Azolla Characteristics and Production technology

Content

1. Introduction and Characteristics of *Azolla.*
2. Structure of *Azolla.*
3. Classification of *Azolla*.
4. Economic value of *Azolla*.
5. Requirements For *Azolla* Culture.
6. Cultivation & Steps of *Azolla* culture.
7. Limitations of *Azolla* Culture.

INTRODUCTION

- ***Azolla*** **/mosquito fern/ duckweed fern/ fairy moss/ water fern** *is a* free floating aquatic ferns and is genus which belongs to family Salviniaceae.
- It grows in fresh water and is naturally available mostly on moist soils, ditches marshy ponds and is widely distributed in tropical belts of India.

Azolla – Characteristics/Habit

The sporophyte of Azolla is extremely small when compared with Marsilea and Salvinia.

It is distinguishable into stem, leaves and roots. The stem is often called the rhizome.

It is profusely branched and on its upper surface is covered with dense leaves.

The leaves are alternate and are arranged in two rows. Each leaf has two lobes, the upper lobe being aerial and green in color.

The lower lobe is thin and colourless, and is completely submerged in water.

The dorsal lobe encloses large mucilage filled cavities. Inhabiting these mucilage cavities is found a Cyanophycean alga, *Anabaena azollae*.

STRUCTURE OF *AZOLLA*

- Shape of Indian species is typically triangular measuring about 1.5 to 3.0 cm in length 1 to 2 cm in breadth.
- Roots emanating from growing branches remained suspended in water.
- The dorsal lobe which remains exposed to air is having a specific cavity containing its **symbiotic partner, a Blue Green Algae (BGA), the *Anabaena azollae*.**
- The fern is capable of fixing atmospheric nitrogen in the soil in the form of NH_4+ and becomes available as a soluble nitrogen for the cultured species.

Classification

Kingdom	:	Plantae
Division	:	Pteridophyta
Class	:	Pteridopsida
Order	:	Salvinales
Family	:	Salvinaceae
Genus	:	*Azolla*

Economic Value

- On dry weight basis *Azolla* contains the following chemical compositions:

Nitrogen	**5.0 %**
Phosphorous	0.5 %
Potassium	2.0-4.5%
Calcium	0.1-1.0%
Magnesium	0.65 %
Manganese	0.16 %
Iron	0.26 %
Crude Fat	3.0-3.3 %
Sugar	3.4-3.5 %
Starch	6.5 %
Chlorophyll	0.34-0.55 %
Ash	10.0 %

REQUIREMENTS FOR *AZOLLA* GROWTH

- **Water:** 10-15 cm fresh current water is necessary in multiplication pond. Maintenance of adequate water level (at least 4 inches in the pond) is essential.
- **Temperature:** Day/night temperatures ranging between 32ºC and 20ºC have found to be most favorable. The optimum temperature for luxurious growth of *Azolla* is 25-30˚C.
- **Light:** It prefers to grow well under partial shade.
- **Relative Humidity:** The optimum relative humidity requirement is 85 to 90 per cent.
- **Soil pH:** *Azolla* grows well in slightly acidic soil having 5.2 to 5.8 pH.
- **Nutrition:** Being an N fixing fern *Azolla* does not require nitrogenous fertilizer for its growth. Phosphorous @20 kg/ha is desirable for good bio-mass production.

CULTIVATION OF *AZOLLA*

Growing of *Azolla* is done basically by two types:

1. ***Azolla in situ*** (grown with standing crop within the field)
2. ***Azolla ex situ*** (grown in an area by accumulating sufficient water)

- There is also another method of culturing ***Azolla*** **in polythene.**

Steps of *Azolla* Culture

1. **Selection of pond location**
2. **Pond size and construction**
3. **Production of *Azolla***
4. **Maintenance of the pond**
5. **Harvesting and feeding**
6. **Yield of *Azolla***
7. **Economics of *Azolla* Cultivation**

1. Selection of pond location

- It is better to select an area near to the house to ensure regular upkeep and monitoring of the pond.
- A suitable water source should be nearby for regular water supply.
- The site under partial shade is ideal or else, shade has to be created to reduce the evaporation of water and also, for better growth of *Azolla*.
- The floor area of the pond should be free of pointed stones, roots and thorns that can puncture the sheet and cause leakage of water.

2. Pond size and construction

- Size of pond depends on factors like number of cultured species, quantity of supplemental feed required and availability of resources.
- For small holders, an area of 6 X 4 feet for *Azolla* cultivation can produce about one kg of supplemental feed per day.
- Selected area should be cleaned and levelled. The side walls of the pond can be of either bricks or raised embankment with the excavated soil.
- After spreading the durable plastic sheet (silpauline, a polythene tarpaulin) in the pond, all the sides have to be secured properly by placing bricks over the side walls.
- After the inoculation of culture, the pond needs to be covered with a net to provide partial shade and also, to prevent the fall of leaves and other debris into the pond.
- Thin wooden poles or bamboo sticks are to be placed over the pond walls to support the shade net.
- Bricks or stones can be used as weights on the edges for securing the plastic sheet and also, the net over the pond area.

3. Production of *Azolla*

- Sieved fertile soil mixed with cow dung and water need to be spread uniformly in the pond.
- About 1 kg of fresh ***Azolla*** **culture is needed for a** pond of 6 X 4 feet size which need to be applied uniformly in the pond.
- Biogas slurry can also be used instead of dung.
- The depth of water should be four to six inches.
- During the monsoon season, if rain water can be harvested from the roof tops and used for cultivation of ***Azolla*****, it will ensure its excellent and faster growth.**
- If the total salt content of the water used for growing ***Azolla*** **is high, it will** adversely affect the growth.

4. Maintenance of the pond

- Application of about one kg of cow dung and about 100 grams of super phosphate once in two weeks will ensure better growth of **Azolla.**
- **Any litter** or aquatic weeds seen in the pond should be removed regularly.
- The pond needs to be emptied once in six months and cultivation has to be restarted with fresh **Azolla**

5. Harvesting and feeding of *Azolla*

- Depending on the initial quantity of culture added, environmental conditions and nutrition, **Azolla growth in the pond will be complete in** about two to three weeks time.
- It can be harvested daily after the full growth. Plastic sieves can be used to harvest the biomass from the pond's surface.
- About 800 to 900 grams of fresh **Azolla (mean yield per day** in a season) can be produced from an area of 6 X 4 feet.
- **Azolla can be fed to the livestock either in fresh** or dried form. It can be give
- **Azolla has to be w** remove the smell o

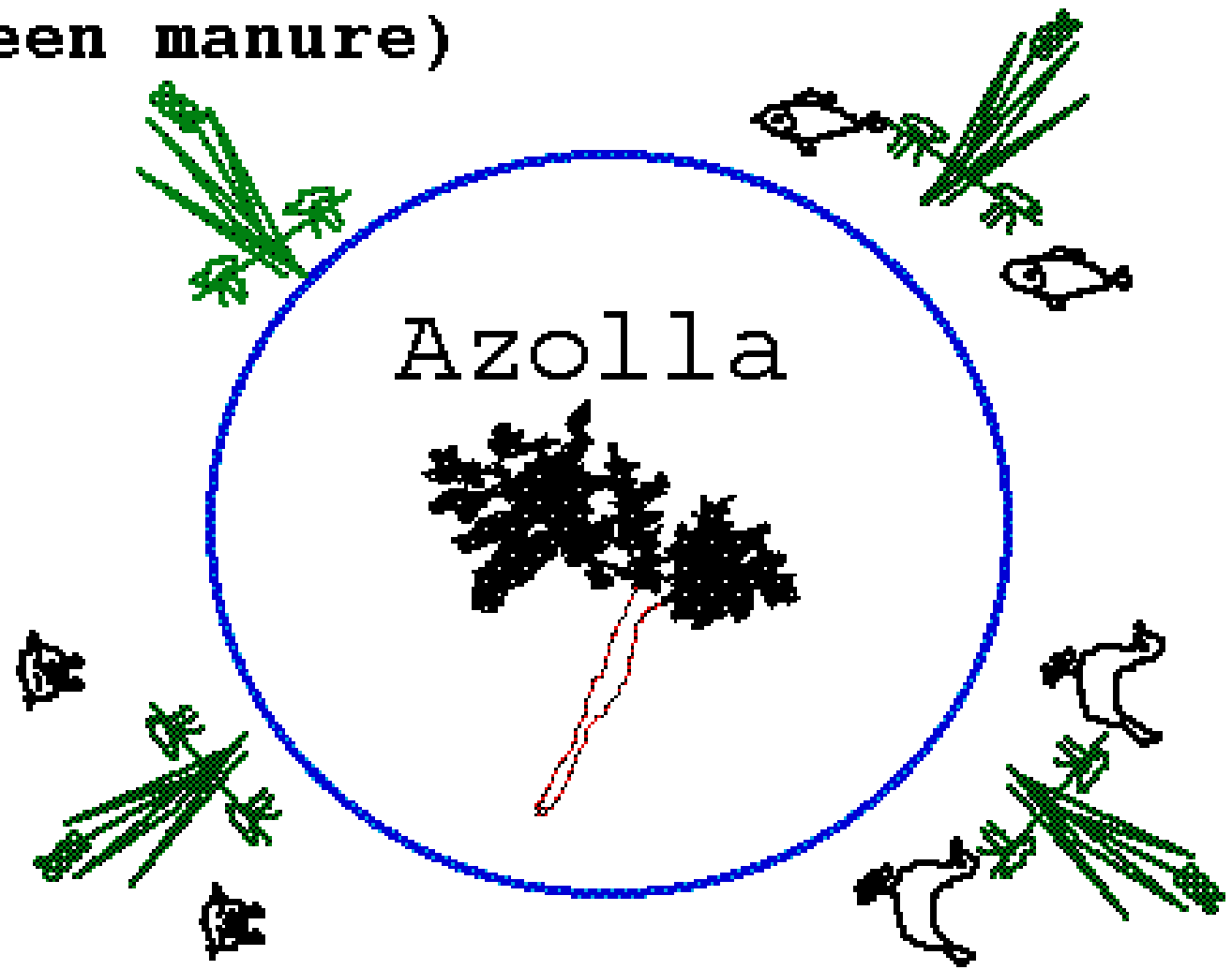
6. Yield of *Azolla*

Azolla produces around 8-10 tonnes of Green mass which is equal to 25-30 kg N_2 which is again equal to 55-66 kg of urea).

7. Economics of *Azolla*

- The expenditure on preparing a 6 × 4 feet pond is minimal at Rs.500 (sheet plus labour cost).
- A farmer can realize a net profit of over Rs. 4000 per annum from the additional fish production and reduced usage of concentrates' feeding for cultured fish species.

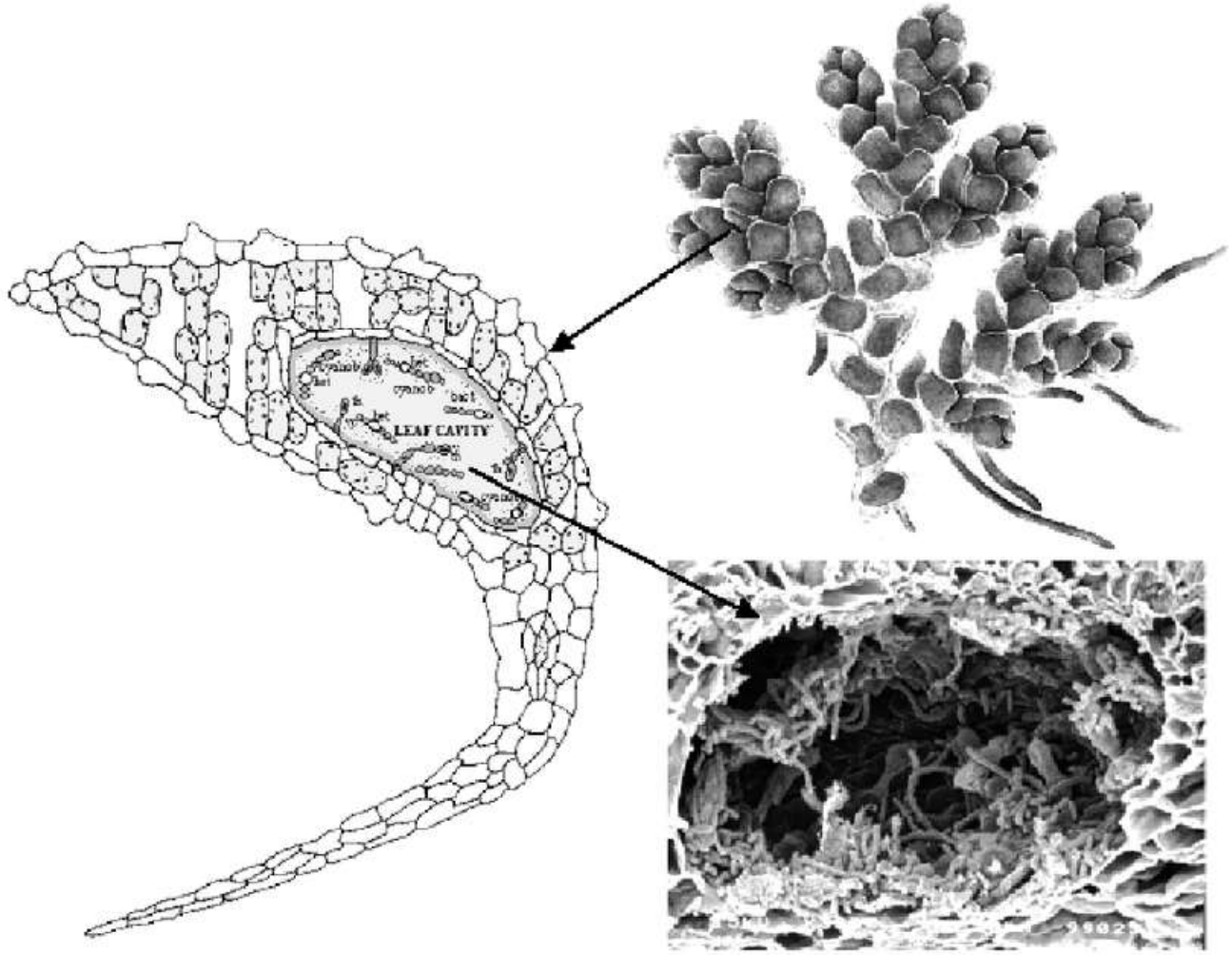
New Horizon of Azolla use



LIMITATIONS OF *AZOLLA* CULTIVATION

- Water is pre-requisite for it's multiplication . so it is not suitable for upland crop.
- Huge quantity of inoculums is required which is difficult for transplanting action during rainy days.
- Temperature more than 35°C is not suitable.
- Extreme low temperature is also not suitable.
- Non availability of technology to use *Azolla* as dry inoculum.
- Non availability of varieties suitable for higher temperature with low pH application.
- Initial cost of cultivation is high.
- Market for azolla is not so
- popular.

Ignorance of people about benefit of *Azolla.*


LEAF CAVITY

Mycorrhizae

Characteristics and Production Technology

Introduction

Mycorrhizae are the symbiotic associations between plant root and fungi, with bidirectional nutrient exchange between the partners.

Vitadini (1842) was the first to recognise the possible beneficial role of fungal mycelia which mantle the root of higher plants.

This association is named as mycorrhiza (pl. mycorrhizae) i.e., the fungal root, by Frank (1885).

The autotrophic host plant acts as the carbon source for the fungus, while the fungus supplies mineral nutrients to the plant. About 90% of all land plants are associated with mycorrhiza. The mycorrhizal association is not available in Cruciferae, Chenopodiaceae and Resedaceae.

Characteristics of Mycorrhizae

- (i) Absence of any phytopathological symptoms in the partners during the active phase of mutualism.
- (ii) Presence of complex interfaces between cells of the partners with a predominant type of perisymbiotic membrane, surrounding intracellular symbionts.
- (iii) Presence of various types of phagocyte like structures during establishment of symbionts and during harvesting phase to control the symbiotic population by the host.

Types of Mycorrhiza

Peterson and Farquhar (1994) classified the mycorrhizae into seven (7) distinct types.

- **These are :**
- (1) Ectomycorrhizae,
- (2) Vesicular-arbuscular mycorrhizae,
- (3) Ectendomycorrhizae (Arbutoid),
- (4) Ericoid mycorrhizae,
- (5) Centianoid mycorrhizae,
- (6) Orchidoid mycorrhizae, and
- (7) Monotropoid mycorrhizae.

Ectomycorrhizae:

- Ectomycorrhiza is commonly called “sheathing mycorrhiza”. They occur in 3% of all seed plants in forests of temperate regions, especially on pine, beech, spruce, birch etc.

Vesicular-arbuscular mycorrhizae (VAM):

- It is a type of endomycorrhizal association, where both vesicles and arbuscles are developed together. VAM is by far the commonest of all mycorrhizae and has been reported in more than 90% of land plants.
- They are found in bryophytes, pteridophytes, gymnosperm (except Pinaceae) and most of angiosperms, commonly in Leguminosae (Fabaceae), Rosaceae, Gramineae (Poaceae) and Palmae (Arecaceae). VAM has even been reported in Lower Devonian plant, Rhynia.
- VAM is produced by aseptate mycelial fungi belong to Endogonaceae under Mucorales of Zygomycotina and those members produced zygospores. The important genera involved in VAM are Glomus, Gyrospora, Acaulospora etc. Most of the members are not culturable.

The AM fungi are important to their hosts as they enhance the ability of plants to absorb phosphorus from soil, which is relatively inaccessible to the plants. However, the AM association may also increase the phytoavailability of micronutrients, e.g., copper and zinc. In a study, absorption of trace elements, such as boron and molybdenum, was thought to be enhanced by VA mycorrhizae. In addition, it has been suggested that some AM associations are able to mobilize organically bound nitrogen, which the plants are unable to absorb.

Symbiotic association of AM fungi with the plants seems influence the composition of bacterial communities in the mycorrhizosphere due to changes in root exudation patterns induced by AM colonization

VERMICOMPOSTING

- ***Definition***

- Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better product.

- Vermicomposting is a method of preparing enriched compost with the use of earthworms. It is one of the easiest methods to recycle agricultural wastes and to produce quality compost.

Vermicompost is stable, fine granular organic manure, which enriches soil quality by improving its physicochemical and biological properties.

Highly useful in raising seedlings and for crop production.

Earthworms consume biomass and excrete it in digested form called worm casts/Black gold.

The casts are rich in nutrients, growth promoting substances, beneficial soil micro flora

Vermicomposting materials

- Decomposable organic wastes such as animal excreta, kitchen waste, farm residues and forest litter are commonly used as composting materials.
- In general, animal dung mostly cow dung and dried chopped crop residues are the key raw materials.
- Mixture of leguminous and non-leguminous crop residues enriches the quality of vermicompost.

Biological advantages	**In many soils, these play major role in converting large pieces of organic matter into rich humus and thus improving soil fertility**
Burrowing activities	The earthworm is of great value in keeping soil structure open, creating multitude of channels that allow processes of both aeration and drainage to occur
Earthworm castings	In home garden, the presence of earthworm castings provide 5 to 11 times more nitrogen, phosphorous, and potassium as the surrounding soil
Secretions in intestinal tracts of earthworms	This help in making nutrients more concentrated as well as readily available for plant uptake including micro nutrients

Species of earthworms

Eisenia foetida (Red earthworm),
Eudrilus eugeniae (night crawler),
Perionyx excavatus etc.

Important characteristics of red earthworm (Eisenia foetida)

Characters	***Eisenia foetida***
Body length	3-10cm
Body weight	0.4-0.6g
Maturity	50-55days
Conversion rate	2.0 q/1500worms/2 months
Cocoon production	1 in every 3 days
Incubation of co coon	20-23days

Types of vermicomposting

Amount of production and composting structures.

- Small-scale vermicomposting:

personal requirement (5-10 tonnes of vermicompost annually).

- large-scale vermicomposting:

commercial scale (50 – 100 tonnes annually)

Methods of vermicomposting

- *Bed method :*

Composting is done on the pucca / kachcha floor by making bed (6x2x2 feet size) of organic mixture. This method is easy to maintain and to practice

- *Pit method:*

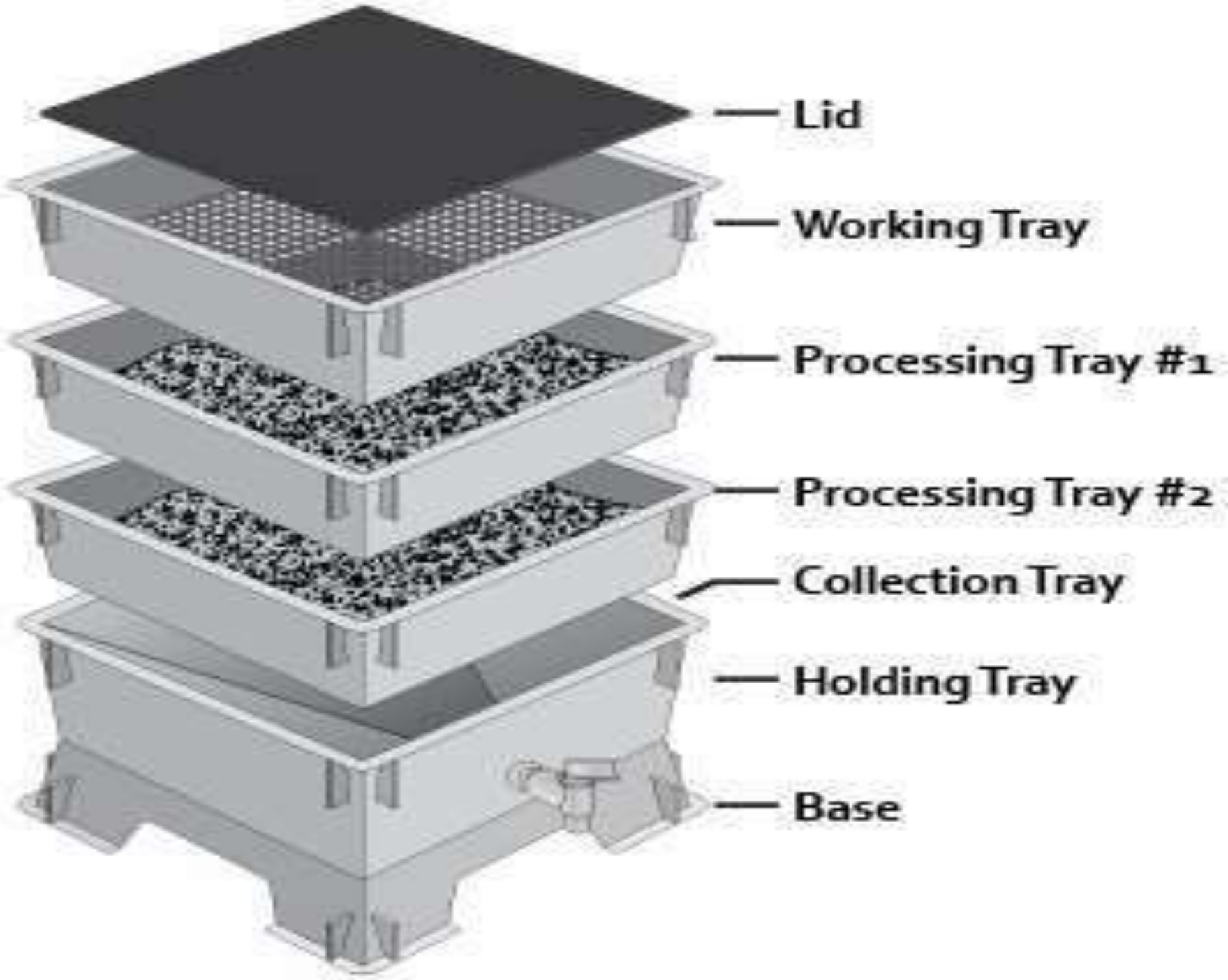
Composting is done in the cemented pits of size 5x5x3 feet. The unit is covered with thatch grass or any other locally available materials. This method is not preferred due to poor aeration, water logging at bottom, and more cost of production.

Bed composting

PIT COMPOSTING

Phases of Vermicomposting

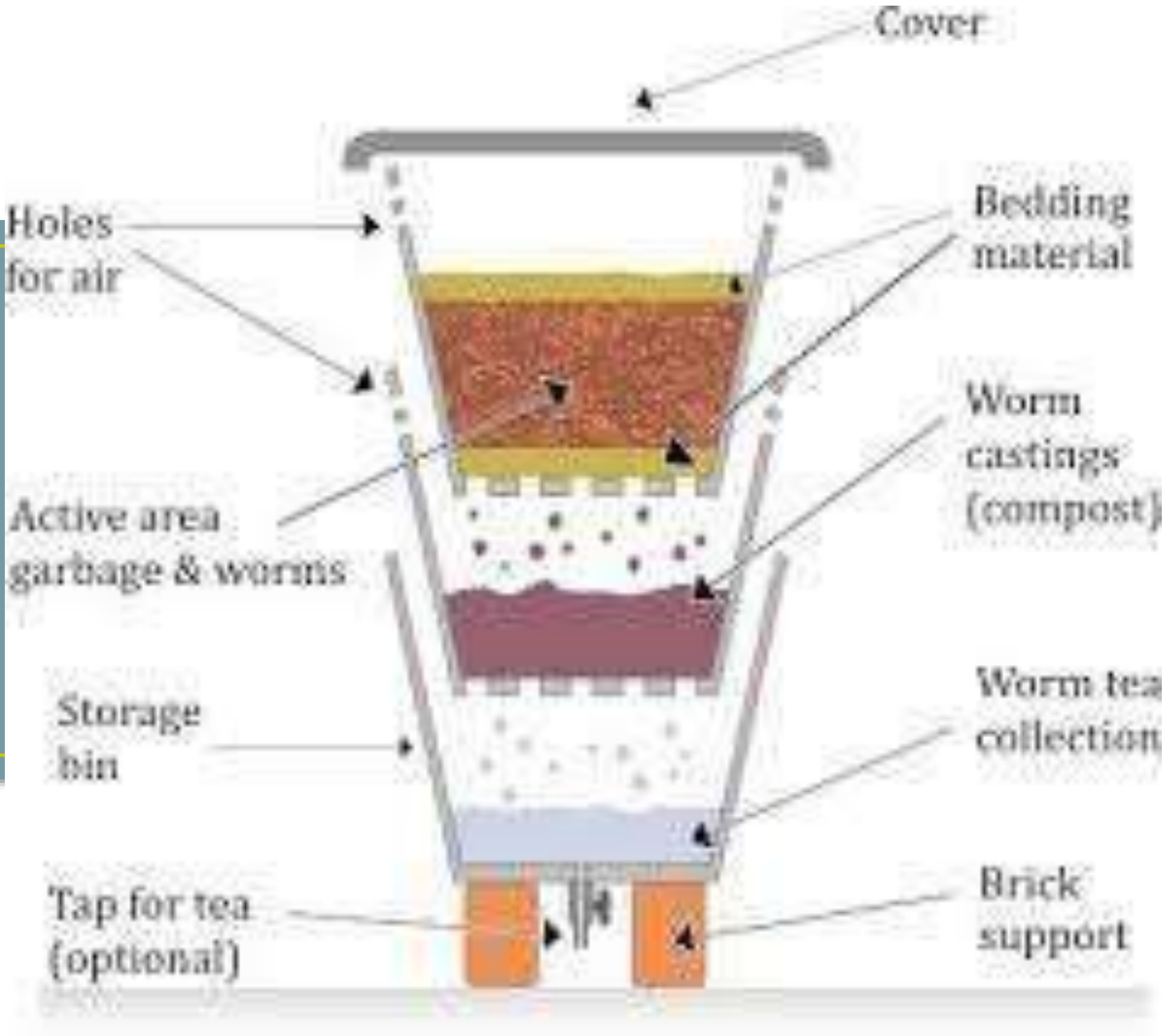
Phase 1	**Processing involving collection of wastes, shredding, mechanical eparation of the metal, glass and ceramics and storage of organic wastes.**
Phase 2	Pre digestion of organic waste for twenty days by heaping the material along with cattle dung slurry. This process partially digests the material and fit for earthworm consumption. Cattle dung and biogas slurry may be used after drying. Wet dung should not be used for vermicompost production.
Phase 3	Preparation of earthworm bed. A concrete base is required to put the waste for vermicompost preparation. Loose soil will allow the worms to go into soil and also while watering, all the dissolvable nutrients go into the soil along with water.
Phase 4	Collection of earthworm after vermicompost collection. Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.
Phase 5	Storing the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.


Lid
Working Tray
Processing Tray #1
Processing Tray #2
Collection Tray
Holding Tray
Base

Steps followed for vermicompost preparation

- Vermicomposting unit should be in a cool, moist and shady site .
- Cow dung and chopped dried leafy materials are mixed in the proportion of 3: 1
- kept for partial decomposition for 15 – 20 days.
- A layer of 15-20cm of chopped dried leaves/grasses should be kept as bedding material at the bottom of the bed.
- Beds of partially decomposed material of size 6x2x2 feet should be made
- Each bed should contain 1.5-2.0q of raw material and the number of beds can be increased as per raw material availability and requirement.

- Red earthworm (1500-2000) should be released on the upper layer of bed.
- Water should be sprinkled with can immediately after the release of worms.
- Beds should be kept moist by sprinkling of water (daily) and b y covering with gunny bags/polythene
- Bed should be turned once after 30 days for maintaining aeration and for proper decomposition.
- Compost gets ready in 45-50 days.
- The finished product is ¾ of the raw materials used.


Cover
Holes for air
Bedding material
Worm castings (compost)
Active area garbage & worms
Storage bin
Worm tea collection
Tap for tea (optional)
Brick support

Harvesting

- When raw material is completely decomposed it appears black and granular.
- Watering should be stopped as compost gets ready.
- The compost should be kept over a heap of partially decomposed cow dung so that earthworms could migrate to cow dung from compost.
- After two days compost can be separated and sieved for use.

Preventive measures

- The floor of the unit should be compact to prevent earthworms' migration into the soil.
- 15-20 days old cow dung should be used to avoid excess heat.
- The organic wastes should be free from plastics, chemicals, pesticides and metals etc.
- Aeration should be maintained for proper growth and multiplication of earthworms.
- Optimum moisture level (30-40 %) should be maintained 18-25°C temperature should be maintained for proper decomposition.

Trouble shooting

- Death of worms
- They are getting enough food----- food should be burried into the bedding
- Food may be too dry---- moisture
- Food may be too wet--- bedding
- Worms may be too hot--- put bin in shade
- Bad smells
- No enough air circulation
- Dry bedding under and over the worms
- Turning of the food

Nutrient content of vermicompost

- The level of nutrients in compost depends upon the source of the raw material and the species of earthworm. A fine worm cast is rich in N P K besides other nutrients.
- Nutrients in vermicompost are in readily available form and are released within a month of application.

Nutrient Analysis of Vermicompost

Parameters	*Content*
pH	6.8
OC%	11.88
OM%	20.46
C/N ration	11.64
Total Nitrogen (%)	1.02
Available N (%)	0.50
Available P (%)	0.30
Available K (%)	0.24
Ca (%)	0.17
Mg (%)	0.06

Nutrients comparison

nutrient element	vermicompost	garden compost
organic carbon	9.8-13.4	12.2
nitrogen	0.51-1.61	0.8
phosphorus	0.19-1.02	0.35
potassium	0.15-0.73	0.48
calcium	1.18-7.61	2.27
magnesium	0.093-0.568	0.57
sodium	0.058-0.158	0.01
zinc	0.0042-0.110	0.0012
copper	0.0026-0.0048	0.0017
iron	0.2050-1.3313	1.169
mangnese	0.0105-0.2038	0.0414

Advantages of vermicompost

- Vermicompost is rich in all essential plant nutrients.
- Provides excellent effect on overall plant growth, encourages the growth of new shoots / leaves and improves the quality and shelf life of the produce.
- Vermicompost is free flowing, easy to apply, handle and store and does not have bad odour.
- It improves soil structure, texture, aeration, and water holding capacity and prevents soil erosion.
- Vermicompost is rich in beneficial micro flora such as a fixers, P- solubilizers, cellulose decomposing micro-flora etc in addition to improve soil environment.
- Vermicompost contains earthworm cocoons and increases the population and activity of earthworm in the soil.
- It neutralizes the soil protection.
- It prevents nutrient losses and increases the use efficiency of chemical fertilizers.
- Vermicompost is free from pathogens, toxic elements, weed seeds etc.
- Vermicompost minimizes the incidence of pest and diseases.
- It enhances the decomposition of organic matter in soil.
- It contains valuable vitamins, enzymes and hormones like auxins, gibberellins