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Ozone & Agriculture

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Impacts of Ozone on Plants

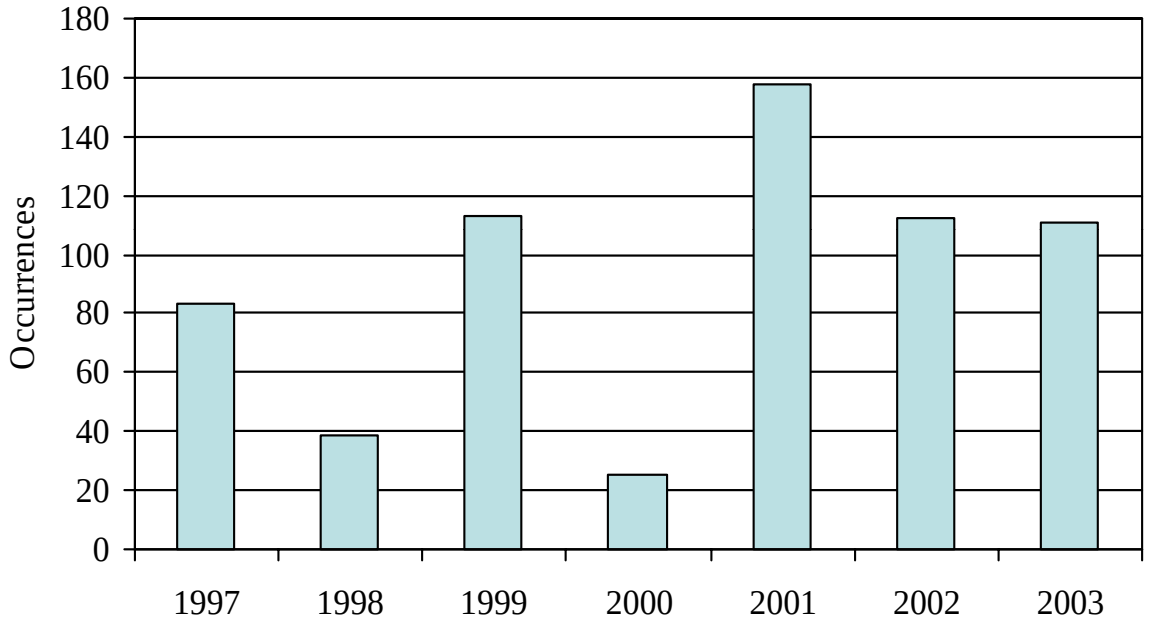
- Tropospheric ozone is an oxidant that damages agriculture, ecosystems, and materials.
- Ozone destroy rubisco, an enzyme crucial for photosynthesis.
- O3 effects on vegetation occur when stomatal gas exchange is active.
- It is also known to make leaves age faster.

Leaf Injuries

due to

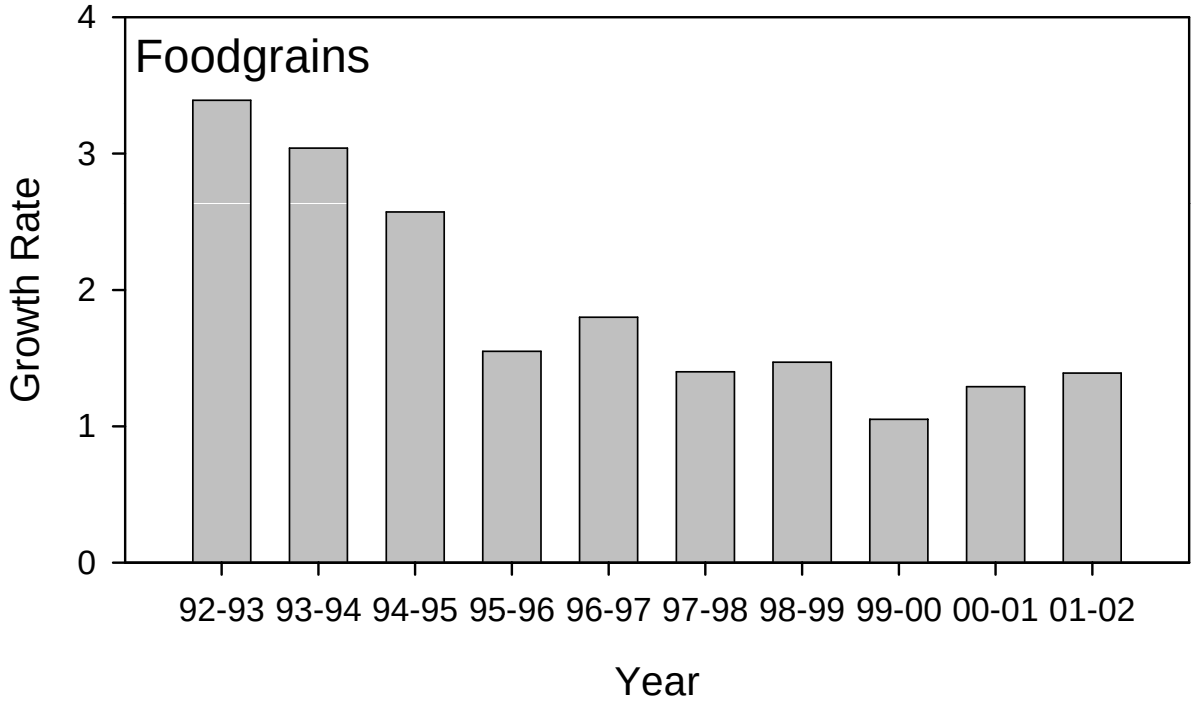
Surface Ozone

High Surface Ozone Occurrences at Delhi



Ref: Jain et al. International Journal of Remote Sensing, 2005

Loss in Food Grain Productivity

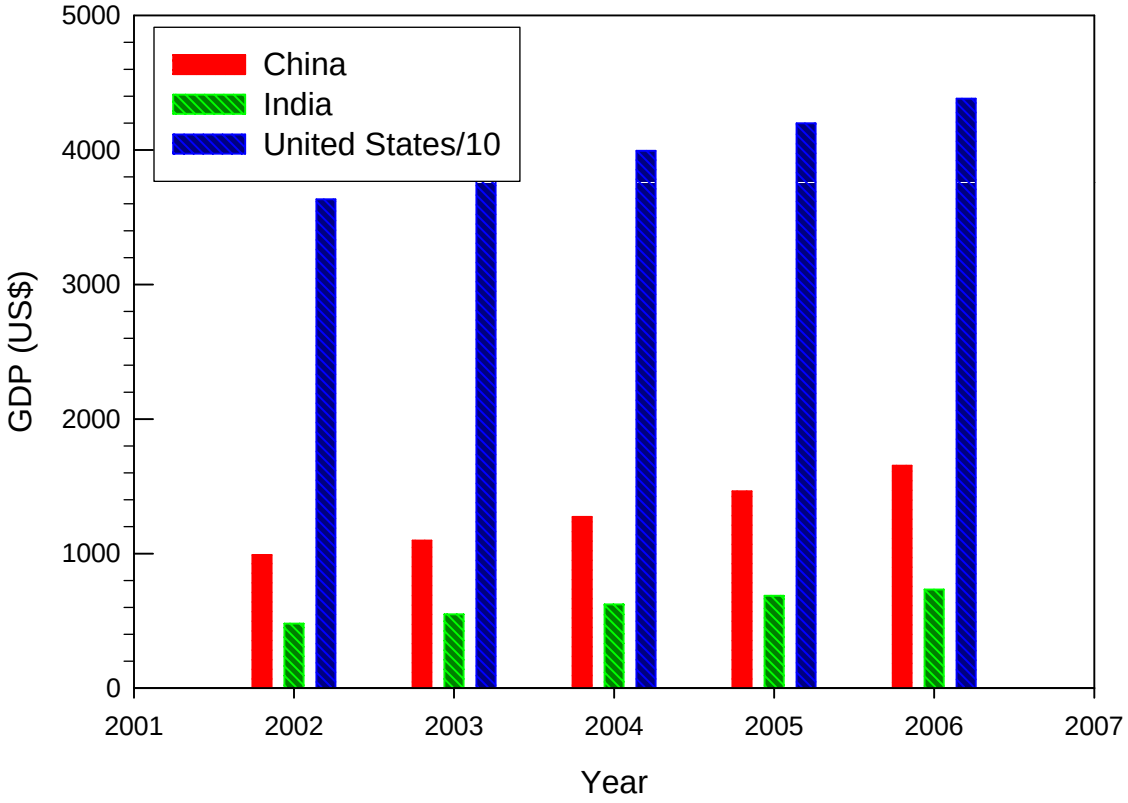


Ref: Aspects of India's Economy, Nos 36 & 37, March 2004

The fact that yields growth is below population growth (1.9 % per year) means that food grain production per capita is falling and will involve economic risks.

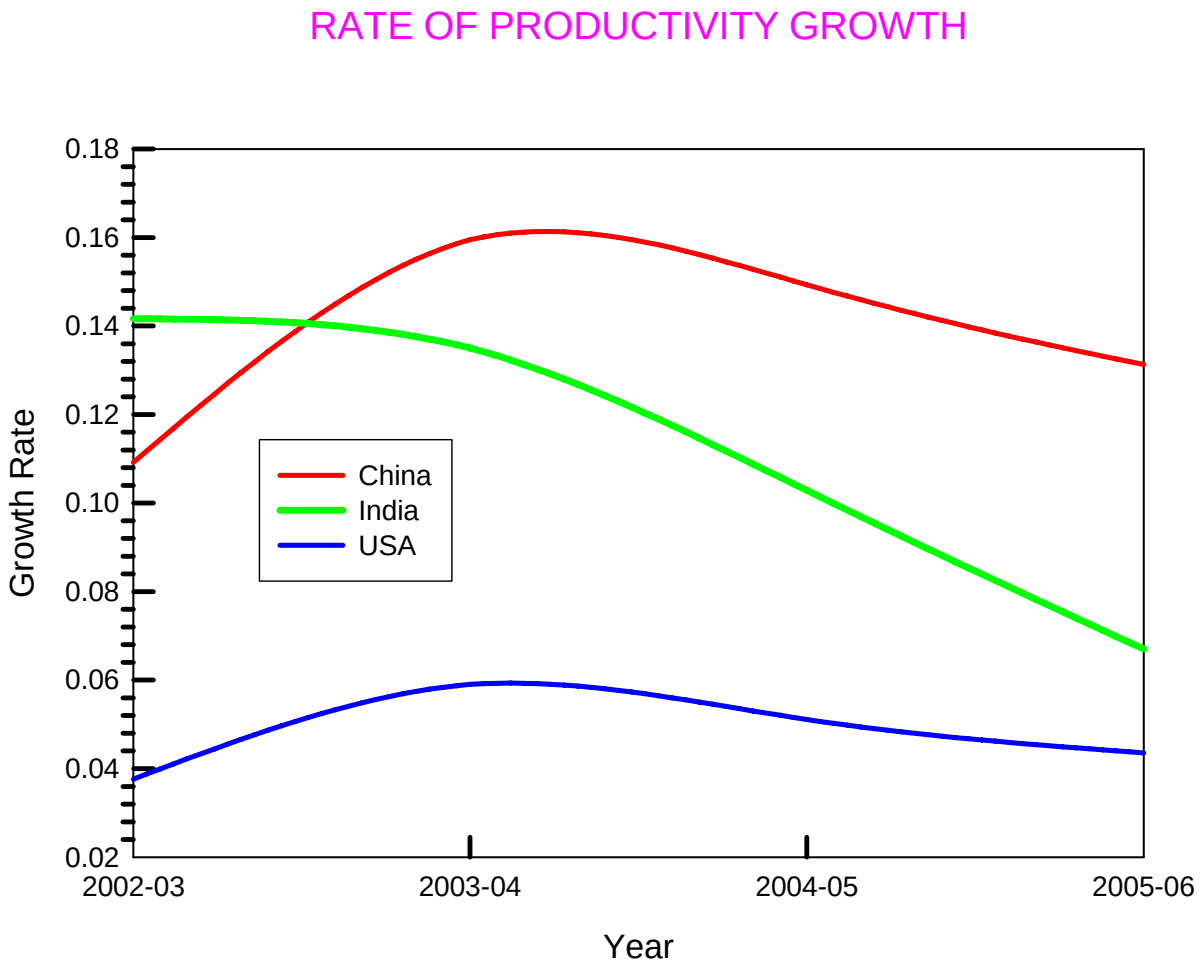
Productivity Levels

Gross Domestic Product per Capita, current prices



Ref: World Economic Outlook Database -IMF

Growth Rate of Productivity



PRODUCTION, ECONOMIC VALUE AND % LOSS IN ECONOMIC VALUE OF YIELD AT DIFFERENT SITES AROUND VARANASI CITY

Sites/Plants	Production ($q\ ha^{-1}$)	Economic value (Rs.)	%loss
Wheat			
Reference area	29.50	17995.0	
Rural area	24.25	14792.5	17.80
Periurban area	22.15	13511.5	24.91
Urban area	20.60	12566.0	30.17
Industrial and Urban area	20.50	12505.0	30.50
Mung			
Reference area	10.11	13244.0	
Rural area	7.20	9432.0	28.78
Periurban area	6.66	8724.6	34.12
Urban area	5.85	7663.0	42.14
Industrial and Urban area	6.00	7860.0	40.65
Pea			
Reference area	23.50	30550.0	
Rural area	17.75	23075.0	24.47
Periurban area	16.57	21541.0	29.49
Urban area	15.92	20702.5	32.23
Industrial and Urban area	14.62	19012.5	37.76

Source: M. Agrawal, BHU

Ambient air pollution effects on selected crops of Pakistan (Wahid, 2003)

Crops	Pollutant (ppb)		Yield losses (%)
	O_3 *	NO_2 **	
Wheat (6 varieties)	33- 85	23- 30	29- 47
Rice (5 varieties)	35- 60	13- 25	28- 42
Soybean (2 varieties)	64	29	37- 46
Chickpea (3 varieties)	59	38	23- 27
Mung bean (2 varieties)	66	31	26- 34

* O_3 (6 h d^{-1} seasonal mean)

** NO_2 seasonal mean (weekly basis)

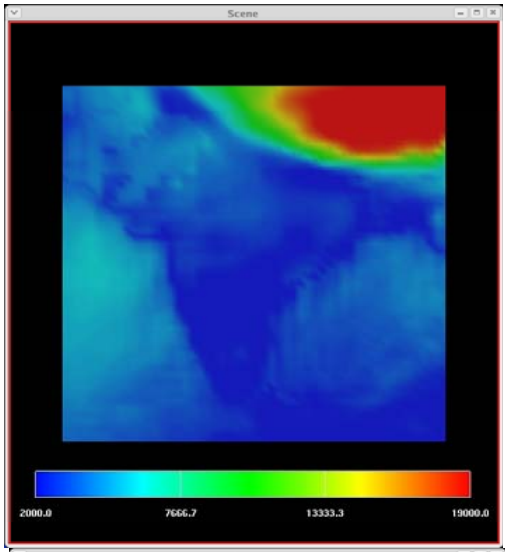
Ambient air pollution effects on crops in selected countries of Asia

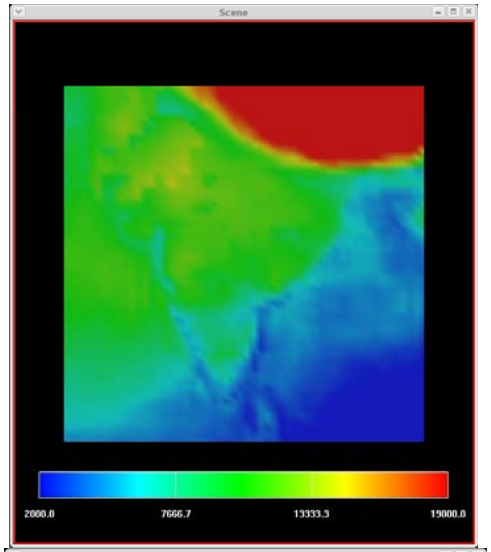
Country	Pollutant	Crop	Yield loss	References
Japan (Kantoh)	O_3 (40-60 ppb)	Rice	0- 7%	Kobayashi (1999)
China (7 provinces) (south west)	SO_2 and acid rain	Vegetables	7.8 %	Feng *et al.*(1999)
		Wheat	5.41 %	
		Soybean	5.73 %	
		Cotton	4.99 %	
	O_3 (ppb) (night 15 mid day max 75)	Green pepper	Sensitive	Zheng *et al.* (1998)
		pepper	"	
		Rice	"	
		Cauliflower	"	
		Aubergine		
Taiwan (S) Taipei Basin	O_3	Spinach	"	Sun (1993)
		Sweat potato	"	
China, Japan and South Korea	O_3 50- 55 ppb (1990)	Corn		
		Rice	1- 9 %	Wang and Mauzerall, 2004)*
		Wheat		
		Soybean	23- 27 %	
	60- 65 ppb (2020)	Corn		
		Rice	2- 16 %	"
		Wheat		
		Soybean	28- 35 %	

*** MOZART- 3 O_3 exposure and yield relationship**

AOT-40 Over Indian Region

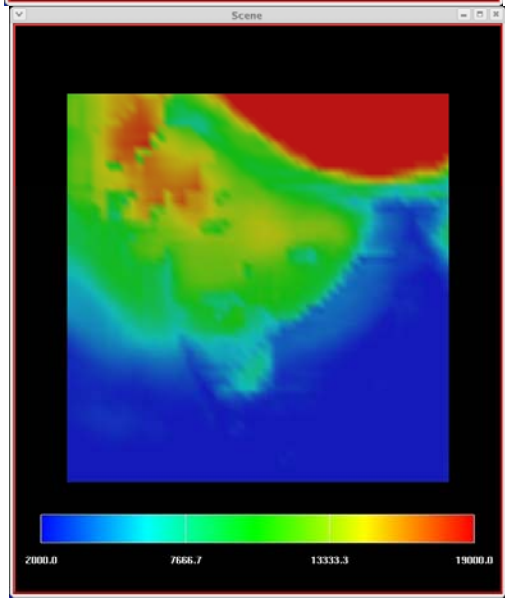
February 2000

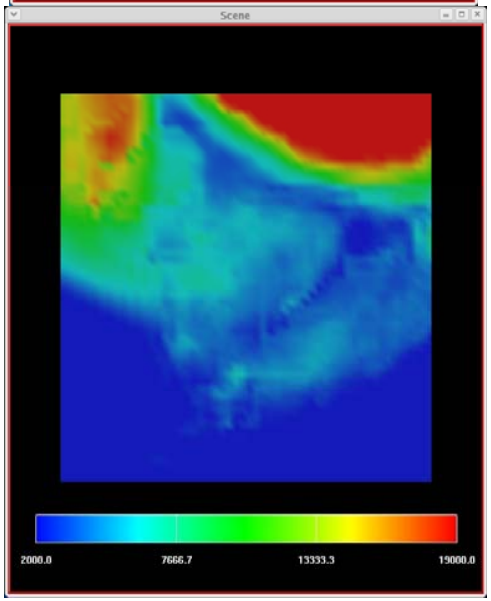




March 2000

April 2000





May 2000

Source: Mittal, Sharma & Pandey 2007

Estimated Potential Yield Losses in India

Crop	% loss in yield	2000 Losses (MT)	2001 Losses (MT)	2002 Losses (MT)	2003 Losses (MT)	2004 Losses (MT)
Wheat	10%	7.6.37	6.97	7.28	6.51	72.06
Rice	12%	10.76	10.2	11.2	8.72	10.44
Maize	5%	0.58	0.60	0.66	0.52	0.74
Soybean	15%	1.06	0.79	0.89	0.68	1.18
Cotton	11%	0.23	0.18	0.19	0.17	0.26
Sugarcane	5%	14.97	14.8	14.86	14.08	11.81

Source: Mittal, Sharma & Pandey 2007

Managing Pollutants

- Ozone and other pollutant concentrations are rising
- Government response limited to *adhoc* mitigation for emission reduction
- Policy challenge lies in identifying appropriate adaptation options for avoiding and/or minimizing adverse impacts

What Do We Do ?

- Learn to live with these levels of ozone and other pollutants – *Adaptation Policies*
- Minimize emissions of pollutants and precursors – Mitigation policies

Adaptation Options

- Technological developments (e.g., new crop varieties, water management innovations etc.)
- Government program and insurance
- Farm production practices (e.g., crop diversification, irrigation).
- Farm financial management (e.g., crop shares, income stabilization programs).
- Other measures (For example, reduce the emissions of precursors, and or change the time they are emitted to miss the peak sunshine and heat).

Adaptation Strategies

- Assess feasibility and economic practicality of adaptation options
- Examine the capacity of producers to undertake adaptation
- Study the affordability of adaptive measures, access to technology, and other constraints

Mitigation Policies/Activities

- Characterize the economic losses from current (and projected) levels of air pollution
- Suggest market-based approaches and technological changes
- Emphasize the long term benefits of the mitigation policies

Thanks