Implications of Government Policies in India on Climate Change Adaptation, Mitigation and Resilience in Agriculture: A First Order Assessment

Outline

- Background
- National level policies and programs and growth in agriculture
- Data & Methodology for evaluating the impacts and indicators
  - Mitigation, adaptation, resilience and sustainability
- Results
  - Intensification, adaptation, resilience, sustainability
- Way forward

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Preamble

- Agriculture is the Nature's Carbon and Water based industry in which major impacts of climate change are being transmitted through changes in Hydro-cycle, adversely impacting the water Demand and Supply equation.
- Adaptation though innovations leads to land saving (Borlaug's hypothesis), as well as mitigation ; and it will remain main the mechanism to meet climate change impacts
- Biotechnology apart , engineering knowledge based technologies will be the major interventions for efficient use of land , water and energy
- Large scale Adoption of Agro-hydro-technologies will be largely policy driven

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India's land &water resources and irrigation statistics

RESOURCES		IRRIGATION STATISTIC ,(Mha)	
LAND(Mha)		Gross irrigated	92.57
Geographical area	329	Net irrigated	66.1
Cropped area	142	Surface water	23.8
Rainfed	76	Ground water	42.3
Cropping intensity (%)	140	Flow irrigation	58.3
WATER(Mha-m)/BCM		Sprinkler	4.4
Total renewable water	2081	Drip	3.4
-Utilizable surface water	690		
-Storage capacity	220		
-Utilizable groundwater	381		

Target 2030- At least 35 % pressurized irrigation

Source: GOI,2015,2016

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The five transitions impacting WEF Security in India

Transition Item	Value in 2010	Value in 2050
Urbanization transition	31 % ;Per capita income INR 53000	55%;Per capita income INR 430000
Nutrition transition	2200 KCI; 8 %from animal products	3000 KCI, 16-20 % from animal product
Climate transition	Shifting of production zones- Yield have stated declining TFP declining	2 ◦C rise, rise in water demand by 15-20 %!
Energy transition	Per cap consumption 725 kWh(74 FS: 26 RS)	Per cap consumption 3000 kWh (50FS:50RS)
Agricultural transition	85 % farms ≤2ha, Per HH Income- INR 40,772(2011-12); Subsistence farming	Increased farm size due to urbanization , Commercialization

***Data taken from different GOI reports; KCI-Kilo calories, FS-Fossil sources, RS-Renewable source**

Contribution of Agriculture to India's GHG Emission Budget

- Total Emission from agriculture, $MtCO_2e$ =334.4
- Emissions from enteric fermentation = 50%
- Emissions from paddy fields = 21%
- Emissions from agricultural soils = 16.5%
- Emissions from crop residue = 1.9%
- Emissions from manure management = 1.4%

Concern : Agriculture in India contributes 19 % of the country's total GHG emissions as compared to global average of 13.5 %

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Projected impacts of climate change on Indian agriculture

- Increased droughts and floods are likely to increase production variability
- Increasing sea and river water temperatures are likely to affect fish breeding, migration, and harvests
- Animal distress due to heat; effects on reproduction
- Loss of 1.5 million tons of milk by 2020
- Wheat and maize yield may decline by 10 % by 2030
- Imbalance in food trade due to positive impacts on Europe and N.America, and negative impacts on us.

"So Paris or no Paris agreement " , climate change is a serious concern for India(PM Modi)

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II

National level policies and programs

Broad national policy initiatives for climate change and sustainable agriculture in South Asia

- National Action Plan for Climate Change
- National Environment Policy
- National Agricultural Policy
- National Water Policy
- National Disaster management Policy
- National Forest Policy
- National Livestock Policy

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Common features of climate change related policies

- Unlike global climate policy, which did not focus on agriculture, South Asian countries have emphasized policies for adapting to climate change in agriculture.
  - In the absence of legislation, national action plans (NAPs) are currently the most common instrument for adaptation policies and
- The NAP specially mention the need to address the concerns of the farming community and rural poor as one of the guiding principles of climate policy.
- Subsidies have been a mechanism for promoting adaptation in economic development programs.
- While policy statements are often elaborate, mechanisms for putting them into practice are often missing.
  - This is particularly true for funding adaptation and mitigation programs.

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Core agriculture policies in South Asian countries

- Improved seeds, fertilizer, irrigation expansion, watershed development, provision of insurance and weather advisory service
- Command area development, and promotion of participatory water management on canals
- Groundwater development is largely private
- Electricity for pumping is highly subsidized
- Subsidies more pronounced
- Seed village/KVK

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Expenditure on Irrigation Development & Fertilizer Subsidy as % of Total Plan Outlay (GoI ,2011; Planning Commission ,2013; and Gulati & Narayanan ,2003)

Plan/Period	Irrigation	Fertilizers
8th (1992-97)	7.59	0.66
9th (1997-02)	6.70	0.70
10th (2002-07)	6.19	0.49
11th (2007-12)	5.81	0.91

The *non-climate* centric policies pertaining to the irrigation and fertilizer sectors have remained central to government's priorities for agricultural development.

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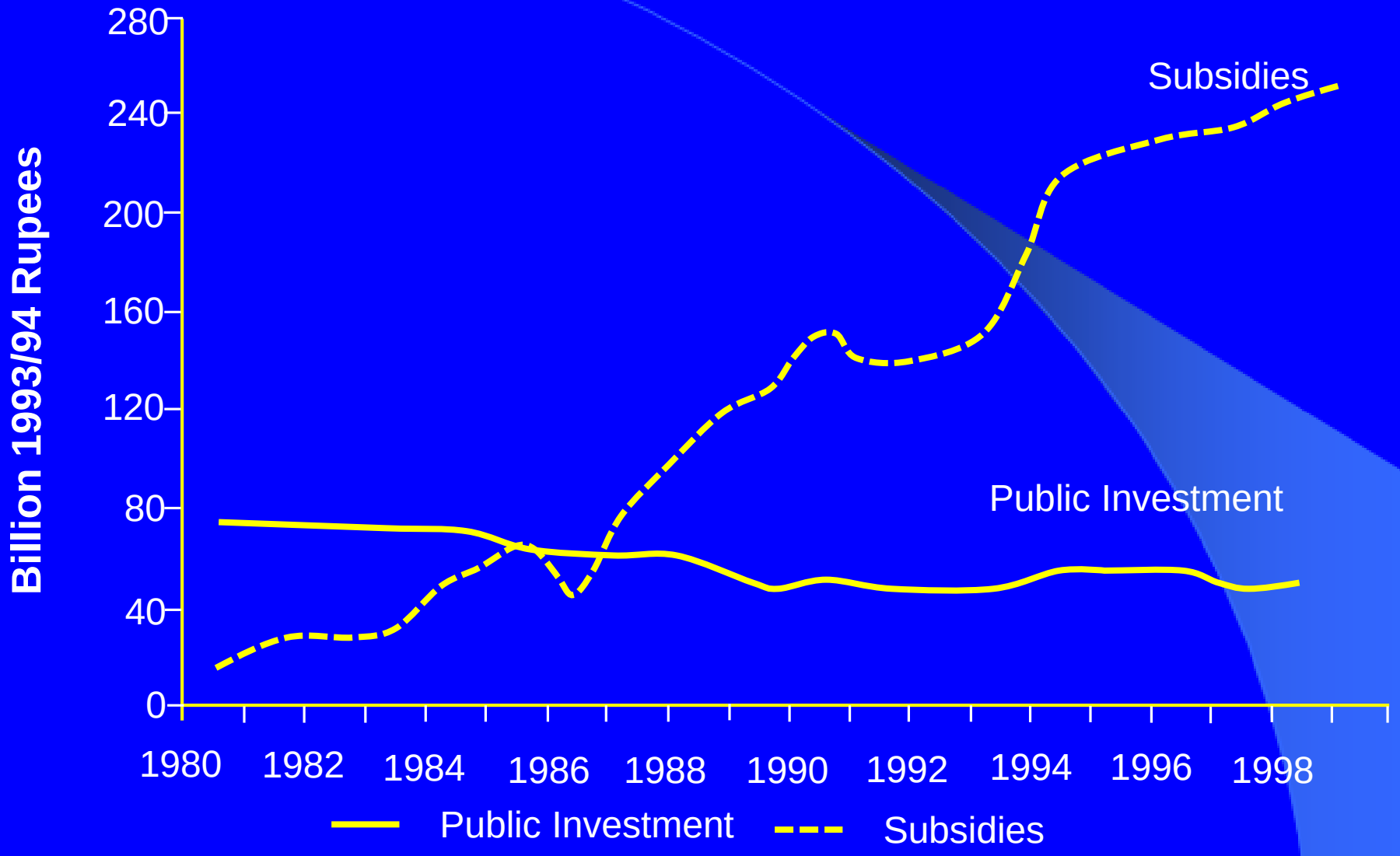
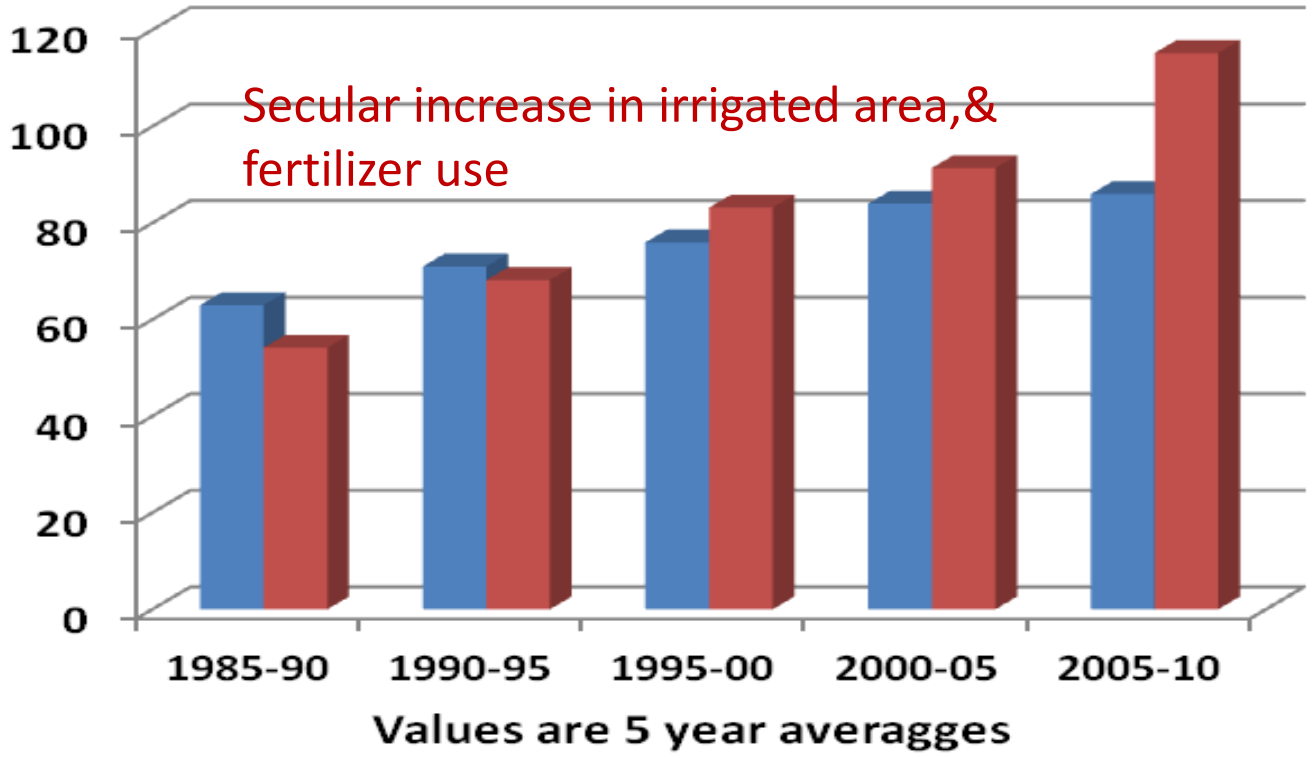
Public Investments and Input Subsidies in Indian Agriculture



Source: Ashok Gulati and Sudha Narayanan, The Subsidy Syndrome in Indian Agriculture (New Delhi: Oxford University Press, 2003).

Area under irrigation (Mha) and fertilizer use (kg/ha) in India



Land under cultivation, mha

1990: 127.8

2010: 124.3

GIA,Mha

FL,kg/ha

Source: GOI,(2011);GOI,(2012);Pandy and Chand, (2008)

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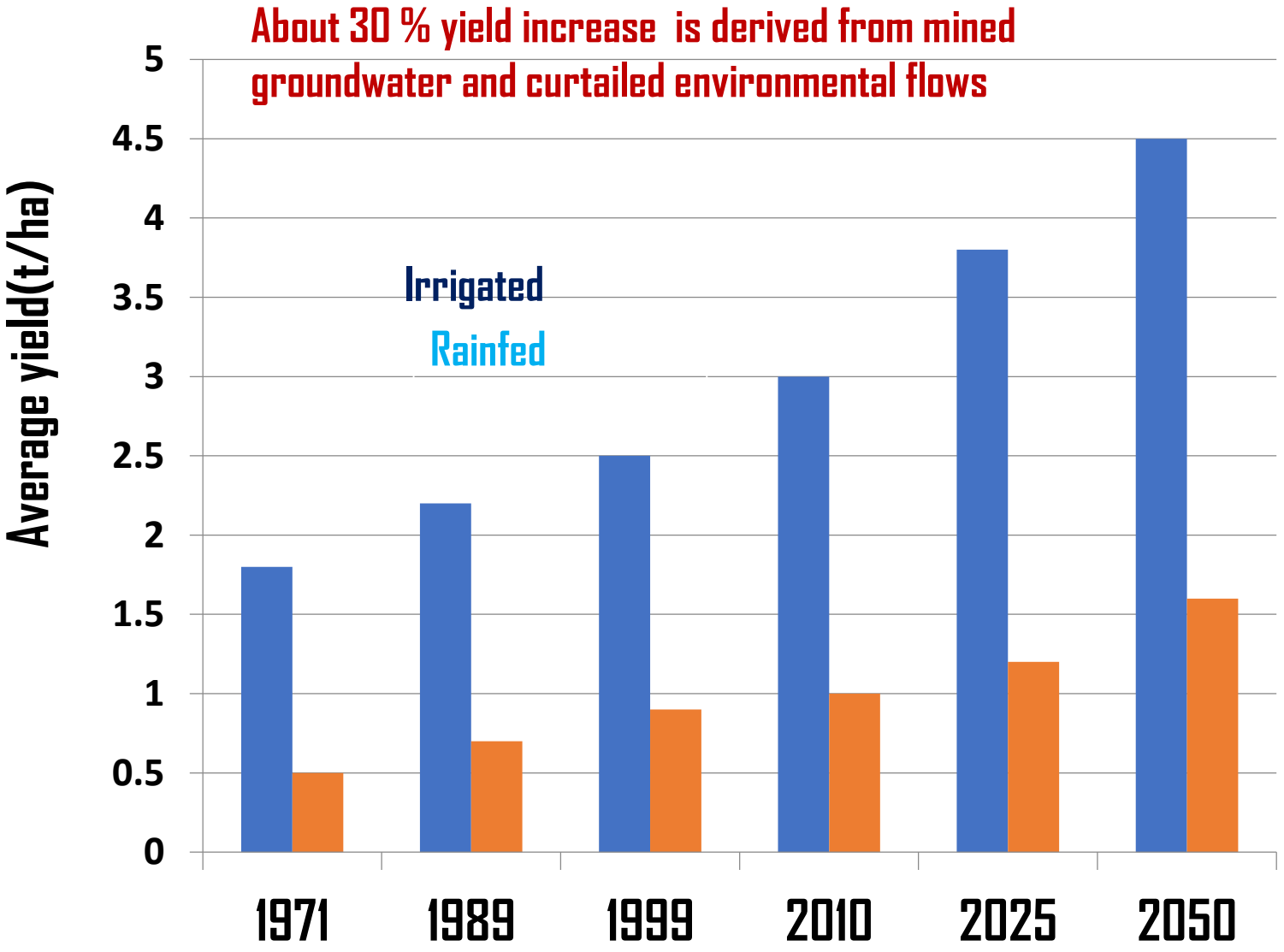
Growth in food grain yield in India (1971-2050)



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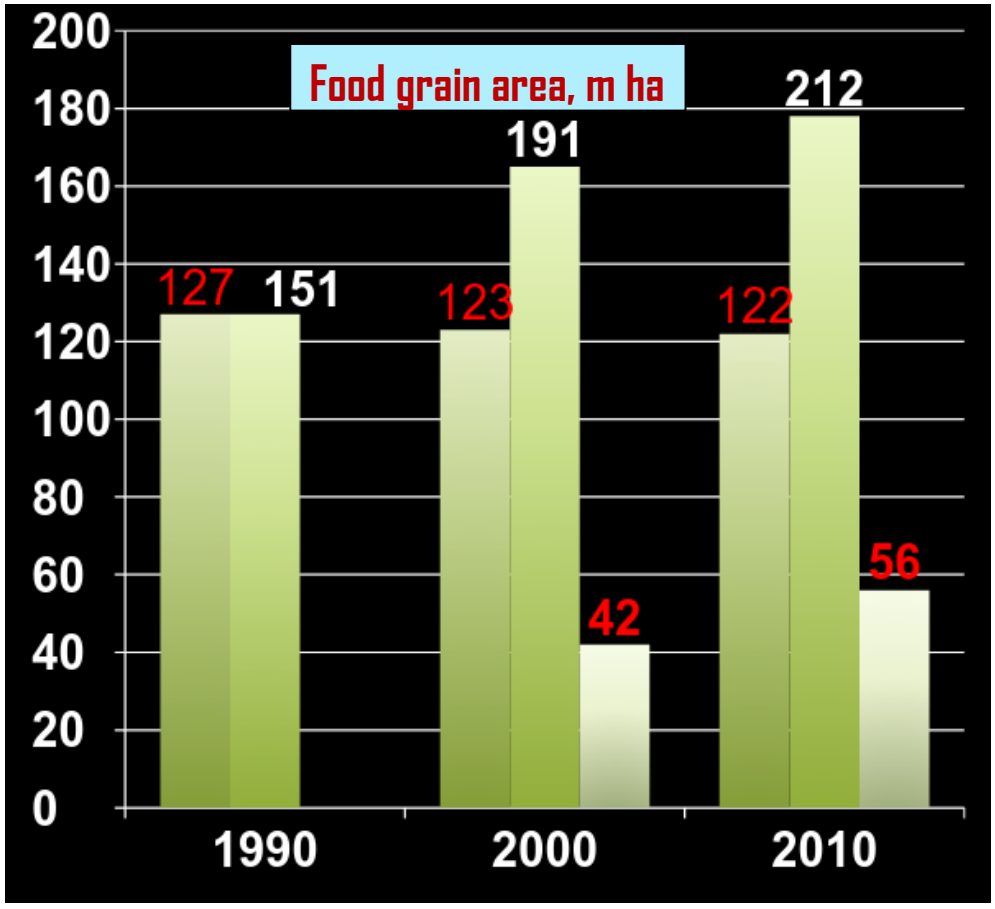
Changes in Production and Productivity due to Policies and Technologies (Tyagi et al,2014)



Food grain production-40.4% increase

- 1990: 151 mt
- 2010: 212 mt

Productivity-46 % increase

1990: 1.19 t/ha

2010 :1.74 t/ha

Population- 40 % increase

1990: 834 million

2010: 1170 million

Avoided deforestation by year 2010=56 m ha.

Proves Borlaug's hypothesis-Agricultural innovations spare land

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Based on results Borlaug's hypothesis that improved technologies save land stands proved

India's transition to high-yield farming spared the country from having to plough an additional 100 million acres of virgin land—an area about equivalent to California

Paul Waggoner
Connecticut Agricultural Experiment Station

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III

Evaluation of Impact of government policies and programs

The Issue

Whether these developments(promotion of irrigation and fertilizer to improve productivity in agriculture-) exacerbated or minimized GHGs emissions is the issue?

"The relevant issue when handling this topic, that is, the ambivalence of development policies that are mainly based on tools which have significant negative environmental impacts."

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Our Approach(With & Without Incremental Change)

1)Compute the combined and disaggregated contributions of GRTs (All GRTs, Irrigation ,and Fertilizers)

2)Analyze and compare the GHGs emissions, with and without incremental change in expansion of technologies

3) Compute the reduction in GHGs due to avoided forest land conversion(AFC)

4) Assign the emission change to combined and individual technologies with and without AFC benefit – Virtual mitigation

5) Positive change in emission over the base is intensification and negative change is mitigation

Impact indicators of past agricultural policies

- Mitigation
  - Reduction in GHG emission between 1990 and 2010
- Adaptation
  - Increase in quantity of food grains/cap between 1990 and 2010
- Resilience
  - Change in variance of food production between 1990/95 and 2005/2010
- Sustainability
  - Ratio of water withdrawal and renewable water

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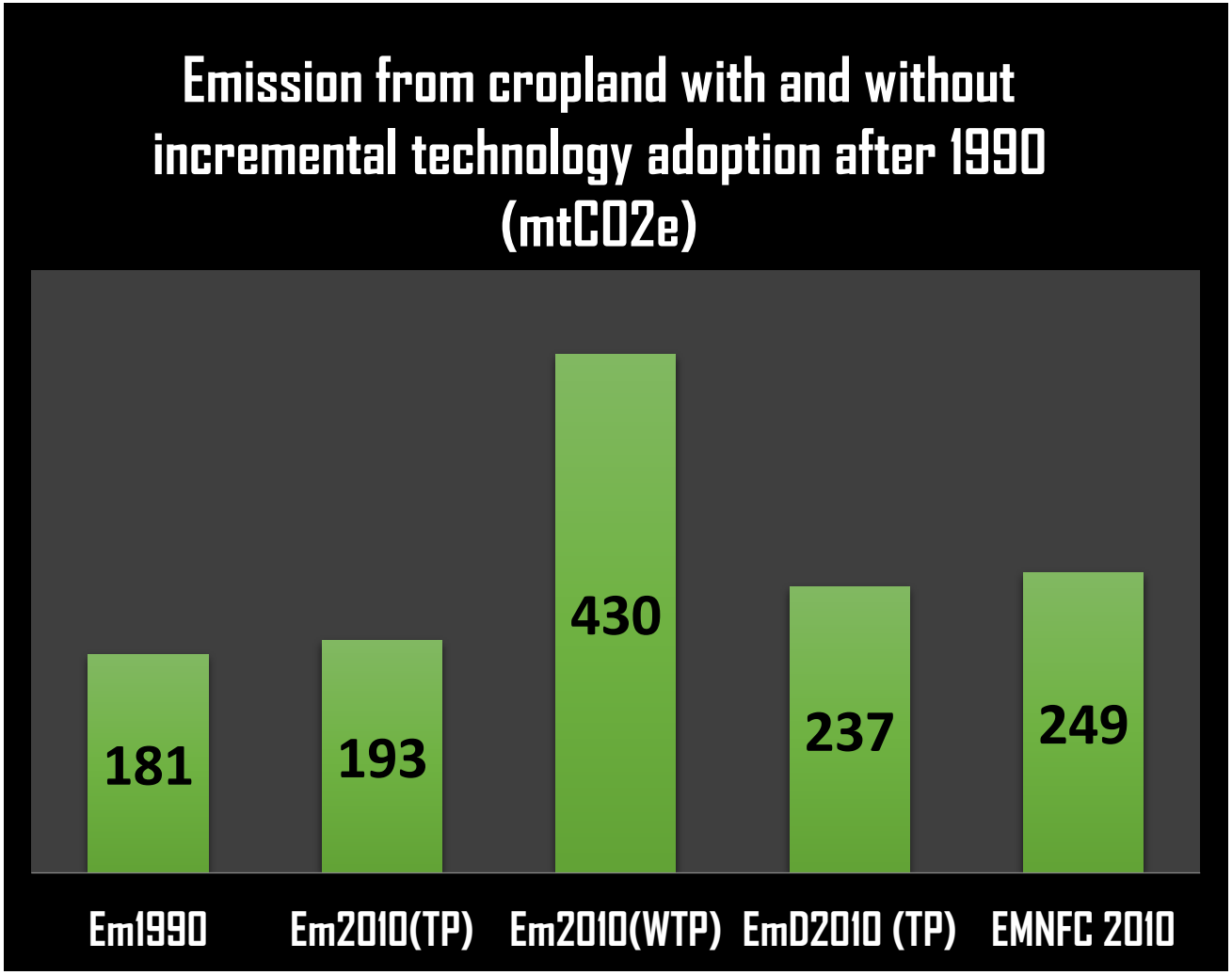

Food grain carbon foot prints, (ton CO_{2e} per ton FG)

1990=1.196

2010=0.907

MI_{AFC}=0.948

MI_{NAFC}=0.539

Policy support for implementation of GRTs(TP) led to virtual emission mitigation (Em) by 237 MtCO2e (Tyagi et al,2014)

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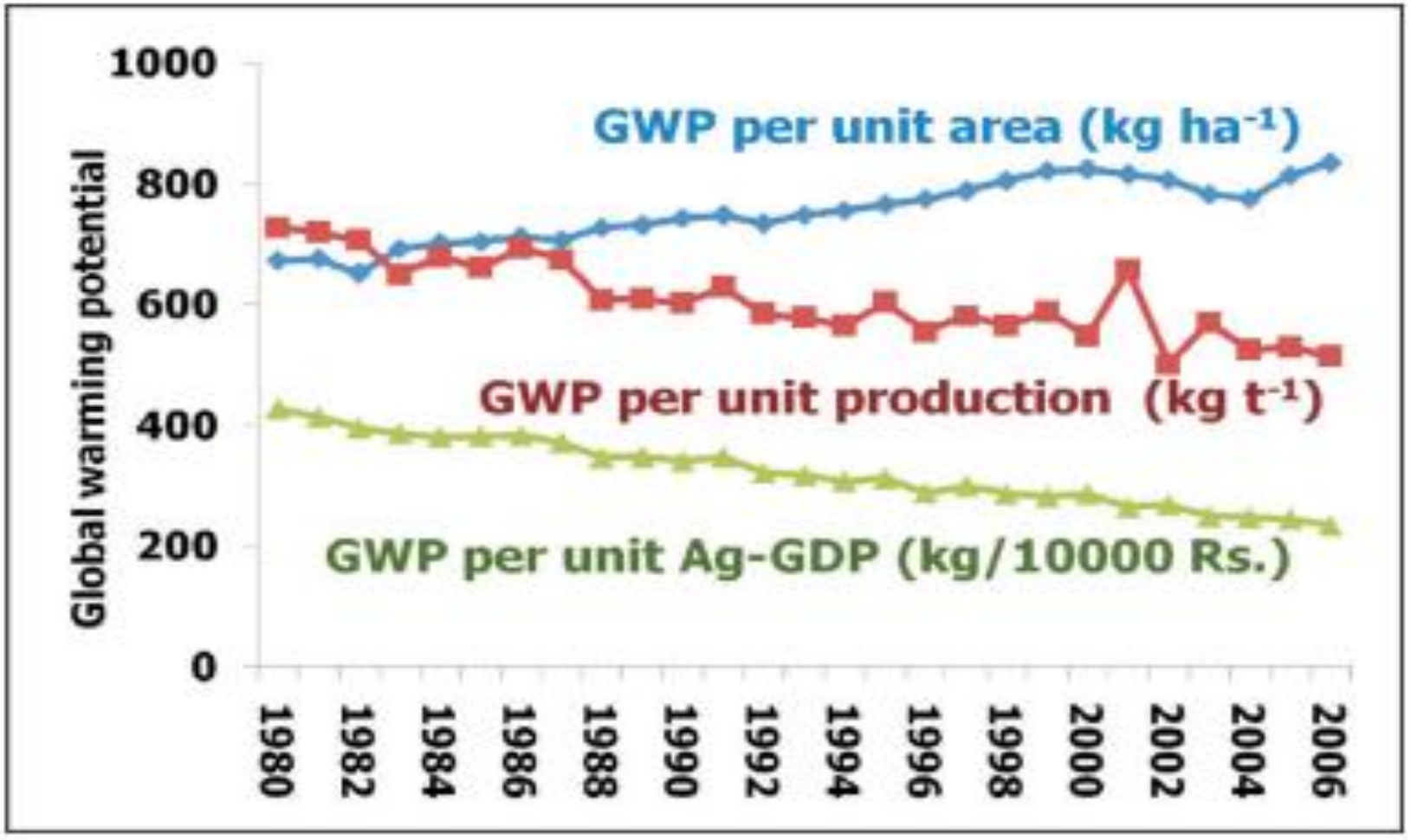
Intensity of greenhouse gas emission from Indian agriculture GWP
Source: Pathak et al. 2011,unpublished



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Intensification and Mitigation for GRTs, (mt CO2e)

Technology	Em2010 (AFC) (Mitigation)	Em2010 (NAFC) (Intensification)
All GRTs	(-)107.4*	(+) 141.80
Fertilizer	(-) 12.26	(+) 35.22
Irrigation (SW+GW)**	(-) 87.32	(+) 7.78
Irrigation (GW)	(-) 41.20	(+) 15.72
Micro-irrigation		
-Current area (4Mha)	(-)2.15	(+) 1.25
-Potential area (40Mha	(-) 22.24	(+) 12.97

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Intensification and mitigation accomplished by GRTs between1990-2010

Intensification Index (IFI) %		Virtual Mitigation Index(MI) %	
IFC_{AFC}	IFC_{NAFC}	MI_{AFC}	MI_{NAFC}
5.22	46.10	94.78	53.90

$IFI_{AFC}2010=(Em_{2010}TP - EmTP_{1990})/ EM_{2010}WTP$;

$MI_{AFC2010}$== (1- IFI_{AFC}) 2010 .EM= Emissions , TP= With implementation of technology policy

WTP= Without implementation of technology policy

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Virtual Mitigation

For all the scaled out technologies, the intensification index $_{(IFI)}$ with and without consideration of avoided forest conversion benefits (AFC), is below 10 per cent and 50 per cent respectively; indicating that the potential intensification with technology policy was reduced to the extent of 90 per cent to 50 per cent.

This reduction in intensification is referred to as *virtual mitigation*.

The *virtual mitigation* potential of micro-irrigation was found to be significantly high; a fact that future research and policies in this realm could potentially exploit.

Improved adaptation due to GRTs

Technology	Increase in food availability(FGA) (kg/cap/year)	Adaptation Index(AI) (%)	Remarks
All GRTs	72.00	26.10	$AI=\frac{FGA_{2010}-FGA_{1990}}{FGA_{1990}}$
Irrigation	28.74	10.56	

Increasing food availability and saving 56 Mha additional land from going under the plough has been the major contributions of incremental adaptation through GRTs in India

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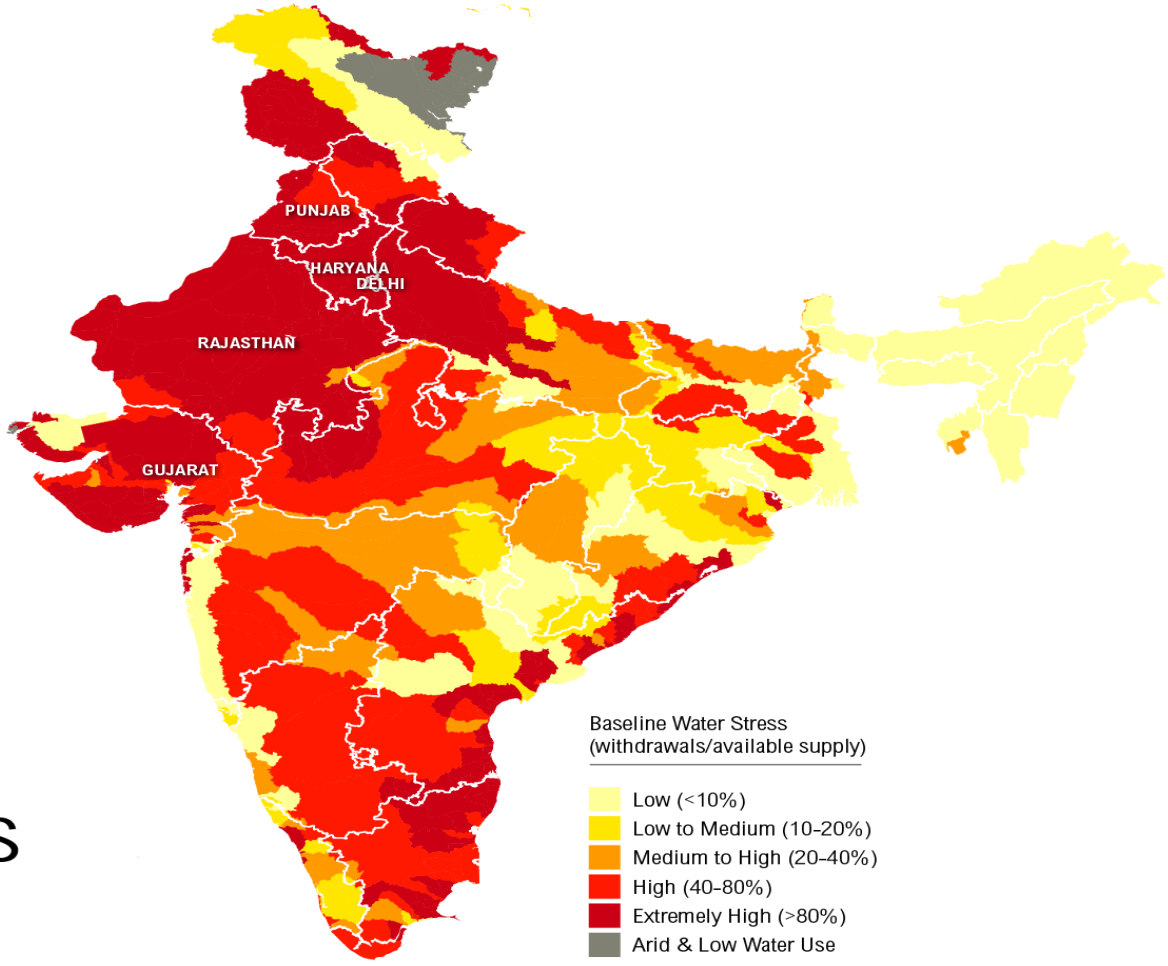
Water resources potential ,development, and degree of stress (2000-2050)

Item	Level of development (BCM)		
	2000	2010	2050
Surface water	360 (690)*	404	647
Groundwater	210 (396)*	260	396
Degree of stress			
DDS	0.522 (High)	0.586 (High)	0.938 (Extremely high)
GWAR	0.530 (Normal)	0.657 (High)	>1.00 (Extremely high)

*Values in parenthesis are the exploitable water potentials

Water stress across India

54%
of India
Faces
High to
Extremely
High
Water Stress



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Inferences (I)

Though not specifically targeted, but modernization of agriculture through subsidies had a significant effect on total GHG emissions.

The good performance of development policies in irrigation and fertilizer sector has :

-reduced climate change induced intensification. This may be called adaptation led mitigation or virtual mitigation

(Range 50-90 %)

- *with incremental adoption of irrigation and fertilizer technologies, Adaptation Index (AI) increased from 0.19 to 0.26. A 27% Increase.*
- *But- performance in respect of* sustainability of natural resources (water and soil) is poor(DD> 0.90 ; GWAR>0. 95; NPK:: 7:2.6:1) .
- This is a matter of grave concern

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Way forward

Turning Down the Heat from Agriculture: What Next?

In agriculture, adaptation would continue to be main mechanism for meeting climate change challenge. But in place of incidental gain in GHGs reduction, it will have to be more policy driven though promotion of climate smart technologies for which there is enough scope

Major required policy shifts:

- Policies that would lead to adoption of efficient technologies and mechanization in agriculture (GoI has announced a budgetary support of about $ 60 billion for irrigation and additional support for Soil health cards)
- Policy on development and use of G M crops to cope with stress and reduce energy foot prints is under review
- Policies for propagation of the concept of bio-industrial watersheds to take care of the population moving-out of inefficient agriculture

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- National Food Security Mission (NICRA, Soil Health Card Scheme, National Agroforestry Policy -NAP)
- Mission for Integrated Development of Horticulture,
- National Mission for Sustainable Agriculture,

  -Paramparagat Krishi Vikas Yojana

  -Pradhan Mantri Krishi Sinchayee Yojana

  National Mission on Agricultural Extension & Technology
- National Water Mission (NWM)

  -Watershed Development Programme- Neeranchal is a recent programme to give additional impetus to watershed development

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Concluding Remarks

- Climate change impacts on agriculture and thereby on food security, would be far more debilitating than in other sectors.
- Adaptation would be the major vehicle to provide resilience to food production system . Creating and accelerating sustainable increases in production and productivity in entire food systems including postharvest and consumption phases through innovations is required.
- Most adaptation interventions require policy support and should be mainstreamed into development programmes of the governments for large scale implementation.
- Recent policy initiatives are in right direction, but impacts would have to await their implementation
- Evolving evidence based recommendations for policy and institutional changes requires continued research support

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Policies, technologies and institutions need attention for a win-win solution

THANK YOU