Effective and Economically Viable Organic Agriculture under Inhana Rational Farming (IRF) Technology – A Potential Alternative to Support India Organic Movement

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ABSTRACT

Organic farming has been identified as the road map for food sovereignty, economic security, and alleviation of food toxicity. And, with changing climatic patterns it has become more of a necessity for harnessing both mitigation and adaptation potentials. For sustainable agriculture qualitative developments of soil has been prioritized. But it has been a time taking process, moreover; component wise redressal has not provided much relief considering that still now not even 1% of total agricultural production world over is organic. To reach the objective in a time bound manner, besides healthy soil, healthy plant system has become pre-requisite, as also supported by 'Trophobiosis theory' of French scientist F. Chabassou (1985) that depicts 'Healthy Plants' as the trump card for successful agriculture. There has been need for a method/ practice/ technology which can etch out the scientific road map towards the objective, at the same time should be Safe, Effective, Complete, Convenient and Economical; i.e., the five foundation pillars for ensuring large scale adoptability.

Inhana Rational Farming (IRF) Technology a comprehensive organic package of practice (POP) was developed by Indian Scientist Dr. P. Das Biswas, and has been ensuring sustainable agriculture for more than a decade now. Production of approximately 2.0 million kg certified organic teas annually in a cost- effective manner substantiates its efficacy while recognition of West Jalinga as 'World's 1st Carbon Neutral, Organic Tea Garden' evidences its GHG mitigation and carbon sequestration potentials. FAO-CFC-TBI Project entitled 'Development, Production and Trade of Organic Tea' (at Maud Tea Estate, Assam; period: 2008-2013) provided opportunity to test IRF Technology in terms of yield, soil development and economics as compared to all other available organic methods/ POP. Highest yield, speedy soil quality rejuvenation was recorded under IRF Technology at lowest economics and under all growth phases of tea plant *viz.* mature, young, newly planted and nursery.

The comprehensive process of soil and plant energization i.e. invigorating the native soil microflora as well infusion of deficient energy for plant metabolic functions has ensured the universality of IRF Technology. Projects undertaken in collaboration of State/ Central Agricultural Universities and Krishi Vigyan Kendra in a wide variety of field crops *viz.* cereals (rain fed and winter paddy, baby corn), pulses (green/ black gram), vegetables (tomato, potato, okra, cauliflower, cabbage, chilli, radish etc.) and exotic vegetables (horse radish, celery, Chinese cabbage, pak choi, broccoli, parsley etc.); have substantiated technological effectiveness. These field trials in diverse ecological regions of West Bengal

indicated that yield sustenance/ hike is possible under organic, even from the very first year, and can ensure economic security even without any support price for organic.

To evaluate the status of developments proposed under IRF Technology and standardize various components of crop production, several tools have also been developed *viz.* Compost Quality Index, Soil Quality/ Development Index, SWOT Study, Crop Pesticide Pollution Index, Pesticide Load on Crop, Soil Pesticide Pollution Index, etc.

The initiatives and experience under IRF Technology indicate that it can be used as a potent weapon for economically viable, large scale and energy efficient organic farming; especially relevant with India's commitment towards climate change and GHG mitigation and for tapping the growing export potentials.

Key words : sustainable organic, plant management, carbon neutral, economic security

INTRODUCTION

High energy intensive farming had resulted in spectacular crop production. But in the process, degradation of the natural resource bases on which agriculture rests; has also been phenomenal. In the ensuing scenario of crop un-sustainability, increasing input requirement, poor soil quality as well as recurrent pest and disease infestation, and especially in the pretext of climate change; need for a nature friendly Package of Practice (POP) has been strongly felt. Organic has been identified as the Road Map for sustainability (Mader et al, 2002), but despite all awareness and the growing compulsion; the organic food basket remains deficient. This is because good soil quality has been indicated as the foundation for healthy plant growth. But in the event of resource scarcity as well as lack of consciousness regarding compost quality; restoration of soil quality has been a difficult and time taking process. For simultaneous mitigation of the critical issues of balanced crop nutrition and effective pest control under organic management, the soil management exercise has to be backed by specific programme towards development of plant health. Inhana Rational Farming (IRF) Technology focuses on the development of 'Healthy Plants', in conformity to the Trophobiosis Theory of F. Chabossou; which indicates that 'Pest starve on healthy plants'. The technology is based on the Element Energy Activation (E.E.A.) Principle and focuses on conjugative rejuvenation of soil and plant, through infusion of the required energies (Barik et al, 2014a). Higher nutrient use efficiency, sustained yield, soil quality development and decline in pest/ disease incidence have indicated that successful organic is possible and without any time lag provided we shift from the compartmental approach and undertake a comprehensive scientific pathway. Also associative projects with state and central agricultural universities have repeatedly demonstrated that quality compost (produced through Novcom composting Method) can mitigate the issue of resource scarcity by enabling lower dosage requirement also facilitated by plant rejuvenation programme towards higher nutrient use efficiency (Barik et al, 2014b; Sarkar et al, 2014; Chatterjee et al, 2014 and bera et al, 2014). The present paper is a scientific documentation of the successful and cost-effective organic farming under IRF Technology.

MATERIALS & METHODS

Inhana Rational Farming Technology that aims at developing healthy plants; bears the essence of Trophobiosis theory. The technology reaches to the root cause of pest interference and works towards amelioration of factors that favourably signals pest/disease advances.

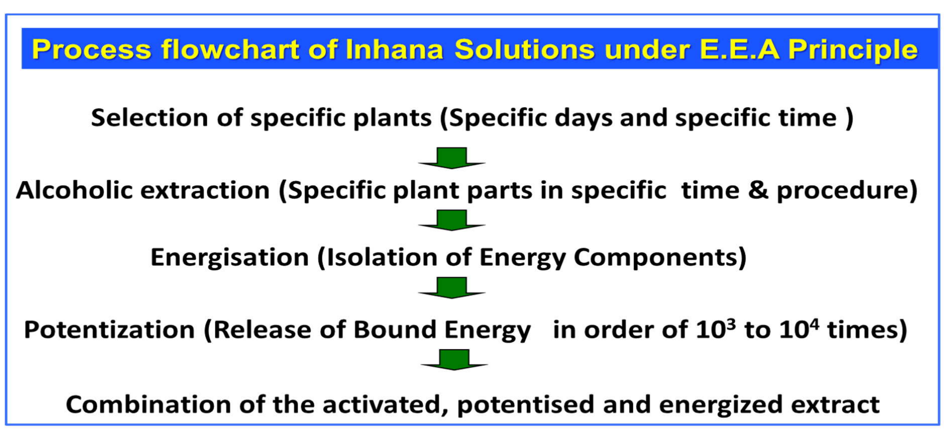
The hypothesis : Adoption of organic plant managements towards re-activation of plant bio-chemical functions can directly compliment plant health while indirectly ensuring lesser pest interference; as pest starve on healthy plants (Paull, 2007). According to the trophobiosis theory of F. Chaboussou (Chaboussou, 2004), pest and disease set in with increase in free amino acids and reducing sugars pools in plant cell sap. The phenomenon usually occurring whenever plant metabolism becomes impaired due to biotic and abiotic factors, excess fertilization specially with nitrogenous fertilizers and application of systemic fungicides/pesticides etc. (Dias, 2012). Hence, better plant health *vis-a-vis* lesser pest incidence along with supportive soil functions can ensure the crop objective and economic balance in agriculture.

Journey of IRF Technology : Inhana Rational Farming (IRF) Technology developed by an Indian Scientist, Dr. P. Das Biswas was introduced as a complete package of practice in 2001 in tea. His in-depth research on vedic philosophy and its logical sublimation with modern science revealed that Elements are not deficient, they are just de-activated under chemical bombardment. But there is scope for re-activation of elements; provided a process of energy infusion was adopted. This led to development of 'Energy Solutions' in the backdrop of Element–Energy–Activation (E.E.A.) Principle, which provided complete cure for problems related to soil and plant, besides triggering the preventive mechanisms.

After successful demonstration of IRF in tea, organic package of practice (POP) for cereals, pulses, vegetables, oilseeds, fruits and flowers were developed. Effectivity of these POP's have been successfully demonstrated since 2008; majorly in farmers' field in collaboration with Calcutta University, Visva Bharati University, Bidhan Chandra Krishi Viswavidyalaya, and Krishi Vigyan Kendra (ICAR). Panchayats and farmers' co-operatives are also involved in some of these important organic exercises.

Inhana Rational Farming Technology : Inhana Rational Farming Technology (IRF) is a comprehensive organic POP aiming at restoration of soil and plant health that simultaneously deflates pest pressure due to alleviation of factors responsible for pest – parasite interactions (Bera et al, 2014). 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 (Barik et al, 2014). 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 in the order of 10^{16} c.f.u.) (Seal et al, 2012); different types of herbal concoctions and adoption of cultural practices. However, the technology emphasizes plant management as a precursor for resilient plant system that can ensure sustainability even under changing climatic patterns. Plant management under this technology is a systemic approach that utilizes a set of potentized and energized botanical solutions developed on 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 towards 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.

Science behind Element Energy Activation Principles (EEA) : Plants are the major life forms, which can receive/ trap energy, transform it into chemical energy, can store the energy both in gross (matter) form and subtle form. The energies stored in subtle nature is in the form of lifetrons, which are much finer than atomic forces. These lifetrons are changed into electrons, protons and atoms at the time of the activation of the matter. Hence, the binding energy stored in the subtle manner in the plant system can be tremendous life force if separated by a fraction. These are again naturally accepted by any other plant system because the matter remains the same. Potentization further enhances the activation potential because of separation of the life forces present as the binding energies changes into the lifetrons or their original/ basic state or intelligent cosmic energy. The basic life forces or energy becomes differential when they interact with the basic elements and thus forms five life forces. In the energy extraction method, the individual energies are isolated and potentized (releasing binding energy from the mass).



Pic. 1 : Flow Diagram of production of Inhana Solutions under EEA Principle

Energy specific plants which store the radiant solar energy or the basic life force in differential forms can serve as a potential medium of energy components, which when released at the right time and in the right proportion can make matter (hereby the plant physiological functions) functional at the desired level and to restore equilibrium.

Working mechanism of IRF Technology : IRF Technology works towards attending two basic mechanisms of plant system, i.e.

(i) **Self Nourishment** & (ii) **Self- Protection**

SELF - NOURISHMENT : Five basic elements (Panchamahabhutas) Soil, Air, Water, Fire and Space take care of nourishment. The individual element responsible for specific mechanism of nourishment are as follows:

Earth : Nutrition and structure formation.
Water : Transportation of nutrients and transpiration.
Fire : Metabolism, Ripening of fruits and Photosynthesis.
Air : Respiration.
Space : Making space for bio-chemical reactions and growth of plant.

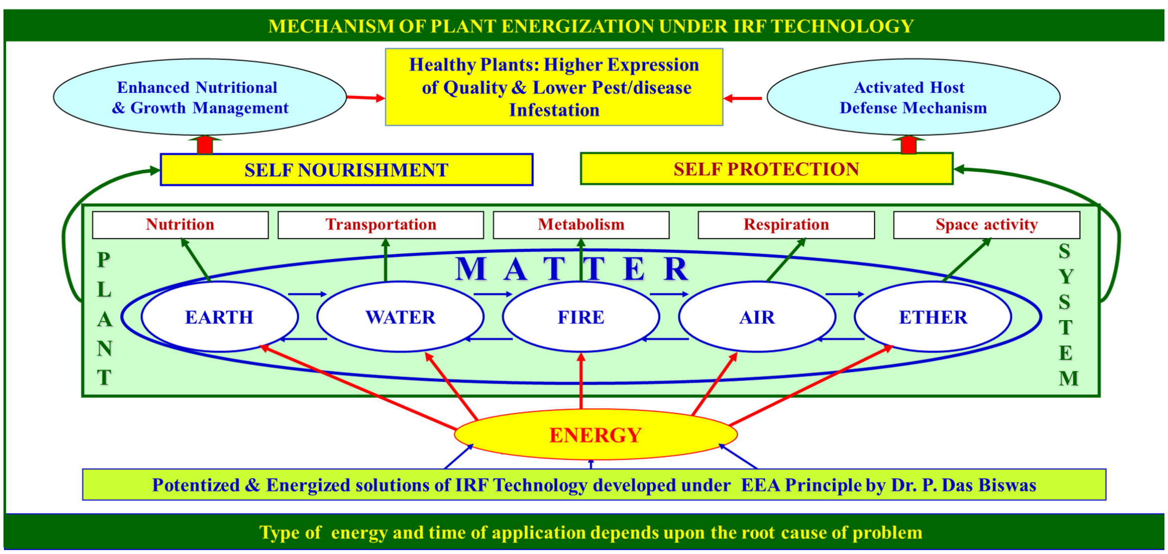


Fig. 1: Role of different energy on plant functioning.

SELF – PROTECTION : The self-defense mechanism is controlled by five different Life Forces or Prana-Shaktis. Their roles in the plant system are as follows:

Apana Prana : Controls the function of root extraction of nutrients.
Samana Prana : Controls transpiration.
Udana Prana : Controls Photosynthesis and secretion of enzymes, hormones.
Prana Prana : Controls respiration & eases movement of respiratory products.
Vyana Prana : Makes space available for all functions.

If there is any imbalance in sub- functions like Transportation, Circulation, Metabolism etc., then the whole system tries to protect itself with the added Energy if provided at right time.

ECCES Model : Economically sustainable organic farming in a time bound manner demands a comprehensive approach and only the practice which can best utilize the potential of nature, can ensure the objectives. As we understand scientifically that potentials of various individual organic inputs (as revealed from the soil input experiments), does not necessarily provide additive effect when they are combined together, therefore their effectiveness need to be judged on the basis of their performance as a complete organic package.

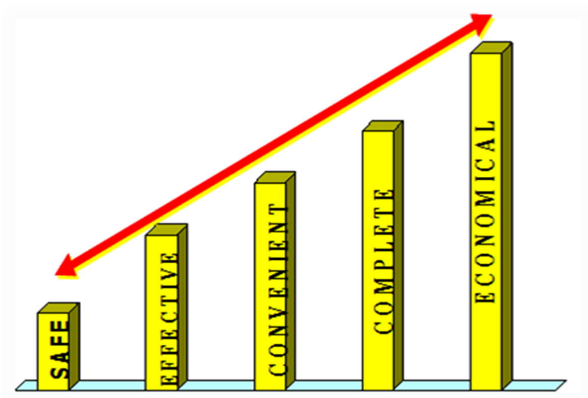


Fig. 2 : ECCES Test for validation of any Organic Package of Practice

ECCES Model indicates that for successful organic farming, selected organic package of practice should be (i) Safe, (ii) Effective, (iii) Convenient, (iv) Complete and (v) Economical.

IRF Technology is perhaps the only method so far that exhibits full compliance to all the five criteria deemed necessary for large scale adoption.

RESULTS & DISCUSSION

1.0 Performance of IRF Technology in Tea

1.1.1 Conversion of West Jalinga Tea estate to Organic Tea Estate with adoption of IRF Package of Practice : Located in the Barak valley of Assam, West Jalinga tea estate was plagued by the usual problems of low yield, severe termite infestation and sandy soil. IRF Technology was introduced in 2001 and during the conversion, no crop loss was experienced; rather 16 % yield increase was noticed in the 1st year of conversion.

Pic. 2 : Large scale on-farm production of compost using Novcom method. The process enables stable, mature and non-phytotoxic compost within a short period of 21- 30 days utilizing any type of biodegradable matter. Quality analysis reveals very high self -generated microbial population in the order of 10^{16} cfu.

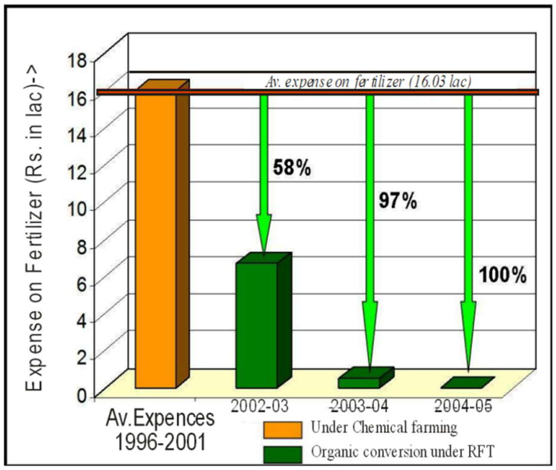


Fig. 3 : Reduction in Expense on Chemical Fertilizer during Organic Conversion

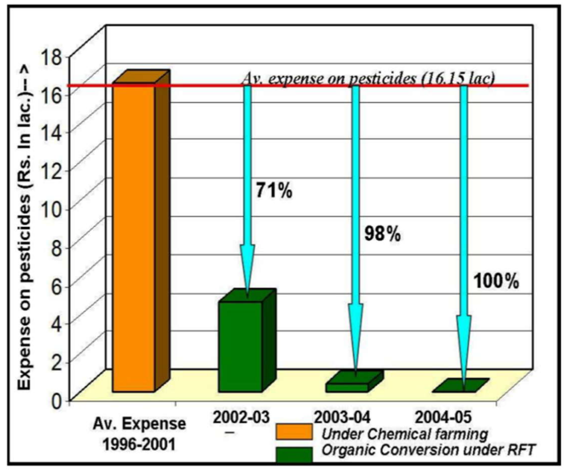


Fig. 4 : Reduction in Expense on Chemical Pesticides during Organic Conversion

When even 10% reduction in chemical fertilizer poses threat towards crop and economic sustainability, expense on fertilizer and pesticide could be reduced by 58 percent and 71 percent respectively even in the very first year under IRF Technology. The garden was converted to 100 percent organic in 2004-05.

1.1.2 Yield Sustainability under of IRF Technology at West Jalinga T.E. : Average crop productivity in West Jalinga tea estate under Inhana Rational Farming (average 1384 $kgha^{-1}$) is higher (Fig. 5) than the average yield obtained under conventional farming (average 1358 $kgha^{-1}$). The primary reason behind this achievement is the high agronomic efficiency of the bushes (Fig. 6), as brought about by IRF Plant Management Package, which strive towards activation of plant physiology.

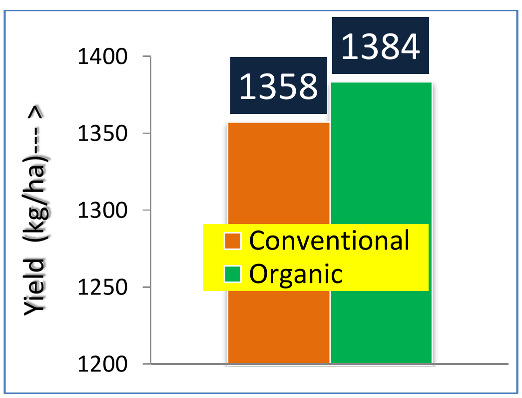


Fig. 5 : Comparative Crop productivity under Conventional and IRF Technology at W. Jalinga T.E.

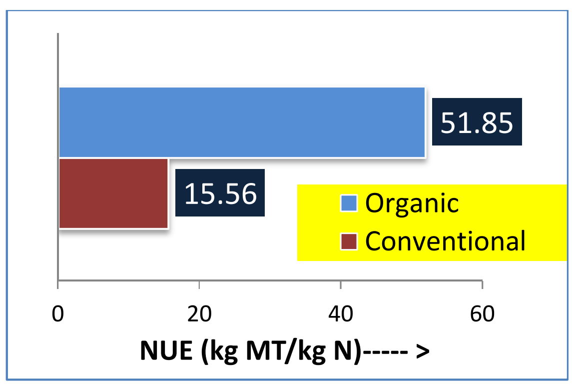


Fig. 6 : Comparative Nutrient Use Efficiency under Conventional and IRF Technology at W. Jalinga T.E.

The significant fact remains that crop sustenance for the last 13 years has been achieved through 86 percent lower dose of N, as compared to that applied under conventional practice;

and with no application micronutrient, growth promoter or hormones**.** These factors ultimately influence cost of production (COP) and presently COP of W. Jalinag T.E. is even lower than similar productive conventional gardens.

1.1.3 Soil Quality Improvement and Enhancement of Biodiversity : Study reveals that adoption of an effective soil management programme under IRF Technology for last 13 years has led to significant increase in the soil microbial population. These being the primary driving force behind efficient soil-plant-nutrient dynamics, that is pre-requisite for crop sustenance even at only 1/3rd dosage of Novcom compost. Biodiversity monitoring study by Department of Ecology and Environmental Science (Assam University) in 2004 and 2014 showed significant improvement of ecological components under IRF Technology (Fig. 7, 8).

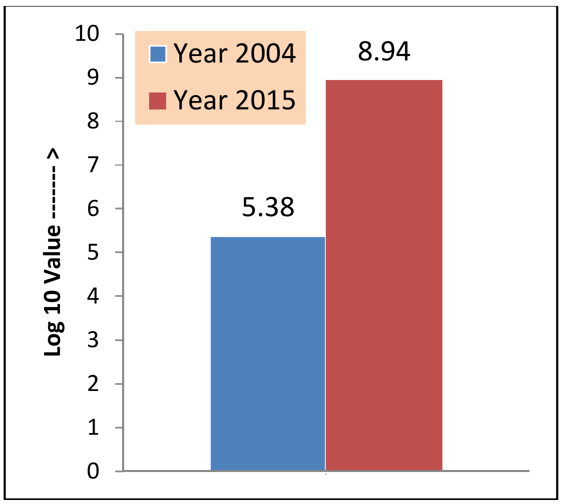


Fig. 7 : Enhancement of Soil Microbial population at W. Jalinga T.E.

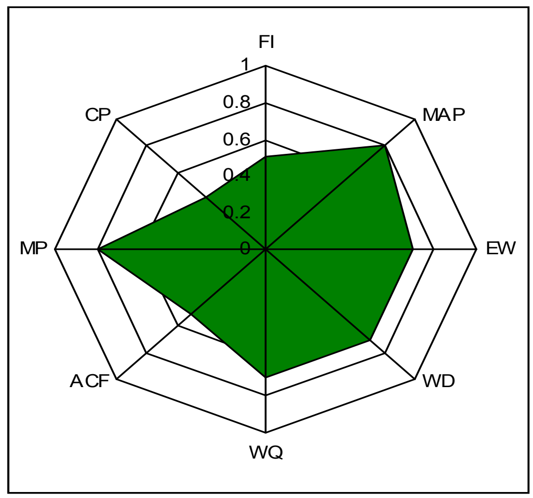
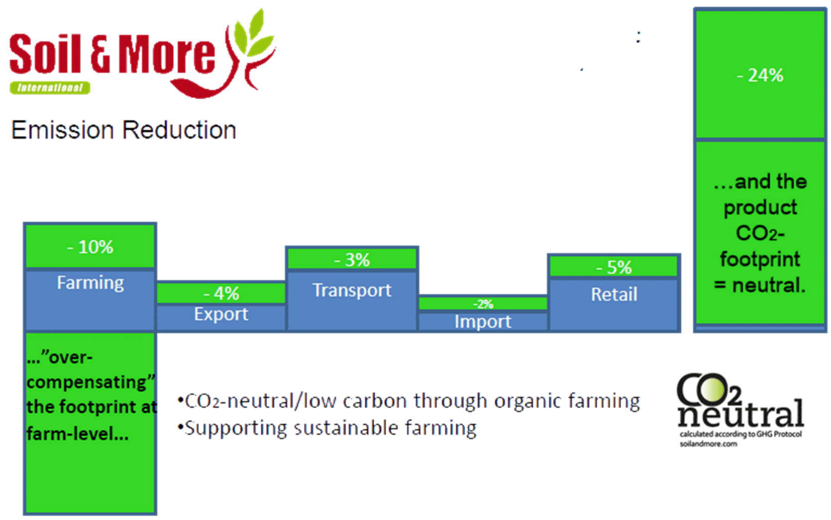


Fig. 8 : Biodiversity Marker Study at W. Jalinga T.E.

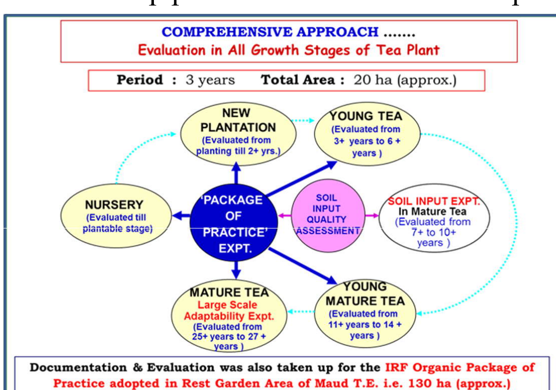
Biodiversity Marker study also showed considerable development of ecological components, which in turn helps to sustain productivity due to better soil-plant-nutrient interaction; pest-predator dynamics; soil microbial efficiency and transfer of energy in ecological food chain, etc.

1.1.4 Achievement of Carbon Neutral Status : West Jalinga tea estate become world's first carbon neutral tea estate, which was the ultimate recognition of adopting a sustainable organic practice for the last 15 years. Effort towards minimization of non-renewable resources and rejuvenation of soil quality through on- farm resource renewal helped towards the objective . This was well collaborated by activation of plant physiology in order to increase plants' nutrient uptake and utilization efficiency as well as restoration of their inherent host-defence mechanism against pest and disease.



Pic 3 : GHG mitigation and carbon sequestration assessment towards conferment of CO_2 neutral status to West Jalinga Tea Estate.

1.2 FAO-CFC-TBI Project (2009-2013): The study at Maud tea estate, Assam; India under the project was aimed at finding out an effective pathway for sustainable organic tea production through evaluation of different organic methods/ 'Packages of Practice (POP)' under all stages of tea growth (Fig. 9). All available organic methods *viz.* Biodynamic Farming (BD) and Inhana Rational Farming (IRF), which are practiced in organic tea gardens in India in reasonably large scale, were taken up for evaluation. Different organic inputs *viz.* vermicompost, bio-fertilizers, bio-pesticides, herbal formulations, etc., which are used in Indian tea industry or agriculture were also taken up for study. However, these inputs were not studied individually but combined to form different POP based on scientific rationale. The POP were evaluated in terms of meeting target yield, their efficiency over control, soil development and finally economic viability. Also different on- farm composting methods were evaluated in terms of speed, cost and end product quality. Finally these inputs along with oil cake and bio-fertilizers were evaluated for their post application effectiveness in terms of crop performance and soil development.



Treatment Details

1. IRF-2 : Inhana Rational Farming with 9 ton Novcom Compost
2. IRF-4 : Inhana Rational Farming with 6 ton Novcom Compost
3. VMI : Vermicompost + Microbial Forms for Soil & Plant Mgt.
4. VMIP: Vermicompost + Microbial Forms for Plant Mgt.
5. VCO : Vermicompost + Conventional Organic Practice
6. CO : Conventional Organic Practice
7. BD : Biodynamic Package of Practice
8. MI : Microbial Formulation for both Soil and Plant Mgt.

Fig. 9 : Evaluation of different Organic Package of Practice under FAO-CFC-TBI Project.

1.2.1 Performance of IRF in Mature Tea : IRF Technology performed best in terms of crop response, nutrient use efficiency, cost effectiveness as well as soil quality development as compared to all other POP's (Table 1; Fig. 10 & 11). Crop productivity under IRF Package of practice is 6 percent higher than next best organic practice and at about 80 percent lower cost in terms of input cost/ kg made tea. IRF Technology was the only organic POP that reflected economic viability represented by value cost ratio (Pervaiz *et al*, 2004).

Table 1: Ranking of different organic POP's in terms of crop efficiency and cost per hectare, for mature tea.

Rank	Package of Practice	per hectare for mature tea				per hectare for mature tea		
		Yield (kg/ha)	Over Target (1220 kg/ha)	Over control	RAE[1]	Cost / ha (Rs.)	Cost/kg made tea (Rs.)	VCR[2]
1.	IRF- 2	1374	113.3 %	45.2%	100.00	13,796/-	10.04/-	6.20
2.	IRF- 4	1369	110.0 %	44.8%	98.83	11,302/-	8.26/-	7.49
3.	VMI	1299	103.5 %	37.3%	82.48	66,257/-	51.01/-	1.07
4.	VMIP	1235	98.9 %	30.5%	67.52	46,832/-	37.92/-	1.23
5.	VCO	1158	92.8 %	22.4%	49.53	40,184/-	34.70/-	1.06
6.	CO	1109	89.2 %	17.2%	38.08	12,954/-	11.68/-	2.52
7.	BD	1075	87.4 %	13.6%	30.14	14,914/-	13.87/-	1.73
8.	MI	1065	86.2 %	12.5%	27.80	28,657/-	26.91/-	0.83

[1]RAE : Relative agronomic effectiveness (Law-Ogbomo *et al*, 2011), [2]VCR : value cost ratio ***Note :*** *Quantity of various soil inputs were calculated on –N requirement basis i.e. for giving 60kg N. Except those ones which had fixed recommended dosage like BF, BD, FYM-2. Actual dosage was calculated based on N and moisture % in the soil input. Pruning : UP - Corrected LP - UP ; Bush Population : 10930/ha ; Age : 11-14 years; VCR was calculated considering Made tea @ Rs. 200/ kg*

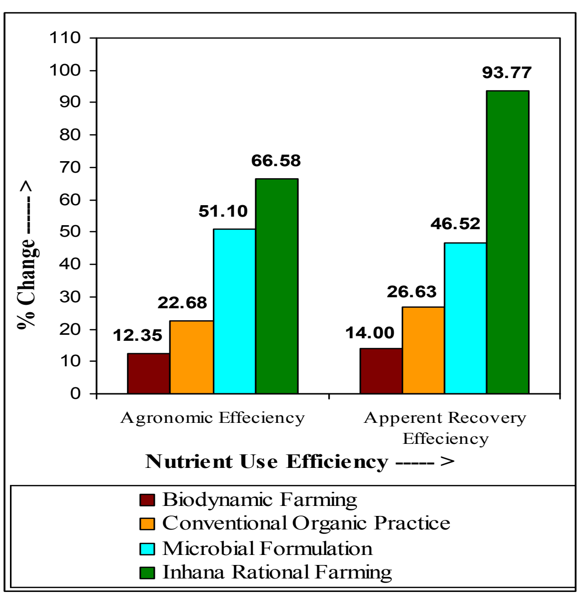


Fig. 10 : Nutrient Use Efficiency (NUE) under different organic POP's

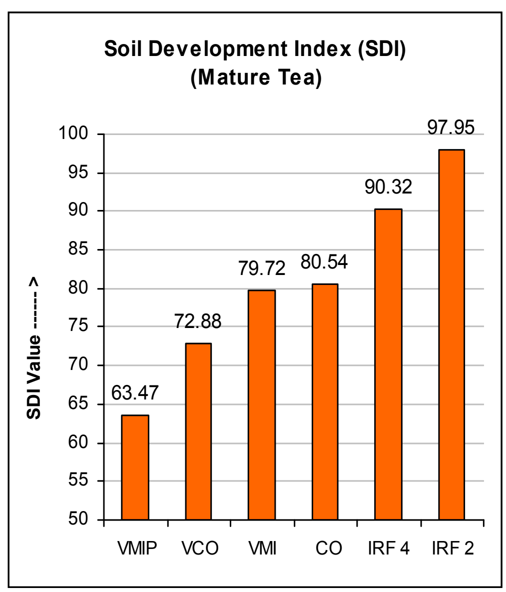


Fig. 11 : Soil Quality development under different organic POP's

Higher nutrient use efficiency under IRF Technology indicated most economic expense of compost- N for crop production, which might be due to increase in plant uptake and decrease in N losses from the soil- plant system (Amanullah and Lal, 2009). Highest SDI was obtained in case of IRF-2 package (SDI: 97.9), followed by IRF-4 (SDI: 90.3), CO (SDI: 80.5), VMI (SDI: 79.7), and VCO (SDI: 72.9). High SDI under IRF Technology might be primarily due to application of Novcom compost containing huge population of self- generated microbes.

1.2.2 Performance of IRF in Young Tea and New Plantation : Evaluation of the effectiveness of different POP in terms of yield performance revealed highest and consistent efficiency of IRF under all the different tea growth phases. VMI (Vermicompost+ Microbial Formulations for soil and plant) came out as the next best package for young tea but lost its position to VCO (Vermicompost+ Conventional organic package) in new plantation.

Table 2 : Crop Performance under different organic POP's (1st Five Ranking) in Young Tea and New Plantation

Package of Practice	Young Tea		New Plantation	
	Yield (kg/ha) (% over Control)	Cost/kg tea production (Rs./kg)	Yield (kg/ha) (% over Control)	Cost/kg tea production (Rs./kg)
IRF-2	807 (55.2)	16.3	956 (48.1)	13.2
VMI	653 (25.6)	101.5	870 (34.7)	9.1
IRF-1	619 (19.0)	13.7	868 (34.4)	45.8
VCO	618 (18.0)	64.8	760 (17.7)	18.2
BD	593 (14.1)	24.2	695 (7.7)	20.5

Comparative evaluation of crop efficiency *vis-à-vis* economics under different organic POP's indicated IRF as the most effective package in terms of highest crop efficiency at a low cost (Table 2). Inclusion of vermicompost in packages like CO and MI enabled slight upliftment in crop; however, their adoption potential was seriously questioned by the very high economics.

1.2.3 Performance of IRF in Nursery : Quality of tea seedlings grown under different organic POP's were evaluated using various agronomic parameters (shoot height, stem diameter, root mass, and shoot/ root ratio etc.) and indices (Specific leaf area, Leaf N content, Plant Strength, Dickson quality index etc.). Dickson quality index, which quantified the overall morphological development of seedlings; was highest (1.41) in case of IRF treated seedlings, followed by MI (1.27) and CO (1.21) treatments. Better and consistent growth performance as well as better survival chances and speedier growth (post transplantation) was observed under IRF Technology as indicated by the high values obtained both in case of agronomic parameters and indices. Irrespective of IRF Technology, other organic POP's like MI and CO also showed higher performance as compared to VCO and BD.

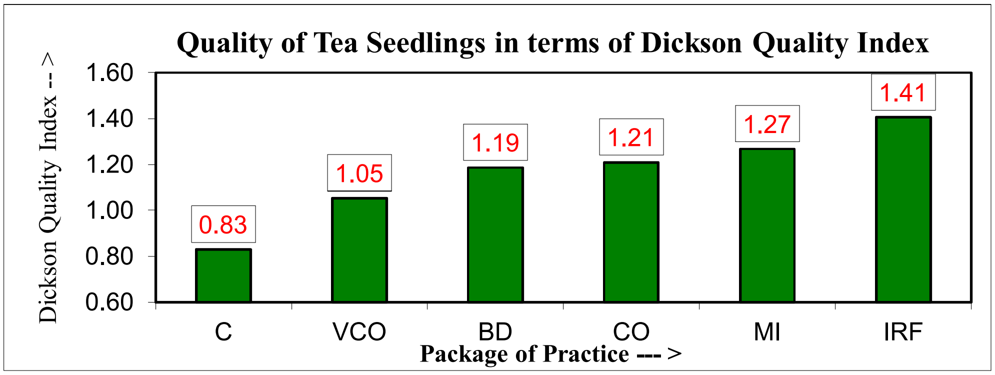


Fig. 12 : Comparative development of tea nursery under different organic POP's in terms of Dickson Quality Index.

1.2.4 Performance of IRF Technology in Large Scale Tea: The technology was adopted and practiced in the entire area (excluding the micro experimental area) of Maud T.E. i.e. in 135 ha area, during 2009 to 2011. Assessment of crop performance (mature tea) during these three years indicated crop productivity (excluding young tea up to 5 years and HRP sections) of 1440, 1363 and 2001 kg/ha in 2009, 2010 and 2011 respectively. When compared with the productivity of Panitola Circle (i.e. the same tea growing zone where all the gardens are under conventional chemical farming), yield at Maud T.E. was 17.0, 3.5 and 41.0 percent higher in 2009, 2010 and 2011 respectively as compared to 2008. Yield obtained during these three years is of special significance considering that post organic conversion in 1999, crop productivity at Maud T.E. was mostly going downwards.

1.2.5 Performance of IRF Technology towards improvement of tea quality: To evaluate the impact of long term organic practice on tea quality, Bera *et al.* (2013) analyzed CTC black tea samples from West Jalinga T.E., which have been practicing IRF for over a decade, Maud T.E. where IRF was adopted for a period of 3 years as well as conventional branded Assam teas (Fig. 13).

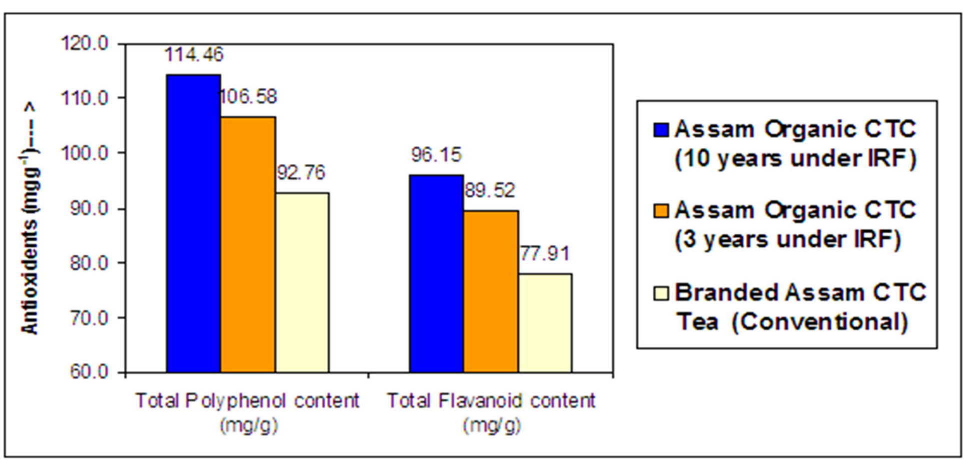


Fig. 13: Variation in antioxidant potential of Assam CTC black tea from gardens practicing IRF *vis-à-vis* Branded Conventional Samples.

The study indicated an increase in total polyphenol and flavanoid content with increase in period under IRF protocol, which might be due to the activation of plant physiology under long term application of a comprehensive soil and plant management programme. Improvement in soil quality leading to better nutrient mineralization and suppression of soil borne pathogens is complimented by the activated plant metabolic functions (through specific plant management protocol) that lead to healthy and productive plants; due to effective nutrient absorption and assimilation as well as lesser disease/ pest incidence.

2. 0 Adoption of IRF for Sustainable Paddy Cultivation : IRF technology was adopted to study paddy performance under organic management and different other sustainable cultivation models.

2.1 Adoption of IRF for Paddy Cultivation at Krishi Vigyan Kendra, ICAR :
IRF technology was adopted for paddy cultivation in a collaborative study at Howrah KVK (ICAR) from 2012 – 2015. Productivity of paddy (varieties: Gobindobhog and Swarna Sub-1) under IRF Technology was found to be 17.19 and 5.22 percent higher than that obtained under conventional practice. Organic plant management under IRF aimed at activation of plant physiology, was found to have a positive impact towards agronomic development and yield performance of the cultivated crop. Assessment of soil quality parameters indicated increasing trend of soil quality for plots receiving compost.

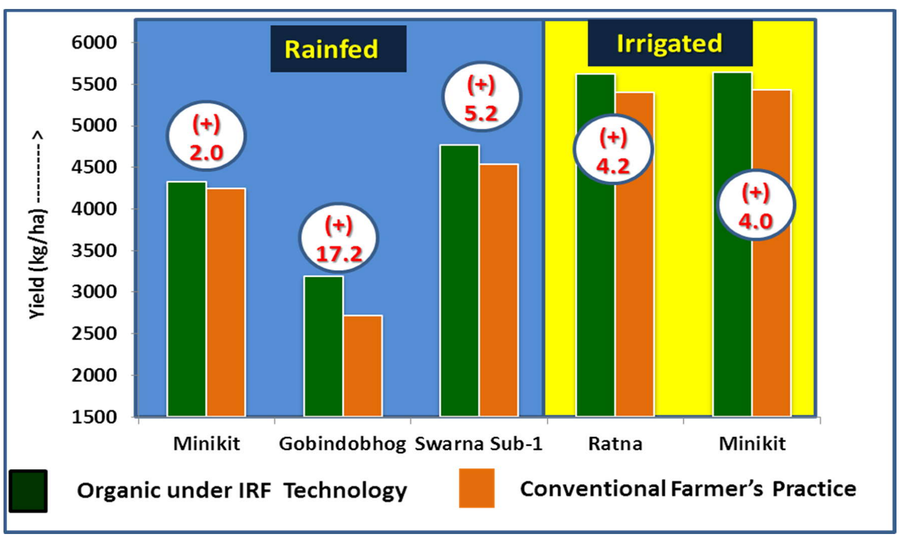


Fig.14 : Productivity of rain fed and irrigated paddy at KVK (ICAR), Howrah (W.B.).

Higher crop yield (under both paddy varieties) as well as high value of other yield parameters like affectivity index, grain filling, etc. under organic crop management, as compared to chemical practice; indicated the potential of this technology towards successful organic paddy cultivation. Simultaneous improvement in soil fertility and microbiological components indicated the effectiveness of compost utilized under IRF technology towards qualitative development of soil. Paddy varieties Minikit and Ratna, cultivated in boro season also showed comparatively higher productivity under organic management (Fig. 14).

2.2 Large scale organic paddy cultivation under IRF Technology in farmers' field: An initiative was undertaken to cultivate organic paddy in large scale at North 24 parganas district of West Bengal, where about 200 farmers adopted IRF Technology for paddy cultivation in about 100 ha area. Plant management under IRF not only helped to get higher yields (up to 25 %), harvesting time was also shortened by 8 to 10 days.

Pic. 4 : Few project farmers participating in organic paddy cultivation under IRF Technology in North 24 Parganas district of West Bengal (India).

3.0 Pulses under IRF Organic Cultivation: Comparative study of green gram under organic and conventional farming was evaluated in different agro-ecosystems.

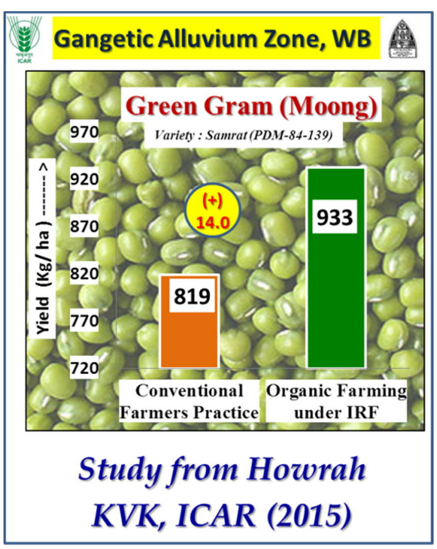
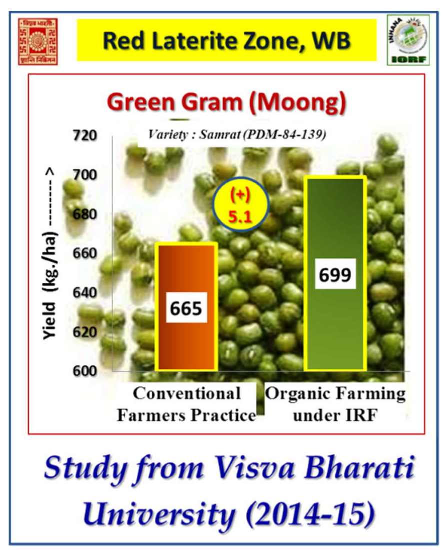


Fig. 15 : Organic green gram cultivation in different agro-ecosystems under IRF Technology.



Crop response was higher under organic (Fig. 15) which might be due to favourable soil-plant-nutrient relationship along with specific management towards activation of plant metabolic functions. In terms of economics, gross income under organic treatment was higher than that obtained uder conventional farming. Post-harvest soil analysis showed an overall positive trend in soil quality in the organically treated plots receiving Novcom compost, especially in terms of biological properties.

4.0 Organic vegetable Cultivation under IRF Technology: The technology successfully demonstrated its potential as an economically sustainable organic package. Its effectiveness in a number of vegetables *viz.* tomato, potato, okra, brinjal, cauliflower, baby corn and different exotic vegetables was documented in collaborative projects of different agricultural universities and Krishi Vigyan Kendra (ICAR).

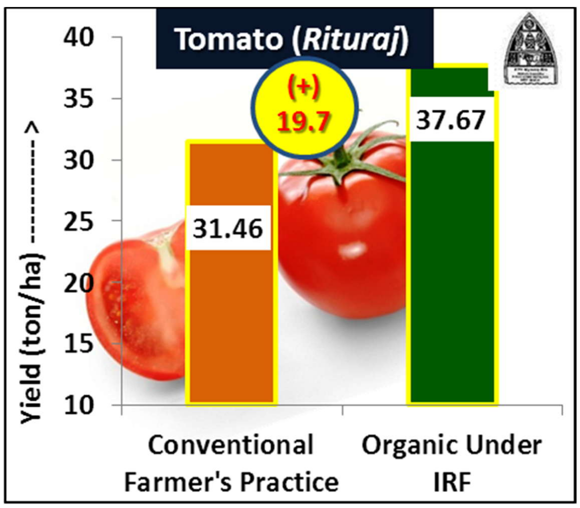


Fig. 16: Organic tomato cultivation under IRF Technology.

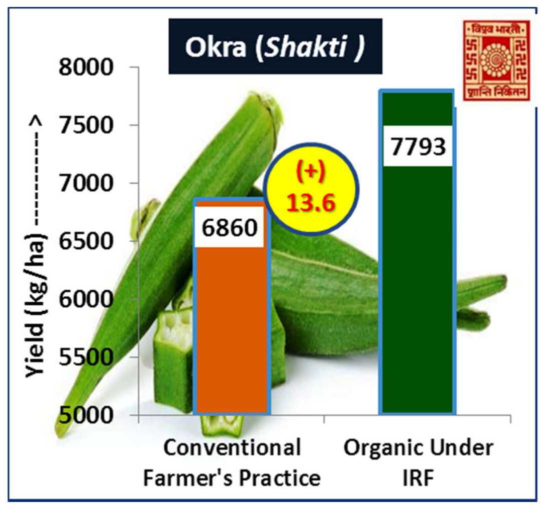


Fig. 17: Organic okra cultivation under IRF Technology.

4.1 Performance of vegetables under IRF Organic Package of Practice : Approximately 10 to 20 percent higher crop response was documented under IRF Treatment as compared to conventional practice in different vegetable and in different agro-ecosystems. The higher yield was basically contributed from higher number of fruits per plant as well as higher average fruit mass. The higher number of fruits per plant may be due to comparatively longer fruit bearing stage of organically treated plants which again indicated that the organic solutions used under IRF has a direct influence on plant metabolic functions leading to efficient nutrient utilization and thereby enhancement of crop yield potentials. Also higher (average) fruit mass at harvestable stage indicated better soil-plant nutrient dynamics in organically treated plots; irrespective of the variation in agro-climatic zone.

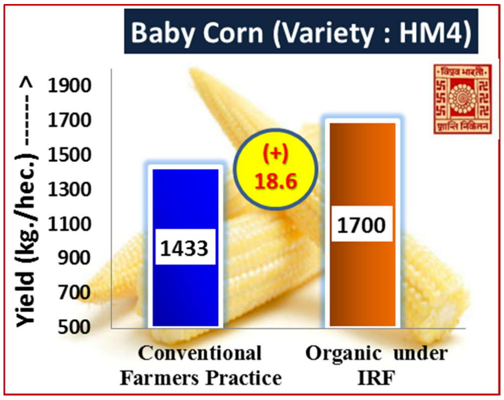


Fig. 18: Organic baby corn cultivation under IRF Technology.

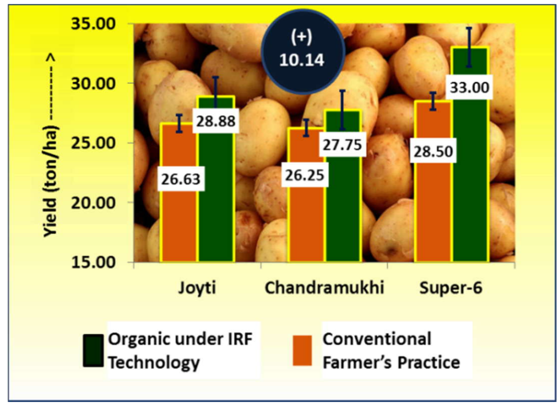


Fig. 19 : Organic potato cultivation under IRF Technology.

Yield of potato under IRF Technology was found to be 10.14 percent higher as compared to conventional practice. Higher nutrient use efficiency and better economic sustainability was also noted, irrespective of study area or potato variety.

4.2 Exotic vegetables cultivation under IRF Organic : An initiative was taken for introduction of organic, exotic vegetable cultivation in farmers' field in North 24 paraganas district of West Bengal using IRF Technology. The effort was made to assess the possibility of effective open field, organic exotic vegetable cultivation. Horse radish, pak choi, celery, red cabbage, chinese cabbage, broccoli, brussels sprout and three varieties of lettuce viz., Cos Rusty, Iceberg and Sangrina were taken for the study. The yield was comparable to the ones cultivated under conventional farmer's practice; but with qualitative attributes being far better than the conventionally grown exotic vegetables. The size of the roots of Horse Radish was found to be larger but still tender as compared to the conventionally grown ones. The leaves remained fresh even after 10 days post-harvest. Leafy vegetables like that of Pak choi, lettuce had a shelf life of 10- 15 days.

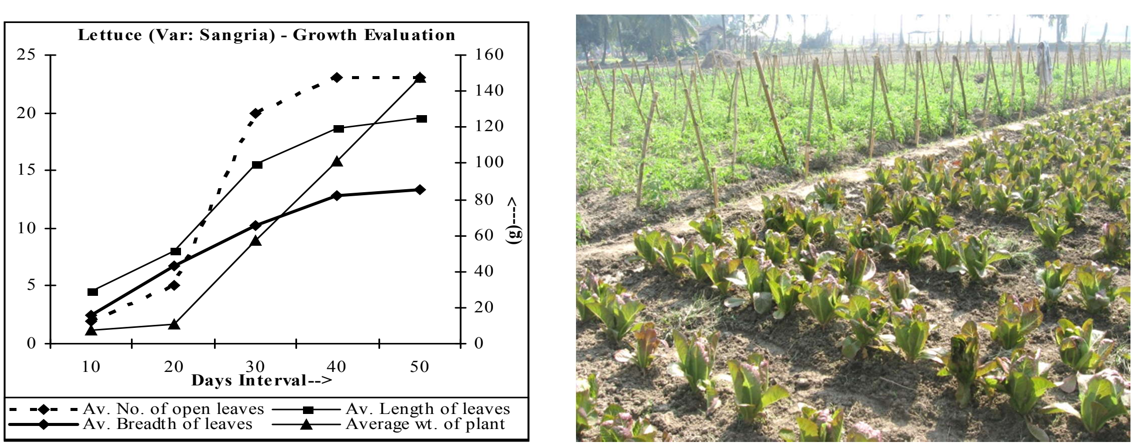


Fig. 20 : Organic lettuce cultivation under IRF Technology.

4.3 Improvement of Food Quality and Energy Use Efficiency under IRF Technology: Enhancement of food quality in terms of its 'Taste value', "Self-life' and anti-oxidant potential under organic farming is a subject of interest for agriculturists. In case of organic potato, higher qualitative expression in terms of starch content, pulp- pH, vitamin- C etc. might be contributed by initiative towards re-activation of plant metabolic efficiency, under this technology.

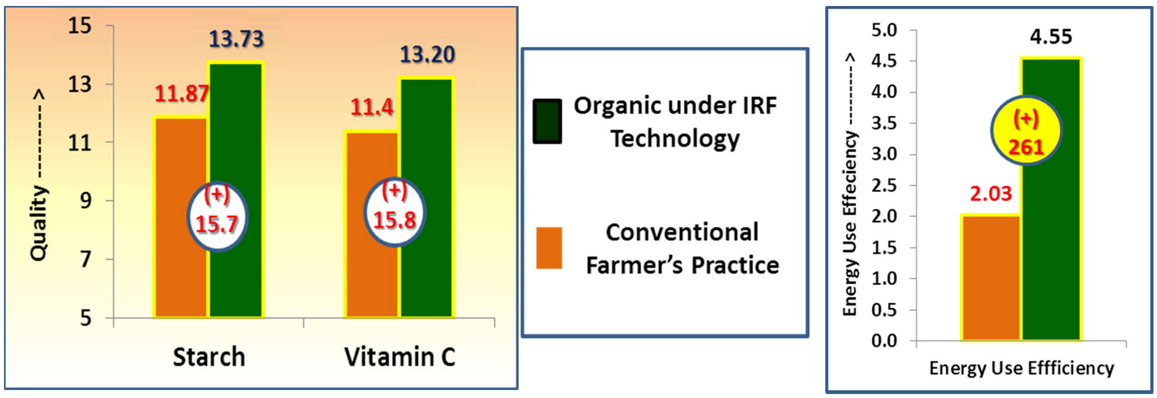


Fig. 21: Comparative study of quality and energetics under conventional and organic crop production using IRF Technology taking potato as test crop.

Conventional agriculture's energy inefficiency is directly tied to energy consumption for producing and transporting synthetic pesticides and fertilizers that is used for growing crops. Whereas, organic agriculture utilizes manure, legumes, and other natural sources of nitrogen, which replace the fossil fuels used for manufacturing synthetic nitrogen fertilizer with a natural biological process (Ziesemer 2007). Energy use efficiency under organic farming (4.55) was 261 percent higher than the value (2.03) recorded under conventional practice (Fig. 21). Similar higher energy efficiency was recorded by Klimeková and Lehocká (2007) under organic agriculture as against conventional farming method. Higher energy use efficiency under organic farming was perhaps due to reliance on organic manure and organic plant/ pest management as well as higher crop response.

5.0 Development of Tools & Indices : Inhana Organic Research foundation has developed different tools and indices to evaluate the impact of management practice on soil, plant and ecology. So far nine different indices have been developed and used in organic farming projects to evaluate qualitative developments. The indices are (i) Soil Quality Index (SQI); (ii) Soil Development Index (SDI); (iii) Compost Quality Index (CQI); (iv) Microbial Activity Potential (MAP); (v) Fertility Index (FI); (vi) Biodiversity Marker (BM); (vii) Soil Pesticide Pollution Index (SPPI); (viii) Crop Pesticide Pollution Index (CPPI) and (ix) Plant Development Index (PDI). These indices help towards SWOT study of any agricultural farm for bringing forth resource maps and development of problem specific management programmes.

CONCLUSION

Scientific documentation of IORF's organic journey using Inhana Rational Farming (IRF) Technology as the vehicle; gives a vivid idea regarding practical possibilities of yield sustenance, soil quality developments and cost effectiveness; in a time bound manner. Consistent performance of the technology irrespective of variation in crop type or agro-ecosystem indicates that if a scientific organic pathway is adopted then its effectiveness will be universal. Recognition of West Jalinga T.E. as world's only 'Carbon Neutral' organic garden conclusively reflects the GHG mitigation and carbon sequestration potentials under this technology. Restoration of soil health is crucial for sustainable agriculture for which, energization of native soil microflora should be prioritized. But speedy recovery can be ensured only by that compost/ manure which contains concentrated population of self-generated microflora along with sufficient food resource. The post soil application effectiveness of Novcom compost as demonstrated in the sustained crop yields and soil microflora regeneration is supported by laboratory analysis (*following national and international protocol*) that concludes stable and mature compost with no phytotoxic effects. Most importantly, better quality end products substantiates that organic plant management towards reactivation of plant metabolic activity is pre-requisite in organic crop production, in addition to soil management; because it enables higher nutrient utilization as well as better control mechanisms against pest/ disease.

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"Inhana Rational Farming (IRF) Technology"

Developed by Dr. P. Das Biswas after in-depth research on Vedic Philosophy and its logical sublimation with Modern Science.

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