Food for future through Sustainable Intensification of Agriculture: Indian perspective

Prof RK Gupta

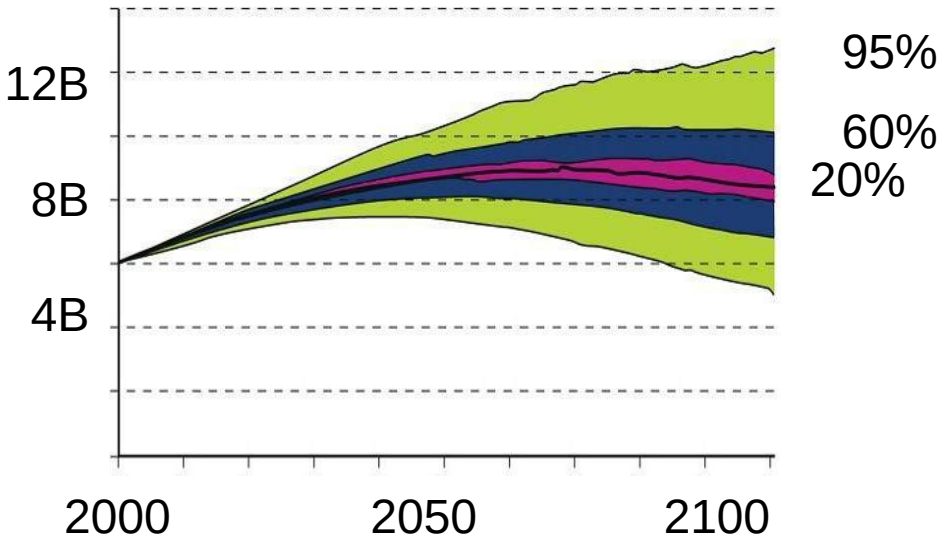
Professor Vegetable Science and Dean , Faculty of Basic Sciences

Sher-e-Kashmir University of Agriculture Sciences and Technology of Jammu , India -180009



Population projections and global food system

Population projection (Lutz & Samir 2010)



Around 0.8 b people are hungry.
People will be richer and demand higher quality diet

The global food system is experiencing:

World grain production struggling - shortfall around 120 million metric tonnes (2009)

Demand increasing – we need to boost production by about 650 m mt by now and 2023

We would need additional 540 million acres without change in yield

Lack of sustainability, price volatility, and increasing population are problems (expected over 9 b by 2050)

Global food system is not sustainable



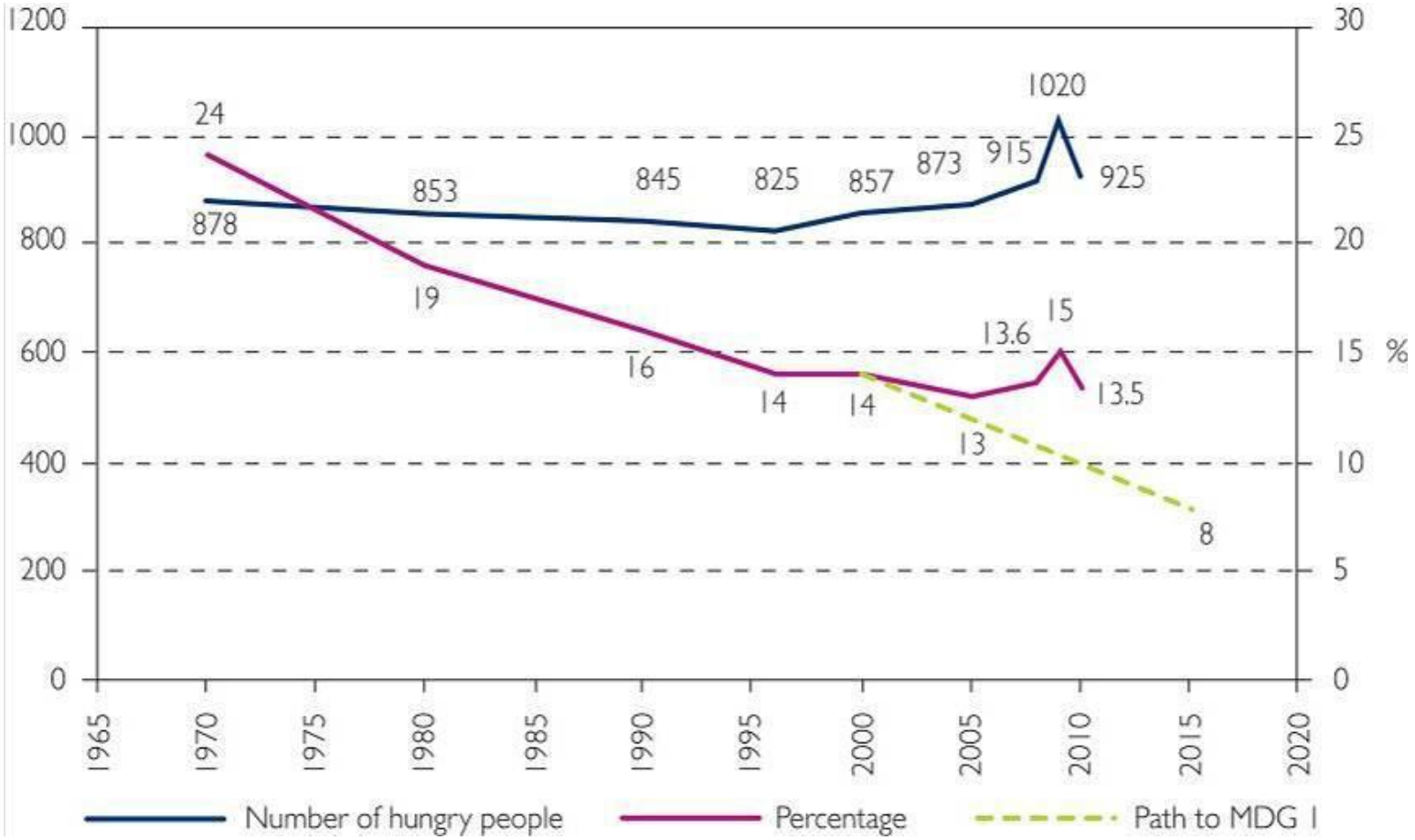
Globals Agriculture

- **Uses ~70% of global fresh water, much non-renewable**
- **24% of vegetated land suffers soil degradation**
- **30% GHG emissions come directly or indirectly from food system**
- **Nitrogen and other pollution**

Hunger in world: Progress since 1970

- Number of food-insecure people has fallen from 959 million to 780 million
- Percentage of food-insecure people has fallen from 37% to 17%
- Progress has been uneven in Developing world
  - Major reduction in East and Southeast Asia
  - Slight increase in South Asia
  - Number of hungry people in Sub-Saharan Africa has more than doubled

Global food system: Undernourishment data versus MDG target



Source: Oxfam (2010) Data cited from FAO Hunger Statistics (from 1969 to 2006); UN (2009)

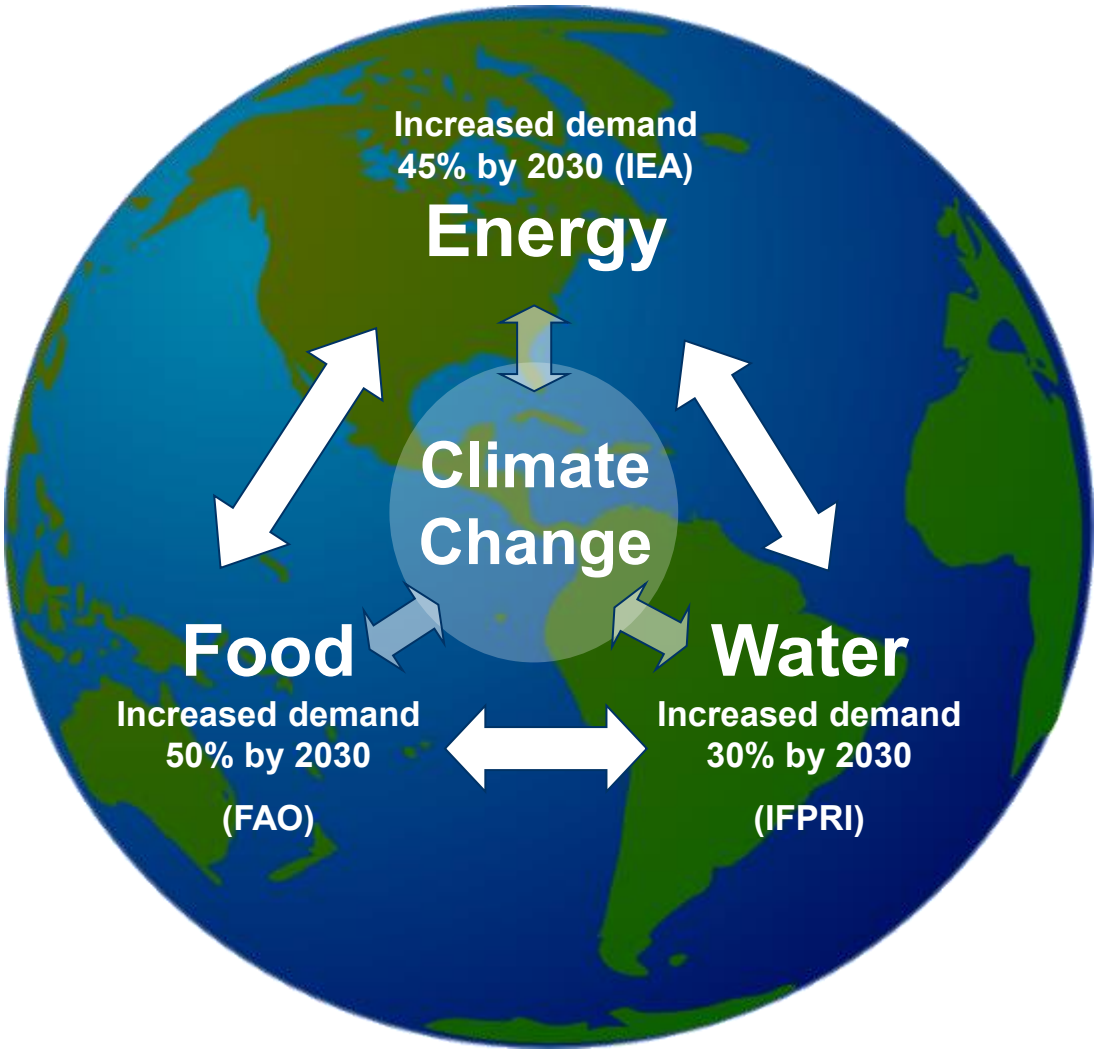
The World Summit Goal: Halve the number of hungry people by 2015

Sustaining production – Limiting factors

Population and Environment	Global food production needs to be doubled by 2050 to meet demand of estimated **9 billion** people and focus will be on reducing GHG emissions
Water supply crunch	Impact of water shortages (by 2020 2/3 of population will be in water stressed countries)
Climate change and variability	Frequent droughts, floods, temperature extremes and weather variations in many regions
Energy supply crunch	Agriculture – energy l dependent for oil, fertilisers, farming, storage or transport. Push to Bio-fuel demand reducing food area
Price rise and volatility	Inevitable as a result of shortages and protectionism

Global food system – Future projections

1. Increasing population
2. Changing diets
3. Losing land to urbanisation and rising sea levels



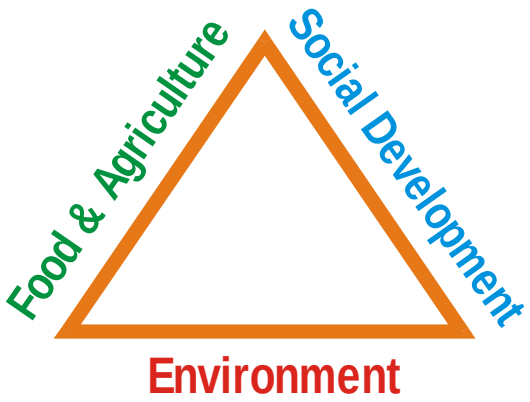
India's natural resources share in world

1	Human population	17%
2	Livestock	> 11%
3	Geographical area	2.4%
4	Water resources	4.2%
5	Forest cover Pastures	1% 0.5%
6	Arable land	51%

Area : 142 m ha cultivated and 60 m ha rainfed, GDP contribut ion 18 % (2013-14) ,Over 52% pop earns livelihood from agriculture

Indian Agriculture

A PARADIGM SHIFT



To the hungry God is bread, the first and foremost duty of independent India is to provide an enabling environment where every citizen can earn his or her daily bread. -- Mahatama Gandhi

Everything else can wait but not agriculture. Pt. Jawahar Lal Nehru

Green revolution

launched in 1967-68

Production increase: 50 MT(1947) to over 250 MT (2014-15)

Impact:- Improved Food production and made country self sufficient by end of 20th century

Frequent drought s (1979, 1987 and onwards), floods,poor monsoons have now raised questions about GR 'S sustainability

Experience: shrinkage of natural resources (land, water, biodiversity)

Damage to environment (Degraded land 187.7 mha)

Per Capita Availability of food grains-trends

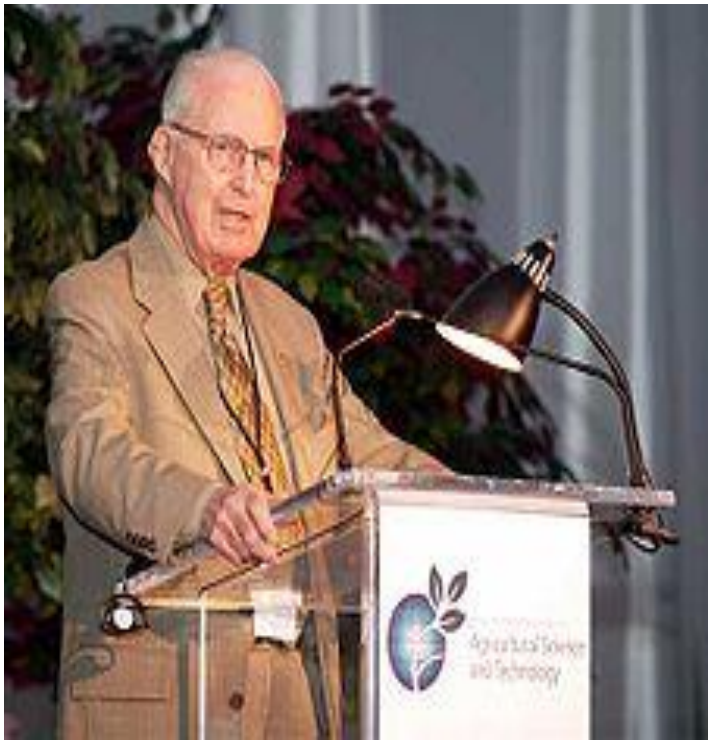
- Green revolution I of 1960's and Hybrid revolution made India self sufficient in food grains.
- Between1950-51 and 2006-07 production increased @ 2.5% compared with population rate of 2.1%
- During same period , availability of food grains per capita per person has also increased
- But per capita annual availability of food grains has fallen sharply by 12 % in past 2 decades

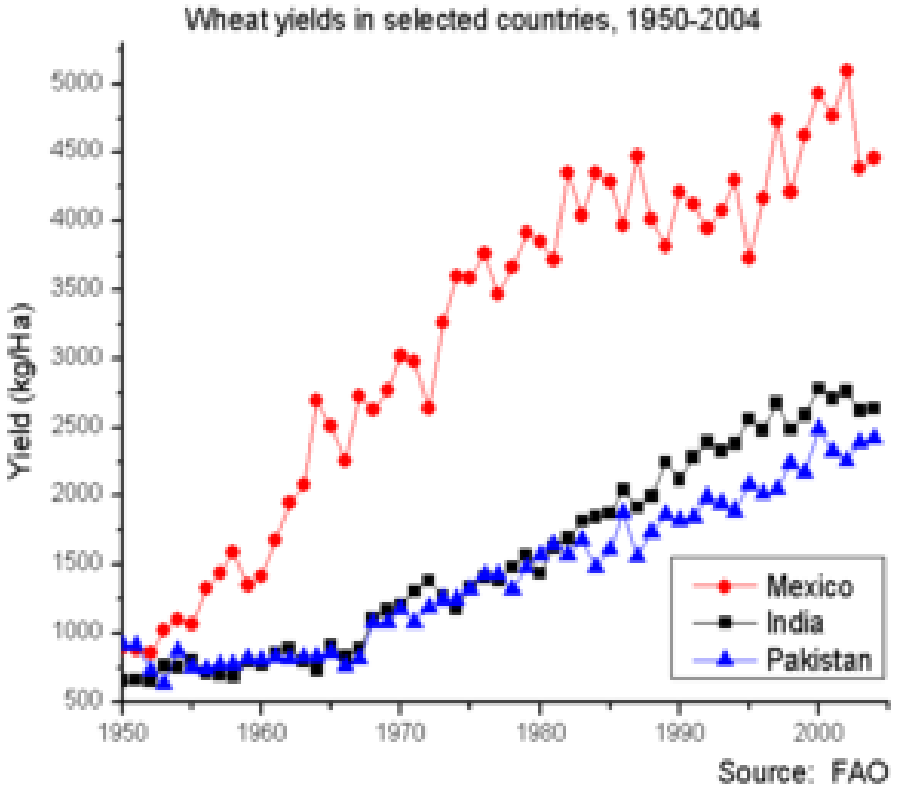
  182.6kg(1991)

  160.4Kg (2007)

This declining trend is threatening food security

Dr Norman Borlaug , Noble laureate

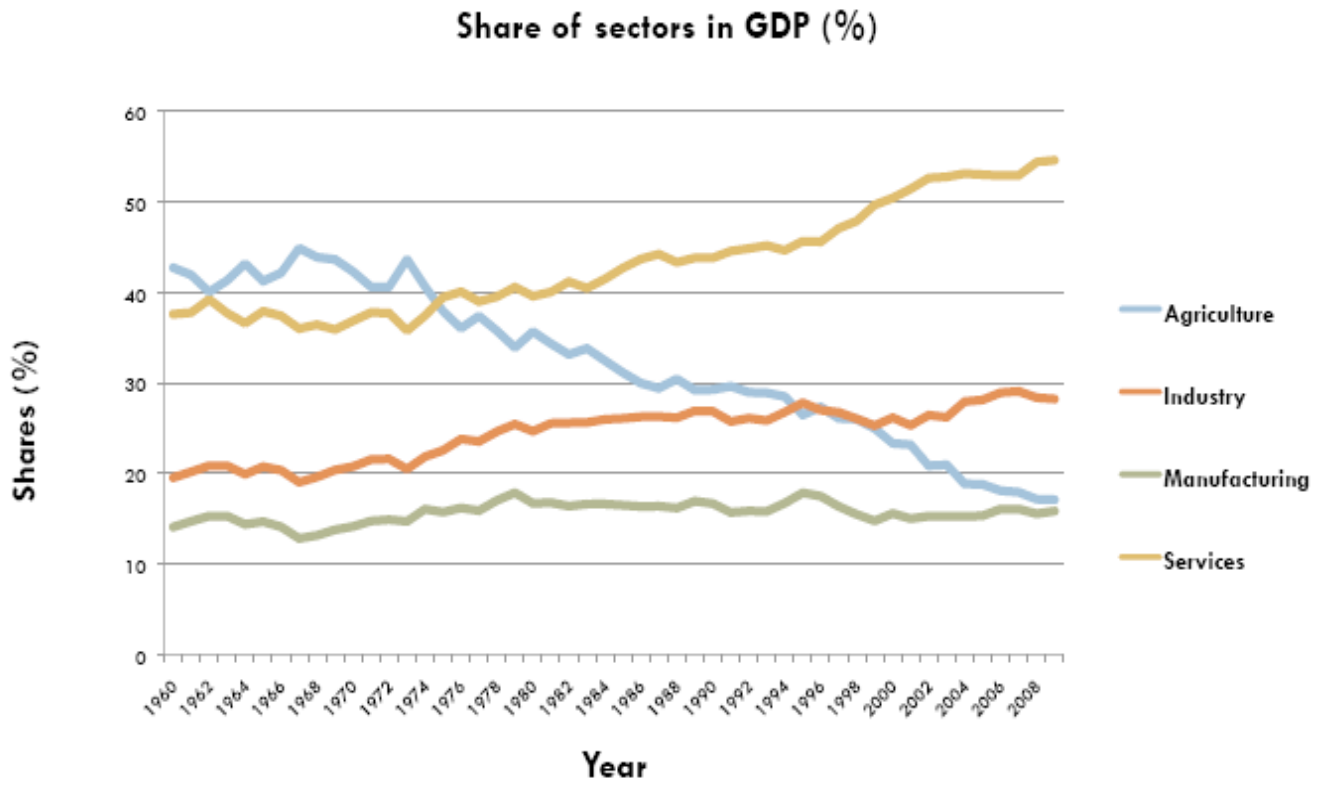


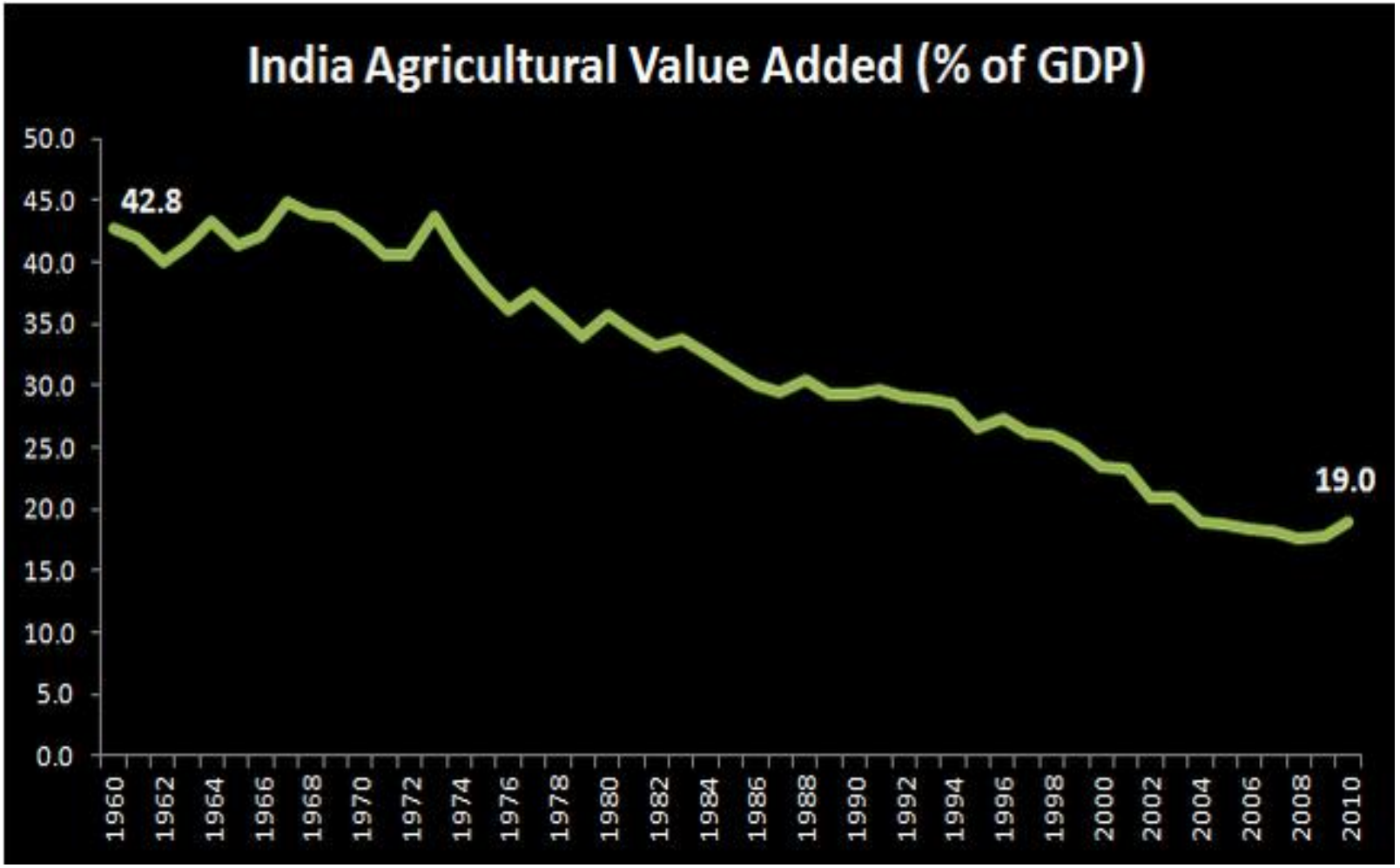


Major Achievements of 20th century

- Population has trebled, food grain production increased over four fold.
- Our per capita income has also doubled
- There is also an impressive increase in life expectancy and decline in child mortality
- Agriculture share in GDP declining
- Productivity growth in agriculture in terms of out put per hectare (1961 to 2009) has been relatively slow (less than 2 times) when compared with animal out put per head of cattle equivalent (over 5 times)
- Rural population and labor force are still growing indicating enormous challenge of employment in days to come

Agricultural share is declining



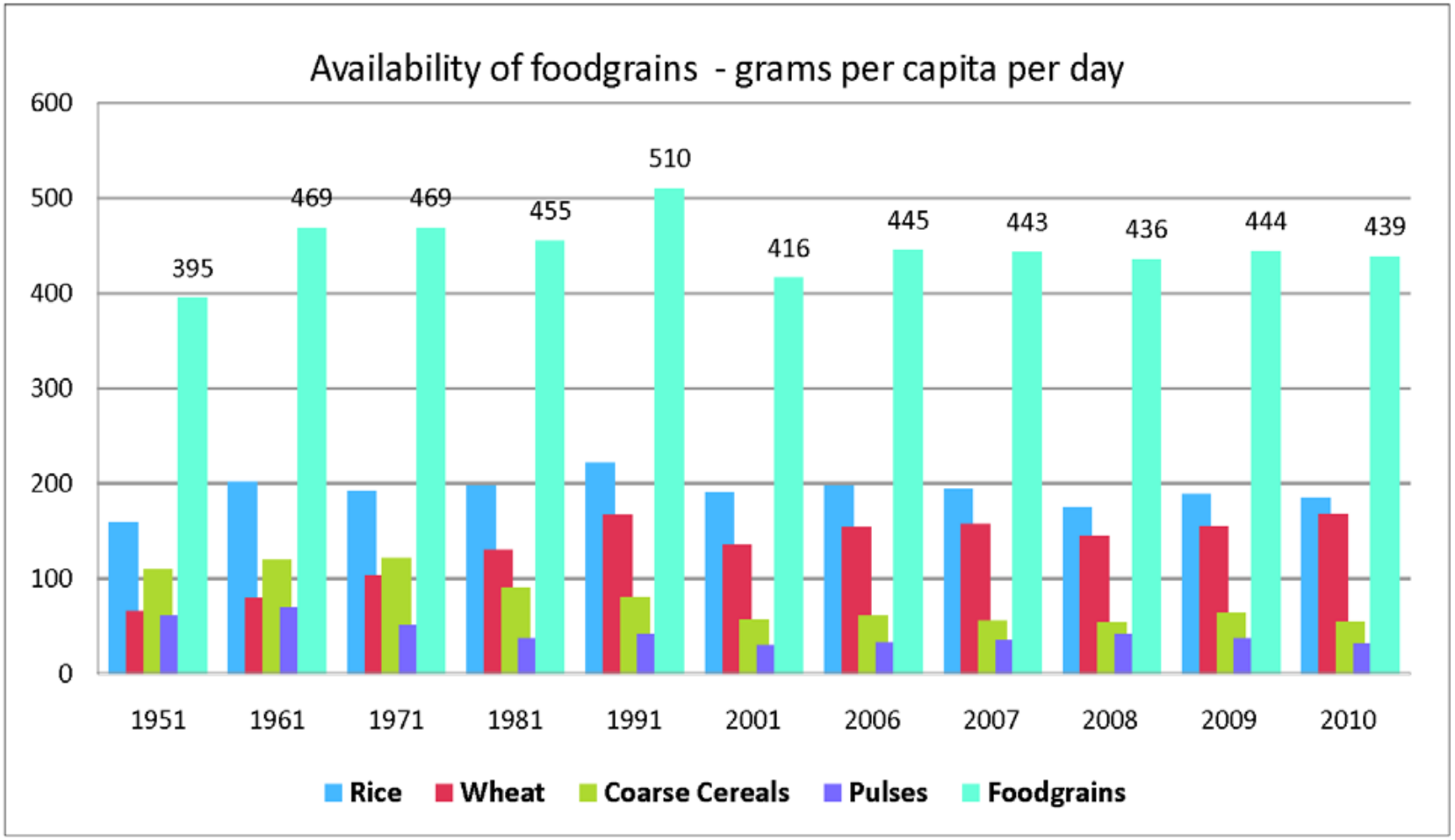


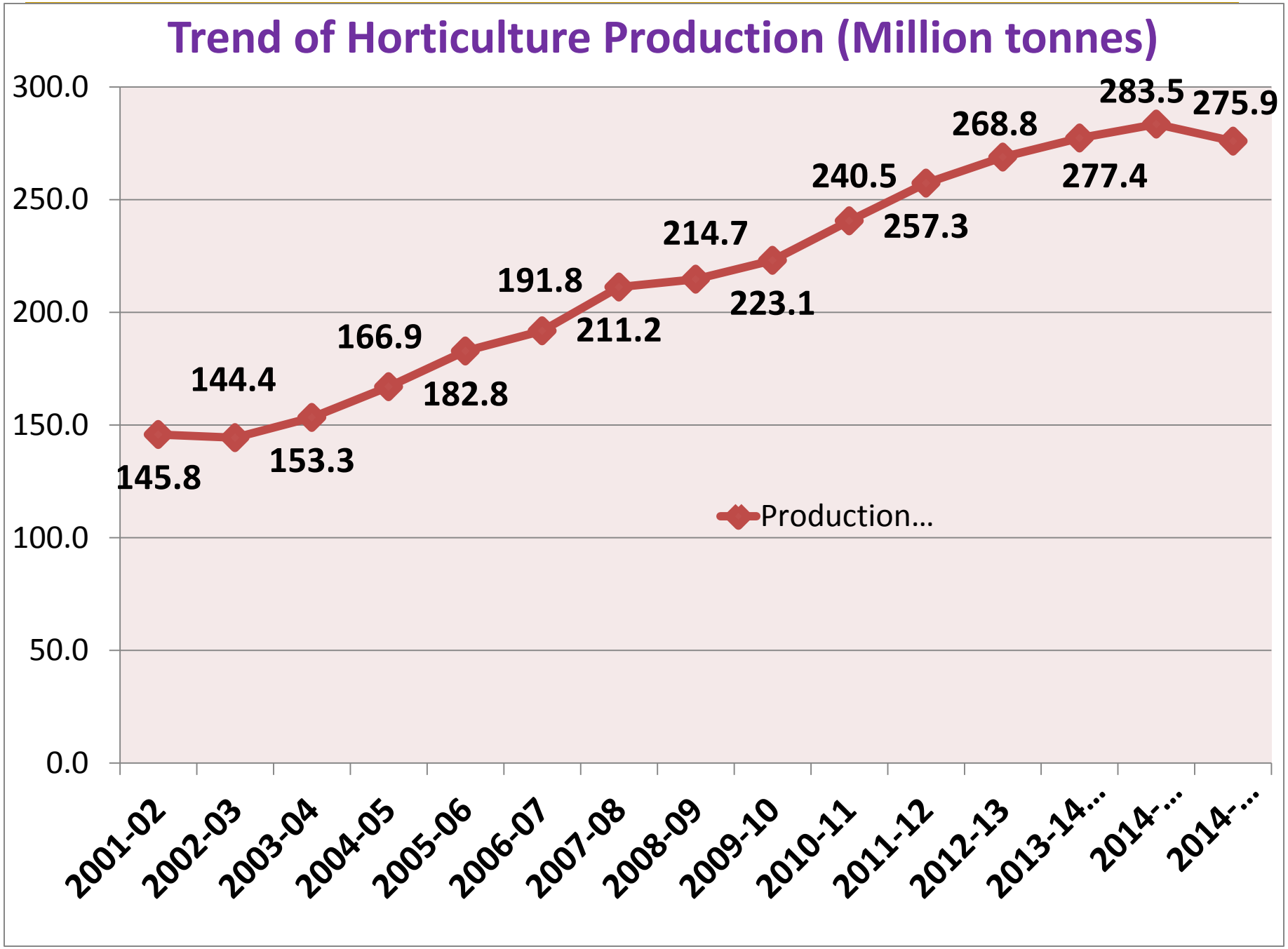
Declining share of Agriculture in GDP demands robust growth

1960-61 (47.6%) 1982-83(36.4%) 2000-01(22.3%) 2011-12(14.5) 2013-14(18%)

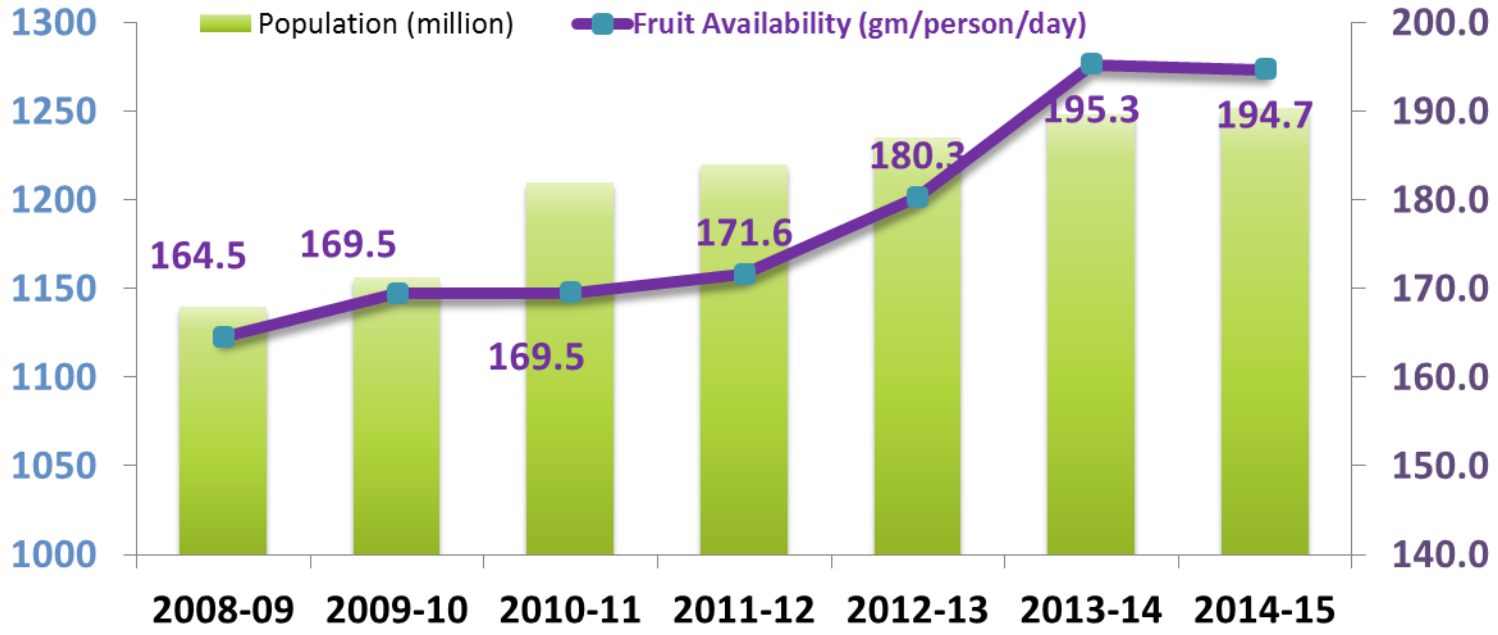
Agriculture GDP growth rate 2.5% (mid 1960's), 3.5%(mid1980's),3.7%(mid 1990's)

Per Capita Availability of food grains, coarse cereals and pulses (Source: DES, DAC)

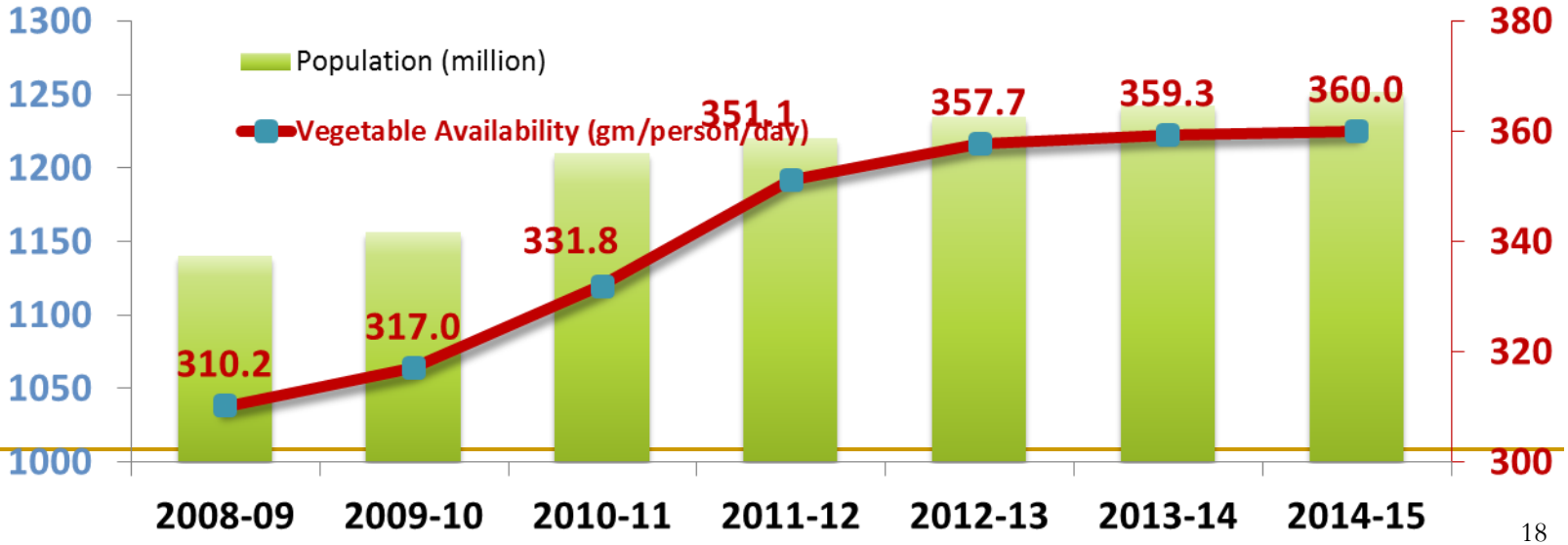



Trend of Horticulture Production (Million tonnes)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
145.8
144.4
153.3
166.9
182.8
191.8
211.2
214.7
223.1
240.5
257.3
268.8
277.4
283.5
275.9
Production…
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14…
2014-…
2014-…

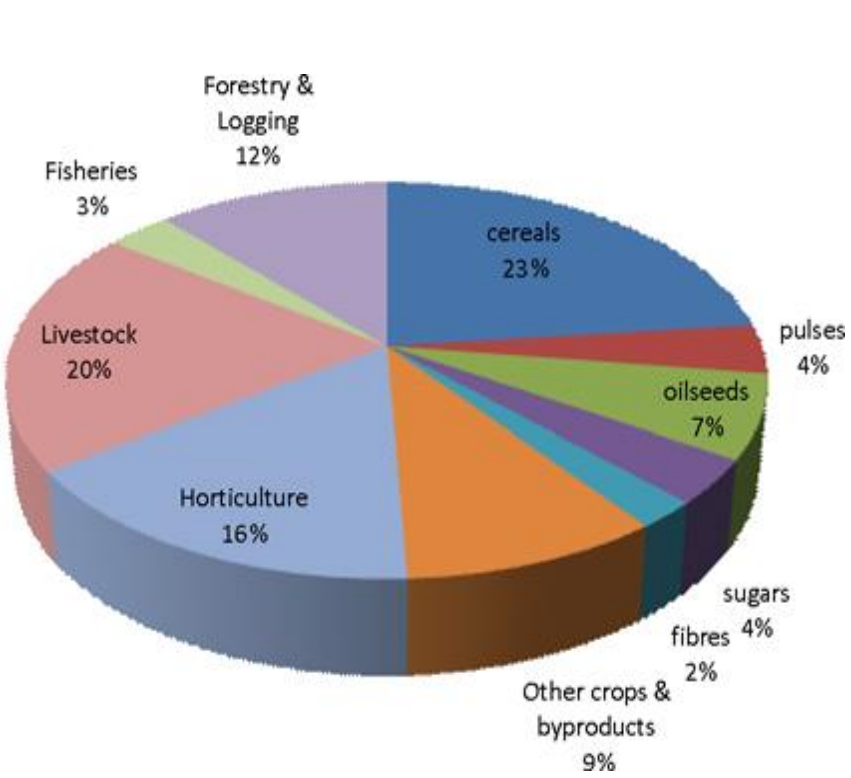
Fruits Per capita Availability (gm/person/day)

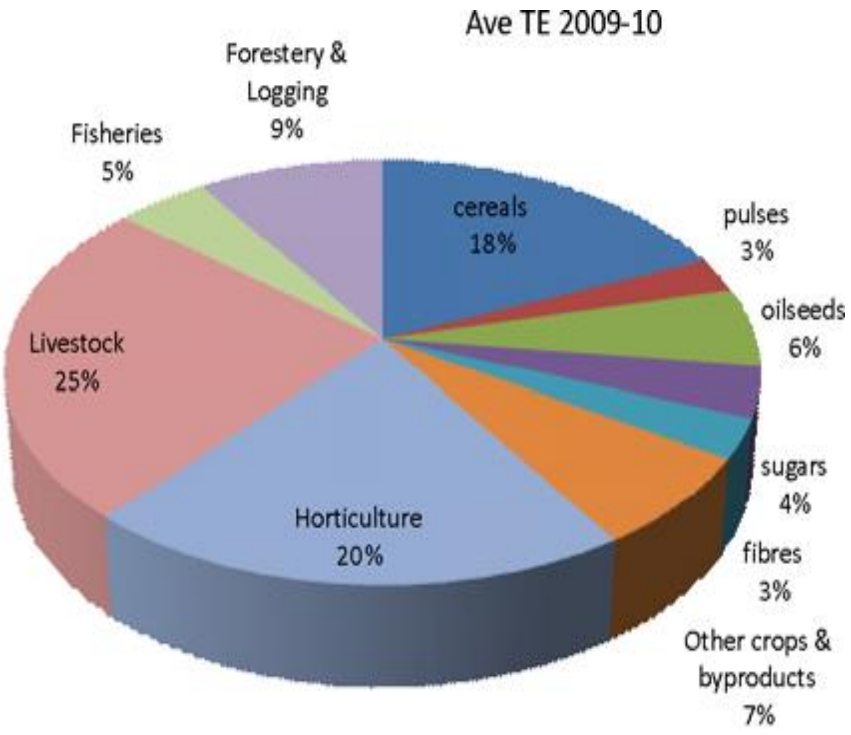


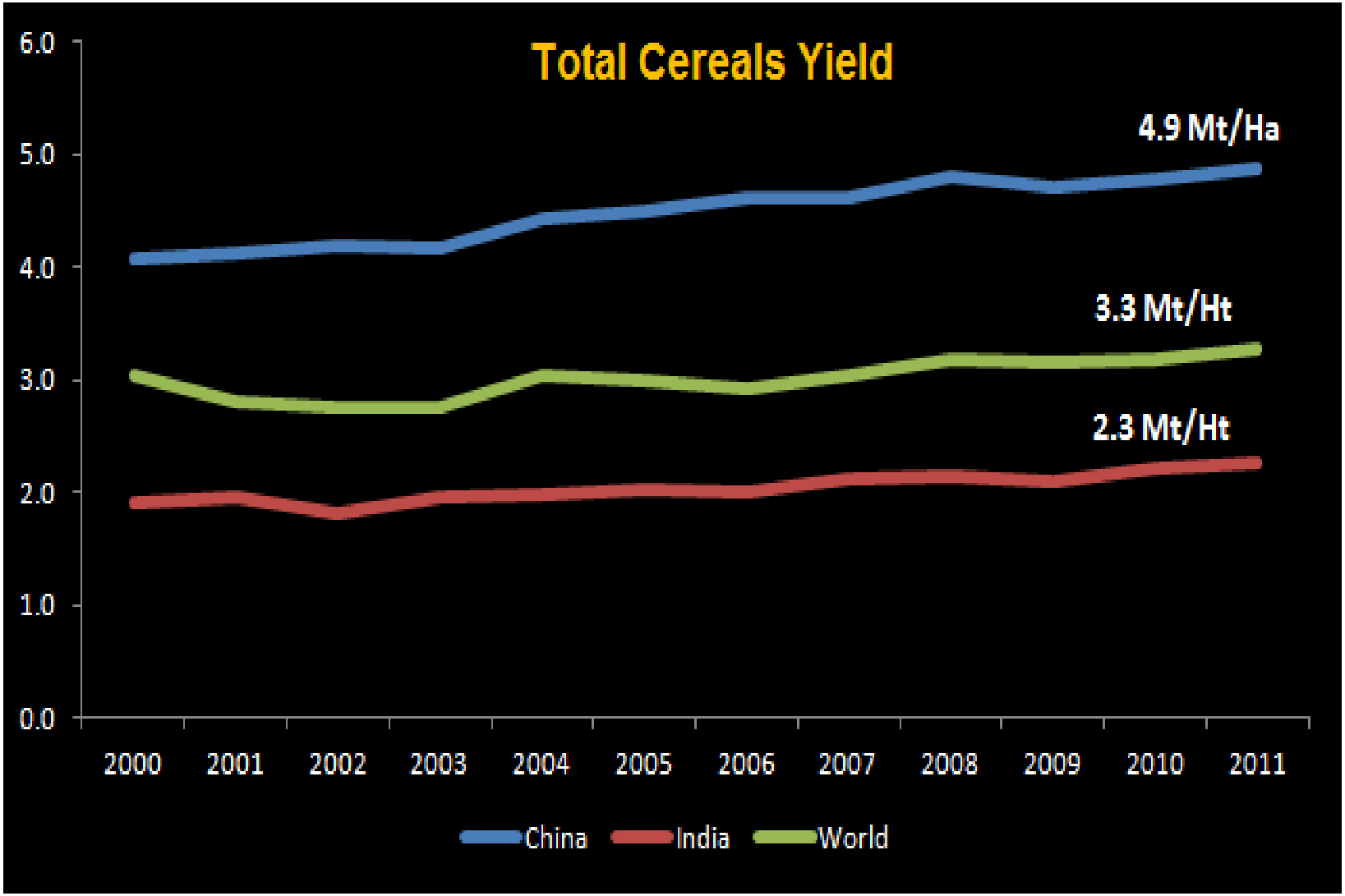
Vegetable Per capita Availability (gm/person/day)



Composition (%) of Output of Agriculture & Allied Sectors (1990-91 and 2009-10)






Total Cereals Yield
6.0
5.0
4.0
3.0
2.0
1.0
0.0
4.9 Mt/Ha
3.3 Mt/Ht
2.3 Mt/Ht
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
China
India
World

Himalayan region: Land resources status

Region/ sub region	Total area (m ha)	Degraded land (m ha)
India	328.7	187.7
Himalayan region (600 to 5000 m AMSL	48.30	**20.05**

Type of degradation in Himalayan region	Area (m ha)
Water erosion	**16.8**
Wind erosion	-
Physical deterioration	0.45
Chemical deterioration	2.80

Hill Agriculture production – Impediments

1. Hill regions did not receive much attention during the era of Green Revolution due to its varied topography and rain fed conditions.

2. Hilly terrain limiting mechanical farming, irrigation and transportation of products especially horticulture produce.

3. Mono-cropping season in temperate and high altitude area

4. Distant markets for export outside the state.

5. Non availability of adequate and timely inputs like quality seed, fertilizer and pesticides

Hill Agriculture: Limitations

- Less arable land – competition with other sectors : Vast area rain fed
- Less water – competition from other sectors and shrinking natural resources
- Climate change and variability leading to slowing down of yield emergence of diseases and insect pests
- Loss of biodiversity: genetic, species and ecosystem
- Less labor and rural to urban youth migration has relegated farm work to the women, uneducated old men, and to the children
- Increasing levels of pollution & Multi-nutrient deficiencies

AGRARIAN CRISIS - Issues

- Climate Change and variability
- Declining share of agriculture in GDP while over 50% population still depending on agriculture
- Arable land per person decreasing
- Large proportion of small / marginal holdings
- Limited access to irrigation and vast area rain fed
- Higher indebtedness of farmers as compared to their annual income
- Limited Accessibility to institutional credit

Sustainable production - Current challenges

Access to inputs and technologies

- **Poor access** to timely inputs (best seeds, agro-chemicals) and irrigation
- **Poor knowledge** about agro-ecological practices – INRM, IPM, and efficient water management
- Non availability of credible medium and long range climate predictions to reduce vulnerability to climate variability
- Inadequate processing and value addition

Rural development

- Meaningful extension services delivery lacking
- Liberal financing from public sector banks problem
- Poor road connectivity – access to markets – storage

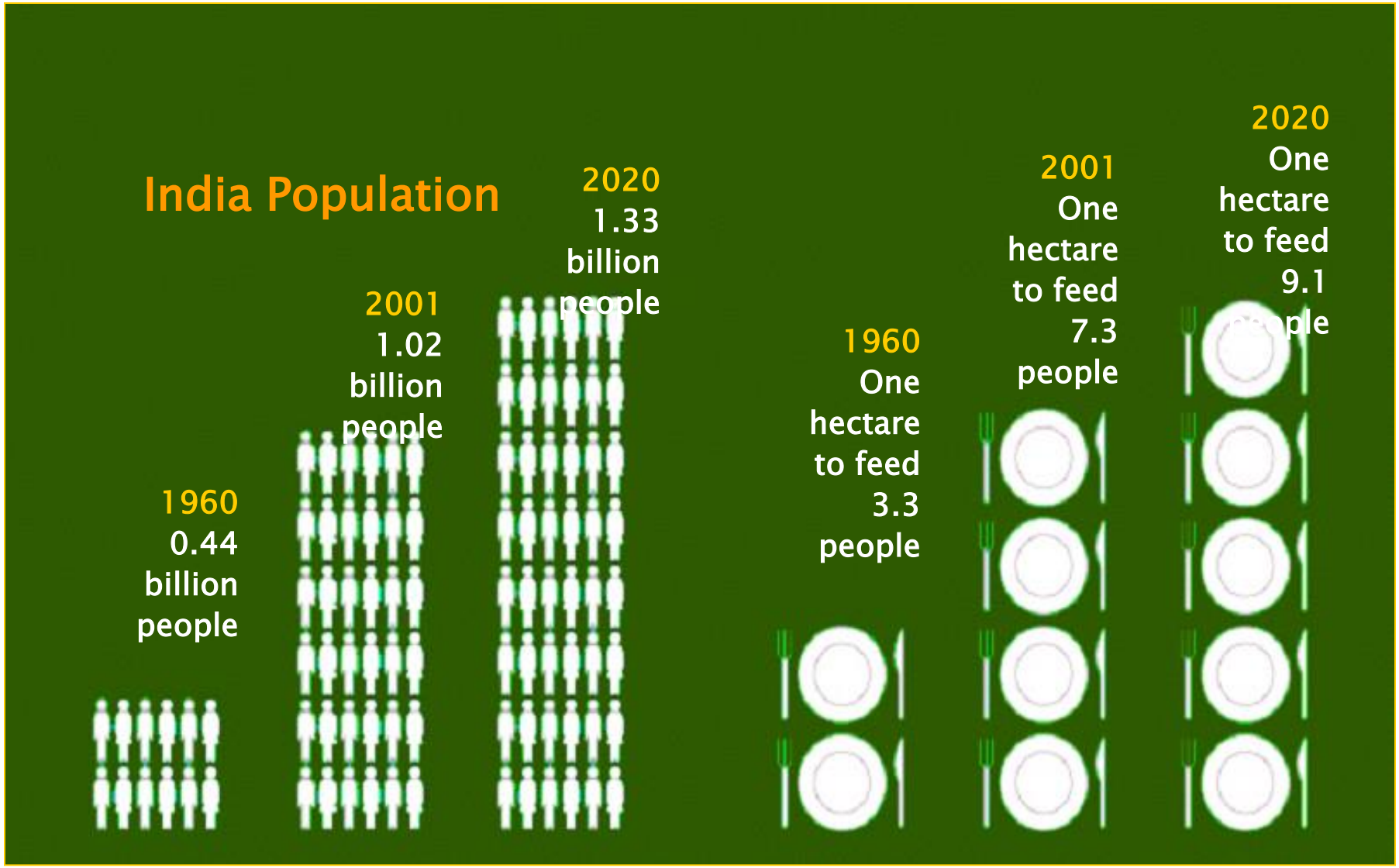
Trade and policy reforms

- Need of rational distribution of subsidies at grass root level
- Recognizing the special needs of the nitch areas
- Geographical Indicators branding /registeration

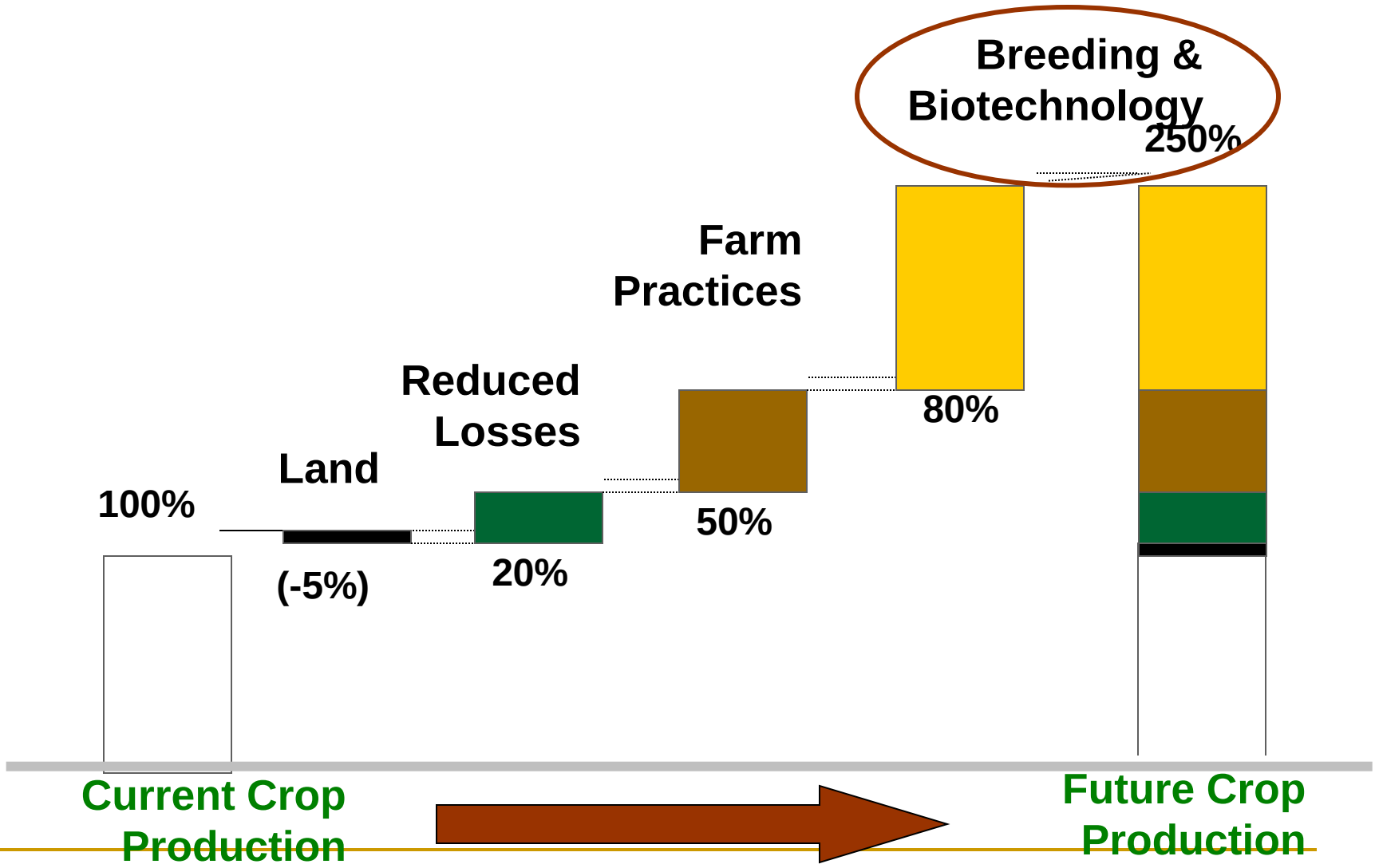
Sustainable production – Why ?

- Arable land available in world per person in 2010 was 0.2 hectares (against requirement of 0.5 ha)
- Arable land available in India per person in 1950-51 was 0.34 hectares and same was reduced to 0.17 ha in1999-2000 and 0.12 ha in 2010-11
- Of about 815 million of the world's hungry and malnutrition people about 233 million live in India. High rate of hunger strongly linked to gender inequality
- Around 43% children (under 5 yrs) are under weight in India while 70% suffer from anemia.
- India is low income, food deficit country with 26 % population. food insecure consuming less than 80 % of the energy requirement.(FAO)

More Food Per Hectare Will be Needed in future



Where will the food come from?



Sustainable production - Future Challenges

The demand for food grains, horticulture products and animal and allied sectors is likely to become double within the next 3-4 decades and demand for the type food and nutritional quality will also change

Sustainable growth needed in the agriculture and allied sector (crops, horticulture, livestock, poultry, fisheries, apiculture, sericulture, mushroom growing,etc)

- to feed ever increasing population
- to enhance rural livelihood security (rain fed areas and hill regions)
- to stimulate economic growth and profitability
- to meet food safety standards

Sustainable intensification – System

- Increase production and productivity (irrigated & rainfed areas)
- Increase crop yields of existing farm lands while reducing wastage
- Increase environmental sustainability
- Efficient natural resources management
- Reduce inputs (chemicals and fertiliser), water and energy use
- (especially in irrigated areas)
- Reduce costs of production and increase affordability
- Improve public perception of emerging technologies in agriculture

Rain fed areas

- The Food Bowl of India (North West) is becoming Unsustainable
- Groundwater Depletion and Climatic Variability threatens Food Security
- India Needs to Sustain Agricultural Growth to ensure Food Security
- Urgent need for 'Second Green' revolution from 'RAINFED AREAS'
- Promote Integrated Watershed development
- Promote dry land technologies for improved production of crops like cereals, oilseeds, pulses, coarse cereals, fodders etc
- In cultivable wastelands, medicinal and aromatic plant cultivation can be promoted on large scale.

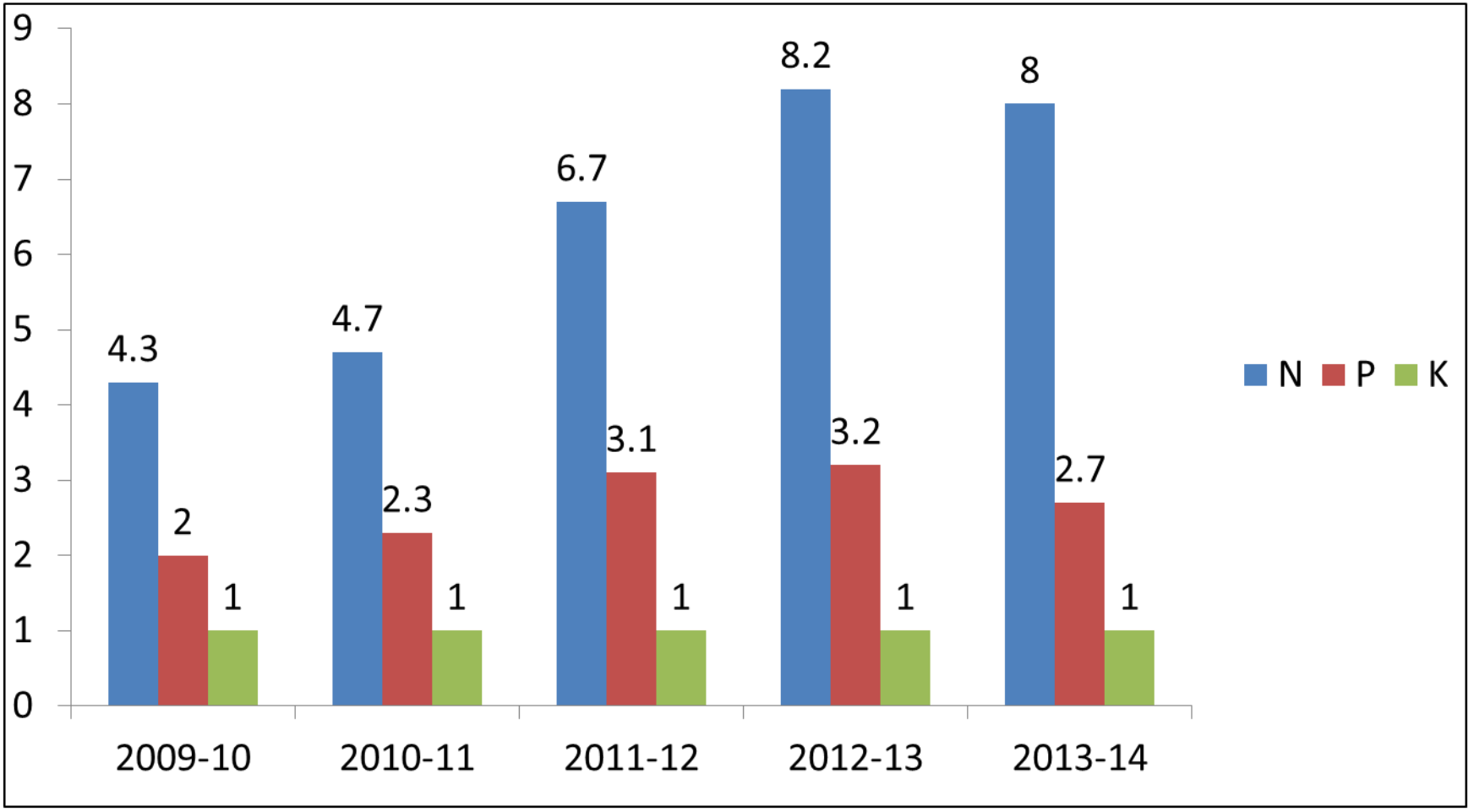
Food for future: Technical interventions and considerations

- Land use and Agro climatic planning
- Sustainable natural resources including biodiversity management
- Climate change (Adaptation and mitigation strategies)
- Productivity enhancement innovations(Agriculture, animal and allied sectors)
- Emerging technologies use (including biotechnology, information and management)
- Rain fed agriculture technologies (including Kandi belts and cold arid areas)
- Technological inputs (Quality Seeds, fertilizers, irrigation, etc - adequate & timely availability at affordable costs)
- Framing of Integrated water use policy
- Adoption Integrated nutrient and pest management

Natural resources management

- Improving water management especially in rainfed areas
- Addressing land degradation with focus on small scale farmers
- Increasing water productivity (irrigated & plains)
- Sustainable utilization of bioresources
- Enhancing the multi - functionality of agricultural landscapes.

Soil Health: Deteriorating balance in NPK



Deteriorating balance in NPK
The N-P-K ratio worsened acutely in certain states

NPK Ratios across states in India for 2013-14			
EAST		**SOUTH**	
Bihar	9.9:2.2:1	Andhra Pradesh	8.1 : 2.9 : 1
Orissa	5.5 : 2.1 : 1	Karnataka	3.7: 1.7 : 1
West Bengal	2.6: 1.0 : 1	Tamil Nadu	3.5 : 1.2 : 1
NORTH		**WEST**	
Haryana	60.7 : 12.7 : 1	Gujarat	12.8 : 3.5 : 1
Punjab	56.8 : 13.5 : 1	Maharashtra	3.7 : 1.8 : 1
Uttar Pradesh	28.4 : 7.3 : 1	Rajasthan	180.3 : 54.6 :

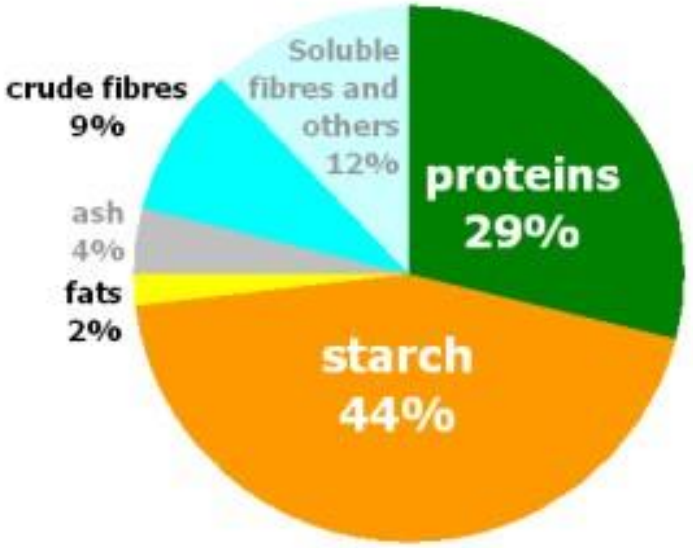
Management of Soil and environment Health

- Popularise use chemical fertilizers in conjunction with organic resources like farm-yard manure, enriched compost, biofertilizers and green manuring in irrigated as well as rain-fed areas
- Strengthen infrastructure and provide soil testing facilities to farmers in remote and isolated areas
- Facilitate establishment of Vermi-Compost Units
- Promote conservative agriculture and Organic Farming
- Develop Soil Fertility maps and Soil Health Cards
- Fully equipped quality control laboratories for leaf analysis for micro nutrients and testing for pesticide residues

Legumes for improving nutrition and soil fertility

Nutritional composition of broad bean 100 g of dry edible parts)





Integrated pest management approach

- Use of resistant varieties
- Appropriate cultural practice
- Biopesticides and biocontrol agents use for disease management
- Ensuring eco friendly environment
- Disease surveillance, in the context of
- emerging threats of climate change, will
- be given due attention.

Seed and gene banks

Establish Seed Banks to meet contingent requirements of seed in the wake of natural calamities.

Create community fodder banks in Ladakh to overcome endemic shortage of fodder

Farm saved seed

Knolkhol



Seed production



Feed and fodder – interventions

- Rejuvenation of pastures and meadows to upgrade their biomass potential to ensure availability of fodder for livestock
- .
- Increasing production of fodder, agroforestry species (of fodder value) to augment the nutrient requirement for the Livestock
- Utilise the crop residues as livestock feed,
- Promote Use Feed Block Technology together with biofortification
- of less nutritive fodder
- Increase area under fodder production from currently level of about 4% to 12%.
- Formulate Grazing Policy for the state will also be formulated.

Address climate change and variability effects

- Rising population and intensification of agriculture : shrinking of natural resources, soil degradation and erosion of flora and fauna
- Results in crop-yield losses due to various factors including changed pest dynamics and emergence of new diseases
- Focus has to be on the sustainability and devising strategies and policies on how to increase the crop productivity under changing climatic conditions
- Develop sustainable land use systems (across the state) and increase resilience to climate change and variations
- Improve farming systems that produce more grain with same or lesser use of water, pesticides, fertilizers and arable land

UN Environment Programme's Green Economy Report demonstrates that

- Green economies are a new engine of growth, generate decent jobs and are vital to eliminating persistent poverty.
- Investing just 2 per cent of global GDP (gross domestic product) into ten key sectors — including agriculture, buildings, energy, fisheries, forests, manufacturing, tourism, transport, water and waste management — can kick-start a transition towards a low-carbon, resource-efficient economy.

Application of frontier sciences

- like biotechnology,
- remote sensing technologies,
- pre- and post- harvest technologies,
- energy saving technologies,
- technology for environmental protection to face the consequences of climate change on production systems

Tissue culture multiplied ginger intercropped in peach orchards





Transgenic - Global acreage and impact

- **Global area increased from 1.7 m ha in 1996 to 148 mha in 2010 (87 fold increase) and over 170 million in 2014**
- No of countries growing biotech crops -29 (2010),
- USA (66.8 ma), Barzil (25.4 ma), Argentina (22.9), India (9.4ma)
- During 2004 there was 27 billion US dollar savings
- Reduced pesticide sprays by 172 million kg and environmental foot print of pesticides down by 14 %
- Reduced green house gas emissions- removing five billion cars from the road

Major developments in transgenics

- GM groundnut - ICRISAT (**Dr. William Dhar**) with participation from others institutions has produced outstanding GM groundnut that have solutions to control Bud Necrosis, Peanut Clump, TSV and Red hairy Caterpillar problems. The drought tolerant research is also in the advanced stage.

- GM potato - JNU (**Prof Asis Datta**) has a gene from Amaranth to add 60% protein. This gene can be further added to other tubers

- GM Mustard / Canola- DU (**Prof. Deepak Pental**) aims at improving productivity by 30% and future ability to add Vitamin – A

- Bt maize has been prophesized as the 21st Century crop by late **Dr. Norman Borlaug,** Nobel laurete and research on GM maize is being done in Directorate of Maize.

GM Rice verses VAD and micronutrient deficiency

VAD deficiency affects 127 million in developing world

SE Asia (VAD 33 %, Iron 57 % and Zinc 71 %)

2000 - The first Golden rice developed (1.6 to 1.8 micro gram beta carotene)

2004 - Syngenta developed Golden Rice I (6 to 8 micro gram beta carotene)

2005 - Syngenta developed Golden Rice 2 (36.7micro gram beta carotene)

100gm Golden rice 2 meets beta carotene requirement of 1-3 year old child

The work on GM Rice tolerant to biotic/ abiotic stress and flood resistance is in the advanced stages. Currently focus is on GM rice rich in carotene, iron and zinc

Trends in cotton productivity due to Bt-cotton



Year	Productivity m bales
2002-03	13.7
2003-04	16.4
2004-05	18.5
2005-06	22.6
2006-07	23.4

By 2012 (90 % area under Bt cotton in India) Production doubled,yield up by 70%

GM Crops - Public Perception

- USA - Acceptance continuing
- EU - Resistance reducing
- Australia - Labeling Important
- Brazil - Excellent progress
- China - Accepted with focus on few crops
- India - Cotton –excellent example

Food and Nutrition Security

"***Hunger, food insecurity and malnutrition can be ended sustainably by 2050. Eradication of hunger and malnutrition must be based on right of everyone to safe, nutritious and affordable food. But bold and effective actions are required .***"

India's Defense of the NFSA and MSP

- Large section of the population is food insecure
- Ensuring the food security of its population is the sovereign right of India
- Most of the Indian farmers are resource poor and the protection through MSPs is legitimate.

Perspectives for food security (2015 – 2050)

Even with relatively small income increases, demand increases for basic food staples will exceed supply, mostly due to the underlying metrics (population, land area).

Imports might not forestall major food price increases due to logistical constraints (volumes) and farm income realities in high income countries.

Emerging technologies including biotechnology can support productivity increases which can help in addressing problems of hunger and poverty provided risk assessment has been done and public confidence won

With appropriate policy support and judicial blending of traditional technologies with biotechnological tools, smallholder women farmers and rural youth can become the engines for agricultural productivity growth and contribute to avoid food crisis in near future

Increasing production –Let us pledge

- Develop varieties/ hybrids/ transgenics that help increasing production by 25% from current levels

- Develop / refine technologies that increase production by atleast by 25% from current level

- Develop varieties and technologies that use fewer resources (¼ th) but permit acceptable or relatively better output
- Improve profitability of farming and living conditions of farmers
- Involve women and rural youth in agriculture

Sustainable Production – Food Security

- **Food security is achievable** but business-as-usual policies, practices and technologies will not work. To produce diversified array of crops, livestock, fish, forests, and biomass (for energy) in an **environmentally and socially sustainable manner** we need to:

- **Embed economic, environmental and social sustainability** into agricultural policies, practices and technologies

- **Address today's hunger** problems with appropriate use of current technologies, emphasizing **agro-ecological** practices (e.g., no/low till, IPM and INRM), coupled with decreased post-harvest losses

- **Address future demands by supplementing or complementing emerging technologies** for increased productivity and crop protection in era of climate change and diminishing natural resources but the risks and benefits must be fully understood

Feeding hungry is our duty

- If we fail to feed the present generation due to pre-concieved fears of frontier technologies then there would probably increased hunger & under/ malnutrition in future generations.

- Responsible emerging technologies including biotechnology are not the enemy but hunger is real enemy that affects around one billion and starvation that causes million of deaths every year.

- Without adequate food supplies at affordable prices to needy we cannot expect world health or peace

Judicial blending of traditional and responsible frontier technologies is our future


THANK YOU