PRINCIPLES OF WEED SCIENCE

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1. WHAT IS A WEED?

Weeds are plants that grow in an area where they are not desired or intentionally cultivated. They are often described as plants that are out of place, unwanted, undesirable, and useless within a specific context. Weeds can be found in various environments, from agricultural fields to gardens, lawns, and natural ecosystems. Their presence can interfere with human activities and have harmful effects that exceed any potential benefits.

Key Characteristics of Weeds

- **Out of Place-** Weeds are considered out of place when they grow in areas where they are not intentionally sown or cultivated. They tend to thrive in environments where they have not been deliberately planted.
- **Unwanted and Undesirable-** Weeds are generally plants that are not intentionally chosen or cultivated by humans. They may lack aesthetic value, nutritional benefits, or other qualities that humans seek in plants.
- **Useless-** Weeds are often characterized by their lack of utility in the context where they are growing. Unlike cultivated crops or purposefully planted vegetation, weeds typically do not provide tangible benefits to humans.
- **Growing in Unintended Areas-** Weeds often grow in areas where they are not intended to be. This could include fields where crops are being cultivated, gardens where specific plants are being grown, or even natural habitats where native species are trying to thrive.

Impact on Human Activity

- **Interference with Agriculture-** Weeds can significantly impact agricultural productivity by competing with cultivated crops for nutrients, water, and sunlight. They reduce crop yields and can even make harvesting difficult.
- **Aesthetic and Landscaping Concerns**- Weeds growing in lawns, gardens, and ornamental landscapes can detract from the desired appearance of these spaces, leading to aesthetic dissatisfaction.
- **Harmful Effects Exceeding Benefits-** Weeds often exhibit aggressive growth and reproduction strategies, enabling them to outcompete desirable plants. This can disrupt ecosystems and reduce biodiversity. Their negative impacts on agriculture, ecosystem health, and even human health can far outweigh any potential benefits.

2. CLASSIFICATION AND IDENTIFICATION OF WEEDS

Origin

a. **Endemic/Native Weeds-** Endemic or native weeds are plant species that naturally occur in a particular region or ecosystem. In the Philippines, these weeds have evolved over time to become part of the local flora. While some of them may be considered weeds due to their interference with human activities, they are still native to the region and play ecological roles.

   Example s:

   - **Cogon Grass (***Imperata cylindrica***)-** Commonly found in grasslands, cogon grass is native to Southeast Asia, including the Philippines. It spreads rapidly, forming dense stands that can outcompete other plants, making it a challenge for agriculture and biodiversity conservation efforts.
   - **Talbos-ng-kamote (***Ipomoea batatas***)** While sweet potato is a staple crop in the Philippines, the wild form can be considered a weed when it grows in unintended areas. It's native to tropical regions and can sometimes interfere with cultivated crops.

b. **Exotic/Introduced Weeds-** Exotic or introduced weeds are plant species that have been brought to the Philippines from other regions, intentionally or accidentally. These plants may

not have natural predators or competitors in the new environment, allowing them to thrive and potentially outcompete native species.

Examples:

- **Water Hyacinth** (*Eichhornia crassipes*)- This aquatic plant, native to South America, has become a major invasive weed in the Philippines. It grows rapidly in water bodies, forming dense mats that obstruct water flow, hinder fishing activities, and degrade aquatic ecosystems.
- **Golden Crownbeard** (*Verbesina encelioides*)- Also known as "Butal-buti," this plant is native to North America. It was introduced to the Philippines and has become a weed in agricultural fields and disturbed areas. Its rapid growth and seed production can lead to competition with crops and native plants.
- **Lantana** (*Lantana camara*)- Introduced from tropical America, lantana is a popular ornamental plant that has become invasive in the Philippines. It spreads quickly and forms dense thickets, outcompeting native vegetation and impacting biodiversity.

Habitat

a. Upland/Terrestial- Upland or terrestrial areas in the Philippines often have their own share of weeds that can impact natural habitats, agricultural fields, and disturbed landscapes.

Examples:

- **Cogon Grass** (*Imperata cylindrica*)- Also known as "Blady Grass," cogon grass is a common weed in grasslands, open areas, and abandoned lands. It forms dense stands and can be a fire hazard due to its high flammability.
- **Talinum** (*Talinum paniculatum*)- Often found in gardens and disturbed areas, talinum is known for its succulent leaves and pink flowers. It can spread rapidly and become invasive in certain habitats.

b. Lowland- Lowland areas in the Philippines encompass a wide range of habitats, including wetlands, rice paddies, and water bodies. Within lowland habitats, there are three subcategories of weeds based on their growth habits:

- **Floating Weeds-** Floating weeds are a type of aquatic plants that grow on the surface of water bodies, such as lakes, ponds, and slow-moving streams. These plants do not have their roots anchored in the soil beneath the water but instead float freely on the water's surface. They are often supported by air-filled tissues that provide buoyancy. Floating weeds can create dense mats on the water's surface, shading the water below and potentially disrupting the balance of the aquatic ecosystem. Common examples of floating weeds include water hyacinth and duckweed.

- **Emerged Weeds-** Emerged weeds are plants that grow in aquatic environments but have their stems and leaves extending above the water's surface. Unlike submerged weeds, which are entirely underwater, emerged weeds have a portion of their vegetation visible in the air. These plants typically have their roots anchored in the soil beneath the water, while their upper parts rise above the water level. Emerged weeds can be found along the edges of lakes, rivers, and marshes. Cattails and bulrushes are examples of emerged weeds.

- **Submerged Weeds-** Submerged weeds are aquatic plants that grow entirely underwater, rooted in the sediment at the bottom of water bodies. These plants are adapted to live in submerged conditions, with their leaves and stems adapted for efficient photosynthesis and nutrient uptake beneath the water's surface. Submerged weeds play an important role in aquatic ecosystems, providing habitat and food for aquatic organisms. However, they can also become problematic if they overgrow and disrupt the balance of the ecosystem or impede water flow. Examples of submerged weeds include various species of pondweed and watermilfoil.

Lifespan

a. **Annual Weeds - complete their life cycle within a single year.**
    - **Germination to Seed Production-** They germinate, grow, flower, produce seeds, and die within a year.
    - Examples- Common examples of annual weeds include chickweed, crabgrass, lamb's quarters, and pigweed. These weeds are often quick to establish and reproduce, leading to their prevalence in disturbed or cultivated areas.

b. **Biennial weeds - have a two-year life cycle.**
    - **First Year-** In the first year, biennials germinate from seeds and establish a rosette of leaves close to the ground.
    - **Second Year**- In the second year, they grow taller, flower, produce seeds, and then die.
    - Examples of biennial weeds include burdock, common mullein, and wild carrot. These weeds often have larger taproots that store energy for their second-year growth and reproduction.

c. **Perennial weeds - have life cycles that extend beyond two years.**
    - **Longevity:** They can live for several years or even indefinitely, depending on the species.
    - **Reproduction:** Perennials typically have both vegetative (through roots, rhizomes, or stolons) and seed-based reproduction strategies.
    - **Examples:** Examples of perennial weeds include dandelion, thistle, quackgrass, and bindweed. Perennials are often challenging to manage due to their ability to regrow from their root systems even after above-ground portions are removed.

Stem Structure

a. **Herbaceous weeds-** are plants with soft, green stems that lack the woody tissue found in trees and shrubs. These weeds typically complete their life cycle within a single growing season, germinating from seeds, growing, flowering, and producing seeds before dying off. They are commonly found in gardens, agricultural fields, lawns, and disturbed areas (Example: Pigweed (Amaranthus spp.), goosegrass (Eleusine indica), and water hyacinth (Eichhornia crassipes)

b. **Woody weeds**- are plants that have a persistent, woody stem and tend to grow as shrubs or small trees. Unlike herbaceous weeds, these plants develop durable, lignified tissue that allows them to survive multiple growing seasons. Woody weeds can be particularly problematic in landscapes, forests, and agricultural fields (Example: cogon grass, talisay tree, lantana)

Growth Habit

a. **Erect weeds-** are characterized by their upright growth, where stems grow vertically without needing support from other plants or structures. They can compete with crops and other desirable plants for resources such as light, water, and nutrients. Examples of erect weeds in the Philippines include:
    - Nutgrass (*Cyperus rotundus*): Commonly known as "kalingag," nutgrass is an erect perennial weed that grows in agricultural fields and lawns. Its extensive rhizome system makes it difficult to control.
    - Marestail (*Conyza spp*.): Also known as "erect horseweed" or "hairy fleabane," marestail is an annual weed that can grow quite tall. It is known for its rapid growth and ability to produce large quantities of seeds.

b. **Twining weeds-** are characterized by their vining or climbing growth habit. They use other plants or structures for support as they grow, often coiling around them. These weeds can smother and shade out desirable plants. Examples in the Philippines include:

- Ipomoea species (e.g., *Ipomoea triloba*): Commonly known as "kutsai" or "morning glory," these twining vines are notorious for their fast growth and ability to cover and compete with crops.
- *Pueraria phaseoloides*- Also known as "tropical kudzu," this invasive twining weed is a legume that can overgrow other vegetation, leading to reduced biodiversity.

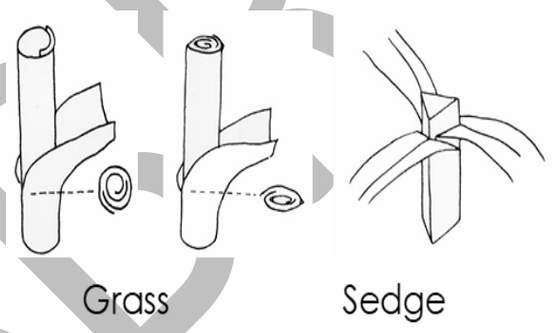
c. Creeping weeds spread horizontally along the ground, often rooting at nodes and producing new shoots. They can form dense mats that outcompete desirable plants for resources. In the Philippines, two common types of creeping weeds are procumbent and decumbent:

- Procumbent weeds- lie flat on the ground without rooting at nodes. An example is **Dichondra repens,** commonly known as "kidney weed," which forms a low, creeping mat in lawns and gardens.
- Decumbent weeds- initially grow horizontally but then turn upward at the tips. An example is **Eleusine indica,** also known as "goosegrass" or "wiregrass," which often invades lawns and turfgrass areas.

Gross Morphology

a. Grasses (Family Poaceae/Graminaceae): are monocot plants characterized by narrow leaves with parallel veins, rounded stems bearing distinct nodes and internodes, and a fibrous root system. They often form dense clumps or mats and are well adapted to a wide range of environments.
Example Weed in the Philippines: *Digitaria ciliaris* (Hairy Crabgrass)

b. Sedges- Sedges are also monocots, but they have solid, triangular stems with edges that are three-angled (hence the name "sedge"). They typically have linear leaves, often arranged in three ranks, and their flowers are clustered in spikelets.
Example Weed in the Philippines: Cyperus rotundus (Nutgrass).



Difference between Grass and Sedges stem, where Grass is rounded stem and sedge is triangular in stem

c. Broadleaves- often dicots, exhibit leaves with reticulate (net-like) veins, and their stems can vary in shape and structure. These weeds encompass a diverse range of plant species with a wide array of growth habits and reproductive strategies.
Example Weed in the Philippines: Ageratum conyzoides (Billygoat Weed)

Cotyledon Number

a. Monocot-have a single cotyledon. This includes plants like grasses

b. Dicot- Dicots usually have two cotyledons. This category includes many broadleaf weeds

Common Weeds in the Philippines

English Name	Family Name	Local Name	Scientific Name	Characteristics
A. Sedges				

1. Flat flower umbrella plant	Cyperaceae	Kalapinpin or Paragis-lukong-kalabaw, mutha	*Cyperus rotundus*	• umbrella-like inflorescence with flat, disk-like flower heads.
2. Bulrush	Cyperaceae	Kilalang-bilog	*Scirpus maritimus*	• with cylindrical stems and bristle-like flower clusters at the tips. • along the edges of bodies of water.
3. Fimbristylis	Cyperaceae	Kulitis-kahoy	*Fimbristylis gaudich*	• known as fringe-rushes, have grass-like leaves and spikelet clusters at the tips of stems. • spikelets often have delicate bristles
4. Flatsedge	Cyperaceae	Barayung-kalabaw	*Cyperus iria*	• triangular stems with leaves arranged in whorls. • lower clusters are often flat-topped and composed of multiple spikelets.
5. Purple nutsedge	Cyperaceae	Soro-soro or Isub-suso	*Cyperus rotundus*	• known for its triangular stems, grass-like leaves, and purple-tinged flower spikes. • underground tubers that make it a persistent and difficult-to-control weed.
B. Grasses				
1. Jungle rice	Poaceae	Palay-Palayan, pulang puit	*Echinochloa colona*	• with nodding seed heads, slender stems, and broad leaves. • Inflorescence is compact and spike-like.
2. Barnyard grass	Poaceae	Kalabaw-kalabaw	*Echinochloa glabrescens*	• with wide leaves, erect stems, and densely flowered inflorescence. • Seeds are in a compact panicle.
3. Sprangletop	Poaceae	Bulubunduking Damo	*Leptochloa chinensis*	• Perennial grass with creeping stems, long and slender leaves, • elongated seed heads.
4. Knot grass	Poaceae	Panglalaki	*Paspalum distichum*	• Perennial grass with flattened stems • spike-like seed heads

5. Southern sandbur	Poaceae	Tagulisang Daga	*Cenchrus echinatus*	• Annual grass with spiny bur-like seed heads, stiff stems, and long leaves with rough edges.
6. Bermuda Grass	Poaceae	Kuka-Kuka, Kulatai	*Cynodon dactylon*	• Perennial grass with creeping stolons • flat leaves, and dense seed heads.
7. Crowfoot grass	Poaceae	Dagum-Dagom	*Dactyloctenium aegyptium*	• Annual grass with unique finger-like seed heads, slender stems, and flat leaves.
8. Crabgrass	Poaceae	Damong-Baybay	*Digitaria sanguinalis*	• Annual grass with branching stems • flattened seed heads, and wide leaves.
9. Goose grass	Poaceae	Duling-Duling, sabung-sabungan	*Eleusine indica L.*	• Annual grass with flattened stems, densely flowered seed heads, and long, narrow leaves.
10. Cogon grass	Poaceae	Kogon	*Imperata cylindrica*	• Perennial grass with tall, coarse leaves, densely flowered seed heads, and rhizomatous growth.
11. Paspalidium	Poaceae	Damo sa Hardin or Makahilig.	*Paspalidium flavidum*	• with slender stems and alternate leaves. • inflorescence is a panicle. • the spikelets are arranged in clusters. • leaves are usually hairless and have a distinct midrib.
12. Itchgrass	Poaceae	Damong Kugon	*Rottboellia cochinchinensis*	• aggressive grassy weed with distinctive spiky bur-like seeds • leaves have a rough texture • grow quite tall
13. Koroniva grass	Poaceae	Damong Gulayan or Damong-Kahoy	*Brachiaria humidicola*	• found in pastures. • leaf sheaths are often densely hairy, and the inflorescence is a panicle with spikelets.
C. Broadleaves				
1. Hydrolea	Hydrophyllaceae	Takip-kohol	*Hydrolea ceilonica*	• Aquatic herb with blue or white flowers • leaves are elliptical and submerged or floating.

2. Water purslane	Onagraceae	Katanda	*Ludwigia octovalvis*	• Aquatic plant with oval-shaped leaves • yellow flowers with four petals.
3. Pickerel Weed	Pontederiaceae	Bbiga-bigaan	*Monochoria vaginalis*	• Aquatic plant with heart-shaped leaves and spikes of blue or purple flowers.
4. Water Lettuce	Araceae	Litsugas-tubig	*Pistia stratiotes*	• Free-floating aquatic plant with rosettes of light green leaves.
5. Tropic ageratum	Asteraceae	Bulak-manok, kolokong-kabayo	*Ageratum conyzoides*	• Herb with soft, hairy leaves; clusters of small white or lavender flowers.
6. Slender amaranth	Amaranthaceae	Uray na walang tinik	*Amaranthus viridis*	• Upright herb with lance-shaped leaves; inconspicuous green flowers.
7. Spiny amaranth	Amaranthaceae	Gulay na Uray na may tinik	*Amaranthus spinosus*	• Upright herb with spiny branches and leaves. • small greenish flowers.
8. Beggar stick	Asteraceae	Pakpak-lawin	*Bidens pilosa*	• Herb with needle-like seeds that stick to clothing or fur; yellow flowers.
9. Celosia	Amaranthaceae	Kokobasilisa	*Celosia spicata*	• Herb with dense, elongated flower spikes. • often brightly colored.
10. Devil weed	Asteraceae	Akapulko	*Chromolaena odonata*	• Shrub with purple or white flowers; leaves have a pungent odor when crushed.
11. Spindle top	Capparaceae	Bakbakot	*Cleome rutidosperma*	• Spindle-shaped seedpods, compound leaves with toothed leaflets, often found in disturbed areas.
12. Day flower	Commelinaceae	alikbangon	*Commelina benghalensis*	• Bright blue flowers, two large and one small petal, succulent stems, commonly grows in gardens and agricultural fields.
13. Spreading day flower	Commelinaceae	alikbangon	*Commelina diffusa Burm. F*	• Similar to Commelina benghalensis but with smaller flowers and a more prostrate growth habit.
14. Eclipta	Asteraceae	Takip-kohol	*Eclipta prostrata*	• Small white flowers, opposite leaves, often grows in moist areas.

15. Garden spurge	Euphorbiaceae	Gatas-gatas	*Euphorbia hirta*	• Hairy stems, small green flowers, milky sap, often considered a weed in gardens.
16. Three lobed morning glory	Convolvulaceae	Alukon	*Ipomea triloba*	• Three-lobed leaves, small pink to lavender flowers, vine-like growth.
17. Lantana	Verbenaceae	Kantutay	*Lantana camara*	• Clusters of colorful flowers, opposite leaves, strong fragrance, often planted as an ornamental but can become invasive.
18. False mallow	Malvaceae	Banaba-banaba	*Malvastrum coromandelianum*	• Heart-shaped leaves, small yellow flowers, often found in waste areas.
19. Sensitive plant	Fabaceae	Makahiya	*Mimosa pudica*	• Fern-like leaves that fold when touched, pink globe-like flowers, sensitive to touch.
20. Physalis	Solanaceae	Kalabo	*Physalis angulata*	• Lantern-like fruits enclosing berries, fuzzy leaves, commonly found in disturbed habitats.
21. Cinderella Weed	Asteraceae	Kamangon-gubat	*Synedrella nodiflora*	• Low-growing herb with small daisy-like flowers, opposite leaves, and a fibrous root system. Leaves are toothed and have a slightly hairy texture.
22. Horse purselane	Aizoaceae	Ulasiman or olasiman i	*Trianthema portulacastrum*	• Succulent annual herb with fleshy leaves, pink to white flowers, and a prostrate growth habit. Leaves are paddle-shaped and alternate.
23. Tridax	Asteraceae	Bulak Manok	*Tridax procumbens*	• Low-spreading plant with yellow daisy-like flowers arranged in clusters, opposite leaves that are toothed or lobed, and a taproot system.
24. Little Iron Weed	Asteraceae	Musa-musa	*Cyanthillium cinereum*	• Small herb with purple or white flowers, deeply lobed leaves covered in fine hairs, and a bushy growth habit.

25. Blue bell	Acanthaceae	Kuping-kupingan	*Ruella Tuberosa*	• Perennial herb with tuberous roots, blue to purple bell-shaped flowers, opposite leaves, and a square stem.
26. Little bell morning glory	Convolvulaceae	Uray	*Ipomoea triloba*	• Herbaceous vine with three-lobed leaves, small bell-shaped flowers, and a climbing or trailing growth habit.
27. Bur-fruited urena	Malvaceae	Kulutan	*Urena lobata*	• Shrub with pink or purple flowers, palmately-lobed leaves, and bur-like fruit capsules covered in hooked bristles.
28. Bibit meniran	Phyllanthaceae	Meniran	*Phyllanthus fratemus*	• Herb with small green flowers, small oval leaves arranged in an alternating pattern, and a central stem.
29. Chicken spike	Sphenocleaceae	Mais-mais, Silisilihan	*Sphenoclea zeylanica*	• leaves are alternate, oval to lanceolate in shape, and have a smooth or slightly wavy margin.

3. WEED ESTABLISHMENT

The weed establishment refers to the successful colonization and growth of weed plants in a particular area. It occurs when weed seeds germinate, develop into seedlings, and ultimately grow into mature plants within a specific ecosystem or environment. Weed establishment is a critical phase in the life cycle of weeds and can have significant implications for agriculture, natural ecosystems, and landscaping.

A. What is a Seedbank?

The term "Seedbank" refers to the part of the Earth where weed seeds are deposited. The major seedbank on Earth is the soil, serving as a repository for various seeds to germinate later. Within the soil, a small number of dominant species make up a significant portion (70-90%) of the seedbank, often posing as primary pests in agricultural systems due to their resistance to control measures. Another group accounts for approximately 10-20% of the seedbank, consisting of weeds adapted to the geographic area but not necessarily current practices. The remaining fraction includes recalcitrant seeds from previous seedbanks, newly introduced species, and seeds from previous crops.

B. Sources of Seed Deposit to the Seed Bank

- Plants are the primary sources of seeds.
- Weeds in agricultural fields produce and contribute fewer seeds to the seedbank.
- Seeds can enter fields from external sources such as contaminated crop seed, farm equipment, animals, and wind.
- Soil can receive seed deposits through animal manure-based fertilizer inputs.

C. Losses in Weed Seedbank

- **Germination-** When weed seeds in the seedbank germinate, they use up their stored energy reserves to initiate growth. Once a seed has germinated and developed into a seedling, it is no longer part of the dormant seedbank. Therefore, germination reduces the number of viable seeds in the seedbank.
- **Predation-** Various organisms, including insects, rodents, birds, and microorganisms, can consume weed seeds. These organisms feed on the seeds, reducing their numbers in the seedbank. For example, birds may consume seeds from the soil surface, while insects and microorganisms in the soil can break down seeds, rendering them nonviable.
- **Seed Decay-** Seeds that are damaged or exposed to unfavorable conditions can deteriorate over time, leading to their loss from the seedbank. High levels of moisture, pathogens, and environmental conditions that promote decay can contribute to seed deterioration.
- **Physical Movement-** Seeds that are dislodged from their original position in the soil may end up in less suitable locations for germination. This movement can lead to seeds being buried deeper in the soil or carried away from areas conducive to germination, resulting in a reduced chance of establishment.

D. Seedbank Dynamics

- Most seeds entering agricultural land's seedbanks are from annual weeds, with only a small percentage being perennial.
- Seedbank dynamics experience wide fluctuations based on new seed introductions and losses.
- Seedbanks vary across different cropping systems.
- Fertile soil tends to accumulate more seeds in the seedbank. e. Farming practices, such as cultivation and herbicide use, influence weed population dynamics and species composition.

E. Implication of Weed Seedbank in Weed Management

- Recognizing the perpetual presence of the weed seedbank, it may be more practical to devise management systems that minimize the impacts of resultant weeds, rather than attempting to eliminate the seedbank.
- Knowledge of seedbank characteristics aids in predicting weed management efficacy. The seedbank composition influences timing and weed population density, both crucial for effective control.
- Understanding the periodicity of germination and emergence of various weed species is vital for effective weed management.

F. Longevity of Weed Seeds

Weed seeds vary in their viability duration. Many weed seeds can remain viable for longer periods than if they were stored under dry and cool conditions. Agricultural soils that have been cultivated for years may contain viable weed seeds capable of germination if brought to the soil surface.

G. Dormancy of Weed Seeds

Dormancy refers to a state in which viable seeds do not germinate even under favorable conditions. It controls the timing of germination or delays it for years. Dormancy is caused by physical and physiological factors, including seed coat impermeability and presence of inhibitors.

H. Weed Seed Germination and Seedling Stage of Weeds

Germination is critical for weed establishment and signifies the resumption of embryo growth. Successful germination depends on factors such as soil moisture, temperature, oxygen supply, light exposure, and burial depth. Weed seeds possess various germination mechanisms adapted to changing environmental conditions.

Steps in Germination

a. Imbibition (water absorption)

Imbibition is the initial step in germination. When a mature and viable seed comes into contact with water, it absorbs the water through its outer seed coat. This uptake of water triggers various biochemical and physiological changes within the seed, reactivating cellular processes that have been suspended during dormancy. Imbibition leads to the swelling of the seed and the softening of the seed coat.

b. Rapid metabolic activities.

Once water is absorbed, the seed undergoes a burst of rapid metabolic activity. Enzymes within the seed are reactivated and begin breaking down stored nutrients, such as starches and proteins, into simpler forms that can be transported to growing regions of the seedling. This energy fuels the subsequent growth of the seedling until it can perform photosynthesis and produce its own nutrients.

c. Emergence of roots

As metabolic activity increases, the embryo within the seed starts elongating, and the radicle (embryonic root) emerges from the seed coat. The radicle is the first part of the seedling to emerge and plays a crucial role in anchoring the seedling to the soil and absorbing water and nutrients.

d. Emergence of shoots

Simultaneously, as the radicle emerges and establishes itself in the soil, the embryonic shoot or plumule starts growing towards the soil surface. This shoot will eventually develop into the stem and leaves of the mature plant. The shoot growth is often accompanied by the elongation of the hypocotyl, the region between the radicle and the emerging plumule.

e. Development of independent plant or seedling.

As the shoot continues to grow and emerges from the soil, the first true leaves unfold. These leaves are essential for photosynthesis, enabling the seedling to produce its own energy from sunlight. At this stage, the seedling becomes independent from the energy reserves stored in the seed. With an established root system and functional leaves, the seedling is prepared to grow into a mature plant and complete its life cycle.

I. Factors Involved in the Germination of Weed Seeds

i. Soil Moisture

Adequate moisture is essential for germination. It softens the seed coat and activates enzymes, allowing the embryo to swell and metabolic processes to begin. Insufficient moisture can delay or prevent germination, while excessive moisture can lead to decay or the development of unfavorable conditions for seedlings.

ii. Temperature

Temperature significantly influences the rate and success of germination. Different weed species have specific temperature ranges for optimal germination. Warm-season weeds tend to germinate better in higher temperatures, while cool-season weeds prefer cooler temperatures. Extreme temperatures can inhibit germination or damage seeds.

iii. Aeration

Oxygen availability is crucial for respiration, which provides energy for germination. Adequate aeration in the soil ensures that oxygen can reach the embryonic tissues. Poorly aerated soils may limit oxygen supply, hindering germination and seedling development.

iv. Light

Light can be an important factor in triggering germination for some weed species. Light-sensitive seeds require exposure to light to break dormancy. Conversely, light-insensitive seeds may germinate in darkness. The presence or absence of light often depends on the depth at which seeds are buried.

v. Disturbance of Soil Surface

Soil disturbance, such as tilling or other mechanical activities, can expose buried weed seeds to light and alter their depth in the soil. This can influence germination by affecting light availability, temperature, and oxygen levels.

vi. Alternate Wetting and Drying of the Soil

Fluctuating soil moisture conditions, such as those occurring with rainfall and subsequent drying, can stimulate germination for certain weed species. This process can help break dormancy in seeds that require specific moisture changes for germination.

vii. Depth of Seed Burial

The depth at which weed seeds are buried in the soil can impact their germination. Seeds buried too deeply may not receive sufficient light for germination, while shallow burial may expose them to temperature fluctuations and predation. Different weed species have varying burial depth preferences for optimal germination.

4. WEED REPRODUCTION AND DISPERSAL

Reproduction is the primary means of weed survival mechanism. Weeds reproduce through two important methods: sexual and vegetative propagation. While most weed species reproduce freely by seeds, others possess the ability to produce modified stems and roots capable of storing reserve food and generating new plants.

a. Types of Reproduction

- **<u>Sexual Reproduction</u>**

Involves the multiplication through seeds. Weed seeds often germinate and mature earlier than associated crops. Seeds also do not ripen simultaneously, resulting in a continuous supply of viable seeds in the field. Reproduction by seed is common in ephemerals, annuals, and simple perennials. Annuals produce seeds within one growing season, while perennials continue seed production as long as they are growing. Two main types of seeds are produced: true seeds resulting from fertilization and seeds produced through apomixis, a method without fertilization.

Types of Weed Seeds Produced

- **True Seeds:** True seeds are produced as a result of fertilization, where pollen from the male part of the flower fertilizes the ovules in the female part. This leads to the formation of seeds with genetic variation. Examples include both single-seeded and multi-seeded fruits. In single-seeded fruits, there's a single seed within each fruit, while multi-seeded fruits contain multiple seeds within a single fruit.
- **Seeds by Apomixis Method:** Some weed species have the ability to produce seeds without undergoing fertilization through a process called apomixis. Apomictic

seeds are essentially clones of the parent plant, with no genetic recombination. This allows certain weeds to reproduce rapidly and maintain specific traits.

Types of Weeds Bearing Fruits:

- **Achene or Caryopsis-** An achene is a single-seeded fruit that does not split open at maturity. The seed is attached to the fruit wall at a single point. Examples of weeds producing achenes include dandelions and sunflowers.
- **Dimorphic Seeds-** Dimorphic seeds are found in two-seeded fruits where there are actually two embryos within a single seed coat. While this might seem like two seeds, it's a single structure with two developing embryos. This phenomenon is common in some weed species like amaranths.

Factors Influencing Flowering and Seed Production

- **Day Length-** The length of daylight, or photoperiod, influences flowering and subsequently seed production in many plants, including weeds. Some plants are classified as short-day plants, requiring shorter daylight hours to induce flowering, while others are long-day plants, flowering when days are longer.
- **Light Intensity-** The intensity of light also affects flowering and seed production. Adequate light is essential for photosynthesis, which provides the energy needed for seed development. Light intensity can impact the timing and quality of flower and seed formation.
- **Nutritional Status-** A plant's nutritional status, particularly the availability of essential nutrients like nitrogen and phosphorus, plays a role in its ability to produce flowers and seeds. Insufficient nutrients can delay or reduce flowering and seed production.
- **Temperature-** Temperature significantly affects plant growth and development, including flowering and seed production. Different plants have optimal temperature ranges for these processes. Temperature extremes or fluctuations can disrupt normal development.

➢ **<u>Vegetative/Asexual Reproduction</u>**

It is a significant survival mechanism in persistent weeds with deep-root systems and numerous dormant buds, bulbs, tubers, and rhizomes. Dormancy and reserve food storage are typical characteristics of these underground plant parts. Rhizomes resemble roots but have nodes, internodes, and scale leaves, while stolons are above-ground structures. Similar to sexual reproduction, asexual reproduction is influenced by factors like light, tillage, soil texture, and type.

Methods of Asexual Reproduction

- **Rhizomes**- are underground horizontal stems that send out roots and shoots from their nodes. Nodes are points on the rhizome where leaves, stems, or roots emerge. Examples of weeds that spread through rhizomes include Bermuda grass and quackgrass.
- **Stolon**- also known as runners, are above-ground horizontal stems that root at the nodes and form new plants. They can extend over the soil surface, producing roots and shoots at intervals. Common examples of stoloniferous weeds are strawberries and creeping buttercup.
- **Tubers**- are swollen, underground storage stems that produce new plants. Each tuber contains buds that can sprout and grow into new shoots. Examples of weeds with tubers include potatoes and yellow nutsedge.

- **Bulbs**- are modified underground stems with fleshy storage leaves that store energy. Buds within the bulbs can give rise to new shoots. Weeds like onion grass and garlic mustard reproduce through bulbs.
- **Corms**- are similar to bulbs but lack fleshy leaves. Instead, they have solid, modified stems that store energy. Buds on corms can develop into new plants. Weeds like nutgrass use corms for asexual reproduction.
- **Fragmentation**- Some weeds can propagate through fragmentation, where a piece of the parent plant breaks off and develops into a new plant. Water hyacinth is an example of a weed that spreads through fragmentation.

Significance of Vegetative Reproduction in Weeds

- Asexual reproduction allows weeds to quickly colonize an area, as new plants can develop from existing plant parts without the need for seeds. This is especially advantageous in disturbed or bare soil areas.
- Weeds that reproduce vegetatively can adapt to various environmental conditions, such as extreme temperatures, drought, or poor soil. They can also quickly recolonize after disturbances like mowing or grazing.
- Some weeds that reproduce vegetatively may also develop resistance to control methods like herbicides. The rapid generation of new plants can allow resistant traits to spread quickly.
- Underground structures like rhizomes and bulbs can persist in the soil for extended periods, allowing weeds to reemerge year after year.
- If the above-ground parts of a plant are damaged, vegetative reproductive structures can quickly generate new shoots and leaves, aiding the plant's recovery.

b. Magnitude of Seed Production

Weeds are prolific seed producers due to their relatively short vegetative stage and extended reproductive period. Annual and biennial weeds heavily depend on seed production for propagation and survival, whereas perennials are less reliant on this mechanism. A single annual weed plant can produce enough seeds in one season to cover a significant area in the next year. Records indicate substantial seed production, such as 20,832 seeds per plant for annuals, 26,600 for biennials, and 16,629 for perennials.

c. Dispersal of Weed Propagules

Weeds are adept at dispersing themselves, utilizing various agents to travel from one place to another. Wind, water, animals, and humans play pivotal roles in weed dispersal.

- **Man:** Human activity frequently carries weed seeds, often introducing them alongside crop seeds or as ornamental plants.
- **Wind:** Seeds with wing-like structures or parachute-like appendages, like those in cogon or talahib, are easily carried by wind.
- **Water:** Moving water, such as surface run-off, streams, irrigation channels, and floods, can transport weed seeds. Seeds carried by water often have saccate coverings impervious to water, as seen in sedges.
- **Animals:** Seeds and fruits may possess spines and hooks that allow them to attach to animal fur, aiding in dispersal.
- **Other:** Farm implements, machinery, and vehicles can inadvertently carry weed propagules.

5. WEED INTERFERENCE

Weed interference, also known as weed competition, refers to the negative effects that weeds have on desired plants or crops. It occurs when weeds compete with cultivated plants for essential resources such as light, water, nutrients, and space. Weed interference can lead to reduced crop yields, poor quality produce, and increased production costs.

a. Yield Losses Due to Weed Competition:

Yield losses in crop production due to weed competition can have significant economic and agricultural implications. Weeds compete with crops for essential resources, leading to reduced growth, development, and ultimately lower yields. The reported yield reductions due to weeds vary depending on the crop and the level of weed infestation. Here are the reported yield reductions for various crops:

1. Lowland Rice- Transplanted- 26% reduction in yield due to weed competition while in Direct-seeded is 76% , Upland Rice- 79% reduction in yield
2. Corn- 90% reduction
3. Soybean- 58% reduction
4. Mungbean- 24% reduction
5. Onion- 96% reduction
6. Tomato (Transplanted) 40% reduction

b. Factors Affecting Competitiveness Ability:

- **Variety of Crop -** Different crop species have varying levels of competitiveness against weeds. Some crops may naturally suppress weed growth, while others are more susceptible to weed interference.
- **Soil Fertility -** Nutrient-rich soils can support vigorous crop growth, allowing crops to compete more effectively against weeds. Adequate nutrients enable crops to develop quickly and establish a competitive advantage.
- **Soil-Water Relation -** Soil moisture availability is crucial for both crops and weeds. Crops that efficiently utilize water have an advantage in competing against water-demanding weeds.
- **Soil Reaction -** Soil pH and other chemical factors can influence plant growth. Crops that thrive in specific soil conditions can outcompete weeds that are less adapted.
- **Date and Rate of Seeding -** The timing and density of crop planting can affect its ability to establish and compete against weeds. Early planting and optimal seeding rates can lead to better crop establishment.
- **Tillage -** Proper tillage practices can disrupt weed growth and promote crop establishment. Adequate soil preparation helps crops compete by reducing weed emergence.
- **Crop Rotation -** Rotating different crops can disrupt the life cycle of specific weeds and reduce their buildup in the field, enhancing crop competitiveness.

c. Types of Competition:

- **Inter specific Competition-** This occurs when individual plants of different species compete for resources. For example, barnyard grass competes with rice for nutrients, water, and light.
- **Intra specific Competition-** Intra specific competition involves individuals of the same species competing for resources. For instance, corn plants may compete with other corn plants for nutrients and space.

d. Factors for Weed Competition:

- Light is crucial for photosynthesis and plant growth. Weeds can compete for available light, overshadowing crops and reducing their energy production.
- Weeds and crops both require essential nutrients. Competition for nutrients can lead to nutrient deficiencies in crops.
- Weeds compete with crops for water, affecting water availability for crop growth and development.

e. Increasing Competitive Ability of Crops:

- Adjusting plant spacing can influence resource availability for crops, affecting their competitiveness.
- Proper fertilizer placement enhances nutrient availability for crops, improving their competitive advantage.
- Mulch can suppress weed growth, conserve soil moisture, and enhance crop competitiveness.
- Choosing appropriate planting systems can create conditions that favor crop competitiveness.
- Intercropping with cover crops can suppress weed growth and provide benefits to main crops.
- Planting multiple crops in close proximity can create a competitive environment for weeds.
- Proper land preparation disrupts weed growth and gives crops an advantage.
- Minimal soil disturbance can reduce weed emergence and conserve soil moisture.
- Efficient irrigation practices support crop growth and competitiveness.

f. Allelopathy

Allelopathy refers to the phenomenon where plants release chemical compounds that negatively affect the growth of neighboring plants. These allelopathic chemicals can hinder seed germination or growth, giving certain plants a competitive advantage. This mechanism involves the release of compounds like phenolic acids, canmarins, terpenoids, and flavonoids. These substances can be emitted as vapor, leach from foliage, exude from roots, or result from decomposition. Allelopathy plays a role in plant ecosystems, affecting crop growth and maintaining balance among plant species. Understanding allelopathy can provide insights into weed-crop interactions and aid in weed management strategies.

6. METHODS OF WEED CONTROL

a. Different Methods of Weed Control

- **Manual Weed Control (Hand weeding/Hand pulling**)

- one of the oldest and simplest methods of weed control.
- physically removing weeds by hand.
- labor-intensive and time-consuming, it is effective for smaller areas, sensitive crops, and situations where other methods might not be suitable.
- environmentally friendly as it doesn't involve the use of chemicals.

- **Mechanical Weed Control**

- involve the use of machines and equipment to control weeds. This can include rotary weeders, cultivators, and other types of machinery that disturb the soil and uproot or damage the weeds.
- efficient for larger areas and can reduce the need for manual labor. However, they need to be used carefully to avoid damaging the main crop or soil structure.

- **Cultural/Ecological Weed Control**

- focus on creating an environment that is less conducive to weed growth while promoting the growth of the main crop.
- involve techniques like mulching, where organic or synthetic materials are placed on the soil surface to suppress weed growth by blocking sunlight and providing a barrier.
- Other methods include flooding fields, proper crop rotation to disrupt weed life cycles, managing nutrient levels to favor the main crop, and preparing the land in a way that minimizes weed establishment.

- **Biological Weed Control**

- involves using living organisms to control weeds.
- introduction of insects, plant pathogens (diseases), or grazing animals that feed on the weeds.

- **Chemical Weed Control (Herbicides)**

- Herbicides are chemicals specifically designed to kill or inhibit the growth of weeds.
- applied directly to the weeds or the soil.

- efficient and can cover large areas quickly, but they must be used with caution to prevent harm to the main crop, the environment, and non-target organisms.

Classification of Herbicides

i. Based on Selectivity

- **Selective Herbicides** - Kill specific plants (Example: butachlor, propanil, 2,4-D, etc.).
- **Non-Selective Herbicides**- Kill all plants (Example: glyphosate, glufosinate, paraquat)

ii. Based on Time of Application

- **Pre-Plant Herbicide Application**

  This method involves applying herbicides to the soil before the main crop is planted. The goal is to prevent weed seeds from germinating and emerging alongside the crop. This approach creates a weed-free zone for the emerging crop, which can reduce competition and improve crop establishment. Pre-plant herbicides are typically incorporated into the soil and work by creating a barrier that inhibits weed seed germination.

- **Pre-Emergence Herbicide Application**

  Pre-emergence herbicides are applied to the soil before either the crop or the weeds emerge from the soil. These herbicides are often applied shortly after planting but before the emergence of the crop or weed seedlings. They form a layer in the soil that prevents the germinating weed seeds from growing, effectively stopping them before they become visible. This method is particularly useful for preventing weed competition during the critical early stages of crop growth.

- **Post-Emergence Herbicide Application**

  Post-emergence weed control involves applying herbicides after both the crop and the weeds have emerged. The herbicide is typically applied to the foliage of the weeds, targeting their above-ground growth. This method is more targeted and can be useful for controlling weeds that have already established themselves. It requires careful selection of herbicides to ensure they effectively target the weeds while minimizing harm to the main crop.

iii. Based on Movements in Plants

- **Contact/Localized-** The site of contact/application is the site of action/phytotoxicity (Example: paraquat, glufosinate ammonium)
- **Translocated/Systemic-** The herbicide moves inside the plant until it reaches a specific site of action (Example: glyphosate, pendimethalin, pretilachlor)

iv. Based on the Rapidity of Phytotoxicity

- **Acute Toxicity-** Rapid expression of phytotoxicity
- **Chronic Phytotoxicity-** Slow expression of phytotoxicity

OTHER PESTS

1. MOLLUSK (GOLDEN APPLE SNAILS)

The Golden Apple Snail, scientifically known as *Pomacea canaliculata*, is a species of freshwater snail. It's commonly referred to as the Golden Mystery Snail or Golden Inca Snail. These snails are known for their striking golden or yellowish shells, which give them their common name, like snails and slugs are pests that feed on a variety of plants, causing damage to leave, stems, and fruits.

Where did GAS come from?

1. The **Golden Apple Snail** is a freshwater gastropod native to South America. It was introduced to various regions around the world, including South Africa, where it was likely introduced for ornamental purposes or through unintentional means, such as contaminated aquatic plant shipments or aquarium releases.

2. **Routes of Introduction to the Philippines**: The Golden Apple Snail was introduced to the Philippines through multiple routes, highlighting its invasive potential:
   a. **From Taiwan to Lemery, Batangas in 1982**- The snail was likely brought into the Philippines from Taiwan, possibly for ornamental purposes or as a potential food source.
   b. **Florida, USA to Makati Metro Manila in 1983**- The snail might have been introduced to the Philippines from Florida, USA, possibly as a result of aquarium trade or other means.
   c. **Argentina to Asturias, Cebu in 1984**- Another introduction point was from Argentina to Asturias, Cebu. This introduction might have been driven by similar reasons, such as the potential for aquaculture or the pet trade.

3. **Intention of Introduction** - The Golden Apple Snail was introduced to the Philippines with the intention of serving as a means of livelihood and as a protein source in the human diet. The snail's rapid reproduction and potential for consumption could have been seen as advantageous in addressing food security concerns.

4. **Invasion and Spread** - Unfortunately, the introduction of Golden Apple Snails had unintended consequences. These snails are known for their invasive nature and rapid reproduction. They can outcompete native species, damage aquatic ecosystems, and harm agricultural fields by consuming plants. As you mentioned, by 200, they had invaded around 1.6 million hectares of land in the Philippines.

Characteristics of GAS

Lifespan and Fertility

Golden Apple Snails typically have a lifespan of 2 to 6 years. During this time, they can exhibit high fertility rates, producing a large number of eggs in their reproductive cycles. This contributes to their ability to rapidly multiply and potentially become invasive in certain environments.

Shell and Flesh Appearance

The shell of the Golden Apple Snail is described as being light brown in color. The flesh, which refers to the soft body of the snail, can range from creamy white to shades of golden pinkish or orange. The combination of these colors adds to the snail's distinct appearance.

Size Variation Due to Food Availability

The size of individual Golden Apple Snails can vary based on the availability of food in their habitat. Snails that have access to abundant food resources tend to grow larger, while those with limited food may remain smaller. This adaptability in size based on food availability is a common phenomenon in many species and can influence their overall fitness and reproductive success.

Differences between male and female

The Golden Apple Snail (GAS) exhibits its highest level of destructiveness when the length of its shell falls within the range of 10 mm to 40 mm. An important distinction exists between male and female GAS:

- In female GAS, the operculum is concave, creating a slight indentation in the structure.

- In male GAS, the operculum is convex, forming a slightly rounded and outwardly curved feature.

Indications of damage caused by the Golden Apple Snail (GAS)

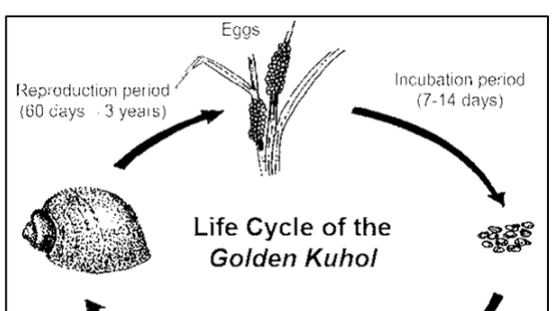
- Rice seedlings that have been recently transplanted remain susceptible to GAS damage for a period of up to 15 days after transplantation (DAT).
- In the case of directly seeded rice, vulnerability to GAS damage extends from 4 to 30 days after sowing (DAS).
- Remarkably, the presence of just a single Golden Kuhol measuring 2-3 cm within a 2 m^2 area can lead to a substantial 19% reduction in crop yield.
- Notable absence of seedlings in certain areas, indicating missing hills where the snails have caused damage.
- The water surface displaying signs of their activity through the presence of cut leaves from the seedlings, which float on the water's surface.

Feeding Habit of GAS

1. Their diet encompasses various plant species, including algae, azolla, duckweed, water hyacinth, rice seedlings, and other water-rich leafy plants.
2. Their preference lies in consuming tender and young plant parts due to their softness. GAS employ their rough, scraping tongue to feed on the surfaces of these plants.
3. Additionally, they are opportunistic feeders and consume decomposing organic matter as part of their diet. This adaptability in feeding habits contributes to their survival in different environments.

Life Cycle of the Golden Apple Snails

1. **Egg Stage** - The life cycle begins with the deposition of eggs. Adult female Golden Apple Snails lay their eggs in clusters, often attached to hard surfaces above the waterline. These eggs are covered with a gelatinous substance for protection. A single adult female can lay a substantial number of eggs, ranging from around 1000 to 1200 eggs within a span of one month.
2. **Incubation Period** - The eggs undergo an incubation period that typically lasts for 7 to 14 days. During this time, the eggs develop and mature within their protective gelatinous casing. Adult Golden Apple Snails engage in mating activities for a duration of approximately 3 to 4 hours, and these mating sessions can occur at any time of the day.
3. **Hatchling Stage** - After the incubation period, the eggs hatch, releasing tiny snails known as hatchlings or juveniles. These hatchlings are equipped with a small shell and start their life in the aquatic environment.
4. **Growth to Sexually Mature Adult** - The hatchlings continue to grow and develop over time. As they consume food and find suitable habitats, they undergo various growth stages. It takes several months for them to reach sexual maturity.
5. **Sexually Mature Adult Stage** - Once the Golden Apple Snails reach sexual maturity, they are capable of reproducing. This stage is characterized by the snails being able to lay eggs and participate in the reproductive process.
6. **Reproductive Period** - The reproductive period of Golden Apple Snails can extend from 60 days to 3 years. During this time, sexually mature adults engage in mating and egg-laying activities. The length of the reproductive period can be influenced by factors such as environmental conditions, food availability, and individual snail health.



The Life Cycle of GAS (*retrieved from:Philrice*)

Where does Golden Kuhol live?

GAS primarily inhabit aquatic and wetland environments. Here are some of the places where they can be found:

1. **Ponds and Swamps** - Golden Kuhol can be commonly found in stagnant or slow-moving water bodies such as ponds and swamps. These environments provide them with the necessary moisture and food sources.
2. **Irrigated Field** - Agricultural fields that are regularly irrigated can also host Golden Kuhol populations. The presence of waterlogged or moist soil creates suitable conditions for them.
3. **Canals and Waterlogged Areas** - Canals and areas prone to waterlogging are often frequented by Golden Kuhol due to the availability of water and suitable habitats.

Management Options of GAS

1. **Biological Control** - It can be controlled by Ducks, Red ants, Field rats and Long-horned grasshoppers.
2. **Cultural Control** - Preparing the land by allowing it to dry out, which has the effect of exposing snails that have buried themselves in the soil to scape dry conditions, Constructing small canals to confine GAS, Transplant the rice seedling 25-30 day old, Use of toxic substance in the plants like *Baringgtonia Asiatic,* Put an attractant like gabi leaves, banana and old newspaper.
3. **Chemical Control** - Applying spot treatment of GAS egg masses with niclosamide 250EC presents a cost-effective approach to managing snail populations.
4. **Physical/Mechanical Control** - Hand pick the GAS and eggs from the paddies.

2. RODENTS

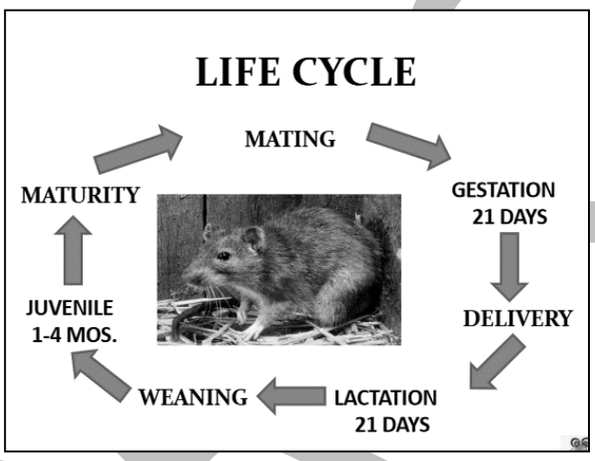
Rodents belong to the mammalian order Rodentia and are distinguished by possessing a unique feature: a solitary set of perpetually growing incisors in both their upper and lower jaws. Approximately 42% of the total species within the mammal classification fall under the category of rodents. These creatures thrive in abundant quantities across every continent, with the exception of Antarctica.

Rodents hold the distinction of being among the most populous mammals on Earth, occupying a wide array of habitats. As vertebrate animals, they exhibit the common traits of having a backbone and mammary glands. They Are notorious pests that can damage crops, contaminate food, and cause structural damage.

Life Cycle of Rodents

1. **Mating-** Rodents engage in mating, during which male and female individuals come together to reproduce.
2. **Gestation (Pregnancy) -** After successful mating, the female rodent undergoes a relatively short gestation period of approximately 21 days.

3. **Delivery-** Following the gestation period, the female gives birth to a litter of baby rodents. The number of offspring in a litter can vary depending on the specific rodent species.
4. **Lactation -** After birth, the mother rodent nourishes her offspring with milk during a lactation period that lasts around 21 days. This milk provides essential nutrients for the rapid growth and development of the young rodents.
5. **Weaning-** As the lactation period concludes, the baby rodents transition to consuming solid foods. This marks the weaning phase, during which they begin to explore and adapt to a more diverse diet.
6. **Juvenile Stage-** Following weaning, the young rodents enter the juvenile stage, which can last anywhere from 1 to 4 months. During this period, they continue to grow, learn essential survival skills, and become increasingly independent.
7. **Maturity-** The final stage of the life cycle is maturity. Rodents reach reproductive maturity, enabling them to engage in mating and continue the cycle by giving birth to their own offspring.



The Life Cycle of Rodents

Characteristics of Rodents

1. Typically have poor vision, but they compensate with a heightened sensitivity to motion.
2. Sensitive in sense like smell, taste, touch and hearing
3. They are active at night (Nocturnal)
4. They are good climbers
5. They are good swimmers
6. They have chisel-like teeth or incisors

Indication of presence in Rodents

1. Runways
2. Dropping
3. Burrows or holes made by rodents
4. Tiller damage
5. Live rodents
6. There is island of damage
7. Feces

Management Strategies

1. **Cultural Control-** This approach involves altering the environment to discourage rodent infestations. It includes practices like proper waste management, reducing food sources,

synchronous planting, and maintaining clean and clutter-free areas to minimize rodent habitats.

2. **Mechanical Control-** Mechanical methods physically prevent or eliminate rodent access. This includes using traps (snap traps, glue boards, live traps) to capture rodents and prevent their reproduction. These methods require regular monitoring and maintenance.
3. **Biological Control**- Natural predators and competitors can be introduced to control rodent populations. This could involve using predators like barn owls or introducing non-harmful organisms that compete with rodents for resources. However, biological control can have unintended ecological consequences and requires careful consideration.
4. **Chemical Control**- Chemical methods involve using rodenticides to poison rodents. These can be baits or traps containing toxic substances that lead to rodent mortality. It's crucial to use rodenticides safely to avoid harming non-target species and to follow regulations and guidelines.

Types of Rodenticide:

- **Acute Rodenticide (Pre-baiting) -** single-dose (acute) poison, such as zinc phosphide, to quickly and effectively eliminate rodent populations, Fast Acting (1:150 ratio), Cause dead shortly after ingestion.
- **Chronic Rodenticide (Continuous Baiting) -** use of a chronic, multiple-dose poison like coumatetralyl (Racumin) to manage rodent populations over an extended period, Slow acting (1:19 ratio), the rodents will bleed and then die.

Different Species of Rodents

Common Name	Scientific Name	Characteristics	Appearance
1. Oriental House Rat	*Rattus tanezumi*	• Also known as the Asian rat or Asian house rat. • Close relative of the black rat (Rattus rattus). • Widely distributed in eastern, southern, and south-eastern Asia. • Formerly named Rattus rattus mindanensis Marns. • Weighs around 175 g, • Tail is uniformly dark • Mammary formula: 2 pairs on the chest and 3 pairs on the abdomen, totaling 10 mammary glands.	
Rice field rat	*Rattus argentiventer*	• Medium-sized rat with grizzled yellow-brown and black pelage, not spiny when stroked. • Belly is grayish • Uniformly medium brown tail. • measures 304-400mm in length, tail length 140-200mm, and skull length 37-41mm (Van Peenen 1969). • Mammary formula: 3+3=12.	

Polynesian rats	*Rattus exulans*	• Live in grassland, scrub and forest • Not a good swimmer • Able to climb trees • Mammary formula 2+2=8	
Norway rat	*Rattus norvegicus*	• Small ears and eyes • Tail os naked • Fur color brown to dark gray • Scattered black hairs • Blunt muzzle	
Roof Rat	*Rattus rattus*	• Slender body • Pointed muzzle • Tail is longer than body • Fur color black to brownish-gray.	
House mice	*Mus musculus castaneous*	• Live close association in human • Found in houses, barns and granaries • Weight is 12 g	

3. BIRDS (AVIAN PESTS)

Certain bird species, like pigeons and sparrows, can become pests by damaging crops, creating unsanitary conditions, and causing structural damage with their nesting habits.

In the Philippines, several bird species are considered avian pests in rice fields. Common avian pests include the Eurasian Tree Sparrow *(Passer montanus),* the Chestnut Munia *(Lonchura malacca),* the Scaly-Breasted Munia *(Lonchura punctulata),* and White-Bellied Munia *(Lonchura leucogastra).*

Why and Where it Occurs

- Birds are problematic from ripening phase until harvest.
- Some species feed off panicles by landing, perching, or eating dropped grain.
- Abundance of bird pests during this time.

How to Identify

- Milky substance on chewed grains, whiteheads with removed grains.
- Distinguish from stem borer damage: not all grains chaffy in bird damage.

Management Strategies

- Bird Boys - Farm workers scaring birds with changing techniques.
- Exclusion Netting - Effective but expensive, excludes beneficial birds too.
- Bird-Tape - Placed over plants, effective for scaring birds.
- Noisemakers - Produce random sounds or recordings, short-term effectiveness.
- Chemical Repellents - Chili extracts, continuous application needed.
- Decoy Birds - Attract or repel birds, relatively cheap and easy.
- Flags, Scarecrows, Bird Kites - Move due to wind, short-term protection.
- Eco-Engineering - Utilize larger birds to balance ecosystem naturally.

4. SWAMP EEL (*Monopterus albus*)

They are known for their burrowing behavior. They create tunnels in the soil, which can lead to water leakage and uneven water distribution in rice paddies. This can disrupt the proper management of water levels needed for rice cultivation.

Habitat

- Asian swamp eels are found in various aquatic habitats in both their native and introduced regions.
- Native regions: lakes, rivers, ponds, marshes, swamps, waste drains, and sewers.
- They can tolerate both fresh and brackish waters.
- Thrive in muddy environments due to cryptically colored skin and adaptation to low-oxygen levels.
- During the day, they burrow under rocks or soft mud.
- Can survive in areas with up to 80% mud and 20% water.
- Preferred habitat temperature: 25-31 degrees Celsius.
- ability to travel short distances across land to move between suitable habitats.
- In introduced regions (Miami and Florida), they inhabit rivers and canals running east-southeastward to the Atlantic Ocean.

Characteristics

- Nocturnal predators.
- Hide in mud or thick vegetation to avoid other animals.
- Highly aggressive and voracious when hunting for prey.
- Male Asian swamp eels exhibit aggressiveness towards each other during mating periods.
- Moving across land to reach other waterways.
- Coloration can vary, often blending with their surroundings, ranging from brown to olive-green.
- Inhabit muddy and swampy areas.
- Breathe through their gills as well as via cutaneous respiration.