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Net-Zero Hydroponics System-Ecoponics

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***Abstract*— The recent pandemic of COVID-19 had convulsed every nation on this globe. Panic and fear had engulfed everyone and everything. In order to be safe from the disease, people had to cage themselves in their homes and governments had to provide their citizens with various relief packages. Most of the countries are still struggling to recover the losses caused during this time. Being specific to India, the concern of arranging for ration during this time created a ruckus almost everywhere.**

There would have been lesser trepidation and strain on the food resources of country if there was some sort of self-dependency in people about growing their own food. Therefore, the intention behind the concept of "Ecoponics" is to develop a gravity powered zero energy consuming hydroponics system that can be used for indoor farming by any household or individual. The system plans to use the principles of a 'Ram pump' and harness Kinetic energy of the waste water from waste valve of the pump to power the system replacing electricity and start a perpetual motion of water, so that the system would not need any human intervention for a considerate amount of time.

Index Terms—*Ecoponics, Hydroponics, Ramp Pump, Perpetual Motion*.

I. INTRODUCTION

Agriculture sector has a great significance in India as it contributes around 16% in the country's GDP and almost 10% in the total exports of the country [5]. With the increasing population of the country and constantly elevating demand for food the farming techniques have become poor and non-ecofriendly. The use of more and more chemicals for a greater crop yield is destroying the land fertility and degrading the quality of the yield as well.

Also, due to rapid population increase, agricultural land is being converted and used for construction of apartment buildings and townships. While it is inexorable to stop this conversion of agricultural land to residential areas, it is necessary to maintain enough agricultural yield to meet the food demands of the country that hosts 17.7% of the global population which is the most after China [4].

With poor farming techniques but greater food demands the harvest from most farmers is not of desired quality. In order to keep pace with the ever increasing supply demand, the farmers are forced to use various chemicals to have a generous yield even if compromises are to be made with the quality of crops. This leaves people with no choice but to buy low quality farm products or pay extremely high prices for some good quality crops.

This must infuse a sense of exigency in people for being able to grow their own food and be sure of yielding high quality crops with eco-friendly farming techniques. However, it is not easy to grow crops in the comfort of home unless all the groundwork is executed properly. A system that is pre-engineered and is ready to use by people with minimum efforts of their own and grow crops can prove to be a savior.

The system of 'Hydroponics' is one such indoor farming technique that is widely adopted by many to harvest premium quality crops. There are a few startups that offer such systems in various sizes to choose from for different space types or need. This paper will discuss about a different approach towards the system of hydroponics, where no electricity will be used, making the system 'Net zero'.

II. CONVENTIONAL HYDROPONICS SYSTEM

The term Hydroponics was derived from the Greek words 'hydro' means water and 'ponos' means labor [2]. It is an indoor gardening or farming technique that uses no soil but mineral nutrient solutions as growing medium for the plants [2]. In such an arrangement terrestrial plants are grown with their roots in the mineral nutrient solution, though inert mediums such as perlite, gravel, or mineral wool may also be used along with the solution but they don't have any part to play in the plant growth and are rather play a role of ornamentation [2].

Most hydroponic systems use a pump to supply nutrient mineral solution to the plants that are potted in channels which hold the solution. These channels are designed to make a close loop, wherein the solution getting into these channels reaches back into the same reservoir it was supplied from. This reservoir is kept close to the system from where the pump continuously supplies the solution in the system ensuring optimum aeration that prevents foul smell that stagnant solution might generate.

As the system requires continuous supply of solution, it demands uninterrupted electricity supply. In a country like India, not many cities can meet up to such demands. Moreover, in times of natural calamities or harsh weather conditions, electricity supply has to be withdrawn in many regions for safety concerns. Therefore, conventional hydroponic systems also require a sound power back-up system to keep the growing medium flowing through the channels at all time.

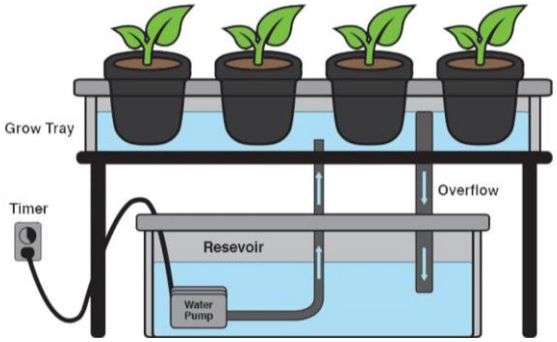

Fig. 1_ Typical Hydroponics system arrangement [6]

III. WHAT IS ECOPONICS?

Ecoponics is a hydroponics system that uses gravity to pump water instead of electricity. The system is designed to use a hydraulic ram pump for supplying nutrition solution to plants in a closed loop so that the pumped solution reaches back to the main reservoir and the cycle continues. The hydraulic Ram pump uses kinetic energy in the solution that flows from main reservoir to downhill and pumps part of the solution to a height above that of the main reservoir [1]. As the system is in a closed loop, the pumped solution reaches back to the main reservoir from where it goes through the same cycle without help of any external energy source like electricity [1].

However, there is one drawback of using a ram pump, that it only pumps a little more than 10% of the total solution being supplied to it, and the rest is wasted fundamentally. This extra solution comes out of the waste valve, that is one of the components in a ram pump. While the waste valve rejects this solution, it induces some kinetic energy into it due to which it splashes out of the valve.

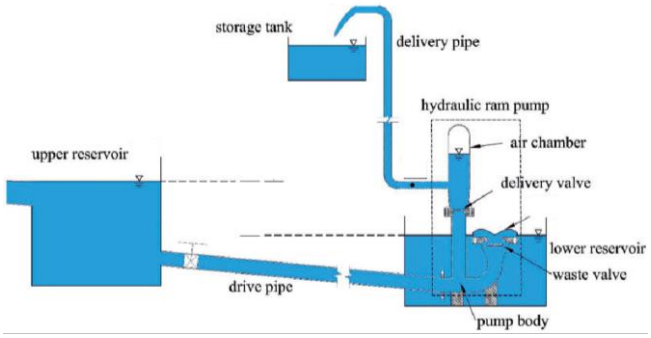

Fig. 2_ A typical ramp pump diagram [7]

In the system of Ecoponics, the wastage from waste valve is collected in a tumbler that is customized to use the induced kinetic energy in the solution when it leaves the waste valve and supply water back to the main reservoir. Hence, this system uses the same solution to supply in the system for a long time, like the conventional hydroponics system but without using any electricity.

IV. WORKING OF ECOPONICS

1. The system shall have a water tank (main reservoir) that supplies nutrition solution to the drive pipe (1/2-inch diameter) from a height of 4 feet.
2. The drive pipe shall have a length of at least 20 feet while carrying the solution at a head pressure of 4 feet to ensure optimum supply to the ram pump.
3. To start the system for the first time, valve connecting the main reservoir and drive pipe is turned open and the solution is supplied to the ram pump.

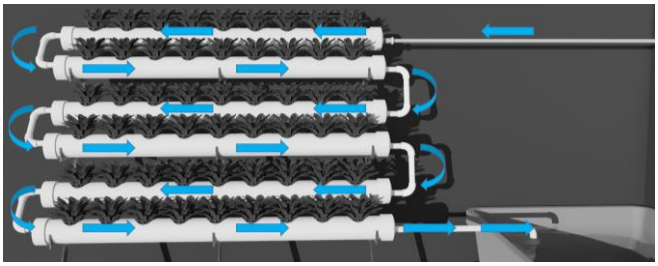

Fig. 3_ Solution travelling diagram in the channels.

4. The ram pump is a 3/8-inch ram pump in this case which is supplied with nutrition solution from a 1/2-inch drive pipe.
5. The ram pump then pumps the solution into the channels or PVC pipes with potted plants through a delivery pipe of 3/8-inch diameter from where the solution reaches the main reservoir again after completing a full cycle.
6. In the process of pumping the solution, ram pump releases a lot of wastage from the waste valve that is collected in a tank.
7. This tank is customized to harness the kinetic energy of wastage from the waste valve, catalyze it and channelize it.
8. This alteration in the tank is done to ensure that the solution leaving the waste valve gains more kinetic energy due to gravity.

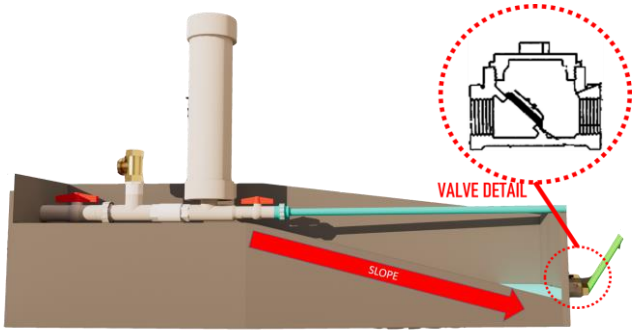

Fig. 4_ Waste water collection tank section.

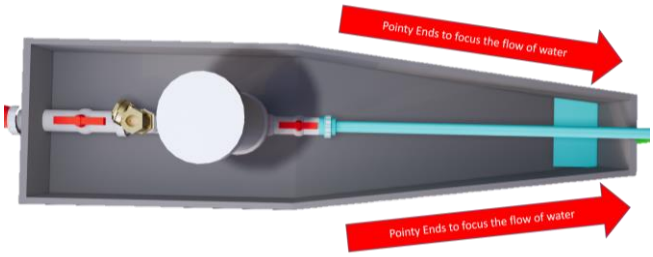

Fig. 5_ Waste water collection tank plan.

9. At the end of this waste water collection tank, there is a swing check valve that is connected to a 1/4-inch PVC pipe (waste water delivery pipe) that opens up into the main reservoir.
10. The solution splashing out from the waste valve of ram pump possesses some kinetic energy, thus flows through the swing check valve into the waste water delivery pipe.
11. Once the solution enters the waste water delivery pipe, its reverse flow shuts the valve close and stops it from flowing back into the waste water collection tank.

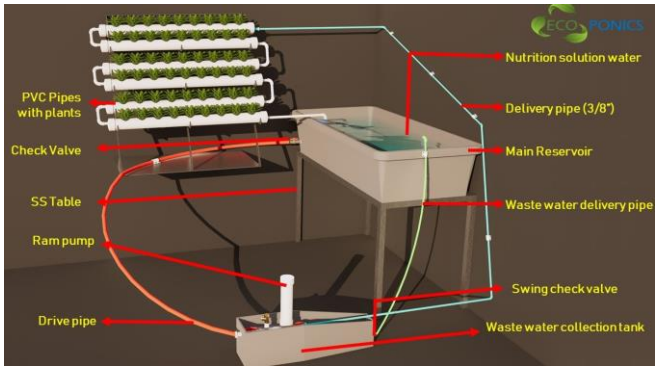

Fig. 6_ Ecoponics system diagram.

12. The waste solution continuously splashes out of the waste valve and flows through the swing check valve into the waste water delivery pipe, due to which the level of solution increases in the waste water delivery pipe until it starts to fill the main reservoir.

13. The waste water collection tank is placed close to the main reservoir so that the solution in waste water delivery pipe has to travel the least distance to reach the main reservoir, thus increasing the efficiency of the system.

16. This system proposes to facilitate a kind of perpetual motion of nutrition solution throughout the system because a perpetual motion continues to function perpetually even if no external energy is supplied to it [3].

V. NET-ZERO INDOOR FARMING WITH ECOPONICS

The proposed system uses no electricity, thus saving electricity costs for anyone who wishes to use hydroponics. This system can prove to be handy for the farmers in remotest of villages, where electricity supply is unreliable. Maintaining favorable indoor temperatures suitable for the plants won't be difficult for such farmers using passive techniques. They can grow food of their choice without any concern of water scarcity or climate change. Also, the farmers will not have to live their lives like nomads and travel to different areas in search of suitable climate for their crops. If the technique is adopted by most of the farmers, it will reduce the water demand drastically.

Using this system is really simple as it only uses nutrient solution to grow crops in controlled temperature. Also, it ensures quality crops grown without use of harmful pesticides; hence the yield from such a system embodies greater nutrition value.

VI. FINANCIAL BREAKDOWN OF THE PROTOTYPE

The material and transportation cost has been considered in the bill of quantity figure (BOQ) below. Labor cost has not been added as that varies in every region. Additional costs may be incurred after procuring all the items due to prototyping errors. All the other material cost would more or less remain the same in various places.

Sr.No	Item	Unit	Quantity	Rate (₹)	Amount (₹)
1	3/8" Ram Pump	Pieces	1	10,000	20,000
2	1/2" Hose Pipe	Feet	20	13	260
3	1000 litre water tank	Pieces	1	3,500	3,500
4	100 litre water tank	Pieces	1	2,000	2,000
5	Polyethylene corrugated sheets (15mm thick)	Sq.ft.	10	45	450
6	Plastic welding torch	Pieces	1	3,000	3,000
7	3/8" Hose Pipe	Metre	12	20	240
8	1/2" Swing check valve	Pieces	1	200	200
9	1/2" Check valve	Pieces	1	200	200
10	UPVC Metal clamps	Pieces	10	25	250
11	150mm PVC Pipe	Metre	12	300	3,600
12	1" PVC Elbow joints	Pieces	15	70	1,050
13	1" PVC Pipe	Metre	10	50	5,000
14	MS Flat section	KG	20	50	1000
15	60W Soldering machine	Pieces	1	3,000	3,000
16	Transporation costs	Kms.	200	3	600
16	Stainless steel table	Pieces	1	5,000	5,000
17	TOTAL COST				49350

Fig. 7_ Bill of Quantity for a prototype of Ecoponics.

CONCLUSION

The system is designed to be used at a small scale right now and it is conceptualized to increase self-dependency in people in terms of growing their food. The prime motive for its concept development has been to have a system in which everyone can have access to quality food that they can grow on their own under their watch and under their roof.

To be used at macro level, the same system can be replicated and multiple such systems can be stacked or installed horizontally. This can be done to help farmers take advantage of this net-zero farming technique as all the components used in the system are readily available everywhere.

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