Journey of 3 Years IBM-IORF Sustainability Program

Phase I : 2021-22 ; Phase II : 2022-23; Phase III : 2023-24

Adoption of a Cluster of Villages for Agricultural Sustainability and Food Security through Clean Food Program

Implemented By
Inhana Organic Research Foundation (IORF)
168 Jodhpur Park, Kolkata – 700068, West Bengal, India
Email : inhana.rftprojects@gmail.com
Website : www.inhana.in

IBM - IORF SUSTAINABILITY PROJECT

Adoption of a Cluster of Villages for Agricultural Sustainability and Food Security through Clean Food Program

PROJECT TEAM
Inhana Organic Research Foundation (IORF)
Dr. Ranjan Bera
Dr. Antara Seal
Dr. Anupam Datta
Ms. Susmita Saha
Mr. Somesh Dutta

Project Sites :

- 100 ha : : Mandya District, Karnataka, India
- 100 ha : Nadia District, W. B., India

Project Duration : 2021 – 2024

TECHNICAL ASSOCIATION

Dr. Koushik Mukhopadhyay,
Nadia Krishi Vigyan Kendra, ICAR

Dr. Arun Kumar Barik
Visvabharati University, Santiniketan

Dr. Rambilash Mallick
Calcutta University, Kolkata

Dr. Pradip Bhattacharya
Indian Statistical Institute, Giridih

Submitted By

Inhana Organic Research Foundation (IORF)
168 Jodhpur Park, Kolkata – 700068, West Bengal, India
Email : inhana.rftprojects@gmail.com
Website : www.inhana.in

IBM - IORF SUSTAINABILITY PROJECT

JOURNEY:
IBM-IORF Sustainability Project 2021-24

Sustainable Agriculture: A Vital Imperative for Global Food Security

In the face of climate change, conventional chemical agriculture struggles to meet global food needs, with 870 million people suffering from hunger despite technological advancements. The heavy reliance on chemical inputs has led to severe environmental degradation, including pollution, soil salinity, loss of biodiversity, and health risks. With the need to increase food production by 60% by 2050 to feed a growing population, climate change is projected to reduce crop yields by up to 25%, while a third of arable land has been lost. Sustainable agriculture, integrating environmental health, economic viability, and social equity, is imperative. However, defining sustainable practices remains a challenge. In India, where 86% of farmers are smallholders, fragmented land holdings and high cropping intensity exacerbate vulnerability to climate change. Despite their significant contribution to agricultural output, these farmers face inconsistent revenues, threatening food security. Thus, prioritizing sustainable agriculture is essential to safeguard food production systems and mitigate climate impacts *(UN Chronicle, 2012; The Guardian, 2023; TOI, 2nd Sept. 2022).*

Some 97.85 million hectares (29.7%) of India's total geographical area (TGA) of 328.72 mha underwent land degradation till 2018-19; out of which 47 % is agricultural land.

In the pursuit of sustainable agriculture, IORF forged the path with its visionary initiative, **Clean Food, in collaboration with Nadia KVK (ICAR) in 2020.** At its core lies the Inhana Rational Farming (IRF) Technology, an exclusive innovation designed to revolutionize agriculture. IRF embodies a holistic approach to crop cultivation, focusing on Plant Health Management and Soil Rejuvenation through its unique Energy Management Approach and Novcom Composting Technology meaning, utilization of **Clean Energy to Produce Clean Food**, marking a shift towards **Resource-independent cultivation models.**

IORF's commitment to sustainability has always guided its partnerships, prioritizing dissemination over mere commercial gain. **In 2021, IORF found an ideal collaborator in IBM for the Clean Food Project, covering 100 hectares exclusively owned by Small and Marginal Farmers.** This partnership exemplifies a dedication to sustainability, ensuring that innovative solutions reach those who need them most, fostering a future of responsible agriculture.

Phase- 1 :1st year IBM-IORF Sustainability Project 2021-22

The IBM IORF sustainability accelerator project was conceived with a clear objective: to provide An Intervention Model For Sustainable Agriculture, focusing primarily on marginal and resource-poor farmers, who constitute a significant portion of the farming community. **The project aimed to address the challenges of unsustainable agriculture, primarily and particularly focusing on soil health and pesticide use, through innovative technologies and interventions.**

CLEAN FOOD MODEL– The Clean Food Model, developed in collaboration with KVK- ICAR, aimed to remove Synthetic Pesticides from agricultural systems, emphasizing the **interconnectedness** of **SAFETY AND SUSTAINABILITY**. By removing pesticides, the model aimed to ensure **Human Health, Reduce Resource Dependence, and Enhance Ecological Sustainability.** The project targeted marginal farmers, often facing resource constraints and high cropping intensity, particularly in vegetable crops.

IBM IORF Sustainability Project was conceived to introduce 'Clean Food' Model of IORF (Model was developed with KVK) as the **1st Model of Safe and Sustainable Food** for **marginal and small farmers** in **high cropping intensity (> 3.5) area** on **wide group of vegetable crops** in New Alluvial Agriculture zone in Nadia district, West Bengal, India in **100 hectare area comprising five villages with about 400 no. of farmers.**

The decision was driven by the recognition of two major unsustainable inputs in agriculture: **FERTILIZERS AND PESTICIDES.** While removal of both the unsustainable inputs ensures most Safe & Sustainable Agriculture, but removal of **Synthetic Crop Nutrients being resource dependent**, **removal of pesticides was chosen for its resource independency and can be ensured through Plant Health Management.** Pesticides, in particular, have been linked to climate change and nutritional depletions in plants, reducing their secondary metabolites.

The program aimed to address **three main areas: 1. Ensuring Crop Yield Despite Eliminating Agrochemicals, 2. Producing value-added products without additional costs for farmers**, and **3. Providing safe and sustainable food for consumers.** Various Tools and indices of IORF were utilized, including **Soil Resource Mapping** and **Soil Health Cards**. A small **MODEL FARM PROJECT** where both Synthetic Crop Nutrient &Crop Protectants were Eliminated, demonstrated significant insights, highlighting the relationship of **Unsustainable Components With GHG Footprints and Energy Footprint.** It also shows the potential for **Carbon-neutral and Net Zero Agriculture through Novcom compost and IRF Technology.**

Phase- 1 :1st year IBM-IORF Sustainability Project 2021-22

Key Outcomes : Phase I (2021-22)

To benefit these farmers, the project conducted detailed **Soil Quality Analysis**, **Soil Resource Mapping**, and provided individual Soil Health Cards through **comprehensive soil assessments, highlighting biological health alongside physical and chemical properties**. However, challenges arose in Scalability, particularly due to soil fragmentation, leading to the development of the **Soil Proximity Model Prototype**.

- **SOIL PROXIMITY MODEL PROTOTYPE:** For very small land holding i.e. 0.14-0.23 Hec with 2-3 land fragmentation, comprehension Soil Health Study requires huge time and exorbitant cost for every farmland. **Soil Proximity Model can provide 10 - 20 analytical assessment from single analysis. Most importantly at 1/10th of the Cost and Time required for conventional soil analysis.**

Similarly, safety assessment of vegetable crops posed challenges due to **cost and time constraints** of existing analytical methods, primarily conducted through HPLC analysis. . In response, a **COLORIMETRIC ASSAY TEST** methodology was developed, providing **cost-effective and timely safety assessments for multiple harvested crops.** This method, standardized and validated through scientific publication, significantly reduced **analysis time and cost, providing timely safety assessment results.**

- **COLORIMETRIC ASSAY TEST (CAT):** Conventional pesticide residue analysis is a extreme cost intensive and time take taken process and not effective in multiple harvesting perishable crops like vegetables.
  Colorimetric Assay Test –Scientific, Comprehensive, Conclusive, Pesticide and other harmful chemical study at 1/10th time and1/15th -1/20th cost.

Phase- 1 :1st year IBM-IORF Sustainability Project 2021-22

Key Outcomes : Phase I (2021-22)

- **THE MODEL FARM :** exhibited **Clean Food Zero Carbon status** with a Net Carbon Foot Print of **(-) 20.57 MT CO2e/ha.** Building on these insights, the **Clean Food Net Zero Model** was conceived. **Carbon Neutrality** and **Energy Transition** in agriculture also addressed from this 2.5 ha. Model Farm area out of 100 ha. Project area.

Insights from the **Clean Food Model** led to the development of a **Carbon Neutral Model or Clean Food Zero Carbon Model,** demonstrating significant negative carbon footprints and Energy transition towards renewable sources. This model showcased the potential for Sustainable Agriculture while Addressing Climate Change Mitigation And Adaptation.

THIS MODEL CLEARLY ESTABLISHED THE RELATIONSHIP OF GHG FOOTPRINT AND ENERGY FOOTPRINT WITH SUSTAINABILITY FOOTPRINT.

- **Development of DARAS Model** for Net Zero Agriculture developed by IORF under IBM-IORF Sustainability Project. Safe & Sustainable Agriculture Models/Pathways must comply FIVE IMPERATIVE COMPONENTS (at their best): **DELIVERABLE, ADOPTABLE, REPLICABLE, AFFORDABLE & SCALABLE. However, scalability posed a challenge due to raw material availability.**

1st time in any Sustainable Agriculture Project

- **Soil Health Card** for individual lands to all the Project Farmers.
- **Soil Resource Map** covering more than 5 times of project area.
- Safety Analysis for all the production of Project Farmers.

Phase- 2 : 2nd year IBM-IORF Sustainability Project 2022-23

The Objectives:

- **REPLICABILITY POTENTIAL OF CLEAN FOOD MODEL** –The IBM IORF Sustainability Project aimed to replicate its success across different agro-climatic regions, initially covering 100 hectares over three years with plans for expansion. Notably, a new 100-hectare project in Mandya, Karnataka, highlighted the adaptability of the **Clean Food Model** to diverse conditions, **in another Agro Climate, in a degraded soil conditions** emphasizing its potential for **Scaling Up in a new 100 ha. area.**

- **Scalability Solution (DARAS Model) of Clean Food Zero Carbon Model through Coirpith Compost** - All the four pillars were thought to be successfully achieved by IRF Technology, only **SCALABILITY ISSUES** needed to persuaded.

Coirpith ushered the potential for solution of SCALABILITY issues being an agri-industry waste, no effective technology for its biodegradation, a high methane emitter, high pollution potential to soil and water. Though **Novcom** Technology had a successful biodegradation potential on Coirpith, this time the experiments was laid down for large scale conversion mechanism.

Key Outcomes : Phase II (2022-23)

BOTH THE OBJECTIVES WERE MOST SUCCESSFULLY CONCLUDED

1. **Clean Food Model** exhibited higher agronomic efficiency towards high yield and improved Plant Health towards 100% pesticides reduction.
2. **Novcom Composting Technology** empathically demonstrated large scale converting of Coir Pith in 30 days towards Novcom Coir Pith compost.

This gave birth of 1st **Agri- Net Zero Model- Clean Food Net Zero (CFNZ).**

Phase- 2 : 2nd year IBM-IORF Sustainability Project 2022-23

Key Outcomes : Phase II (2022-23)

CLEAN FOOD NET ZERO (CFNZ) MODEL was implemented in 25 hectare of the 100 hec. project area and 1000 MT of Novcom Coir Pith compost was applied. 100% fertilizers and 100% pesticide were removed.

Coir pith composting emerged as a solution, transforming a waste material into a valuable resource for **Soil Health Management.** The integration of **IRF Technology and NOVCOM Composting** in the **Clean Food Net Zero Model** demonstrated remarkable carbon sequestration potential and crop enhancement, paving the way for agri-net-zero initiatives.

More than 6000 MT CO_2e carbon credit was generated from 25 ha.

Here also, Some Sustainable Tools and indices were developed for successful implementation of models.

THIS INNOVATIVE APPROACH REPRESENTS A PARADIGM SHIFT TOWARDS CIRCULAR BIO-ECONOMY MODELS AND SETS NEW STANDARDS FOR CARBON FOOTPRINT ESTIMATION IN AGRICULTURE.

- **NOVCOM TECHNOLOGY'S PROCESS EMISSION EFFICIENCY STUDY:** This was extremely necessary to establish the methane mitigation potential, the GHG emission from the process towards **Carbon Footprint Computation**. Detailed study collaborated with KVK ICAR proved the 99% higher process efficiency of **Novcom Composting Technology in the value upto 6.013 mt CO_2e / ton Coir pith. This was Subsequently validated Through two research publications.**

Phase- 2 : 2nd year IBM-IORF Sustainability Project 2022-23

Key Outcomes : Phase II (2022-23)

- **COIR PITH QUALITY ASSESSMENT STANDARD:** As Coir Pith is very different material than most other materials from its **lignin % , Na+ and K+ ions very high C:N ratio .** A comprehensive analytical protocol was developed and standardized for the estimation of Soluble And Insoluble Lignin , Sodium And Potassium Irons And Electrical Conductivity to assess and affirm the quality of the Novcom Coir Pith compost.

Similarly this study along with other defined compost analysis is can provide compost Quality Index of any Coir Pith compost.

- **Development of standard for GHG Emission, Assessment from Agriculture and Components of Carbon Footprint in Crop Production:** In the absence of any comprehensive guidelines for the estimation of GHG emission of all the components of agricultural practices with the relevance of Indian Agriculture, IORF felt the necessity of developing a scientific and comprehensive standard for GHG emission assessment standard.

Existing available agricultural carbon assessment tools often overlook **Qualitative Aspects**, focusing solely on **Quantitative Measurements**. Inhana, in collaboration with various universities including the Indian Statistical Institute(ISI), sought to address this gap by developing standards that consider **both quantitative and qualitative aspects of carbon management, and thus ACFA (Agriculture Carbon Footprint Assessor) Version 1** was developed in collaboration with **ATARI (Agriculture Technology Application Research Institute), Zone –V, the apex organization of KVKs under ICAR** followed by the **SACFA toolkit in validated by I - No Carbon, UK, a** Premium Carbon Assessment Organization of UK .

This transformative journey toward sustainability not only led to the development of robust assessment tools but also paved the way for government initiatives promoting sustainable agriculture and voluntary carbon market projects. The resulting models demonstrate high negative carbon footprints and adhere to safety and sustainability standards, marking a significant advancement in achieving agri-net-zero objectives.

Phase- 2 : 2nd year IBM-IORF Sustainability Project 2022-23

Key Outcomes : Phase II (2022-23)

CLEAN FOOD NET ZERO : PERHAPS THE FIRST AGRI NET ZERO MODEL

The most **Sustainable Agricultural Model**

- **Methane Mitigation** from its source.
- **Landfill Waste Recycling** into ideal manure - GHG Abatement of approx. **6340 MT CO2 eq. from CFNZ Model in the 25 ha Project Area.**
- **Degraded Soil Management.**
- **100% fertilizer (NPK) reduction.**
- **N_2O abetment,** more than **2000 kg CO2e/ha.**
- **40 Trillion Brilliant Self-generated Microbial Pool** to enliven the soil.
- **Higher Photosynthetic Efficiency** towards minimum **10% up to 20% higher yield.**
- **CARBON FOOTPRINT** of Vegetable production indicated that CFNZ Model **POTENTIALLY MITIGATES** about **13.78 kg CO_2 eq./ kg vegetable produced**.
- ENERGY FOOTRPINT of Vegetable production under CFNZ program revealed **432% Higher Energy Efficiency** i.e. Crop productivity per Unit Energy Investment (for crop Nutrient Management).
- C- Sequestration (due to Land Use Change) in 25.2 ha. **(-)28473.48 kg CO2e.**

Net Carbon Footprint 250 MT CO2e/ha. and total Net Carbon Footprint 6340 MT CO2e Carbon Credit generated from 25.2 ha. Agri Net Zero Model

Energy Transitions by 57% MJ from 25.2 ha. Agri Net Zero Model

Phase- 2 : 2nd year IBM-IORF Sustainability Project 2022-23

Key Outcomes : Phase II (2022-23)

CLEAN FOOD NET ZERO (CFNZ) : A Model to Pledge, Adopt and Support by every conscious corporates.

- ❑ A single model for ESG , CSR & NET ZERO.
- ❑ A single model that attains **GLOBAL WARMING, CLIMATE CHANGE AND AGRICULTURAL SUSTAINABILITY**
- ❑ A single intervention with **MULTIPLE IMPACTS.**
- ❑ A single model for **Accomplishment of 7 SDGs,** simultaneously attends both **SDG2 and SDG 13 together.**
- ❑ Validation of the **CFNZ Model by INC, UK.**

Development of crop specific Agri- Net Zero Model

Started with Clean Food to Clean Food Zero Carbon to Clean Food Net Zero by Phase II of IBM-IORF Sustainability Project.

Development of Zero Carbon Clean Vegetables Climate Resilient, Agronomicaly efficient seed of paramount important and perhaps not available in the world. Net Zero Clean Vegetable seed at affordable cost is a seemingly impossible proposition to marginal and small farmers. **Net Zero Clean vegetable seed of 8 varieties is the 1st model (in 25.2 ha. Karnataka) in this aspect.**

- ➢ Net Zero Clean Paddy with Carbon Footprint : **(-)236.01 (MT CO2 e)**
- ➢ Net Zero Clean Sugarcane with Carbon Footprint: **(-)249.62 (MT CO2 e)**
- ➢ Net Zero Clean Coconut with Carbon Footprint: **(-)253.06 (MT CO2 e)**
- ➢ Net Zero Clean Ginger with Carbon Footprint: **(-)249.74(MT CO2 e)**
- ➢ Net Zero Clean Ragi with Carbon Footprint: **(-)249.83 (MT CO2 e)**
- ➢ Net Zero Clean Vegetables with Carbon Footprint: **(-)249.63(MT CO2 e)**

NET CARBON FOOTPRINT from 25.2 ha. CFNZ is (-)6339.06 MT CO2 e

Phase- 3 : 3rd year IBM-IORF Sustainability Project 2023-24

OBJECTIVES : Phase III (2023-24)

In the final phase of the project, efforts were made to validate the **CLEAN FOOD NET ZERO MODEL** across similar agro-climatic conditions, **Reaffirming** its **Replicability** and **Functionality.**

This phase marked the importance of **Backward Integration For Sustainability,** particularly in developing **Seeds, Seedlings, and Planting Materials under the Net Zero Model.** The project showcased various **Clean Food Net Zero Models For Different Crops,** highlighting their significant carbon sequestration potential compared to conventional agricultural practices.

Phase III project introduced innovative models such as the integrated crop model and the **CIRCULAR BIO-ECONOMY MODEL**, demonstrating **Substantial Carbon Sequestration And Crop Yield Improvements.**

Key Outcomes : Phase III (2023-24)

❑ CLEAN FOOD NET ZERO CONTINUATION (Karnataka)

Agri Net Zero Model that was developed in **PHASE 2** of the project continued as the major project objectivity primarily & majorly on the same crops for standardization & conclusive validation.

The project exhibited similar success in the second year establishing the effectivity of IRF Technology towards **Plant Health Management, and Novom Composting Technology for Novcom coir pith compost towards Soil Health Management.**
NET CARBON FOOTPRINT from 25.2 ha. CFNZ is (-)6309.73 MT CO2e has become certified by i-NO Carbon, UK. & Net Carbon Footprint from CFNZ Continuation Model 250.39 MT CO2e/ha.

Phase- 3 : 3nd year IBM-IORF Sustainability Project 2023-24

Key Outcomes : Phase III (2023-24)

- **New models development through backward integration to offer 360° pathway to sustainable agriculture.**

The necessity and relevance of Net Zero Clean seed or seedling or planting materials are enormously lager for **Agri Net Zero Programme** with crop sustainability. Therefore, a program was taken to develop **Net Zero Clean seed and planting materials of the major crops grown and have bottleneck for quality seed or planting materials.** Total 4 crops Coconut, Sugarcane. Ginger, Millet were taken under the project. The programme successfully exhibited the Effectivity in growth and crop performance for all the test crops.

- **Project on crop performance of own developed zero carbon clean vegetable seeds.**

The potential Crop Efficiency of the **Zero Carbon Clean Vegetable Seeds** was to evaluate in actual crop performance for the field validation. Clean Vegetable Seeds wear under Zero Carbon Clean Vegetable Programme (Phase II) and taken all the varieties, successfully exhibited their crop yield, little higher or Comparable to the Conventional Crop Yield.

- **DEVELOPMENT OF COCONUT BASED CIRCULAR BIO-ECONOMY MODEL**

Circular Economy is one of the most important Sustainability and Livelihood Generation Model. Bio- Circular Economy is the best Circular Economy Model. Coconut being the prime crop of the project area as well as the state of Karnataka. This agriculture model, can potentially offset more than **500 MT CO2 eq /ha, along with substantial increases in Coconut Equivalent Yield (CEY) and farm income. Soil health assessments revealed positive impacts on soil carbon levels, fertility, and microbial activity. Overall, the project showcased the potential of CIRCULAR BIO-BASED ECONOMIES to enhance Agricultural Sustainability, Improve Livelihoods, And Contribute To Climate Change Mitigation.**

CONCLUSION

In essence, over the course of three years, the project evolved from a pursuit of **SUSTAINABILITY TO ACHIEVING THE HIGHEST FORM THEREOF.** Through a comprehensive array of Measures and Tools, including sustainability indices assessed by ACFA Version 1 and SACFA, we endeavored to provide a holistic solution for sustainable agriculture also paved the way for government initiatives promoting sustainable agriculture and Voluntary Carbon Market (VCM) Projects.

Overall, the project represented a transformative journey towards sustainability, showcasing scalable models, innovative technologies, and comprehensive assessments for promoting sustainable agriculture and addressing climate change challenges.

THIS JOURNEY NOT ONLY VALIDATED THE FEASIBILITY OF SUSTAINABLE PRACTICES BUT ALSO SERVED AS A TESTAMENT TO THE TRANSFORMATIVE POWER OF INNOVATION AND COLLABORATION IN SHAPING A MORE SUSTAINABLE FUTURE.