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# Negative Pressure Irrigation System

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**ABSTRACT:** Subsurface irrigation can effectively improve water use efficiency by supplying water directly to the crop root zone. The process in which the pressure of the water supply is controlled to a negative value relying on soil matric suction and is called negative-pressure irrigation (NPI). Consequently, NPI can regulate soil moisture precisely and continuously, improving crop productivity by controlling root zone soil water and solute content at optimal levels for crop growth via irrigation pressure and emitter hydraulic conductivity control. NPI can also reduce surface evaporation, runoff, and deep seepage loss over the growing season compared to traditional drip irrigation methods. The continuous and stable water supply produced by NPI has been results in improved plant height, stem diameter, fruit yield, and water use efficiency compared to drip. Moreover, because NPI integrates water and fertilizer delivery, it is appropriate for vegetable production. More than 25 lakh hectare area in India is under water in flood hit states of Gujarat, Rajasthan, Bihar, West Bengal and Assam according to preliminary reports of these state governments. A New technology namely negative pressure irrigation system based on the principle of soil water dynamics. It is one kind of subsurface irrigation has been widely used to reduce the conveyance, evaporation and percolation losses. By using this technology, the irrigation water can be automatically supplied from the source tank lower than the irrigation field without the pumping system which is effective management of irrigation water. The effectiveness of the system depends upon the soil wetting pattern as well as the characteristics of the porous pipes.

**KEYWORDS:** Negative Pressure, Subsurface irrigation, Soil matrix suction.

## I. INTRODUCTION

There is a global crisis about water and its management. The crisis is significantly about availability of water for use and its highly uneven spatial distribution. Measures to increase water supply such as completion of storage dams, interlinking of rivers, desalination of sea-water and artificial recharge of groundwater and rainwater harvesting are costly and long term steps (Sipes, 2010). The marginal gains from traditional, civil and engineering oriented solutions have increasingly become costlier and more difficult to achieve. Agriculture accounts for a majority of global freshwater withdrawals and almost all in some fast-growing economies (WWDR, 2012). At the global level more than two thirds of the blue water withdrawals are for irrigation. Irrigated agriculture represents almost a fifth of the total cultivated land but contributes more than one third of the total food produced worldwide (FAO, 2012) and therefore it is of critical importance to sustenance of the human race. In India the area irrigated with groundwater has increased 500% since 1960. As of 2009, annual ground water withdrawal for irrigation has been estimated as 221 billion cubic meters (BCM). The overall irrigation efficiency in India is often found to be quite low compared to global standards due to the use of conventional flood irrigation technique, practiced in large parts of India. Micro – irrigation (MI) techniques, including drip and sprinkler irrigation, were introduced as water saving technologies (Narayanamoorthy, 2003). They were expected to make a contribution to conservation of the water resource in India. (Phansalkar and Verma, 2008). In this series a new technology named NPIS system is found to be an effective method to conserve water. Micro-Irrigation has made its mark as an agri-input that enhances productivity and enables cash crop and in some cases export oriented cultivation using very little water by enabling better nutrient management. Various field experiments have shown this technique to increase farm level water use efficiency up to 80 - 90% depending on the crop and soil type (J- Tech Transfer and Trading Fukuoka, Japan).



## II. RELATED WORK

MADHU MOHANAN, APRIL 23, 2021 entitled as “PRESSURIZED IRRIGATION” said that In pressurized irrigation systems water is pressurised and precisely applied to the plants under pressure through a system of pipes. Pressurized irrigation systems, as opposed to the surface irrigation systems, are more effective in application of irrigation water to the crops. They provide improved farm distribution, improved control over timing, reduced wastage of land in laying field distribution network, reduced demand for labour and better use of limited water resources. There are many variations of pressurized irrigation systems but the two major ones are: drip irrigation systems and sprinkler systems. Among them, there are many variations depending on the type of field, the crop and the kind of water delivery fittings needed, but the components of the basic system remain the same. They consist of the control station where the pressure is applied; the mains and sub mains, which are pipes of differing dimensions; the manifolds or feeder pipelines; and the laterals or irrigating pipelines equipped with emitters (in drip irrigation systems) or other fixtures delivering water to plants or spray booms for forage and grains and centre-pivot systems (in sprinkler systems). Fertilizer injectors can be incorporated into pressurized irrigation systems to perform fertigation.[1]

JUNAID NAWAZ CHAUHDARY, GHULAM SHABBIR, SHAHZAD AHMED AND AHMAD WAQAS entitled as “PRESSURIZED IRRIGATION SYSTEMS” said that Pakistan’s cultivable area lies mostly in arid and semiarid climatic regions. Thus, more than 80 percent of its irrigation water requirement is met either through canal system or groundwater pumping. As the population is increasing every year, food requirement is also increasing and thus water required to produce more food is ultimately going higher every year. On the other hand, the per capita water availability is reducing and groundwater extraction is increasing annually. Therefore, the overall available water resources (surface and groundwater) are shrinking. Consequently, there is an imbalance between supply and demand, which demands more efficient utilization of the available water resources. Use of pressurized irrigation systems (Sprinkler and Drip Irrigation Systems), which have performance efficiencies significantly higher than the gravity irrigation system, may help solving the problem. Adoption and successful use of pressurized irrigation systems require that all the stakeholders, practicing irrigated agriculture, including farmers and professionals must update their knowledge about these systems. The Punjab Irrigation and Agriculture Departments have recently launched LBDCIP and PIP projects to introduce high efficiency irrigation systems (HEIS) among farmers for row crops, particularly cotton, maize, sugarcane vegetables and orchards on a participatory basis. Thus, it becomes important to provide sound knowledge based information to the professionals and users of these systems through books and other printed materials.[2]

S. AHMAD, M. YASIN, G. AKBAR, Z. KHAN AND M.M. AHMAD entitled as “PRESSURIZED AND INNOVATIVE IRRIGATION SYSTEMS: RAINGUN SPRINKLER SYSTEMS” said that Exploitation of groundwater for agricultural, municipal and industrial uses is severely hampered in many parts of the world by the encroachment of brackish groundwater in response to fresh water withdrawals. Examples of brackish groundwater intrusion are common in coastal aquifers, but are sometimes present in inland aquifers as well. Probably, the most important example of the latter case exists in the Indus Basin Irrigation System (IBIS). The IBIS has caused disruption of hydraulic regime due to seepage from extensive water conveyance and distribution system, as well as deep percolation from irrigation and precipitation. The native groundwater that existed in the pre-irrigation period (early 19th century) was saline because of the underlying geologic formation being of marine origin. Now, this native saline groundwater is overlain by fresh groundwater due to seepage from rivers and canals of the IBIS.[3]

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS entitled as “HANDBOOK ON PRESSURIZED IRRIGATION TECHNIQUES” said that In the Proceedings of the Consultation on Irrigation in Africa (Lomé, Togo, 1997) irrigation was defined as “the application of water supplementary to that supplied directly by precipitation for the production of crops”. Although clearly defined, irrigation has not been clearly identified and separated from the wide-ranging area of water development activities, such as major and minor constructions for water harvesting, storing, conveyance and allocation; the drilling of tube-wells; and pumping. Most of the efforts and investments made in many countries for irrigation development result in water resources development and very few in on-farm water use improvement. The application of improved irrigation methods and techniques on small farms is expanding rapidly as a result of the increasing demand for higher irrigation efficiency, improved utilization of water and intensification and diversification of production. [4]



### III. METHODOLOGY

Power supply has had major impact on the farmers in a variety of ways. It transformed the irrigation system. Larger areas could be irrigated in lesser time with the help of tube wells and pump sets, which ran on power supply. It is used to generate motor which is use to pump out water, this water is used as irrigation water in fields. The water pump works using the water suction method which drains the water through its inlet and released it through the outlet. A Siphon arrangement is set up and hence the surface tension pulls the stream of liquid into separate droplets inside of a sealed air-filled chamber, preventing the liquid going down from having contact with the liquid going up, and thereby preventing liquid tensile strength from pulling the liquid up. This allows flow of water or stoppage of water to the plants by using an automated irrigation system. In this system the same method is applied to maintain constant water level in the control tank. Here, the sensor is used. When using for large field, ball tap arrangement is recommended. PVC hose for suction and discharge for use with liquid agricultural fertiliser, air-flow seeding lines, drainage lines, irrigation, drainage pumps and garbage suction, rock dust, and water in general. Here it is used to carryout water to the porous pipe which is at the root zone of plants. In this system, ceramic porous pipe is used since it withstands high temperature. Good rigidity and dimensional stability.

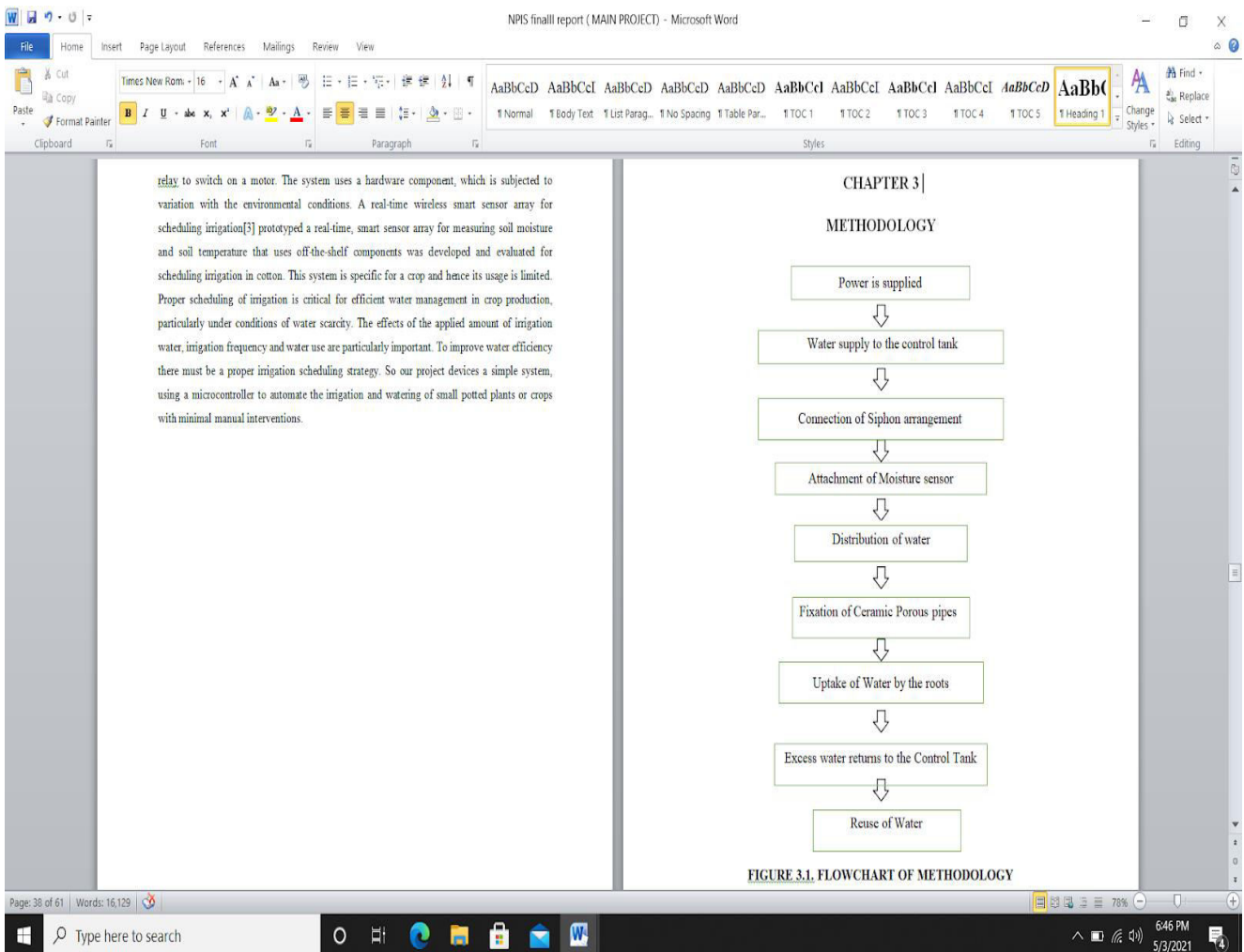


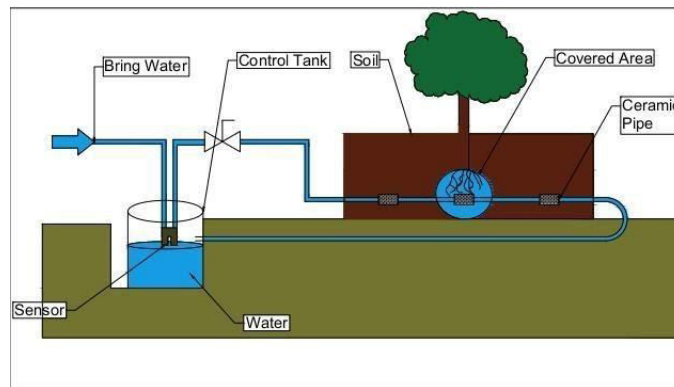
FIGURE.1 METHODOLOGY

Can be coated or immobilized with virtually any catalytic or other functional materials. High porosity and uniform pore size enable low resistance for liquid flow. A single tree will have many xylem tissues, or elements, extending up through the tree. The roots search for water when required. Here the porous pipe is placed directly below root zone making the plants easy to meet their water requirement. Hence now negative pressure is created at porous pipe and

water reaches the porous pipe. The pores get saturated and the roots keep on continuous uptake of water from the porous pipe whenever required. Once the pores of porous pipe get saturated and the plant's water requirement is fulfilled, the water flows back to the control tank. This is to avoid wastage of water. During rain, the soil will have enough water to meet the water requirement of plant. Hence no water is supplied. Now water is saved. Water reuse generally refers to the process of using treated wastewater (reclaimed water) for beneficial purposes.

#### IV. EXPERIMENTAL RESULTS

Figure illustrates embodiment of the present invention in which the negative pressure difference water supply system comprises a single water tank. The water supply system also comprises a circulating pipe having inserted therein a ceramic porous tubes. The circulating pipe has an inlet end inserted into the tank and opens under a water level and an outlet end above a water level. The circulating pipe has a pump disposed downstream of the porous tubes. So that a negative pressure sufficient to suck the water in the tank through the inlet end and to discharge from the outlet end is generated within the pipe. Also in this embodiment, the water in the ceramic porous tubes is allowed to seep out of or into the porous tube through their porous walls according to the pressure difference between the inside and outside of the porous tubes. As has been described, according to the negative pressure difference water supply system of the present invention, gas bubbles formed in the ceramic porous tubes embedded in the soil can automatically be purged by the water low within the supply pipes with a relatively simple inexpensive siphon arrangement.



**FIGURE.2 PROPOSED BLOCK DIAGRAM**

The roots of the plant which generally extend in continuous search for water and nutrient elements do not have to expand for a long distance because the water supply is readily available in the vicinity of the plant roots when the negative pressure difference water supply system of the present invention is utilized, so that the amount of soil needed for growing the plant may be small.

An excess amount of water is not supplied to the soil, so that the soil is not hardened due to the over-watering. Therefore, the soil is not hard and has sufficient oxygen supply even after the cultivation, so that a subsequent cultivation can be carried out without the need for ploughing.

Also, since the watering is carried out underground in this system, the pathogenic fungi within the soil are not spread by the water splashes of surface watering or rain, thereby decreasing the plant damages and disease.

#### V. CONCLUSION

The developed cultivation system would be a useful and practical technique for vegetable production. It is found that the soil moisture content for plant growth can be maintained satisfactorily throughout the growth period regardless of plant type. The pressure distribution was also influenced by the position of the source in the system. It has been found that the pressure distributions differ in the direction of water circulation. Among the irrigation methods applied, the use of a "self-irrigator" with porous ceramic tubes filled with water under a definite negative pressure (negative with respect to the atmospheric pressure) seemed to be most suitable for the uniform supply of water due to its adaptability to water consumption. By this technique, we have grown spinach and it gave sprouts in 3 days which may take up to 5-



9 days in normal cultivation method. The growth of plant is recorded and this result showed that there was no wastage of water.

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