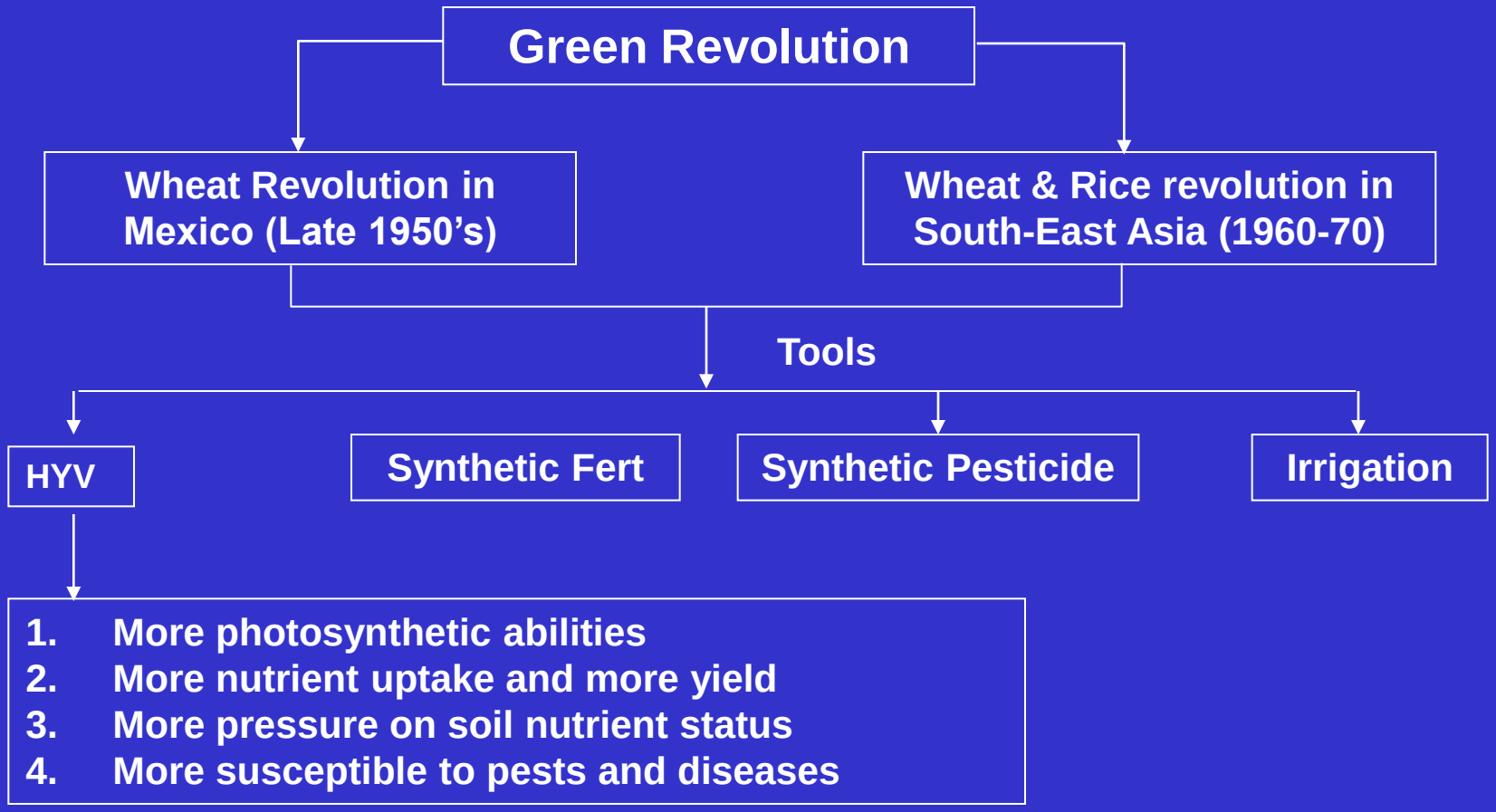
INM FOR SUSTAINABLE CROP PRODUCTION


Green Revolution
Wheat Revolution in Mexico (Late 1950's)
Wheat & Rice revolution in South-East Asia (1960-70)
Tools
HYV
Synthetic Fert
Synthetic Pesticide
Irrigation
1. More photosynthetic abilities
2. More nutrient uptake and more yield
3. More pressure on soil nutrient status
4. More susceptible to pests and diseases

Three major events led to chemical input intensive revolution in Agriculture

1. Successful synthesis of NH3 by by Fritz Herber (1907)
2. Discovery of remarkable insecticidal power of DDT by Dr.Paul Muller (1939)
3. Introduction of dwarfism
    i. Norin-10 into Mexican wheat by Norman Borlaug
    (1954) and
    i. Dee-geo-woo –gen into tall Indonesian rice variety at IRRI (1966)

SYNTHETIC FERTILIZER
(Example of adverse affects)

$N \equiv N \longrightarrow NH_3$ First revolutionary chemical reaction by Fritz Haber, a German scientist, Nobel Prize winner (3rd decade of 20th century)

1. Urea : $Co(NH_2)_2 \longrightarrow NO_3^-, NH_4^+$

Free radials from urea application ------ NO_3^-, NO_2^- ⟶ harmful

Haematoglobimea (Blue disease syndrome)
>10 ppm ⟶ O_2 carrying capacity decreases

Free NO_3^- accumulation in animal cells

NH_2NO(Nitrosamine)
(Carcinogenic affect)

2. LEAD AND CADMIUM CONTENT INFERTILIZER (ppm) :

Fertilizer	Lead	Cadmium
Urea	4	1
SSP	609	187
DAP	188	109
RP	1135	303
MOP	88	14

Harmful effect of chemical fertilizer

Glasgow university scientists (1993)

↓

Found link between levels of nitrate in vegetables and gullet cancer due to increase use of nitrate fertilizer since world war II

Harmful effects of insecticide

Norman Moore – A British Scientist first to suggest the decline of population of eagles due to use of DDT

↓

Rachel Carsons book Silent Spring – Did much to popularize Moore's theory

↓

Progressive concentration of DDT

↓ 0.02 ppm in water

↓

5ppm in plankton

↓

40---300 ppm in plant eating fish

↓

2500 ppm in carnivorous spp

SYNTHETIC PESTICIDE
(Example of adverse affects)

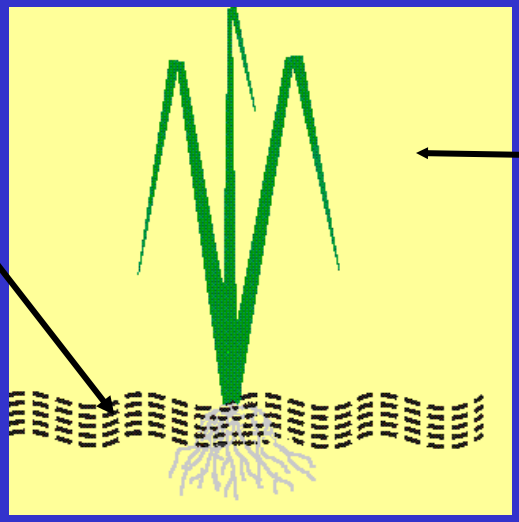
(i) DDT – During 2nd World War Paul Mullar (British) – Insceticidal property.

↓

Silent Spring (Book)–

In California – Lake – DDT was used to repel / kill mosquito – aquatic plants absorbed DDT – Duck ate aquatic plants – Population drastically reduced due to Biomagnification.

(ii) Furadon 3 G



Hispa / Stemborer

Fish
Frog
Earth worm → Dead → Heron → Fox → Vulture

Now, what is the answer?

Organic Farming
or
INM

INM:

INM is a production management system which promotes & enhances agro-ecosystem health, including biodiversity, biological cycles & soil biological activity and this is accomplished by using agronomic methods to reduce the use of synthetic fertilizer to maximum possible extent for higher as well as quality production.

OBJECTIVES of INM :

1. **To produce food of high nutritional quality in sufficient quantity.**
2. **To work with natural system with more scientific design in order to leave a living soil for our next generations.**

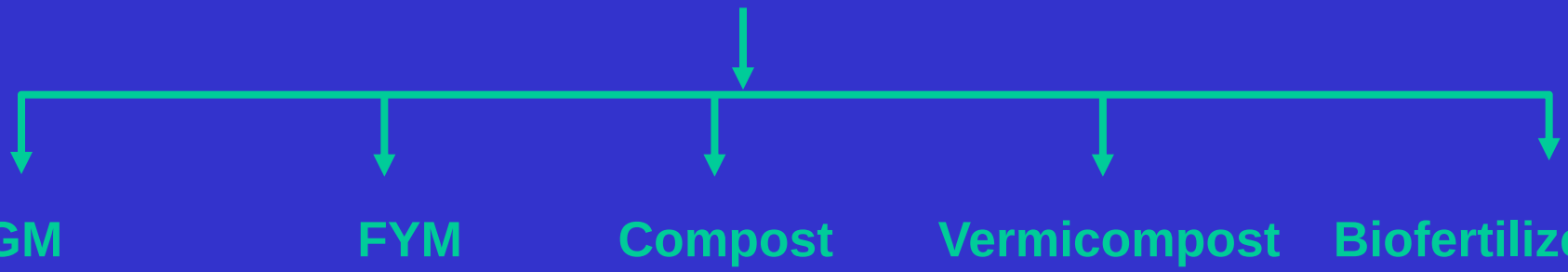
Fertilizer use (India) → Up to 1906 no. chemical fertilizer was used in India

1950-51	------- -------	0.5 kg/ha	INDIA
Now	------- -------	91.0 Kg/ha	
2006-07 (Assam)	------- -------	52 Kg/ha	

PESTICIDES CONSUMPTIONS :

India	------- -------	0.448 Kg/Ha
Japan	------- -------	10-12 Kg/ha
USA	------- -------	8-10 Kg/ha
Asam	------- -------	40.46 gm/ha

SOIL FERTILITY MANAGEMENT IN INM



GREEN MANURING CROPS (45-60 days)

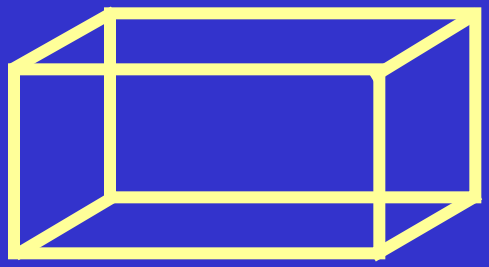
Sl. No.	Crops		Organic matter addition (Kg/Bigha)	N_2-fixation (Kg/ha)
1.	Sun hemp (Crotolaria juncea)		2825.0	55.0
2.	Dhainsa –	S. acculeata	2020.0	86.0
	(Sesbania)	S. rostrata	2400.0	120.0
3.	Green gram		1065.0	25.0
4.	Cowpea		2000.0	37.0
5.	Lathyrus		1640.0	40.0

VERMI COMPOST :

Important verms are :

1. **Eisenia faetida**
2. **Eudrillus euginae**
3. **Perionyx excavatus**

Length = 10 feet
Breadth = 3 feet
Depth = 2-2.5 feet



Ratio of cowdung and agro-waste = 40.60
Average nutrients contents in vermicompost

N	**------- -------**	**2.5-3.0%**
P_2O_5	**------- -------**	**1.0-1.5%**
K_2O	**------- -------**	**1.5-2.0%**

HORMONAL EFFECT
Better plant and root growth

Maximum permissible limit of heavy metals in compost

Parameter	Concentration not to exceed (mg / kg dry basis)	Testing methodology
Arsenic (As)	10.0	IS : 11124-1984
Cadmium (Cd)	5.0	
Chromium (Cr)	50.0	
Copper (Cu)	300.0	AOAC method 975.01-1988
Lead (Pb)	100.0	IS: 12074-1987

AN IDEAL VERMI COMPOST PRODUCTION UNIT

Advantages of Bio-fertilizers

1. 20-50% chemical N replacement
2. 15-25% synthetic P replacement
3. 10-40% grain yd increase
4. 15-30% vegetative growth

Chemical analysis of Soil samples collected from the farmers fields under organic and conventional farming systems

Characteristics	Organic sources*		Integrated nutrient use**		Chemical fertilizer ***	
	Depth (cm)		Depth (cm)		Depth (cm)	
	0-7.5	7.5-15.0	0-7.5	7.5-15.0	0-7.5	7.5-15.0
pH (1:2.5)	7.25	7.25	7.41	7.43	7.51	7.51
Organic carbon (%)	0.60	0.58	0.53	0.52	0.41	0.39
Available N (kg ha^{-1})	2.56	255	224	222	185	184
Available $P_2 O_5$ (kg ha^{-1})	49	49	42	41	29	28
Available $K_2 O$ (kg ha^{-1})	458	459	477	470	426	427
Mineral (ug g^{-1})	70.37	66.00	57.33	54.66	46.28	44.43

* Average of 8 soil samples; ** Average of 6 soil samples; *** Average of 7 soil samples

Source: Anonymous (2002)

Microbiological analysis of Soil samples collected from the farmers fields under organic and conventional farming systems

Characteristics	Organic sources*		Integrated nutrient use**		Chemical fertilizer ***	
	Depth (cm)		Depth (cm)		Depth (cm)	
	0-7.5	7.5-15.0	0-7.5	7.5-15.0	0-7.5	7.5-15.0
Soil microbial biomass C (mg kg^{-1} soil)	272	264	235	229	220	214
Soil microbial biomass N (mg kg^{-1} soil)	39	37	34	31	30	27
Dehydrogenase activity (ug TPF g^{-1} soil 24 hr^{-1})	54	51	45	42	35	31
Acid phosphatase activity (ug TPF g^{-1} soil 24 hr^{-1})	629	613	603	590	558	543
Azotobacter (10^3 g^{-1})	12.7	10.5	6.3	5.3	0.9	0.6
P-solubilizing bacteria (10^5 g^{-1})	9.1	8.8	6.5	6.2	3.2	2.9
Actinomycetes (10^5 g^{-1})	26.7	22.9	18.3	16.	1.8	1.2
Fluorescent pseudomonas (10^5 g^{-1})	22.3	19.9	13.3	12.1	9.9	9.1

Yield of cotton under different systems (kg / ha^{-1} cv. LRA 5166)

Year	Organic	Integrated crop management	Non-organic
1993-94	464	807	1159
1994-95	530	740	652
1995-96	849	781	651
1996-97	898	710	623
Soyabean-as rotational Crop			
1998-99	2769	1961	1199

Seed yield of soybean-safflower due to continuous use of fertilizer and FYM (Mean of 7 years)

Treatment	Seed Yield (Kg ha-^{1})	
	Soybean	Safflower
RDF	1926	1405
½ RDF+FYM 6t ha^{-1}	2062	1645
FYM 6t ha^{-1}	1851	1480
Crop Residues 5t ha^{-1}	1589	1075

Source: Verma and Sharma (2000)

Yields and economics of organic farming vis-à-vis conventional farming

Year	Status	Yield q ha^{-1}	Gross income (Rs.)	Premium (20%)	Total (Rs.)	Net income (Rs.)	Surplus/ deficit over conventional (Rs.)
Conventional	-	10	20000	0	20000	9000	0
First year	Year of conversion	5	10000	0	10000	750	-8250
Second year	Year of conversion	5.75	11250	0	11250	3750	-5250
Third year	Organic	6.25	12500	2500	15000	7000	-1500
Fourth year	Organic	7.50	15000	3000	18000	10500	1500
Fifth year	Organic	8.75	17500	3500	21000	13500	4500
Sixth year	Organic	10.00	20000	4000	24000	165000	7500

Source: Rajendran etal. (2000)

Bio-fertilizer based INM

↓

grain yield of Rice-Pea-Wheat cropping system

↓

over 3 years 14.5% higher over yield of NPK fertilizer treatment

Source: Talukdar, NC, et al (2004)

Nutritional Aspects of Organic Produce

Percent change in nutrient components in Organic over conventional produce

Nutrient	% difference in organic over conventional	Remarks
Vitamin C	+22.7	Compiled from a review of 1230 published reports in Britain, Europe and USA (1999). Ref. : Organic Agriculture-Philosophy and Science- *-By Dr. A.K.Yadav et al.(2006)*
Iron	+17.2	
Calcium	+30.8	
Phosphorus	+12.5	
Sodium	+19.6	
Potassium	+14.1	
Magnesium	+24.4	
B-carotene	-00.3	
Nitrates	-33.9	

N.B. : Keeping the values of conventional produce at 100

Beneficial effect of Organic Nutrients

1. **117 nanogram salicylic acid/gm organic vegetable soup**
2. **20 nanogram salicylic acid/gm non organic vegetable soup**

----European J of Nutrition (2002), 40,289

3. **Salicylic acid helps in preventing hardening of arteries & bowel cancer**

---- J. Clin Pathol.(2001), 54,553

4. **Higher concentration of Antioxidents (10-15%)than chemical Agriculture**

a. Protect plant against insect-pest, Bactrial and Fungal infection & photooxidation

b. Prevent heart disease & age related neurological problems

c. Protect body from harmful effects of free radicals

Scope of INM in ASSAM

Enriched phosphocompost production from paddy straw

Treatments	Total-N (%)	C:N	N-loss (% of initial)	Mineral-N (mg kg -I)	Citrate Soluble P (mg g -I)
Straw mix*	0.69	34.2	9	80	9950
Straw mix +	1.02	19.4	49	300	10780
Urea-N (1% w/w)					
Straw mix- +	1.15	17.6	65	1440	13100
Urea-N (2% w/w)					
Straw mix +	1.48	13.4	13	1870	10780
Urea-N(1%)+ Pyrite (10% w/w)					
Straw mix +	1.56	12.6	43	3683	14220
Urea-N(2%)+ Pyrite (10% w/w)					
Straw mix +	1.68	11.6	28	4837	14480
Urea-N(2%)+ Pyrite (20% w/w)					

* Straw mix= Rice straw: Cattle dung: compost: soil (8:1:0.5:0.5) plus rock phosphate 25% (w/w)

Source: Anonymous (1998)