FBMPs and Sustainable Agricultural Development

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Global Food Security

- MDGs – Halving number of undernourished by 2015 ;
- World Population at 8 billions by 2030 ;
- Future path of sustainable Agriculture Production and Natural Resources use;

World Population Growth

Region	Population (million)			Annual increment (million)			Growth rate % p.a.	
	1997-99	2015	2030	1995-2000	2010-2015	2025-2030	1997-2015	2015-2030
World	5900	7207	8270	79	76	67	1.2	0.9
South Asia	1283	1672	1969	23	22	19	1.6	1.1
East Asia	1839	2128	2303	20	16	9	0.9	0.5

Source: FAO (2003)

Future Agriculture Scenario

- Demand driven;
- Intensive agricultural crop production;
- More technology dependent;
- Higher levels of nutrient inputs;
- Shifts in World crop Production through trade.
- Emergence of Bio-fuels.

Projected world biofuels consumption

Million tonnes of oil equivalent

With no new government measures on climate change				With government measures			
	2010	2015	2030		2010	2015	2030
Europe	14.8	18.0	26.6	Europe	16.4	21.5	35.6
US	14.9	19.8	22.8	US	16.4	27.5	42.9
Brazil	8.3	10.4	20.3	Brazil	8.6	11.0	23.0
China	0.7	1.5	7.9	China	1.2	2.7	13.0
India	0.1	0.2	2.4	India	0.1	0.3	4.5
Total	**41.5**	**54.4**	**92.4**	**Total**	**48.8**	**73.0**	**146.7**

Source : IEA World Energy Outlook 2006

Consumption of Fertilizers in Major Countries (2003-04)

Country	Consumption				Kg/ha
	N	P_2O_5	K_2O	Total	
China	24.75	9.83	4.66	39.24	275.1
USA	11.89	4.36	4.99	21.24	122.4
India	11.08	4.12	1.60	16.80	104.7
Brazil#	1.82	2.81	4.29	8.92	171.9
France#	2.28	0.73	0.96	3.97	215.9
Total World	86.96	35.04	25.91	147.98	105.5

Future of Fertilisers

- Role of fertilisers in transformation of Agriculture;
- Future productivity increases to come mainly from greater use of fertilisers/fertiliser responsive varieties- no land expansion;
- Share of mineral fertilisers increased from 43% in 1960 to 84% in 2015;
- Greater use of organic and inorganic fertilisers to respond to increased demand for food, fibre and fuels.

Nutrient Use Efficiency

- Integrated Plant Nutrient Systems;
- Soil Fertility – Depth, structure, nutrient content, storage capacity, humus;
- Soil testing;
- Application methods :
  Irrigation,
  Fertigation
- Extension services.

Integrated Plant Nutrient Management

- To increase farm productivity and economic returns
- Increase uptake of plant nutrients
- Increase productivity of the uptake
- Reduce nutrient losses
- Use crop rotation
- Manage crop residue
- Increase soil fertility
- Synergy among soil, crop, water and nutrition.

Components of Balance Fertilisation

- Judicious use of chemical fertilisers based on deficient soil nutrients as established by soil testing.
- Use of all sources of plant nutrients including organic manures and bio-fertilisers besides chemical fertilisers (i.e. INM)
- Use of soil amendments in acidic/alkaline soils to improve soil health and its fertility.
- Ensuring adequate availability of Plant Nutrients in soils to meet the requirement of plants at critical stages of growth.
- Ensuring adequate soil humus to improve the physico-chemical and biological properties of soils.

Yield of Cereal Crops (kg/ha) in Selected Countries

Country	Paddy	Wheat	Maize	Cereals	Fertilizer Consumption (Kg/ha)	Average holding (ha)
India	3040	2707	1880	2427	104.7	1.4
China	6308	4252	5122	5177	275.1	NA
Bangladesh	3621	1952	5145	3531	188.6	NA
Pakistan	2992	2373	2849	2431	164.1	3.1
Japan	6415	4047	2500	5942	292.7	1.2
Korea DR.	4065	2500	3489	3450	433.0	NA
Thailand	2592	615	3869	2706	NA	3.2
Philippines	3513	NA	2142	2992	NA	2.0
Russian Fed.	3768	1981	4039	1883	11.9	NA
USA	7781	2903	10065	6851	122.4	178.4
Brazil	3556	2040	3369	3126	171.9	72.8
World	4037	2914	4920	3348	105.5	NA

Source Fertilizer Statistics 2005-06

India in World Agriculture

Item	India	World	India's position in world		
			% Share	Rank	Next to
Total Area (mha)	329	13425	2.5	7th	Russia, Canada, USA, China, Brazil & Australia
Arable Land (mha)	162	1364	11.9	2nd	USA
Irrigated Area (mha)	56	272	20.2	Ist	
Wheat Production (mt)	68	583	11.7	2nd	China
Rice (Paddy) (mt)	132	593	22.3	2nd	China
Total Pulses (mt)	11	52	21.2	1st	

India in World Agriculture (contd)

Item	India	World	India's position in world		
			% Share	Rank	Next to
Total Cereals (mt)	231	2086	11.1	3rd	China, USA
Ground nut (mt)	6	35	17.1	2nd	China
Vegetables (mt)	68	698	9.7	2nd	China
Fruits (mt)	49	466	10.5	2nd	China
Potato (mt)	25	308	8.1	3rd	China, Russia
Cattle (million heads)	220	1352	16.3	Ist	
Buffaloes (million heads)	94	166	56.6	Ist	
Total Milk (mt)	84	583	14.4	Ist	
Eggs (Million No)	1906	56594	3.4	5th	China, USA, Japan, Russia

Characteristics of Indian Agriculture

- Physical
  - Rainfall dependent
  - Vulnerability to natural disasters
  - Preponderance of small and marginal farmers
  - Diversity of production
  - Low productivity.

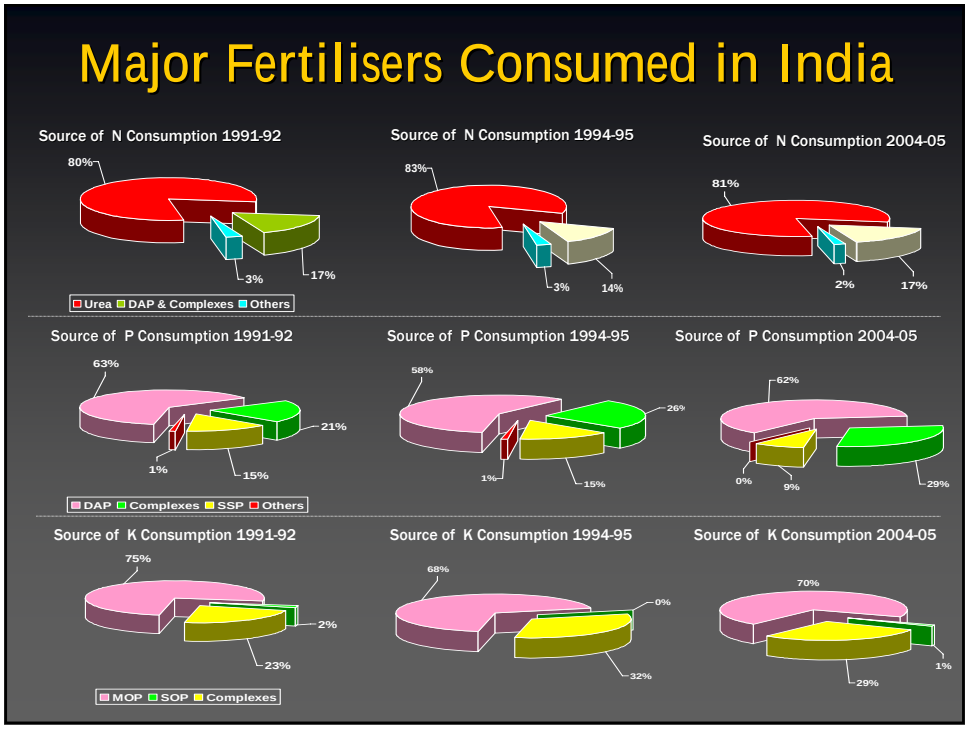
Characteristics of Indian Agriculture (contd.)

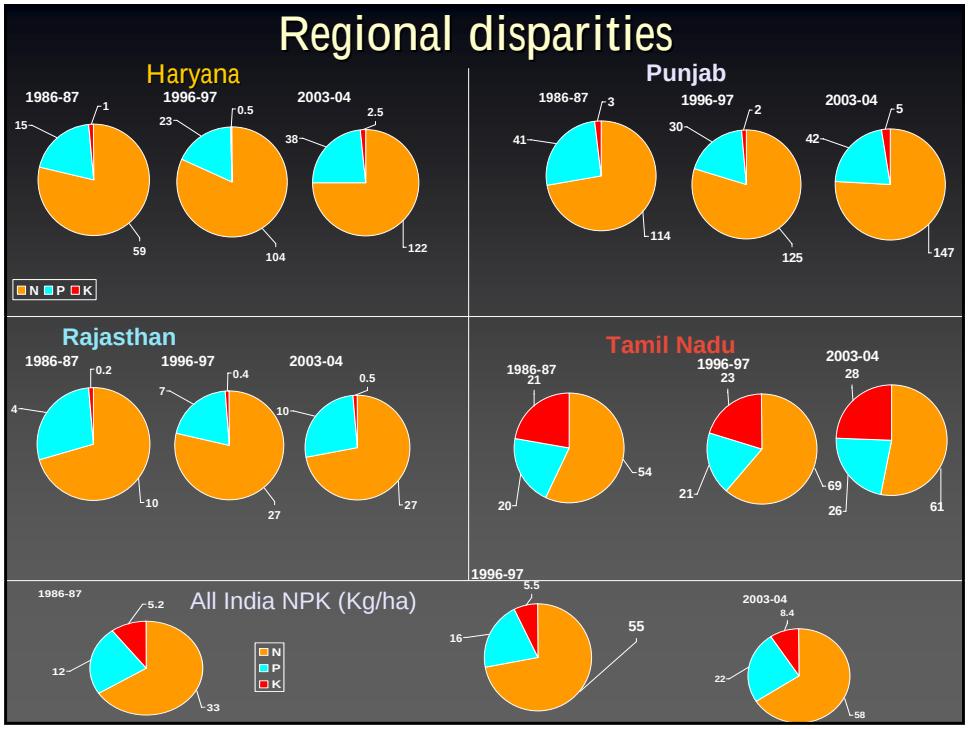
- Economic
  - Agriculture employs 58% of the work force
  - Contributes 18% of GDP
  - Trade importance(13% of exports-6% of import)
  - Low level of commercialisation
  - Weak infrastructure
  - Low capital investment.

Fertilisers Consumption in India

(NPK)

Year	Consumption (in lakh tones)				Per hectare consumption (in Kg/ha)	N:P:K Ratio	Food production (mt)
	N	P	K	TOTAL			
1951-52	0.59	0.07	-	0.66	0.5	8.4:1:0	52.0
1966-67	7.38	2.49	1.14	11.01	7.0	6.5:2.2:1	74.23
1976-77	24.57	6.35	3.19	34.11	20.4	7.7:2.0:1	111.17
1986-87	57.17	20.78	8.50	86.45	49.0	6.7:2.4:1	143.42
1991-92	80.46	33.21	13.61	127.28	69.8	5.9:2.4:1	168.38
1996-97	103.01	29.77	10.30	143.08	75.5	10.0:2.9:1	199.44
1999-00	115.92	47.99	16.78	180.69	94.9	6.9:2.9:1	209.80
2000-01	109.20	42.15	15.67	167.02	89.3	7.0:2.7:1	196.81
2001-02	113.10	43.82	16.67	173.60	92.8	6.8:2.6:1	212.85
2002-03	104.74	40.19	16.01	160.94	86.1	6.5:2.5:1	174.77
2003-04	110.76	41.24	15.98	167.98	89.8	6.9:2.6:1	213.19
2004-05	117.12	46.23	20.60	183.95	98.4	5.7:2.2:1	198.36
2005-06	127.23	52.04	24.13	203.40	104.5	5.3:2.2:1	208.30


Major Fertilisers Consumed in India
Source of N Consumption 1991-92
80%
3%
17%
Urea DAP & Complexes Others
Source of N Consumption 1994-95
83%
3%
14%
Source of N Consumption 2004-05
81%
2%
17%
Source of P Consumption 1991-92
63%
1%
15%
21%
DAP Complexes SSP Others
Source of P Consumption 1994-95
58%
1%
15%
26%
Source of P Consumption 2004-05
62%
0%
9%
29%
Source of K Consumption 1991-92
75%
2%
23%
MOP SOP Complexes
Source of K Consumption 1994-95
68%
0%
32%
Source of K Consumption 2004-05
70%
1%
29%


Regional disparities
Haryana
1986-87
15
1
59
1996-97
23
0.5
104
2003-04
38
2.5
122
N P K
Punjab
1986-87
41
3
114
1996-97
30
2
125
2003-04
42
5
147
Rajasthan
1986-87
4
0.2
10
1996-97
7
0.4
27
2003-04
10
0.5
27
Tamil Nadu
1986-87
21
20
54
1996-97
23
21
69
2003-04
28
26
61
All India NPK (Kg/ha)
1986-87
12
5.2
33
N
P
K
1996-97
16
5.5
55
2003-04
22
8.4
58

Fertility Status of Indian Soils

Nutrient	Extent of deficiency (low to medium soil available nutrient status)
Nitrogen	89%
Phosphorous	80%
Potassium	50%
Sulphur	40%
Micronutrients Zinc	48%
Boron	33%
Iron	12%
Manganese	5%

Balance Sheet of NPK

Nutrient	Net balance sheet (000 t)		
	Addition	Removal	Balance
N	5461	7690	-2229
P_2O_5	1466	2961	-1496
K_2O	1018	6994	-5976
NPK Total	7945	17645	-9701

Source : Tondon (2004)

Imbalanced Use of Fertilizers

- Inappropriate NPK ratio :

  National 5.3: 2.2 : 1

  Regional –

  Haryana -29.5 : 8.8 : 1

  Kerala 1.1: 0.6 : 1
- Not based on soil testing nor nutrient deficiency nor crop needs
- Threat to crop productivity, soil fertility and sustainability

Effects of Imbalanced Use of Fertilisers

Decline in Response Ratio:-

The response ratio is normally defined as the additional increase of food grains obtained from an additional use of fertilizer nutrient applied.

Period	Response ratio of NPK application on food grains
5th Plan	1:15.0
8th Plan	1:7.5
9th Plan	1:7
10th Plan	1:6.5

Nutrient-wise response ratio (kg grain/kg nutrient)

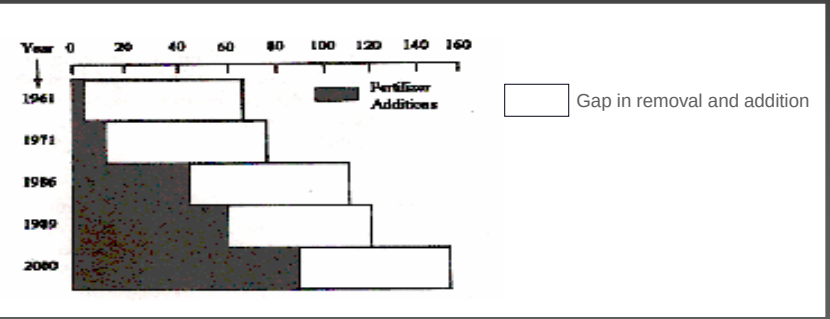
Nutrient	Paddy		Wheat	
	1991-92	2004-05	1991-92	2004-05
N	12	9.59	12	7.20
P_2O_5	7	5.60	7	4.20
K_2O	5	4.00	5	3.00

Effect of Imbalanced Use of Fertilisers

Depletion of soil nutrient reserve:

For each tonne of grain produced the nutrient removal is of the order of 68-80 kg/ha. The inadequate replenishment through chemical fertilisers (& organic manures) cause depletion (mining) of soil nutrients. Presently this annual gap is about 10 mt of NPK nutrients.

For Gap in nutrient (N+P+K) removal and that added through chemical fertilisers (kg/ha)



Decline in Soil Fertility

- Decline in soil organic carbon content — adverse effect on soil porosity & soil structure
- Decline in water holding capacity
- Increased loss of nutrients through leaching and denitrification
- Lower fertilizer use efficiency due to low microbial activities
- Increasing salinity and alkalinity of soil and ground water

Potential & Present Utilization of Organic nutrients

(Million Tonne)

Organic Manures	Achievable Potential		Present Utilization	
	Product	Nutrient (NPK)	Product	Nutrient (NPK)
Farm Yard Manures	250	3.75	100	1.5
Crop Residue/Rural Compost	150	2.25	100	1.5
City Compost	14	1.87	1.50	0.2
Biogas Slurry	28	1.20	7.0	0.3
Bio Fertilizer	0.03	0.72	0.01	0.24
Green Manuring	230 lakh ha	1.16	20.51 lakh ha	0.01
Total	442.03	10.75	208.51	3.75

Best Management Practices

- Application of proper type of fertilizer in adequate quantity based on soil test data including secondary and micronutrients.
- Adoption of Integrated Nutrient Management (INM) i.e. conjunctive use of chemical fertilizers along with organic manures, green manures and bio fertilizers.
- Time and method of application of fertilizers- split application of N & K (in high rainfall areas).
- Use of soil amendments in problem soils (lime in acidic soils and gypsum in alkaline soils).
- Adoption of Soil Specific Nutrient Management (SSNM) including customized and 100% Water Soluble fertilizers.
- Adoption of Agronomic practices including minimum tillage, cultural practices, INM & IPM (Integrated Pest Management).
- Water saving methodology i.e. fertigation/furrow irrigation .
- Use of High Yielding Varieties/ weather compatible varieties.
- Adoption of scientific and precision agriculture to minimize cost of production and increased farmers profitability.

Govt.Initiatives for promoting FBMPs

- Statutory Regulation of price of Urea fertilizer & ensuring its availability to farmers through regulatory mechanism ;
- Provides major fertilizers on subsidized basis ;
- Approved 74 fertilizers of various types under Fertilizer Control Order to meet soil/crop specific demand including liquid fertilizers and 100% Water Soluble Fertilizers ;
- Fertilizer mixtures are approved for location and crop specific demand;
- Regulatory mechanism provided for Provisional and customized fertilizers for better efficiency and profitability .

Facilitating FBMPs

- Strengthening of infrastructure of soil testing laboratories in each district with required technical manpower and equipments to analyze soil samples for primary, secondary and micronutrients with PPP (Public Private Participation) model.
- Preparation of soil fertility maps for macro planning and issuance of soil health cards to farmers for their holding specific fertilizer recommendations.
- Promoting INM with special efforts to augment production and uses of various sources of organic nutrients including use of soil amendments in problem soils.
- Promoting IPM with more stress on bio agents and bio pesticides with minimal use of agro chemicals.
- Augmenting Irrigation facilities and promoting water saving systems by strengthening micro irrigation system/fertigation with commensurate incentives.
- Capacity building through training and demonstration of farmers and extension agencies to bridge the knowledge gap through PPP model.

Constraints in popularising BMPs

- Small holdings preventing use of modern technology and farm mechanization.
- Inadequate Soil Testing facilities and lack of infrastructure to analyze secondary and micronutrients and lack of timely recommendations resulting in very low acceptability by farmers.
- Declining total factor productivity in agriculture due to multiple factors like technology fatigue, soil degradation and diminished fertilizer response ratio ;
- Lack of HYV in pulses and oil seeds and aberrant weather compatible varieties for cereals, pulses and oilseeds and low seed replacement ratio.

Constraints in popularising FBMPs (contd.)

- Non conducive Govt. Pricing Policy of Fertilizers- adversely affecting balanced use of fertilizers and neglect of organic manures and bio fertilizers.
- Weakness of the supporting institutions for research and extension;
- Wide knowledge gap between SAUs, extension staff and farmers.
- Inadequate support for adoption of Micro irrigation in rainfed areas..
- Non effective price support system through Minimum Support Prices.

Future Directions

- A mix of regulatory and voluntary mechanisms for optimal prices.
- Conducive fertilizer pricing i.e. Nutrient Based Subsidy and Pricing Mechanism against existing product based subsidy to promote balanced use of fertilizers.
- Ensuring adequate availability of credit to the farmers.
- Development of newer and improved seed varieties and promotion of bio technology.
- Promotion of site specific crop management practices.
- Promoting farm mechanization to enhance Energy use efficiency.

Economics of FBMPs

- Fertiliser use for increased production depends entirely on its economics
- More popular in irrigated areas
- Inadequate risk management products
- Inadequate credit
- High cost of Fertilisers:
  - Subsidy
  - Low Efficiency
- Unremunerative output prices.

Macro Economic Issues Impacting adoption of FBMPs

- Making Agriculture Remunerative;
- Risk Management in Agriculture;
- Emergence of Bio fuels.

Making Agriculture Remunerative

- Market reforms;
- Doha Development Round;
- Value Addition in agriculture;
- Cost reduction technologies ;
- Post harvest.

Managing Risks in Agriculture

Risk sharing and transfer for :

- Diversification & modernisation
- Extreme Climate events and variability
- Insurance products like Crop insurance, weather Index Insurance and Income Insurance need to be popularized in developing countries
- Commodities markets for price discovery & risk hedging

Merger of Agriculture with Energy

- Almost limitless demand for bio fuels
- Firming of Agriculture commodities prices
- Eliminating need for agriculture subsidies in developed countries
- Shifting of production bases for food crops to developing countries
- Achieving Rural Energy security

Second Generation technologies hold greater promise for making agriculture remunerative and self reliant in meeting energy needs.

Biofuels will also transform agriculture from being a contributor to the problem of Climate change to be a part of the solution.

Thanks.