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Sustainable Farming Future: Unlocking the Potential for Circular Agriculture Food Systems for Farming

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Abstract: ***"Climate change poses significant challenges to agriculture, particularly in resource-constrained regions like India. This study examines climate resilience through circular agriculture, a sustainable approach that minimizes waste, recycles resources, and enhances system efficiency. Addressing issues such as nutrient pollution, water scarcity, and soil degradation, the research highlights Aquaponics and smart farming as viable solutions. Using secondary data from governmental and private sources, it demonstrates how these methods reduce environmental impact while boosting productivity and farmer livelihoods. The findings underscore the potential of technology-driven circular systems to ensure food security and ecological balance amidst a changing climate."***

Keywords: Sustainable Farming, circular agriculture, food systems, Aquaponics, Smart Farming

1. Introduction

Sustainable development is an approach to growth that aims to meet the needs of the present without compromising the ability of future generations to meet their own needs. It balances economic development, environmental protection, and social well-being. The concept was popularized by the Brundtland Report (also known as "Our Common Future") in 1987. This report published by the World Commission on Environment and Development, defined sustainable development and brought it to global attention.

Agriculture, with its allied sectors, is unquestionably the largest livelihood provider in India, more so in the vast rural areas. It also contributes a significant figure to the Gross Domestic Product (GDP). Sustainable agriculture, in terms of food security, rural employment, and environmentally sustainable technologies such as soil conservation, sustainable natural resource management and biodiversity protection, are essential for holistic rural development. Indian agriculture and allied activities have witnessed a green revolution, a white revolution, a yellow revolution and a blue revolution.

The current state of agriculture is significantly influenced by climate change and various hazards. Here are some key points:

1) Climate Change

a) Temperature Increase: Rising temperatures affect crop growth cycles and yields.
b) Altered Rainfall Patterns: Changes in precipitation patterns lead to droughts or floods, impacting water availability for crops.

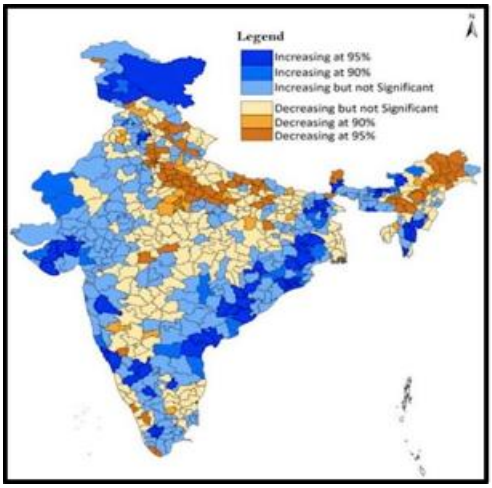

Figure 1: Change in rainfall pattern in India

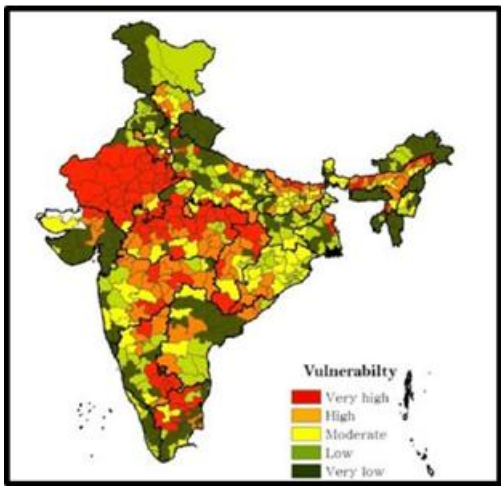

Figure 2: Vulnerability of Indian agriculture to climate change: A district level assessment for 1960-2010

c) Extreme Weather Events: More frequent and severe weather events, such as storms and heat waves, damage crops and infrastructure.
d) Shifting Growing Seasons: Changes in climate are causing shifts in planting and harvesting times.

2) Hazards

a) Chemical Exposure: Farmers are exposed to pesticides, herbicides, and fertilizers, which can be harmful to health and the environment.
b) Machinery Accidents: Working with heavy machinery poses risks of injuries and fatalities.
c) Animal-Related Injuries: Handling livestock can lead to injuries from bites, kicks, or trampling.
d) Environmental Factors: Extreme weather conditions, such as droughts and floods, pose significant risks to farming operations.

3) Government Schemes

a) Pradhan Mantri Kisan Samman Nidhi (PM-KISAN): Provides direct income support of ₹6,000 per year to small and marginal farmers. Pradhan Mantri Fasal Bima Yojana (PMFBY): Offers crop insurance to protect against natural risks.
b) Pradhan Mantri Krishi Sinchai Yojana (PMKSY): Focuses on improving irrigation infrastructure.
c) National Food Security Mission (NFSM): Aims to increase the production of staple foods.
d) Rashtriya Krishi Vikas Yojana (RKVY): Promotes holistic agricultural growth.
e) National Bamboo Mission: Supports the development of bamboo resources.
f) National Mission on Natural Farming (NMNF): Encourages natural farming practices.
g) e-NAM (National Agriculture Market): Facilitates online trading of agricultural commodities.
h) Soil Health Cards (SHC) Scheme: Provides farmers with information on soil health for better crop planning.
i) Paramparagat Krishi Vikas Yojana (PKVY): Promotes organic farming

2. Proposed Methods

The research paper focuses on two modern techniques which are:

Aquaponics

It is a sustainable food production system that combines aquaculture (raising aquatic animals like fish, crayfish, or prawns) with hydroponics (growing plants in water without soil)

Fish raised in tanks produce waste that provides nutrients for plants. The nutrient-rich water is then circulated to hydroponically grown plants, which filter out the waste, cleaning the water for the fish. The plants use the nutrients from the fish waste, and in turn, purify the water for the fish. Aquaponics uses up to 90% less water than traditional farming, requires less land, and can produce higher yields. It also eliminates the need for chemical fertilizers and pesticides

Types of Aquaponics systems in brief:

1) Media-Based: Uses grow beds filled with a medium like clay pebbles. Nutrient-rich water flows through, benefiting plants.
2) NFT (Nutrient Film Technique): A thin film of water flows over plant roots in channels, great for leafy greens.
3) DWC (Deep Water Culture): Plants are suspended with their roots in nutrient-rich water, ideal for fast growers.
4) Vertical: Stacks grow beds vertically to maximize space, perfect for urban farming.
5) Hybrid: Combines different methods to tailor the system to specific needs.

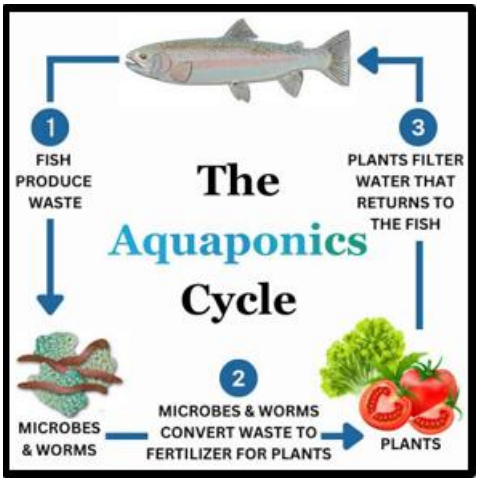

Figure 3: Aquaponics Cycle

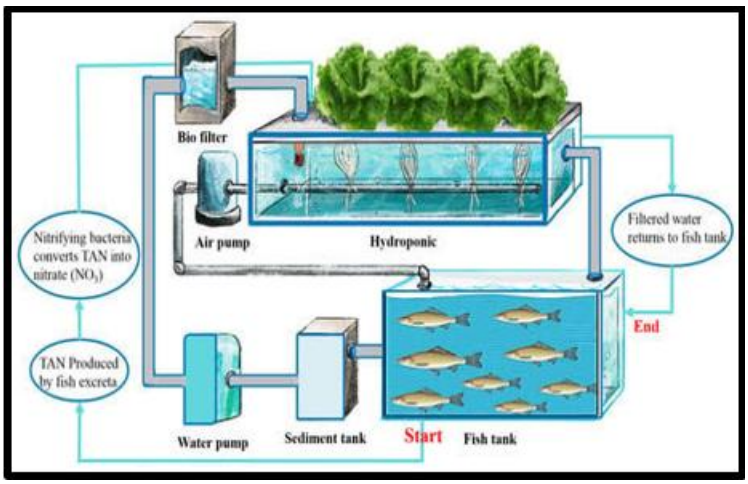

Figure 4: Working of Aquaponics.

Smart Farm

Smart farming, also known as precision agriculture, is an innovative way to increase the efficiency and sustainability of agricultural practices. It involves the use of technology like IoT (Internet of Things), AI, drones, and sensors to monitor and manage farming activities.

Smart Farming refers to the application of modern Information and Communication Technologies (ICT) in agriculture. It promises to revolutionize the world of agriculture through the application of solutions such as Internet of Things (IoT), actuators and sensors, geo-positioning systems, drones or unmanned aerial vehicles (UAVs), precision equipment, robotics, etc. backed and powered by technologies such as Big Data, Analytics, and Cloud.

From the farmer's point of view, Smart Farming will provide the farmer the means for better decision making and more efficient operations and management. Smart farming is associated to three fields of technology

With AI becoming the future, farming industry can also incorporate automation in the form of self-driving tractors and other automated vehicles, agro-bots, surveillance drones, smart cameras which can detect the health of the crop and supervise the farmers, watering systems, field sensors, etc.

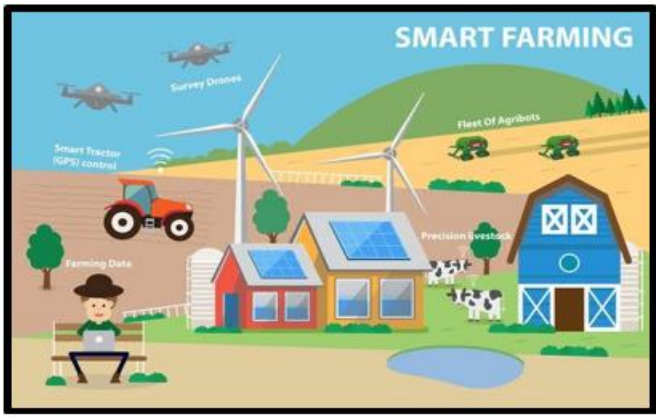

Figure 5: Smart farm at work

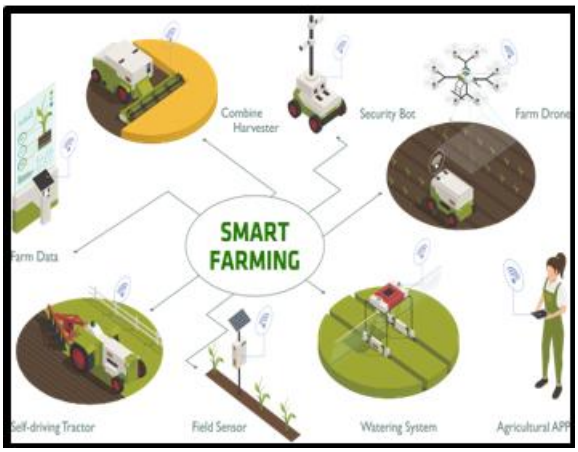

Figure 6: Smart farm appliances

3. Case Study

Aquaponics 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. Various cultivation methods are being implemented at the Nanniode Aquaponics Research and Development Centre (NARDC) in Palakkad, Kerala.Prakruthi Aquaponics, a dedicated voluntary group, initiated the setup of an Aquaponics unit at the Coconut Nursery in Thiruvananthapuram, Kerala

Red otter farm' and 'Madhabi farm' are two renowned Aquaponics farms in India. Red Otter Farm situated in Kotabagh, Uttarakhand, is one of the fastest-growing Aquaponics farms in India, spanning 10,000 sq. ft. Madhavi Farms, located in Bangalore, India, is a pioneering organic estate established in 1998 on a barren plot of land. Spanning 20 acres

Smart Farming in India

According to the Ministry of Agriculture, the government is taking various smart agriculture initiatives such as:

- Crop yield prediction model using artificial intelligence (AI): In 2018, the National Institution for Transforming India (NITI Aayog) partnered with IBM for developing a crop yield prediction model using AI. This helps in providing real-time advisory to farmers.
- AI sensors for smart farming: The Indian government has partnered with Microsoft for empowering small-holder farmers in India. The partnership seeks to increase the income of the farmers through greater crop yield and superior price control using AI sensors. The partnership would help boost the adoption of AI in farming.
- Drones for monitoring soil and crop health: The government has launched a project, Sensor-based Smart Agriculture (SENSAGRI), involving six institutes. In this project, drones would be used for smooth scouting over land fields, for collecting precious information and transferring the data to farmers on a real-time basis. The project would be funded by institutes such as Ministry of Communication and Information Technology (MCIT), Department of Electronics and Information Technology (DEITY), Information Technology Research Academy (ITRA) and Indian Council of Agricultural Research (ICAR).

One notable example of smart farming in India is the Dhundi village project in Gujarat. Farmers here use solar power for irrigation, integrating renewable energy with smart farming techniques. This initiative not only optimizes water usage but also reduces reliance on traditional energy sources, making it a sustainable and innovative approach to agriculture.

4. Literature Review

The concept of circular agriculture is gaining traction as a sustainable approach to address the challenges posed by climate change and conventional farming practices. Circular agriculture aims to create a closed-loop system where resources are continually reused, minimizing waste and environmental impact. This literature review explores the potential of circular agriculture in enhancing climate resilience and promoting sustainable farming practices

Key Concepts:

- Circular Economy Principles: Circular agriculture integrates principles of the circular economy, such as reducing resource input, reusing materials, and recycling nutrients. By mimicking natural ecosystems, circular agriculture ensures that resources like water, nutrients, and energy are continually reused within the agricultural system.
- Climate Resilience: Climate-resilient agriculture involves adopting practices that enhance the ability of farming systems to withstand and recover from climate-related shocks. This includes the use of drought-tolerant crops, efficient water management, and conservation agriculture.
- Sustainable Development Goals (SDGs): Circular agriculture aligns with several SDGs, including SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). By promoting resource efficiency and reducing environmental impact, circular agriculture contributes to achieving these global goals[3].

Current Research and Findings:

- Farmers' Resilience to Climate Change: Studies have shown that farmers' awareness of climate change, knowledge, and skills are crucial for adapting and mitigating its effects. Circular agriculture practices, such as integrated organic farming and reprocessing agricultural residues, have been found to support environmental-friendly agriculture activities while improving farm income.
- Technological Innovations: Advances in technology, such as precision agriculture, IoT, and GPS, have enabled farmers to implement circular agriculture practices more effectively. These technologies help in optimizing resource use, reducing waste, and enhancing productivity
- Policy and Financial Support: Policies and financial incentives play a vital role in promoting the adoption of circular agriculture. Governments and organizations are providing support to farmers to transition towards sustainable practices, including training, extension services, and access to technology.

5. Results

In India, the integration of smart farming and Aquaponics is gaining momentum, showcasing promising results. For instance, Aquaponics systems in India have demonstrated a 90% reduction in water usage compared to traditional farming methods. Additionally, the use of IoT and data analytics has led to a 30% increase in productivity by optimizing growing conditions. These advancements not only conserve resources but also enhance crop quality and yield, making agriculture more sustainable and efficient.

6. Methodology

Secondary data and existing techniques have been used. The data has been derived from government as well as private institutions. The data used has been cross-checked from various other online platforms to ensure its reliability.

7. Conclusion

Climate change majorly affects the poor and marginal farmers who make their livelihoods from agriculture. Technology and smart practices can help mitigate risks caused by climate change, among others. India is constantly making efforts to formulate and implement policies to make agriculture more sustainable. AI has the potential to completely revolutionise the existing trends in agriculture and farming. Given India's vibrant corporate structure, partnerships between the corporates and the government can help create a smart agriculture industry.

References

[1] https://www.ibm.com/think/topics/smart-farming
[2] https://journalijecc.com/index.php/IJECC
[3] https://www.ibef.org/blogs/india-s-smart-agriculture-strategies
[4] https://en.m.wikipedia.org/wiki/Agriculture_in_India
[5] https://www.india.gov.in/topics/agriculture/agricultural-machinery
[6] https://www.india.gov.in/topics/agriculture
[7] https://www.redotterfarms.in/
[8] https://www.ibef.org/blogs/india-s-smart-agriculture-strategies
[9] https://www.agritecture.com/blog/2020/5/15/one-of-indias-biggest-aquaponics-farms-employs-80-women
[10] https://www.agriculturejournal.org/volume12number3/aquaponics-advancements-a-comprehensive-exploration-of-sustainable-aqua-agriculture-practices-in-the-indian-context/#:~:text='Red%20otter%20farm'%20and%20',renowned%20aquaponics%20farms%20in%20India.&text=Red%20Otter%20Farm%20situated%20in,India%2C%20spanning%2010%2C000%20sq%20ft.
[11] https://www.agriculturejournal.org/volume12number3/aquaponics-advancements-a-comprehensive-exploration-of-sustainable-aqua-agriculture-practices-in-the-indian-context/
[12] https://agriwelfare.gov.in/