Integrated Farming System to Mitigate Climate Change Impact on Horticulture in India

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Abstract— *This research examines the function of Integrated Farming Systems (IFS) in the sustainable agricultural approach which address the ill effects of changing climatic conditions on horticulture crops in India. It analyses the various elements of IFS across different agro-climatic regions and assesses its potential to strengthen farmers' resilience against unpredictable weather events like droughts and floods. The study utilizes secondary data from governmental reports, international organizations, academic research, and case studies, employing a descriptive methodology to evaluate environmental and socio-economic advantages, significant obstacles to implementation, and strategies for successful execution. The results indicate that IFS enhances resource efficiency, improves soil health, and promotes biodiversity, while also diversifying income streams, boosting food security, and creating job opportunities. However, widespread adoption is hindered by factors such as lack of awareness, financial constraints, inadequate infrastructure, and limited access to institutional support. The study concludes that a region-specific, policy-driven, and technologically enabled approach—supported by training, financial aid, and market linkages—is vital for scaling up IFS practices across India. This transformation is essential to achieving long-term agricultural sustainability, climate resilience, and rural development.*

Keywords— Farmers, climatic conditions, Integrated Farming, sustainability, livelihood.

I. INTRODUCTION

In India fruits, vegetables, ornamental plants, aromatic and medicinal plants come under the head of horticulture crops. There is major contribution of these crops in increasing agriculture prosperity of the nation. India ranked First in whole world in terms of production, consumption and exports of spices and also ranked Second in production of fruits and vegetables in the whole world. With reference to the Second Advance Estimates for the year 2023-24 by the Department of Agriculture and Farmers Welfare, India's total horticulture production is estimated to be 352.23 million tonnes, which is slightly lower than the 355.48 million tonnes recorded in 2022-23, marking a decline of 0.91%. However, the area under horticulture cultivation has slightly increased from 28.44 million hectares to 28.63 million hectares, showing a growth of 0.66%. (Datta et al., 2022)The total fruit output is projected at 112.63 million tonnes, compared to 110.21 million tonnes in the previous year—an increase of 2.19%. Fruits like banana, mango, guava, lemon, and grapes have shown growth in production but there is a decline in the production of apple and pomegranate. Vegetable production has declined. The estimated vegetable output for 2023-24 stands at 204.96 million tonnes, down from 212.55 million tonnes in 2022-23, reflecting a 3.55% decrease. Increase in production can be seen in bottle gourd, bitter gourd, cabbage, cauliflower, pumpkin, tapioca, carrot, and tomato, while major crops like onion, potato, and brinjal have shown a drop. (Muchie & Assefa, 2021)

Climate change or we can say unpredictable and uneven weather conditions in a nation directly affects its agriculture sector. It causes biotic and abiotic stress while adversely affecting the horticulture crops of the country. Changing climatic conditions are as follows: -

- Global warming
- Rise in temperatures

- Uneven monsoon rains
- Unexpected cold & heat waves,
- Droughts
- Floods
- Rise in Sea Level
- Extreme & Unpredictable Weather Events
- Glaciers and Ice Melting
- Ocean Acidification
- Loss of Biodiversity
- Stronger Tropical Storms
- Thawing Permafrost
- Desertification

The damages faced by farmers due to these adverse and unpredictable effects of climate change on different horticulture crops are stated below: -

- Change in time taken for production of crops, because of rise in temperature crops develop very fast and mature early especially citrus fruits like lemon, oranges, melon and grapes.
- Reduction in crop yield and production
- Poor quality of crops due to drastic temperature variants.
- Increased risk of pest and other sudden weather change diseases.
- Flooding & Waterlogging
- Soil Degradation
- Reduction in Pollination
- Nutrient Imbalance

The above stated problems, causes huge losses to the livelihood of farmers across the nation. To overcome these losses the adoption of sustainable agriculture farming techniques is required. Sustainable agriculture practices are conservative agriculture methods used for the optimization of natural resources. Integrated Farming System is one of the many methods of sustainable agriculture used in the nation. Integrated Farming System (IFS) is the best remedy to deal with all sorts of problems faced by the farmers of Horticulture crops in India. IFS is a holistic approach that helps in a year-round income generation and ensure food and nutritional security to farmers, especially small and marginal farmers, Overall, IFS promotes economic stability, resource conservation, and environmentally friendly farming. (Bhagat et al., 2024)

The IFS has following Goals:

- To Enhance the productivity of per unit area in production of the crops.
- To improve the Soil heath and fertility
- To Maximize the reduction of chemical fertilizers usage while encouraging the use of organic fertilizers.
- Maximum yield & continuous income throughout the year.
- Proper Waste Management System
- Pest management.
- Economic Stability to farmers
- Conservation of natural resources

- Protection of Environment and Biodiversity as a whole.

The Various Components in Integrated Farming System (IFS) are as follows:

TABLE 1

VARIOUS COMPONENTS IN INTEGRATED FARMING SYSTEM (IFS)

Crop Husbandry	Growing and managing of crops for food, fodder and other purposes.
Aquaculture	Farming of different species of fish and other water animals or water plants.
Apiculture	Keeping bees for production of honey and also to help pollinate plants.
Sericulture	Growing silkworms to make silk.
Poultry	Raising birds like geese, chicken and emu for eggs and meat.
Livestock Husbandry	Raising of cows, buffaloes' goats, sheep, camels, horses and pigs for milk, wool, meat & transport.
Agro-forestry	Growing trees, shrubs & herbs together with crops or animals on the same land to increase soil fertility & additional income generation
Biogas Plants	Turning organic waste into gas for energy and compost.
Mushroom Cultivation	Growing mushrooms for food or medicinal use.
Duckery *(corrected)*	Raising ducks for their meat, eggs, or feathers.
Horticulture	Growing fruits, vegetables, flowers, and ornamental plants.

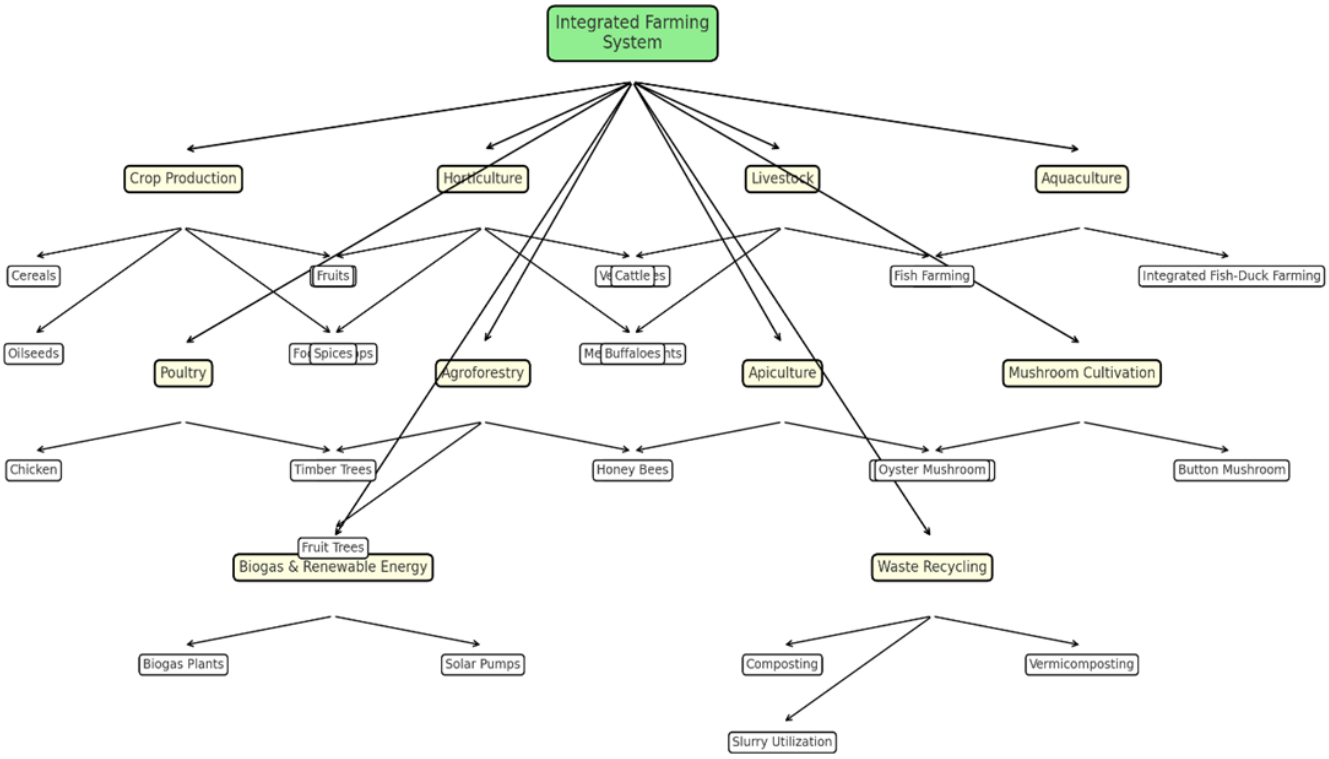

FIGURE 1: Various Components in Integrated Farming System (IFS)

Source: Self-Created

Research Gap:

Despite various national and international studies highlighting the impact of climate change on horticultural crops, there remains a lack of comprehensive, region-specific evidence on the effectiveness of Integrated Farming Systems (IFS) in enhancing climate resilience among Indian farmers. Furthermore, most existing literature does not focus on the unique challenges faced by small and marginal farmers in adopting such systems. Therefore, this study is crucial in bridging this

research gap by examining IFS applications, benefits, barriers, and policy needs, thereby underlining the significance of adopting IFS as a sustainable model to mitigate climate-related risks in horticulture.

II. LITERATURE REVIEW

Climate Change refers to the notable changes in mean state of climate or its variability or in any one of them which persistent in large period of time (10 years or more). These changes effects agriculture, horticulture fish and livestock production impacting the food supply., Main problems arising from the climate change are extreme unpredictable events, more erratic rainfall and unexpected high temperatures. Due to large burning of fossil fuels there is an increase in concentration of greenhouse gasses like CO2, nitrous oxide, and methane which is called greenhouse effect and it is a projected warning to the earth. (Kaur & Singh, 2021). To deal with changing climatic conditions and maintaining long term sustainability in agriculture agroforestry is one of the most adaptive methods to be used in India. Agroforestry can be used to improve soil fertility, increase water holding capacity and reduction in greenhouse gas emissions. It also provides additional livelihoods to farmers and helps in biodiversity conservation by minimizing risk of climate change conditions. Investment in research & development, awareness programs to increase farmers involvement and good government policies can lead to full potential utilization of the agroforestry which will ensure climate resilience for future generations**.** (Vaishnav et al., 2025).

To fight with the climate change adversities like rise in temperature, erratic & decrease in rainfall, the perceptions & adaptation of the farmers plays a pivotal role. Majority of famers in India are able to perceived these adversities with accordant to the metrological department. Farmers are doing necessary changes land use ,labour allocation .occupational pattern, and cropping system to adapt these unexpected changes due to climate change .But the factors like income, farm size ,gender, resource endowment, lack of information and lack of sufficient credit at right time are becoming hindrance to the farmers .There is need of large scale investment in agriculture sector which will lead farmers towards prosperity and long term sustainability as a whole. (Datta et al., 2022) To save horticulture from the negative effects of changing climate scenario & to sustain productivity, horticulturists need to play a significant role by implementing effective methods and strategies such as: More use of greenhouse technology, use of renewable energy, forest and water conservation, reforestation developing new cultivars which are immune of pest & diseases and also produce good yield in short duration. Wise use of natural resources will as play important role to face this challenge. (Kumar, 2024)

The main cause of biotic and abiotic stress in horticulture crops is climate change. Thers is a need to adopt certain strategies to minimize this stress. Use of renewable energy, developing new crops which are tolerant to high temperature, intercropping crop diversification, use of sustainably customized fertilizers, tillage practices, improving irrigation system, modifying date of planting, adjusting cropping seasons, improving pest control methods, adapting new farm techniques, mulching are some of these strategies. Accurate weather forecast, enabling GIS & insurance of crops scheme can also help in stress reduction in horticulture crops. (Thakre & Bisen, 2023)

A study conducted on variability of annual rainfall pattern during the growing season of crops across the nation for past 5 years highlights adverse effect like fluctuating monsoon onset, increase in number of dry spells & heavy rainfalls. It also reveals that farmers in India only protects their crops against these ill effects of rainfall only when they believe in climate change. Therefore, it is required that climate change adaptation should focus on farmers perception & weather records history befitted for each climatic zone. To improve farmers knowledge about weather change conditions and efficient land management, continuous integration of site- specific knowledge as well as practical experience can play an important role in future. (Paramesh et al., 2022) Protecting the environment by ensuring farmers' food, nutrition and livelihood needs and to encourage green revolution IFS is the most important tool. If implemented systematically IFS farms are more profitable and productive in comparison to the simple farms. IFS farms provide income generation and food diversification to meet the needs of farmers, these farms also help in conservation of biodiversity, reduction in greenhouse gas emissions, meet food demands in long run and ensure that farms are climate-resilient in this current climate change scenario. To achieve these benefits of IFS government should provide good capital investments, infrastructure and on-field demonstration to farmers specially the one with small and marginal land holdings. (Bhagat et al., 2024)

Integrated Farming Systems (IFS) have emerged as a promising approach to address the increasing challenges in the field of food security, income instability, and environmental degradation in Indian agriculture. Several studies across the country highlight that crop cultivation alone is insufficient to meet the nutritional and economic needs of small and marginal farmers. IFS, which integrates multiple farm enterprises such as livestock, poultry, fishery, and agroforestry with crop production, has proven effective in improving resource use efficiency and ensuring better livelihood outcomes. It facilitates nutrient recycling,

enhances soil fertility, and supports sustainable agricultural practices while preserving ecological balance. Overall, IFS is increasingly recognized as a viable and sustainable model for holistic rural development. (S. Kumar et al., 2018).

The research is conducted on the trends in mean annual precipitation & temperature for 115 years in the 15 districts of Madhya Pradesh. Case study of four main agriculture crops was also done for better understanding of production process and forecasting future growth trend. With the implementation of Man-Kendall test it was found that there is rise in temperature due to climate change. the aim of the research was to reduce loss of production in horticulture crops by providing detail understanding present as well as future of changing climatic conditions. (Sharma et al., 2022). Adaptation towards environment friendly and sustainable methods is becoming more and more important in gardening due to various ill effects of traditional horticulture methods such as soil erosion, water pollution & greenhouse emissions. The study examines the efficacy of different techniques which includes organic farming, integrated pest control, water conservation, soil health management and biodiversity improvement. It is revealed that environmentally friendly gardening methods results in lower input costs and more ecosystem benefits. But the broad use of these methods also has some hinderance and problems which needs to be resolved with help of providing proper guidance, financial support and training for the persons involved in gardening industry. (M. Kumar et al., 2023).

Research on sustainable resource management for the climate-smart 0.4-hectare Integrated Farming System (IFS) model was conducted at the College of Agriculture, Rewa, as part of an all-India initiative during 2021-2023. IFS model yielded a rice equivalent of 131.24 quintals, generating a gross return of Rs. 271,531, a net profit of Rs. 130,090, & a benefit-cost ratio i.e. 1.91. Dairy component, featuring two cows, produced a net profit of Rs. 86,933 and a benefit-cost ratio of 1.92. Among cropping systems, the okra and garlic combination achieved a benefit-cost ratio of 2.23, yielding a net profit of Rs. 8,066 from 0.02 hectares. Employment generation varied from 36 man-days in June to 51 in October, totalling 513 man-days annually. Monthly income ranged from Rs. 2,501 in June to Rs. 29,913 in April. The IFS model's self-reliance status was 89%, with green fodder at 27.39%, dry fodder at 41.87%, and concentrates for cattle. Additionally, vermicompost and compost units provided 36.1% of total nitrogen, 46.26% of total phosphorus, and met 95% of total potassium needs. (Mourya et al., 2024) Due to changes in climate, the growth and development of good quality fruits is severely affected because it increases pest evasions, altered flowering and also effects the geographic distribution, phenology & local abundance of plants and pollinators. One such example of weather change is low winter chills. To deal with this situation there is a need to develop heat & drought resistant crops by the researchers with the help of modern genetic & Production methods. (Lal et al., 2018)

Projected climate data (2071–2100) downscaled via the PRECIS model for seven stations in Gujarat indicate a 15–101% increase in annual rainfall compared to the 1961–1990 baseline. Maximum and minimum temperatures are expected to rise by 2.8–7.7°C and 3.8–5.2°C, respectively. Crop simulations using Info Crop and DSSAT models suggest significant yield reductions under future climate scenarios. Wheat shows the highest projected decline (up to 61%), while pearl millet is least affected (–8% to –14%). Maize is more vulnerable in the kharif season (–47%) than in rabi (–10%). (Patel et al., 2015) Adverse & ill effects of global warming such as uneven climate and accelerated warming can be seen across the India nowadays, especially in North Western India. The productivity & quality of horticulture crops is affected due to these. For minimizing losses in the horticulture sector there is need to focus on adoption of conservative agriculture, use of renewable energy, natural resources conservation, modification of present horticulture practices and by developing pest and variations resistant crops. (Bhati et al., 2018).

To counterattack the negative consequences of changing climatic conditions horticultural crops, have better advantage over other agriculture crops by providing better carbon trade &carbon silk. Smart horticulture, keeping a watch on carbon silk potential and crop-based strategies will help to provide a pathway to reduce climate change issues. (MALHOTRA et al., 2017) At both local and global scales, farmers decision-making process in response to climate change has gained a significant attention within the broader discourse of human-environment interactions. A study was conducted to explore the human dimension of adaptation decisions among farmers in rural India. Specifically, farmers' perceptions on climate change and the socio-economic determinants that influence both their decision to adapt and their choice of adaptation strategies. In a micro-level assessment involving 700 farmers across seven districts of Bihar, India. The data were analysed using descriptive statistics and logistic regression methods. Findings indicate that approximately 80% of the surveyed farmers perceive changes in climate and respond by adopting various adaptation measures. Key socio-economic factors—such as age, gender, household size, education level, farm income, and farm size—were found to significantly influence adaptation decisions. The insights from the study were highlighting critical household characteristics that should be considered to design and implement effective and inclusive climate adaptation strategies. (Jha & Gupta, 2021).

Majority of fruit crops are grown in open fields condition which makes them highly vulnerable to the impacts of climate change. Rise in temperatures adversely affect the establishment, growth, and yield of fruit crops. Physiological disorders such as spongy tissue in mangoes, fruit cracking in litchis, and flower/fruit abscission are likely to become more pronounced. Additionally, air pollution exacerbates certain disorders, including black tip in mangoes, while low winter temperatures can cause chilling injury in tropical fruits like bananas. To ensure the sustainability of these crops, it is crucial to adapt horticultural practices such as, increasing the use of greenhouse technologies, and developing hybrids or cultivars resistant to abiotic and biotic stresses. Adopting high-tech horticulture and optimizing resource management will be key strategies in mitigating the adversity of climate change in the production of fruit crop. (Reddy et al., 2016)

Production factors such as use of fertilizers and cultivated area deeply effect the horticulture crops, vegetables are one of them. To mitigate climate change and to improve vegetables supply in the market, there is a need of proper advisory services by government and policy makers and establishment of agriculture credit channels with the help of banks. By implementing these farmers will be able to get financial support to cope up with changing weather which can lead to increase in food production and food security in the nation. (Chandio et al., 2025) Changing climate or we can say environmental stress leads to decrease in irrigation water, rise in temperatures, flooding, salinity, reduction in soil moisture & increase in heat stress which causes negative effects like shortened growth period, reduction in yield & decline in quality of fruits and vegetables across the world. Due to these unpredictable climatic variations for example melting of ice caps in Himalayas, cultivation of horticulture crops has become unreliable and inconsistence in both quantity & quality. These challenges can be overcome by adopting improved management practices, increase use of greenhouse, modified cultivation techniques and developing crops which are heat resistant, pest resistant as well as provide high yields in short period of time. (Hirpo, 2019)

Being perishable and highly sensitive to the variations in climate horticulture crops are facing decrease in quantity and quality across the globe. This ill effect is also called as Abiotic Stress. Cracks & sun burns in apples, drying of cashew flower and hindrance in growth of roots in potatoes are adverse effects of temperature change. Not only this but due to recent climatic disasters across the globe has caused hug loss of yield in horticulture crops. For example, 1) 47.5% yield loss of vegetables & 40% of onions yield lost due to flooding in China .2) In Indian state of Kerala flooding caused huge loss of 25,138 tonnes of species, 80% tomato yield lost to TLM. bugs in banana and high amount of CO2 in coffee lead to quality degradation. (Muchie & Assefa, 2021).

III. RESEARCH QUESTIONS

- In what ways do Integrated Farming Systems enhance climate resilience in horticulture throughout India?
- What are the primary socio-economic and ecological advantages gained from IFS?
- What are the main obstacles to the adoption of IFS, and how can policy and practice address these challenges?

IV. OBJECTIVES

The objectives of the study are: -

1. To examine how Integrated Farming Systems (IFS) contribute to improving climate resilience in horticultural practices.
2. To evaluate the socio-economic and environmental advantages of IFS for smallholder and marginal farmers.
3. To recognize the obstacles to adoption and propose strategies for the successful implementation of IFS in India.

V. RESEARCH METHODOLOGY

The study is a phenomenal and descriptive research in nature which aims to describe a population, situation, or phenomenon in a very systematically accurate manner. The main focus of this research is on "what" of a subject rather than the "why" or "how." It is mainly used to gather information about current conditions without altering the environment or making any assumptions for the same.

In this study secondary data is used which is derived from reputable and credible sources only. The details of various sources are mentioned below:

1. Government Reports and Publications:

- Data from the Ministry of Agriculture and Farmers Welfare, GOI

- Reports of the Department of Horticulture, National Horticulture Board (NHB), and the Indian Council of Agricultural Research (ICAR).

2. Research Studies:

- Academic papers, theses, and dissertations related to Integrated Farming Systems (IFS) and horticulture crop productivity for past 10 years.

3. International Organizations:

- Data from organizations such as the FAO (Food and Agriculture Organization) and the World Bank on farming systems, climate change, and agricultural sustainability in India.

4. Industry Reports:

- Reports from market research firms, agricultural industry bodies, and non-governmental organizations (NGOs) focused on sustainable farming and rural development.

5. Statistical Databases:

- National Sample Survey Office (NSSO) data, National Agricultural Survey (NAS), and other relevant databases.

6. Climate Data:

- Data from meteorological agencies and climate prediction centres.

VI. DISCUSSION

To minimize the adverse effects of the present unpredictable weather and variations in climatic conditions on horticulture crops Integrated Farming Systems (IFS) provides a reliable and strategic remedy.

Key contributions of IFS include:

- Economic Resilience by enabling multiple income streams, IFS cushions farmers against the failure of only crop which leads to failure of only source of income.
- Resource Optimization by promoting organic waste recycle and converting it into productive resources which reduces environmental contamination.
- Increase in Soil Health by adopting organic practices like vermicomposting & green manuring to restore soil structure & improve microbial activity.
- Climate Adaptation through practices like agroforestry which offer shade and windbreaks, and rainwater harvesting to supports irrigation during dry spells.
- Pest and Disease Control by promoting natural pest control and maintaining ecological balance.
- Environmental Protection through reduction in chemical inputs which helps in biodiversity conservation, and improved carbon sequestration contribute to ecological stability.

The successful adoption of Integrated Farming System (IFS) models by farmers requires careful planning, resource management, technical know-how, and strong support systems. This can be achieved by implementing proper strategic planning which has the following components:

1. Training and Capacity Building:

This provides technical knowledge and practical skills to farmers to manage various components of IFS with help of

- Farmers' Training Programs
- Workshops and Demonstrations
- Farmer Field Schools (FFS)

2. Financial and Policy Support:

This help farmers to reduce their financial burden by providing the required finance assistance as per the needs of the farmers, which will also help in increasing productivity in long run. Below are the ways thorough which farmers can be provided support.

- Subsidies and Grants by the Government or private agencies.
- Micro-Credit for Farmers for small-scale farmers to buy inputs like seeds, equipment, and livestock.
- Insurance Schemes for crops and livestock
- Subsidized Inputs such as organic fertilizers, pest management tools, and other critical resources.

3. Resource Optimization and Sustainable Practices:

This will help the farmers to reduce the use of chemical inputs which will lead to natural resource conservation. Some methods which can be used are as follows:

- Adoption of Water Conservation Techniques such as rainwater harvesting systems, using drip irrigation or sprinkler systems and aquaculture ponds.
- Soil Health Management by using crop rotation, green manuring, and vermicomposting, bio-fertilizers, and crop residues as natural nutrients for the soil.
- Waste Recycling through using animal manure for biogas production or as organic fertilizer for crops and crop residues as fodder for livestock
- Implement multi-layer agroforestry systems, such as integrating fruit trees and timber species with crops and livestock.

4. Diversification and Risk Management:

Reduction in risk of losses due to market fluctuations or weather-induced crop failure can be done through diversified sources of income which will help farmers, especially small farmers to improve economic resilience. Some most used methods are:

- Crop and Livestock Diversification:
- Integration of Aquaculture and Livestock:
- Risk Mitigation through Agroforestry:

5. Infrastructure Development to ensure smooth IFS operations. This can be done by the following ways:

- Establishment of efficient irrigation systems such as drip, sprinkler, or rainwater harvesting to ensure water supply.
- By providing farmers with low-cost yet effective housing for poultry, dairy cattle, and goats.
- Development of fish ponds or tanks integrated with crop fields. Farmers can use pond water for irrigation and grow crops on raised beds around the pond.
- Establishment of biogas plants to convert organic waste into energy for cooking and heating, and the slurry can be used as organic fertilizer.

6. Technological Interventions and Innovation:

With the help of data driven and technology-enabled practices farmers can increase productivity and profitability. Some ways are as follows:

- To encourage farmers for adopting digital tools and mobile applications to gather information about weather forecasting, market price information, and crop management guidance.
- To increase the use of smart sensors to monitor soil health, water levels, and plant growth.
- Implementation of precision farming technologies, such as drones, GPS mapping, and remote sensing, to enhance productivity and efficient use of resources.

- Use of Integrated Pest Management (IPM) and eco-friendly pest management practices, to reduce reliance on chemical pesticides.

7. Market Linkages and Value Addition:

To gain better prices for farmers, increase value of their produce and to Improve farmers' access to markets in rural areas following ways can be adopted: -

- Encouraging farmers to form cooperatives or farmer producer organizations (FPOs) to collectively market and sell their produce, which will improve their bargaining power.
- Promotion of more processing units for crops such as fruits (e.g., making jams, juices), dairy (e.g., making cheese), and mushrooms (e.g., drying or canning).
- To provide cold storage facilities for perishable products, especially in horticulture and dairy.
- Establishment of direct sales channels, such as farmer markets, online platforms, or community-supported agriculture (CSA) models, to bypass middlemen.

Few Case Studies that showcase the successful implementation of Integrated Farming Systems (IFS) in India are stated below:

1. Chhindwara, Madhya Pradesh – Organic Cotton and Diversified Farming:

With WWF's assistance, the SRIJAN organisation in Chhindwara helped 6,000 farmers switch from traditional GMO cotton production to organic methods. Cotton, orange trees, millet, wheat, corn, millet, vegetables and cattle were all part of the integrated system. Even though the production was initially lower, this method enhanced soil health, decreased input costs, and raised profitability. In order to facilitate irrigation during dry spells, water retention facilities were also put in place. This allowed for several harvests and decreased labour migration.

2. Champawat District, Uttarakhand – Multi-Component IFS Model:

A farmer in the Champawat area used an IFS model on a 1-hectare plot of land, combining the production of fish, dairy, poultry, vegetables, orchards, bees, and mushrooms. A benefit-cost ratio of 3.08 and a gross revenue of ₹6,94,000 were the outcomes of this diversified strategy. Additionally, for eight months per year, the system guaranteed the household's food and nutritional security.

3. Muzaffarnagar, Uttar Pradesh – Crop-Livestock Integration:

Compared to monoculture, integrating crops with dairy, horticultural, and goat husbandry increased system yields by 58.89% to 86.17%, according to four-year research conducted in the Muzaffarnagar area with 1,036 families. Improved fodder supply and the introduction of exotic crops raised net returns per hectare from ₹60,000 to ₹2,20,000. Furthermore, a season's worth of household costs were cut by $20 to $27 thanks to healthy kitchen gardening.

4. Modipuram, Uttar Pradesh – Diversified IFS Model:

An IFS model combining crops, dairy, horticulture, aquaculture, mushroom production, and border plants on 1.38 hectares at the Indian Institute of Farming Systems Research (ICAR) at Modipuram produced net yearly returns of ₹5,50,090 with a benefit-cost ratio of 3.42. Through excess production of grains, fruits, milk, fish, and mushrooms, this approach also improved food and nutritional security and produced 34% more man-days of annual employment.

5. Koraput, Odisha – Rice-Fish-Poultry System:

An IFS model integrating rice, fish, ducks, veggies, and fruit trees was put into practice by a tribal farmer in Koraput. When compared to traditional ways, this integrated approach tripled income. Additionally, the approach improved sustainability and output by using ducks to aerate and eliminate pests in fish ponds.

6. Kuttanad, Kerala – Rice-Fish and Coconut-Based IFS:

With benefit-cost ratios of 2.63 and 2.86, respectively, the rice-fish and coconut-banana-dairy-poultry-goat systems were determined to be extremely lucrative in Kuttanad. Increased net returns from resource allocation optimisation in these systems showed how integrated techniques could result in higher income.

7. Bidar, Karnataka – Horticulture-Based IFS:

In Bidar, the adoption of IFS resulted in a change from conventional crops to horticultural varieties. Farmers growing plants such as papaya, marigold, watermelon, onion, chili, and brinjal experienced increased net earnings per acre, with papaya achieving the highest profit at ₹1,10,988 per acre. This change also enhanced soil fertility and lowered input expenses.

8. Karaikal, Puducherry – Livestock and Crop Integration:

In Karaikal, an Integrated Farming System (IFS) that combines livestock, crops, and waste management showed a benefit-cost ratio of 1.75. This approach boosted productivity, optimized resource use, and increased food production, aiding small and marginal farmers in achieving income stability and nutritional security.

9. Gariyaband, Chhattisgarh – Rainfed vs. Irrigated IFS Models:

A research project conducted in Gariyaband analyzed Integrated Farming System (IFS) models in both rainfed and irrigated environments. The irrigated model over 1.5 acres demonstrated greater profitability, yielding higher net returns and enhanced employment generation potential when compared to the rainfed model occupying 3.5 acres, underlining the significance of water access in the success of IFS.

10. Integrated Farming System (IFS) in Andhra Pradesh – Sree Sairam Integrated Farming System Model:

In the Andhra Pradesh area, smallholder farmers have historically relied on monoculture cropping practices. The Sree Sairam Integrated Farming System (IFS) model was implemented, which incorporates Crop cultivation, Livestock, Aquaculture, Agroforestry, and Agro-processing. The IFS model resulted in enhanced farm income, offering year-round profits from its diverse components.

VII. FINDINGS

This research reveals that due to some constraints the Indian farmers are still hesitant to adopt IFS and they need more knowledge and awareness to overcome this resistance. Some major challenges are:

- Climate change causes extreme weather, erratic rainfall, and rising temperatures.
- Global climate stress reduces water availability, yield, and crop quality.
- Integrated Farming Systems (IFS) enhance sustainability and profitability.
- IFS models show high resource efficiency and employment generation.
- Farmers in India are slowly adopting IFS methods.
- Lack of knowledge and awareness among the farmers about the different IFS methods and ways to use them.
- Lack of ease in loan taking and credit facilities for farmers
- Lack of proper transport and storage facilities especially for perishable commodities.
- Small land holdings by majority of farmers which leads to financial incapability to adopt something new.
- Dependence on Traditional agriculture practices by the farmers
- Lack of knowledge about different government policies, schemes and programmes to promote sustainable agriculture development in India.
- Lack of timely availability of various inputs required.
- Major loss of crops is also seen worldwide due to unpredictable weather events.

VIII. SUGGESTIONS

On the basis of the study, here are few suggestions which can help to better implementation of Integrated Farming System in India: -

- Promotion of climate-resilient horticulture methods, through awareness campaigns, farmer training, and field demonstrations should be held by the central and state government in villages as well as taluka levels with the help of NGO and other cooperative societies to educate the Indian farmers.

- Expand adoption of IFS by showcasing success stories and offering region-specific models for small and marginal farmers.
- A contingent planning is required to be prepared to deal wisely with changing climate/weather threats by Developing early warning systems and crop insurance schemes to protect farmers from losses due to unpredictable weather.
- The government should provide more financial aids to the farmers for adopting IFS and other Sustainable farming practicing. They should also improve access to institutional credit and subsidies with simplified loan procedures and financial literacy programs.
- Increase awareness about government schemes through local extension services, farmer help desks, and digital platforms.
- More emphasis should be laid on new research to find to more economical and feasible methods in modern sustainable farming practices by introducing farmers to innovative tools, techniques, and climate-smart technologies.
- Ensure timely supply of all necessary inputs required farmers in implementation of IFS methods.
- Tailored IFS Models or Region-specific models should be adopted by considering agro-climatic conditions, dominant crops, and socio-economic contexts of the area.
- Strengthening local and export markets for diversified IFS products.
- To increase the usage of ICT tools, mobile advisory services, and climate data for improvement in decision-making and resource planning at the farm level.

Above stated suggestions will help to increase number of farmers adopting Integrated Farming System India as well as will help to attain the futuristic goal of our nation, which is: Sustainability as a whole.

IX. CONCLUSION

The study highlights that climate change effects like rise in temperature, erratic rainfall, significantly and extreme weather events significantly affects horticulture crops which leads to loss of farmers livelihood. Integrated Farming methods have full potential in improving resilience to climate change and farmers are also slowly adopting different methods of IFS but are facing challenges of limited resources, lack of proper training and lack of credit facility. Therefore, to unlock the full potential of IFS, a collaborative approach involving government, scientists, and communities is essential. The goal of a climate-resilient agricultural system for long-term sustainability and food security will also be achieved through this.

X. LIMITATIONS

Although the study provides a brief idea about the effects of changing climatic conditions on horticulture crops of the nation and how the implementation of integrated Farming System techniques is helping the farmers to minimizes their losses, but this study also has its certain limitation, which is: It is mainly based on the secondary data and therefore it lacks the data about the current situation, so more primary data will be required for further studies in this field to find out real time solution.

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