# WATER AS A NUTRIENT CARRIER: ENHANCING MANURE/FERTILIZER EFFICIENCY THROUGH LAYERED SOLUTIONS IN AN INVERTED BOTTLE AND DRIP IRRIGATION SYSTEM

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## INTRODUCTION

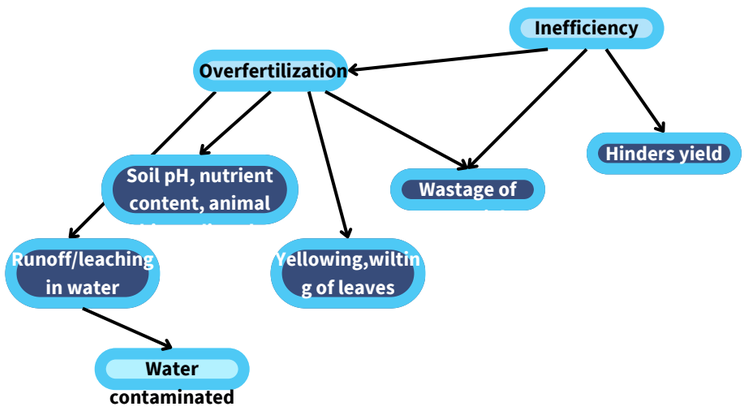
In 2022, global fertilizer consumption stood at 200 million tonnes and with the evergrowing increase in demand for food and other agricultural products; fertilizers, manure and other additives remain the go-to solution when it comes to agriculture, nurseries and also smaller gardners and it is essential to use these substances to increase efficiency.

### Solid vs Liquid Manure/Fertilizer

Fertilizers/Manure can be distinguished into 2 major categories based on their composition, farmer preferences, usage and other relevant physical/chemical factors:

| Reference | Solid | Liquid |
|---|---|---|
| Price Point | 40 INR/kg (avg.) | 130 INR/L (avg) |
| Storage | easy: godowns, warehouses | hard: sealed tanks, drums |
| Transport | easier to transport solids | harder to transport liquids, especially flammable ones |
| shelf-life | longer: 1-5 years | shorter: 6 months - 2 years |
| Nutrient Distribution | irregular | uniform |
| Nutrient Access | slow: needs irrigation | fast: directly available |
| Foliage Feeding | Not possible | possible |

In India and globally, the price of liquid fertilizers is significantly higher than their counterpart solid fertilizer. As a result, 74% of the fertilizer sold in India is solid, whereas a mere 26% is liquid. This sale directly corresponds to farmers and gardeners predominantly using solid fertilizer.
But, as outlined in the table above, soliid fertilizers have low nutrient retention capabilities, due to the low ion exchange. Studies have proven that Water Soluble Fertilizers are more effective than non-soluble fertilizers as they stimulate new root development, reduce flower drop and increase yield and quality of the produce
The problems associated with solid additives:




## OBJECTIVE

- With liquid manure/fertilizers being better for the plants overall, while solid being more economical; this applied research project tries to bridge the gap between the two.
- The desired solution is a system which converts solid manure/fertilizer into a liquid solution which is simple, cheap and has the potential for large-scale implementation.

## FUTURE WORK

1. The addition of a device that measures and displays the exact amount of nutrients, quality and potential effects of addition.
2. The drip irrigation to which is connected can be fully automated.

## METHODOLOGY/ANALYSIS

- An experiment was conduct to test out whether nutrients dissolved in water increase the plant growth rate and quality.
- 3 soil samples were taken with similar conditions, the first Soil Sample A having no manure or additives. Soil Sample B containing solid manure, and Soil Sample C containing nutrient solution given by the plant nutriator.
- With the experiment being conducted, the following results are understood:

- The soil sample with no manure (A) had adequate growth. Most of the seedlings sprouted, growing up to 3-4 cm in length. The plant quality on the other hand was mediocre, with thin stems and leaves being a darker shade of green and having a smaller surface area.
- The soil sample with only solid manure (B) had very poor growth. Some seedlings had sprouted, although only 4 grew to 2-3 cm. A majority of the other seedlings did grow initially but later broke off from the main stem due to poor stem strength. But of the 4 that grew, their leaf quality was considerably better and had a light-green shade
- The soil sample with the nutrient solutions (C) had superior growth. Most of the seedlings had sprouted with none of them showing inferior quality. The leaf quality was the best, with light-green leaves and a larger surface area. The saplings grew up to 5-6 cm each.

| | Plant A | Plant B | Plant C |
|---|---|---|---|
| Specifications | No manure/additives | Solid manure/additives | Used the Plant Nutriator |
| Avg. Height at Day 7 | 2 cm | 2 cm | 3 cm |
| Avg. Height at Day 14 | 4 cm | 3 cm | 6 cm |
| Stem Width, desc. | Thin, light green | Very thin, pale | Thicker, light green |
| Leaf Surface | medium surface | small surface | larger surface |
| Leaf Colour | Green | pale green | Green |
| No. of Seeds Sprouted | 15-18 | 7 | 14-16 |

### The Plant Nutriator

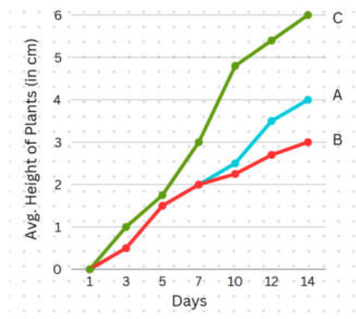
- This is a simple device made from a plastic water bottle in which nutrient solutions are placed. These solutions can be traditional manure, fertilizer and any other plant-aiding additives.
- Water is let in, which then absorbs nutrients from the nutrient solutions and is then sprayed on to plants whenever needed. This design is more preferable than manually mixing all the solutions of nutrients and water together, which is not ideal for larger usage and can cause overfertilization; instead of our physical work, gravity alone will let the water flow, through all the nutrient solutions and into the storage unit; to be released when the bottle is squeezed.

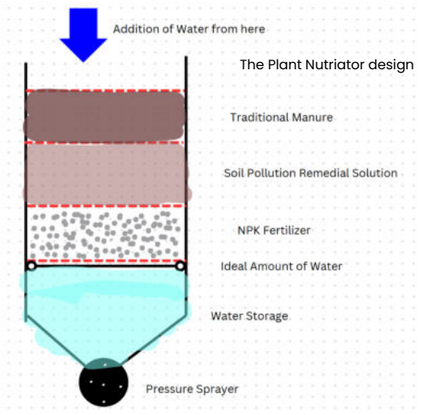
- In my experiment, traditional manure and 10-10-10 NPK fertilizer was used.

- The flow of water is can be described as:
  1. Water is first added to the larger end of a plastic water bottle.
  2. It then slowly percolates through traditional manure, consisting of animal feces, fruit/vegetable peels and any other readily available biodegradable substances. This is usually available at any nursery or gardening store.
  3. There is a 10-10-10 composition NPK layer below it. Some NPK fertilizer can be toxic if excess is added; Instead if a diluted or organic NPK is used, there is no risk for overnutrition.
  4. After this dual stage process, the water, containing all these nutrients, is collected at the base of the bottle [near the cap], with the cap closed. The cap has 5 minute holes, so when pressure is given, water is released like a sprinkler.

- The water accumulated at the bottom had 1.2 grams of NPK per litre/ The ideal amount is considered to be 1.5 - 2 grams. On increasing the concentration of NPK or increasing the height of the NPK layer, the ideal threshold can be obtained.

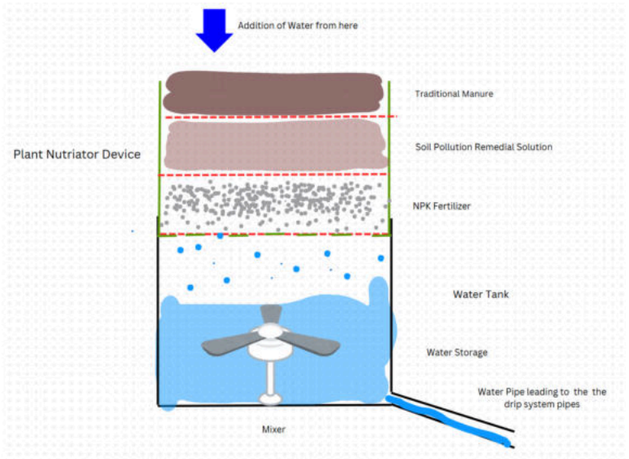
Result of the experiment after 14 days




## IMPLEMENTATION/IMPACT/NOVELTY

- As of 2024, 20% of India's farmland follows a drip-irrigation system, with evergrowing demand.
- Drip irrigation systems have small nozzles spread out all throughout the farm in order to provide minute irrigation for an extended period of time.
- The Plant Nutriator device can be placed on top of a tank which supplies water to the drip irrigation system. A mixer continues to dissolve the few undissolved particles, to ensure that the pipes do not clog. This ensures that all the water supplied to the plants already contains the sufficient amount of nutrients without having to do any effort.
- Farmers would not need any additional effort for the addition of fertilizers/manure. The flow of nutrients would be uniform and in control. They can use different fertilizers, or alternate between them easily by switching out nutrient solutions. The amount of particles per litre can also be varied by increasing the height of a layer.
- This model also uses of abundantly available substances and has customisability of nutrient solutions based on terrain, vegetation, region, farm-type
- It has the potential to save farmers about INR 15,000 per hectare, due to the reduction in use of liquid fertilizers.




## CONCLUSION

- The multi-staged structure solves the problems presented effectively and ensures that overfertilization and other inefficiances are overcome.
- Both the small-scale and large-scale models let water absorb nutrients from the nutrient solutions and directly enter the soil without the rigidity of directly adding solid manure. This invention bridges the gap between liquid and solid fertilizer/manure by combining the advantages of both, being cheap, easy to store, handle and transport, along with rapid absorption by the plants, even distribution and a quicker response.

### Imp References:

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