CSE'S NATIONAL CONCLAVE ON SUSTAINABLE FOOD SYSTEMS 2022

APRIL 19-21, 2022

Anil Agarwal Environment Training Institute (AAETI) Nimli, Rajasthan

Amit Khurana, CSE

April 19, Session 1 – Inaugural session

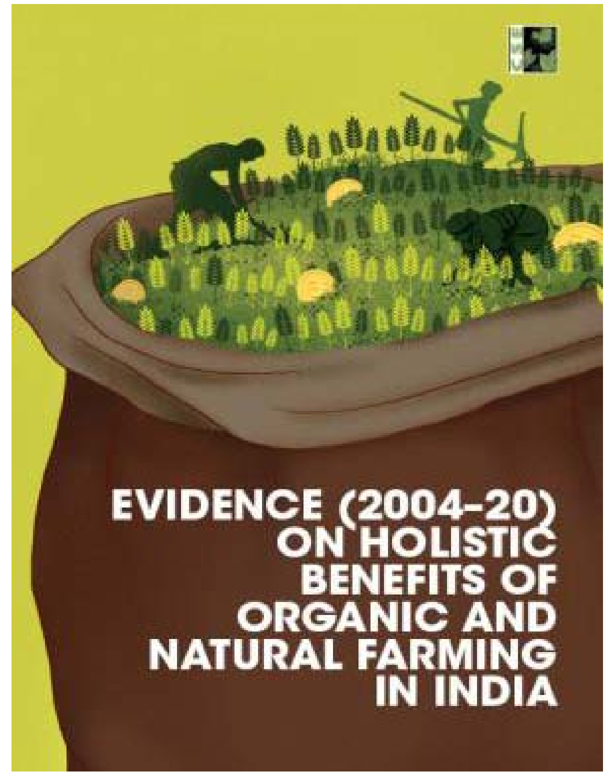
Why this report?

- Agro-ecological movement started gaining momentum after negative impacts of an **input and chemical intensive** agriculture model

  - First policy on organic farming in 2005, but subsequent action **half-hearted**
  - Paramparagat Krishi Vikas Yojana (PKVY; started in 2015-16) has **implementation challenges** and is limited in scale

- Action at the state has been **suboptimal** barring few exceptions

- **Explains why only 2.7 per cent (3.8 million ha) of net sown area (140.1 million ha) in India is covered under organic and natural farming as part of different policies. This includes 0.41 million ha of natural farming**



Why this report?

- **One main reason of the half-hearted effort is lack of conviction among scientific community and extension workers.** Largely due to:
  - **Limited consensus** among the scientific community
  - **Singular view of yield** to assess non-chemical agricultural practices
- **Both attributed to limited evidence, building-up over the last two decades but failed to catch the attention of policymakers**
- In a recent shift, the **government** is promoting organic and natural farming. The Prime Minister has highlighted ill-effects of chemical-based farming and appealed to make natural farming a mass movement
- **But the budgetary allocations speak differently; scientific community is yet to come along in full support; and challenges related to transition and upscaling are yet to be addressed systematically.**

Approach to collection, analysis and presentation of evidence

Collection of evidence (2004–2020)

1. All India-Network Project on Organic Farming (AI-NPOF)

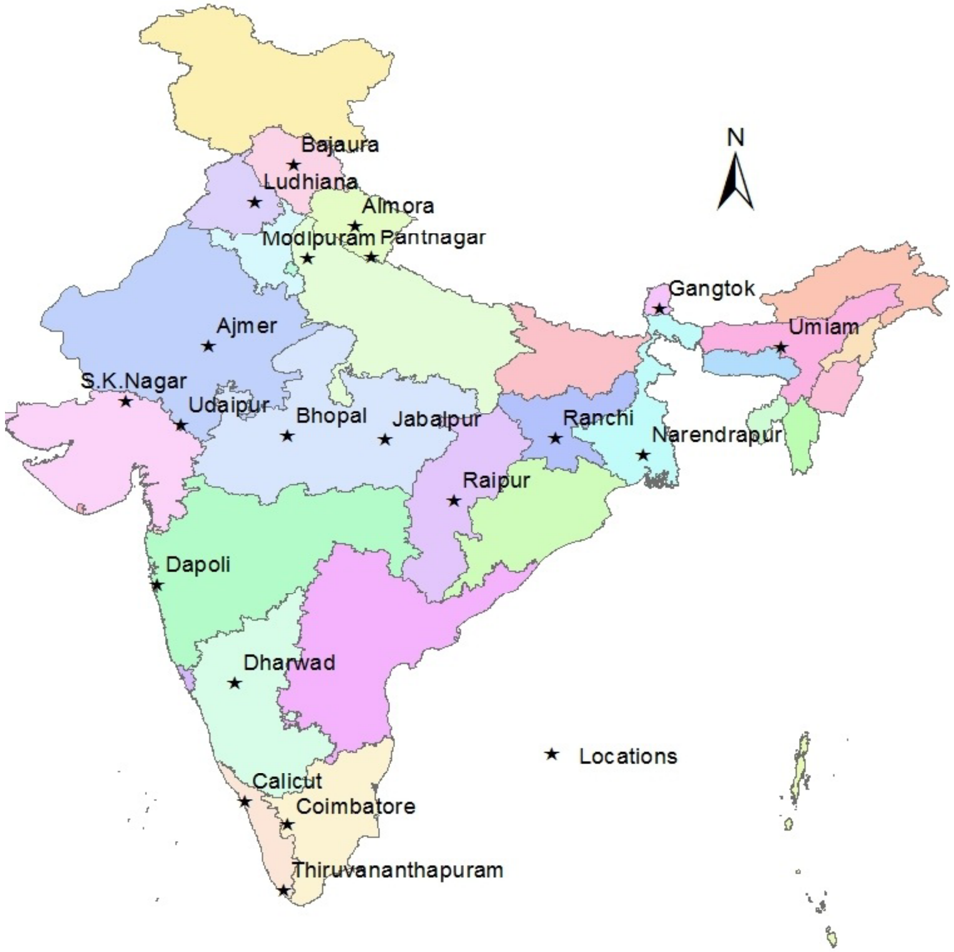
- Conducted by ICAR through **Indian Institute of Farming System Research** (IIFSR), Modipuram
- Started in **2004-05** at 13 centres in 12 states. **Ongoing at 20 centres in 16 states, in five ecosystems** – arid, semi-arid, humid, sub-humid and coastal
- Results of **74 cropping systems at 19 centres** are used (2004-19)

Three approaches	Six methods
Organic approach (ORG)	**Organic method (OF),** with 100 per cent of the nutrients from organic sources and complete organic management
	Organic innovative method (OIN), with 75 per cent of the nutrients from organic sources + innovative inputs 25 per cent [any two of cow urine (10 per cent), panchagavya, plant growth-promoting rhizobacteria and vermiwash (10 per cent)]
Integrated approach (INT)	**Integrated method (IN75),** with 75 per cent organic + 25 per cent inorganic nutrients and management
	Integrated method (IN50), with 50 per cent organic + 50 per cent inorganic nutrients and management
Inorganic approach (INO)	**Inorganic method (IOF),** with 100 per cent inorganic nutrients and management
	State recommended (SR) method or farmers' package (choice given to centres)

2. Scientific studies on Organic and Natural farming

About **90 scientific studies** published in India during **2010-20** by a wide set of stakeholders

Location of Network Project on Organic Farming (NePOF)



Analysis (AI-NPOF results)

Results analysed in one or more of the following ways w.r.t 1) **yield**; 2) **cost, income and livelihood; 3) soil health and environment; 4) food quality and nutrition**

1. **Based on mean values (2014-19):**
   - **Five-year mean values** of three approaches - organic approach and integrated approach **(towards organic)** compared with inorganic approach. Also done for all six methods and compared with inorganic method.
   - Analysis also done to know **significantly higher (>20 per cent)** mean values and ascertain **highest mean value**
2. **Based on actual values** (during 2014-19 or 2018-19):
   - Analysis to know **number of times** actual values were **highest** across methods
3. **Long-term trends (2004–19):**
   - Based on actual values (data point for 2004-11 and then for subsequent years)
   - Out of six, three methods added 2013-14 onwards
   - Presented as graphs in annexure

Presentation (snapshot)

Table comparing mean yield values of organic and integrated with inorganic method and approaches

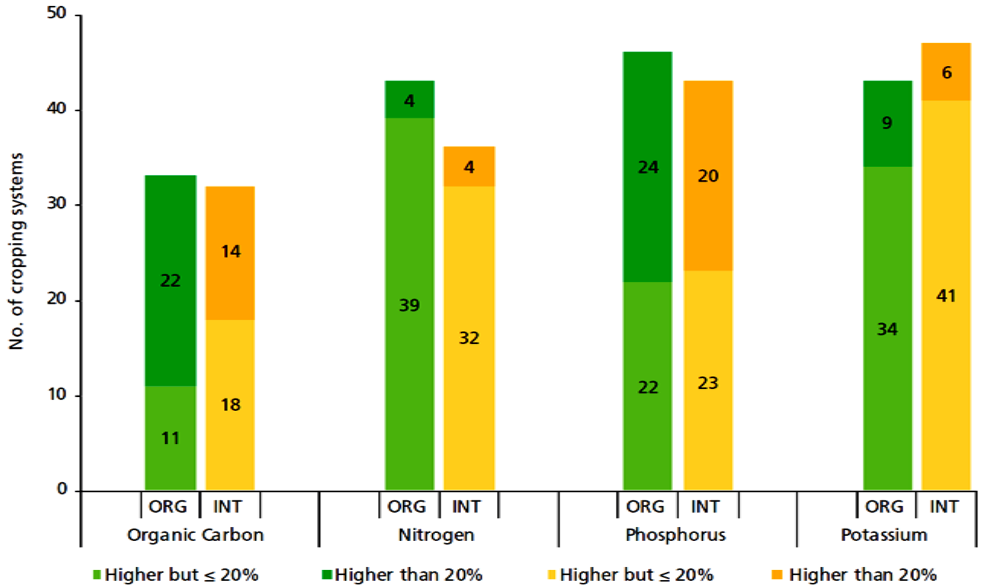
Table 4: Comparison of mean yields of spices with different approaches and methods (2014-19)

Crops	Cropping systems	Centre (season)	Ecosystem	Mean yield as per IOF method (Kg/ha)	Mean yield difference compared to IOF method (%)					Mean yield as per INO approach (Kg/ha)	Mean yield difference compared to INO approach (%)		No. of times highest yields were recorded			
					OF	OIN	IN75	IN50	SR		ORG	INT	Total	ORG	INT	INO
Ginger	Ginger (Sole)	Calicut (Kha)	Coastal	15,648	37	56	78	14	-	15,648	46	46	2	1	1	0
Turmeric	Turmeric (Sole)	Calicut (Kha)	Coastal	17,493	12	28	63	34	-	17,493	20	48	2	0	2	0
Coriander	Basmati rice – chickpea	Pantnagar (Rabi)	Humid	1,033	-0.1	11	13	5	-27	891	22	26	14	6	7	1
	Basmati rice – vegetable pea	Pantnagar (Rabi)	Humid	923	27	23	4	11	4	942	22	5				
	Cluster bean/green gram – coriander	Ajmer (Rabi)	Arid	687	-5	-1	26	12	19	751	-12	9				
Fennel	Cluster bean/green gram – fennel	Ajmer (Rabi)	Arid	1,512	-4	-1	18	8	13	1,611	-8	6	7	0	4	3
	Green gram – fennel – fennel	Sardarkrushinagar (Rabi)	Arid	1,636	-26	-28	-9	1	11	1,727	-31	-9				
Black Pepper	Black Pepper (Sole)	Calicut (Kha)	Coastal	1,272	38	-	-	10	-	1,272	38	10	3	2	1	0
Total Crops – 5	Total unique cropping systems – 8	Centres – 5	Ecosystems – 3													
Number of recorded results					8	7	7	8	5		8	8	28	9	15	4
Crop yields with higher respective values than inorganic method (IOF) and approach (INO=IOF+SR) (in per cent cases)					50	57	86	100	80		63	88				
Crop yield where values are significantly higher (> 20 per cent) than inorganic method (IOF) and approach (INO=IOF+SR), calculated out of overall higher yields (in per cent cases)					50	75	50	13	0		80	43				
Range of difference in mean with inorganic method (IOF) and approach (INO=IOF+SR) (in per cent)					-26 – 38	-28 – 56	-9 – 78	-0.6 – 34	- 27 – 19		-31 – 46	-9 – 48				

Presentation (snapshots)

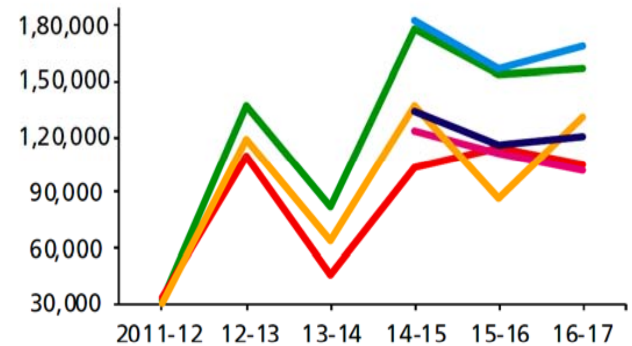
Graphs showing higher and significantly higher mean values (> 20 per cent) in comparison with inorganic

Graph 3: Comparison of mean organic carbon, available nitrogen, phosphorus and potassium of organic and integrated approaches with inorganic approach



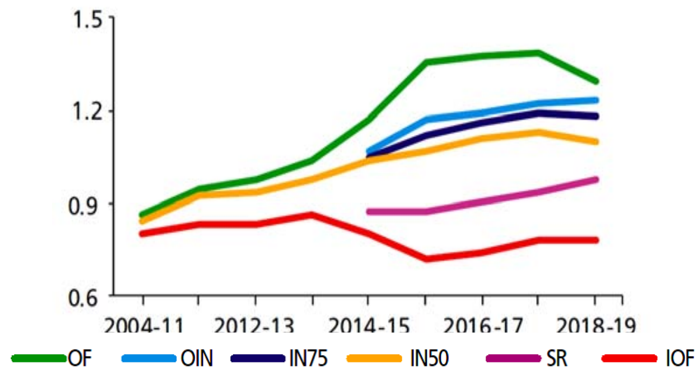
Graphs showing centre-wise long-term trends for net returns (Rs/hectare)

Graph 8: Modipuram-Net returns



Graphs showing centre-wise long-term trends for organic carbon (per cent)

Graph 10: Organic carbon-Pantnagar



Analysis and presentation of evidence (scientific studies on organic and natural farming)

As part of chapters along with AI-NPOF results

Crop yield:

- Higher yield with organic farming and natural farming
- Transition time to attain comparable or higher yields with organic farming

Cost, income and livelihood:

- Cost of cultivation with organic and natural farming
- Price, income and livelihood with organic and natural farming

Soil health and environment:

- Benefits of organic and natural farming on soil health
- Impact of organic and natural farming on climate and environment

Food quality and nutrients:

- Benefits of organic farming on food quality and nutrition

Evidence on Crop Yield

Select 31 crops across five food groups

Grown as part of 74 cropping systems; 19 centres; five ecosystems; three seasons (Kharif, Rabi, Summer)

- **Vegetables (10)**: Broccoli, potato, French bean, vegetable pea, tomato, cauliflower, chillies, onion, capsicum and ladyfinger
- **Oilseeds (5):** linseed, groundnut, mustard, sunflower and soybean
- **Pulses (6):** Black gram, pigeon pea, chickpea, green gram, cowpea and lentils
- **Spices (5):** Ginger, turmeric, coriander, fennel and black pepper
- **Cereals (5):** Basmati rice, rice, wheat, durum wheat and maize

Productivity (crop yield): summary based on AI-NPOF results

Food groups (no. of recorded results)	Instances where yields are highest with each of the three farming approaches (in %, based on actual values)	% times where organic or integrated approaches showed higher yield than inorganic (in %, based on mean values)	% times where organic or integrated approaches showed significantly higher yield (>20 per cent) than inorganic (% of overall higher yield, based on mean values)	Range of difference in mean with inorganic approach (INO=IOF+SR) (in %)
Vegetables (122)	**ORG: 48**; INT: 36; INO: 16	**ORG: 70**; INT: 63	ORG: 29; INT: 42	ORG: -18 – 62 INT: -15 – 59
Oilseeds (91)	**ORG: 58**; INT: 17; INO: 25	**ORG: 45**; INT: 45	ORG: 10; INT: 20	ORG: -16 – 39 INT: -5 – 25
Pulses (81)	ORG:32; INT:42; INO: 26	**ORG: 67**; INT: 62	ORG: 21; INT: 54	ORG: -29 – 66 INT: -33 – 109
Spices (28)	ORG: 32; INT: 54; INO: 14	ORG: 63; INT: 88	**ORG: 80**; INT: 43	ORG: -31 – 46 INT: -9 – 48
Cereals (182)	**ORG: 35**; INT: 32; INO: 33	ORG: 22; INT: 37	**ORG: 27**; INT: 17	ORG: -22 – 88 INT: -18 – 59

Key highlights – AI-NPOF

- Overall, out of the 504 times yield results were recorded during 2014–19:
  - **41 per cent of the times, yields were highest with organic approach**
  - 33 per cent with integrated and 26 per cent with inorganic approach
- When **five-year mean yields** (2014-19) are compared, in **27 out of 31 crops** **(87 per cent)** yields were higher with organic approach than with inorganic approach as part of one or more cropping systems
- **Long-term trends** revealed that <u>organic approach is better than inorganic and is at par with integrated approach</u>

Key highlights (studies on organic and natural farming)

Higher yield:

Organic farming

- Compared to chemical-based farming, yields are higher with organic in crops - **Spinach, baby corn, broccoli, potato, ladyfinger, tomato, onion, chilli, pigeon pea, cowpea, black gram, rice, ragi, pearl millet, wheat, and banana**

Natural farming

- Crops like **maize, groundnut, sugarcane, finger millet, soybean, jowar and turmeric** showed higher yields with natural farming

Transition time to attain comparable or higher yield with organic farming

- Yields usually **improve over time** with organic inputs and bio-inputs (although yields may reduce during the transition phase)
- Some crops may **take more years than others** to attain higher or comparable yields - wheat, maize, rice, cluster bean, sesame, cumin, and psyllium husk

Evidence on Cost, Income and Livelihood

Profitability (cost, income and livelihood): summary AI-NPOF results

Up to 63 cropping systems; 17 centres; five ecosystems

Cost, income and profitability (no. of cropping systems)	% of cropping systems showing highest mean values with each of the three approaches	% of cropping systems showing higher mean values with organic or integrated approaches over inorganic	% of cropping systems showing significantly higher (>20 per cent) mean values with organic or integrated approaches over inorganic (% of overall higher)	Range of difference in mean with inorganic approach (INO=IOF+SR) (in %)
Cost of cultivation (63)	ORG: 63; INT: 8; INO: 29	ORG: 81; INT: 71	ORG: 67; INT: 36	ORG: -24 – 72 INT: -26 – 51
Gross returns (61)	ORG: 49; INT: 15; INO: 36	ORG: 74; INT: 67	ORG: 82; INT: 20	ORG: -24 – 97 INT: -22 – 125
Net returns (61)	ORG: 64; INT: 11; INO: 25	ORG: 67; INT: 56	ORG: 88; INT: 12	ORG: -145 – 370 INT: -99 – 395
Benefit-cost ratio (61)	ORG: 21; INT: 13; INO: 66	ORG: 56; INT: 34	ORG: 53; INT: 29	ORG: -55 – 171 INT: -37 – 69

Key highlights – AI-NPOF

Net returns

- Out of 61 cropping systems, net returns are **highest in 64 per cent** with organic approach at 12 centres, 11 per cent with integrated approach at four centres, and 25 per cent with inorganic approach at five centres.

- **Despite high cost of cultivation** in 51 cropping systems **(81 percent)** (largely due to **purchase** of on-farm organic inputs for experimental farms)**,** net returns are highest in **63 per cent** of these cropping systems

- The **five-year mean net returns** with organic approach are **higher than inorganic in 67 per cent** cropping systems. Similarly, mean net returns with integrated approach are higher than inorganic in 56 per cent cropping systems.

- The **long-term trends** revealed that net returns are much better with organic than inorganic approach and also better than integrated approach

Key highlights (studies on organic and natural farming)

Cost of cultivation with organic and natural farming

- **Cost of inputs comparatively less** as these are locally and naturally available
- Major cost comes as manual labour cost and from production of vermicompost

Price, income and livelihood with organic and natural farming

Organic farming

- Provides sustained livelihood for marginal farmers due to low cost of cultivation, inter-cropping, labour requirements, and comparatively good market rates

Natural farming

- Minimized cost, helps fetch premium prices
- Higher income and profit than conventional farming
- Benefit-cost ratio is several times higher than chemical-based farming
- **Has potential to provide year-long sustained food production for consumption and sales**

Evidence on Soil Health and Environment

Sustainability (soil health and environment): summary based on AI-NPOF results

Organic carbon: nine centres (five ecosystems); Available N, P, and K: 16 centres (five ecosystems)

Soil health parameters (no. of cropping systems)	**% of cropping systems showing highest mean values with each of the three approaches**	**% of cropping systems showing higher mean values with organic or integrated approaches over inorganic**	**% of cropping systems showing significantly higher (>20 per cent) mean values with organic or integrated approach over inorganic (% of overall higher)**	**Range of difference in mean with inorganic approach (INO=IOF+SR) (in %)**
Organic Carbon **(34)**	**ORG: 91**; INT: 9; INO: 0	**ORG: 97**; INT: 94	**ORG: 67**; INT: 44	ORG: 0 – 241.8 INT: -2.50 – 195.1
Available Nitrogen – N **(58)**	**ORG: 57**; INT: 21; INO: 22	**ORG: 74**; INT: 62	**ORG: 12**; INT: 11	ORG: -24.7 – 40.2 INT: -23.3 – 38.5
Available Phosphorus – P **(62)**	**ORG: 58**; INT: 23; INO: 19	**ORG: 74**; INT: 69	**ORG: 52**; INT: 47	ORG: -46.3 – 242.6 INT: -280.8 – 232.2
Available Potassium – K **(62)**	**ORG: 53**; INT: 28; INO: 19	ORG: 69; INT: 76	**ORG: 21**; INT: 13	ORG: -8.1 – 95.5 INT: -12.1 – 101.4

Key highlights – AI-NPOF

Organic carbon, available nitrogen, phosphorus, potassium in soil are better with organic approach than with integrated and inorganic approaches

Soil organic carbon

- Out of 34 cropping systems at nine centres, mean organic carbon in soil is **highest in 91 per cent cropping systems** with organic approach at all centres

- The **five-year mean** organic carbon, with organic approach is higher than inorganic in **97 per cent cropping systems**

- **Long-term trends:** Organic carbon (OC) is **highest throughout** with Organic approach at all nine centres

Available nitrogen, phosphorus and potassium, **collectively**

- **Mean values of all three** macronutrients with organic approach are **higher** than with inorganic approach in 26 cropping systems (**42 per cent**) at 10 centres.

Key highlights – AI-NPOF

Available nitrogen in soil

- Out of 58 cropping systems at 15 centres, **mean available nitrogen is highest in 57 per cent cropping systems with organic approach at 12 centres**. It is highest in 21 per cent with integrated approach at eight centres and in 22 per cent with inorganic approach at four centres.
- The **five-year mean** available nitrogen with organic approach is higher than inorganic in **74 per cent cropping systems**. Similarly, with integrated approach, it is higher than inorganic in 62 per cent cropping systems.

Available phosphorus in soil

- Out of 62 cropping systems at 16 centres, **mean available phosphorus is highest in 58 per cent cropping systems at 13 centres with organic approach**. It is highest in 23 per cent with integrated approach at eight centres and in 19 per cent with inorganic approach at five centres.
- The **five-year mean** available phosphorus with organic approach is higher than inorganic in **74 per cent** cropping systems.

Available potassium in soil

- Out of 59 cropping systems at 16 centres, **mean available potassium is highest in 53 per cent cropping systems** at 12 centres with organic approach. It is highest in 28 per cent with integrated approach at eight centres and in 19 per cent with inorganic approach at five centres.
- The **five-year mean** available potassium with organic approach is higher than inorganic **in 69 per cent** cropping systems.

Sustainability (soil and environment): summary based on AI-NPOF results

- **Bulk density: seven centres (five ecosystems); rhizosphere microbial population (except PSB): eight centres (five ecosystems); PSB: six centres (five ecosystems)**

Soil health parameters (no. of cropping system)	**% of cropping systems showing highest mean values with each of the three approaches**	**% of cropping systems showing higher mean values with organic or integrated approaches over inorganic**	**% of cropping systems showing significantly higher (>20 per cent) mean values with organic or integrated approach over inorganic (% of overall higher)**
Bulk density **(28) – LOWEST/LOWER VALUES**	**ORG: 52;** INT: 34; INO: 14	ORG: 75; INT: 79	ORG: 0; INT: 0
Bacteria **(32)**	**ORG: 84;** INT: 13; INO: 03	**ORG: 91**; INT: 81	**ORG: 86**; INT: 65
Fungi **(32)**	**ORG: 72;** INT: 13; INO: 16	**ORG: 78**; INT: 66	**ORG: 76**; INT: 52
Soil actinomycetes **(32)**	**ORG: 69**; INT: 25; INO: 06	**ORG: 84**; INT: 34	ORG: 56; INT: 73
Phosphate solubilizing bacteria (PSB) **(32)**	**ORG: 76;** INT: 10; INO: 14	**ORG: 81**; INT: 19	ORG: 47; INT: 50

Key highlights – AI-NPOF

Soil bulk density

- Out of 28 cropping systems at seven centres, **mean bulk density is lowest in 52 per cent cropping systems with organic approach at four centres.** It is lowest in 34 per cent cropping systems with integrated approach at four centres and it is lowest in 14 per cent with inorganic approach at two centres.

- The **five-year mean** bulk density with organic approach **is lower than inorganic in 75 per cent** cropping systems.

Soil bacteria, fungi, actinomycetes and phosphate solubilizing bacteria

- Collectively, **mean values** of bacteria, fungi and soil actinomycetes with organic approach **are higher** than with inorganic approach in 21 cropping systems (**about 66 per cent**) at eight centres. In the case of integrated approach, it is higher than inorganic approach in five cropping systems (about 17 per cent) at two centres.

Sustainability (soil and environment): summary based on AI-NPOF results

Collectively, values of all four micronutrients with organic approach are higher than inorganic approach in 16 cropping systems (76 per cent) at five centres (three ecosystems)

Soil health parameters* (no. of cropping systems)	% of cropping systems showing highest mean values with each of the three approaches	% of cropping systems showing higher mean values with organic or integrated approaches over inorganic	% of cropping systems showing significantly higher (>20 per cent) mean values with organic or integrated approach over inorganic (% of overall higher)	Range of difference in mean with inorganic approach (INO=IOF+SR) (in %)
Iron **(19)**	**ORG: 74**; INT: 21; INO: 5	ORG: 90; INT: 100	**ORG: 65**; INT: 53	ORG: -20.3 – 86.6 INT: 0.0 – 65.1
Manganese **(19)**	**ORG: 63**; INT: 37; INO: 0	ORG: 90; INT: 100	**ORG: 71**; INT: 58	ORG: -0.3 – 58.4 INT: 7.6 – 55.9
Zinc **(19)**	**ORG: 89**; INT: 11; INO: 0	**ORG: 100**; INT: 100	**ORG: 89**; INT: 72	ORG: 18.9 – 341.2 INT: 9.1 – 250
Copper **(19)**	**ORG: 78**; INT: 22; INO: 0	**ORG: 89**; INT: 61	**ORG: 50**; INT: 46	ORG: -2.3 – 133.2 INT: -218.5 – 66.4

Key highlights (studies on organic and natural farming)

- **Benefits on soil health**

Organic farming

- Leads to active organic matter and microorganisms, increases soil fertility
- Manure improves soil health and fertility - improves soil structure, fertility, organic carbon, bulk density, soil moisture, porosity, water holding capacity, plant and animal biodiversity

Natural farming

- Increases soil health and fertility - increases macro and micro nutrients, organic carbon, soil enzymes, earthworms, soil respiration, microbial biomass, soil porosity, aeration, light texture, moisture retention

- **Impact on climate and environment**

Organic farming

- Improves sustainability index and increases carbon sequestration

Natural farming

- Improves overall resilience of crops to adverse climatic conditions, improves energy and water efficiency, has high potential to reduce carbon emission, prevents over extraction of ground water

Evidence on Food Quality and Nutrition

Key highlights: AI-NPOF and scientific studies

AI-NPOF:

- Actual values 2018-19, of 28 different food quality and nutrient parameters were analyzed in 15 crops from five groups – Vegetables, Oilseeds, Pulses, Spices and Cereals
- **In 12 out of 15 crops**, **parameters tested were highest with organic approach**
- Values with organic approach were higher than inorganic in **67 per cent cases** (across 51 sets of test results); with integrated, it was higher in 64 per cent cases

Scientific studies:

- Additional food quality and nutrition parameters were better with organic farming
- Organic farming also improved the physical attributes; showed higher nutritive values than their conventionally grown counterparts; have higher disease fighting antioxidants

Conclusion

- **It is clear that the consolidated holistic evidence is in favour of organic and natural farming over chemical-dependent inorganic farming. Organic and natural farming approaches are not only profitable and sustainable but also productive**
- **It is also evident that organic approach has fared better than integrated approach on profitability and sustainability and is at par with it in the case of productivity**
- **It is also clear that the strength of this consolidated evidence is high. It is holistic, comprehensive and robust.** (covers almost all relevant aspects; both organic and natural farming; multiple dimensions within each; compares organic with inorganic and integrated both)
- **It is also clear that one major part of this evidence, which is developed based on results of the AI-NPOF, failed to receive the attention that it deserved by policy makers and larger scientific community at the centre as well as in states.**

Way ahead

Recommendations

1. It is critical that the evidence consolidated is well recognized and accepted by the larger scientific community, which can play a big role in spreading awareness, building capacity and influencing policymakers
2. It is important that the holistic evidence consolidated on organic and natural farming is considered, while assessing their benefits and advantages, instead of just focusing singularly on yield
3. All ongoing and future action should be aligned and informed by the strong evidence consolidated in favour of organic and natural farming
4. Develop a roadmap that sets the long-term agenda for adoption of agro-ecological approaches across different parts of the country
5. Specifically, focus on supporting farmers during the transition to organic and natural farming through technical and financial support

For information, contact:

Amit Khurana
Director
Sustainable Food Systems programme, CSE
k_amit@cseindia.org

Abhay Kumar Singh
Programme Manager
Sustainable Food Systems Programme, CSE
abhaykumar.singh@cseindia.org

Abdul Halim
Deputy Programme Manager
Sustainable Food Systems Programme, CSE
abdul.halim@cseindia.org