1st Agri Net Zero Model

developed under IBM - IORF SUSTAINABILITY PROJECT

Clean Food 'Net Zero'

Program Mandya, Karnataka

(Case Study: 25.2 ha)

Developed By
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Crop Production and Safety Assessment under Clean Food 'Net Zero' Program

Summary

The existential climate change impact is increasing the food security challenge, more so as the world will need to produce about 70 percent more food by 2050 to feed an estimated 9 billion people. This is due to agriculture's extreme vulnerability to climate change. Climate change's negative impacts are already being felt, in the form of increasing temperatures, weather variability, shifting agro-ecosystem boundaries, invasive crops and pests, and more frequent extreme weather events.

In the existing situation we need **HIGHER FOOD PRODUCTION FROM LESSER LAND AREA WHILE REDUCING/ ELIMINATING THE USE OF UNSUSTAINABLE/ NON RENEWABLE INPUTS.** Hence, the situation demands a **TRANSFORMATIVE CHANGE** in Agricultural Practices to ensure **SUSTAINED** production and availability of Safe Food for the rising global population while Mitigating Climate Change Impact (The Future of Food and Agriculture- Trends and Challenges, FAO-2017). Sustainable agriculture that integrates three main goals i.e., environmental health, economic profitability, and social equity is the only solution especially in for a country like India with 224.3 million undernourished people. But the CHALLENGE is exhibited by UN's own Statement "It is currently not clear or well defined what constitutes productive and Sustainable Agricultural Practice".

The relevance of Sustainable Agriculture increases multifold in the Indian context where more than 90% farmers are marginal and resource poor, with a land holding less than 0.38 hec., are therefore highly vulnerable to climate change, compelled to use a large quantity of synthetic agrochemicals but often receive inconsistent revenue.

Agriculture is the most vulnerable to climate change, at the same time it is the only sector that can make a significant contribution towards both GHG mitigation and adaptation. Omitting source point METHANE emissions e.g. from any form of agri- waste especially landfill materials, lowering/ eliminating fertilizer use, especially nitrate fertilizers in crop production and higher application of microflora (self- generated) rich organic amendments for improving the Soil- C sequestration can serve towards GHG mitigation. At the same time improving the crop yields vis-à-vis eliminating chemicals pesticides and fertilizers can serve the adaptation strategies. In this backdrop, the **Clean Food 'Net Zero' Program was initiated** under the IBM-IORF Sustainability Project **at Mandya, Karnataka, India.**

IRF Technology was adopted as the Safe and Sustainable Crop Technology towards the objective of 'Clean Energy for Clean food' focusing on Soil and Plant Health Management. **Thus Clean Food 'Net Zero' means SAFEST Food production- SAFE for human health, soil and environment; with No Crop Loss and No hike in the Cost of Production and finally significant climate action in terms of GHG Mitigation, especially Source Point Methane Mitigation.**

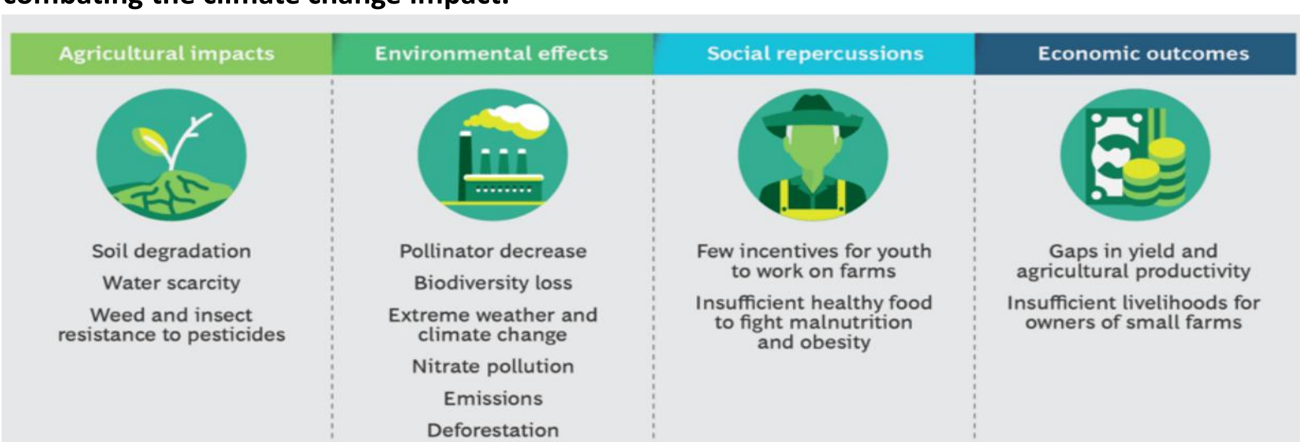
The Safety aspect of Clean Food 'Net Zero' is authenticated through Colorimetric Pesticide Assay Test developed by IORF in the Phase-I Project, which enables safety analysis in the speediest manner and most importantly at 1/10th of the Conventional Cost of Residue Analysis, which is especially relevant for multiple harvest crops like vegetables that have a period small time gap between field harvest and actual consumption.

Introduction

Climate change is sowing the seeds of food crisis in its path. **Agricultures' vulnerability to climate change is reflective in the depleting crop yields especially under the extreme climatic events and the rising pest intensity.** Climate change is now affecting every country on every continent, disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow. **The poorest and most vulnerable people are being affected the most, and for a country like India these are basically the marginal and small farmers.**

Agriculture, while being highly vulnerable, is also a major contributor to climate change. In particular, agricultural practices and processes can emit significant amounts of methane and nitrous oxide, two powerful greenhouse gases. According to the OECD, agriculture contributes approximately 17% greenhouse gas (GHG) emissions directly through agricultural activities and an additional 7% to 14% through land use changes. **On the flip side agriculture is the only sector that has both GHG mitigation and adaptation potentials, provided conventional agriculture is transformed into Sustainable Agriculture.**

Besides climate change, **SOIL DEGRADATION** which contributes to 36–75 billion tons of land depletion every year, threatens the global food supply; which implies that now; More Crop has to be Produced from Less Land. **Hence, the major challenge facing mankind today is to produce sufficient food, for the rising human population, from a comparatively lesser land, while combating the climate change impact.**



Consequences of Current Farming Practices

The Pathway to Adopt

So we have to move towards sustainable practice to counteract climate change impact and create more sources of carbon sink. When agricultural operations are sustainably managed, they can preserve and restore critical habitats, help protect watersheds, and improve soil health and water quality. Sustainable farming that addresses the interlinked challenges of food security and accelerating climate change can simultaneously achieve higher productivity, enhanced resilience and reduced emission.

The situation demands a format for Sustainable Agriculture, which can sustain/ improve crop yields through efficient use of on- farm resources, while reducing the dependency on off- farm unsustainable inputs, maintaining ecological integrity and enable sustainable production of Safe Food that can secure farmers' livelihood while opening the access of Pure Food for All.

Climate change poses an existential threat and is already impacting food security due to rising temperatures, shifting precipitation patterns, and more frequent extreme events. While global efforts have mainly targeted reducing carbon dioxide emissions from fossil fuel combustion, it is equally crucial to address methane emissions, given its potent near-term warming impact compared to CO2.

In this background Inhana initiated '**Clean Food Net Zero' program** utilizing available agro waste/landfill waste at Mandya, Karnataka in 25.2 ha. through our Novcom Composting Technology along with IRF Plant Health Management Practice to ensure crop sustainability, complete elimination of chemical pesticides & synthetic fertilizer to produce Safest & Sustainabliest Food Product.

Journey of Clean Food to Clean Food Net Zero Program

In the Phase-I Project, IORF demonstrated the pathway to produce **'Clean Food'- Safe for Human Health and Sustainable for all, with an impact area in respect of SDG-2 'Access of Safe and Nutritious Food' for all (SDG 2.1).**

'CLEAN FOOD' Model – executed in a cluster of villages at Nadia district of West Bengal, India – delivered **'Accountable Safety and Tangible Sustainability' for any Sustainable Agriculture based interventional program ever undertaken.** This was also probably the first initiative towards Farmers' Empowerment & Healthy Life through development of Safe & Sustainable 'Clean Food' (by elimination of Chemical Pesticides), i.e. crop sustainability without raising the cost of production, and establishment of a transparent supply mechanism from farmers' field to consumers in order to ensure affordable safe food for all.

UNIQUENESS of CLEAN FOOD Model

Clean Food is the First & Only Offer in the direction of **'Safe & Sustainable' Food** that can enable :

- **LARGE SCALE PRODUCTION of SAFE FOOD &**
- **PRODUCERS' PROFITABILITY, while Ensuring VALUE ADDED PRODUCT at AFFORDABLE PRICING**

SAFE FOOD FOR HUMAN HEALTH – SUSTAINABLE FOR ALL

SCIENCE BEHIND CLEAN FOOD PRODUCTION

Development of Clean Food under IBM-IORF Sustainable Project in Nadia, West Bengal is based on a Scientific Hypothesis that the relationship between a Plant and Pest is Purely Nutritional.

The life time research of F. Chaboussou showed that application of chemical fertilizers, specially N-fertilizers along with depressed plant metabolism enhance the free amino acids and free sugar pools in the plant cell sap which serve as the ready food for the pest. **So if pesticide usage is to be reduced/ eliminated, then first pest need to be reduced and for that the ready food source need to be cut off**.

Natural reduction in the requirements of pesticides, growth promoters, micronutrients etc. is primarily accomplished through IORF's path-breaking PLANT HEALTH MANAGEMENT protocols, i.e. through scheduled application of different 'Inhana Energy Solutions' under IRF Technology. This model is very different from integrated farming, because here integration is primarily done in case of soil, that involves integration with on farm-produced (depending upon the raw material availability) self-generated-microflora-rich Novcom compost that helps to slowly ease out any dependency on artificial fertilizers. However, as composting raw materials were scarce, compost application was not pushed.

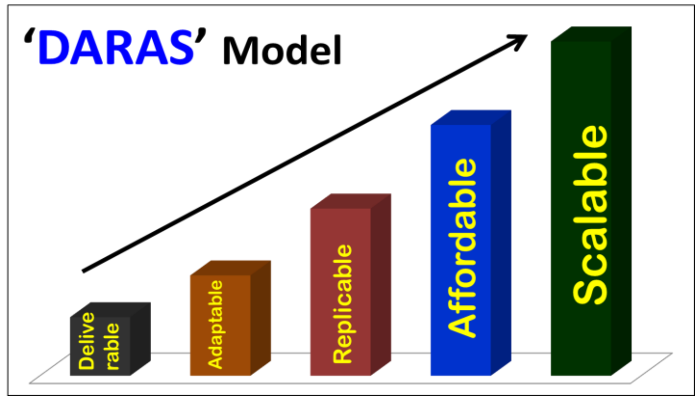
Hence, IORF selected **MODEL FARM (About 2.5 hec.)** for demonstration of **Inhana Soil Health Management (ISHM)** towards Reduction/ Elimination of N- fertilizer under five major cropping sequences followed in the area, with an objective to estimate different Sustainability Footprint **i.e. the GHG and Energy Footprint , the Crop efficiency, the adoptability & scalability potential of Clean Food Model with 100% Reduction of N- Fertilizer.**

A five pillar 'DARAS Model' was designed to best judge a Sustainable Agricultural Model.

The ‘DARAS Model’ of Sustainable Agriculture

The five irreversible Pillars or Components are in the order of priority based on the level of their increased importance. Hence, for achievement of any subsequent pillar in this model, the preceding pillar needs to be fulfilled.

The DARAS model of Sustainable Agriculture developed by IORF under IBM-IORF Sustainability Project. Safe & Sustainable Agriculture Models/Pathways must comply FIVE IMPERATIVE COMPONENTS (at their best)



DELIVERABLE: Best comply/attend the objectivities/goals of transforming agriculture from a source of carbon emissions to that of a carbon sink (Agenda of COP 27) – Deliverables for HUMAN-ENVIRONMENT–SOIL.

ADAPTABLE: Must be suitable for Marginal & Resource-poor farmers.

REPLICABLE: It should not be region or crop specific. To be customized for various agro-climatic conditions and crops.

AFFORDABLE: It should assure economic returns & must be convenient to every member of the food value-chain – right from the Producers to the end Consumers.

SCALABLE: The model should be adaptable in the large scale area without compromising crop.

Instead of 100 hec. Clean food programme in the Project Area, t**he 2.5 ha. MODEL FARM** was selected in addition to undertake **SUSTAINABLE SOIL HEALTH MANAGEMENT towards 100% elimination of synthetic Fertilizers,** which was not possible for the entire 100 hec. Project area, considering the acute resource scarcity, fuelled by critical land fragmentation and resource poorness of the farmers. This area also served for critical scientific documentation of field data that were judged by ‘DARAS Model’ developed under the Project specifically for the assessment of Sustainable Agriculture Models.

Based on resource availability, there is also a transitional program of Clean Food to Clean Food ‘Net Zero’ (CFNZ) where complete elimination of chemical fertilizer along with chemical pesticide has been demonstrated for speedy rejuvenation of soil health and quantifiable carbon mitigation apart from increase in crop productivity.

'Clean Food Model with 100% Fertilizers Elimination' Assessment through 'DARAS Model' of Sustainable Agriculture

Clean Food Model successfully achieved all the respective pillars of '**DARAS Model'** and with ADDITION OF SUSTAINABLE SOIL HEALTH MANAGEMENT for **100% reduction of Synthetic Fertilizers the model itself becomes the SAFEST & SUSTAINABLIEST Food Production Model.**

Apart from Chemical Pesticides, chemical fertilizers **especially N- Fertilizers form the other major UNSUSTAINABLE component of conventional food production.** However, reduction/ elimination of N- Fertilizer Without Crop Loss is possible only
through application of Quality Compost in soil. But acute scarcity of raw material for on- farm compost production, especially in respect of marginal and small land holdings; forms the primary bottleneck towards the objective.

In spite of having an effective and quickest Composting Technology for highest resource recovery potential, resource (raw material) availability was a major bottleneck for compost generation and thereby complete elimination of synthetic fertilizers. Hence, the only practical limitation faced by IORF was 'SCLABALITY' of this Clean Food model with 100% reduction of Fertilizers.

Based on resource availability, the transitional program of Clean Food to Clean Food 'Net Zero' (CFNZ) where complete elimination of chemical fertilizer along with chemical pesticide has been demonstrated for speedy rejuvenation of soil health and quantifiable carbon mitigation apart from increase in crop productivity.

The 'Clean Food Model with 100% Fertilizers Elimination' was found to be the best model that Sustainable Agriculture can aspire for and gave us the template for development of the ultimate Climate Action Pathway in this domain – viz. 'CLEAN FOOD NET ZERO' model. This total elimination of Nitrate Fertilizers required abundant and cheap availability of raw material for composting.

GHG footprint of Clean Food and Clean Food Net Zero CFNZ program vs. conventional practice was evaluated using the newly developed (developed by IORF based on relevant IPCC Guideline) Agriculture Carbon Footprint Assessor (ACFA version 1.0)- a carbon footprint assessment standard for the Indian ecosystem and a first such encompassing sustainable agriculture.

The Inhana Soil Health Management (ISHM) approach aims to eliminate nitrogen fertilizer usage in five key cropping sequences in the area. The primary goal is to assess the Greenhouse Gas (GHG) mitigation potential of producing clean food by completely eliminating fertilizer, contrasting it with the conventional farmer's practices.

The Five Major Cropping Sequences, followed in the area(Nadia, West Bengal) are as follows:

Crop Sequence 1: Tomato-Cucumber-Coriander

Crop Sequence 2: Potato-Brinjal-Cauliflower,

Crop Sequence 3: Potato-Okra-Cabbage,

Crop Sequence 4 : Brinjal-French bean-Spinach

Crop Sequence 5 : Pumpkin-Okra-Cabbage

Total GHG Emission (kg. CO_2 eq./ha./year) under Conventional Chemical Practice

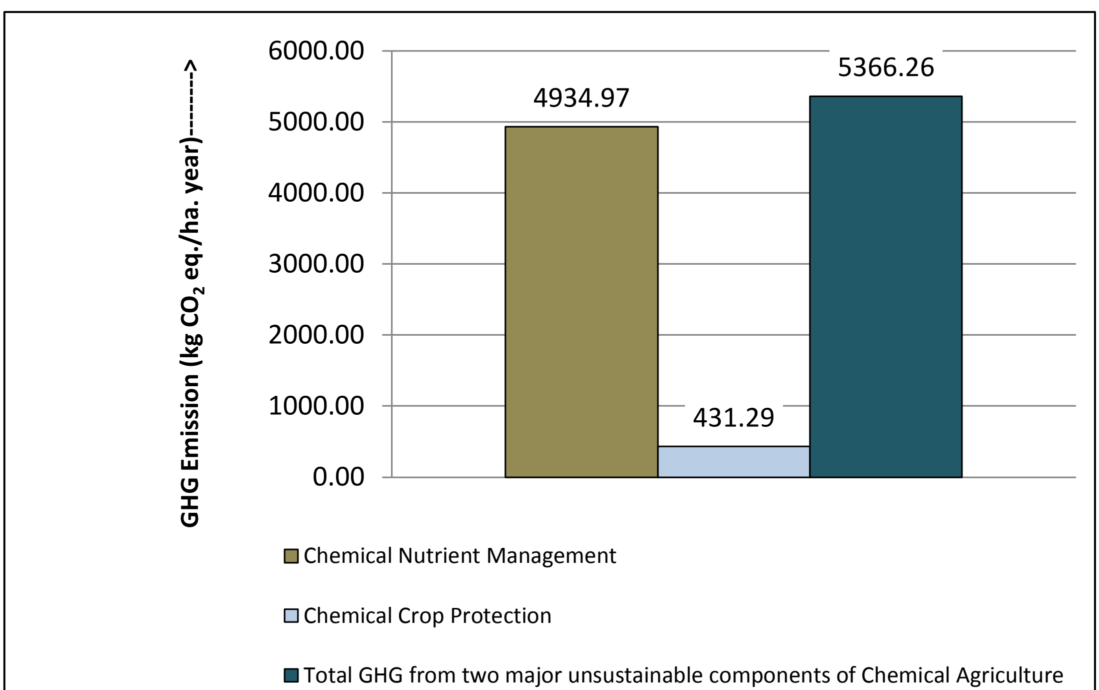
Agricultural Component wise GHG (kg CO2 equv./ha/year) Footprint under Conventional Chemical Practice	Crop Sequence 1: Tomato-Cucumber-Coriander	Crop Sequence 2: Potato-Brinjal-Cauliflower	Crop Sequence 3: Potato-Okra-Cabbage	Crop Sequence 4 : Brinjal-French bean-Spinach	Crop Sequence 5 : Pumpkin-Okra-Cabbage	Avg. of 5 crop Seq.
Chemical Seed Treatment	0.21	19.09	19.56	1.82	0.73	8.28
Seed Bed & Nursery	2.20	2.20	4.39	2.20	4.39	3.08
Direct Seed Sowing	11.87	21.20	14.41	10.17	4.24	12.38
Transplanting	3.39	2.12	11.87	2.12	11.87	6.27
Mainland Preparation	345.18	400.45	417.41	341.79	360.45	373.06
Irrigation	464.77	377.03	519.30	436.31	521.68	463.82
Weed management	6.36	4.19	4.52	6.19	6.53	5.56
Chemical Nutrient Management	3534.28	5101.02	6824.64	3655.18	5559.72	4934.97
Chemical Crop Protection	314.62	427.17	438.38	480.52	495.77	431.29
Total GHG (kg CO2equv. /ha/year)	4682.88	6354.46	8254.50	4936.30	6965.37	6238.70
Crop Kg. /ha	42375.00	52125.00	66937.50	44250.00	48187.50	50775.00
GHG (kg CO2equv. /kg crop)	0.34	0.36	0.41	0.33	0.51	0.39

Avg. 86% GHG Footprint (kg CO2 equv./ha) Share from only Two Major Unsustainable Inputs of Conventional Chemical Agriculture.

GHG (kg CO2 equv./ha/year) Footprint under Conventional Chemical Practice	Crop Sequence 1: Tomato-Cucumber-Coriander	Crop Sequence 2: Potato-Brinjal-Cauliflower	Crop Sequence 3: Potato-Okra-Cabbage	Crop Sequence 4 : Brinjal-French bean-Spinach	Crop Sequence 5 : Pumpkin-Okra-Cabbage	Avg. of 5 crop Seq.
Chemical Nutrient Management	3534.28	5101.02	6824.64	3655.18	5559.72	**4934.97**
Chemical Crop Protection	314.62	427.17	438.38	480.52	495.77	**431.29**
Total GHG from two major unsustainable components of Chemical Agriculture	3848.90	5528.19	7263.03	4135.69	6055.48	5366.26
% Share of Total GHG (kg CO2equv. /ha/year)	82.19	87.00	87.99	83.78	86.94	86.02

The GHG Emission (kg CO_2 eq) from two major unsustainable sources (Chemical Fertilizers & Pesticides) under Conventional Farmers' Practice (CFP) was recorded > 86% of total GHG emission under CFP. **The average GHG Emission indicates that among the two most un-sustainable inputs, Chemical Fertilizers contribute about 79 % of the total emission.**

GHG Emission (kg CO_2 eq) from two major unsustainable sources (Chemical Fertilizers & Pesticides) in five Major Crop Sequences under Conventional Farmers' Practice (CFP).



Assessment of GHG Footprint under same 5 different cropping sequences were done in Model Farm under 'Clean Food' Program with 100% Reduction of Chemical Pesticides and 100% Reduction of fertilizer (particularly N- fertilizers).

The average GHG mitigation per hectare per year under this 'Clean food' Model (with 100% Reduction of Chemical Pesticides and 100% Reduction of fertilizer) was recorded as (-) 14330.77 kg CO2 eq.

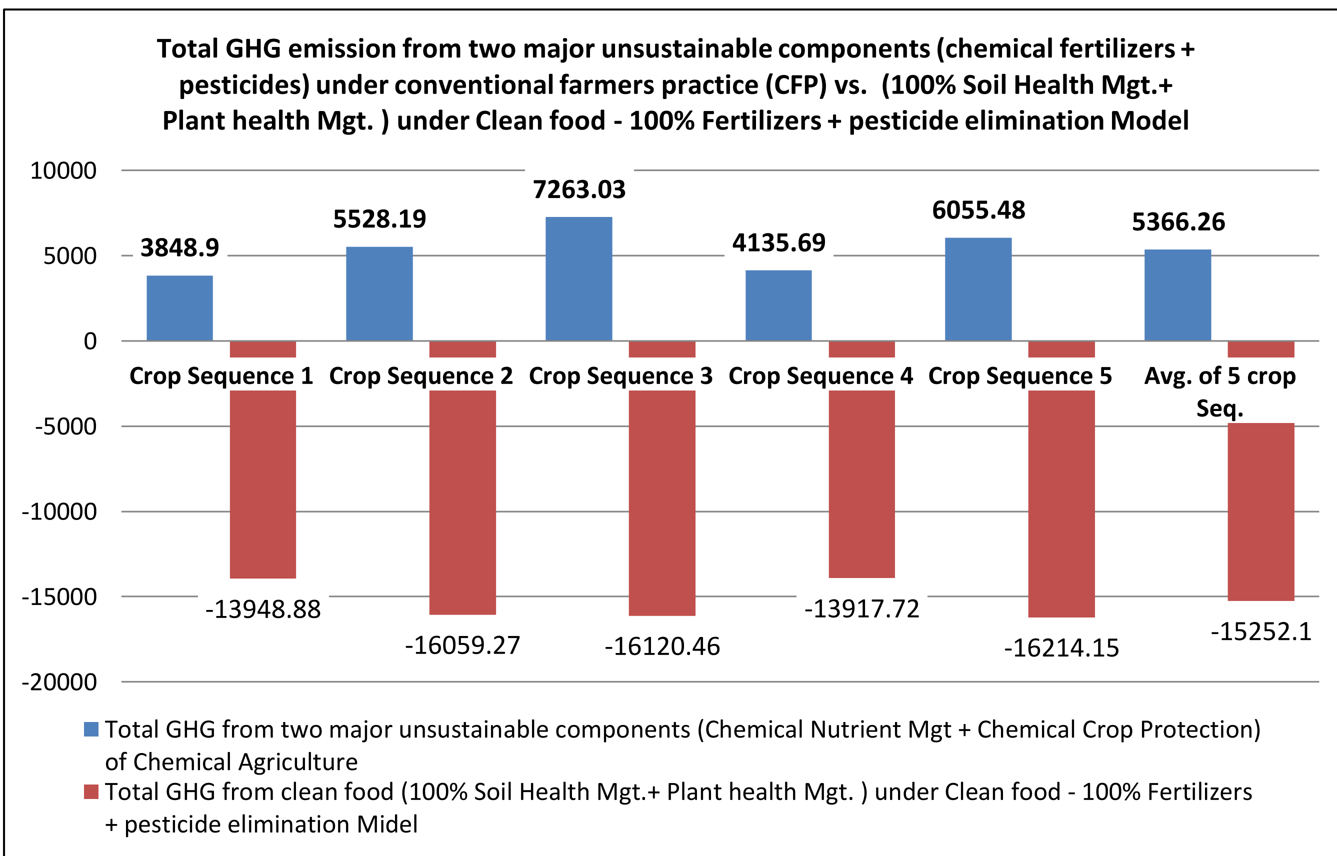
Total GHG Emission (kg. CO2 eq./ha./year) under Clean food' Model (with 100% Reduction of Chemical Pesticides and 100% Reduction of fertilizer)

Agricultural Component wise GHG (kg CO2 equv./ha/year) Footprint under with 100% Reduction of Chemical Pesticides and 100% Reduction of fertilizer)under IRF Technology	Crop Sequence 1:	Crop Sequence 2:	Crop Sequence 3:	Crop Sequence 4 :	Crop Sequence 5 :	**Avg. of 5 crop Seq.**
IRF Seed Treatment	0.16	0.90	1.35	1.36	0.54	**0.86**
SeedBed & Nursery	0.94	1.87	1.87	0.94	1.87	**1.50**
Direct Seed Sowing	11.87	14.41	14.41	10.17	4.24	**11.02**
Transplanting	3.39	8.90	11.87	2.12	11.87	**7.63**
Mainland Preparation	345.18	415.72	417.41	341.79	360.45	**376.11**
Irrigation	464.77	500.33	519.30	436.31	521.68	**488.48**
Weed management	6.36	5.02	4.52	6.19	6.53	**5.73**
Total GHG from Inhana Soil Health Management -Nutrient Management through Novcom Compost	-13964.16	-16078.24	-16136.80	-13935.11	-16230.49	**-15268.96**
Total GHG for Inhana Plant Health Mgt (IPHM)	15.28	18.97	16.34	17.39	16.34	**16.86**
Total GHG Footprint under IRF Technology (per ha)	-13085.32	-15082.43	-15121.29	-13088.94	-15275.88	**-14330.77**
Yield of clean food (100 % N - Fertilizers elimination) (kg/ha)	54000.00	92775.00	82125.00	53400.00	58425.00	**68145.00**
GHG/kg crop (kg CO2 equv./kg crop)	-1.06	-0.49	-0.60	-0.86	-0.95	**-0.79**

GHG Emission (kg CO2 eq/ha./year) from Inhana Soil Health Management (ISHM) -Nutrient Management through Novcom Compost has been done in all 5 crop sequences under Clean Food with 100% Fertilizers + 100% Pesticide Elimination Model.

Agricultural Component wise GHG (kg CO2 equv./ha/year) Footprint under with 100% Reduction of Chemical Pesticides and 100% Reduction of fertilizer)under IRF Technology	Crop Sequence 1:	Crop Sequence 2:	Crop Sequence 3:	Crop Sequence 4 :	Crop Sequence 5 :	**Avg. of 5 crop Seq.**
Total GHG from Inhana Soil Health Management -Nutrient Management through Novcom Compost	-13964.16	-16078.24	-16136.80	-13935.11	-16230.49	-15268.96
Total GHG for Inhana Plant Health Mgt (IPHM)	15.28	18.97	16.34	17.39	16.34	16.86
Total GHG from two components of clean food -100% Soil Health Mgt.+ Plant health Mgt. , under Clean food - 100% Fertilizers + pesticide elimination Model	**-13948.88**	**-16059.27**	**-16120.46**	**-13917.72**	**-16214.16**	**-15252.10**

Comparative GHG Emission (kg CO_2 eq) from two major components Inhana Soil Health Management & Inhana Plant Health Management under Clean Food (with 100% Fertilizers + pesticide elimination) Model vs. GHG total emission from two major unsustainable components i.e. Fertilizers & Pesticides was done, which indicates **384% LOWER GHG FOOTPRINT** as compared to Conventional Farmers' Practice from only two components.



Agricultural Component wise GHG (kg CO2 equv./ha/year) Footprint	Avg. of 5 crop Seq. under Conventional Chemical Practice	Agricultural Component wise GHG (kg CO2 equv./ha/year) Footprint	Avg. of 5 crop Seq. under CF(100% Fertilizers + pesticide)elimination Model under IRF Technology
Chemical Seed Treatment	8.28	IRF Seed Treatment	0.86
SeedBed & Nursery	3.08	SeedBed & Nursery	1.50
Direct Seed Sowing	12.38	Direct Seed Sowing	11.02
Transplanting	6.27	Transplanting	7.63
Mainland Preparation	373.06	Mainland Preparation	376.11
Irrigation	463.82	Irrigation	488.48
Weed management	5.56	Weed management	5.72
Chemical Nutrient Management	4934.97	Total GHG from Inhana Soil Health Management -Nutrient Management through Novcom Compost	-15269.0
Chemical Crop Protection	431.29	Total GHG for Inhana Plant Health Mgt (IPHM)	16.86
Total GHG (kg CO2equv. /ha/year)	**6238.70**	**Total GHG (kg CO2equv. /ha/year)**	**-14330.77**

Avg. Net GHG kg. CO2 equv./ha/year : (-)20568.7

Net GHG (kg. CO2 equv.)/kg crop : (-)1.18

The Positive GHG value under Conventional Farmers' Practice was primarily due to the use of Chemical N Fertilizers and pesticides. While the **Clean Food Model with 100% Reduction of both N-Fertilizer and Chemical Pesticides** recorded **330% LOWER GHG FOOTPRINT** as compared to Conventional Farmers' Practice. The Comparative GHG Emission/ Mitigation Potential (kg CO_2 eq/ kg produce) under 'Clean Food' Models showed that a **SWITCH OVER from Conventional Farmers' Practice to Clean Food Model with 100 % N Reduction- driven by IRF Technology; can totally transform agriculture from being GHG emitting source to a GHG Sink.**

This Model Farm initiative led to Development of Clean Food 'NET ZERO' - A Stupendous- First of a Kind Climate Action Model in Agriculture

What is Net Zero Commitment?

Net zero refers to the balance between the amount of greenhouse gas emission and the amount removed from the atmosphere through specific action taken. We reach net zero when the amount we add is no more than the amount taken away. As per Paris Agreement, the goal is to limit global warming to well below 2.0, preferably to 1.5 degrees Celsius, compared to pre-industrial levels and to achieve that, we need to achieve net zero greenhouse gas emission by 2050.

However it is clearly understood that Technological Intervention is prerequisite for achieving the target in time bound manner.

SUSTAINABLE AGRICULTURE

Best way to attend Net Zero Commitment with Social and Environmental Footprints

According to an estimate by Dr. Lal, the renowned Soil Scientist and the 2020 World Food Prize Winner, **our soil can hold 42 to 78 billion metric tons more carbon.**

But more importantly, Increasing the amount of carbon in soil also makes it more productive for farmers which can only be through Sustainable Farming Approaches.

Sustainable Development Goals

Most Importantly when 'Net Zero' is achieved through Sustainable Agriculture, we simultaneously achieve the Sustainable Development Goals (SDG)

Social & Environmental Footprints

WASTE of any type especially landfill/ legacy waste/ MSW or waste from Agro-industry perfectly fit the bill. But apparently there is **dearth of Environmentally Safe and Economically Viable Composting Technology/ ies that can transform these Toxic, especially METHANE EMIITING pollutants** into a Safe, Stable and Mature Compost, suitable for agricultural use.

The Mandya District of Karnataka has an abundant source of Coir pith – a toxic, hard to biodegrade, and a very high Methane emitting waste from coir industry. But, considering that so far there is no effective and economically viable composting technology which can effectively biodegrade coir pith, hence; it continues to be dumped in open lands and during the rainy season, the tannins and phenols of the coir pith leach out into the soil and the irrigation canals, thereby making agricultural lands unproductive.

In Karnataka alone about 5.0-6.0 lakh MT coir pith is generated every year, and forms a major source of environmental pollution due to lack of effective, economically viable and socially acceptable technology/ies for its bioconversion

Moreover, Coir pith forms a VERY HIGH GHG EMITTER (6.0 mt CO_2-eq per ton of coir pith approx.) – primarily METHANE, which has 75 times Higher Global Warming Potential ($GWP_{24\ years}$) as compared to CO_2, and is also the Precursor to O_3, which itself is a GHG.

From the 'model farm' area within the IBM-IORF Sustainability Project (Phase- I) at Nadia, IORF developed the key insight that the GHG Footprint and the Sustainability Footprint are inversely correlated. And the abundant WASTE material at Karnataka however, can serve as excellent Soil Rejuvenators when recycled following a Technology Driven Process.

The insight gave the Impetus to IORF to initiate the Clean Food 'NET ZERO' Program at Mandya, in order to demonstrate a **CLIMATE ACTION MODEL** that will actually deliver **SAFEST FOOD –** Safe for Human Health, Soil & Environment.

To work out a **SUSTAINABLE and SCALABLE SOLUTION**, IORF initiated a Pioneering Program in Mandya (Karnataka) using **NOVCOM COMPOSTING TECHNOLOGY for bio-conversion of COIR PITH – a TOXIC WASTE from Coir Industry,** which is also a High METHANE EMITTER (GHG emission potential of approx. 6.0 MT CO_2 eq./ per MT Coir pith).

Hence, the Clean Food 'NET ZERO' (CFNZ) program was initiated in 25 ha. (25%) of total 100 ha. Project Area in Mandya with an aim to demonstrate :

1. **SAFEST FOOD – SAFE for Human health, Soil & Environment**
2. **Coir pith Waste based GHG (METHANE) Mitigation MODEL**
3. **Utilization of Coconut Waste (coir pith) to improve Coconut Productivity**
4. **Coconut Plantation based 'Net Zero' Intercropping MODEL in Marginal Soils, to improve Farm Productivity and Farm Economics**
5. **MODEL for Reclamation of Agriculturally Degraded Lands**

Novcom Composting Technology was adopted towards safe and effective recycling of coir pith. Approximately **1000 MT Novcom Coirpith Compost was produced and applied in 25 ha area** out of the total 100 ha Project in Mandya (Karnataka), towards development of **Clean Food 'NET ZERO' (CFNZ) through complete elimination Chemical Fertilizers and Chemical Pesticides. CFNZ is the SAFEST FOOD – Safe for Human Health Soil and Environment.** Development of CFNZ encompassed crops like paddy, maize, finger millet, vegetables, ginger, sugarcane and coconut, and the initiative was driven by INHANA RATIONAL FARMING (IRF) TECHNOLOGY, where Novcom coir pith compost was used for Soil Health Management and Inhana 'Energy' Solutions were used for Plant Health Management.

Most importantly, in this project, bio- conversion of WASTE (Coir pith) using Novcom Composting Technology and application of waste bio- converted Novcom compost in soil rendered **Three Way GHG Mitigation** – i) **Methane Mitigation from source** during waste bioconversion, ii) **Nitrous Oxide Abatement** due to elimination of N- Fertilizers, enabled by application of compost in soil and; iii) the related **Soil- C Sequestration**.

District Mandya - the Challenges

The soils are highly leached and poor in bases and the water holding capacity is low. **The high gravel content of the soil (sometimes up to 50%) coupled with Very Low Soil Organic Carbon means the soil are HIGHLY PRONE TO EROSION and this proneness has become multifold with repeated and high and injudicious fertilizer application. The fact is vividly demonstrated by the MODERATELY ERODED SOILS that measure 249,166 ha and account for about 50.28% of the total geographical area of the district.**

Among the challenges faced by the District Farmers Four, are Critical and Need Immediate Attention to Ensure both Present and the Future Crop Sustainability :

- Soil Degradation
- Increasing Incidence of Pest and Disease
- Rising Cost of Cultivation

While some efforts are being made through programs such as the Integrated Watershed Management, **Effective Models are Still lacking that can Singlehandedly Mitigate all three Constraints.**

Land Characteristics of the Project Area

Very low soil organic carbon (0.5 to 0.6%) and more than 50% Gravel Content pose major challenges w.r.t. crop cultivation especially for vegetable crops. **Another important constraint is the lack of microflora dynamics in soil and the low micronutrient status; which renders moderate to poor Soil Quality Index value. Moreover, the endless rows of a single crop (sugarcane and coconut mono cropping) year after year**, continuous application of chemical fertilizers especially nitrates and lack of soil health management **has initiated the cycle of soil depletion and led to higher and repeated pest leading to a higher application of pesticides and therefore a highly toxic and unsustainable environment that is threatening the farmers’ livelihood.** Restoration of Soil Biological Productivity, forms the only Solution to mitigate the Rising Challenges towards Crop sustenance and Farmers' Livelihood security, and application of Safe and Quality Compost in Soil forms the Only Solution towards the Objective.

25.2 ha. Clean Food 'NET ZERO' (CFNZ) Model, Mandya, Karnataka

- About 1000 ton of Coir Pith was bio-converted to produce Novcom compost and utilized for elimination of artificial fertilizers, especially Nitrate Fertilizers, through sustainable soil health management towards development of SAFEST food – 'Clean Food Net Zero'.

- Bioconversion of raw Coir Pith – a landfill waste, especially a prolific Methane emitter – using Novcom Composting Technology demonstrated GHG OMISSION FROM SOURCE while converting this Waste into a Stable, Mature and Non-phytotoxic compost within the shortest period of 30 days.

Distribution of Crops in 25.2 ha. area (where Approximately 1000 MT Novcom Coirpith Compost was applied)

Sl. No.	Crops		Area (ha.)
1.	Paddy	:	1.8
2.	Ragi	:	4.0
3.	Maize	:	0.8
4.	Vegetables	:	3.6
5.	Ginger	:	0.8
6.	Sugarcane	:	4.0
7.	Coconut	:	10.2
	TOTAL SEVEN CROPS	:	25.2

- The cessation of nitrogenous (N) fertilizers holds the promise of halting N_2O emissions, a significant greenhouse gas. Meanwhile, the application of Novcom Compost presents an avenue for revitalizing soil biological productivity. This approach can catalyse the resurgence of soil's capacity for carbon (C) sequestration, contributing to enhanced sustainability and reduced environmental impact.

- Adaptation to Climate Change was exhibited through the adoption of INHANA PLANT HEALTH MANAGEMENT (IPHM), driven by Inhana 'ENERGY SOLUTIONS'. IPHM was adopted towards reactivation of Plant Physiology.

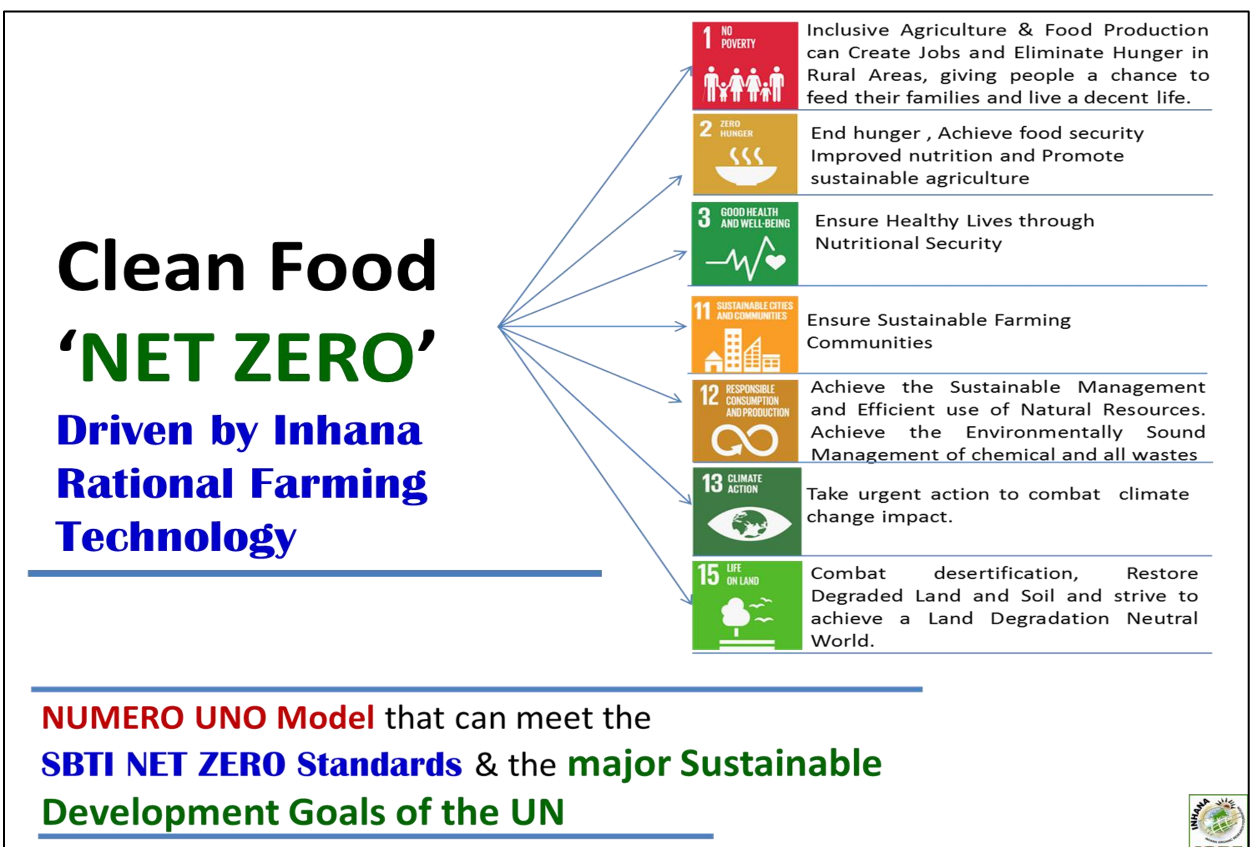
- IPHM works towards curtailing the accumulation of ready food source for pests in plants' cell sap; thereby enhancing the host-defence of plants to discourage disease and pest related incidences leading to the ELIMINATION OF PESTICIDES.

GHG Mitigation Under Clean Food Net Zero Program under IBM-IORF Sustainability Project

Agriculture plays a unique role in the context of climate change. On one hand, it is a significant contributor to climate change, **responsible for up to 24% of global greenhouse gas (GHG) emissions AFOLU** (Agriculture, Forestry, and Other Land Use). Agricultural production is also the largest source of methane and nitrogen dioxide emissions. Agriculture in India contributes about 47% and 80% of total anthropogenic emission of Methane (CH_4) and Nitrous Oxide (N_2O).

However, agriculture also wields two powerful tools in the fight against climate change: adaptation and mitigation. It's not only a contributor but also a potential solution. **Agriculture is the key sector can generate negative emission through the production of bioenergy with carbon capture and storage (BECCS), provided it can reduce its reliance on the unsustainable inputs like chemical fertilizers and pesticides and adopt renewable energy sources.**

Hence, the sustainability quotient of any non- chemical crop production initiative will be primarily determined by the systems' GHG mitigation potential. Under IBM-IORF Sustainability Project, the Clean Food 'Net Zero' (CFNZ) Model not only demonstrated Profound GHG Mitigation, especially in terms of METHANE ABATEMENT; which is a major solution towards the NET ZERO Carbon Goal; but at the same time of GREATEST SOCIAL RELEVANCE due to the development of SAFEST FOOD @ SAME COST – HENCE, SUSTAINABLE FOR ALL.



Components of Agricultural Operations considered for GHG Calculation

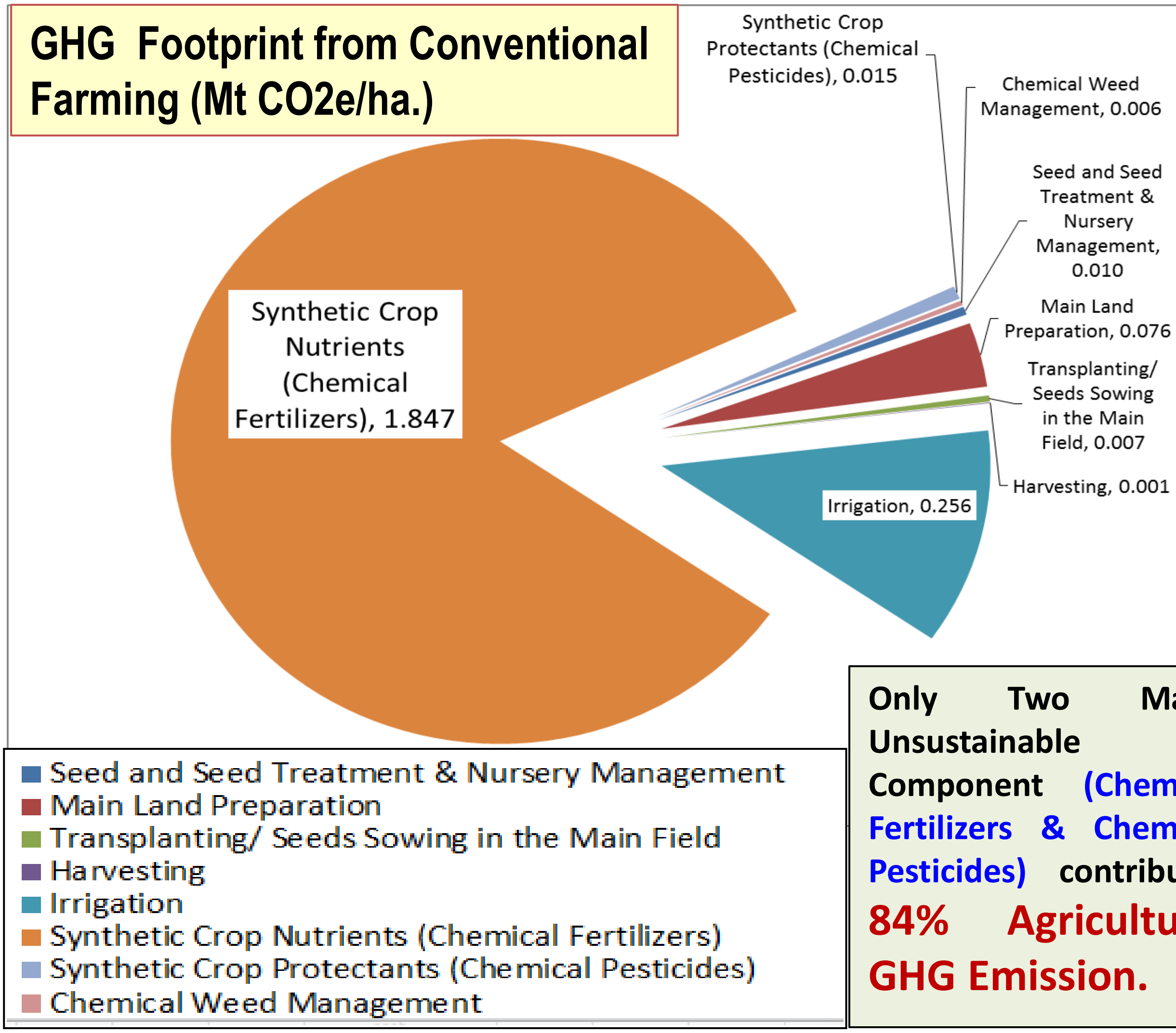
All the possible specific Activities/ Operations have been considered (even if minor) for GHG Calculation both from Conventional Chemical Agriculture and 'Clean Food Net Zero' the Safest & Sustainabiliest Agricultural Food Production Model, developed by IORF under IBM-IORF Sustainability Project.

For the calculation of carbon footprint of 'Clean Food Net Zero' (CFNZ) program under IBM-IORF Sustainability Project Phase- II information has been taken regarding management inputs under conventional farming through farmers interview, generated field data base in CFNZ model farm, design experimental protocol and execute the study in the model farm, analysis soil and compost samples, sourcing reference data base specific to that agro-ecosystem and **finally calculated the carbon footprint as per ACFA (Version. 1) developed based on IPCC guideline.**

In gist, concise classification of agricultural operations based on their importance and GHG footprint of Agricultural Operations considered for GHG Calculation

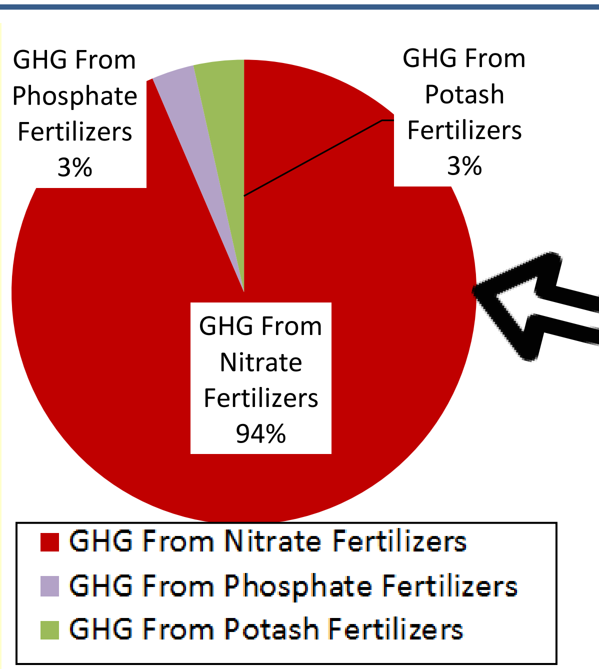
A case Study from Mandya Karnataka from 25.2 Ha. Conventional Farming			% Contribution to the Total Conventional Ag. GHG Footprint
1.	**Essential and Irreplaceable Components:**		
	a)	Seed and Seed Treatment	0.44 %
	a)	Nursery Management	
	a)	Main Land Preparation	3.44 %
	a)	Transplanting/ Seeds Sowing in the Main Field	0.33 %
	a)	Harvesting	0.035 %
2.	**Reducible Components:**		
	a)	Irrigation	11.54 %
3.	**Major Unsustainable Components:**		
	a)	Synthetic Crop Nutrients (Chemical Fertilizers)	83.27 %
	a)	Synthetic Crop Protectants (Chemical Pesticides)	0.70 %
	a)	Chemical Weed Management	0.26%

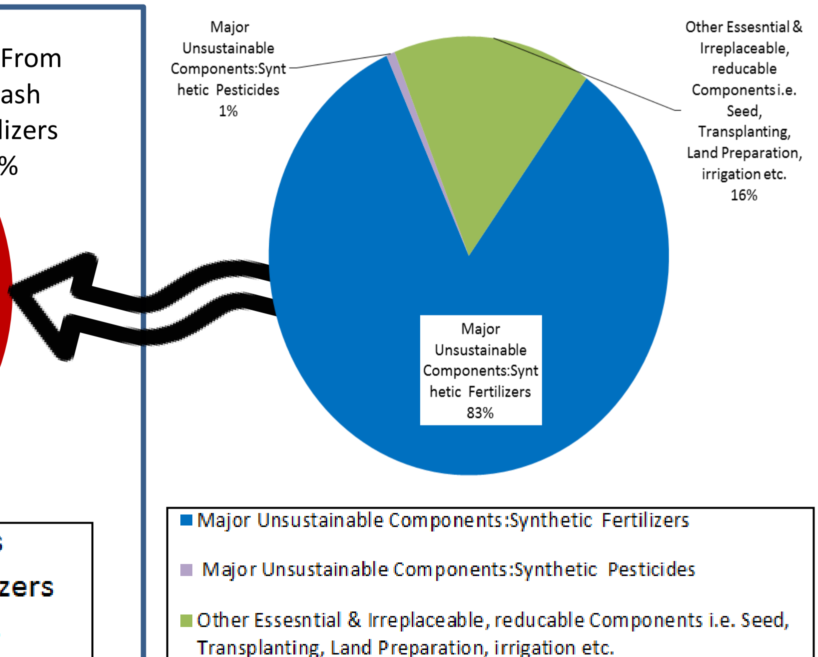
GHG Footprint from Conventional Farming (Mt CO2e/ha.)



Only Two Major Unsustainable Component (Chemical Fertilizers & Chemical Pesticides) contributes 84% Agricultural GHG Emission.

Out of 83% Agricultural GHG Emission from Synthetic Fertilizers 94% comes from NITRATE.





Two unique components have also been included in the assessment of net greenhouse gas (GHG) footprint, tailored to certain specific crops.

- Methane emission from cultivation practice: Specific for Paddy Cultivation

Methane is released from anaerobic wetland soils to the atmosphere through diffusion of dissolved methane, ebullition of gas bubbles, and via plants that, like rice, develop aerenchyma tissue. Large portions of methane formed in an anaerobic soil may remain trapped in the flooded soil (Neue, 1993). The major pathways of CH_4 production in flooded soils are the reduction of CO_2 with H_2, with fatty acids or alcohols as hydrogen donor, and the transmethylation of acetic acid or methanol by methane-producing bacteria (Takai, 1970; Conrad 1989).

- GHG mitigation from perennial plantation-

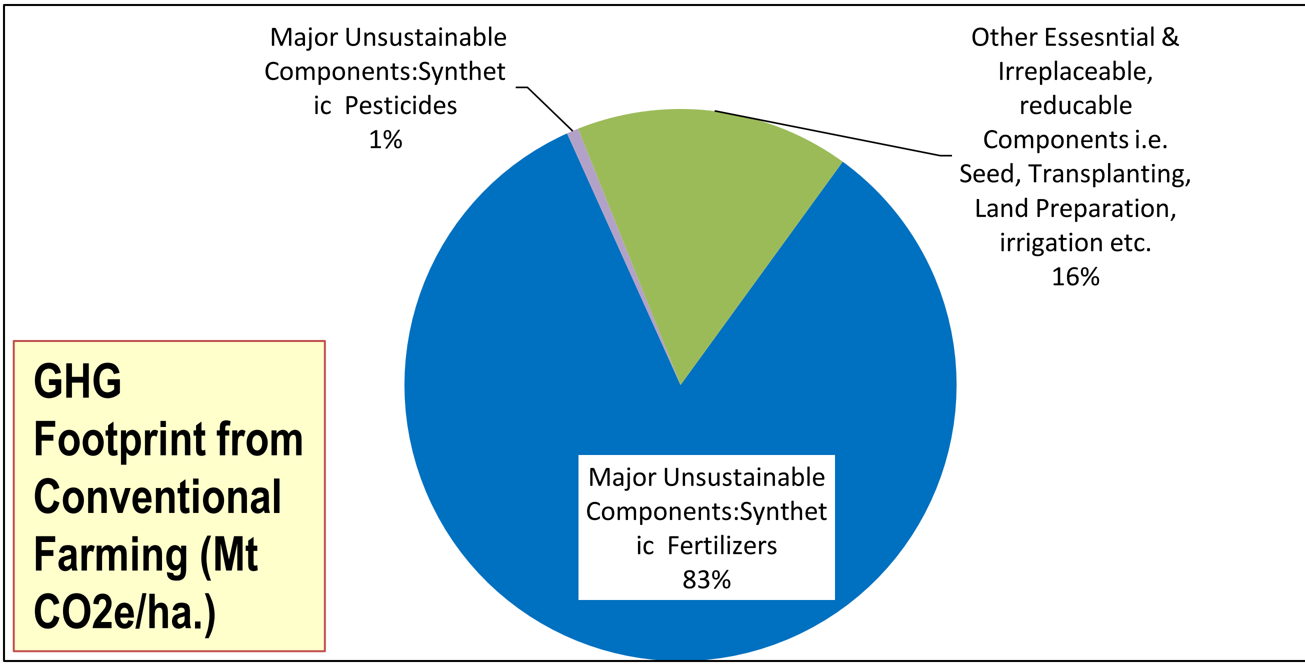
Perennial plantation plays a crucial role in addressing climate change by effectively reducing greenhouse gas emissions. Its primary function lies in sequestering carbon from the atmosphere, as outlined by Morgan (2010). This process involves absorbing atmospheric CO_2 during photosynthesis and storing the fixed carbon in vegetation, detritus, and soil for long-term security (Murthy, 2013). Perennial plantations contribute to greenhouse gas mitigation by storing carbon in biomass and soil, while also curbing emissions on agricultural lands, particularly through energy and fuel savings. The adoption of this practice has greater potential to increase C sequestration of predominantly agriculture dominated landscapes than the monocrop agriculture (Labata, 2012).

Certain input components of agricultural operations, **such as Seeds, Nursery Bed and/or Main Land preparation, transplanting/ sowing and harvesting etc. are indispensable and tend to have a consistent greenhouse gas (GHG) footprint** regardless of whether conventional chemical or sustainable agricultural practices are employed for crop production. This is because these core activities involve fundamental processes that remain relatively unchanged, and their emissions are less influenced by the specific approach chosen. Hence, the GHG impact of these essential components remains relatively stable across different farming methods.

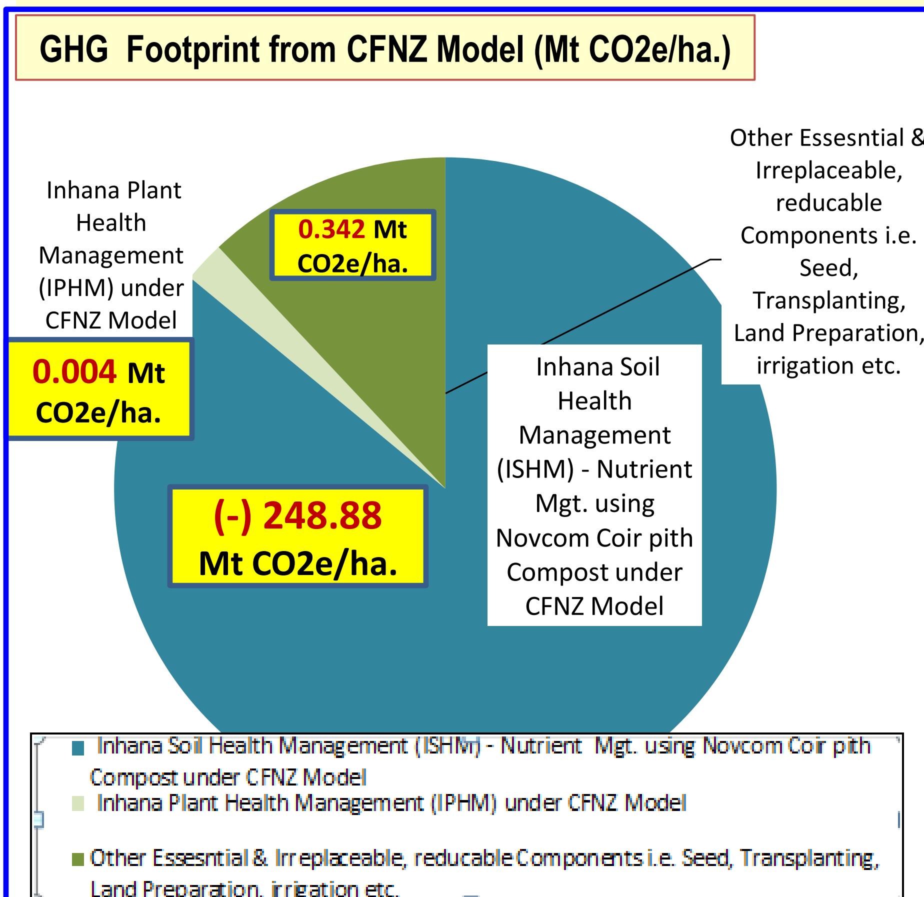
On the other hand input like irrigation offer opportunities for GHG footprint reduction. For crops like paddy, opting for rainfed cultivation can inherently reduce emissions compared to irrigated methods. Sustainable agricultural practices, with efficient resource use, further contribute to diminishing this dependency over time.

The significant contributors to the **unsustainable aspect of industrial agriculture are chemical crop protectants (pesticides) and chemical crop nutrients (nitrogenous fertilizers).** These components notably amplify the agricultural energy consumption and contribute substantially to the greenhouse gas (GHG) footprint. Their use leads to environmental concerns due to energy-intensive production & application and associated emissions and their subsequent environmental effects, underscoring the need for more sustainable alternatives.

A case Study from Mandya Karnataka (25.2 Ha.)	GHG (MT CO2 e per ha.) Footprint from Conventional Farming	GHG (MT CO2 e per ha.) from CFNZ Model under IRF Technology
Essential and Irreplaceable Components:		
a)Seed and Seed Treatment & Nursery Management	**0.010**	**0.002**
b)Main Land Preparation	**0.076**	**0.076**
c)Transplanting/ Seeds Sowing in the Main Field	**0.007**	**0.007**
d)Harvesting	**0.001**	**0.001**
Reducible Components:		
a)Irrigation	**0.256**	**0.256**
Major Unsustainable Components: Chemical Crop Nutrients & Chemical Crop Protectants		
Chemical **Crop Nutrients** - Ferlilizers- as per farmers practice and Inhana Soil Health Management (ISHM) - Nutrient Mgt. using Novcom Coir pith Compost under CFNZ Model	**1.847**	**-248.885**
Chemical **Crop Protectants** - Chemical Pesticide used under farmers practice and Inhana Plant Health Management (IPHM) under CFNZ Model	**0.015**	**0.004**
c)Chemical Weed Management under Conventional Farming and Manual Weed Mgt. under CFNZ Model under IRF Technology	**0.006**	**0.001**

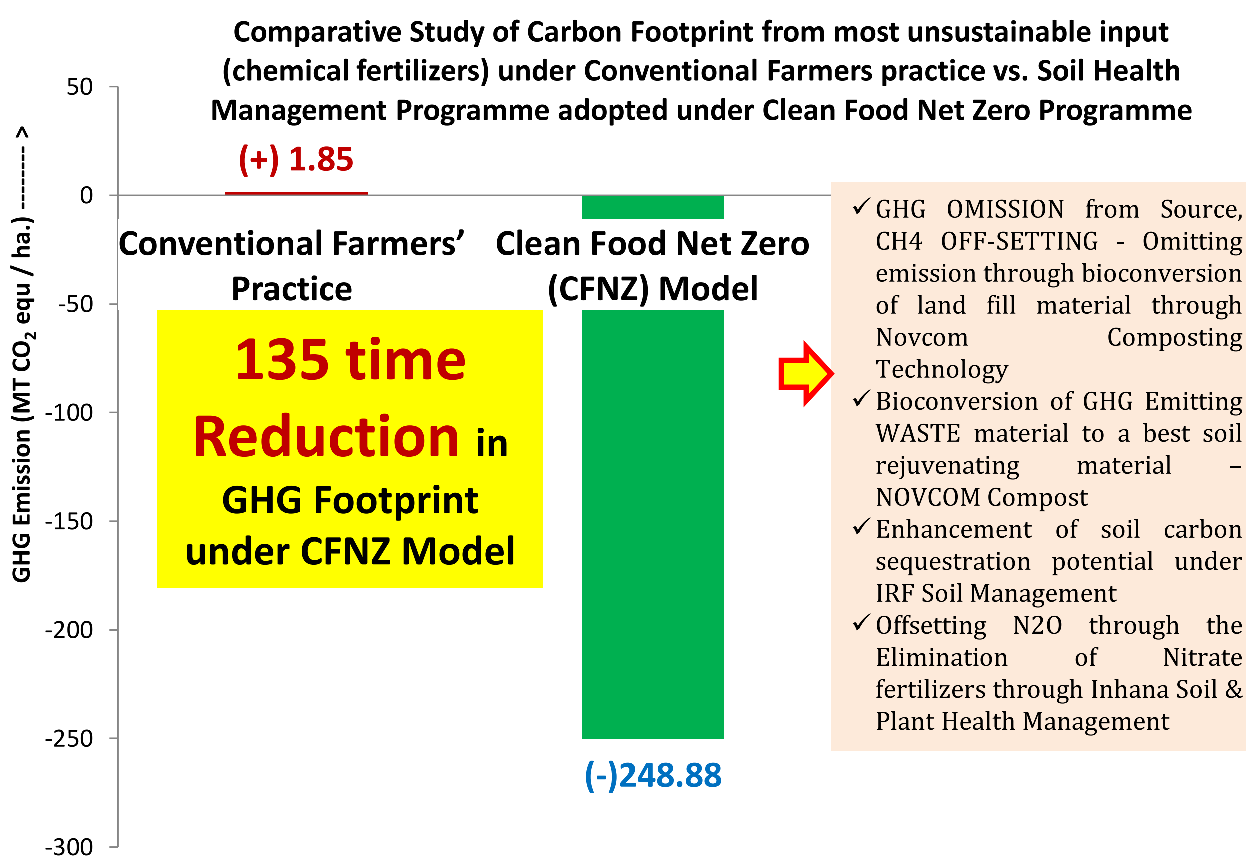


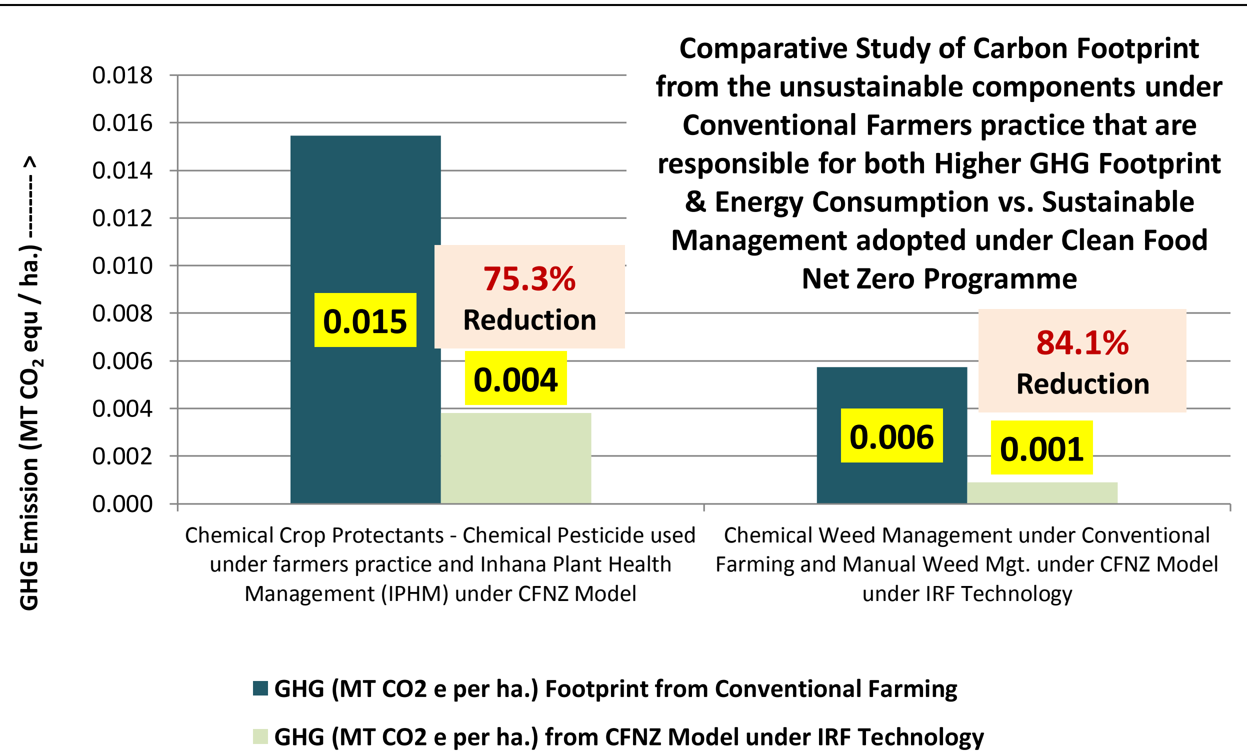
83% GHG Emission from Synthetic Fertilizers particularly from NITRATE has been replaced by Soil Health Management under CFNZ Model that contributes to the mitigation of greenhouse gas emissions, amounting to an impressive 248.88 Mt CO2e per hectare.



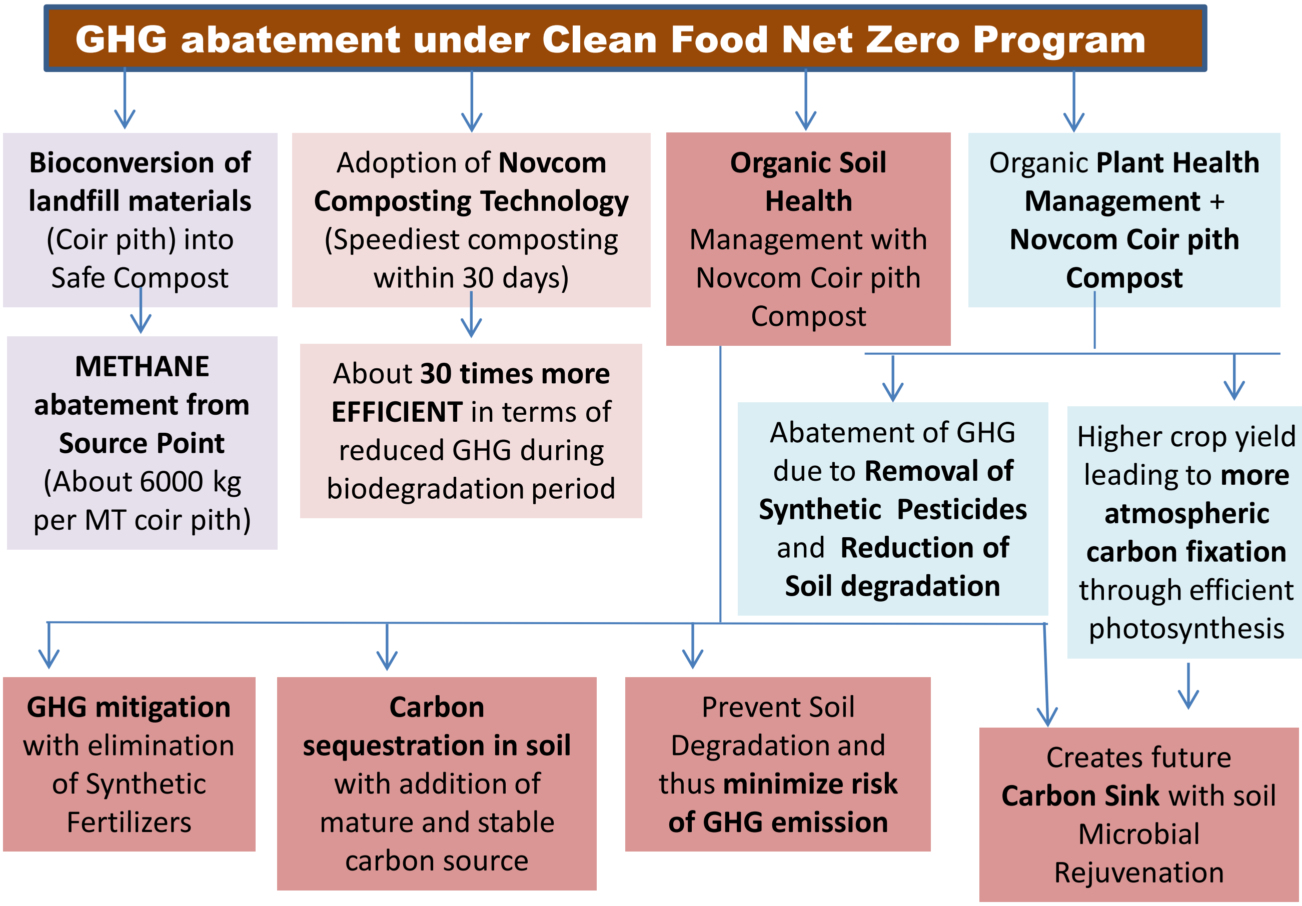
135 time Reduction in GHG Footprint under CFNZ Model only through elimination of Synthetic Fertilizers & adoption of Inhana Soil Health Management using Novcom Composting Technology

GHG abatement under Clean Food Net Zero Program:





In Gist: Inhana Clean Food Net Zero (CFNZ) Program for GHG Mitigation



Under Clean Food 'Net Zero' program at Mandya, Karnataka under IBM-IORF Sustainability Project with the adoption of IRF Technology, bio- conversion of coir pith (Landfill WASTE from coir industry) was taken up through utilization **of Novcom Composting Technology in order to transform it into Safe and Mature Novcom Coir pith compost. This was to serve the dual objective of soil health management and elimination of N- fertilizers. This approach actually provided three way benefits in respect of GHG mitigation.** Firstly, bioconversion of landfill materials, cut off the METHANE emission potential directly from SOURCE POINT. Secondly, bioconversion of the material through Novcom Composting Technology, reduced the GHG emission by about 30 times than the average GHG emission recorded under any biodegradation process. Thirdly, Novcom coir pith was utilized for soil health management towards elimination of synthetic fertilizers specially N fertilizers, which on one hand stopped N_2O emission while also enabling soil carbon sequestration.

Organic Plant Health Management under IRF Technology, ensure elimination of synthetic pesticides that enabled reduction of indirect GHG emission. Moreover, adoption of IRF Technology improved crop productivity, which meant higher atmosphere carbon fixation through efficient photosynthesis.

Table 1: Farm Operation wise GHG Emission & Carbon Footprint Assessment (kg CO_2 e per ha) on seven different crops from Conventional (Chemical Fertilizers & Pesticides)

Sl. No.	Farm Operation wise - Crop wise - GHG Emission (kg CO_2 e per ha) under Conventional Farmers' Practice	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut
1	Seed Treatment, Bed Preparation & Nursery Mgt.	6.512	6.787	0.315	2.348	34.17	42.08	0
2	Land Preparation	110.54	110.54	110.54	120.714	120.714	165.81	-
3	Transplanting	13.565	13.565	-	13.565	13.565	11.304	-
4	Irrigation	1707.3	42.684	56.912	227.65	113.824	199.192	142.28
5	Crop Management (under Farmer's Practice)							
	Chemical Crop Nutrients - Fertilizers- as per Farmers Practice	1031.6	958.48	1212.74	2271.59	1948.6	4021.57	1378.68
	Chemical Crop Protectants - Chemical Pesticide used under Farmers Practice	10.211	0	0	13.722	36.544	73.085	0
6	Weed Management	-	2.226	7.156	1.507	30.839	15.767	3.626
7	Cultural Practice	-	-	-	-	-	-	-
8	Methane Generation	7530.8	-	-	-	-	-	-
9	Carbon from Biomass	-	-	-	-	-	-	-3183.25
10	Harvesting	0.446	0.446	0.446	-	6.782	2.79	-
	Total Carbon footprint (kg CO_{2e}/ ha)	(+) 10410.97	(+) 1134.73	(+) 1388.11	(+) 2651.10	(+) 2305.04	(+) 4531.60	(-) 1658.66
	Crop yield (kg/ha)	4050	2100	2950	15180	10500	108500	4512
	Carbon Footprint (kg CO_2 / kg)	(+) 2.571	(+) 0.540	(+) 0.471	(+) 0.175	(+) 0.220	(+) 0.042	(-) 0.368

Table 2: Farm Operation wise GHG Emission & Carbon Footprint Assessment (kg CO_2 e per ha) on seven different crops taken in 25.2 ha. CFNZ MODEL under IRF Technology

Sl. No.	Farm Operation wise - Crop wise - GHG Emission (kg CO_2 e per ha) from CFNZ MODEL under IRF Technology	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut
1	Seed Treatment, Seed bed Preparation & Nursery Mgt.	6.056	6.029	0.027	0.944	1.02	2.04	0
2	Land Preparation	110.54	110.54	110.54	120.714	120.714	165.81	-
3	Transplanting	13.57	13.57	-	13.57	13.57	11.30	-
4	Irrigation	1707.3	42.7	56.9	227.7	113.8	199.2	142.3
5	Crop Management (under CFNZ MODEL)							
	Inhana Soil Health Management (ISHM) - Nutrient Mgt. using Novcom Coir pith Compost	-249055	-248872	-248872	-248872	-248872	-248872	-248872
	Inhana Plant Health Management (IPHM)	3.23	3.23	3.23	5.39	6.47	4.31	3.23
6	Weed Management	-	0.67	0.67	1.507	1.507	1.507	0.67
7	Methane Generation	12336	-	-	-	-	-	-
8	Carbon from Biomass	-	-	-	-	-	-	-3183
9	C- Sequestration due to Land Use Change	-1130	-1130	-1130	-1130	-1130	-1130	-1130
10	Cultural Practice	-	-	-	-	-	-	-
11	Harvesting	0.446	0.446	0.446	-	6.782	2.790	-
	Total Carbon footprint (kg CO_2 e/ ha)	(-) 236008.0	(-) 249824.3	(-) 249829.7	(-) 249631.7	(-) 249737.6	(-) 249614.5	(-) 253038.6
	Crop yield (kg/ha)	4335	2210	3270	18360	11450	119000	4736
	Carbon footprint (kg CO_2e/ kg)	(-) 54.44	(-) 113.04	(-) 76.40	(-) 13.60	(-) 21.81	(-) 2.10	(-) 53.43

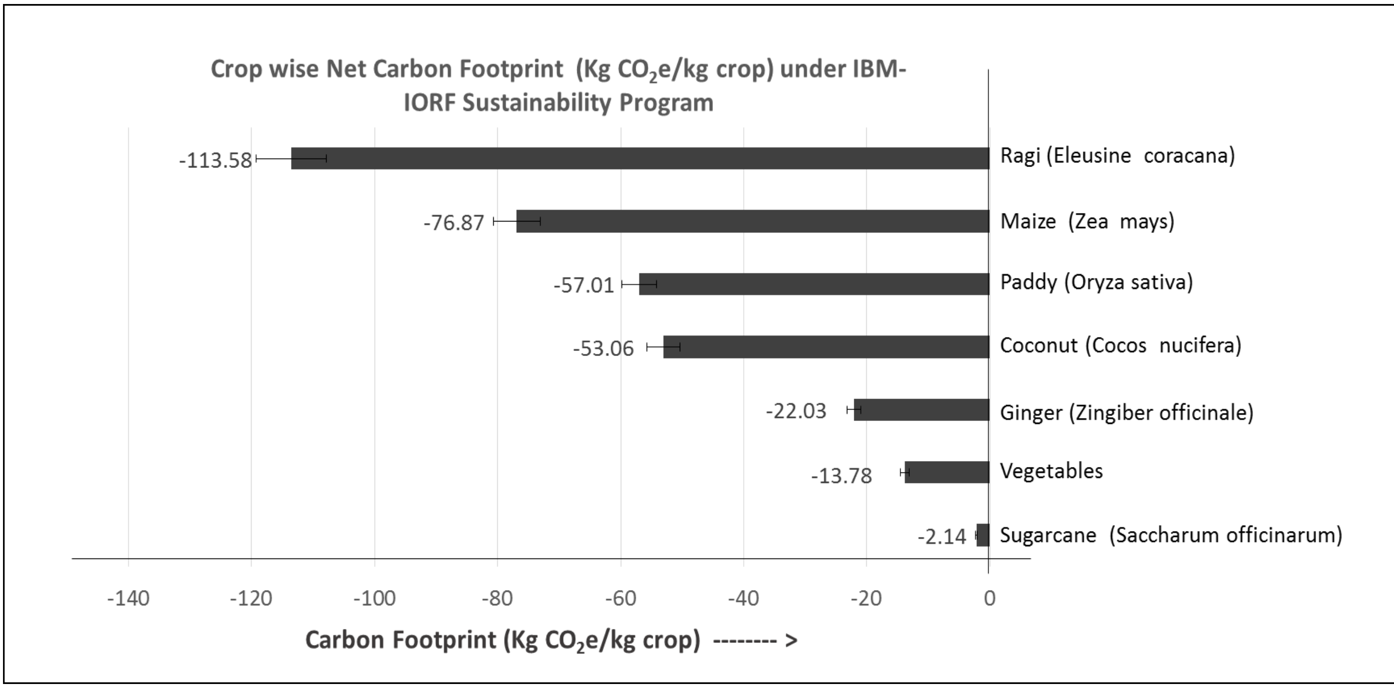
Table 3: Farm Operation wise Total GHG Emission & Carbon Footprint Assessment (MT CO_2 e) on seven different crops from Conventional (Chemical Fertilizers & Pesticides)

Sl. No.	Farm Operations	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut
	Area under individual Crop (ha)	1.8	4	0.8	3.6	0.8	4	10.2
1	Seed Treatment, Bed Preparation & Nursery Mgt.	11.72	27.148	0.252	8.4528	27.336	168.32	0
2	Land Preparation	198.97	442.16	88.432	434.5704	96.5712	663.24	-
3	Transplanting	24.42	54.26	-	48.834	10.852	45.216	-
4	Irrigation	3073.14	170.736	45.5296	819.54	91.0592	796.768	1451.256
5	Crop Management (under Farmer's Practice)							
	Chemical Crop Nutrients - Ferlilizers- as per farmers practice	1856.88	3833.92	970.192	8177.724	1558.88	16086.28	14062.536
	Chemical Crop Protectants - Chemical Pesticide used under farmers practice	18.38	0	0	49.3992	29.2352	292.34	0
6	Weed Management	-	8.904	5.7248	5.4252	24.6712	63.068	36.9852
7	Cultural Practice	-	-	-	-	-	-	-
8	Methane Generation	13555.44	-	-	-	-	-	-
9	Carbon from Biomass	-	-	-	-	-	-	-32469.15
10	Harvesting	0.80	1.784	0.3568	-	5.4256	11.16	-
	Conventional Farmers' Practice (Chemical Fertilizers & Pesticides): Crop wise Total Carbon Footprint (MT CO2 e)	**18.74**	**4.54**	**1.11**	**9.54**	**1.84**	**18.13**	**-16.92**

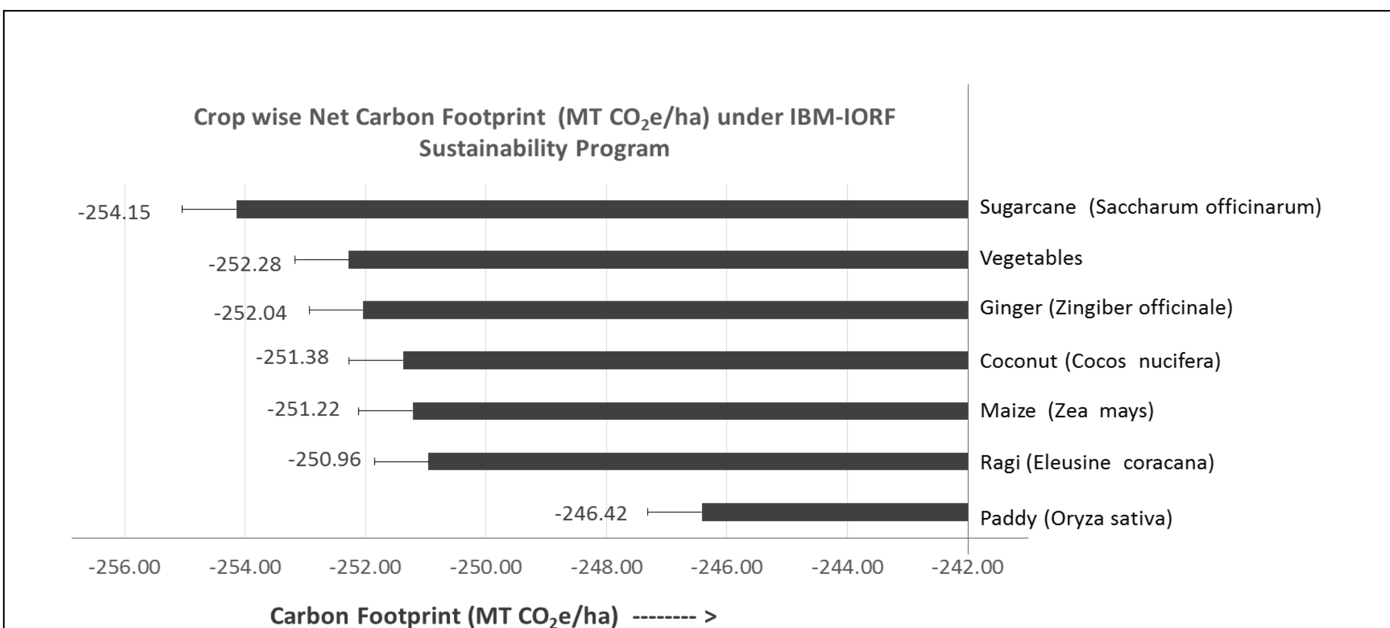
Table 4: Farm Operation wise Total GHG Emission & Carbon Footprint Assessment (MT CO2 e) on seven different crops from in 25.2 ha. CFNZ MODEL under IRF Technology

Sl. No.	Farm Operations	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut
	Area under individual Crop (ha)	1.8	4	0.8	3.6	0.8	4	10.2
1	**Seed Treatment, Seed bed Preparation & Nursery Mgt.**	10.90	24.12	0.02	3.40	0.82	8.16	0.00
2	**Land Preparation**	198.97	442.16	88.43	434.57	96.57	663.24	-
3	**Transplanting**	24.42	54.26	-	48.83	10.85	45.22	-
4	**Irrigation**	3073.14	170.74	45.53	819.54	91.06	796.77	1451.26
5	**Crop Management (under CFNZ MODEL)**							
	Inhana Soil Health Management (ISHM) - Nutrient Mgt. using Novcom Coir pith Compost	-448299.86	-995486.40	-199097.28	-895937.76	-199097.28	-995486.40	-2538490.32
	Inhana Plant Health Management (IPHM)	5.82	12.94	2.59	19.40	5.17	17.25	32.99
6	**Weed Management**	-	2.68	0.54	5.43	1.21	6.03	6.83
7	**Methane Generation**	22205.16	-	-	-	-	-	-
8	**Carbon from Biomass**	-	-	-	-	-	-	-32469.15
9	**C- Sequestration due to Land Use Change**	-2033.82	-4519.60	-903.92	-4067.64	-903.92	-4519.60	-11524.98
10	**Cultural Practice**	-	-	-	-	-	-	-
11	**Harvesting**	0.80	1.78	0.36	-	5.43	11.16	-
	Clean Food 'NET ZERO' under IRF Technology: Crop wise Total Carbon Footprint (MT CO2 e)	**-424.81**	**-999.30**	**-199.86**	**-898.67**	**-199.79**	**-998.46**	**-2580.99**

Crop wise Net Carbon Footprint (kg CO_2 e/ kg crop) (per Kg. crop) from total 25.2 ha. from both from CFNZ Model (under IRF Technology) at Mandya, Karnataka (Phase II: 2022-23)



Crop wise Net Carbon Footprint (kg CO_2 e/ kg crop) (per Kg. crop) from total 25.2 ha. from both from CFNZ Model (under IRF Technology) at Mandya, Karnataka (Phase II: 2022-23)



Net Avg. GHG Savings: (-) 251.55 mtCO_2e/ha

Carbon Footprint (kg CO_2 e) from total 25.2 ha. And Avg. Carbon Footprint (kg CO_2 e) per ha. from both from both Conventional (Chemical) & CFNZ Model (under IRF Technology) at Mandya, Karnataka (Phase II: 2022-23)

Total Carbon Footprint of 25.2 ha. under Conventional Farmers' Practice (Chemical Fertilizers & Pesticides)

Cultivation Practice	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut	TOTAL Carbon Footprint (MT kg. CO2 equivalent)
Area distribution of the individual Crop in 25.2 ha. area (ha)	1.8	4	0.8	3.6	0.8	4	10.2	25.2 ha
Crop wise GHG Footprint /ha. (kg CO_2 / ha)	(+) 10410.97	(+) 1134.73	(+) 1388.11	(+) 2651.10	(+) 2305.04	(+) 4531.60	(-) 1658.66	*Conventional Farmers' Practice*
Crop wise Total Carbon Footprint (MT CO_2 e)	**18.74**	**4.54**	**1.11**	**9.54**	**1.84**	**18.13**	**-16.92**	**36.99**

Avg. Carbon Footprint: **(+) 1.47 mtCO_2e/ha.**

Total Carbon Footprint of 25.2 ha. from the Cultivation of Clean Food 'NET ZERO' under IRF Technology

Cultivation Practice	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut	TOTAL Carbon Footprint (MT kg. CO2 equivalent)
Area distribution of the individual Crop in 25.2 ha. area (ha)	1.8	4	0.8	3.6	0.8	4	10.2	25.2 ha.
Crop wise GHG Footprint /ha. (kg CO_2 / ha)	(-) 236008.0	(-) 249824.3	(-) 249829.7	(-) 249631.7	(-) 249737.6	(-) 249614.5	(-) 253038.6	*Clean Food 'NET ZERO'*
Crop wise Total Carbon Footprint (MT CO_2 e)	**-424.81**	**-999.30**	**-199.86**	**-898.67**	**-199.79**	**-998.46**	**-2580.99**	**-6302.07**

Avg. Carbon Footprint : **(-) 250.08 mtCO_2e/ha.**

Net Carbon Footprint (kg CO_2 e) from total 25.2 ha. And Net GHG Savings (kg CO_2 e) per ha. under CFNZ Model (under IRF Technology) at Mandya, Karnataka (Phase II: 2022-23)

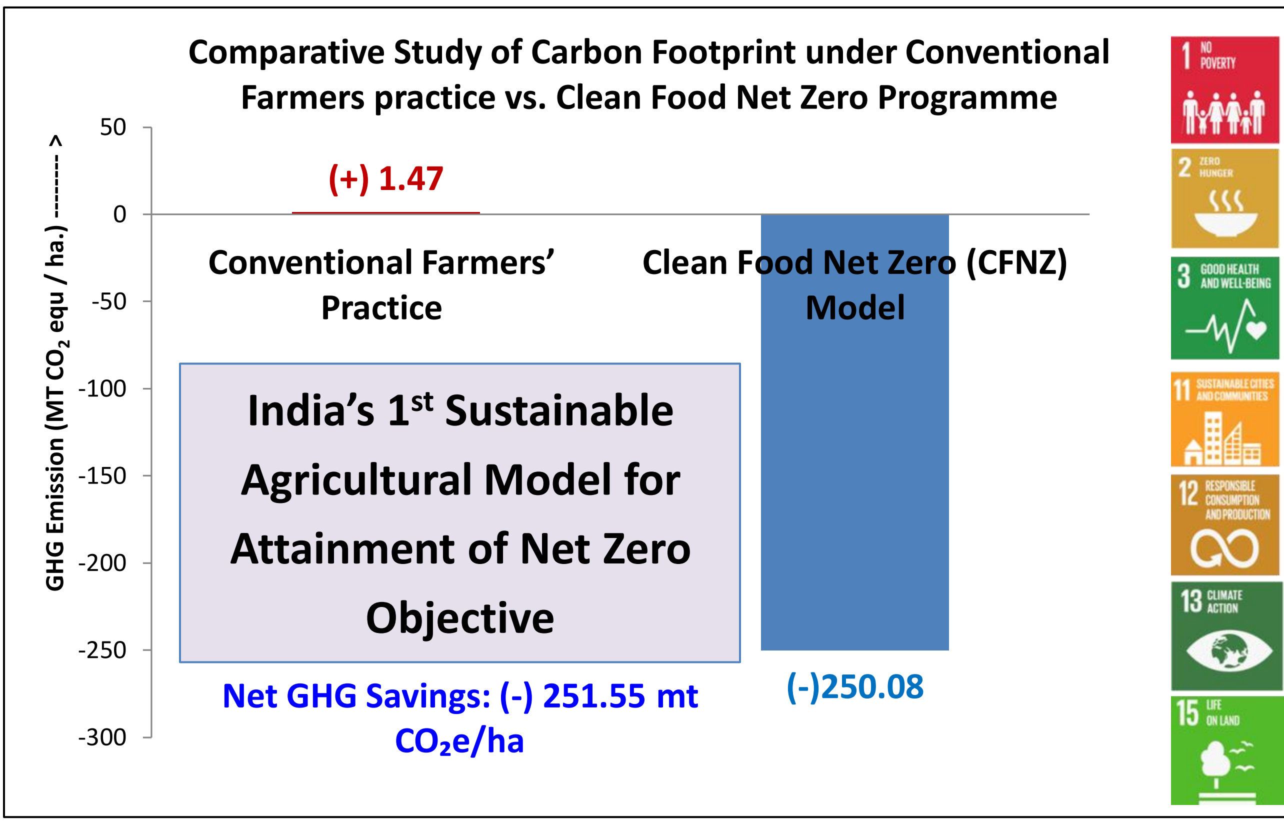
Cultivation Practice	Paddy	Ragi	Maize	Vegetables	Ginger	Sugarcane	Coconut	TOTAL Carbon Footprint (MT kg. CO2 equivalent) from 25.2 ha.
Area distribution of the individual Crop in 25.2 ha. area (ha)	1.8	4	0.8	3.6	0.8	4	10.2	
Conventional Farmers' Practice (Chemical Fertilizers & Pesticides): Crop wise Total Carbon Footprint (MT CO2 e)	18.74	4.54	1.11	9.54	1.84	18.13	-16.92	**36.99**
Clean Food 'NET ZERO' under IRF Technology: Crop wise Carbon Footprint (MT CO2 e)	-424.81	-999.30	-199.86	-898.67	-199.79	-998.46	-2581.17	**-6302.07**
Net Carbon Footprint Achieved (MT CO2 e)	-443.55	-1003.84	-200.97	-908.22	-201.63	-1016.58	-2564.08	**-6339.06**

Net GHG Savings: (-) 251.55 mtCO_2e/ha

Comparative study of GHG Emission under Conventional farmer's Practice and Clean Food 'Net Zero' Program

Adoption of CFNZ Model in the 25 ha Project Area has enabled GHG Abatement of approx. 6300 MT CO2 eq. through Stoppage of GHG emission from Source Point and GHG mitigation through elimination of Synthetic Fertilizers. Moreover, Adaptation to Climate Change is exhibited through higher crop yields; that also indicated higher atmospheric C- capture; along with SAFEST FOOD production.

GHG Footprint evaluation in respect of seven major crops production under Clean Food Net Zero program (CFNZ) in 25.2 ha. area in Mandya, Karnataka, was done through ACFA (Version 1.0) tool and it was found that replacing conventional farmers' practice with CFNZ Program has the potential to mitigate about 250.08 Mt CO_2 equivalent per ha..



This is probably the **1st Ever Sustainable Agricultural Model** which can sustain crop productivity, create opportunities for employment and sustain farmer livelihood, provide Safe Food to all Without deteriorating the Soil and Environment; while providing the Road Map for attaining NET ZERO Goal and making significant impact w.r.t. Seven Crucial SDGs

Inhana Rational Farming (IRF) Technology - *the Driving Force Behind Target Accomplishment*

Intervention of a **NEGATIVE EMISSION TECHNOLOGY i.e. Inhana Rational Farming (IRF) Technology of IORF is the primary driving force behind development of Clean Food 'NET ZERO'** through the approach of '**PLANT HEALTH MANAGEMENT'**

First of a Kind Approach in terms of '**PLANT HEALTH MANAGEMENT**', which is well accepted even by apex organizations like FAO, but **interventions in this aspect is completely lacking not only at national level but also in world agriculture**.

Inhana Rational Farming Technology (IRF) developed by Indian Scientist Dr. P. Das Biswas, is a comprehensive organic crop technology that aims at restoration of soil and plant health, which actually deflates pest pressure due to alleviation of factors responsible for pest – parasite interactions. The package works towards (i) energization of soil system i.e., enabling the soil to function naturally as an effective growth medium for plants and (ii) energization of plant system i.e., enabling higher nutrient use efficiency alongside better bio-chemical functions; that leads to activation of the plants' host defense mechanism.

Soil energization aimed at rejuvenation of soil microflora, is primarily attended by application of on-farm produced Novcom compost (that contains rich population of self-generated micro flora- one trillion billion per ton Novcom Compost; different types of herbal concoctions and adoption of sustainable field practices. However, the technology emphasizes Plant Health Management as a precursor for resilient plant system that can ensure sustainability even under changing climatic patterns. Plant Health Management under this technology is a systemic approach that utilizes a set of potentized and energized botanical solutions developed under Element Energy Activation (EEA) Principle. According to EEA Principle, radiant solar energy is stored in plants and the bound or stored energy components from energy rich plants are extracted on specific day, time, by specific extraction procedure and subsequently potentized so that energy components can be effectively received by plant system for activation of various metabolic functions. Each solution has one or more defined functions, but work in an integrated manner when applied in a schedule, for bringing about harmonized plant growth with ensured aggregation of biological compounds responsible for flavour, nutrition and medicinal properties.

How the Clean Food 'NET ZERO' Status was attained

This Program focused on demonstrating the Pathway for Net Zero GHG Emission in Agriculture through GHG Omission from Source , GHG Abatement and GHG Adaptation through High Atmospheric-C capture. The Dual approach of Soil Health Management & Plant Health Management in this program was aimed at attaining these very objectives.

GHG OMISSION FROM SOURCE POINT was demonstrated through Novcom Composting Technology that enabled Bioconversion of raw coir pith – a landfill waste, especially a High METHANE Emitter; into Stable, Mature and Non- phytotoxic compost within a shortest period of time (30 days).

GHG Omission from Source Point through bio-conversion of Coir pith –

Coir pith, a waste from coir industry forms a major threat to soil, water, ecology and environment and a is a major source of GHG Emission (6.0 mt CO_2-eq per ton approx.) – primarily **METHANE**, which has 75 times Higher Global Warming Potential as compared to CO_2.

1000 ton Novcom Coir Pith Compost was produced under this Project utilizing **NOVCOM COMPOSTING TECHNOLOGY**, which has been applied in the project sugarcane fields, paddy fields as well as Model Farm for cultivation of a wide variety of vegetables and demonstration of coconut based intercropping model.

GHG ABATEMENT through Inhana Soil Health Management (ISHM)

On- farm produced **Novcom Coir pith Compost** at 40 ton/ ha as well as various organic concoctions were used for **SOIL HEALTH MANAGEMENT** towards **elimination of Nitrate Fertilizers.** Elimination of N- fertilizers means **stoppage of $N_2$0 Emission- another critical GHG**, while Restoration of Soil Biological productivity, through Novcom Compost application can initiate the regeneration process of **Soil-C Sequestration Potential-** a critical step towards GHG abatement

Bioconversion of coir pith to a quality compost through Novcom composting Technology and application of this compost for sustainable soil management and removal of synthetic chemical fertilizers are the keys towards attending Clean Food ‘Net Zero’ objectives.

Adaptation to Climate Change was exhibited through the adoption of **INHANA PLANT HEALTH MANAGEMENT (IPHM),** driven by **Inhana** ‘**ENERGY SOLUTIONS**’.

IPHM has been adopted towards reactivation of Plant Physiology. The approach ensures **higher agronomic efficiency towards Sustained/ Higher Crop Yields**, meaning **Higher atmospheric- C capture- a critical measure for Adaptation to Climate Change**

Moreover, IPHM works towards **Curtailing the Accumulation of Ready Food Source** for Pests, in Plants’ Cell Sap & **Enhancement of Host- Defense** of Plants t**o Discourage Disease and Pest Incidence leading to the ELIMINATION OF PESTICIDE**

The Dual approach of Soil & Plant Health Management in this program demonstrated the pathway towards production of **Clean Food ‘NET ZERO’.**

Pic. Farm visit of Clean Food Net Zero Paddy at Mandya, Karnataka under IBM-IORF Sustainability project

Pic.: Clean Food 'Net Zero' Vegetables under IBM-IORF Sustainability Project

Pic.: Clean Food 'Net Zero' Vegetables under IBM-IORF Sustainability Project

Pic.: Clean Food 'Net Zero' Vegetables under IBM-IORF Sustainability Project

Pic.: Clean Food 'Net Zero' Vegetables under IBM-IORF Sustainability Project

SAFETY ASSESSMENT OF CLEAN FOOD ‘NET ZERO’ : a Fresh Perspective from IORF- in the Food Safety Arena

The UN recognizes that “there is no food security without food safety” . . . that it is not enough to produce **SUFFICIENT FOOD** and ensure everyone has access to it, but the food must be **SAFE AND NUTRITIOUS**.

But pesticide monitoring in food is often most difficult in countries where that monitoring is arguably most needed. This is because the present chromatographic techniques can precisely determine the presence of every chemical at the minute level but the process is **hugely expensive, complex, time-consuming and require specific resources and infrastructure** which offer major hindrance towards regular analysis for monitoring of food safety.

Especially for a country like India, with absolute dominance of marginal farmers in vegetable cultivation, lack of awareness, resource scarcity, inability to take economic risk and flaws in maintaining the standard practices w.r.t. chemical usage enhances the availability of pesticides in food product.

Moreover the short time gap between the field harvest of vegetables and their consumption, limits the scope for safety analysis even if the infrastructure and economics is not considered.

Clean Food means SAFETY authenticated by Actual Residue Analysis. Most Importantly as the Clean Food primarily comprised short duration, multiple harvest- Vegetable Crops, hence, batch wise residue assessment was necessary.

In this background **an effective, speedy, yet an affordable method** was needed to enable pesticide residue analysis in situations of limited resources more so for Safe and Sustainable Agriculture; to comply the requirement for SDG-2 of the United Nations, more meaningfully SDG- Target 2.1 (SAFE, Nutritious and sufficient food all year round).

Colorimetric Pesticide Assay Test : a Path breaking Exercise in the field of FOOD SAFETY

The Colorimetric Pesticide Assay Test has been utilized round the globe to identify pesticides residues in food products both in a quantitative and qualitative manner.

However, there is lack of information regarding any comprehensive approach towards utilization of this test method in formulating a protocol towards safety evaluation of food crops especially vegetables in terms of detecting the presence/absence of the major pesticide groups

Inhana Organic Research Foundation (IORF), Kolkata in collaboration with Krishi Vigyan Kendra (Nadia, ICAR) developed the Protocol for Colorimetric Pesticide Assay Test of vegetables. The development was done in three basic aspects:

- **Most Authentic and Speedy Measurement of the major groups of pesticides**, that are used during vegetable crop production.
- **Identifying the collective presence/ absence of the pesticide residues up to the lowest-group specific permissible limits** (same type of pesticides in terms of chemical structure).
- **Standardization of the Method** towards its effective utilization for large scale Pesticide Residue Study in the most economical manner.

The newly standardized Colorimetric Pesticide Assay Test Protocol can enable **detection of the collective presence/ absence of pesticides up to group specific- lowest permissible limit; for more than 90 percent of the pesticides- permitted for use in India, for most of the banned chemicals, as well as chances of residual presence in case of chemicals like DDT and its isomer**.

In addition; this Assay Test can be also utilized for detecting the presence/ absence of toxic heavy metals and a wide range of other toxic substance of known/unknown origin related to human health and safety.

A limiting point w.r.t. the study of individual pesticide residue is that, their individual presence might be below the detectable limit (0.01 ppm) or the MRL, but the value might go up in respect of their collective presence as a group; which ever is considered for 'SAFETY' evaluation. The Colorimetric Pesticide Assay Test also takes care of this problem because of **scope for detection of the Collective Presence/ Absence of the Pesticide Residues upto the Lowest-Group Specific Permissible Limits**

Colorimetric Pesticide Assay Test for Safety Analysis of crops grown under Clean Food 'Net Zero' Program

The 'Clean Food' Project (Phase- I) led to Clean Food 'NET ZERO' Model; with the potential to Alleviate both the CAUSE (Climate Change) & the EFFECT (Food Insecurity) with a New Dimension of uplifting Small & Marginal farmers' livelihood.

In Phase- II Project, Development of Clean Food 'NET ZERO' (CFNZ) means a Model for SAFEST Food Production- SAFE for Human Health, Soil & Environment. **Hence, here again the Primary Safety (*for human health*) is ensured through actual analysis following the Colorimetric Pesticide Assay Test.**

Comparative Safety Assessment of 18 different varieties of vegetables (*viz. brinjal, radish, French beans, cabbage, capsicum, cucumber, tomato, chilli, red amaranth, bitter gourd, etc.*) developed under **Clean Food 'NET ZERO' Model (in Model Farm)** was done **vis-à-vis organic vegetables (market source) as well as the conventionally grown counterparts.** A total of **224 Samples** were studied for the purpose. Safety Authentication of other crops like **paddy, maize, ginger, papaya, sugarcane and coconut** was also undertaken for which samples were collected from the fields and plantation belonging to the CFNZ Project farmers.

While No Residue was detected in respect of the Clean Food 'NET ZERO' and Organic Samples; **44% *(on an average)* of the conventionally grown vegetables were found to be tainted with pesticides.**

Out of the conventionally grown vegetables, chances for pesticide residue was found to be highest in the case of brinjal followed by French beans, cucumber and lowest for pumpkin.

Pic. : Different stages of analysis towards Safety authentication of Clean Food 'Net Zero' utilizing Colorimetric Pesticide Assay Test

Clean Food 'NET ZERO' Safety Assessment- **THE MOOT POINTS**

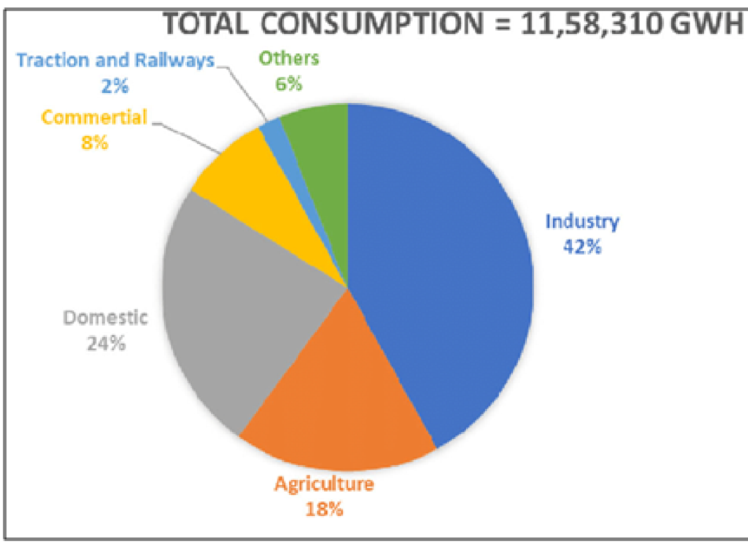
- **Clean Food 'NET ZERO'** – SAFEST FOOD – SAFE for Human Health, Soil & Environment
- Also SAFETY is the Cursor for **SUSTAINABILITY.**
- For Safety Authentication of Clean Food 'NET ZERO', especially for Multiple Harvest Crops like vegetables- **Batch wise Testing was a must**.
- But the Conventional Process of Pesticide Analysis is **COSTLY & TIME CONSUMING**– due to high investment, lack of infrastructure, resources and technical manpower.
- **Hence, frequent Safety Assessment of Produce especially vegetables is beyond question** because majority of the growers are small and marginal land holders.
- So the Need was felt for a Process/ Method that would enable **Pesticide Residue Assessment in the most Authenticated Manner** but at the same time **will be SPEEDY & ECONOMICAL**.
- The **Colorimetric Pesticide Assay Test developed in Phase-1 of the IBM-IORF Sustainability project** came out as the Right Solution considering that it can enable **Both Qualitative & Quantitative Residue Analysis,** at **1/10th of Conventional Cost and Time required for Analysis** *(respectively).*

Pic. : Clean Food 'Net Zero' Safety authentication utilizing Colorimetric Pesticide Assay Test

Relevance of energy footprint in Food and Agriculture

Agriculture, is both a user and a supplier of energy in the form of bioenergy and food. The advent of green revolution led to an increased use of energy in agriculture primarily due to increasing use of chemical fertilizers, pesticides, farm mechanization, etc. **The amount of energy used in agriculture has grown substantially, and currently, the agrifood chain accounts for 30 percent of the total energy used around the world.**

In India, about 18% of the Total Energy is consumed in the agricultural and food sector. Agriculture Energy Consumption in 2020 was 19,6,913 GWH.



Agriculture Energy Consumption in 2020

19,6,913 GWH

Major challenge for the agricultural sector is to reduce environmental impacts while maintaining an economic activity

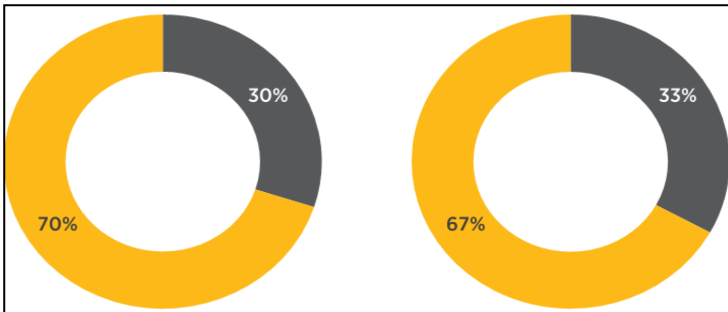
Ref.:https://indiaenergyportal.org/energy-consumption-in-india/

The lack of energy efficiency in the agricultural and food sector causes significant Greenhouse Gas Emissions. The UN IPCC has identified improved energy efficiency in the agricultural sector as a key intervention in this field.

(IPCC, 2007. Climate Change 2007: Mitigation. Contribution of Working)

The world's energy and food systems must be transformed to cope with growing demand; to become more inclusive, s secure, and sustainable; and to come into alignment with the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change.

The transformation pathways of the two systems are deeply entwined: Agri-food systems consume about 30% of the world's energy, and a third of agri-food systems' emissions of greenhouse gases stem from energy use. The energy transition will directly affect the food system, and vice versa.



Share of food systems in global energy consumption

Share of energy in total GHG emissions from food systems

- About **30% of the world's energy** is consumed **within agri-food systems**.
- Energy is also responsible for **a third of agri-food systems' emissions of GHGs.**

Both systems must be transformed to meet current and future demand for food and energy in a fair, environmentally sustainable, and inclusive manner.

Intensive Use of Energy in turn has led to environmental problems such as those associated with soil, water pollution and CO_2 and N_2O emissions that contribute to global warming. Hence, efficient use of energy in agriculture is crucial for minimization of the environmental problems, to prevent destruction of natural resources and promote sustainable agriculture as an economical production system.

But the major Challenges for Energy Transition in agri-food systems is to decouple the use of fossil fuels in food-system transformation and related innovations without compromising food security. With the growing demand for energy and food, the transformation of both systems is necessary to align them more closely with global climate and sustainability goals.

Food and energy systems also have a profound impact on society, economies and the environment, making them central to meeting multiple Sustainable Development Goals. **Over 2.5 billion people worldwide rely on agriculture for their livelihoods making the sector a key driver for development.**

Present patterns of energy use in agri-food systems point to regional disparities, lack of access to modern energy (especially in the developing world) and **continuing dependence on fossil fuels.**

The structure of energy consumption in food systems varies significantly between developing and developed countries. **In the latter, about 25% of total energy use occurs in the production stage (crop, livestock and fishery), 45% in food processing and distribution, and 30% in retail, preparation and cooking.**

Everything can be delayed, deferred , downsized except Food Production, rather there has to be **50 - 90% more Food Production by 2050** to feed the Growing Population. If higher Crop Production accounts further higher GHG Emission or Energy Usage **– Sustainability Will Be Severely Compromised or Affected.**

Most importantly More Output is required from Less or Same Inputs means Higher Energy Use Efficiency and that that too Clean Energy.

Energy Transition and Transformation of agri-food systems is crucial to meet the SUSTAINABLE DEVELOPMENT GOALS (SDGS). *(Source: Renewable energy for agri-food systems, 2021 by IRENA and the FAO, UN.)*

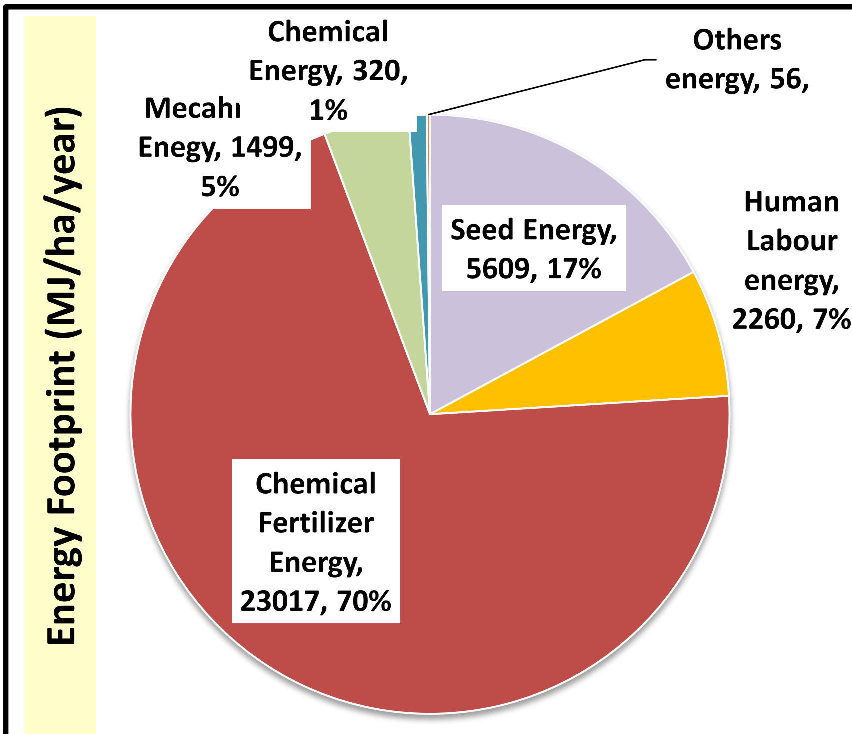
But Most importantly which forms of Energy should be taken for Transition?

Share of different Energy Inputs (Energy Input % Share) in Total Energy Usage for crop production under Conventional Farming Practice & under CFNZ Model under IRF Technology in 25.2 ha. area at Mandya, Karnataka under IBM-IORF Sustainability Project has been a audited for detailed assessment.

Input Energy	Conventional Farmers Practice (MJ/ha/year)	% Share
Seed Energy	5609	17.12
Human Labour Energy	2260	6.90
Chemical Fertilizer Energy	23017	70.26
Chemical Pesticide Energy	320	0.98
Mechanical Energy	1499	4.58
Others energy	56	0.17
Total Energy Input	**32761**	**100**

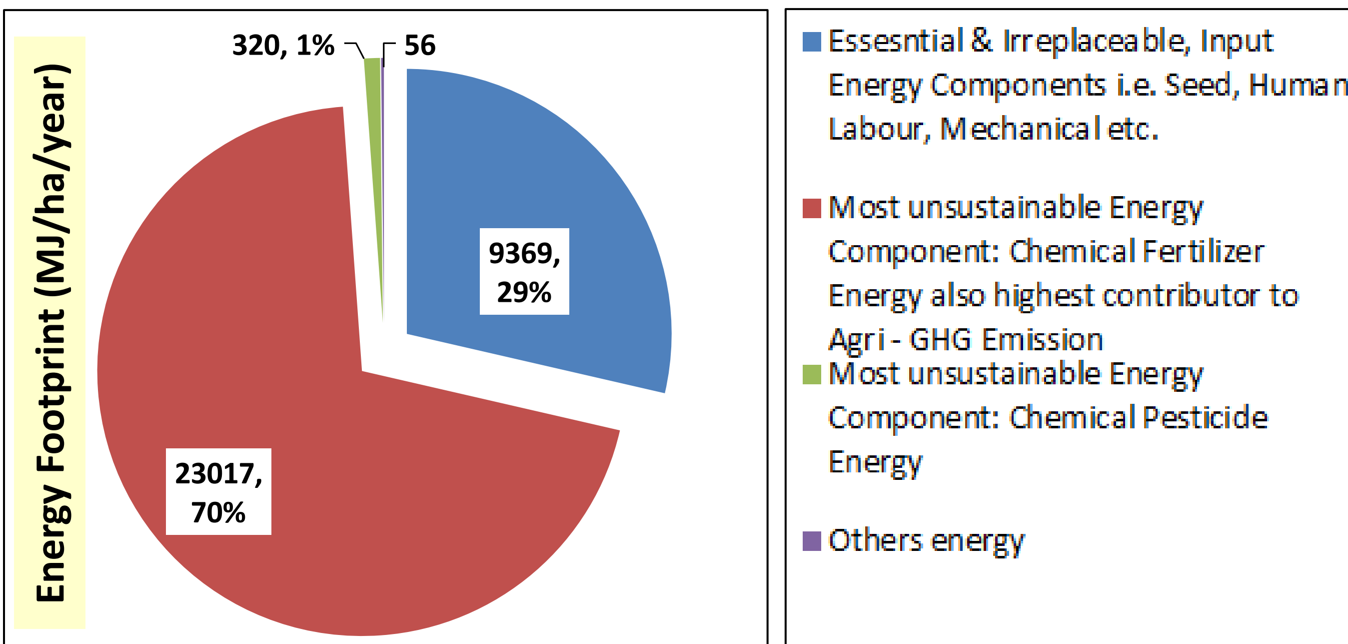
71% Share from two Major Unsustainable components, highly dependent on Fossil Fuels directly increases the GHG Footprint

Energy Audit under Conventional Chemical Farming, Mandya, Karnataka



Two Major Unsustainable Energy inputs i.e. **Chemical (Pesticide) Energy & Chemical Fertilizers, are** recognized as the most important factor contributing to direct N_2O and other GHG emissions from agricultural soil comprise – **71% Share of Total Energy Inputs under Conventional Farmers or Chemical Farming or Industrial Agricultural Practice (in 25.2 ha.).**

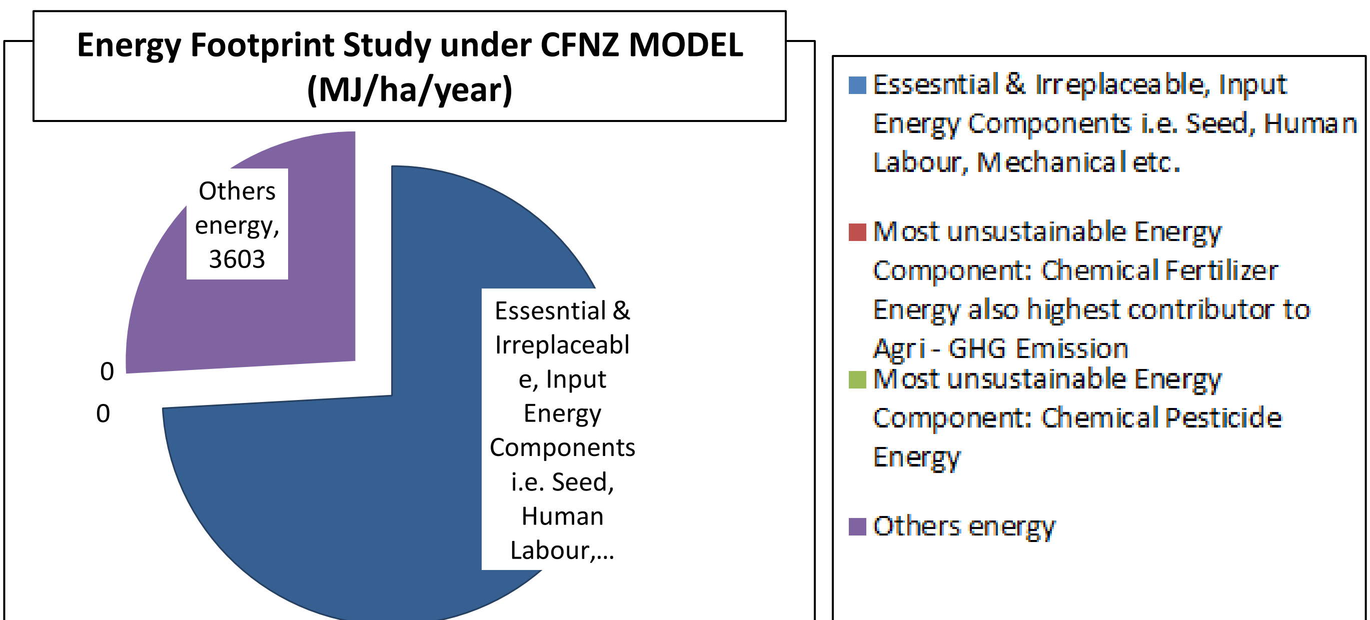
Essential & Irreplaceable, Input Energy Components i.e. Seed, Human Labour, Mechanical etc. under Conventional Farming Practice consume only 29% whereas rest 71% Energy Consumption due to only 2 major Energy Component: Chemical Fertilizer & Pesticides, that are Energy also highest contributor to Agri - GHG Emission. Even between the two alone chemical fertilizers consume 70% Energy.



Comparative Study of Total Energy Input under Conventional Farmers Practice vs. Inhana CFNZ Model under IRF Technology

Input Energy	Conventional Farmers Practice (MJ/ha/yr)	CFNZ MODEL under IRF Technology(MJ/ha/yr)
Seed Energy	5609	5609
Human Labour energy	2260	3124
Mechanical Energy	1499	1586
Chemical Fertilizer Energy	**23017**	**0**
Chemical Pesticide Energy	**320**	**0**
Others energy	56	3603*
Total Energy Input	**32761**	**13923**

*** The energy components related to adoption of Inhana Plant & Soil Health Management under CFNZ Programme (in 25.2 ha.) at Mandya, Karnataka has been included in the other energy, that are completely Renewable Energies.**



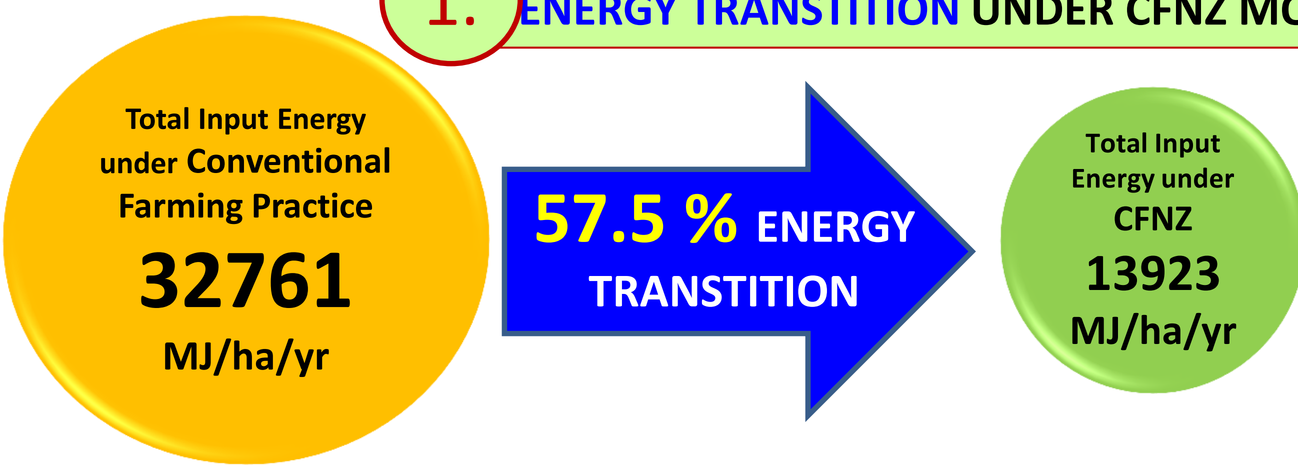
100 % ENERGY TRANSTITION in terms of the two most unsustainable Energy Components Chemical Fertilizer Energy & Chemical Pesticide Energy

57.5 % ENERGY TRANSTITION in total (MJ/ha/year) under CFNZ MODEL

KEY OUTCOMES : 25.2 ha. CFNZ MODEL

Inhana CFNZ Programme at Mandya, Karnataka with 100% Reduction of both N-Fertilizer and Chemical Pesticides conclusively demonstrates SAFETY & SUSTAINABILITY enabled by the interventional IRF Technology a benchmark criteria for SUSTAINABLE AGRICULTURE.

1. ENERGY TRANSTITION UNDER CFNZ MODEL



ENERGY TRANSITION, 57.5% SHIFT to RENEWABLE ENERGY SOURCES

Net 475 Gigajoules Energy Saving from **25.2 ha.** **due** to adoption of CFNZ Model under IRF Technology .

KEY OUTCOMES : 25.2 ha. CFNZ MODEL

2. GHG TRANSTITION UNDER CFNZ MODEL

Conventional Farming Practice
(+)1.47 mt CO_2e/ha

171 times
GHG Savings

CFNZ
(-) 250.08
mt CO_2e/ha

Net Carbon Footprint Achieved from 25.2 ha. : **(-) 6339.06 mt CO_2e** & **Net GHG Savings: (-) 251.55 mt CO_2e/ha**

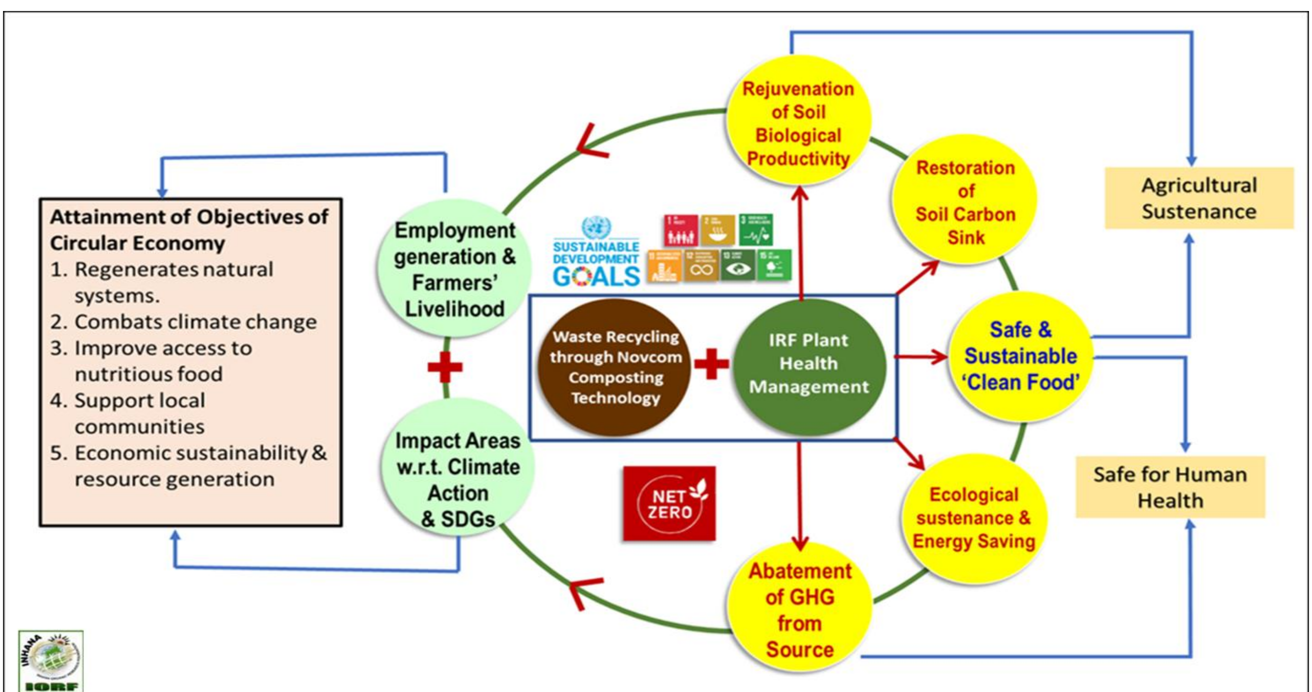
- **Stops GHG Emission from SOURCE** → GHG Omission → Use of Novcom Composting Technology for Effective Bio-conversion of **WASTE**– **Very High GHG (METHANE) Emitter**
- **Enable GHG Mitigation by improving Soil- C Sequestration & Removing N- Fertlizers** → GHG Mitigation → **Waste Bio converted Novcom Compost** application in **AGRICULTURALLY DEGRADED SOIL** to **RESTORE SOIL- C SINK** **& ELIMINATE N- FERTILIZERS** from Crop Cultivation
- **Captures Atmospheric- C through Improved Plant Photosynthesis leading to Higher Crop Yields** ***(Resilient to Climate Change)*** → GHG Adaptation → Inhana Plant Health Mgt. to ensure **HIGHER CROP YIELDS with Elimination of Chemical Pesticides**

1st Model for AGRICULTURE NET ZERO

CLEAN FOOD 'NET ZERO' MODEL

Numero- Uno Climate Action Model in the Food & Agriculture Sector

- **GHG OMISSION from Source** → Omitting emission through bioconversion of land fill material
- **GHG MITIGATION**
  - → Incorporation of Org. Matter & Org.-C in Soil through Bio-converted Waste material
  - → Regeneration of the Largest-C Sink
- **GHG ADAPTATION** → High Biomass/ Crop Production with Lesser C-Input
- **Reclamation of DEGRADED SOIL** → Inoculation of 40 Trillian billion self-generated microbial population.
- **Model for SAFEST & SUSTAINABLE Agriculture**
  - → Intervention of Safe & Sustainable IRF Technology
  - → NO HIKE **in the Cost of Production**
- **Transformation of GHG Emitting Agriculture to GHG OMITTED AGRICULTURE** → Elimination of fertilizers & Synthetic Pesticides **through Inhana Soil & Plant Health Management**
- **CLIMATE NEUTRAL FOOD**
  - → Safest for Human Health
  - → Safest for Soil
  - → Safest for Environment



Agricultural GHG emissions of the project, were calculated using the **Sustainable Agriculture Carbon Footprint Assessment (SACFA) Toolkit developed & certified by i-NoCarbon Limited, UK.**

i-NoCarbon Limited
Change Today for a Better Tomorrow
59, Harfield Road, Sunbury on Thames, TW16 5PT, The UK

The **SACFA Toolkit** has been developed based on the Agriculture Carbon Footprint Assessor (ACFA) Standards – version 1.0 expounded by Inhana Organization Research Foundation (IORF) in association with **i-NoCarbon Limited** (based on relevant IPCC Guidelines and empirical scientific research works).

i-NoCarbon Limited from London played a pivotal role in the "Clean Food – Net Zero" (CFNZ) Program by leveraging their expertise in developing carbon calculator (SACFA). Recognizing the global shortage of carbon footprint calculators in the realm of sustainable agriculture, and the crucial relevance of the ACFA Standards being developed by IORF, their involvement helps fill this vital gap.

Sustainable Agriculture Carbon Footprint Assessment (SACFA) Toolkit is a pioneering initiative in the domain of truly Sustainable Agriculture – measuring the actual abatement of GHG emission from a shift of agricultural practices.

A noteworthy aspect of the "Clean Food – Net Zero" (CFNZ) Program is its dual impact of **delivering safe food and empowering farmers while also making significant strides in climate action.** Specifically, it contributes to the mitigation of greenhouse gas emissions, amounting to **an impressive 251.5 mtCO2e per hectare.**

Notably, a substantial portion of this remarkable GHG emission reduction comes from preventing methane emissions, which is a particularly concerning greenhouse gas due to its transformation in the atmosphere into CO2, water vapor, and tropospheric ozone—all of which are hazardous to terrestrial life forms. These emissions are mainly curbed at their source, which includes previously undiagnosed agricultural landfill waste like Coir Pith.

Clean Food 'Net Zero' has been validated and certified using the SACFA toolkit.

Introduction | Farm/Project Details | Carbon Footprint Conventional | Carbon Footprint CFNZ of IORF | Net GHG Abatement | References | SACFA CERTIFICATE | FAQ / F1 Help

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SACFA Toolkit

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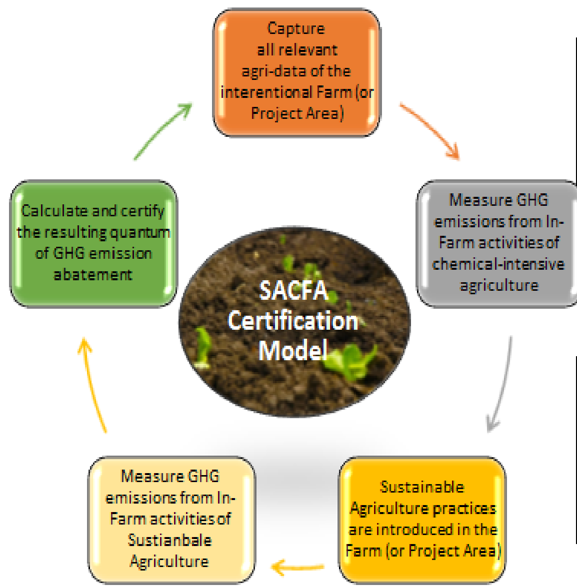
CARBON FOOTPRINT ASSESSMENT (SACFA)

Inhana Organic Research Foundation
IN HArmony with NAture

Welcome to the **i-NoCarbon Sustainable Agriculture Carbon Footprint Assessment (SACFA) Toolkit** for farmers and growers.
This toolkit has been released for use by licensee only. The fuller version comes with detailed carbon emission calculations.

Sustainable Agriculture Carbon Footprint Assessment (SACFA) Toolkit is a pioneering initiative in the domain of truly **Sustainable Agriculture**
- measuring the actual abatement of GHG emissions from a shift of agricultural practices.

Agriculture is the second highest emitting sector, accounting for > 20% of global GHG emissions.
Climate Change, in turn, adversely affects agricultural systems and food production!



Agriculture GHG emissions are "impossible to abate"
due to our own food security.
As the global population increases, food production needs to increase from a fixed amount of agricultural land, which is often degraded.

The **SACFA Toolkit** has been developed based on the Agriculture Carbon Footprint Assessor (ACFA) Standards – version 1.0 expounded by Inhana Organization Research Foundation (IORF) in association with **i-NoCarbon Limited** (based on relevant IPCC Guidelines and empirical scientific research works).

Legends used in calculating worksheets

Instructions / Guidance	Cells for data input	Calculated figures	Output/Index Data

Please note that you can press [F1]

Disclaimer

The accuracy of the input data used in this Sustainable Agriculture Carbon Footprint Assessment (SACFA) Toolkit rests with the user. Only authorized personnel of i-NoCarbon are permitted to generate the SACFA Certificate from this toolkit. i-NoCarbon Limited will not be liable for any errors, omissions, or damages of any kind arising from the use of this calculator, including but not limited to direct, indirect, incidental, punitive or consequential damages.

Release Date
10 December 2023

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GHG Emission from Conventional Agriculture

Inhana Organic Research Foundation
IN HArmony with NAture

Carbon Footprint of agricultural practices under Chemical-intensive Agriculture or Organic Agriculture

The rationale behind GHG emissions calculations for the respective agricultural activities is provided separately in the sections "IPCC Ref" and "Non-IPCC Ref" under **References**.

For the numeric values of GHG Emissions, the +ve sign signifies a net emission while the -ve sign signifies a net sequestration/abatement for the respective agricultural activity.

Sl	Farm Operations under Chemical Farming	Chemical Intensive Agriculture	GHG (mt CO_2e/ha)
1	Seed Treatment, Bed Preparation & Nursery Mgt.		0.010
2	Land Preparation		0.076
3	Transplanting		0.007
4	Irrigation		0.256
5	Crop Management (under Farmer's Practice)		
	Crop Nutrients - Ferlilizers as per farmers practice	*Chemical Fertilizer Application*	1.847
	Crop Protectants - Pesticide as per farmers practice	*Chemical Fungicides, Insecticides Application*	0.015
6	Weed Management		0.006
7	Cultural Practice		-
8	Methane Generation		0.538
9	Carbon from Biomass		(1.288)
10	Harvesting		0.001
		Conventional Farmers' Practice (Chemical Fertilizers & Pesticides) Carbon Footprint (mtCO_2e/ha)	**1.468**

Sl	Farm Operations under Organic Farming	Conventional Organic Agriculture	GHG (mt CO_2e/ha)
1	Seed Treatment, Bed Preparation & Nursery Mgt.		
2	Land Preparation		
3	Transplanting		
4	Irrigation		
5	Crop Management (under Farmer's Practice)		
	Crop Nutrients - Ferlilizers as per farmers practice	*Compost/Bio-Fertilizer Application*	
	Crop Protectants - Pesticide as per farmers practice	*Bio-Fungicides, Bio-Insecticides Application*	
6	Weed Management		
7	Cultural Practice		
8	Methane Generation		
9	Carbon from Biomass		
10	Harvesting		
		Conventional Organic Practice Carbon Footprint (mtCO_2e per ha)	-

Total Carbon Footprint (+) / Sequestered (-)	1.468

Introduction | Farm/Project Details | Carbon Footprint Conventional | Carbon Footprint CFNZ of IORF | Net GHG Abatement | References | SACFA CERTIFICATE | FAQ / F1 Help

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GHG Emission from CFNZ

Inhana Organic Research Foundation
IN HArmony with NAture

IORF

Carbon Footprint of agricultural practices under truly Sustainable Agriculture of IORF

The rationale behind GHG emissions calculations for the respective agricultural activities is provided separately in the sections "IPCC Ref" and "Non-IPCC Ref" under **References**.

For the numeric values of GHG Emissions, the +ve sign signifies a net emission while the -ve sign signifies a net sequestration/abatement for the respective agricultural activity.

Sl	Farm Operations under CFNZ	INHANA Rational Farming (IRF) Technology of IORF	GHG (mt CO_2e/ha)
1	Seed Treatment, Bed Preparation & Nursery Mgt.	Under IRF Technology	0.002
2	Land Preparation		0.076
3	Transplanting		0.007
4	Irrigation		0.256
5	Crop Management (under CNFZ Model)		
	Inhana Soil Health Mgmt (ISHM) - Nutrient Mgt. Novcom Coir pith Compost	*Novcom Compost Application*	(248.885)
	Inhana Plant Health Management (IPHM)	*First & Unique concept introduced under IRF Technology*	0.004
6	Weed Management		0.001
7	Cultural Practice		-
8	Methane Generation		0.881
9	Carbon from Biomass		(1.290)
10	Harvesting		0.001
11	*C- Sequestration due to Land Use Change*		(1.130)
		Clean Food Net Zero IRF Tech Carbon Footprint (mtCO_2e/ha)	(250.077)

Clean Food 'Net Zero' has been validated and certified using the SACFA toolkit.

Introduction | Farm/Project Details | Carbon Footprint Conventional | Carbon Footprint CFNZ of IORF | Net GHG Abatement | References | SACFA CERTIFICATE | FAQ / F1 Help

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Net GHG Abatement

Inhana Organic Research Foundation
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Net Carbon Emission abatement for the shift in agricultural practices of the Farm (or Project Area)

The rationale behind GHG emissions calculations for the respective agricultural activities is provided separately in the sections "IPCC Ref" and "Non-IPCC Ref" under **References**.

For the numeric values of GHG Emissions, the +ve sign signifies a net emission while the -ve sign signifies a net sequestration/abatement for the respective agricultural activity.

Sl	Farm Operations	INHANA Rational Farming (IRF) Technology of IORF	GHG (mt CO_2e/ha)		Carbon Footprint - Conventional			Carbon Footprint CFNZ Model
				FORMULATED FROM	Chemical	Organic	AGAINST	
1	Seed Treatment, Bed Preparation & Nursery Mgt.	Under IRF Technology	(0.008)		0.010	-		0.002
2	Land Preparation		-		0.076	-		0.076
3	Transplanting		-		0.007	-		0.007
4	Irrigation		-		0.256	-		0.256
5	Crop Management (Farmer's Practice & CFNZ)							
	Crop Nutrients Management	*Novcom Compost Application*	(250.732)		1.847	-		(248.885)
	Crop Protection/ Management	*First & Unique concept introduced under IRF Technology*	(0.011)		0.015	-		0.004
6	Weed Management		(0.005)		0.006	-		0.001
7	Cultural Practice		-		-	-		-
8	Methane Generation		0.343		0.538	-		0.881
9	Carbon from Biomass		(0.002)		(1.288)	-		(1.290)
10	Harvesting		-		0.001	-		0.001
11	*C- Sequestration due to Land Use Change*		(1.130)					(1.130)
		Net GHG emissions abatement achieved (mtCO_2e/ha)	**(251.545)**		**1.468**	-		**(250.077)**

Ref: SACFA/0923/001

Period Certified: 03 October 2023
To: 02 October 2024

SUSTAINABLE AGRICULTURE CARBON FOOTPRINT CERTIFICATE

This document certifies that the agricultural GHG emissions of the project were calculated using the **Sustainable Agriculture Carbon Footprint Assessment (SACFA) Toolkit developed by i-NoCarbon Limited**.

Farm/Project Name & Location	**IBM-IORF Sustainability Project at Mandya District, Karnataka, India**
Project Details	**Clean Food – Net Zero (CFNZ) Project in 25.2 ha area using NOVCOM Coir Pith compost under INHANA Soil Health Management (ISHM) & Inhana Plant Health Management (IPHM), through Inhana Rational Farming (IRF) Technology of Inhana Organic Research Foundation (IORF), Kolkata, India (Phase II : 2022 - 2023).**

Chemical-Intensive Agriculture was practised in the above project area wherein Sustainable Agriculture under IRF Technology was introduced and the Carbon Footprint from on-farm activities were calculated using the **SACFA Toolkit** for both the practices:

Erstwhile Agricultural practice followed:	**Conventional (Chemical Fertilizers & Pesticides)**
Erstwhile Carbon Footprint:	**(+) 1.468 mt CO_2e/ha**
Present Agricultural practice followed:	**Inhana Rational Farming (IRF) Technology**
Present Carbon Footprint:	**(-) (250.077) mt CO_2e/ha**

Carbon Footprint Reduction / Sequestration	from	**25.20 ha**	**(-)**	**6,338.934**	**mt CO_2e**

This means that this IBM-IORF Sustainability Project has shown the potential of **REDUCING**

251.55 mt CO_2e/ha

for such De-carbonization Programme towards Net Zero compliance.

Vijay L Narasimhan

Authorised Signature

Date of Issue: 03 October 2023

i-NoCarbon Limited
Change Today for a Better Tomorrow!
Sunbury-on-Thames, United Kingdom

This **SACFA Toolkit** has been developed based on the **Agriculture Carbon Footprint Assessor (ACFA)** Version 1.0 expounded by **Inhana Organization Research Foundation (IORF)** in association with **i-NoCarbon Limited (i-NC)** (based on relevant IPCC Guidelines and empirical scientific research works).

This assessment was carried out remotely, using data provided by the client. All obligations of the accuracy of the data rest with the client.

Vers: 2023/iNC-EdQu/v2