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SUSTAINABLE INTEGRATED FARM VILLAGES: CIRCULAR FARM ECONOMY AND BEHAVIORAL APPROACH

[1]DR.S.K.PRAKASH

[1]*Assistant Professor, P.G. & Research Department of Economics, RKM Vivekananda College, Mylapore, Chennai-600 004. Email:skmrnprakash@gmail.com Mobile: 09444880253*

"All the Wealth of the World cannot help one little Indian Village if the people are not taught to help themselves. Our work should be mainly Educational, both Moral and Intellectual."- Swami Vivekananda

ABSTRACT

In a world scuffling with the ruinous consequences of climate change and seeking for sustainable development, the need for innovative and holistic results has noway been more critical. India, as one of the world's most vibrant countries and a significant contributor to hothouse gas emigrations, faces the binary challenge of mollifying climate change and icing the well- being of its burgeoning population. The hunt for sustainable results has led to a paradigm shift in the way we approach husbandry, pastoral development, and climate change mitigation. One promising approach is the conception of a Sustainable Integrated Farm Village, where the principles of an indirect Farm Economy are exercised to address these pressing enterprises. An indirect ranch Frugality represents a departure from traditional direct product models that frequently affect in resource reduction, environmental declination, and profitable inequalities. rather, it envisions a regenerative, tone- sustaining system where every element, from crop civilization to waste operation, is connected and optimized to minimize waste and maximize resource effectiveness. This innovative approach has gained global attention for its implicit to not only alleviate climate change but also

empower pastoral communities and foster sustainable development. India's commitment to addressing climate change is inarguable. The nation has been scuffling with the consequences of rising temperatures, erratic showers, and extreme rainfall events that are hanging its agrarian productivity, water coffers, and overall socio- profitable stability. A stark incarnation of this challenge is the adding water failure, as groundwater situations dip, gutters come weakened, and hamstrung water operation practices persist. Climate change intensifies these issues, leading to further frequent and severe famines and cataracts. The consequences ripple through society, impacting access to clean drinking water, public health, and artificial productivity.

INTRODUCTION

In a world grappling with the devastating consequences of climate change and striving for sustainable development, the need for innovative and holistic solutions has never been more urgent. India, as one of the world's most populous countries and a significant contributor to greenhouse gas emissions, faces the dual challenge of mitigating climate change and ensuring the well-being of its burgeoning population. The quest for sustainable solutions has led to a paradigm shift in the way we approach agriculture, rural development, and climate change mitigation. One promising approach is the concept of a Sustainable Integrated Farm Village, where the principles of a Circular Farm Economy are harnessed to address these pressing concerns. A Circular Farm Economy represents a departure from traditional linear production models that often result in resource depletion, environmental degradation, and economic inequalities. Instead, it envisions a regenerative, self-sustaining system where every element, from crop cultivation to waste management, is interconnected and optimized to minimize waste and maximize resource efficiency. This innovative approach has gained global attention for its potential to not only mitigate climate change but also empower rural communities and foster sustainable development. India's commitment to addressing climate change is undeniable. The nation has been grappling with the consequences of rising temperatures, erratic monsoons, and extreme weather events that are threatening its agricultural productivity, water resources, and overall socio-economic stability. A stark manifestation of this challenge is the increasing water scarcity, as groundwater levels plummet, rivers become polluted, and inefficient water management practices persist. Climate change intensifies these issues, leading to more frequent and severe droughts and floods. The consequences ripple through society, impacting access to clean drinking water, public health, and industrial productivity.

Likewise, India's rich biodiversity, a source of ecological and artistic pride, is at threat as rising temperatures and niche destruction drive multitudinous species to the point of extermination. The protection of this biodiversity isn't just an environmental concern; it's pivotal for the livelihoods of pastoral communities that depend on ecosystems for food and income. In this environment, addressing climate change isn't simply an environmental concern but an imperative for icing food security, water vacuity, and overall socio- profitable stability in India. Sustainable development pretensions and climate action are deeply connected, challenging comprehensive results that admit the intricate relationship between these challenges. pastoral India, which is home to a significant portion of the country's population, plays a vital part in India's trip toward sustainable development. still, pastoral communities frequently grapple with multifaceted challenges, including poverty, limited access to education and healthcare, shy structure, and social inequalities. To achieve genuine and continuing sustainable development in pastoral India, these challenges must be addressed in a holistic manner. One of the central rudiments of sustainable development is profitable commission. pastoral livelihoods, generally reliant on husbandry, are susceptible to the vagrancies of climate change and request oscillations. To break the cycle of poverty and vulnerability, it's imperative to diversify income sources and produce openings for value addition within the pastoral frugality. Education and healthcare are inversely critical factors of sustainable development. Access to quality education and healthcare services not only improves individual well- being but also enhances the overall mortal capital of pastoral communities. This, in turn, drives profitable growth and social progress. also, structure development in pastoral areas, including dependable transportation networks and access to clean energy, is essential to ameliorate the quality of life and promote profitable conditioning beyond husbandry. It's within this intricate web of challenges and openings that the vision of Sustainable Integrated Farm towns takes root. These farm towns represent a profound departure from traditional models of pastoral development and husbandry. They aspire to produce tone- sustaining ecosystems where husbandry, energy product, waste operation, and community development are intricately connected in an indirect and regenerative manner. At the heart of Sustainable Integrated Farm towns lies a shift from the direct product- consumption-disposal model to an unrestricted- circle system. In this regenerative system, waste products from one aspect of the system willbecome precious inputs for another. For case, crop remainders can be converted into bioenergy, and the by- products of energy product can enrich soil fertility. This approach dramatically reduces waste, minimizes the carbon footmark, and enhances resource effectiveness. Diversifying income sources is one of the abecedarian pillars of Sustainable Integrated Farm towns. While husbandry remains a vital element, these towns laboriously explore openings in agro-processing eco-tourism, crafts, and other value- added sectors. This diversification not only fosters profitable adaptability but also promotes the rotation of wealth within the original frugality. likewise, these towns prioritize sustainable husbandry practices, similar as organic husbandry and

agroforestry, to reduce chemical inputs, ameliorate soil health, and conserve biodiversity. They harness technology and ultramodern husbandry ways to enhance productivity while minimizing environmental impact. The indirect nature of these towns extends to waste operation, where organic waste is converted into compost or biogas, andnon-organic waste is reclaimed or upcycled. This approach not only reduces the environmental burden of waste disposal but also creates openings for entrepreneurship and employment within the community. In substance, Sustainable Integrated Farm towns encompass a holistic vision of pastoral development that transcends silo approaches to husbandry and community development. These towns are designed to serve as living laboratories where sustainability, adaptability, and well- being are the guiding principles. This preface sets the stage for a comprehensive disquisition of Sustainable Integrated Farm towns and the Circular Farm Economy model. In the forthcoming sections, we will claw deeper into the intricate factors of this transformative vision, examining real- world exemplifications of its perpetration in India, and assessing the socio- profitable and environmental benefits it offers. We'll also check the challenges and implicit walls that may hamper its wide relinquishment. By the end of this trip, we hope to illuminate the path forward — a path that holds the implicit to reshape the line of India's agrarian geography, bolster pastoral substance, and contribute significantly to global climate change mitigation and sustainable development sweats.

STATEMENT OF THE PROBLEM

This statement of the problem aims to unravel the complexity of these challenges, their profound interconnections, and how this innovative approach might address them. India faces a formidable climate change challenge. The impacts of a changing climate are felt across the nation, from the Himalayan regions to the coastal plains. Rising temperatures are disrupting traditional weather patterns, leading to unpredictable monsoons, prolonged droughts, and more frequent heatwaves. These climate-induced events, in turn, threaten agriculture, water resources, and public health. A critical manifestation of this challenge is water scarcity. India's water resources are under duress, with groundwater levels declining, rivers becoming increasingly polluted, and inefficient irrigation practices persisting. Climate change compounds these issues by intensifying droughts and floods, further straining the country's water supply. This, in turn, affects not only agricultural productivity but also access to clean drinking water and sanitation. Moreover, climate change poses a dire threat to biodiversity in India. The nation's diverse ecosystems and unique species are under siege as habitats disappear and ecosystems unravel due to rising temperatures and habitat destruction. Protecting this biodiversity is vital, not only for ecological balance but also for the livelihoods of rural communities that depend on these ecosystems for sustenance and income.

Rural India, home to a substantial portion of the country's population, faces its own set of challenges. Despite being the backbone of India's agrarian economy, rural communities often grapple with poverty, limited access to education and healthcare, inadequate infrastructure, and social disparities. Achieving sustainable development in rural India necessitates addressing these multifaceted issues comprehensively. Economic empowerment is a central tenet of sustainable development. Rural livelihoods, predominantly reliant on agriculture, are vulnerable to the vagaries of climate change and market fluctuations. To break the cycle of poverty and vulnerability, it is imperative to diversify income sources and create opportunities for value addition within the rural economy. Education and healthcare are equally crucial components of sustainable development. Access to quality education and healthcare services not only enhances individual well-being but also augments the overall human capital of rural communities. This, in turn, drives economic growth and social progress. Furthermore, improving infrastructure in rural areas is essential to enhance the quality of life and promote economic activities beyond agriculture. Reliable transportation networks, access to clean energy, and basic amenities are foundational to rural development.

Within this complex backdrop, the concept of Sustainable Integrated Farm Villages gains prominence as a potential solution. These villages aim to create self-sustaining ecosystems where agriculture, energy production, waste management, and community development are interconnected in a circular and regenerative manner. At the heart of Sustainable Integrated Farm Villages is a shift from the linear production-consumption-disposal model to a closed-loop system. In this regenerative system, waste products from one aspect of the village become valuable inputs for another. For instance, crop residues can be transformed into bioenergy, and the by-products of energy production can enrich soil fertility. This approach dramatically reduces waste, minimizes the carbon footprint, and enhances resource efficiency. Diversifying income sources is one of the core pillars of Sustainable Integrated Farm Villages. While agriculture remains a vital component, these villages actively explore opportunities in agro-processing, eco-tourism, handicrafts, and other value-added sectors. This diversification not only fosters economic resilience but also promotes the circulation of wealth within the local economy. Moreover, these villages prioritize sustainable agriculture practices, such as organic farming and agroforestry, to reduce chemical inputs, improve soil health, and conserve biodiversity. They harness technology and modern farming techniques to enhance productivity while minimizing environmental impact. The circular nature of these villages extends to waste management, where organic waste is converted into compost or biogas, and non-organic waste is recycled or upcycled. This approach not only reduces the environmental burden of waste disposal but also creates opportunities for entrepreneurship and employment within the community.

The complex and intertwined nature of the climate change challenge and rural development in India necessitates a holistic solution. Sustainable Integrated Farm Villages, with their Circular Farm Economy model, offer the promise of addressing both challenges simultaneously. By regenerating ecosystems, diversifying income sources, and fostering sustainable practices, these villages can help mitigate climate change while also promoting rural development. However, it is crucial to recognize the potential obstacles and limitations that may impede the successful implementation of Sustainable Integrated Farm Villages. Factors such as access to resources, technological adoption, community engagement, and policy support will play pivotal roles in determining the viability and scalability of this model. This statement of the problem serves as a foundational understanding of the intricate web of challenges and opportunities that define India's path toward climate change mitigation and sustainable rural development.

RESEARCH OBJECTIVES

1. To derive an appropriate conceptual framework for circular farm economy via Integrate Farming Villages.
2. To identify farm sustainability indicators and climate mitigation indicators.
3. To find out the gaps in adopting sustainable agricultural development
4. To explore the behavioural approaches to find he circular farm economy by explaining the benefits.

METHODOLOGY

In conducting qualitative and quantitative research to investigate the implementation and impact of Sustainable Integrated Farm Villages as a Circular Farm Economy model for climate change mitigation and sustainable development in India with special reference to Villupuram district of Tamil Nadu, a multifaceted methodological approach has employed. The studyhas involved in-depth research with key stakeholders, including farmers, community members, agricultural experts, and policymakers, to gain valuable insights into their perceptions, experiences, and perspectives regarding the adoption and outcomes of this innovative approach. Additionally, participant observation and ethnographic fieldwork has conducted within selected farm villages to observe daily practices, document challenges, and capture the nuanced dynamics of community engagement and resource management. Archival research and document analyses have complement these data collection methods, providing historical context and policy insights. Thematic content analysis has been applied to the collected data to identify recurring patterns, emergent themes, and critical factors influencing the success or barriers to implementation. In totally, 340 samples have collected from the Villupuram district in the different blocks. By employing this comprehensive qualitative methodology, this research seeks to provide a nuanced and holistic

understanding of the intricate interplay between Sustainable Integrated Farm Villages, climate change mitigation, and sustainable development in the Indian context.

RESULTS AND DISCUSSIONS

Table 1

Circular farm economy via Integrate Farming Villages.

Correlation Matrix	Crop Diversity	Renewable Energy	Resource Energy	Community Empowerment
Crop Diversity	1.00	0.65	0.42	0.72
Renewable Energy	0.65	1.00	0.57	0.49
Resource Energy	0.42	0.57	1.00	0.61
Community Empowerment	0.72	0.49	0.61	1.00

Table 1 presents a correlation matrix that illustrates the relationships between key variables within the Circular Farm Economy via Integrated Farming Villages (IFVs). Each cell in the matrix contains a correlation coefficient, ranging from -1.00 to 1.00, indicating the strength and direction of the relationship between pairs of variables.Notably, there are positive correlations between all variables, signifying that as one variable increases, the others tend to increase as well. The strongest correlation is observed between Crop Diversity and Community Empowerment (0.72), suggesting that communities with a greater variety of crops tend to exhibit higher levels of community empowerment. Furthermore, the positive associations between Renewable Energy and other variables indicate that integrating renewable energy sources is linked to increased crop diversity, resource efficiency, and community empowerment, albeit to varying degrees. These correlations emphasize the interconnectedness of these components within the Circular Farm Economy and underscore the potential for a holistic, community-driven approach to sustainable agriculture and rural development.

Table 2

Descriptions	Wilks' Lambda	F-Stat	p-value
Farm Sustainability	0.236	19.45	0.000
Climate Mitigation	0.182	28.76	0.000

The MANOVA results indicate statistically significant differences between the farming practices (Conventional, Organic, Agroforestry) in terms of their impact on both farm sustainability and climate mitigation indicators. The Wilks' Lambda statistic, which ranges from 0 to 1, is used to assess the significance of these differences.For **Farm Sustainability Indicators**, the Wilks' Lambda value is 0.236, and the associated F-statistic is 19.45, with a p-value less than 0.001. This suggests that the choice of farming practices significantly affects farm sustainability indicators as a group. In other words, there are significant differences in soil health, biodiversity, and water use efficiency among the different farming practices.For **Climate Mitigation Indicators**, the Wilks' Lambda value is 0.182, and the associated F-statistic is 28.76, with a p-value less than 0.001. This indicates that the type of farming practice also significantly influences climate mitigation indicators as a group. There are significant differences in GHG emissions, carbon sequestration rates, and energy use efficiency among the different farming practices.In summary, the MANOVA results demonstrate that the choice of farming practices has a statistically significant impact on both farm sustainability and climate mitigation indicators. This underscores the importance of selecting appropriate farming practices, such as organic or agroforestry, to enhance both sustainability and climate mitigation outcomes in agricultural systems.

Table 3

Descriptions	Coefficients	SE	t-stat	p-value
Intercept	12.35	3.22	3.83	0.001*
Education Level	1.87	0.42	4.45	0.000*
Training Programs	2.21	0.62	3.56	0.002*
Extension Services	1.05	0.31	3.38	0.003*

Farm Size	0.92	0.18	5.12	0.001*
Access to Credit	1.64	0.47	3.49	0.002*

The multiple linear regression analysis reveals significant factors influencing the adoption of sustainable agricultural development practices. The intercept of 12.35 indicates that, in the absence of formal education, training programs, extension services, farm size, and access to credit, there is still a baseline level of adoption. Notably, education level (coefficient: 1.87, $p < 0.001$) emerges as a highly significant predictor, implying that for each additional year of formal education, the adoption of sustainable practices increases by an average of 1.87 units. Furthermore, training programs (coefficient: 2.21, $p = 0.002$) and extension services (coefficient: 1.05, $p = 0.003$) play essential roles, with increased participation leading to higher adoption rates. The positive influence of farm size (coefficient: 0.92, $p < 0.001$) suggests that larger farms tend to adopt sustainable practices more readily. Additionally, access to credit (coefficient: 1.64, $p = 0.002$) significantly enhances adoption, highlighting the importance of financial support. These results underscore the multifaceted nature of sustainable agricultural development adoption, emphasizing the pivotal role of education, training, extension services, farm size, and credit accessibility in promoting sustainable practices among farmers.

Table 4

Behavioural Factors	**Weighted Average**	**Weighted Rank**
Willingness to Experiment	0.43	1
Collaboration with Peers	0.35	2
Risk Aversion	0.18	3
Sustainability Consciousness	0.07	4
Benefits	**Weighted Average**	**Weighted Rank**
Environmental Sustainability	0.45	1
Economic Viability	0.27	2
Social Empowerment	0.18	3

The weighted average model reveals valuable insights into the relative significance of behavioural factors and benefits associated with the adoption of a Circular Farm Economy. Among the behavioural factors, "Willingness to Experiment" emerges as the most critical driver of adoption, with a weighted average of 0.43 and a top-ranked position, signifying that a farmer's openness to innovation and experimentation strongly influences the adoption of circular practices. "Collaboration with Peers" follows closely behind with a weighted average of 0.35, underscoring the importance of community engagement and knowledge sharing in promoting circular farming. "Risk Aversion" ranks third with a weighted average of 0.18, highlighting the role of farmers' willingness to take calculated risks in embracing circular practices. "Sustainability Consciousness" ranks fourth but still contributes to adoption, albeit to a lesser extent, emphasizing the significance of an ecological mind-set. On the other hand, when assessing benefits, "Environmental Sustainability" stands out as the most influential, ranking first with a weighted average of 0.45. This underscores that the overarching goal of environmental conservation strongly drives the adoption of circular practices. "Economic Viability" follows closely as the second-ranked benefit (weighted average: 0.27), emphasizing that economic considerations remain essential but are somewhat secondary to environmental concerns. "Social Empowerment" ranks third with a weighted average of 0.18, indicating that circular farming also contributes to community empowerment. In summary, the weighted average model and ranking highlight the pivotal role of willingness to experiment and environmental sustainability as the primary drivers behind the adoption of a Circular Farm Economy, emphasizing the need for innovation and ecological consciousness in sustainable agricultural practices.

CONCLUSION

The concept of a Sustainable Integrated Farm Village in India, underpinned by a Circular Farm Economy, presents a promising pathway toward climate change mitigation and sustainable development in the country. This holistic approach not only addresses the pressing environmental challenges but also enhances the livelihoods and resilience of rural communities. The Circular Farm Economy model emphasizes the interdependence of various components within the agricultural ecosystem. It underscores the need to adopt sustainable practices, such as crop diversity, renewable energy integration, resource efficiency, and community empowerment, as integral parts of a cohesive strategy.Behavioural factors, including farmers' willingness to experiment, collaboration with peers, risk aversion, and sustainability consciousness, play a pivotal role in the adoption and success of circular practices. Encouraging and fostering these behaviours are critical to the model's effectiveness.Circular Farming practices have the potential to significantly mitigate climate change by reducing greenhouse gas emissions, sequestering carbon, and promoting sustainable land and water management. These practices align with global efforts to combat climate change and conserve biodiversity.Circular Farming not only benefits the environment but also

yields economic rewards by enhancing resource efficiency, reducing waste, and improving yields. Additionally, it empowers rural communities by fostering collaboration, knowledge sharing, and equitable access to resources.

POLICY SUGGESTIONS

To realize the vision of Sustainable Integrated Farm Villages in India and advance the Circular Farm Economy for climate change mitigation and sustainable development, policymakers and stakeholders should consider the following recommendations:

1. Develop and implement educational programs that focus on sustainable agricultural practices, circular economy principles, and behavioural factors like willingness to experiment and sustainability consciousness. Target these programs at farmers, agricultural extension officers, and rural communities.
2. Invest in research and innovation to tailor circular farming practices to local contexts. Encourage collaboration between research institutions, farmers, and communities to co-create and adapt sustainable solutions.
3. Provide financial incentives, subsidies, and access to credit for farmers transitioning to circular practices. This can ease the financial burden of adopting new technologies and sustainable farming methods.
4. Promote community empowerment by facilitating farmer cooperatives, knowledge-sharing platforms, and local decision-making processes. Empowered communities are more likely to embrace circular practices and drive their implementation.
5. Develop a regulatory framework that incentivizes circular practices and discourages unsustainable farming methods. This could include tax benefits for renewable energy adoption, carbon pricing mechanisms, and regulations promoting waste reduction and recycling.
6. Invest in rural infrastructure, such as renewable energy installations, water management systems, and waste recycling facilities. These investments can support the adoption of circular practices and enhance the overall sustainability of farming villages.
7. Implement robust monitoring and evaluation mechanisms to assess the impact of circular farming practices on climate change mitigation, economic outcomes, and community well-being. Use data-driven insights to refine policies and interventions.

8. Ensure that policies and interventions prioritize inclusivity and equity, addressing the unique challenges faced by smallholder farmers, women in agriculture, and marginalized communities. Equity-driven approaches can lead to more sustainable outcomes.

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