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Aquaponics Advancements: A Comprehensive Exploration of Sustainable Aqua-Agriculture Practices in the Indian Context

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Abstract
Aquaponics, an innovative and symbiotic approach to agricultural practices, has gained increasing attention as a potential pathway to enhance the sustainability of 'Aqua-Agri' farming in India. This review comprehensively explores the current state of aquaponics in the Indian context, examining its overview, suitability, challenges, and potentiality. The analysis encompasses the ecological dynamics of aquaponic systems, emphasizing the efficient utilization of resources in Indian context, minimal environmental impact, and the potential for increased yields in both fish and plant production. Additionally, it explores successful case studies, showcasing the viability and adaptability of aquaponics across diverse regions in India. The review concludes by outlining future research directions and policy recommendations to foster the widespread adoption of aquaponics as a transformative and sustainable method within the aquaculture sector in India.

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Introduction

The Blue Revolution, which transformed India's fisheries and aquaculture sector, has played a crucial role in meeting the growing demand for fish products.[1] However, the conventional methods employed in aquaculture often raise concerns about environmental sustainability, water usage, and the discharge of pollutants.[2] Aquaponics which is the practice of growing plants and fish together in recirculating systems, has gained popularity in recent years.[3,4] The water cycle, coupled with the recycling of aquaculture wastewater,[5] presents a sustainable alternative that mitigates the environmental pollution associated with conventional fisheries.[6] The integration of aquaponics into traditional aquaculture practices has emerged as a promising solution to address the above-mentioned challenges. The key feature that sets Aquaponic Systems apart is their minimal space requirement, giving rise to the emerging trends of Urban Aquaponics, Urban Agriculture, Urban Farming, Urban Gardening, Terrace Gardening, Vertical Gardening, and even

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Office Farms (indoors), among others.[7] This review paper explores the potential of aquaponics to enhance the sustainability of aquaculture in India and contribute to a 'Greener Blue Revolution'.

Aquaponics

An overview

Aquaponics is a symbiotic system that combines aquaculture (fish farming) and hydroponics (soilless plant cultivation).[8] In this closed-loop system, fish waste provides essential nutrients for plant growth, and the plants act as a natural filter, purifying the water for the fish.[9-10] This innovative approach not only maximizes resource utilization but also minimizes environmental impact.[11]

Sustainable Water usage

One of the primary concerns in traditional aquaculture is the excessive use of water. Aquaponics, however, represents a water-efficient alternative. The closed-loop system allows for significant water savings compared to conventional aquaculture, making it particularly relevant in regions facing water scarcity.[12] By recycling and reusing water within the system, aquaponics reduces the overall demand for freshwater and minimizes the environmental footprint of aquaculture operations.[5]

Nutrient Recycling for Improved Efficiency

Aquaponics is a sustainable agricultural system that capitalizes on the symbiotic relationship between fish and plants, establishing a regenerating nutrient cycle.[13] In this system, fish thrive in tanks, generating waste in the form of Total Ammonia Nitrogen (TAN), encompassing both NH_3 and NH_4^+ in the water. To facilitate the conversion of ammonia, beneficial bacteria, such as Nitrosomonas sp., play a crucial role by transforming it into nitrites (NO_2^-).[14]

Another group of bacteria, including *Nitrobacter* sp. and *Nitrospira* sp., further refine the process by converting nitrites into nitrates (NO_3^-). Nitrates serve as an invaluable nutrient for plants, constituting the final stage of the ammonia conversion cycle.[15] The nutrient-enriched water is then circulated through plant grow beds, where plants absorb the nitrates through their root systems.[16] This symbiotic exchange not only nourishes the plants but also naturally filters the water, removing excess nutrients, and redirected back to the fish tanks.[17] This continuous circulation reared a healthy and sustainable environment for both fish and plants.[14] Aquaponics stands as a witness for the interconnectedness of these organisms, demonstrating how their collaboration improved the efficiency of the ecosystem that promotes growth and well-being.

Different Types of Aquaponics Systems Suitable for the Indian Context

In the Indian context, where water scarcity and the need for efficient resource utilization are significant concerns, aquaponics can be a promising agricultural approach. The decision regarding a particular aquaponics system is influenced by factors like the available space and the specific types of fish and plants intended, climatic conditions in that area chosen for farming.[4,13,18-23] Here are different types of aquaponics systems suitable for the Indian context,

Media-Based Aquaponics

Description

In this system, plants are grown in a media-filled bed, such as gravel or expanded clay pellets.[11,24-25] The media provides support for the plants and acts as a biofilter for the aquaculture system. (Figure 1.)

Suitability for India

Media-based systems are versatile and can be adapted to various climates. They are suitable for small-scale and backyard setups, making them accessible for Indian farmers with limited space.

Deep Water Culture (DWC) Aquaponics

Description

Plants are suspended in floating rafts above a nutrient-rich water tank where fish are raised. The plant roots are submerged in the nutrient solution, allowing for direct nutrient uptake.[26-28] (Figure 2.)

Suitability for India

DWC systems are well-suited for warm climates. They are efficient in water usage and can be scaled up for commercial production in regions with abundant sunlight.

Nutrient Film Technique (NFT) Aquaponics

Description

A thin film of nutrient-rich water flows over plant roots, providing essential nutrients. The system is typically used for growing smaller plants like herbs and lettuce.[24,29-30] (Figure 3.)

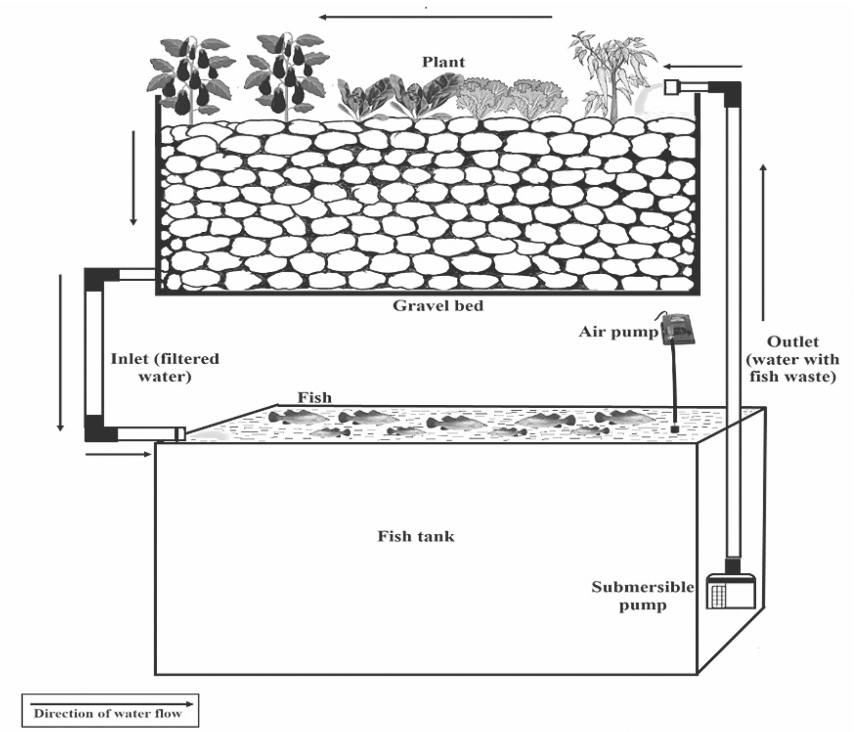

Fig. 1: Media-Based (Gravel) Aquaponics

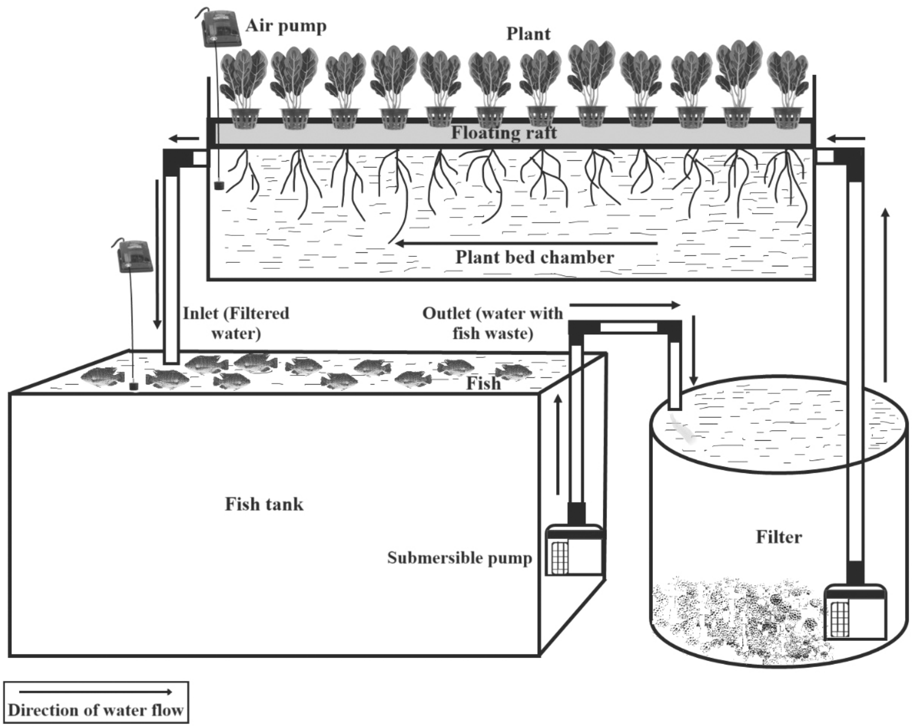

Fig. 2: Deep Water Culture (DWC) Aquaponics

Suitability for India

NFT systems are suitable for Indian conditions, especially in controlled environments or greenhouses. They are efficient in water usage and can be employed in urban and peri-urban settings.

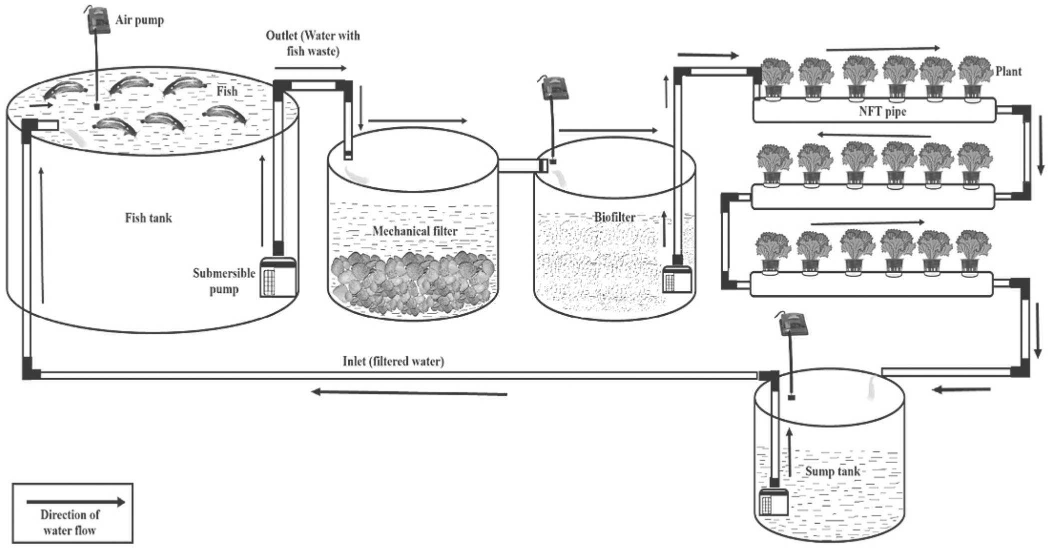

Fig. 3: Nutrient Film Technique (NFT) Aquaponics

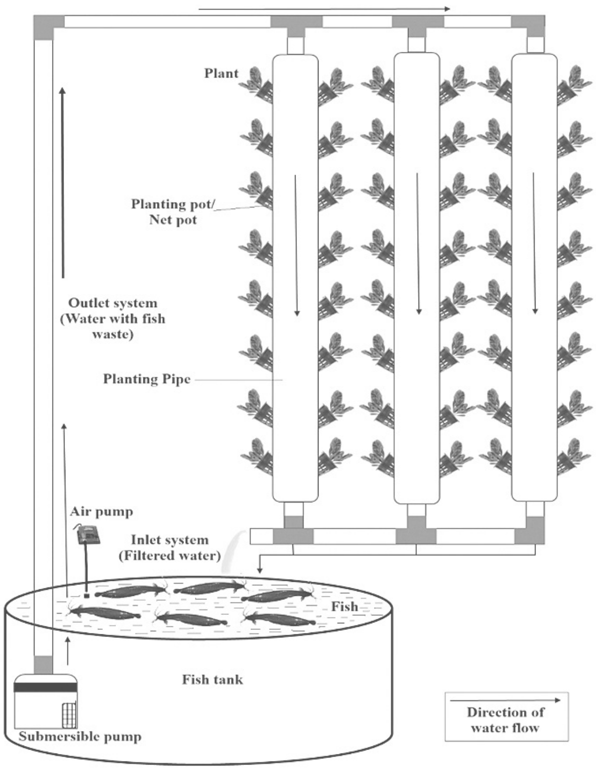

Fig. 4: Vertical Aquaponics

Vertical Aquaponics

Description: Vertical aquaponics utilizes vertical space for plant cultivation, making it suitable for areas with limited horizontal space. Vertical towers or stacked systems are commonly used.[24,30] (Figure 4.)

Suitability for India

Vertical systems are advantageous in densely populated areas where space is limited. They can be employed in urban agriculture projects, allowing for efficient use of available space.

Hybrid Aquaponics

Description

Hybrid systems combine different aquaponics methods, such as integrating media beds with DWC or NFT systems. This approach maximizes efficiency and flexibility.[31-32] (Figure 5.)

Suitability for India

Hybrid systems can be tailored to suit specific needs and conditions, making them adaptable to diverse climates and available resources.

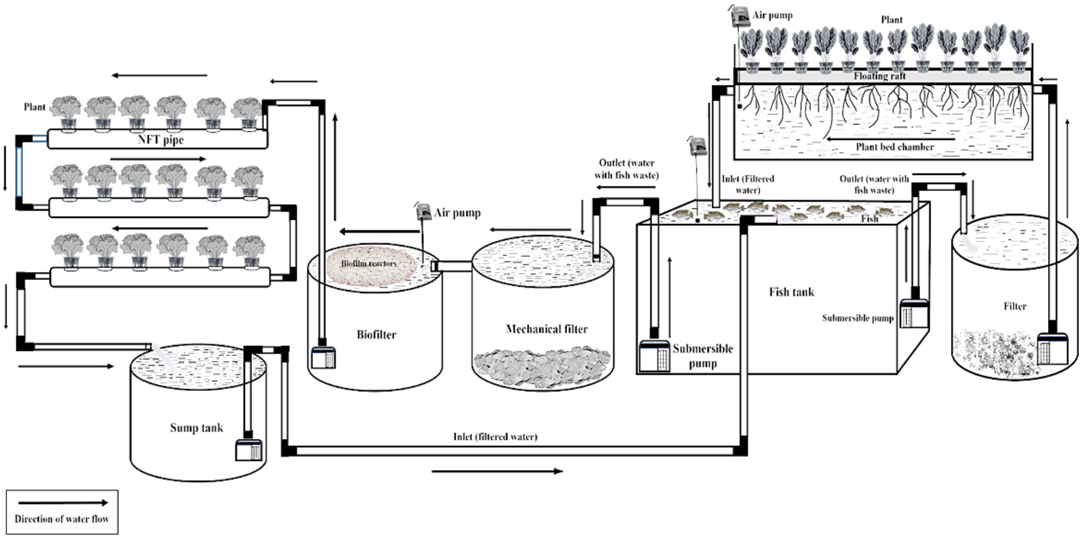

Fig. 5: Hybrid Aquaponics

Integrated Aquaponics with Vermiculture (Vermiponics)

Description

Combining aquaponics with vermiculture (worm farming) enhances nutrient cycling and promotes a more balanced ecosystem. Worm castings contribute to the nutrient content of the system.[33-34]

Suitability for India

Integrated systems provide additional benefits in terms of nutrient availability and system resilience. They are well-suited for sustainable and organic farming practices.

Ideal Fish and Plant Species for Aquaponics Cultivation in India

The choice of ideal fish and plant species in an aquaponics system can be influenced by region-wise climatic conditions and market demand.[35-38] So, there is a need to select ideal species that thrive in the Indian climate, contribute effectively to nutrient cycling, and have better commercial value.[4,21,39] (Table 1)

Table 1: Ideal Fish and plant Species for aquaponics Cultivation in India

Fish Species	Common Name	Plant Species	Common Name
Finfish		**Vegetables**	
Labeo rohita (Hamilton, 1822)	Rohu/Rui	*Spinacia oleracea* L.	Spinach/ Palong
		Lactuca sativa L.	Lettuce
Catla catla (Hamilton, 1822)	Catla	*Cucumis sativus* L.	Cucumber/ Sosha
		Solanum lycopersicum L.	Tomato
Oreochromis mossambicus (Peters, 1852)	Tilapia	*Capsicum annuum* L.	Sweet Pepper/ Shimla Mirch
		Capsicum frutescens L.	Green Chilli/ Mirch
		Pisum sativum L.	Pea/ Motor
Anabas testudineus (Bloch, 1792)	Koi	*Lablab purpureus* (L.) Sweet	Rajashimbi/ Wild Bean/ Sim
		Pisum sativum L.	Pea/ Motor
Lates calcarifer (Bloch, 1790)	Barramundi/ Bhetki	*Brassica oleracea italica* Plenck	Broccoli
		Abelmoschus esculentus (L.) Moench	Lady's Finger/ Bhendi
		Fruits	
Heteropneustes fossilis (Bloch, 1794)	Singhi	*Duchesnea indica* (Andr.) Focke	Indian Strawberry/ Kiphaliya
		Citrullus lanatus (Thunb.) Matsumura & Nakai	Tarmuj/ Watermelon
Clarias batrachus (Linnaeus, 1758)	Magur	*Musa paradisiaca* L.	
Clarias magur (Hamilton, 1822)	Magur	*Musa acuminata* Colla	Banana/ Kola
		Flowers	
		Tagetes erecta L.	Marigold/ Ganda
Cyprinus carpio (Linnaeus, 1758)	Common carp/ American Rui	*Rosa indica* L.	Rose/ Golap
		Helianthus annuus L.	Sunflower/ Surjamukhi
Pangasius pangasius (Hamilton, 1822)	Pangas/ Basa		
		Herbs	
Mystus vittatus (Bloch, 1794)	Tangra	*Ocimum basilicum* L.	Basil/ Ram Tulsi
Ompok pabda (Hamilton, 1822)	Pabda	*Ocimum sanctum* L.	Holy Basil/ Kola Tulsi
Carassius auratus (Linnaeus, 1758)	Goldfish	*Ocimum tenuiflorum* L.	Tulsi/ Basil
		Bacopa monnieri (L.) Pennell	Brahmisak/ Bacopa
		Thymus vulgaris L.	Thyme/ Ajwain
Trichogaster fasciata (Bloch & J. G. Schneider, 1801)	Gourami	*Coriandrum sativum* L.	Coriander/ Dhania
		Stevia rebaudiana (Bertoni) Bertoni	Sugar leaf/ Mou -tulasi
Shellfish		*Salvia officinalis* L.	Common Sage
Penaeus monodon (Fabricius, 1798)	Tiger Prawn/ Bagda	*Origanum vulgare* L.	Oregano/ Sathra
		Plectranthus amboinicus (Lour.) Spreng.	Indian Borage/ Patta Ajwain

Macrobrachium rosenbergii (De Man, 1879)	Giant Prawn/ Galda	*Mentha arvensis* L. *Mentha spicata* L.	Field mint/ Pudina Gardenmint/ Pudina
Litopenaeus vannamei (Boone, 1931)	Vannamei/ Whiteleg Shrimp	**Shrubs**	
		Tinospora cordifolia (Willd.) Miers	Gulancha/ Indian Tinospora
		Withania somnifera (L.) Dunal	Ashwagandha/ Winter Cherry
		Chamaecostus cuspidatus (Nees & Mart.) C.Specht & D.W.Stev.	Insulin Plant

Present Scenario of Aquaponics Farming in India

Commercial aquaponics has gained significant momentum in recent years in India, with notable increases observed in states such as Maharashtra, Karnataka, and Kerala. According to a study, over 200 families in Cherai, Kerala, actively engaged in aquaponics farming.[40] Various cultivation methods are being implemented at the Nanniode Aquaponics Research and Development Centre (NARDC) in Palakkad, Kerala.[41] Prakruthi Aquaponics, a dedicated voluntary group, initiated the setup of an Aquaponics unit at the Coconut Nursery in Thiruvananthapuram, Kerala.[42] Mori, a small village known for cashew exports in the East Godavari district of Andhra Pradesh, is transforming into a 'Smart Village' through collaborative efforts by the Innovation Society of the A.P. Government and the Garwood Centre for Corporate Innovation at the University of California, USA, and Swedish communication technology firm Ericsson. Their proposed 'Connected Aquaponics' and 'Smart Water Grid Management' IoT solutions combine aquaculture and hydroponics, creating a sustainable cycle by recycling ammonia-rich wastewater back to the aqua farm.[43] Anjali Aquaponics Farm which was founded in 2014 by Bh. R. Viswanadha Raju, spanning about 15 acres in Mahboobnagar district, Telangana. The farm incorporates the cultivation of fish varieties such as 'GIFT' and 'Red Tilapia,' alongside crops, including cabbage, lettuce, tomatoes, bitter gourd, bottle gourd, and other leafy vegetables.[7]

'Red otter farm' and 'Madhabi farm' are two renowned aquaponics farms in India.[44] Red Otter Farm situated in kotabagh, Uttarakhand, is one of the fastest-growing aquaponics farms in India, spanning 10,000 sq ft. While Bengaluru-based Madhabi Farm started its journey in 2017 and produced 'Satvik Sabji' in collaboration with a Canadian Company 'Waterfarmers'. North India's first aquaponics farm (Named as Urban Kheti) was started by Sushant Madaan in 2016 at Gurugram, Haryana.[45] Vegetables like tomato and lady's finger, soft herbs like Basil, Mint, and Coriander are produced by that farm. 'India Aquaponics' was established in 2013 at Chandigarh by Parag Thakkar, Parul Thakkar, and Pardeep Vedi. They developed an aquaponics monitoring system capable of delivering real-time online information to users, accessible from any location. They also provide online consultancy and aquaponics-specific equipment through the India Aquaponics e-store.[46] 'Vigyan Ashram' in Pune, Maharashtra, boasts an experimental Aquaponics setup that has shown initial success. The institution is actively engaged in the process of advancing and commercializing this innovative approach.[47] Himanshu Jakhar, Sneh Shekhawat, Pippa Woodhead established an aquaponics farm in Jaipur, Rajasthan, named 'Aquaponics India'. They offer an intensive residential training program at their farm as well as an essential aquaponics online course.[48]

During the Covid-19 pandemic, the industrial sector in India faced substantial challenges, experiencing a significant downturn.[49] But at that time India's one of the largest aquaponics startups in Kolhapur, Maharashtra was at the peak of success by Mayank Gupta and Lalit Zhavar. They have made up to 10 crores from a one-hectare aquaponics system.[50] Recipes made of aquaponics vegetables are in high demand in different restaurants like the ITC Royal Bengal in Kolkata, West Bengal.[44] Urbagrow Aquaponics in Kolkata, West Bengal, set up a 15k sq ft Aquaponics system, yielding as much as a two-acre open fish farm and a two-acre vegetable farm.[51] The Aquaponics Experimental Unit at ICAR-CIFE in Mumbai includes an open-air section where Spinach flourishes in gravel beds integrated with fish tanks containing Koi Carp.[7] Dr. Harpreet Singh is leading the initiative at IIT-Ropar to conceptualize and build a scalable aquaponics system integrated with solar technology within the framework of the TIGR2ESS project. Aquaculture engineering dept. of IIT Kharagpur set up an NFT aquaponics system in which Ashwagandha, Brahmi, Sweet Leaf, Chili Pepper, lettuce, and Giloy are famed with tilapia fish for experimental purposes.[52] Alternative Green Energy Solutions Private Limited, Agro Labs, City Greens, Radongrow India are some major companies involved in manufacturing hydroponics and aquaponics set up to support hydroponics and aquaponics farming in India.[53]

Trouble in Soil Agriculture in India

Soil plays a crucial role in supporting plant growth and animal activity, serving as a reservoir for water and nutrients.[54] The soils that support agriculture in the Indian subcontinent include alluvial, red, black or regur, arid or desert, laterite, saline, peaty or marshy, forest, and sub-mountain soils.[54] Soil degradation in agriculture is a widespread issue that affects crop productivity and sustainability across the globe. It encompasses various forms of deterioration in soil quality and function, which can hinder agricultural practices and impact food security.[55] Out of India's total geographical area of 328.8 million hectares, an estimated 96.4 million hectares are degraded with 70% of this caused by water erosion and producing less than 20% of their full production.[56] Slow-draining soil can contribute to poor agricultural outcomes, leading to soil erosion and loss of nutrients. There are about 7,54,631 hectares of slow-permeable soils present in Tamil Nadu state of India.[57] Inadequate use of chemical fertilizers is disrupting the soil food web and damaging the living organisms responsible for soil fertility, soil structure, and water retention.[58-59] Overuse of acid-forming fertilizers (like ammonium-based fertilizers) or acid rain can lead to soil acidification, which can negatively impact plant growth and soil microorganisms. Over 70% of soil in India is affected by either high acidity or alkalinity. The ongoing decline in soil health across the country is causing nutrient deficiencies in plants and contributing to widespread malnutrition.[60] Approximately the World's 100 million hectares of land suitable for rice cultivation remain unused due to soil toxicities from salt, alkali, acid, or organic matter, as well as areas where deficiencies in zinc, phosphate, and iron, or excesses of iron, aluminum, and manganese, limit rice yields.[61] Soil exhaustion creates problems in soil agriculture by diminishing the soil's ability to support healthy crops and sustain productivity.[62] Conventional tillage farming is also a major problem in soil agriculture. Conventional tillage farming, which involves regularly turning and breaking up the soil, can lead to several problems in soil agriculture. It exposes the soil to wind and water erosion, which can strip away nutrient-rich topsoil and reduce soil fertility.[63] Water scarcity is a major concern for soil agriculture as it directly impacts the availability of water for crop cultivation. Declining groundwater levels increase reliance on other irrigation methods, putting additional strain on these resources and impeding agricultural progress.[64] Improper crop rotation and inadequate soil and water conservation practices are key factors leading to soil erosion on cultivated lands.[55]

India faces a complex challenge in ensuring food security due to its limited arable land and rapidly growing population. The country holds just 2.4% of the world's arable land yet supports 17.5% of the global population. Each year, India's population increases by 1.19%, adding pressure on its agricultural resources.[65] Soil degradation caused by human activities arises from various factors such as land clearing and deforestation, suboptimal agricultural practices, improper disposal of chemical waste, unsustainable grazing, mineral extraction, urban expansion, and industrial development. These activities lead to a decline in soil quality and fertility, impacting agricultural productivity and the environment.[66] Excessive use of pesticides, combined with the application of sewage sludge and composted municipal waste, can contaminate soil and water with toxic substances and heavy metals.[55]

Role of Aquaponics in India

Empowering Small-Scale Farmers

Despite the considerable growth in fish farming in recent years, Indian small-scale fish farmers in this sector are facing various challenges.[67] Small-scale fish farming faces challenges like low productivity, high setup costs, farm losses, and marketing issues in India.[67]

Aquaponics presents an opportunity for small-scale farmers to diversify their income and improve food security.[12] With relatively low space requirements, less water or other input requirements, and the potential for year-round cultivation, aquaponics systems can be adapted to various scales, from backyard setups to larger commercial operations.[68] This is particularly advantageous for small-scale farmers who may not have access to extensive agricultural land. Aquaponics systems can reduce the need for expensive fertilizers and other inputs.[69] This is beneficial for small-scale farmers who may face financial constraints and need cost-effective farming methods.[36] Farmers can sell both fish and vegetables, thereby spreading risks and increasing their overall income. This farming practice allows small-scale farmers to access niche markets for fresh, locally produced, and sustainably grown products. This can open up opportunities for better market prices and increased competitiveness.[70]

Training programs and support initiatives can empower local farmers to adopt aquaponics, fostering sustainable practices in rural communities.

Biodiversity Conservation and Ecosystem Health

Traditional aquaculture practices can sometimes lead to environmental degradation and harm to local ecosystems. Aquaponics, by contrast, promotes biodiversity and ecosystem health because in this system, decreasing chemical inputs helps in reducing the environmental impacts associated with traditional farming practices.[71] It provides a more sustainable approach to cultivating plant-based food for human consumption.[72] The integrated approach ensures that the balance between fish and plants is maintained, reducing the risk of diseases and pests.[73] Additionally, using natural, biological filtration methods contributes to a healthier aquatic environment.[74] It proves to be a highly efficient method for cultivating food, utilizing only 10% of the water required in traditional farming and eliminating the need for chemical fertilizers.[75] The Sundarbans' rich potential for fish farming offers an opportunity to integrate aquaponics systems that are in a rithm with the mangrove ecosystem. This approach can enhance alternative livelihoods for the local population while supporting the growth of mangrove coverage through careful water management.[76]

Today, overpopulation stands as a pressing concern for humanity. This demographic situation leads to an increased global demand for protein, placing considerable stress on finite land and water resources.[77-78] The clean water problem is a rising global crisis that impacts about 785 million people across the globe.[79-80] By incorporating aquaponics into agricultural practices, communities can exploit the benefits of a recirculatory system that conserves water, minimizes environmental impact, and contributes to sustainable land-water utilization in the face of land-water scarcity.

Climate Resilience

In India, the climate poses challenges to achieving optimal yields from traditional soil-based agriculture due to unpredictable weather patterns. Aquaponics offers a solution by providing a controlled environment for cultivation, allowing farmers to adjust to demand and better manage weather-related challenges.[81]

India's diverse terrain experiences significant physical variations, from arid deserts to lush forests and fertile plains.[82] These differences in landscape and climate can pose challenges to traditional farming. However, aquaponics offers a solution by enabling year-round farming in any part of the country. In this system, plants and fish are grown in a closed, controlled environment, making them less susceptible to external climate fluctuations.[83] This consistent growing environment allows farmers to cultivate crops and raise fish throughout the year, regardless of regional climate variations.[81]

Household Production

In India, many households adopt aquaponics farming on balconies, rooftops, and even indoors. This practice provides fresh produce and fish for daily use and appeals to gardening enthusiasts.[40] In many areas small aquaponics units are set up in gardens or backyards, even in water-scarce areas. When properly managed, an aquaponics setup can provide a good source of income for small households.[84]

Academic Opportunities and Job Creation

An aquaponics system is a sophisticated technology that functions as a dynamic educational environment, merging hydroponics, aquaculture, microbiology, hydrology, physics, and civil engineering. This integrated approach offers practical insights into nutrient cycling, water management, and the interconnections between plants, fish, and microorganisms. It provides a comprehensive learning experience, combining theory with hands-on applications for the learners. Indian research institutions and startups are exploring aquaponics as a potential solution for sustainable agriculture, leading to innovations in this field.[81]

The growth of the aquaponics sector in India can lead to job creation in areas such as farming, marketing, distribution, and training in aquaponics techniques. LandCraft Agro, one of India's largest farms, employs over 80% women in its workforce. The farm offers these women steady employment and improved working conditions compared to their previous jobs.[85]

Challenges and Potentiality

While aquaponics holds great promise for sustainable aquaculture in India, challenges such as initial setup costs, technical knowledge dissemination, and cultural acceptance need to be addressed.[86] In order to build a recirculating system with zero discharge, the main issue is to maximize the effective use of nutrient inputs while minimizing waste.[87] According to several researches, adding phosphate to aquaponic systems is beneficial, particularly for fruits and vegetables that do not currently grow well in aquaponics.[88]

Indian farmers face difficulties due to slow agricultural growth, sustainability problems, and land degradation. A significant amount of farmland has become infertile because of excessive use of fertilizers and pesticides, adding to their challenges.[89] Introducing aquaponics to third-world countries (developing nations) could contribute significantly to hunger prevention by establishing fish and plants as a primary nutritional source.[48] An Aquaponics System has the potential to yield up to five times more fish within the same area annually, in addition to abundant vegetables.[90] Many countries currently equip aquaponics systems with smart technology based on the Internet of Things (IoT). Farmers may monitor water level, acidity, temperature, and fish feed using internet-based smartphone apps and contemporary sensors.[91-93] Collaborative efforts involving government agencies, research institutions, and private enterprises can play a crucial role in overcoming these hurdles and promoting the widespread adoption of aquaponics. The establishment of aquaponics units will consequently enhance the knowledge of fish farmers regarding emerging and future technologies in aquaculture.[90]

Conclusion

As India seeks to further develop its aquaculture sector, a transition towards sustainable practices is imperative. Aquaponics stands out as a pathway to greening the Blue Revolution, offering a holistic and eco-friendly approach to fish and vegetable production. By embracing this innovative system, India can not only enhance food security and rural livelihoods but also contribute to global efforts in creating a more sustainable and resilient food production system. There is a lack of established standards for the sale of aquaponic goods, guaranteeing quality, safety, and the verification of authentic aquaponic farming in India. A clear and comprehensive set of aquaponic standards should be developed to facilitate the growth of a more structured market for these products.

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Conflict of Interest

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Data Availability Statement

This statement does not apply to this article.

Ethical Approval Statement

Since this review paper does not include any human or animal experimentation, it is not subject to ethical approval requirements. Therefore, no specific ethical approval was required for the completion of this study.

Author Contributions

- **Avik Bhanja:** conducted the primary literature review, synthesized the gathered information, and prepared the manuscript.
- **Pijush Payra:** contributed to the manuscript by reviewing and synthesizing the data collected by the first author.
- **Basudev Mandal:** played a key role in manuscript revisions and formatting, ensuring coherence and clarity in presenting complex scientific concepts.

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