New Aspect for Organic Farming Practices: Controlled Crop Nutrition and Soilless Agriculture

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***Abstract*— It has been a great leap through the biotechnology by enabling genetically modified crops to farmers for getting best ever yields. Yet the practice itself and the output is still questionable in regards of its safety. For the modern era a reliable way is open for productive organic farming practices through the adoption of technology. No questions on biotechnology and its outputs are analyzed here. New breakthroughs can be made in the field of modern agricultural practices through technology aided organic farming. Various modern organic farming practices and new aspects for efficient large scale organic crop cultivation methods are discussed. Some proposals are also made in this work.**

Keywords—hydroponics; aquaponics; aeroponics; organic farming; indoor farming.

I. INTRODUCTION

There are various methods for successive organic farming using technological aids. There are methods for large farm lands as well as cultivations indoor home cultivations.

Using a method of pipe fencing, automated plant watering is possible in necessary levels by subdividing large farm lands. Optimum amount of water and nutrition can be distributed to crops by this technique. Hydroponics is a recent and a very best method for soilless organic plant development. Cultivable plants can be grown in dynamic water flowing pipes. Nutrients are circulated through the water. This method is being tested for the cultivation of food crops as well. Hydroponics along with aquaculture is a self-feeding mechanism. This sustainable method can be implemented in individual homes as well as in a large scale level.

These methods can considerably make organic farming an easy and routine process at homes. The above implementations have potential possibilities for finding solutions to meet growing food demand in the near future. A simpler integration and leverage is needed to make these techniques feasible for common people and farmers in the market.

II. MODERN METHODS IN ORGANIC FARMING APPROACH

A. Hydroponics: approch of soilless farming

Hydroponics is a modern method soilless plant culture. It requires a network of specifically cut and designed PVC pipes through which water is flowing and through which nutrients are continuously delivered to growing plants. This method has great impact in the modern plant culture because of its concise nature and ability to be automated. Home cultivators interested in seamless organic cultivation are choosing market available hydroponic systems today.

Nutrient Film Technique (NFT) is the prominent hydroponic technique. The system requires side opened pipes to grow plants upward from the crust of the nutrient water flowing inside. NFT can grow the plants in very short periods. The system is automated by deployment of various sensors for pH, solution conductivity and temperature measurements. Efficient conditioning circuits for pH and conductivity is used and PVC is the preferred material for the pipes [1] .These sensors determines the potency of nutrient water which is continuously flowing through the plant roots.

a. Advantages of Hydroponic culture for organic cultivation:
   - Less water is required and can be reused. (About 20 times less water compared to gardening practice)
   - Can be grown anywhere at a less space.
   - Efficient automation is possible.

- No pesticide is required as the medium is safe and sterile.
- Soilless and no weeding.
- Easier and better harvesting.

b. Impacts in organic culture
   - Branding for organic farming and more modern people are attracted towards.
   - Self-sustained house concept has a market version through hydroponics.
   - Automation makes the culture seamless and people can rely on the yield.
   - Ability to alter the nutrients going to the plants and hence in the food.

Companies are providing market models of the hydroponic for home and commercial cultivation. Nutrient solutions, grow medium, designed systems for requirement, and portable pH instruments for manual check of the system.

Fig. 1. A hydroponic system growing plants (PVC system as inset image) Market model by futurefarms.in

B. Aquaponics: Aquaculture linked hydroponics

The nutrients are manually supplied either made by cultivators or made from market available nutrient solutions. But in aquaponics the water is supplied from an aquaculture tank or basement. This water is rich in water and upon filtering has considerable nutrition for hydroponic culture. The plants are grown in special growbeds avoiding the use of soil.
Domestic models for home and indoor culture is also available with the help of an aquarium an existing hydroponic system.

The system is a self-sustainable model. The water from aquaculture is not wasted through this incorporation and at the same time free nutrient rich water can be obtained for hydroponics as well.

Various vegetable like spinach and tomato can be cultured through aquaponics with comet gold fish aquarium [2].

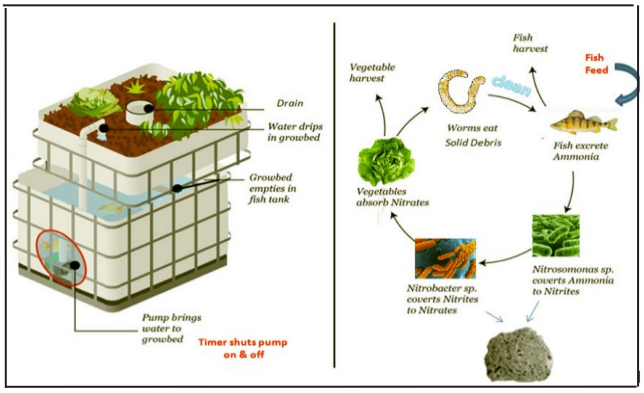

Fig. 2. Aquaponics technique overview (Taken from: abundance.org)

a. Advantages of Aquaponics:
   - 90% less water is required for the organic plant culture referring to conventional gardening.
   - Very efficient in water reusing aspect.
   - Self-sustainable model to an extent as both sections feed each other.
   - Indoor method is possible in incorporation with a conventional aquarium. Less space required as the plants grow over the sets of aquarium.
   - Soilless practice and no weeding interventions.
   - Fish food yield and self-fed fast growing vegetables for home needs.

Fig. 3. A commercial aquaculture farm (Wikimedia foundation)

b. Impacts in organic culture:

- People are attracted toward the indoor technique due to its aesthetics.
- Automation is possible and less water is required.
- Good and ensured organic yield.

Fig. 4. An aquarium incorporated home aquaponics system (Taken from: gardenculturemagazine.com)

C. Aeroponics:

Aeroponics is the recent advancement in the modern organic plant culture. In this process of culture nutrient rich air or mist is used as the growing medium. Plants are grown on a solid cloth or equivalent membrane like holding medium and which takes the nutrients from the spray or mist given to the roots. A minimum support of the plant to the holding medium is ensured in order to avoid pathogen and other cosmopolitan microbe growth.

Aeroponics provide fast and efficient food production.

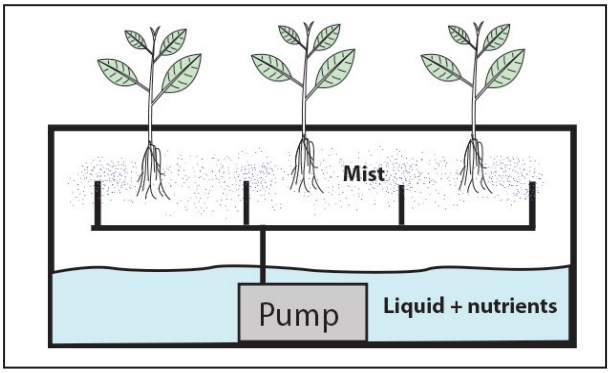

Fig. 5. Aeroponics system plant growth illustration (gardeningsite.com)

Advantages of aeroponics:

- Less water and nutrients are required.(water required is 40% less than hydroponics and 95% less than conventional methods)
- Faster plant growth.
- Less space is required.
- The culture system is mobile.
- System maintenance is easy.
- Cultivation is disease free as the medium can be made as much sterile.
- Calculated nutrient uptake is possible.
- Research tool for root morphology studies.

Disadvantages of aeroponics:

- Growth is dependable to system. A minor flaw in pressure pumps or sprinkle time can destroy plants.
- More technical.
- Higher cost.
- Regular mandatory cleaning is required.

Fig. 6. Root growth in aeroponics (farmxchange.org)

NASA sponsored progressive aeroponic system:

In 1997 NASA (National Aeronautics and Space Administration) funded AgriHouse Inc. for the development of an inflatable aeroponics system for space and earth food production. The successful system was economically not feasible for earth during the time but NASA found further research on it as a mandatory process for its future space missions including Mars exploration.

In Spinoff 2008, NASA reveals about the aeroponics system upon which it worked. NASA's BioServe research partnership center in University of Colorado was extensively participated in aeroponics developments funded by the agency since from 1997 [3]. NASA finds aeroponics as the most feasible technique for growing plants in long term space expeditions.

BioServe and AeroGrow International Inc. developed AeroGardens, a portable aeroponic indoor kitchen gardening appliance. The appliance was a final result from space oriented aeroponics research. More than 3lakhs of AeroGardens have been now commercially shipped by the company to its customers.

Fig. 7. AeroGarden grow bowl appliance growing Strawberry (aerogarden.com)

III. INDOOR ORGANIC FARMS

A growing trend is observed in developed countries for indoor organic farms. These modern farms have the specialty that they can be made possible even in the midst of any of the world's biggest metropolis. Cultivation is aided by controlled nutrition techniques and doesn't rely on sunlight using LED radiations to meet photo requirements for plant growth. Cultivators interested in yielding more price for the part of vanity in modern organic cultivation from its consumers are also turning for indoor farms. The final benefit is the crowd movement towards organic culture.

Indoors organic farm systematics:

Modern indoor farms are soilless and hydroponic or aeroponics. Aeroponics use nutrient rich mist as the growing medium. These farms are generally vertical farms. Vertical farm cultivates tray of setups arranged one over the other in vertical manner utilizing the indoor space to its maximum with minimum effort of arranging the growing systems. World's largest indoor farm is a vertical indoor farm in New Jersey. These indoor farms apparently have 1 acre space for cultivation.

The system includes [4]*:-*

- *Light weight cloth or clay pellet hydroponic/aeroponic grow medium trays.*
- *LED lightings over each tray and programmable logic controls for lighting time, wavelength and amount of light.*
- *Tray sensors measuring O_2 and CO_2 levels, nutrients like nitrogen, potassium and phosphorus, temperature and humidity.*
- *Grow medium nutrient water or air recycling and distribution systems.*

The grow mediums can be cloth made from recycled plastics or clay pellets for home versions of the farm. These aeroponic farms require 95% less water that is needed for conventional soil organic cultivation practices.

A greater importance is given for LED lightings and its control engineering. The lighting variation in intensity and wavelength can bring changes in the growth of plant, and surprisingly quality and flavor of the yield. More efficient photosynthesis than outdoor can be achieved with indoor lightings [4].

LED lightings also avoid entry of pests and insects as the lights are designed to be pest repellent. This can avoid the entire use of pesticides. Hence this way nongenetic pure organic seeds can be grown for best yields.

Fig. 8. Indoor farm aeroponic tray assembly at AeroFarms, NJ (theinstitute.ieee.org)

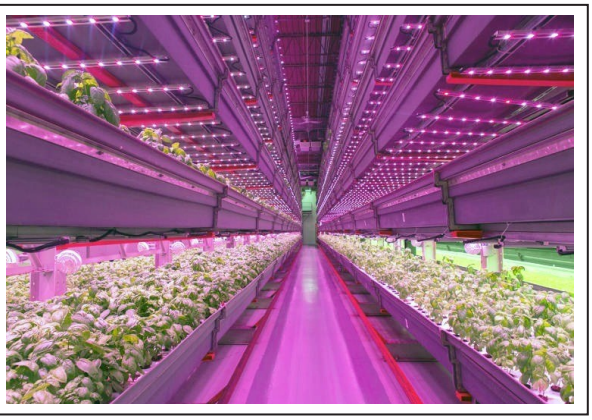

Fig. 9. Vertical indoor farm of AeroFarms, NJ (ecowatch.com)

The surprising fact of the LED lighting is that the variations given in the control of lighting can change the yield's color, texture and even the taste itself.

IV. ASSISTED FARM LANDS

A. *Pipe fenced- system assisted farm lands: An irrigation proposal overview*

This is a possible irrigation method being proposed here. The system is prototyping by various agricultural and ecological scientists.

In places where farming is difficult due to unavailability of enough water for conventional irrigation methods of canals and surface water irrigation, a system similar to sprinkle water irrigation with engineering assist can be provided.

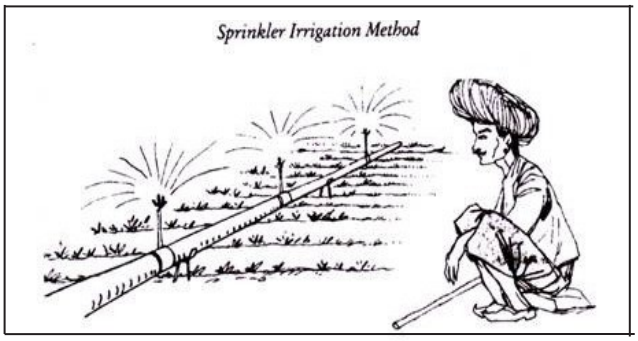

Fig. 10. Sprinkle irrigation method (biologydiscussion.com)

Fig. 11. Irrigation and water monitoring system made by IEEE students in EPICS (theinstitute.ieee.org)

System overview:

- Farm lands are divided into sub plots.(about 500 square feet each)
- Sprinkle attached and under hole flow pipes are used to deliver water at preset intervals
- Under holes can provide more water flow in soil when necessary. (i.e., In paddy fields some water sump is necessary for crop to sustain in certain time of its life cycle.)
- Pipes are fenced through the separations of sub divided plots.
- Pumping system is electrically controlled for sprinkling and under flow. Pump is operated from the area from where water is reaching to the farm location.
- Water available is locked to designed pump area with more water logging capacity.
- Water monitoring system decides the water pump timings.
- Nutrient supply is either given through water as well as through conventional method.

The fenced pipe need to be secured safe against climbing weeds or similar plant growths that may cause problems to the pipes.

This method need to be engineered to its perfection as some of the preliminary sections across the world has found possibilities in it. Students of IEEE has made a similar assisted farm land system. They used pipes to distribute water to the farm lands and monitored it. (See Fig. x.). Less harmful pesticides were tested with drone spray system and thy have found success [5].

V. CONCLUSION:

A major breakthrough is required in the organic farming practices. Pesticide and modern fertilizer usages are bringing various health hazards. Plant and food quality is being in a state of degradation day by day. Personal or home farming practices are to be rejuvenated and supported in various manners.

Hydroponics and aquaponics systems are pointing to success of the technology adoption in the organic farming culture. Possibilities in assisted large farmlands also need to be confronted through agricultural technologies. Worldwatch institute, a global environmental institution explains prominent agricultural researchers, experts and scientists believe in the organic farming in near future still has the potency to feed the whole world. Smart farm lands and organic indoor farms have lot to do and succeed to every corner of the world.

VI. REFERENCE

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