialized epidermal cells called
- a. Trichomes
 - b. Root hairs
 - c. Root caps
 - d. Root cells
472. In the root tip, the variety of fully differentiated cells and tissues can be found in the
- a. Meristematic region
 - b. Elongation region
 - c. Maturation region
 - d. Root cap
473. The ratio of genotypic variance to the total variance is termed as
- a. Genetic advance
 - b. Repeatability
 - c. Heritability
 - d. Combining
474. Characters governed by several genes with small effects are known as
- a. Qualitative
 - b. Dominant
 - c. Quantitative
 - d. Recessive characters
475. The phenomenon of a single major gene affecting more than one character is known as
- a. Pleiotropy
 - b. Expressivity
 - c. Penetrance
 - d. Isogenic
476. Modification in the expression of a dominant gene by another non-allelic dominant gene is known as
- a. Gene interaction
 - b. Geneflow
 - c. Gene action
 - d. Modifies
477. *Bacillus thuringensis* is
- a. Bacterium
 - b. Virus
 - c. Fungi
 - d. All of the above

478. The first genetically modified food crop produced in developed countries due to its delayed ripening is

- a. Tomato
- b. Watermelon
- c. Eggplant
- d. Soybean

479. Certain plant organ move when exposed:

- a. To maintain adequate moisture content
- b. To maximize photosynthetic activity
- c. To maintain optimum translocation during the day
- d. To balance their heat load with the surrounding air

480. Essential elements in the soil must be:

- a. In inert form to be available to plants
- b. Soluble and in ionic form(s) for efficient absorption
- c. Kept in the maximum supply in the soil to maximize utilization
- d. In the form of organic compounds

481. Both photosynthetic and respiration rates are influenced by:

- a. Relatively humidity and CO₂ concentration
- b. Oxygen concentration
- c. Temperature and CO₂ concentration
- d. Temperature and relative humidity

482. Nutrient uptake by the soil is affected by:

- a. Air temperature
- b. Soil and water temperature
- c. Soil texture and structure
- d. Soil color

483. Native (inherent) soil nutrient are derived from:

- a. Applied fertilizer
- b. Weathering of minerals in the soil
- c. Decomposition of organic matter in the soil
- d. Physical disintegration of minerals in the soil

484. Nitrogen as an essential element is taken by the crops in the following forms:

- a. N₂, NO₂ and NH₄⁺
- b. N₂O, NO₃⁻ and NO₂⁻
- c. NH₄⁺, NO₂⁻
- d. NO₂, NH4⁺

485. A root crop having a short shelf life of not more than 48 hours and should be processed immediately after harvest

- a. Sweet potato
- b. Yam
- c. Cassava
- d. Taro

486. A postproduction operation in root crops involving the process of allowing self-healing of bruised and skinned off areas of the roots

- a. Crying
- b. Curing
- c. Processing
- d. Storage

487. A critical phase in the production of sugarcane because improper and untimely application of this activity will result in substantial losses in sugar

- a. Transplanting
- b. Irrigation
- c. Harvesting
- d. Storage

488. A common method of curing employed in native tobaccos

- a. Bulk curing
- b. Sun curing
- c. Flue curing
- d. Night curing

489. How many heads of coconut will make 1 kg of copra?

- a. 3 to 5
- b. 5 to 7
- c. 7 to 10
- d. 1 to 3

490. A type of storage for perishable crops that involves manipulating the supply and level of oxygen and carbon dioxide through the use of gas generators and other control devices
- Refrigeration
 - Atmosphere storage
 - Modified atmosphere storage
 - Evaporative cooling
491. A type of processing for annual and plantation crops involving handling of products to make them suitable to the needs of manufacturers and consumers. Examples are washing and cleaning
- Primary processing
 - Secondary processing
 - Tertiary processing
 - Postproduction
492. Kangkong, ampalaya, and camote tops are easily chewed because of the absence of supporting and strengthening tissue called
- Parenchyma
 - Sclerenchyma
 - Collenchyma
 - Chlorenchyma
493. The anaerobic phase of respiration is linked to the aerobic phase by means of:
- Succinyl Co-A
 - Glutaryl Co-A
 - Acetyl Co-A
 - Gluconyl Co-A
494. It is a process by which the soil clods are broken or the soil is puddled by means of a spike-toothed harrow or comb harrow. Usually the operation is done by alternate directions with two lengthwise and one crosswise.
- Plowing
 - Rotavating
 - Harrowing
 - Furrowing
495. The recommended seeding rate of peanut is 90 kilograms per hectare. To ensure a good crop stand, how many kilograms of seed is needed if the germination percentage is only 70 percent?
- 100.0
 - 125.0
 - 112.5
 - 128.6
496. In landscaping, the fine texture of small leaves gives an illusion of distance while the coarse texture of broadleaves gives an illusion of
- Softness
 - Closeness
 - Neatness
 - Gracefulness
497. Type of fruits that exhibits an increase in respiration rate when it starts to ripen
- Non-climacteric fruit
 - Tropical fruits
 - Climacteric fruit
 - Temperate fruits
498. The most critical determinant of the cropping pattern rice followed by rice is:
- Water availability
 - Market accessibility
 - Soil texture and topography
 - Technology
499. To obtain a good result, a farmer can spray his crop if the clouds in the sky are of these types.
- Cumulonimbus clouds
 - Cirrus clouds
 - Nimbus clouds
 - Nimbostratus clouds

500. The deadly disease of unborn infants caused by high nitrate levels in drinking water is:

- a. Methemoglobinemia
- b. Diarrhea
- c. Cancer
- d. Nitrate toxicity

501. Growth in size or secondary growth of roots and stems is generally absent in

- a. Gymnosperms
- b. Angiosperms
- c. Monocots
- d. Dicots

502. The enlarged fleshy underground part of the following crops are generally classified as stems, except

- a. Cassava
- b. Potato
- c. Ginger
- d. Gabi

503. Small raised areas in the bark of woody stems which function for gas exchange are called

- a. Pneumatophores
- b. Lenticels
- c. Stomata
- d. Pits

504. The point in the stem where leaves and buds arise is the

- a. Branch axil
- b. Internode
- c. Leaf axil
- d. Node

505. The vascular bundles are in scattered arrangement in the stem of

- a. Monocots
- b. Ferns
- c. Dicots

d. Pines

506. Dicots are flowering plants having the following characteristics, except

- a. Flower parts in 3's or their multiples
- b. Netted leaf venation
- c. Secondary growth
- d. Two cotyledons

507. During drought conditions, monocot leaves roll their leaves in order to prevent excessive evaporation of water. This rolling phenomenon occurs as a result of specialized large epidermal cells which become flaccid during drought. These cells are called

- a. Bulliform cells
- b. Subsidiary cells
- c. Guard cells
- d. Trichomes

508. The process of introducing recombinant DNA molecules into cells of bacteria plants or animal is called

- a. DNA cloning
- b. Recombination
- c. Transformation
- d. Introduction

509. Cells containing nucleus of one species but cytoplasm from both the parental species

- a. Cybrids
- b. Transgenic
- c. Hybrids
- d. Symmetric hybrids

510. Plant in which a gene has been transformed through genetic engineering is called

- a. Transgenic plant
- b. Engineered plant
- c. Modified plant
- d. Biotech plant

511. The capacity of a cell cultured in vitro to regenerate into a plant

- a. Potency
 - b. Sustainability
 - c. Totipotency
 - d. Culturability
512. Production of various organs such as root, shoot, etc. From cells and tissue cultures is known as
- a. Organogenesis
 - b. Megagametogenesis
 - c. Adventitious
 - d. Gametogenesis
513. The plant part to be cultured in vitro is known as
- a. Mother plant
 - b. Explant
 - c. Source plant
 - d. Stock plant
514. Removal of developing embryo from seed and its cultivation in vitro is called
- a. Ovule culture
 - b. Seed culture
 - c. Endosperm culture
 - d. Embryo cultures
515. The sites of the C₃ and C₄ pathways of CO₂ fixation are compartmentalized in the leaves of:
- a. Corn, sugar and rice
 - b. Sugarcane and corn
 - c. Mungbean and pineapple
 - d. Corn and soybean
516. The following are events that led to the development of agriculture except:
- a. Collection of plants
 - b. Colonization of pre-adapted plant species
 - c. Cultivation of plants in order to reap a better harvest
 - d. Improvement of soil fertility
517. Current crop production technologies considered scientific because:
- a. Several steps from planting to harvesting have evolved
 - b. They generate facts and empirical data
 - c. They were formulated through scientific investigations
 - d. None of the above
518. The relationship between the growth rates of individual parts of an organ or organism is known as:
- a. Shoot-root ratio
 - b. Harvest index
 - c. Cylometry
 - d. Giant symmetry
519. Plants roll their leaves to:
- a. Reduce the rate of transpiration or water loss
 - b. Increase the probability of dissimilation
 - c. Change the angle of incidence of diffused light with respect to the leaf surface
 - d. Increase leaf water content
520. Net assimilation rate is sometimes referred to as:
- a. Photosynthesis
 - b. Crop growth rate
 - c. Unit leaf rate
 - d. Specific growth rate
521. Respiration is a necessary evil in plants because:
- a. It breaks down glucose which should have been used in the synthesis of complex compounds
 - b. It leads to the loss of glucose but generates metabolic energy and organic compounds that are used in the synthesis of structural and storage compounds
 - c. It generates CO₂, H₂O, and ATP
 - d. It generates heat energy for transpiration
522. A gas that is removed from modified atmosphere storage to slow down ripening of Cavendish bananas exported to the Middle East

- a. Oxygen
 - b. Carbon dioxide
 - c. Ethylene
 - d. Potassium permanganate
523. Frequency of harvesting of coconut for one year is
- a. 4 times
 - b. 8 times
 - c. 12 times
 - d. 16 times
524. The ability of a certain crop to fit or acclimatize into a given environment
- a. Crop characterization
 - b. Crop adaptation
 - c. Crop selection
 - d. Crop improvement
525. A blueprint on how a farm is to be developed given its resources and the environment
- a. Farm plan
 - b. Land use
 - c. Site evaluation
 - d. Farm suitability
526. The process of assessing the site's resources and environment for developing a crop production enterprise
- a. Farm plan
 - b. Land use
 - c. Site evaluation
 - d. Farm suitability
527. The study of the interactions and relationships between the organisms and their environment
- a. Biology
 - b. Ecology
 - c. Botany
 - d. Zoology
528. This environmental factor includes the temperature, rainfall, light and gases
- a. Physical factor
 - b. Biological factor
 - c. Climatic factor
 - d. Socio-economic factor
529. This factor pertains to the people and resources
- a. Physical factor
 - b. Biological factor
 - c. Climatic factor
 - d. Socio-economic factor
530. Compared to shallow-rooted plants, deep-rooted plants require:
- a. More frequent irrigation and larger volume of water per irrigation
 - b. More frequent irrigation but smaller volume of water per irrigation
 - c. Less frequent irrigation but larger volume of water per irrigation
 - d. Less frequent irrigation and smaller volume of water per irrigation
531. Seeds are classified according to their purity. In rice seeds, a white tag is attached to the bag of this class of seed
- a. Breeder Seed
 - b. Registered Seed
 - c. Foundation Seed
 - d. Certified Seed
532. This is the treatment that removes the seed coat or alters it making it permeable to water, so it will emerge faster.
- a. Stratification
 - b. Vernalization
 - c. Scarification
 - d. Separation

533. The presence of these parts is an indication that corms and rhizomes are stems although they are generally found below the ground.

- a. Nodes and leaf sheaths
- b. Nodes and internodes
- c. Nodes and buds
- d. Nodes and toots

534. In glycolysis glucose is converted to:

- a. Phosphoglyceric acid
- b. Succinic acid
- c. Pyruvic acid
- d. Malic acid

535. The purpose of tillage that is peculiar to wetland preparation.

- a. Turn soil into soft puddle and form a hard pan
- b. Develop proper soil tilth
- c. Improve soil aeration
- d. Promote erosion

536. Double fertilization which results to the formation of an embryo and an endosperm tissue is a reproductive process which is unique to

- a. Angiosperms
- b. Algae
- c. Gymnosperms
- d. Ferns

537. In the mango fruit, the sweet edible part is botanically termed

- a. Pericarp
- b. Endosperm
- c. Mesocarp
- d. Exocarp

538. In a corn embryo, the embryonic shoot is enclosed by a sheath called the

- a. Coleoptile
- b. Coleus
- c. Coleo

d. Coleos

539. Stems basically differs from roots because of the presence of

- a. Nodes and internodes
- b. Woody tissue
- c. Lateral branches
- d. Bark

540. Flowers bearing both stamens and pistils are always considered

- a. Complete
- b. Regular
- c. Perfect
- d. Imperfect

541. C₄ plants like corn has a Kranz leaf anatomy, wherein the leaf possesses a well-developed

- a. Vascular bundle sheath
- b. Vascular cambium
- c. Vascular tissue
- d. Vascular bundle

542. In some dicots like legumes and cucurbits, the reserve food of the seed is stored in the

- a. Endosperm
- b. Perisperm
- c. Cotyledon
- d. Exoderm

543. The pineapple fruit is derived from several ovaries of several flowers, hence it is referred to as

- a. Aggregate fruit
- b. Fused fruit
- c. Multiple fruit
- d. Simple fruit

544. In the agronomic classification of agricultural crops peanut is classified under

- a. Rootcrops
- b. Cereals

- c. Tuber crops
d. Legume
545. The cultivation of apical meristems, particularly of shoot apical meristem is known as
a. Meristem culture
b. Apiculture
c. Root culture
d. Stem culture
546. A drill method of seeding mungbean will be followed with 30 seeds per linear meter and the rows are spaced at 50 cm. How many plants are these per hectare?
a. 60,000
b. 66,000
c. 63,000
d. 69,000
547. The implantation of a meristem from another plant to a plantlet or sterile plant in vitro
a. Grafting
b. Budding
c. Micrografting
d. Layering
548. This refers to a group of cells, tissues or plant derived from a single mother cell, tissue or plant through asexual means and is expected to be genetically identical
a. Clone
b. Bud
c. Meristem
d. Scion
549. A standard procedure of testing whether plant or plant tissue carry known diseases or not
a. Quarantine
b. Disease tracing
c. Diagnostic
d. Disease indexing
550. A substance whether natural or synthetic that can modify growth
a. Growth regulator
b. Nutrient media
c. Fertilizer
d. Enhancer
551. A plant originating from a meristem or other organ isolated in vitro
a. Mericlon
b. Shoot
c. Cyclone
d. Protocorm
552. The clonal true-to-type rapid propagation of plants in vitro is
a. Enculturation
b. Fertilization
c. Clonal propagation
d. Micropropagation
553. A sterile plant with a functional roots and shoots developed in vitro is
a. Seedling
b. Plantlet
c. Embryo
d. Radicle
554. This refers to the group of cells that develops into an organ
a. Somatic cells
b. Callus
c. Primordium
d. Cell culture
555. The sum total or average weather of a place on earth
a. Weather
b. Climate
c. Climate change
d. Global warming

556. The process of classifying produce into groups according to a set of recognized criteria of quality and size, with each group bearing an accepted name and size grouping.
- Sorting
 - Grading
 - Sizing
 - Selection
557. Plants grown for their short thickened underground stem
- Rootcrops
 - Cereals
 - Tuber crops
 - Legume
558. The increased genetic variability brought about by tissue culture is
- Mutation
 - Somaclonal variation
 - Genetic variation
 - None of the above
559. The ratio of shoot dry weight to root dry weight is known as:
- Root-shoot ratio
 - Shoot-root ratio
 - Plant biomass ratio
 - Harvest ratio
560. A long-term significant change in the average weather in a given region that involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years
- Weather
 - Climate
 - Climate change
 - Global warming
561. This is a concept used for maturity determination in crop by using the heat accumulation during growing season
- Seasonal fluctuation
562. Light duration
- Growing degree day
 - Thermoperiod
563. The deteriorative process that ends the functional life of an organism or organ is called
- Deterioration
 - Senility
 - Senescence
 - Disease
564. When a cropping pattern is written, sequential cropping is denoted by what symbol between two crops?
- Hypen (-)
 - Slash (/)
 - Plus (+)
 - Multiply (x)
565. Mango requires a climate with distinct dry season of at least four consecutive months. The best climate for mango that meets at least four months dry is:
- Type 1
 - Type 2
 - Type 3
 - Type 4
566. The study of fruit production
- Floriculture
 - Olericulture
 - Pomology
 - Plantation
567. A large-scale type of vegetable production
- Market gardening
 - Truck gardening
 - Home gardening
 - Backyard gardening
568. Group of plant hormones that induces cell elongation and cell division

- a. Gibberellins
b. Vitamins
c. Growth regulator
d. Trace elements
568. Any organic substance which at low concentrations, promotes inhibits or modifies growth
a. Hormone
b. Enhancer
c. Fertilizer
d. Modifier
569. Nutrient availability in the soil is largely dependent on:
a. pH and moisture content
b. Structure and bulk density
c. Water holding capacity
d. Color
570. Decarboxylation of malate in the leaves of corn takes place in the:
a. Cytosol of mesophyll cells
b. Cytosol of the bundle sheath cells
c. Mitochondrion of the bundle sheath cells
d. Peroxisome
571. This is the primary source of energy for all the physical and biological processes on earth.
a. Water
b. Temperature
c. Light
d. Gases
572. This refers to the physiological response of plants to variations in the duration of day light length of days and night
a. Photoperiodism
b. Phototropism
c. Light intensity
d. Light quality
573. The biotic factor that affects plant growth and development excludes
a. Fungi
b. Earthworm
c. Organic matter
d. Butterfly
574. Which of the following practices are sustainable?
a. Recycling of nutrients, and use of compost, green manures and other forms of organic fertilizers
b. Non-pesticidal control of pests
c. Diversified and integrated farming system
d. All of the above.
575. Breaking hardpans in the soil and improving soil structure enhances
a. Drainage
b. Internal drainage
c. Surface drainage
d. Seepage
576. Medicines in tablet or liquid forms are usually derived from plants. An example of a horticultural crop that has medicinal properties is
a. Vitex negundo
b. Pennisetum purpureum
c. Brachiaria mutica
d. All of the Above
577. Vegetable crops grown for aerial portion
a. Pepper
b. Radish
c. Garlic
d. Carrots
578. The study of growing, arranging and marketing of flowers and foliage plants.
a. Olericulture
b. Floriculture

- c. Selviculture
d. Agriculture
579. Industrial crops classified as beverage
a. Coconut
b. Papaya
c. Cacao
d. Vanilla
580. Actively dividing non-organized tissues of undifferentiated and differentiated cells often developing from injury (wounding) or in tissue cultures,
a. Celloluse
b. Protocorm
c. Callus
d. Cell suspension
581. Organic compounds serving as a source of energy, including sugars, starches and cellulose.
a. Fertilizer
b. CO₂
c. Carbohydrates
d. Hormone
582. The development of cells or tissues with a specific function and/or the regeneration of organs or organ-like structure (roots, shoots, etc.) Or embryo
a. Differentiation
b. Rejuvenation
c. Development
d. Organogenesis
583. Phenotype refers to the:
a. Breeding potential of a plant
b. Physical appearance of a plant
c. Genetic makeup of a plant
d. Chromosome content of a nucleus
584. Which of the following must exist in order for the plant breeder to select superior plants?
- a. F1 generation
b. Artificial hybridization
c. Homogenous population
d. Genetic variation
585. Gene recombination occur as a result of:
a. Vegetative propagation
b. Clonal propagation
c. Self-pollination of a pureline
d. Sexual reproduction
586. Weeds are
a. Out of place plants
b. Increase biodiversity
c. Nutrient competitor
d. All of the above
587. A non-parasitic agent that causes discolorations on the plant's foliage like chlorosis
a. Nutritional abnormalities
b. High temperature
c. Flooding
d. Adverse weather condition
588. Considered the best soil phfor crop production
a. Strongly acidic
b. Moderately acidic
c. Slightly acidic
d. Alkaline
589. The artificial means of applying water to plants
a. Flooding
b. Irrigation
c. Drip irrigation
d. Water harvesting
590. The collection of rain water runoff for a productive use
a. Flooding
b. Irrigation

591. A natural source of water for plant's use
- Flood
 - Typhoon
 - Rain
 - Sea water
592. The new name of the agency authorized in approving the release of recommended crop varieties in the Philippines is:
- Philippine Seed Board (PSB)
 - National Seed Industry Council (NSIC)
 - Department of Agriculture (DA)
 - International Rice Research Institute (IRRI)
593. An aggregate fruit is derived from one flower with several ovaries. An example of an aggregate fruit is:
- Atis
 - Orange
 - Jackfruit
 - Lanzones
594. These are seeds that cannot be kept viable for a long period of time for they cannot withstand drying and should not be permitted to dry out before planting,
- Recalcitrant seeds
 - Foundation seeds
 - Registered seeds
 - Orthodox seeds
595. If photosynthesis is limited to the reactions that take place inside the chloroplast, the product of photosynthesis is
- Glucose
 - Sucrose
 - Phosphoglyceraldehyde
 - Phosphoglyceric acid
596. Succulent plants with little or no secondary stem or woody tissue.
597. Short or low self-supporting several stemmed woody plants.
- Vine
 - Tree
 - Shrub
 - Herb
598. Crops grown to reduce soil erosion, control weeds and conserve moisture.
- Silage crops
 - Cover crops
 - Soiling crops
 - Catch crops
599. Short season crops grown for additional income.
- Cash crops
 - Cover crops
 - Nurse crops
 - Trap crops
600. Is the phenomena that, after a number of subcultures, cells can grow without the addition of hormones, although this was originally necessary.
- Habituation
 - Acclimatization
 - Adaptation
 - Maturation
601. An undesirable phenomenon that sometime develops in culture appearing as overly succulent, crisp water-logged or glassy tissues,
- Vitification
 - Degradation
 - Oxidation
 - Retardation

602. Combining together a root stock and scion until they unite permanently
- Marcotting
 - Grafting
 - Layering
 - Cutting
603. Example of plant propagated by root cutting
- Onion
 - Guava
 - Okra
 - Eggplant
604. The breeding method which may involve bringing a species or variety into an area and using it without change or additional breeding methods is called:
- Hybridization
 - Introduction
 - Pedigree selection
 - Pureline selection
605. Inbreeding leads to:
- Heterosis
 - Homozygosity
 - Allelism
 - Increase productivity
606. Plant breeding is:
- More of selection than hybridization
 - More hybridization than selection
 - Equal selection and hybridization
 - More of introduction than hybridization
607. In rice, the best time of the day to conduct emasculation is:
- In the morning
 - In the afternoon
 - At noon time
 - Anytime of the day
608. The amount of water held by the soil after gravitational water is drained away.
- Field capacity
 - Permanent wilting point
 - Available soil moisture
 - Infiltration rate
609. This refers to the speed at which water sinks into the soil
- Field capacity
 - Permanent wilting point
 - Available soil moisture
 - Infiltration rate
610. The removal of excess water from the soil through the construction of drainage canals
- Evaporation
 - Drainage
 - Transpiration
 - Seepage
611. The loss of water from the plant's leaves in the form of water vapor
- Evaporation
 - Drainage
 - Transpiration
 - Seepage
612. The general critical period of water needs by legumes is during
- Head development
 - Silking and tasseling
 - Pod development and enlargement
 - Root and tuber setting and enlargement
613. These are examples of crops that are generally high in moisture and therefore are highly perishable commodities.
- Durian, lanzones, mangosteen
 - Squash, cucumber, watermelon
 - Eggplant, tomato, pepper

- d. All of the above
614. In the wet bed method of raising rice seedlings, how many square meters of seedbed is needed to sow a bag of palay seed to plant one hectare?
- 200 sq m
 - 400 sq m
 - 300 sq m
 - 500 sq m
615. It is the training system of trees that results in the strongest branches but allows the entry of the least light in the canopy.
- Central leader
 - Open center or vase
 - Modified leader
 - None of the above
616. Technology or process that ensures adequate protection and safe delivery of a produce from the producers to the consumers
- Trucking
 - Packaging
 - Bundling
 - Handling
617. The multiple cropping technology is quite difficult for farmers to adopt because of:
- The need to grow new and unfamiliar crops
 - The need for timely implementation of required practices
 - The need for additional resources
 - All of the above
618. Legume crops plowed under the soil at flowering stage to increase soil productivity.
- Soiling crops
 - Green manure crops
 - Cover crops
 - Silage crops
619. Crops planted to attract certain insects or parasites
- a. Nurse crops
b. Cover crops
c. Trap crops
d. Catch crops
620. Plants that require support or that creep along the ground.
- Herbs
 - Vines
 - Shrubs
 - Trees
621. A plant that germinates, matures and dies in a span of one year.
- Biennial
 - Perennial
 - Annual
 - Permanent
622. Plants that could not withstand chilling or low temperature.
- Temperate crops
 - Tropical crops
 - Semi-temperate crops
 - Sub-tropical crops
623. Air layering is also known as
- Marcotting
 - Grafting
 - Budding
 - Inarching
624. In cleft grafting the wedge is located at the
- Scion
 - Top of the scion
 - Root Stock
 - Above the scion
625. Inarching is also known as
- Grafting by approach
 - Marcotting
 - Layering

- d. Serpentine
626. A sugarcane field has a loamy sand soil. To deliver water effectively, what irrigation methods should be used?
- Sprinkler irrigation
 - Drip irrigation
 - Furrow irrigation
 - Any of the above
627. For rapid rate of multiplication the type of propagation generally practiced is
- Micro propagation
 - Sexual
 - Asexual
 - Grafting
628. Phenotype is determined by:
- Genotype
 - Environment
 - Genotype x environment
 - Genotype, environment and genotype x environment
629. A food production campaign introduced in the 60's and 70's which aimed at solving problems related to overpopulation and world hunger by introducing new technologies including high yielding varieties, pesticides, fertilizers, irrigation and machines
- Kasakalikasan
 - Sustainable agriculture
 - Gintongani
 - Green revolution
630. A rice floret has how many anthers?
- 5
 - 11
 - 6
 - 15
631. In the point of view of a seed technologies, a seed has germinated:
- When the radicle has emerged
 - When the plumule has emerged
 - When both the radicle and the plumule have emerged
 - None of the above
632. A seed is considered alive in the tetrazolium test when the:
- Whole seed is stained
 - Radicle portion is not stained but the rest of the seed is
 - Plumuleportion is not stained but the rest of the seed is
 - Half the seed is stained
633. Considered the best index for determining irrigation schedules by knowing the amount of moisture loss by the crop, soil moisture and rainfall
- Feel of the soil
 - Based on evapotranspiration rate
 - Based on water measurements
 - Rate of plant growth
634. Irrigation schedules are determined by measuring directly the amount of moisture in the soil with the use of devices
- Temporary wilting
 - Feel of the soil
 - Bases on water measurements
 - Rate of plant growth
635. The method of slowly applying small amounts of water directly to the plant root zone.
- Water harvesting
 - Chemigation
 - Trickle irrigation
 - Fertigation
636. This technology aims to conserve water through establishment of catchments
- Water harvesting
 - Chemigation
 - Trickle irrigation
 - Fertigation

637. This method of irrigation is applicable under greenhouse systems that provides constant moisture but keeps foliage dry
- Flooding
 - Drip irrigation
 - Spray nozzles
 - Capillary mat
638. A method of irrigation that provides good wetting and applicable for leveled land
- Flooding
 - Drip irrigation
 - Spray nozzles
 - Capillary mat
639. Aurora province is on the eastern part of Luzon, between the Pacific Ocean and the Sierra Madre mountains. West of the Sierra Madre is the town of Gabaldon, Nueva Ecija. When the northeast monsoon prevails, this condition occurs:
- More rain falls in Aurora than in Gabaldon
 - More rain falls in Gabaldon than in Aurora
 - Aurora and Gabaldon receive equal amounts of rain
 - EI Niño occurs in both municipalities.
640. Because it is not prescriptive of a defined set of practices, methods, techniques/technologies or policies that would restrict the options of farmers, sustainable agriculture is considered as:
- Flexible
 - Proactive
 - Experiential
 - Participatory
641. Drainage is important in agriculture. Which is not a role of drainage?
- Soil aeration
 - Entry of oxygen from the atmosphere to the soil
 - Release of carbon dioxide from the soil to the atmosphere
 - Dissolve nutrients in the soil
642. These are field crops that belong to a special purpose classification:
- Pulses
 - Tuber crops
 - Cover crops
 - None of the above
643. Which of the following is an optional requirement for seed germination?
- Favorable temperature
 - Light
 - 20% oxygen concentration
 - Proper amount of water
644. When a plant experiences water stress, it conserves water by closing the stomata. This is return effected by this plant hormone
- Ethylene
 - Abscisic acid
 - Cytokinin
 - Auxin
645. Plants that require long darkness to flower are:
- Long day plants
 - Day neutral plants
 - Short day plants
 - Dry season plants
646. Plants that require short darkness to flower are:
- Long day plants
 - Day neutral plants
 - Short day plants
 - Dry season plants
647. The common planting material for abaca.
- Tubers
 - Bulbs
 - Suckers
 - Rhizomes

648. Crops that could be propagated by crown suckers and slips.
- Abaca
 - Pineapple
 - Banana
 - Gabi
649. A prevailing environmental condition in a region over a period.
- Temperature
 - Climate
 - Weather
 - Humidity
650. Day to day changes of environmental conditions as influenced by wind, rainfall, temperature and light.
- Humidity
 - Climate
 - Weather
 - Intensity
651. Method of plant propagation for discovery of new variety
- Tissue propagation
 - Vegetative propagation
 - Embryo propagation
 - Sexual propagation
652. The easiest method of artificial propagation
- Marcotting
 - Layering
 - Inarching
 - Cutting
653. Type of germination when the cotyledon comes above the ground
- Hypogeal
 - Hypo-epigeal
 - Epigeal
 - Exodermus
654. Term to describe the mucilage or waxy materials around some seed which causes physical dormancy
- a. Exodernus
b. Sarco-testa
c. Seed coat
d. Hypogea
655. The treatment that removes the seed coat or alter it making it permeable to water
- Scarification
 - Vernalization
 - Stratification
 - Separation
656. The placement of seeds between layers of either moist, sand, soil or sawdust at high or low temperature so the action of water high and low temperature will soften the seedcoat
- Separation
 - Scarification
 - Vernalization
 - Stratification
657. Seeds which can be dried to a low moisture level but cannot tolerate low temperature like coffee and papaya are considered:
- Recalcitrant
 - Orthodox
 - Intermediate
 - None of the above
658. Which of the following is/are optional requirement/s for favorable seed germination?
- Optimum temperature
 - 20% oxygen concentration
 - Light
 - Proper amount of water
659. The most favorable condition for storing orthodox seed is:
- Dry and cool condition
 - Dry and hot condition
 - Moist and cool condition
 - Moist and hot condition

660. Hard-seededness may be broken by the following methods except:

- a. Soaking in boiling water for several minutes
- b. Soaking in tap water for 24 hours
- c. Rubbing the embryo part on sand paper
- d. Both a and c

661. Among the following desiccants or drying agent, _____ is the most effective, thus a smaller amount is required:

- a. Lime
- b. Charcoal
- c. Silica gel
- d. Wood ash

662. The most suitable substrate for germination best of a very small seeds is:

- a. Rolled filter paper
- b. Petri dish line with filter paper
- c. Ragdoll method
- d. Sand

663. The use of specialized structure to shield plants from too much rain

- a. Crop forcing
- b. Crop improvement
- c. Cropping system
- d. Drainage

664. The outer weathered layer of the earth's crust that provides support and anchorage to the plant

- a. Soil
- b. Bedrock
- c. Growing media
- d. Parent material

665. This are highly amended soils in which plants grow

- a. Soil
- b. Bedrock
- c. Growing media

d. Parent material

666. A type of soil with acid pH and a characteristics of soils found in regions of high rainfall

- a. Organic soil
- b. Acid soil
- c. Basic soil
- d. Alkaline soil

667. There are ___ essential elements required by plants

- a. 15
- b. 16
- c. 17
- d. 18

668. The elements naturally supplied by air and water

- a. NPK
- b. NCO
- c. CHO
- d. OHP

669. The 3 elements required by plants in large amount

- a. NPK
- b. NCO
- c. CHO
- d. OHP

670. The movement of nutrients towards the apex through the xylem

- a. Acropetal
- b. Basipetal
- c. Mobile
- d. Immobile

671. This type of cutting consists of the leaf blade, petiole and a short piece of the stem with an axillary bud.

- a. Stem cutting
- b. Leaf-bud cutting
- c. Leaf cutting
- d. Root cutting

672. A factor wherein population, neighborhood, peace and order are considered in site selection for crop production.
- Biological factor
 - Environmental factor
 - Sociological factor
 - Ecological factor
673. Term used to described seeds of some plants that could be kept viable for longer periods, provided they are properly dried and stored
- Recalcitrant
 - Orthodox
 - Foundation
 - Certified
674. In storing seed with desiccants, seeds should be placed inside
- a:
- Polyethylene or plastic bag
 - Cloth bag
 - Aluminum foil
 - Paper bag
675. This element makes plants robust and it is a part of the chlorophyll molecule
- Nitrogen
 - Phosphorus
 - Potassium
 - Sulfur
676. This element is present in the organic compounds that give the odors of onion, garlic and mustard
- Nitrogen
 - Phosphorus
 - Potassium
 - Sulfur
677. The phenomenon of a single major gene affecting more than one character is known as:
- Pleiotropy
678. To prevent soil erosion, the direction of tillage on rolling or hilly fields
- Across the contour
 - Follow the general contour of the land
 - Against the contour
 - Down-up direction
679. What factor is considered when the cost of land, local taxes, labor and facilities are given priority?
- Environmental factor
 - Economic factor
 - Biological factor
 - Ecological factor
680. When climate, soil, water and air are given attention in the site selection, what factor is considered?
- Economical factor
 - Biological factor
 - Ecological factor
 - Sociological factor
681. Term used to describe seeds of plants that could not kept viable for a long time, It cannot withstand drying and should not permit to dry out before planting,
- Recalcitrant
 - Foundation
 - Registered
 - Orthodox
682. Another term for propagating material
- Vegetative
 - Division
 - Separation
 - Propagules

683. The following pairs of reactant/product involved in seed germination are correct except:
- Glycerol-protease
 - Starch-amylase
 - Lipid-amylase
 - Fatty acid-lipase
684. Which product is mostly produced by the Quezon province?
- buko pie
 - virgin coconut oil
 - copra
 - coconut (with husk)
685. While Coffee Arabica and Robusta are produced mostly in Sultan Kudarat, which province has the most Excelsa and Liberica productions?
- Sulu
 - Zamboanga
 - Sorsogon
 - South Cotabato
686. Which latex crop is mostly produced in the province of North Cotabato?
- Rimas
 - Rubber
 - Pili
 - Papaya
687. Sugarcane has the most production in which province?
- Negros Occidental
 - Negros Oriental
 - Pangasinan
 - Isabela
688. This province in Visayas is the top producer of camote
- Samar
 - Southern Leyte
689. While dried coffee beans are mostly produced in Sultan Kudarat, cacao has the most productions in what province?
- Sorsogon
 - Catanduanes
 - Davao del norte
 - Davao del sur
690. The provinces which are top producers of root crops camote, ube and gabi all belong to which major island group/s?
- Luzon
 - Visayas
 - Mindanao
 - a and b
691. The deficiency of this element will cause hollow heart in peanuts or hollow stem in celery
- Calcium
 - Magnesium
 - Boron
 - Zinc
692. The function of this element in plant is to give strength to cell walls
- Calcium
 - Magnesium
 - Boron
 - Zinc
693. The materials or substances added to the soil or applied to plants to provide the needed nutrients for plant's growth and development
- Fertilizer
 - Fertilizer grade
 - Fertilizer recommendation
 - Filler

694. A design principle that focuses the attention of the eye on some dominant feature of the design and helps make the garden personal and interesting.

- a. Emphasis
- b. Unity
- c. Balance
- d. Contrast

695. Rapid cooling of produce immediately after harvest

- a. On-site cooling
- b. Pre-cooling
- c. Post cooling
- d. All of the above

696. Farmers intercrop peanut in between corn plants because:

- a. It serves as animal feed
- b. It serves as source of seeds
- c. It reduces corn borer infestation
- d. All of the above

697. The following are nonsense codons, except

- a. UAG
- b. AUG
- c. UAA
- d. UGA

698. The father of Genetics

- a. Mendel
- b. Bateson
- c. Darwin
- d. Weismann

699. The genetic component of the phenotypic value is composed of the following except:

- a. Additive gene effects
- b. Dominance gene effect
- c. Epistasis gene effect
- d. Environment gene effect

700. Slender specialized aerial stem that grows horizontally along the ground from the leaf axil at the base or crown that produce roots and leaf at the near tip

- a. Sucker
- b. Slip
- c. Runner/stolon
- d. Water sucker

701. Method of artificial vegetative propagation involving regeneration of severed plant part (roots, leafs or stem, from the parent plant)

- a. Layering
- b. Budding
- c. Grafting
- d. Cutting

702. Type of cuttings consist of leaf blade, petiole and short piece of the stem with an axillary bud

- a. Stem cutting
- b. Leaf bud
- c. Leaf
- d. Root

703. Which region is the top producer of tomatoes (mtons)?

- e. CALABARZON
- f. Ilocos region
- g. Central Luzon
- h. Western Visayas

704. Which region located in Luzon has no production of Ubi, white potato, gabi, and other root crops?

- a. Cagayan valley
- b. Central Luzon
- c. NCR
- d. CALABARZON

705. This province is the top producer of cutflowers Chrysanthemum, gladiola, and roses.

- a. Benguet

- b. Albay
- c. Quezon
- d. Palawan

706. Rambutan has the most number of production in this province

- a. Cavite
- b. Laguna
- c. Batangas
- d. Romblon

707. The minimum guarantee of the plant nutrient content in terms of percentage total nitrogen, available phosphorus and water soluble potassium

- a. Fertilizer
- b. Fertilizer grade
- c. Fertilizer recommendation
- d. Filler

708. The method of fertilizer application where the materials are applied uniformly over the entire area before planning or while the crops is growing

- a. Broadcast
- b. Localized application
- c. Foliar application
- d. Knife application

709. Nutrients are applied on the aerial part of the plant and penetrate the cuticle of the leaf or the stomata

- a. Broadcast
- b. Localized application
- c. Foliar application
- d. Knife application

710. Light management involves the following practices except

- a. Regulation of light intensity
- b. Interception of light quality/wavelength in plant canopy
- c. Regulation of light during light sensitive stages of crops
- d. Regulation of required irrigation water by the plant

711. The lack of rain during El Niño episodes is an example of:

- a. Permanent drought
- b. Contingent drought
- c. Seasonal drought
- d. Invisible drought

712. The constancy of production under a given set of environmental, economic, and management conditions is known as:

- a. Stability
- b. Flexibility
- c. Sustainability
- d. Resiliency

713. The removal of excess water from the soil is:

- e. Drainage
- f. Internal drainage
- g. Surface drainage
- h. Seepage

714. A woody plant that needs a support to be able to stand upright is a

- a. Vine
- b. Shrub
- c. Liana
- d. Climber

715. A factor affecting farmer's preference which reflects what the farmers desires or what he is seeking

- a. Farmer's knowledge
- b. Beliefs
- c. Attitudes
- d. Goals

716. A socioeconomic factor affecting farmer's capability which refers to the carrying out of farming activities

- a. Marketing
- b. Capital
- c. Management

- d. Land
717. A major cause of reduction in agricultural land areas due to political factor brought about by urbanization
- Land grabing
 - Soil erosion
 - Land conversion
 - Agrarian reform
718. A work exchange system of traditional societies with agricultural roots which influence the farmer's agricultural production
- Credit system
 - Marketing system
 - Bayanihan system
 - Extension system
719. These are small suckers just emerging from underground stem
- Maiden
 - Peepers
 - Water
 - Sword
720. Type of grafting for overgrown stocks too large for other grafting operation
- Saddle
 - Cleft
 - Whip and tongue
 - Bark
721. In grafting, when the wedge is made on the stock and the split on the scion the process is called.
- Whip and tongue grafting
 - Saddle grafting
 - Bark grafting
 - Cleft grafting
722. Wider plant spacing is adapted when
- Soil fertility is low
 - Plants have erect or vertical growth habit
- c. Plant grow into a big tree at maturity
- d. Soil have water holding capacity
723. These type of grafting allows a bigger area of cambial contract between the rootstock and the scion hence, it heals quickly and makes a very strong union.
- Cleft grafting
 - Whip & tongue grafting
 - Saddle grafting
 - Budding
724. Chinese pechay is mostly produced in Ilocos Region while the native pechay is mostly produced in _____.
- Ilocos region also
 - CAR
 - Bicol region
 - Cagayan Valley
725. The Autonomous Region of Muslim Mindanao is the top producer of which fruit crop?
- rambutan
 - mango
 - atis
 - mangosteen
726. The leading region in terms of volume of pineapple produced in metric tons.
- Northern Mindanao
 - Davao Region
 - SOCCSKSARGEN
 - ARMM
727. Calamansi is mostly produced in MIMAROPA. The top calamansi producing province also belongs to this region. What province is it?
- Occidental Mindoro
 - Oriental Mindoro
 - Romblon
 - Palawan
728. Which province is the top producer of kangkong?

- a. Sorsogon
 - b. Benguet
 - c. Maguindanao
 - d. Lanao del sur
729. Light requirement of shade-tolerant crops can be manipulated by the following practices except
- a. Building shading structures
 - b. Application of plant growth regulators
 - c. Manipulating plant density
 - d. Intercropping
730. Shading in shade-loving plants can be imposed by building shading structure using the following except
- a. Polypropylene plastic
 - b. Galvanized iron
 - c. Plant leaves
 - d. Net screen
731. The following can be used as mulching materials except
- a. Grasses
 - b. Rice straw
 - c. Rice hull
 - d. Decomposed plant waste
732. The most practical mulching material in the lowland tropics is
- a. Dark plastic
 - b. Rice straw
 - c. Leaves
 - d. Rice hull
733. The most suitable mulching material in the highland because of lower temperature is
- a. Leaves
 - b. Dark plastic
 - c. Rice straw
 - d. Grasses
734. The most favorable condition for storing orthodox seeds is:
- a. Dry and cool condition
 - b. Moist and cool condition
 - c. Dry and hot condition
 - d. Moist and hot condition
735. These are small suckers just emerging from an underground stem.
- a. Maiden suckers
 - b. Peepers
 - c. Water sprouts
 - d. Swords
736. Analyze the following statement: "A juvenile plant will initiate the flower when it receives the proper daylength."
- a. The statement is always true.
 - b. The statement is sometimes true and sometimes false
 - c. The statement is always false
 - d. None of the above
737. The modification in the expression of a dominant gene by another non-allelic dominant gene is known as:
- a. Gene interaction
 - b. Gene flow
 - c. Gene action
 - d. None of the above
738. One purpose of tillage is to:
- a. Develop a desirable soil structure
 - b. Promote soil compaction
 - c. Form hard surface crust
 - d. Reduce soil granulation
739. A household resource characterized by size, quality, water availability, and location affecting productivity where famr enterprises are established.
- a. Labor
 - b. Land
 - c. Capital
 - d. Management

740. A household resource which includes members of the household who are capable of working and also the family's participation in cooperative efforts.

- a. Land
- b. Labor
- c. Capital
- d. Management skills

741. A social institution affecting crop production which includes people with common ancestry having communal land holding systems.

- a. Corporate kin groups
- b. Social classes
- c. Agricultural associations
- d. Cooperative

742. An actor affecting crop production related to government programs which adversely affect productivity of local farmers due to market competition.

- a. Importation
- b. Exportation
- c. Land conversion
- d. Taxation

743. The totality of genes, species, and ecosystems in a region.

- a. Biodiversity
- b. Sustainability
- c. Ecology
- d. Complexity

744. A specialized form of grafting in which a single detached bud is used as the scion, instead of the stem.

- a. Cleft
- b. Whip & Tongue
- c. Saddle
- d. Budding

745. Method of artificial vegetative propagation when the plant part to be rooted is still attached from the parent plant which supplies the nutrients and moisture while the parts is rooting

- a. Cutting
- b. Layering
- c. Grafting
- d. Budding

746. This type of layering was originated by the Chinese centuries ago

- a. Tip layering
- b. Air layering
- c. Simple layering
- d. Mound layering

747. Method of artificial plant propagation when rootstock and scion are made to unite while both of them are still growing on their own roots.

- a. Marcotting
- b. Embryo Culture
- c. Inarching
- d. Seed Propagation

748. Sexual propagation is also known as

- a. Vegetative propagation
- b. Micro propagation
- c. Tissue Culture
- d. Seed propagation

749. A plant belonging to the grass family which has a very extensive root system and is effectiveness as soil stabilizer.

- a. Corn
- b. Vetiver
- c. Lemon grass
- d. Napier grass

750. The temperature, sunlight, humidity and other climatic conditions in a small localized area.

- a. Climate

- b. Weather
 - c. Microclimate
 - d. None of the above
751. Squash is mostly produced in the province of Albay which is also the top producer of what other vegetable crop?
- a. string beans
 - b. okra
 - c. gourd
 - d. pechay native
752. Which province in Luzon is the top producer of string beans?
- a. Nueva Ecija
 - b. Nueva Viscaya
 - c. Bulacan
 - d. Laguna
753. Central Luzon is the top producer of onion. The top onion producer in provincial level also belongs to this region. What province is it?
- a. Nueva Ecija
 - b. Nueva Viscaya
 - c. Ilocos Norte
 - d. Isabela
754. Which fiber crop has the most volume of production in the Bicol region?
- a. ramie
 - b. jute
 - c. kenaf
 - d. abaca
755. White potato is mostly produced in what region?
- a. Cordillera Administrative Region
 - b. Cagayan Valley
 - c. CARAGA
 - d. SOCKSKSARGEN
756. Which region produces the most volume of garlic in metric tons?
- a. CAR
- b. CALABARZON
 - c. Ilocos Region
 - d. Central Luzon
757. Carrots and cabbage are mostly produced in what region?
- a. Western Visayas
 - b. CALABARZON
 - c. Cagayan Valley
 - d. CAR
758. Peanut is mostly produced in this province
- a. Albay
 - b. Isabela
 - c. Pangasinan
 - d. Ilocos Sur
759. The top producer of ube belongs to this province in the Visayas
- a. Cebu
 - b. Bohol
 - c. Samar
 - d. Leyte
760. Which province in CALABARZON is the top producer of ampalaya?
- a. Laguna
 - b. Batangas
 - c. Rizal
 - d. Quezon
761. Isabela is the top producer of what crop?
- a. mungbean
 - b. stringbean
 - c. wingedbean
 - d. soybean
762. The highest volume of durian production is registered in which region?
- a. Northern Mindanao
 - b. Davao region
 - c. Eastern Visayas

- d. CARAGA
763. Davao region is the top producer of banana Cavendish and saba while _____ is the top producer of banana Lacatan.
- Eastern Visayas
 - Western Visayas
 - SOCCSKSARGEN
 - ARMM
764. Sulu is the top producer of which fruit crop?
- Ianzones
 - rambutan
 - banana
 - mango
765. Which province has the highest asparagus production?
- Bukidnon
 - Laguna
 - Benguet
 - South Cotabato
766. Lanao del norte is the top producer of which crop?
- ginger
 - cassava
 - mandarin
 - pili
767. Pili nut has the most production in which province?
- Catanduanes
 - Sorsogon
 - Albay
 - Palawan
768. Which of the following crops is mostly produced in Palawan?
- peanut
 - coconut
 - cashew
 - atis
769. Cauliflower and habitchuelas are mostly produced in which region?
- a. Bicol region
b. Eastern Visayas
c. CAR
d. Western Visayas
770. The highest volume of watermelon production is in which region?
- Western Visayas
 - CARAGA
 - Zamboanga Peninsula
 - MIMAROPA
771. Papaya is mostly produced in which region?
- Davao region
 - Eastern Visayas
 - SOCCSKSARGEN
 - ARMM
772. Tobacco Virginia is mostly produced in Ilocos Sur while tobacco native is mostly produced in what province?
- Ilocos Norte
 - Cagayan
 - Nueva Ecija
 - Isabela
773. Which region is the top producer of tamarind?
- Pangasinan
 - Batangas
 - Quezon
 - Ilocos Norte
774. Gabi is mostly produced in the province of _____.
- Southern Leyte
 - Northern Samar
 - Iloilo
 - Sorsogon
775. Fresh fruits of oil palm are mostly produced in what region?
- Agusan del sur
 - Lanao del sur

- c. Davao del sur
- d. Ilocos Sur

776. Orange is mostly produced in Benguet while mandarin is mostly produced in what province?

- a. Benguet also
- b. Quezon
- c. Oriental Mindoro
- d. Nueva Vizcaya

777. What region is the top producer of radish?

- a. CALABARZON
- b. Central Luzon
- c. CAR
- d. Cagayan valley

778. Which region is the top producer of cashew as ripe fruit with nut?

- a. Bicol region
- b. Central Visayas
- c. MIMAROPA
- d. Ilocos region

779. Which region is the top producer of orchids?

- a. CAR
- b. Central Luzon
- c. Cagayan Valley
- d. Bicol region

780. Which region is the top producer of carabao mangoes?

- a. Ilocos region
- b. CARAGA
- c. CALABARZON
- d. Central Visayas

781. Kangkong is mostly produced in which region?

- a. Cagayan Valley
- b. ARMM
- c. Western Visayas
- d. MIMAROPA

782. Which region is the top producer of sugarcane?

- a. Ilocos region
- b. Central Luzon
- c. Western Visayas
- d. CALABARZON

783. Which region in Mindanao has the most volume of lettuce produced?

- a. Zamboanga peninsula
- b. Davao region
- c. Northern Mindanao
- d. ARMM

784. Which region is the top producer of eggplant?

- a. CALABARZON
- b. MIMAROPA
- c. Central Luzon
- d. Ilocos region

785. The only region in Mindanao that produces cotton.

- a. Davao del Norte
- b. Bukidnon
- c. Surigao del Sur
- d. South Cotabato

Answer Key of Review Questions in Crop Science

1	C	26	C	51	B	76	B	101	B	126	D	151	A	176	D
2	A	27	A	52	C	77	C	102	C	127	D	152	B	177	B
3	C	28	C	53	B	78	D	103	D	128	B	153	B	178	B
4	D	29	A	54	D	79	D	104	B	129	A	154	B	179	B
5	D	30	B	55	A	80	B	105	A	130	B	155	C	180	B
6	C	31	B	56	D	81	A	106	C	131	A	156	C	181	C
7	D	32	D	57	D	82	A	107	C	132	B	157	C	182	A
8	B	33	D	58	B	83	C	108	B	133	B	158	B	183	D
9	C	34	C	59	D	84	B	109	C	134	A	159	C	184	C
10	A	35	B	60	C	85	C	110	A	135	C	160	C	185	C
11	D	36	B	61	C	86	C	111	B	136	A	161	D	186	B
12	B	37	D	62	A	87	A	112	A	137	D	162	B	187	C
13	D	38	B	63	A	88	A	113	B	138	D	163	B	188	D
14	C	39	C	64	C	89	A	114	D	139	B	164	B	189	C
15	A	40	D	65	A	90	D	115	C	140	B	165	B	190	C
16	D	41	D	66	D	91	A	116	D	141	A	166	D	191	B
17	C	42	C	67	A	92	A	117	B	142	C	167	C	192	A
18	D	43	D	68	B	93	A	118	B	143	C	168	A	193	B
19	C	44	D	69	A	94	A	119	A	144	C	169	A	194	B
20	C	45	A	70	C	95	A	120	B	145	B	170	A	195	C
21	B	46	A	71	A	96	D	121	A	146	B	171	C	196	A
22	B	47	B	72	A	97	C	122	A	147	D	172	A	197	B
23	D	48	A	73	B	98	A	123	A	148	C	173	A	198	D
24	B	49	C	74	A	99	A	124	D	149	A	174	B	199	B
25	B	50	D	75	A	100	C	125	C	150	D	175	C	200	B

Answer Key of Review Questions in Crop Science

201	B	226	D	251	D	276	A	301	C	326	C	351	A	376	C
202	C	227	A	252	B	277	C	302	D	327	B	352	D	377	A
203	C	228	B	253	A	278	A	303	A	328	B	353	C	378	D
204	A	229	D	254	B	279	B	304	B	329	D	354	A	379	A
205	B	230	A	255	B	280	A	305	A	330	A	355	A	380	B
206	B	231	A	256	C	281	A	306	C	331	B	356	B	381	A
207	B	232	C	257	B	282	A	307	C	332	C	357	D	382	B
208	B	233	C	258	D	283	C	308	D	333	D	358	B	383	B
209	D	234	D	259	A	284	C	309	B	334	B	359	D	384	A
210	C	235	B	260	B	285	D	310	A	335	C	360	B	385	A
211	A	236	B	261	A	286	B	311	D	336	A	361	D	386	C
212	B	237	B	262	B	287	A	312	B	337	A	362	A	387	D
213	B	238	A	263	A	288	B	313	B	338	A	363	C	388	A
214	A	239	D	264	B	289	B	314	D	339	C	364	B	389	C
215	B	240	D	265	B	290	D	315	C	340	D	365	D	390	A
216	A	241	B	266	A	291	D	316	D	341	B	366	D	391	A
217	A	242	A	267	B	292	B	317	B	342	B	367	A	392	B
218	C	243	A	268	B	293	A	318	B	343	D	368	A	393	C
219	C	244	C	269	A	294	C	319	A	344	D	369	B	394	C
220	C	245	B	270	A	295	B	320	C	345	C	370	A	395	C
221	B	246	D	271	B	296	D	321	A	346	B	371	C	396	C
222	A	247	C	272	B	297	B	322	A	347	C	372	D	397	B
223	C	248	D	273	B	298	C	323	A	348	C	373	A	398	B
224	D	249	B	274	B	299	A	324	A	349	B	374	A	399	B
225	A	250	C	275	B	300	A	325	C	350	A	375	A	400	C

Answer Key of Review Questions in Crop Science

401	B	426	C	451	B	476	A	501	C	526	C	551	D	576	A
402	D	427	A	452	D	477	A	502	A	527	B	552	D	577	A
403	B	428	C	453	B	478	A	503	B	528	C	553	B	578	B
404	A	429	B	454	A	479	D	504	D	529	D	554	C	579	C
405	A	430	A	455	D	480	B	505	A	530	C	555	B	580	C
406	B	431	A	456	A	481	C	506	A	531	A	556	B	581	C
407	C	432	B	457	B	482	C	507	A	532	C	557	C	582	A
408	C	433	D	458	C	483	B	508	C	533	C	558	B	583	B
409	C	434	A	459	A	484	D	509	A	534	C	559	B	584	D
410	B	435	A	460	B	485	C	510	A	535	A	560	C	585	D
411	D	436	B	461	B	486	B	511	C	536	A	561	C	586	D
412	A	437	B	462	A	487	C	512	A	537	C	562	C	587	A
413	C	438	B	463	D	488	B	513	B	538	A	563	A	588	C
414	A	439	C	464	B	489	A	514	D	539	A	564	C	589	B
415	B	440	A	465	D	490	B	515	B	540	C	565	C	590	D
416	A	441	C	466	B	491	A	516	D	541	A	566	B	591	C
417	B	442	C	467	D	492	B	517	C	542	C	567	A	592	B
418	D	443	D	468	C	493	C	518	C	543	C	568	A	593	A
419	D	444	C	469	A	494	C	519	A	544	D	569	A	594	A
420	D	445	B	470	A	495	D	520	C	545	A	570	B	595	C
421	C	446	A	471	B	496	B	521	B	546	A	571	C	596	D
422	A	447	A	472	C	497	B	522	C	547	C	572	A	597	C
423	B	448	A	473	C	498	A	523	B	548	A	573	C	598	B
424	A	449	C	474	C	499	B	524	B	549	D	574	D	599	A
425	B	450	C	475	A	500	A	525	A	550	A	575	D	600	A

Answer Key of Review Questions in Crop Science

601	B	626	C	651	D	676	D	701	D	726	A	751	D	776	D
602	B	627	B	652	D	677	A	702	B	727	B	752	C	777	A
603	B	628	D	653	C	678	B	703	B	728	C	753	A	778	C
604	B	629	D	654	B	679	B	704	C	729	B	754	D	779	D
605	B	630	C	655	A	680	C	705	A	730	B	755	A	780	A
606	A	631	C	656	D	681	A	706	B	731	D	756	C	781	B
607	B	632	A	657	C	682	D	707	B	732	B	757	D	782	C
608	A	633	B	658	C	683	A	708	A	733	B	758	C	783	C
609	D	634	C	659	D	684	D	709	C	734	A	759	B	784	D
610	B	635	C	660	D	685	A	710	D	735	B	760	D	785	D
611	C	636	A	661	C	686	B	711	C	736	B	761	A		
612	C	637	D	662	B	687	A	712	C	737	A	762	B		
613	D	638	A	663	A	688	C	713	A	738	A	763	C		
614	B	639	A	664	A	689	D	714	C	739	B	764	A		
615	A	640	D	665	C	690	B	715	D	740	B	765	D		
616	B	641	C	666	B	691	C	716	C	741	A	766	A		
617	D	642	C	667	B	692	A	717	C	742	A	767	B		
618	B	643	B	668	B	693	A	718	C	743	A	768	C		
619	C	644	B	669	A	694	A	719	B	744	D	769	C		
620	B	645	C	670	A	695	B	720	D	745	B	770	A		
621	C	646	A	671	B	696	C	721	B	746	B	771	C		
622	B	647	C	672	C	697	B	722	C	747	C	772	D		
623	A	648	B	673	B	698	A	723	B	748	D	773	D		
624	A	649	B	674	C	699	D	724	C	749	B	774	B		
625	A	650	C	675	A	700	C	725	D	750	C	775	A		