Farmers' participatory on-farm testing (FP-OFT) of organic and conventional systems on productivity, soil and grain quality of aromatic rice in India

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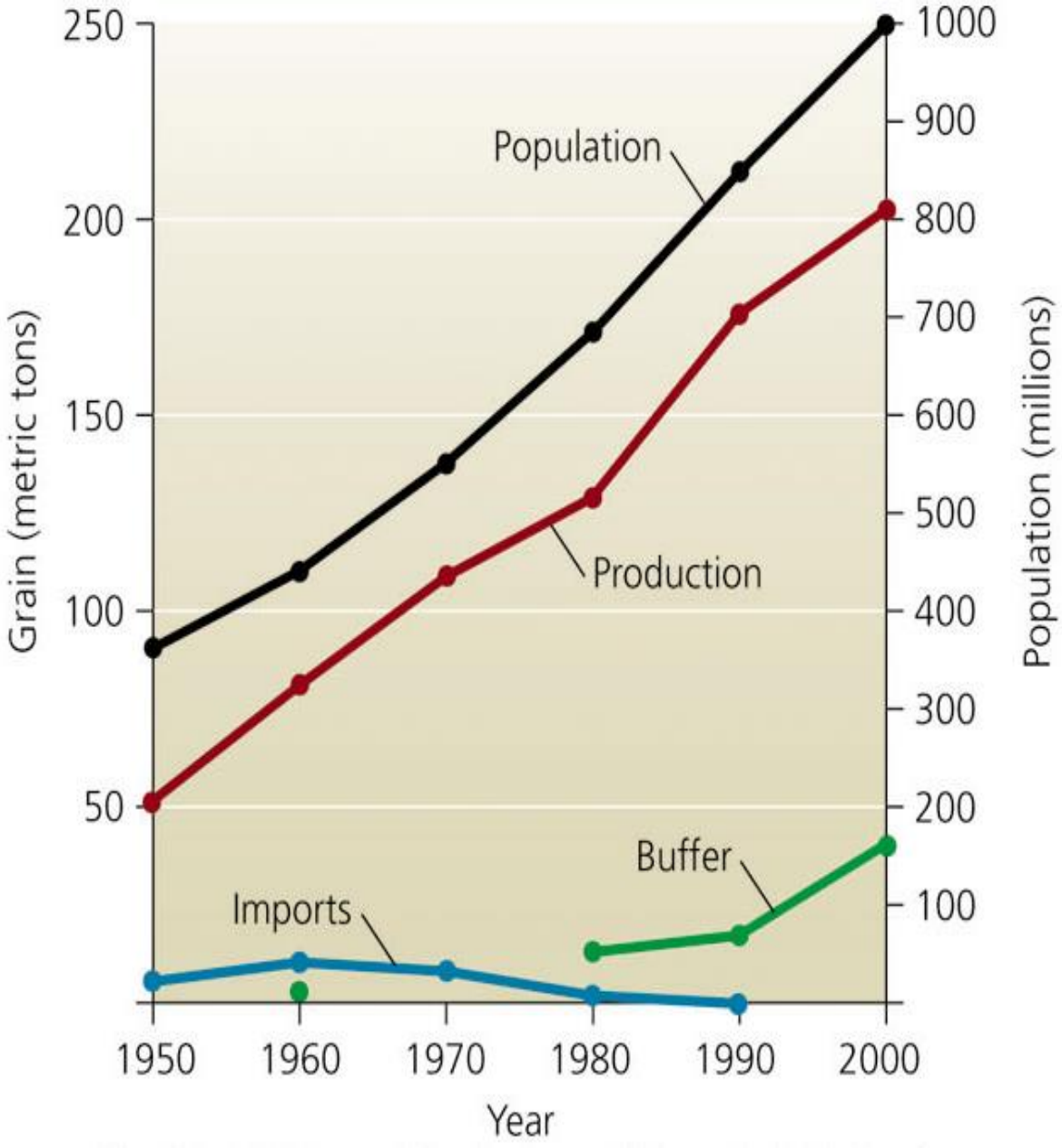
The Indian green revolution



GR was due to:

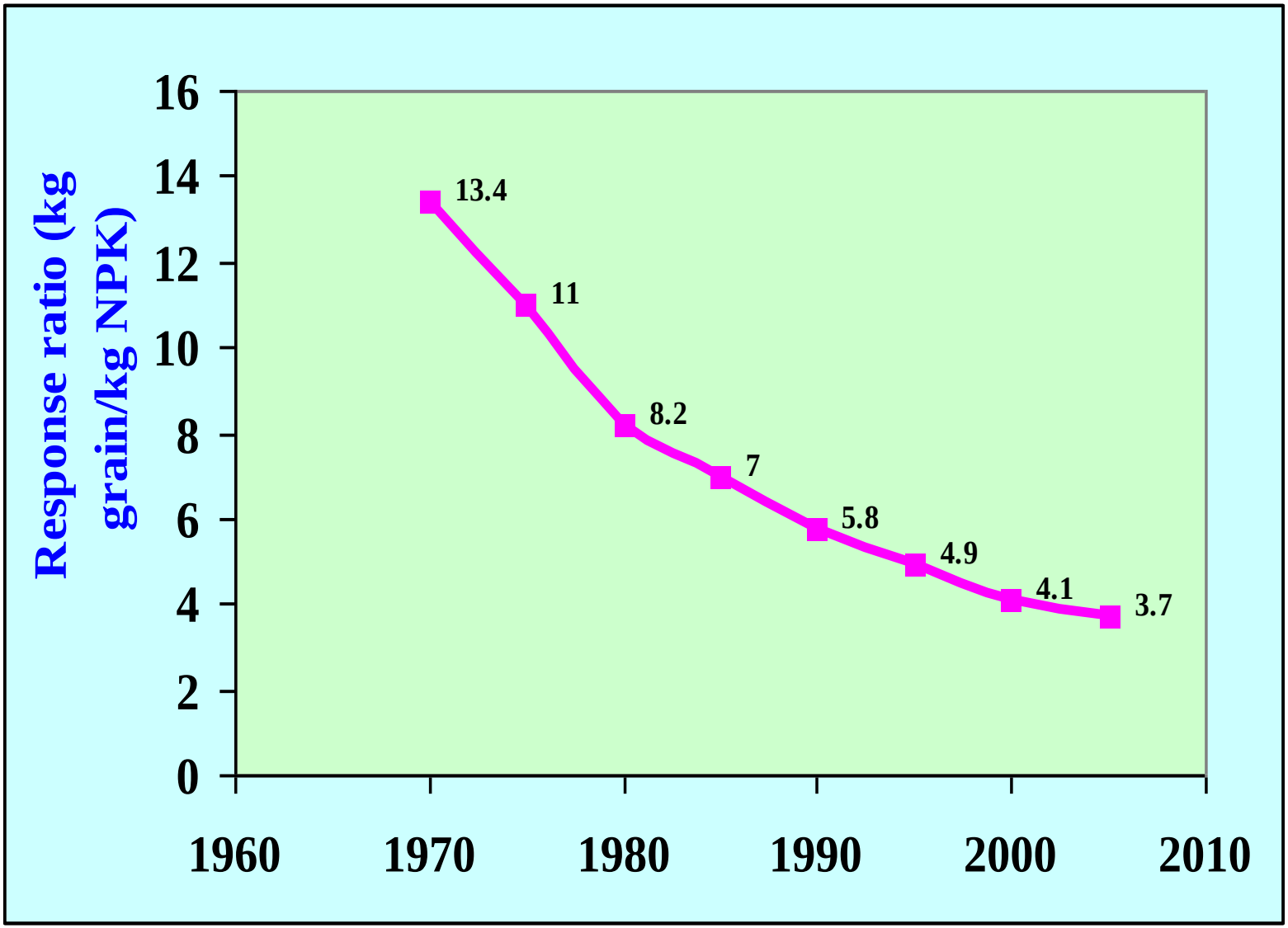
- ✓ **Adoption of HYVs**
- ✓ **Use of agro-chemicals**
- ✓ **Irrigation**

The green revolution enabled India's food production to keep up with population growth.

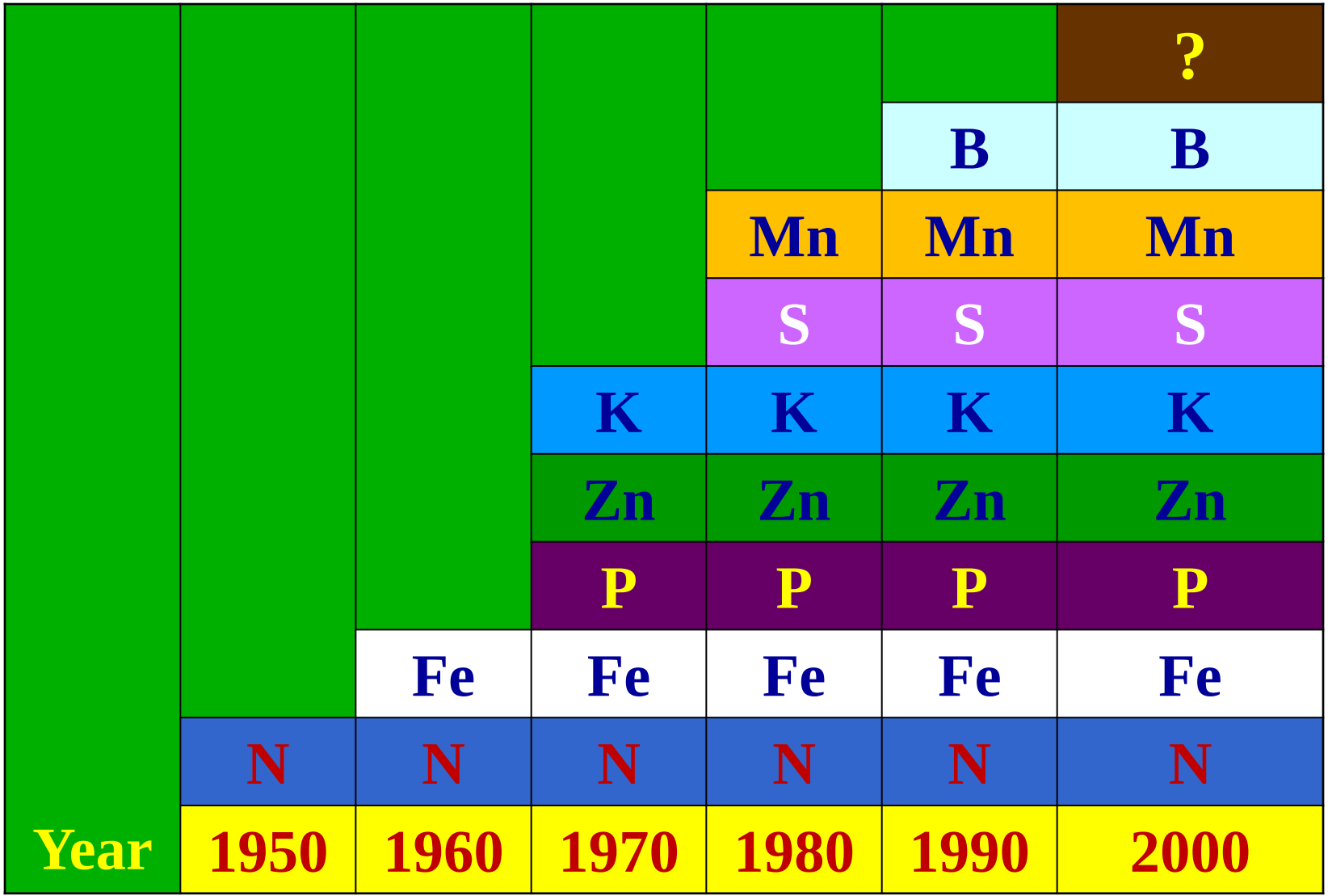
Adverse impacts of Green Revolution

- Soil fatigue due to intensive cultivation
- Stagnation of HYV yield
- Decrease in input use efficiency/ factor productivity
- Declining water table
- Increase susceptibility to pest & diseases
- Pest becoming tolerant to pesticides
- Increased soil salinity
- Serious imbalance in nutrient status
- Deficiency in secondary & micronutrients i.e. S, Zn, B,Fe, Mn, Mo including universal deficiency of N,P,K
- Nitrate contamination in ground water
- Accumulation of heavy metals like Arsenic, Lead & Cadmium
- Presence of pesticide residue in food material and milk etc
- Ever increasing subsidy burdens

Declining Fertilizer Response



Emerging Multi-Nutrient Deficiencies in Soils



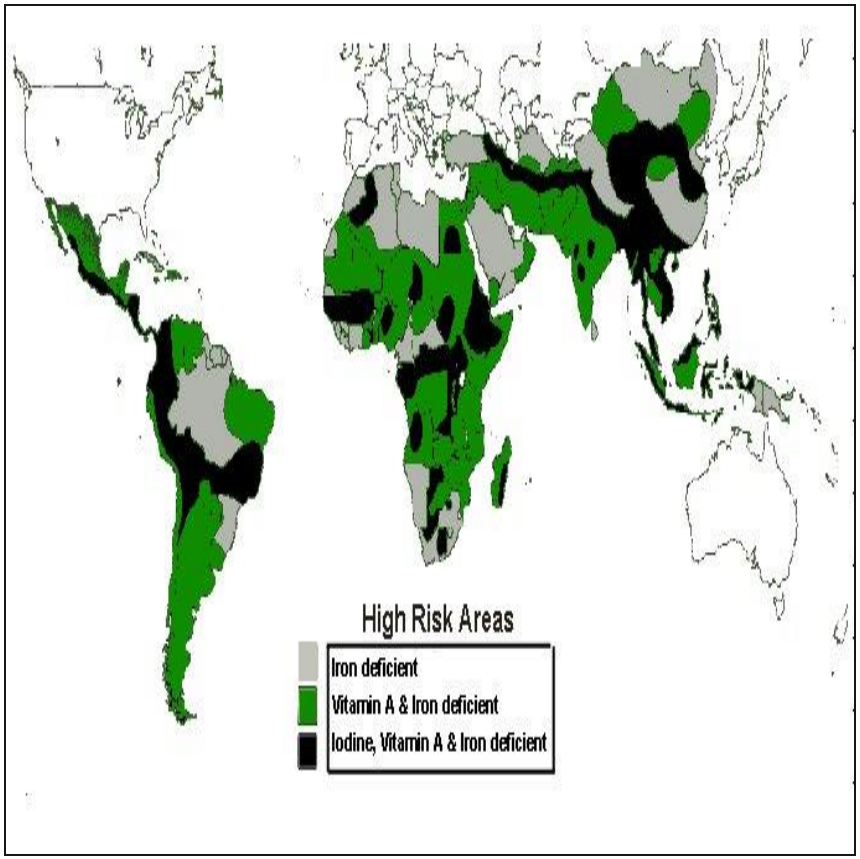
Deteriorating balance in NPK

The N-P-K ratio worsened acutely in certain states

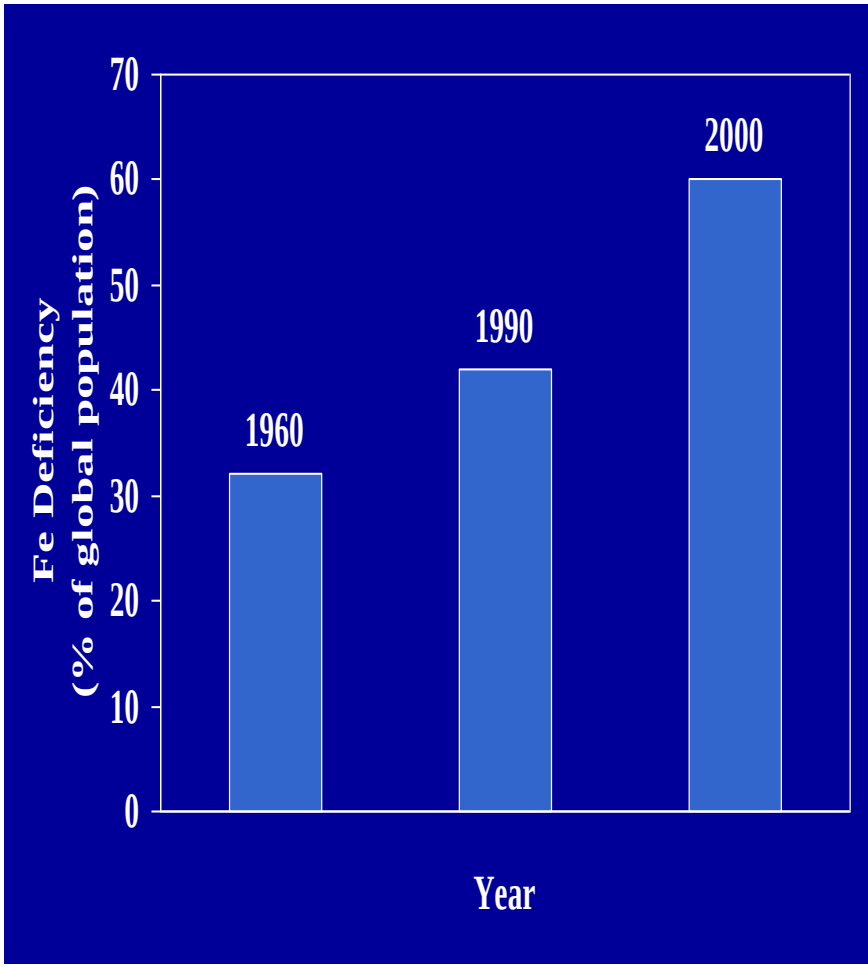
NPK Ratios across states in India for 2013			
EAST		**SOUTH**	
Bihar	12.3 : 3.6 : 1	Andhra Pradesh	7.1 : 2.8 : 1
Orissa	6.2 : 2.4 : 1	Karnataka	3.6 : 1.6 : 1
West Bengal	2.9 : 1.6 : 1	Tamil Nadu	3.9 : 1.5 : 1
NORTH		**WEST**	
Haryana	61.4 : 18.7 : 1	Gujarat	13.2 : 3.4 : 1
Punjab	61.7 : 19.2 : 1	Maharashtra	3.5 : 1.8 : 1
Uttar Pradesh	25.2 : 8.8 : 1	Rajasthan	44.9 : 16.5 : 1

NPK ratio of **4:2:1** ($N:P_2O_5:K_2O$) is generally considered ideal

Micronutrient Deficiencies



(Map from USAID)



Change in Prevalence of Iron Deficiency Globally

> 3 billion people afflicted

Nitrate pollution and human health

- Methaemoglobinemia
- Thyroid problems
- Reproductive problems
- Stomach and gastrointestinal cancer

Image: This train that travels through Bhatinda to Bikaner, Rajastan is also known as the cancer train. It routinely carries cancer patients from Bhatinda who travel to Bikaner for treatment at the government's regional cancer center.

Greenpeace India (2009)

Plates loaded with pesticides: Survey

Scope of Organic Farming in India

Areas having vary low levels of fertilliser consumption e.g. hilly, rainfed, North-Eastern states.

Seventy districts in the country consuming less than 25 kg/ha of NPK eg. Assam (10), Jharkhand (5), Himachal Pradesh (2), Uttar Pradesh (8), Uttarakhand (8), Madhya Pradesh (7), Chattishgarh (1), Rajasthan (13) and North Eastern Region (16).

Rainfed Agriculture

- Covers 66% of the net sown area, 91% coarse cereals, 90% Pulses, 85% oilseeds, 65% Cotton are rain fed

Main organically grown crops in India

Cereals: **Basmati rice,** Wheat, Maize

Pulses: Red gram, Blackgram, Greengram, Bengal gram

Spices: **Candamon, Black pepper, Ginger, Turmeric, Clove, Vanilla**

Vegetables: **Cabbage, Cauliflower, Broccoli, Okra, Potato, Onion, Garlic**

Fruits: **Mango, Banana, Pineapple, Grape, Orange, Cashew nut**

Commodity: Tea, Coffee.

Cash Crop: Cotton

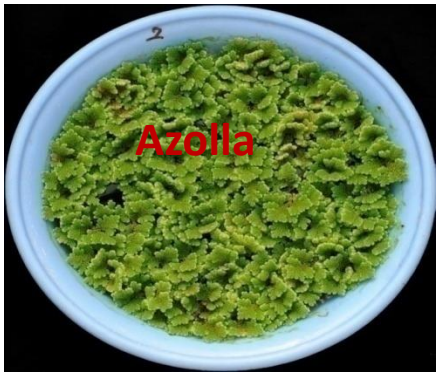
TREATMENTS

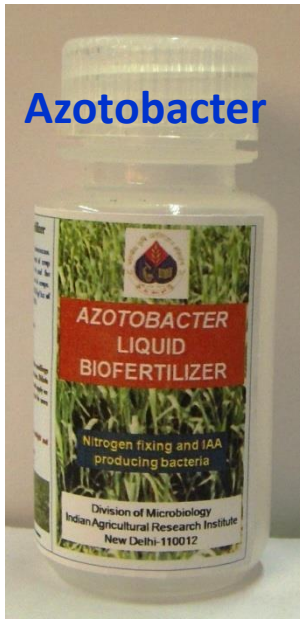
Crop nutrition (main plot)

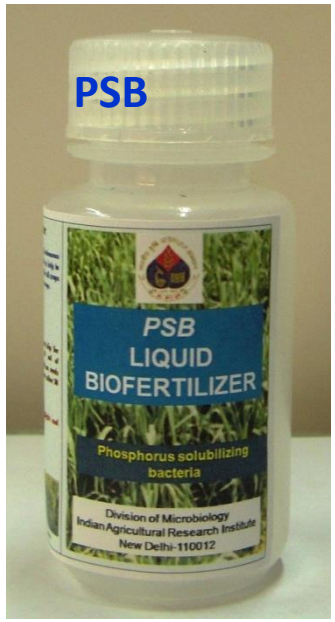
T1: Organic (BGA@ 2.0 Kg/ha + *Azolla* @ 1.0 t /ha or *Azotobacter* @ 0.5 kg/ha + FYM @5.0 t/ha + Vermicompost@ 2.0 t/ha)

T2: INM (FYM 5 t/ha + Chemical Fertilizer $N_{90}P_{60}K_{60}$)

T3: Chemical fertilizer alone $N_{120}P_{60}K_{60}$ (Recommended dose)

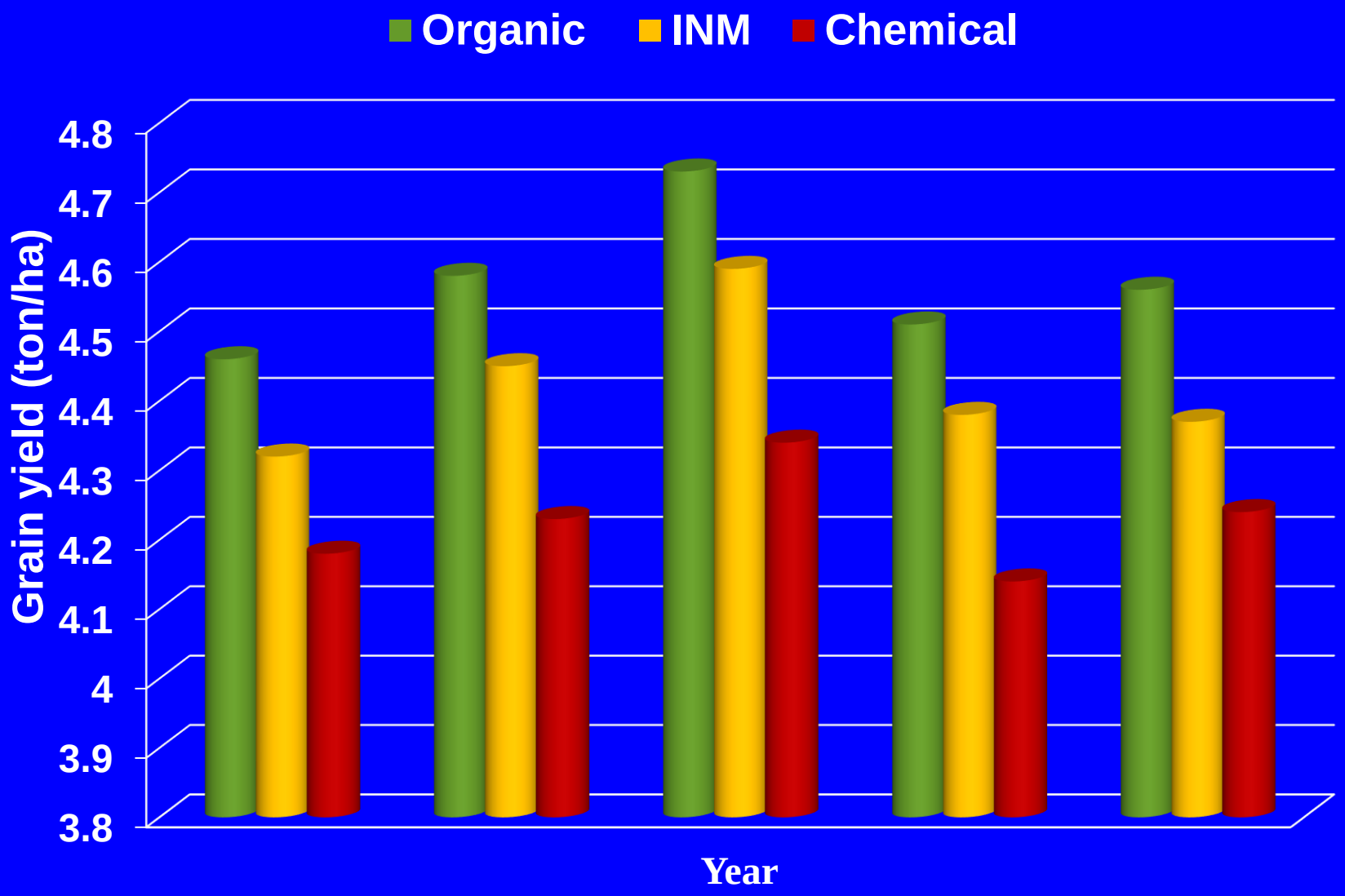




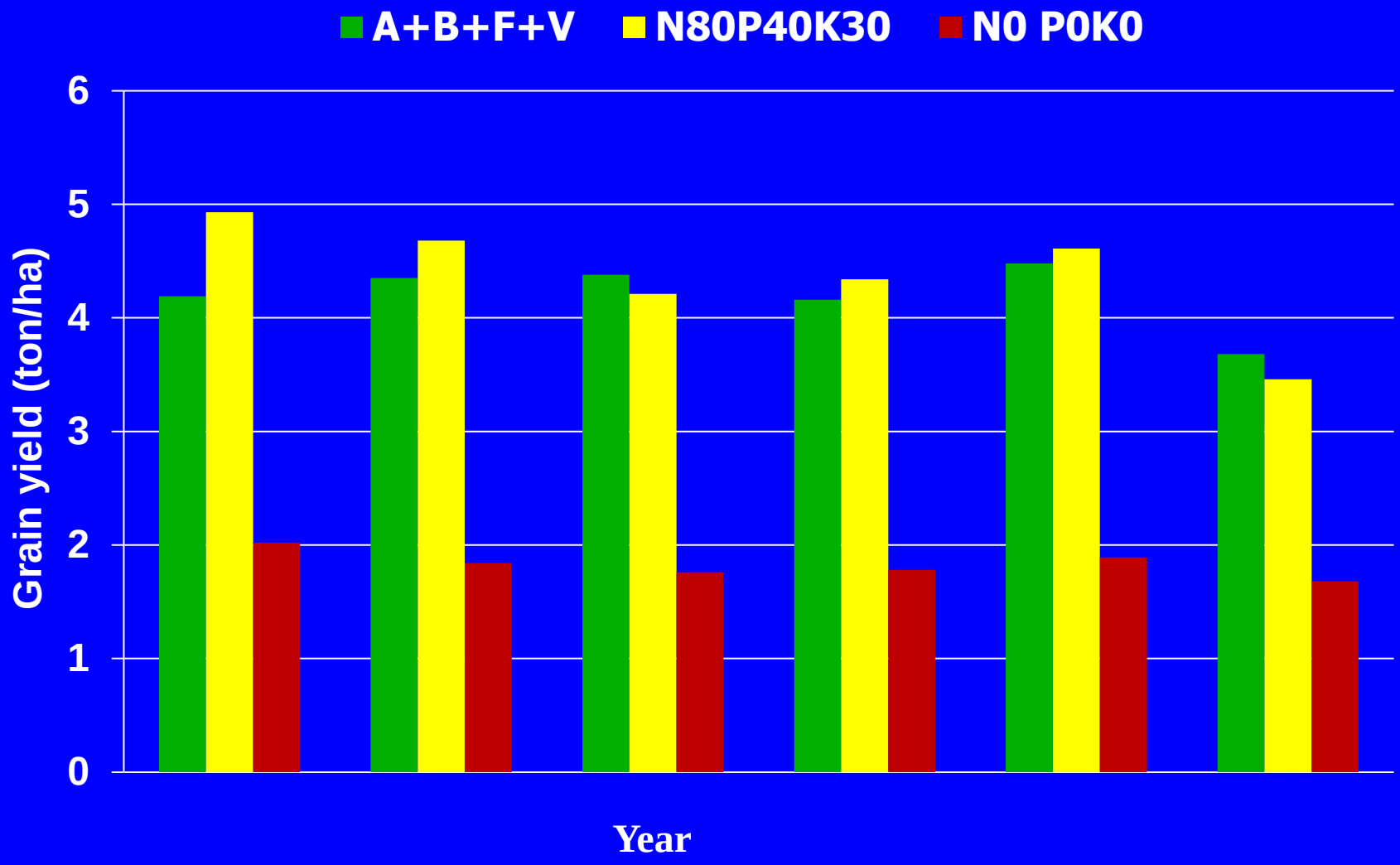


Organic inputs uses

Effect of nutrition practices on aromatic rice grain yield (2018-22)



Effect of rice nutrition practices on grain yield during 2013-18



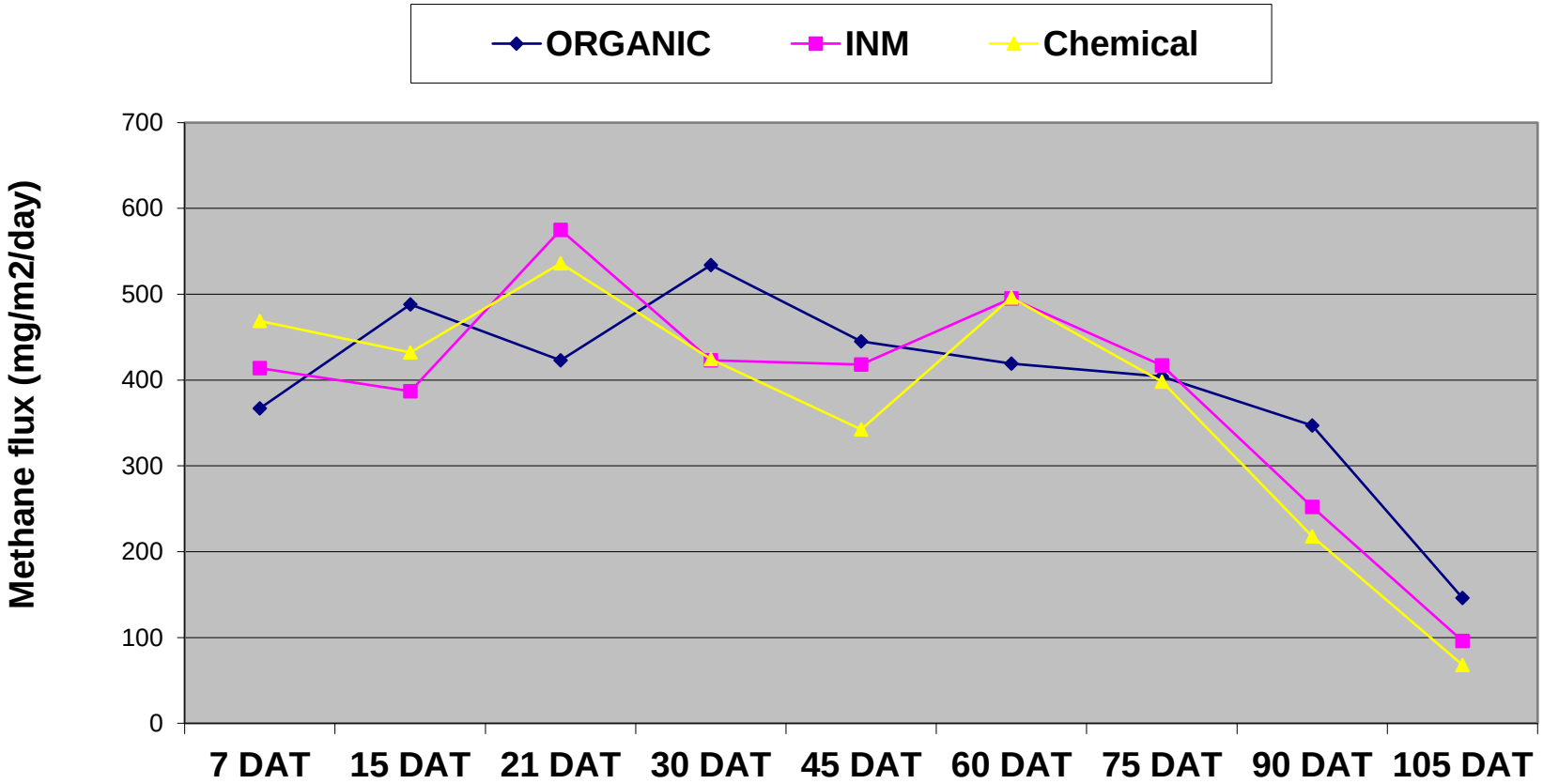
Yield and economics of aromatic rice (cv. PB 6) under different methods of nutrition

Treatment	Grain yield (tonne/ ha)	Straw yield (t/ha)	Harvest Index	Cultivation Cost (Rs/ ha)	Gross return (Rs/ ha)	Net return* (Rs/ha)	Net return** (Rs/ ha)
Organic	4.56	11.34	28.7	48393	125,340	76,947	1,05,447
INM	4.37	10.81	28.8	41424	120,060	78,636	
Chemical (control)	4.24	10.76	28.3	37783	116,760	78,977	
CD at 5%	NS	0.36	NS				

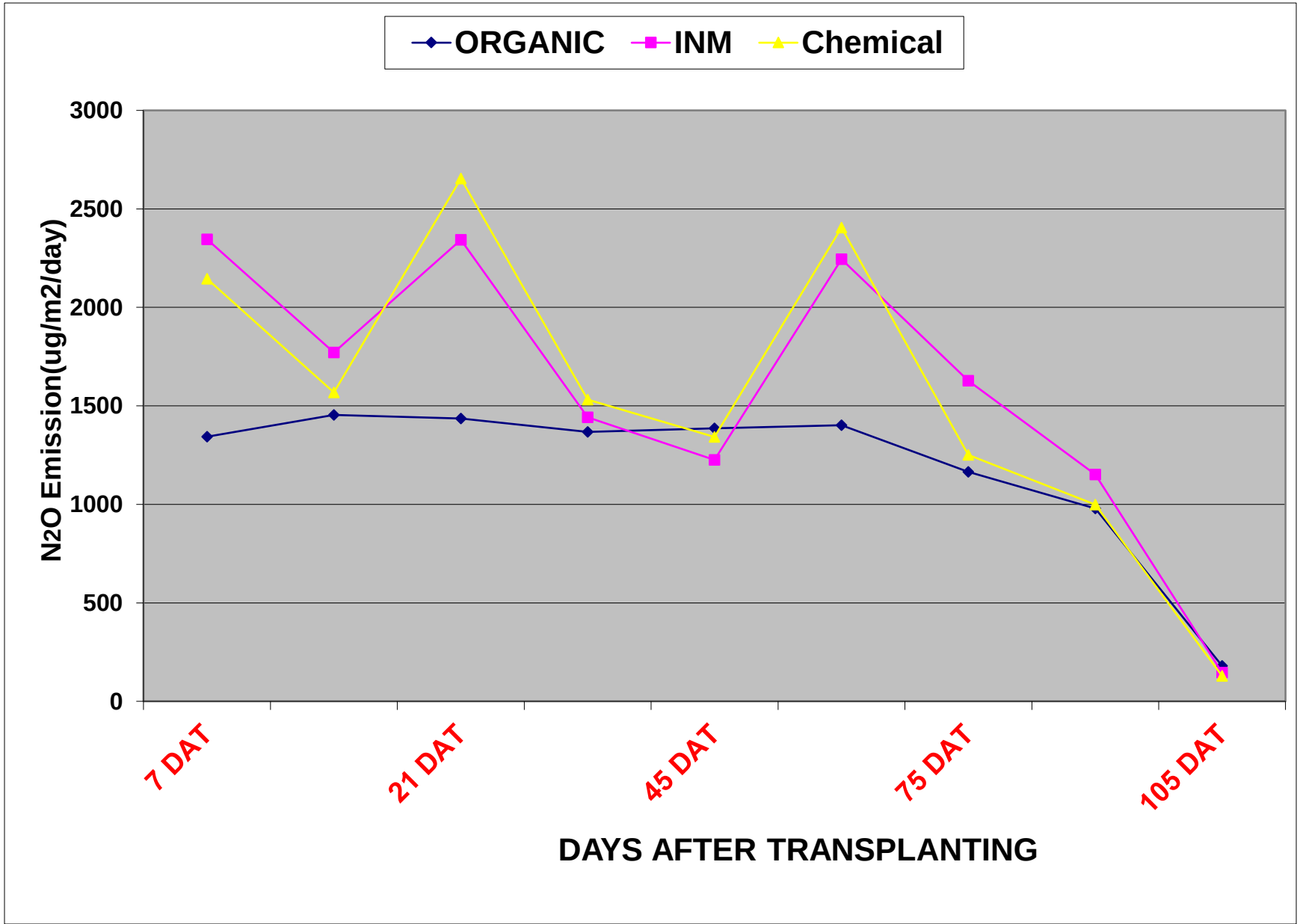
*at equal price
** at 25% premium price
Price / kg : Paddy Rs 25
Straw Rs 1

1 Dollar = 81 INR

Seasonal Methane flux in rice field under different crop nutrition



Seasonal Nitrous oxide emission from rice fields under different nutrition



Total Methane and Nitrous oxide emission (kg/ha) and Global Warming Potential(GWP) in rice field under different crop nutrition

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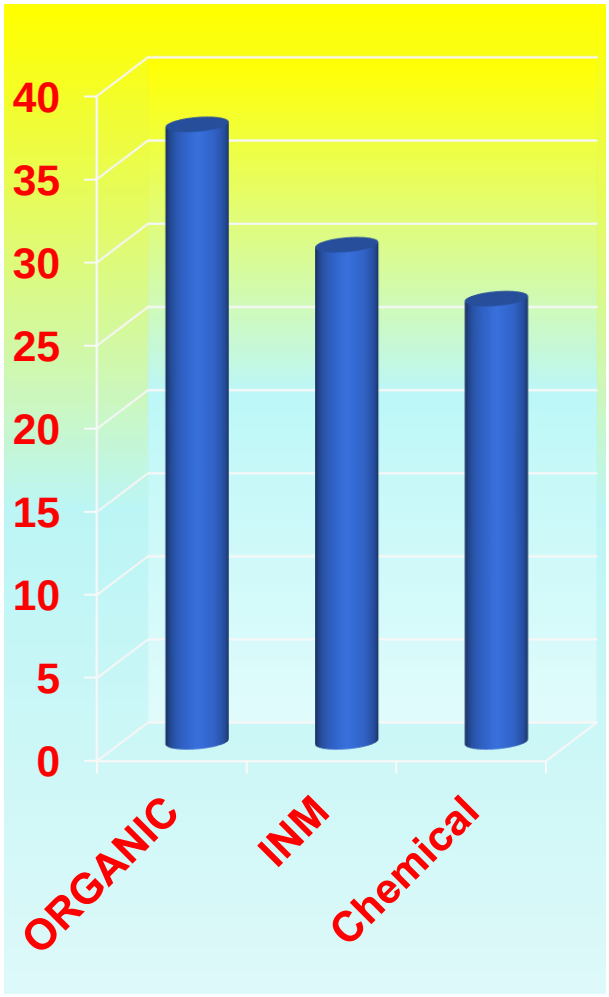
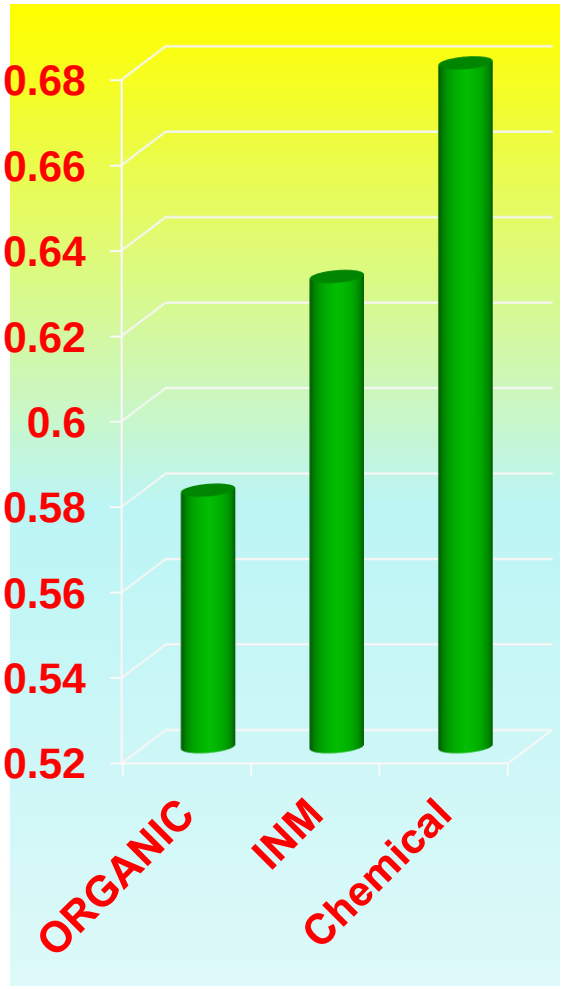
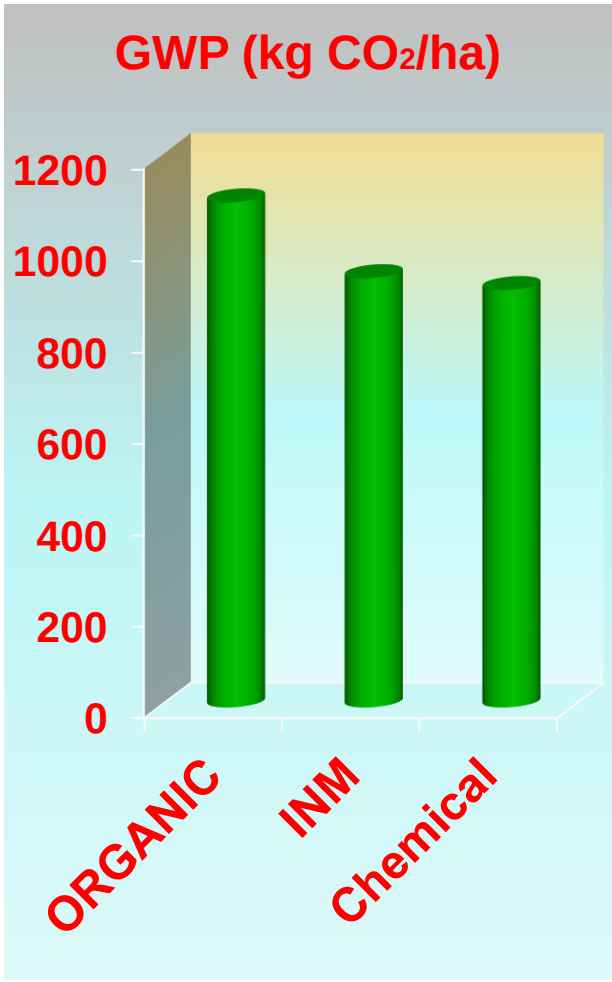
Total Methane emission



Total Nitrous oxide emission



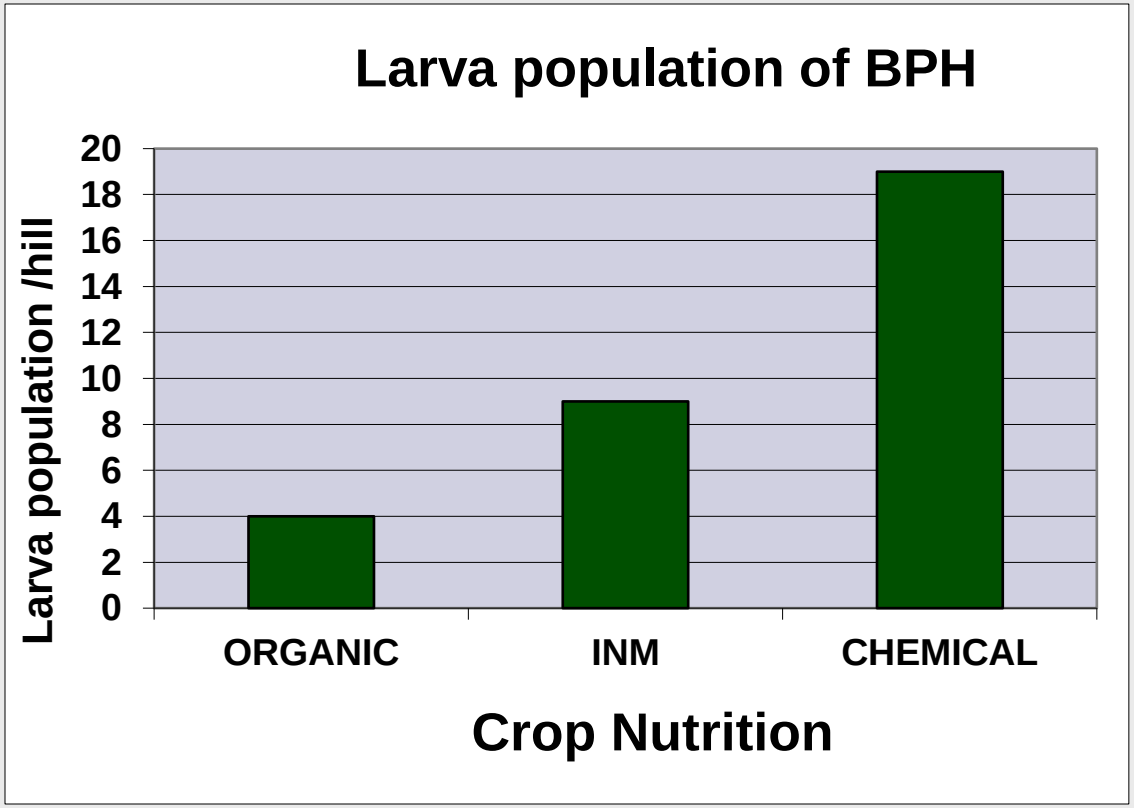
Global Warming Potential



For production of one kg urea 610 g CO_2 emitted for production (260 x .61 = 160)

For production of 1.0 ton of Ammonia 1.52 to 3.06 ton CO_2 is produced (PSI,2004)

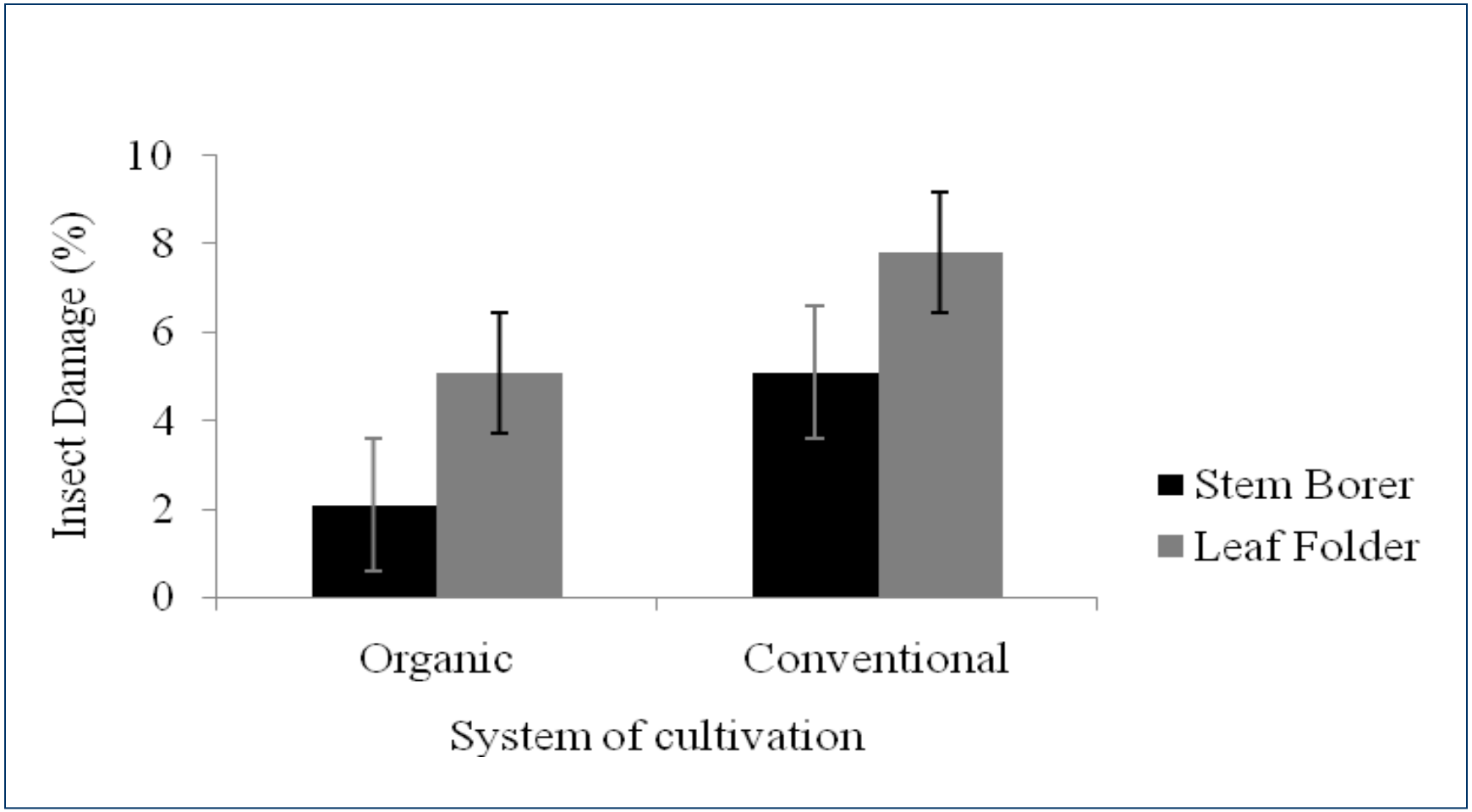
- There was no serious incidence of any insect pest or disease in organic farming though there were severe incidences of BPH in some rice fields in inorganic fertilized fields



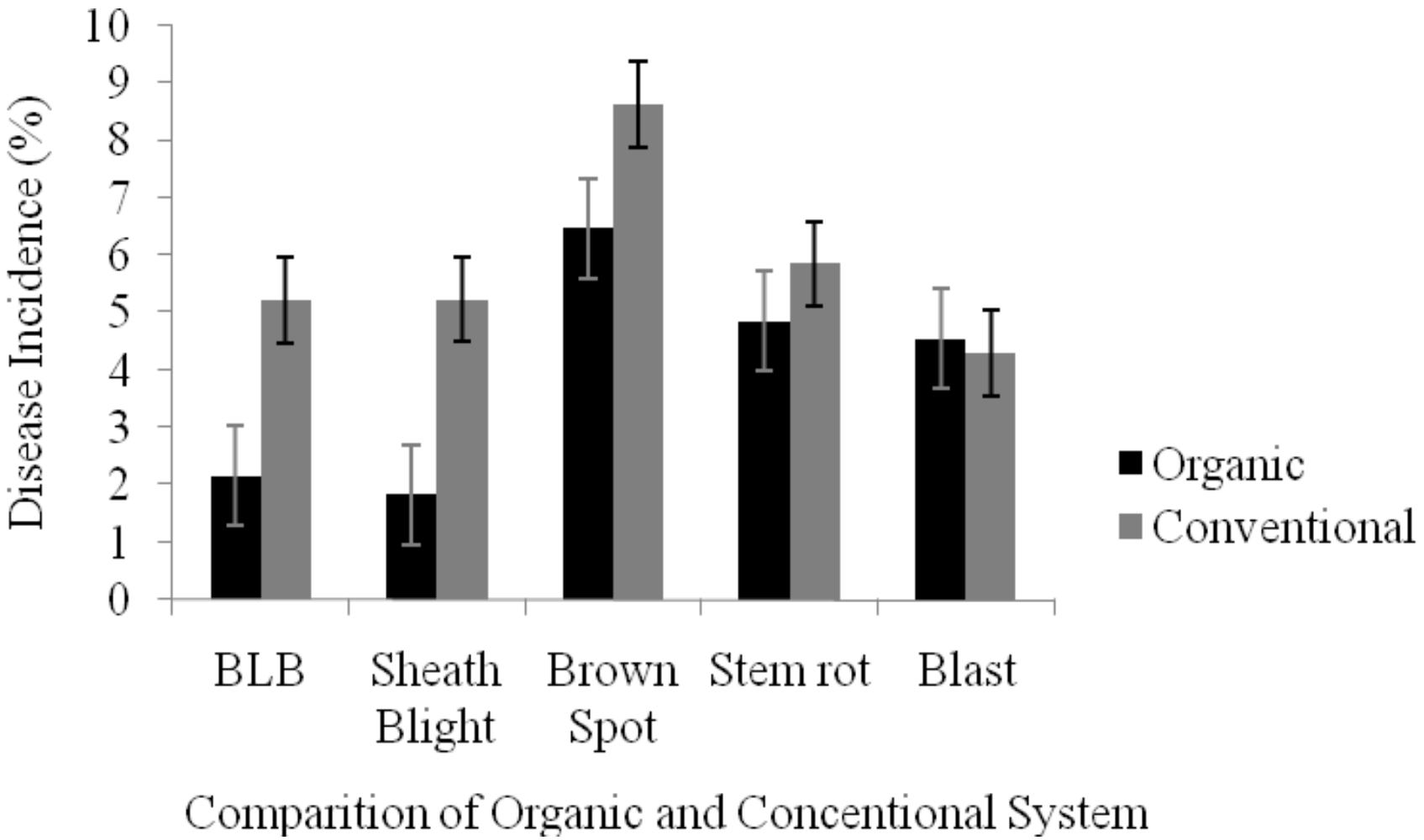
- Higher population of beneficial insects like spiders & earthworms was found under OF over inorganic and INM treatments.

There was no serious attack of any insect pest or disease in organically grown rice crop.

Damage by Insect Pest Infestation under Organic and Conventional Aromatic Rice Cultivation



Disease Incidences under Organic and Conventional Aromatic Rice Cultivation



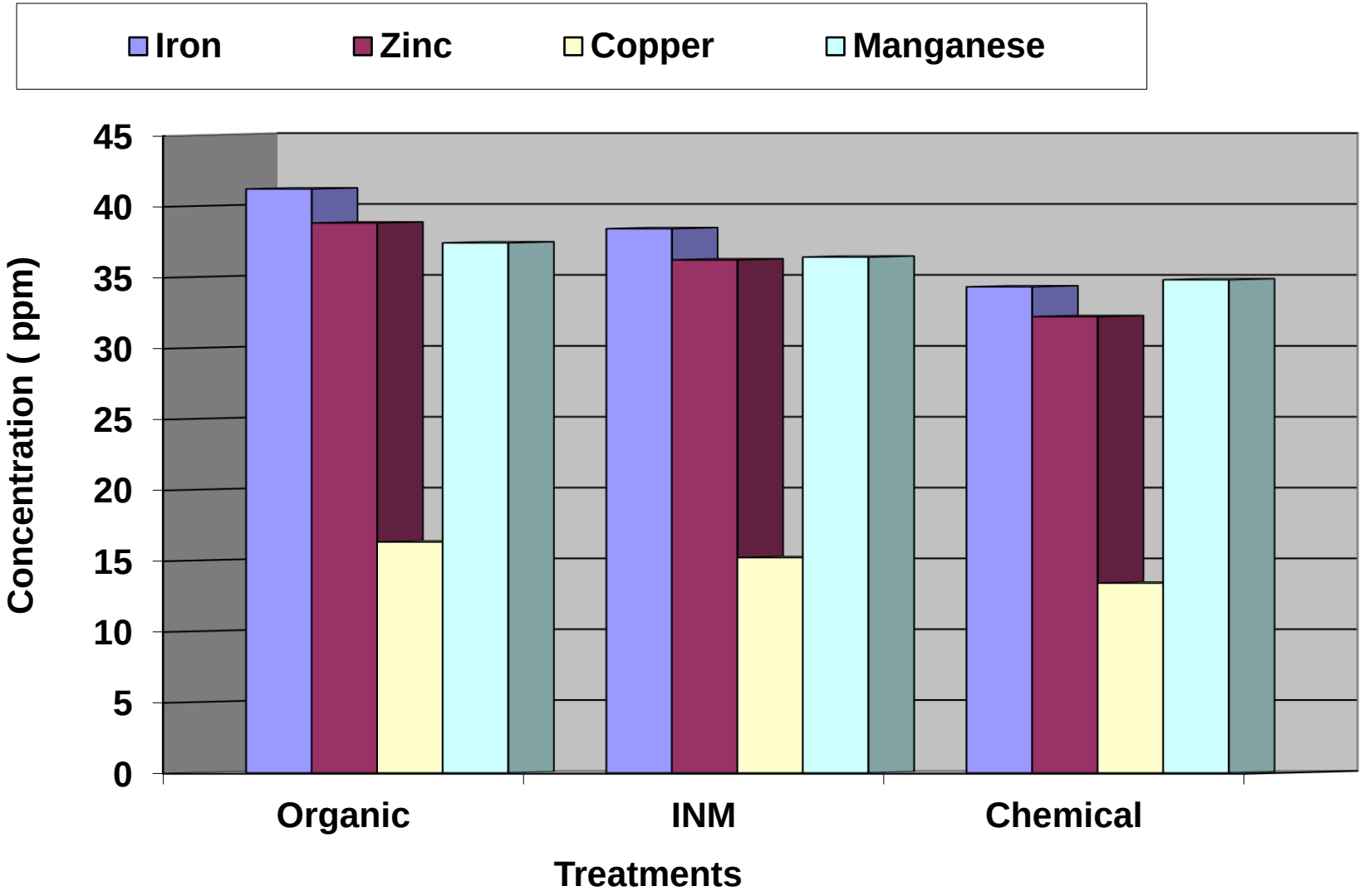
On-farm Testing

Treatment	RICE		WHEAT	
	CSR 30	PB 1121	HD 2851	C 306
Organic	4.03[a]	4.47[a]	4.52[a]	3.86[a]
INM	4.16[a]	4.56[a]	4.39[a]	3.78[a]
Chemical	3.85[b]	4.23[b]	4.16[b]	3.51[b]
LSD (P=0.05)	0.23	0.28	0.14	0.24

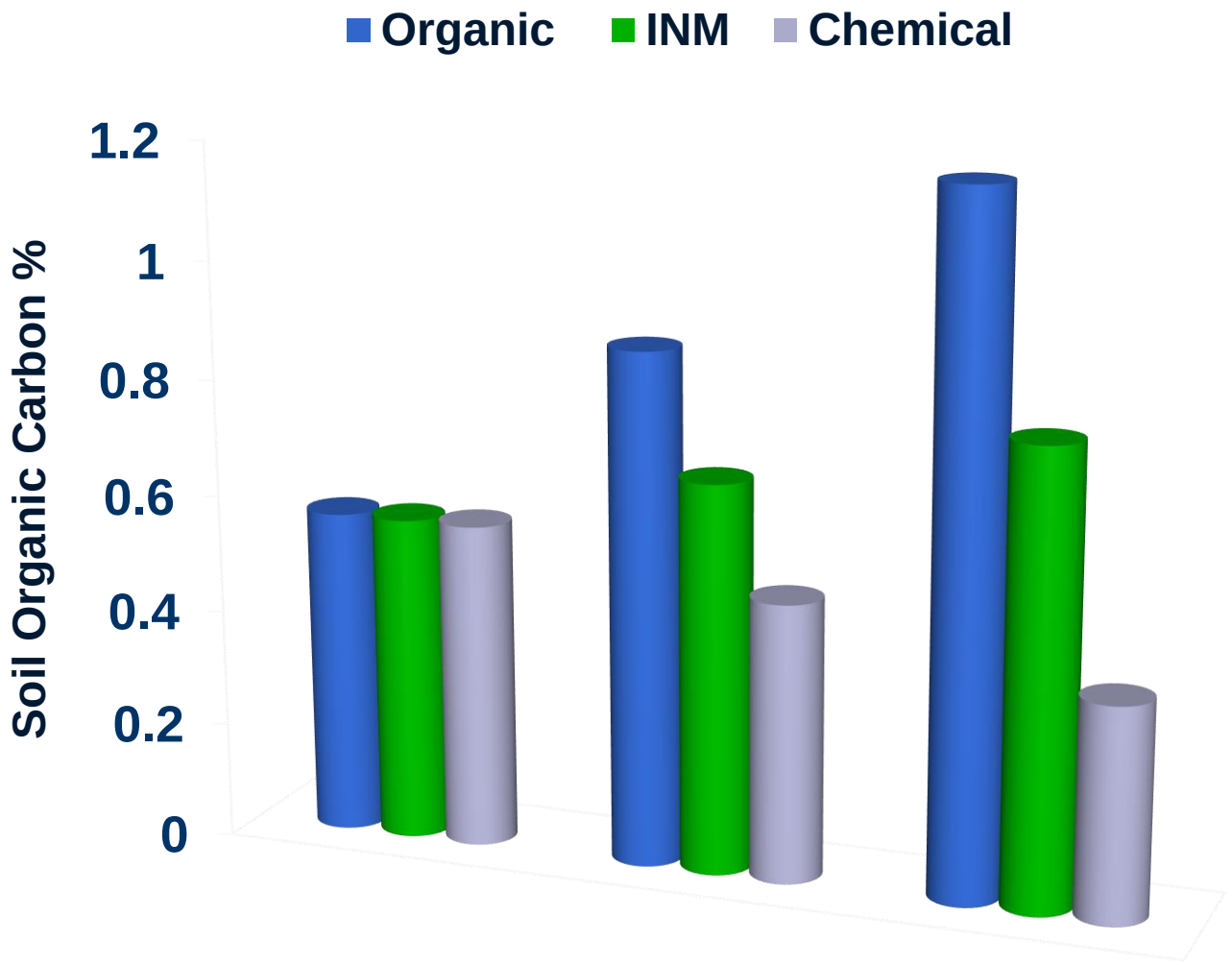
Effect of crop nutrition on Nitrogen, Phosphorus and Potassium concentration in grain and straw of rice

Treatment	N conc. in grain (%)	Protein content (%) in grain	N conc. in straw (%)	P conc. in grain (%)	P conc. in straw (%)	K conc. in grain (%)	K conc. in straw (%)
Organic	1.32	7.85	0.52	0.25	0.13	0.32	1.64
INM	1.35	8.03	0.55	0.26	0.14	0.33	1.67
Chemical	1.29	7.68	0.50	0.22	0.11	0.28	1.64
LSD (P=0.05)	NS	0.23	0.04	0.02	NS	0.02	0.05

Effect of crop nutrition on concentration of iron, zinc, copper and manganese in rice grains



Soil Organic Carbon Status In Rice Fields At Crop Harvest Under Different Crop Nutrition At 5 Year Interval



Effect of different organic treatments on microbial population and dehydrogenase enzymatic activity in soil at mid crop stage of rice

Treatment	2018					2022				
	1*	2 *	3*	4*	5*	1*	2 *	3*	4*	5*
A+B+F+V	311	360	34	27	128	506	673	79	95	241
$N_{120}P_{40}K_{30}$	197	371	44	13	103	147	268	38	36	123
$N_0 P_0K_0$	201	356	27	2	96	132	298	21	10	87

INITIAL MICROBIAL POPULATION OF ACTINOMYCETES, BACTERIA, FUNGI AND BGA IN A COMPOSITE SOIL SAMPLE BEFORE STARTING OF EXPERIMENTATION IN JUNE 2003 WAS 74, 203,14 AND 3, RESPECTIVELY

1* = Actinomycetes x 10^3

2*= Bacteria x 10^3

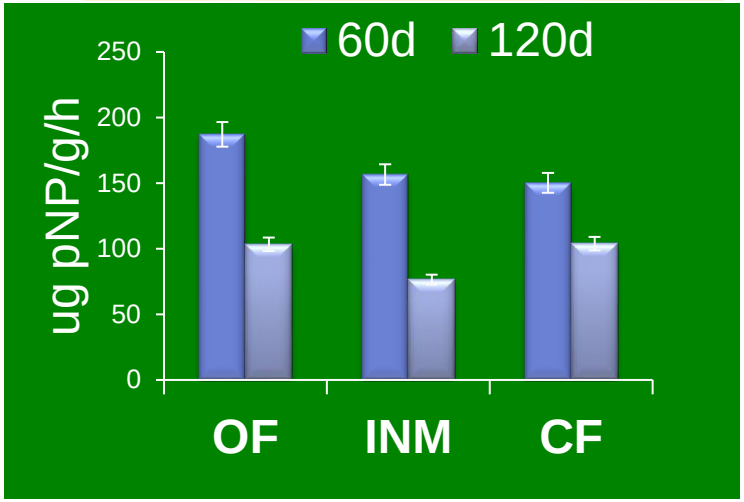
3* = Fungi x 10^3

4*= BGA x10^3

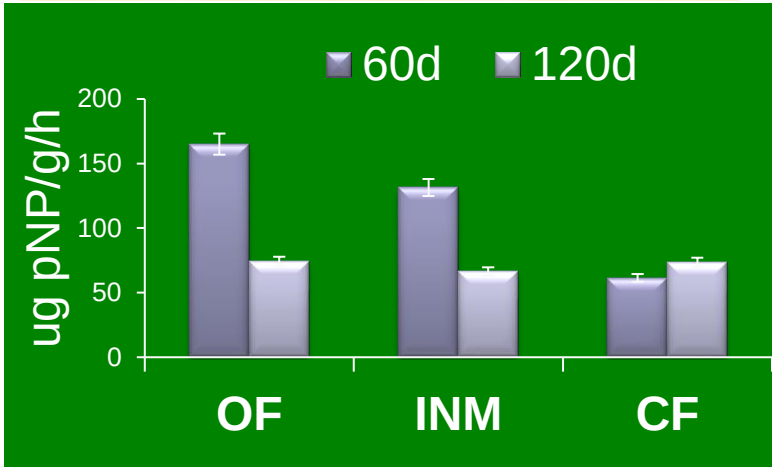
5* = Dehydrogenase enzyme activity

Effect on soil microbial parameters

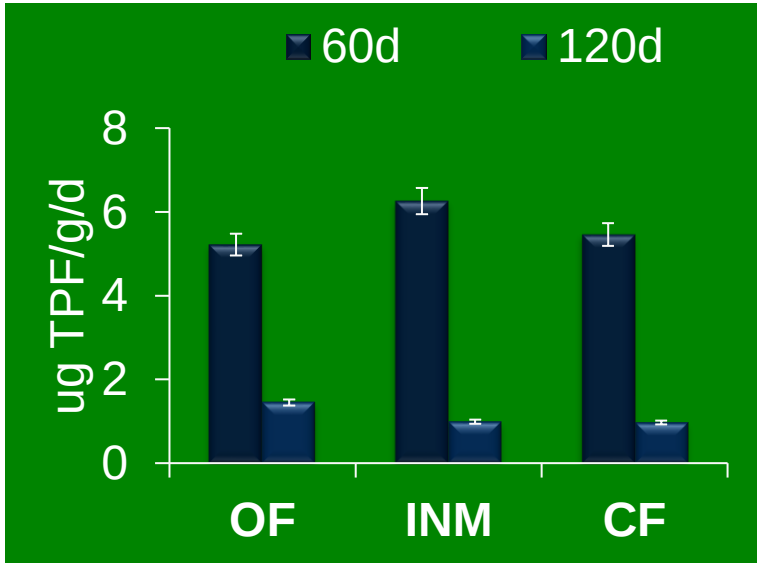
Acid Phosphatase activity



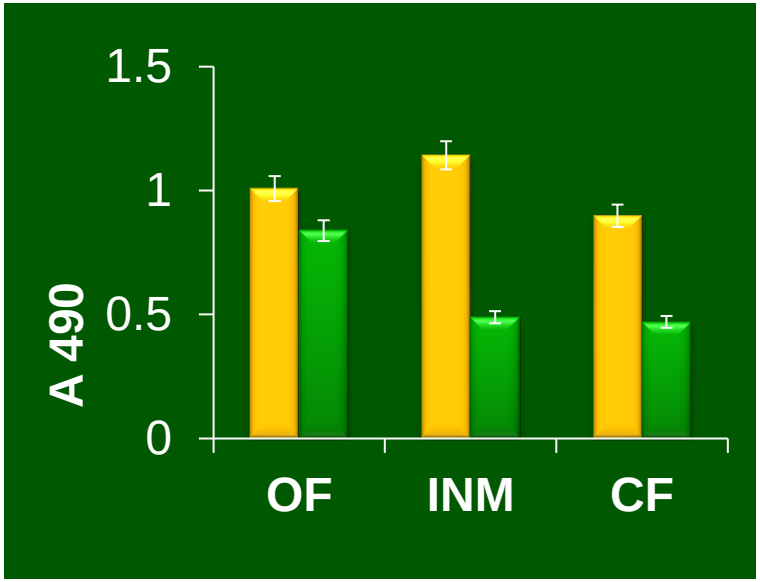
Alkaline Phosphatase activity



Dehydrogenase



FDAse activity



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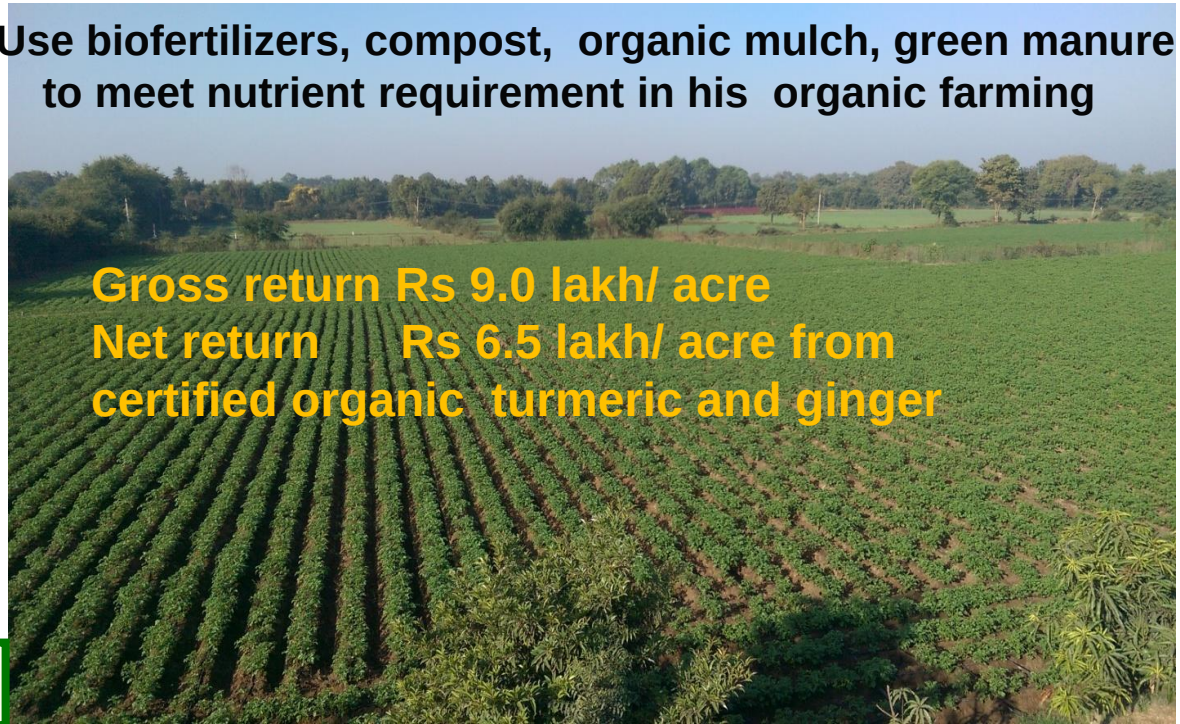
Success story of Devesh Patel, Anand (Gujarat), Organic turmeric, ginger and potato farming

Use biofertilizers, compost, organic mulch, green manure to meet nutrient requirement in his organic farming



Gross return Rs 9.0 lakh/ acre
Net return Rs 6.5 lakh/ acre from certified organic turmeric and ginger

CONCLUSIONS

- Yields with organic nutrient management was at par with INM and higher than chemical fertilization.
- Less incidence of insect- pest or disease in OF
- Organic farming was profitable only when produce are sold at premium price.
- Macro- and micro-nutrient concentrations significantly increased in grains due to OF over chemical fertilization.
- Soil carbon content was considerably built up under organic farming.
- Soil physical and microbial quality improved due to organic farming.
- Methane emission was slightly higher in OF but NO_2 was lower .
- Overall, GHG emissions was at par in all nutrient management practices


The greatest threat to our planet is the belief that someone else will save it.
-Robert Swan
Thank you