



ICID-CIID

**N.D. Gulhati Memorial Lecture
October 13, 2008
20th ICID Congress
Lahore, Pakistan**



LAHORE 2008



**IRRIGATION IN THE CONTEXT OF
TODAY'S GLOBAL FOOD CRISIS**

Chandra A. Madramootoo

Vice President Hon. ICID

**Dean of Agricultural and
Environmental Sciences**

McGill University



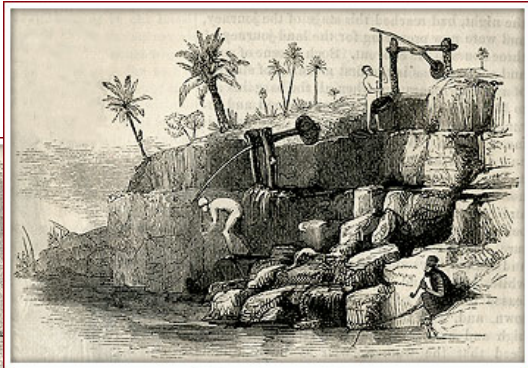
CANCID CNCID

Canadian Council on International Development
Conseil canadien de développement international

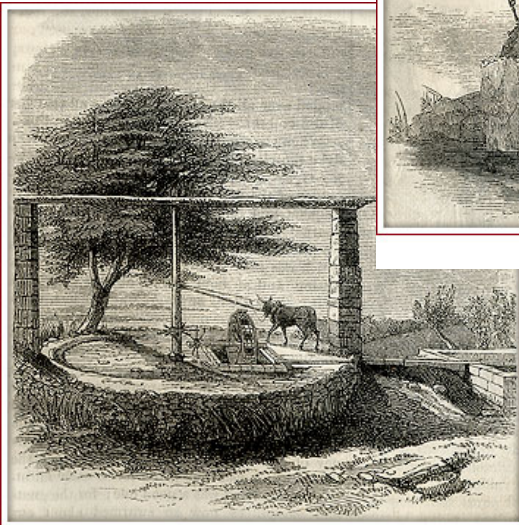
**75,000 protest tortilla prices in Mexico
Unionists, farmers, leftists march against price
increases that hurt the poor**



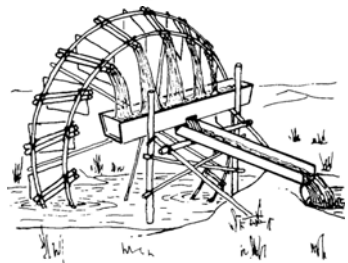
Tortilla Revolution - Mexico



The Shadoof



The Sakia, or Persian Wheel



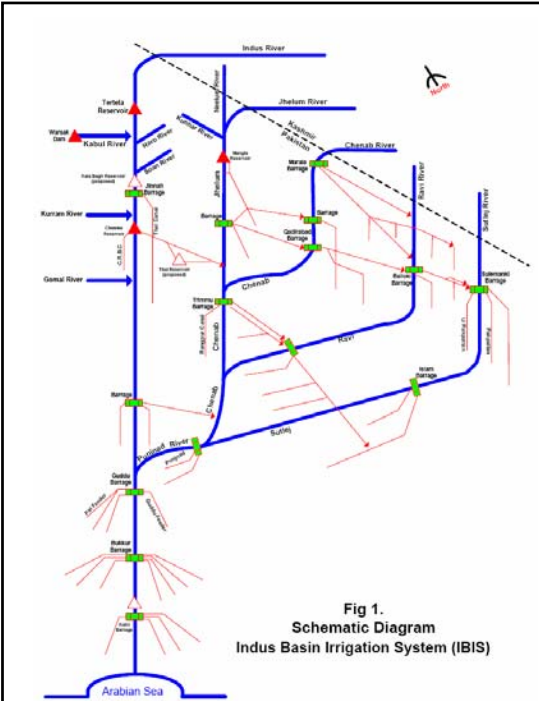
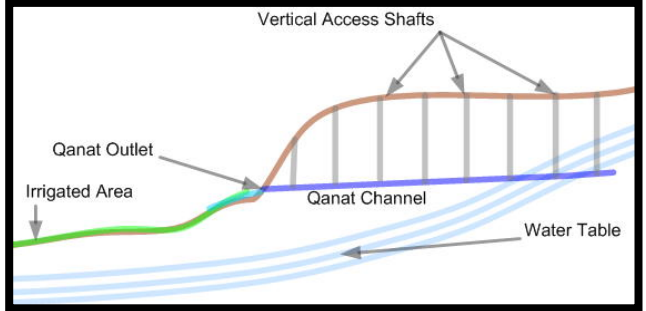


Fig 1. Schematic Diagram Indus Basin Irrigation System (IBIS)





Droughts and recurring famine since the 1940s-



Advent of the Green Revolution – 1970s



World Irrigated Area by Region



2004

Region	Irrigated Area (Million ha)	Share of World Total* (Per cent)	Share of Cropland That is Irrigated (Per cent)
Asia +	193.9	70	33
North and Central America	31.4	11	12
Europe	25.2	9	8
Africa +	12.9	5	6
South America +	10.5	4	8
Oceania	2.8	1	5

World	276.7	100	18

+ Scope for irrigation expansion.

FAOSTAT, 2004

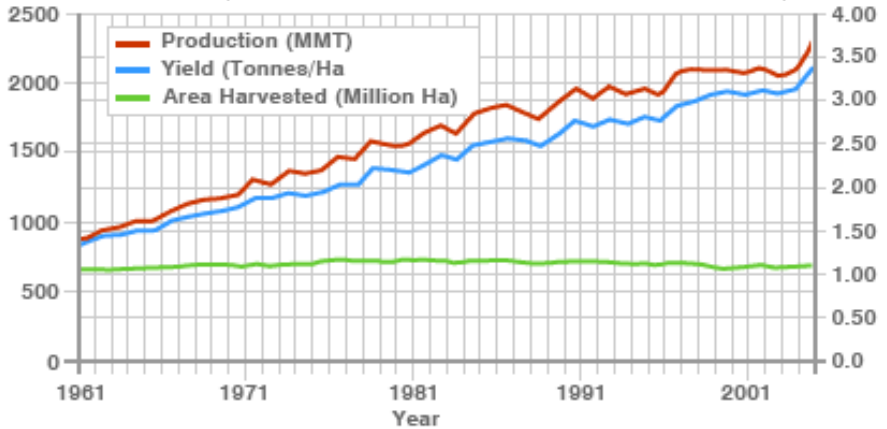
Global Irrigated and Rainfed Cropland Statistics

- 1,500 million ha of global cropland
- 275 m ha irrigated (17%)
- Irrigated lands produce 40% of world's food
- 1,250 m ha of rainfed lands producing 60% of the world's food

WORLD CEREALS PRODUCTION AND YIELDS

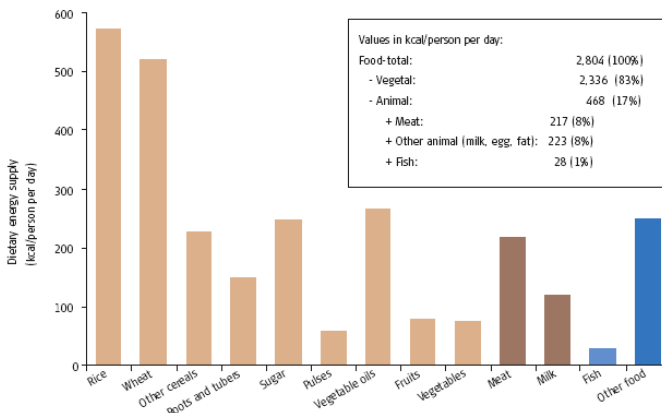
Million metric tonnes / million hectares

Tonnes / hectare



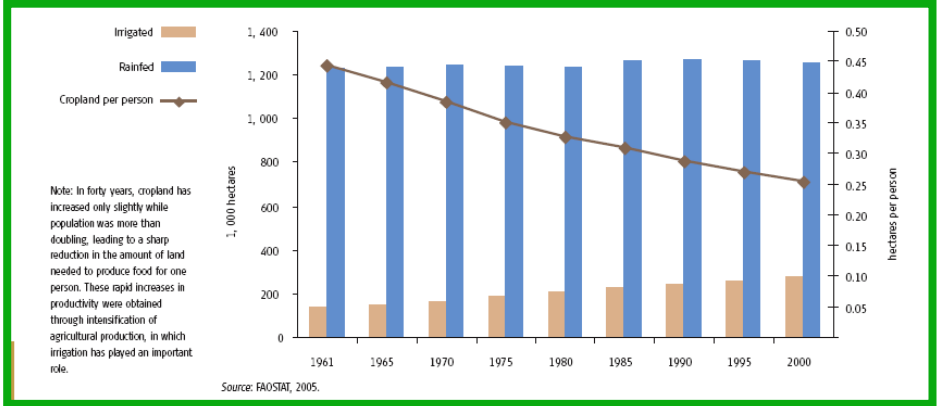
SOURCE: UN Food and Agriculture Organization

Main dietary food sources

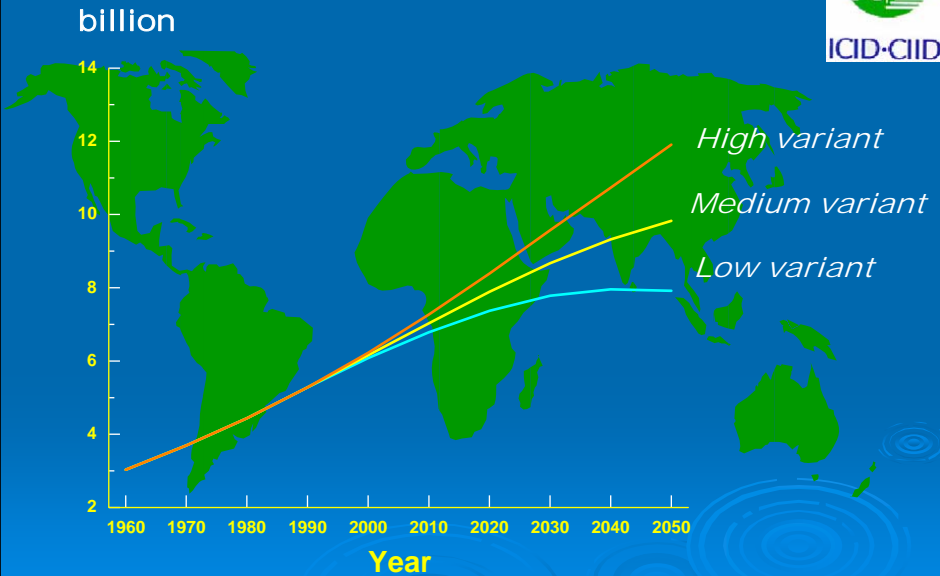


Note: Cereals, in particular rice and wheat, dominate food supply and provide the largest share of energy to the world's population. Although the livestock and fisheries sectors remain marginal in global terms, they play an important role in the supply of proteins. These global figures hide a large geographical variability in people's dietary energy supply.

Evolution of Irrigation Development



Global Population 1960 - 2050



Rehab, maintenance, upgrading



Freshwater availability per capita 1950-2050



1950
12,050m³



2000
7,310m³



2025
5,120m³



2050
4,580m³

ON FARM WATER MANAGEMENT



CONCERNS OVER IRRIGATION SYSTEM PERFORMANCE AND INVESTMENT BENEFITS



Overall Command Area Efficiency



$$E_{\text{overall}} = \frac{SWR - ER}{WDF} \times 100$$

$$ER = \sum_{i=1}^n [10 \times A_i \times (1 - 0.006 R_i) R_i]$$

$$WDF = (I \times E_c + N) - (D + C)$$

Where

- E_{overall} : Overall Command Area Efficiency (%)
- SWS : System Water Supply (m^3)
- ER : Effective Rainfall (m^3), from FAO
- WSF : Water Delivery to the Fields (m^3)
- A : Progress planted Area (ha)
- I : Intake water through main canal (m^3)
- N : Total natural flows entering command area (m^3)
- D : Drain water to sinks outside and without reuse or non-utilizable water supplies (m^3)
- C : Committed flows to other areas (e.g. legally or conventionally committed outflows from command areas to outside (m^3))

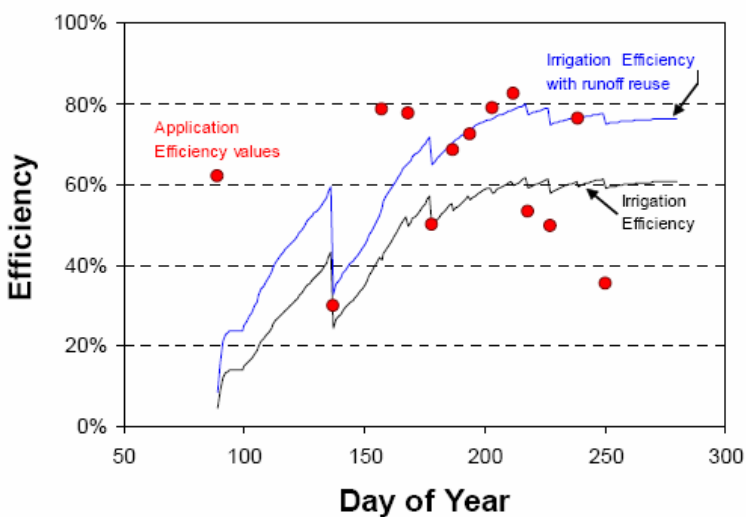


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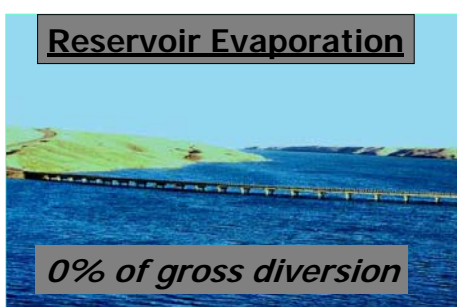
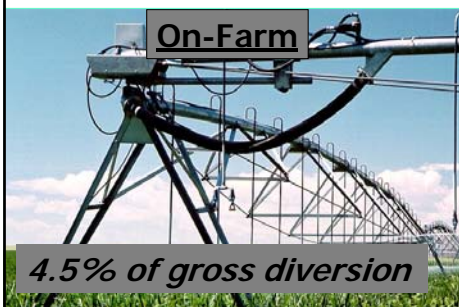


Furrow Irrigation Efficiencies

(Rice et al., 2001)



Irrigation Efficiency Gains



1990s:

**Social
aspects
of
irrigation**

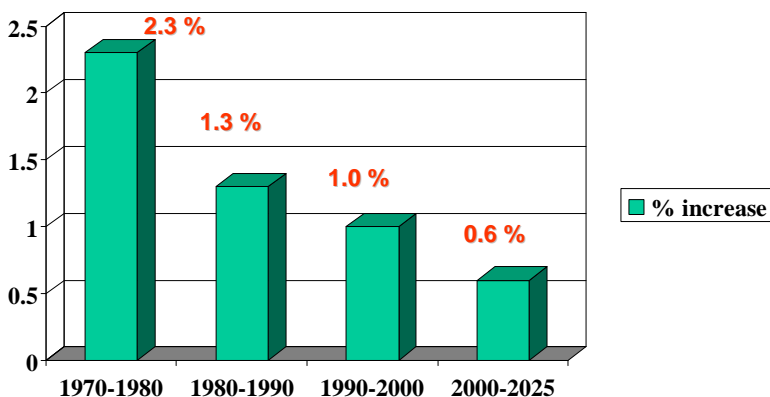
**PIM
WUAS**

Water Quality Impairment



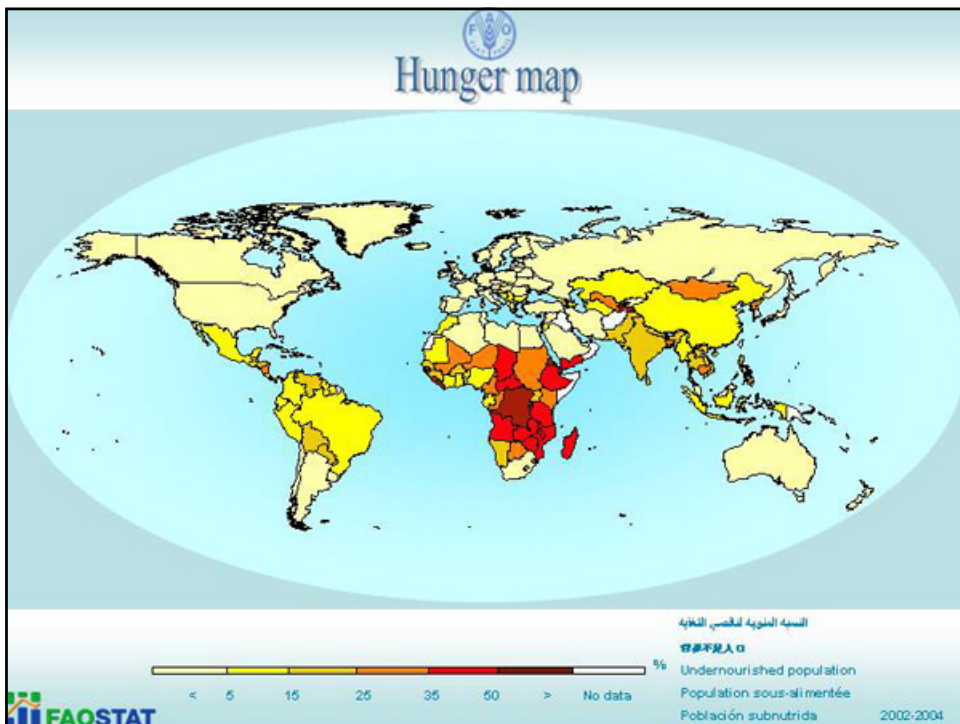
THE DEBATE ABOUT DAMS





Irrigation Expansion

Ref: Hopper



AREAS OF PHYSICAL AND ECONOMIC WATER SCARCITY

Physical water scarcity

Water resources development is approaching or has exceeded sustainable limits. More than 75% of the river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.

Approaching physical water scarcity

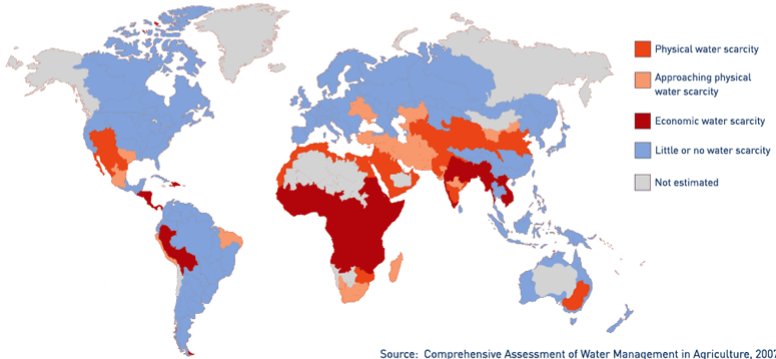
More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.

Economic water scarcity

(human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

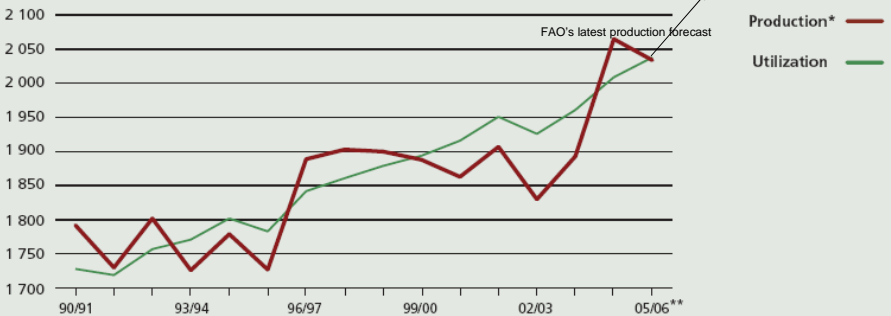
Little or no water scarcity

Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.



World cereal production and utilization

Million tonnes



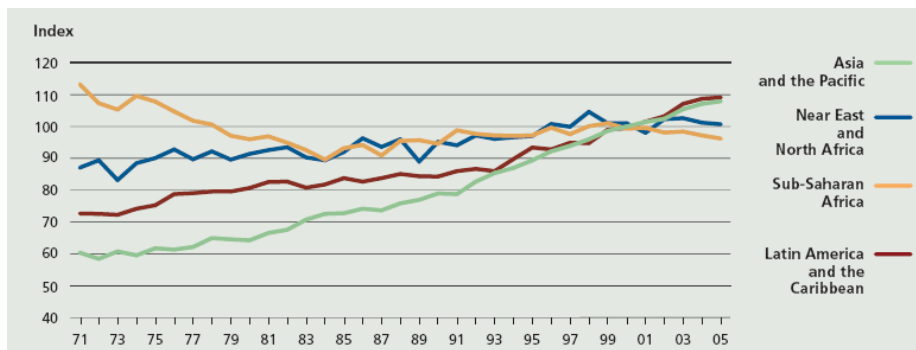
* Data refer to the calendar year of the first year shown.

** Forecast

Source: FAO.

Source: State of Food and Agriculture 2006

Long term trend in per capita food production



Source: FAO 2006

Virtual water content of selected products

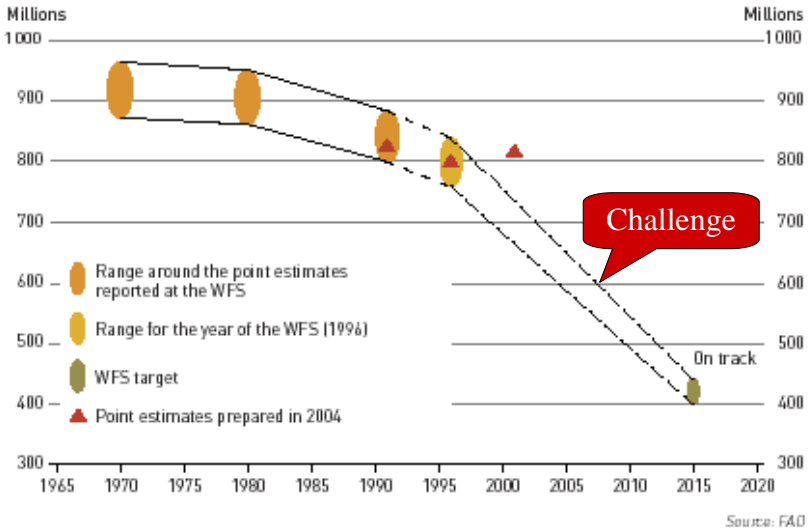
Product	Litres of water per kilo of crop
Wheat	1, 150
Rice	2, 656
Maize	450
Potatoes	160
Soybeans	2, 300
Beef	15, 977
Pork	5, 906
Poultry	2, 828
Eggs	4, 657
Milk	865
Cheese	5, 288

Virtual water is the total amount of water used in the production and processing of a given product.

Source: Hoekstra, 2003 adapted by UNESCO-WWAP 2006

Persisting hunger

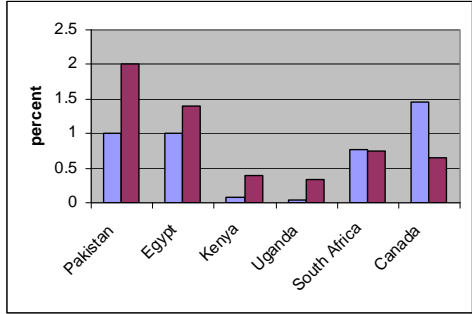
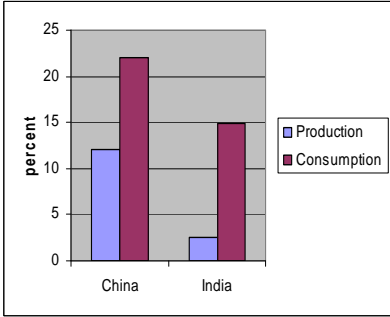
Number of undernourished in the developing world: observed and projected ranges compared with the World Food Summit target



Food Shortages

- Close to one billion remain malnourished
- Close to 800 million in less developed countries
- World Food Summit → reduce by 50% by 2015
- Need to reduce by 22 million / yr
- Current rate – 6 million / yr
- 2.8 billion people earn \$2 or less

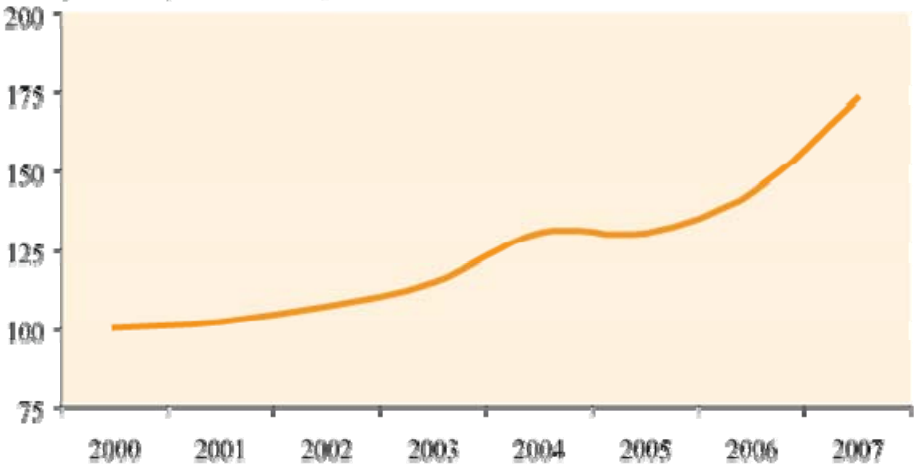
Food Production and Consumption Patterns in Selected Countries



Source: FAO Statistical Yearbook 2005/2006

Overall food prices (US\$) up 75 percent since 2000

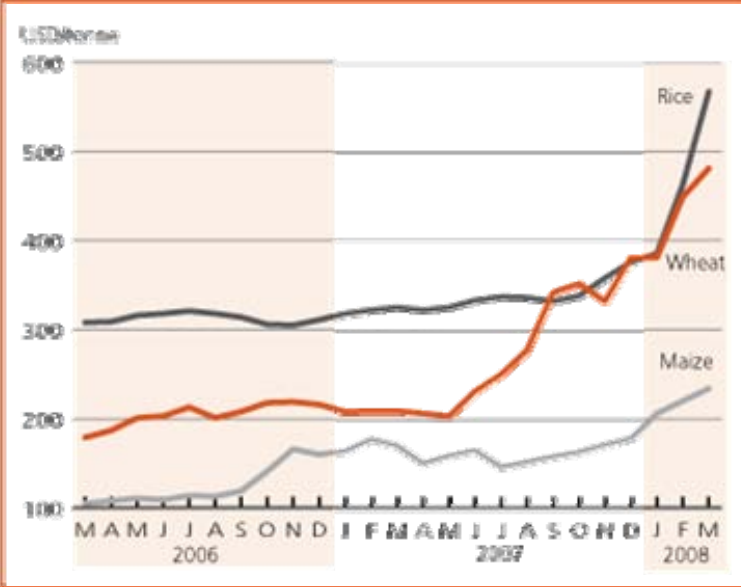
Index, nominal price index US\$



Source: World Bank, DECPB

Selected international cereal prices

Source: FAO



4

THE GAZETTE, MONTREAL, FRIDAY, APRIL 25, 2008

FOOD CRISIS

"It's an extremely competitive business, and people are going to make money where they can in this situation." Importer Kanti Shah

Fears mount as rice prices soar

CONSUMERS HIT
Food, gas
costs also
rising:
experts

A perfect storm,
grocers say

TIFFANY CRAWFORD
and ERIC BEAUCHESE
CANWEST NEWS SERVICE

SUPPLIES SHORT

Basmati has gone from \$850 to \$1,600 a tonne

JEFF HEINRICH
THE GAZETTE

he's been in the business of importing foreign foods to Canada for 30 years, but never has Kanti Shah seen one of his staples — so expensive and hard to supply as rice.

American long-grain and short-grain white rice, Indian basmati rice, Thai jasmine rice — wholesale prices of those popular varieties has risen by double or almost double in the last few months because of shortages overseas, said Shah, co-owner of Shah Trading Co.

"Right now, the scenario is: Where can I get my rice?" said Shah, a Keweenaw Indian immigrant whose St. Laurent firm supplies Loblaw's, Wal-Mart, Costco and other big chains.

"It's definitely a crisis. I don't



A farmer walks through rice paddies on the mountain slopes of Banaue City, Ifugao province, north of Manila.

JOHN LAVELLANA/REUTERS

Soaring prices on everything from food to gasoline walloped consumers yesterday as the Bank of Canada warned of weaker economic growth to come — new evidence the U.S. recession has deepened and is dragging down other sectors of the economy as it continues to slide.

Basic food items are becoming more scarce and the price of those commodities is soaring, matched only by the rapid increase in the cost of gasoline. Food shortages, hoarding by producing countries and a perils



BUSINESS B5

Tripled rice price threatens Asian stability: ADB

BILLIONS SERIOUSLY AFFECTED

Export restrictions, subsidies could make situation

ACCESS TO FOOD ... DENIED

Civil wars may come, UN food chief warns

A 'predictable catastrophe'

AGENCE FRANCE-PRESSE

Cameroon, Ivory Coast, Mauritania, Ethiopia, Madagascar, the Philippines and Indonesia, in what UN Secretary-General Ban Ki-moon called a "global crisis."

Cameroon's prime minister said a special fund was being

The Economist

Read it the next day
and today, too.
London's finest food and drinks
The return of Stanley
Cancer's link to stress calls

The silent tsunami

The food crisis and how to solve it

The Gazette

MONTREAL | SATURDAY, APRIL 26, 2008 | SINCE 1778 | montrealgazette.com

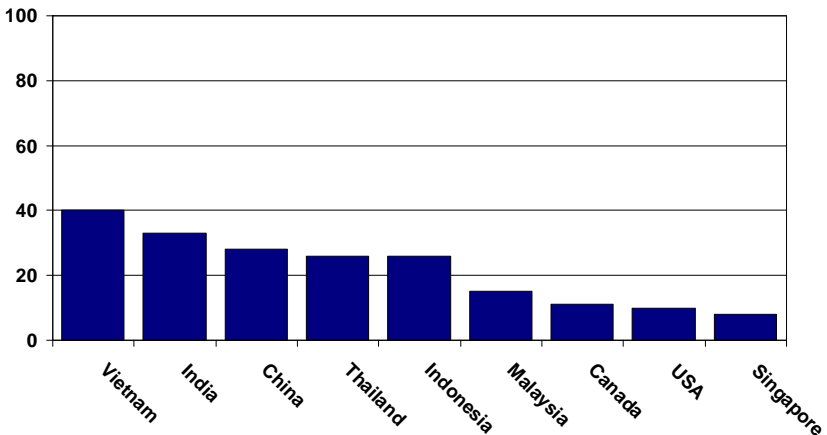
FINA

The hardest hit are the humblest citizens of the poorest nations
MARIAN SCOTT REPORTS ON THE GLOBAL FOOD CRISIS



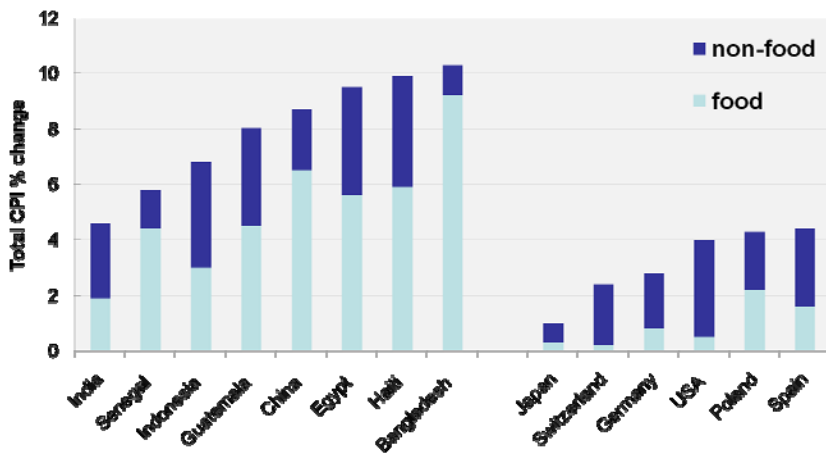
Average percent of income spent on food

Source: Globe and Mail April 30, 2008
(Source: USDA)

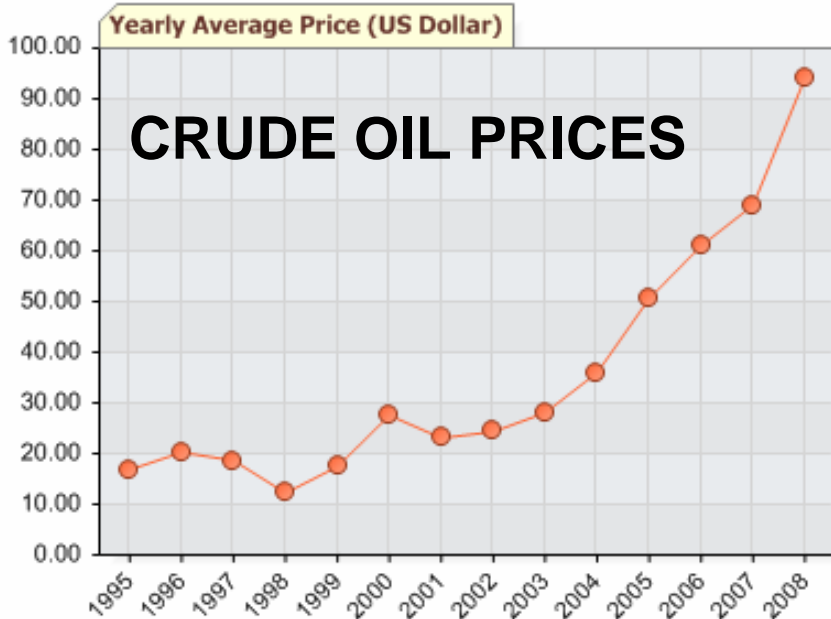


Contribution of food to consumer price inflation

February 2007 to February 2008

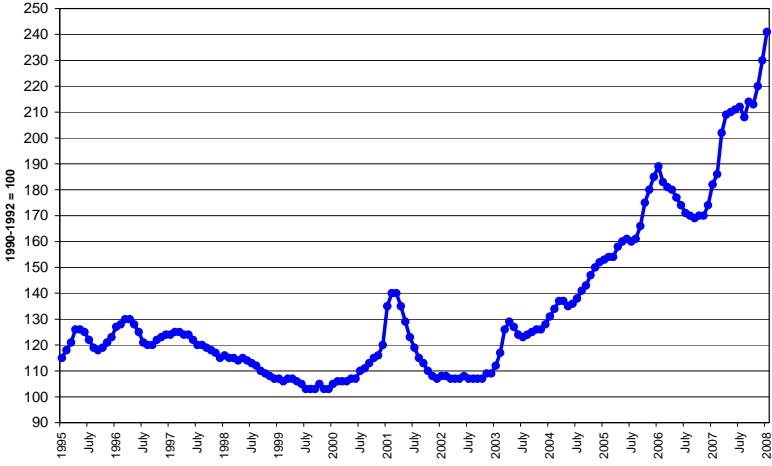


Source: Ash 2008



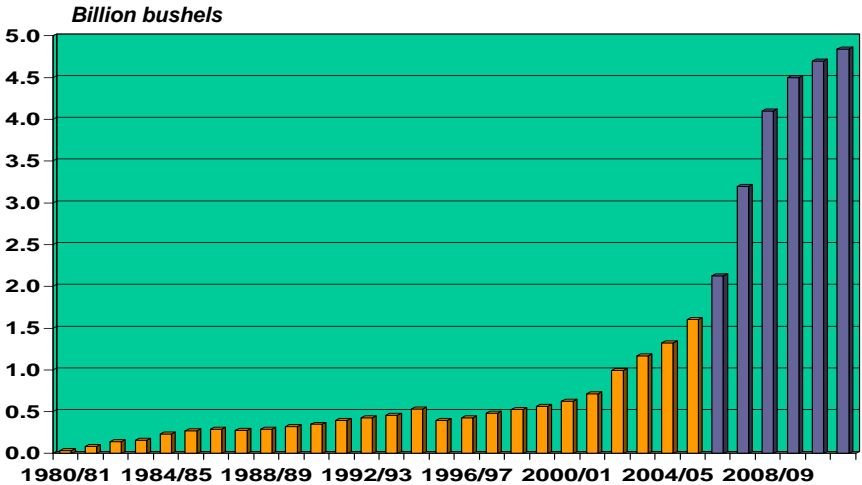
Fertilizer Prices at Record Levels

Index of Fertilizer Prices Paid by Farmers, Jan. 1995 - Jan. 2008



Source: National Agricultural Statistics Service, USDA.

U.S. Corn Used For Ethanol Production



Source: USDA; Doane forecast.

WILL THE BIOFUELS CRAZE CAUSE MASS STARVATION?

Turning corn into fuel was seen as a solution to energy and climate problems. Instead, it may be taking food from the world's poorest.



Britain fears food shortages caused by biofuels

APPEAL TO G8
European Union might resist

biofuels
agricultural sector

LONDON — Prime Minister Gordon Brown said the European Union must resist the United States' demand that it allow the export of corn to be used for biofuels.

Britain is a net importer of the grain, and Brown said the government would not support the European Union's demand that the United States stop exporting corn to be used for biofuels.

The group of eight nations might consider to study the impact of using the food made into biofuels on the world's poor. The U.S. and other nations are encouraging the biofuels as a means to be added to gasoline as a way of reducing damage to the environment.

The group of eight, the G8, met in London on Monday.

Britain's Prime Minister Gordon Brown has called on G8 nations to study the impact biofuels might have on the world's food supply.



LONDON — Thousands of tons of wheat are shipped at the Dalrymple ports factory in Fife, Scotland, for use in biofuels.

A10

CANADA

biofuels from corn, wheat, grain, oil, and soybeans

Biofuels are blamed for food shortages

ETHANOL

Continued from Page A1

Farmers would also see new crops of food for fuel crops, and wheat, soy, and corn, which are the main crops for ethanol production, would be used for fuel.

That message came from the former senior agricultural analyst for the U.S. State Department, who had the credit among farmers, who liked the word.

farmers have been put to biofuel production, creating a shortage of food and livestock creating a problem of high prices," said John H. Kline, vice president of the American Ethanol Association. He said the ethanol industry is not doing well, and that the ethanol industry is not doing well, and that the ethanol industry is not doing well.



These stalks of biofuel grain that released from Brazilian sugar cane produce positive results.



September 24-26, 2008

An International Consortium on Global Food Security

- International experts
- International scholars
- Government policy and decision makers
- Farmer organizations
- NGOs
- Business sector
- National and international relief organizations

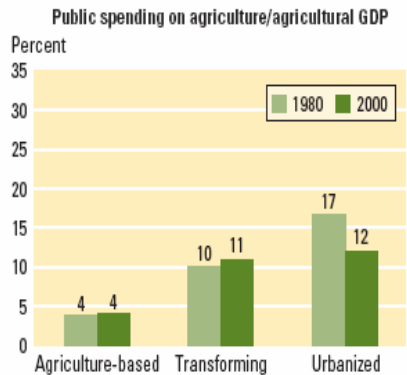
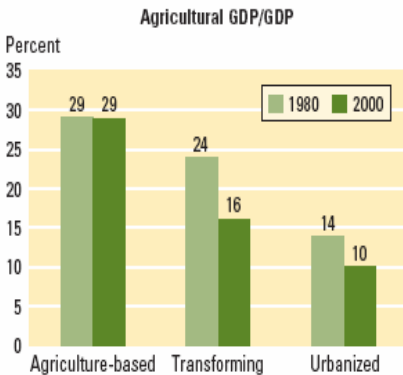


**Conference Co-Chairs
Rt. Hon Joe Clark
Mr. Richard Pound**



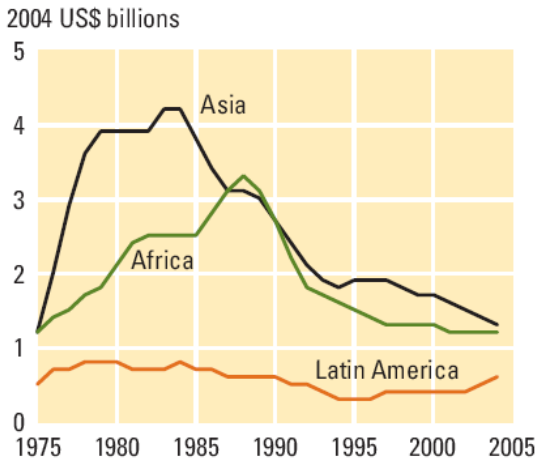
**Dr. Kanayo Nwanze
Vice President, IFAD**





Public spending on agriculture is lowest in the agricultural based countries, while their share of agriculture in GDP is highest

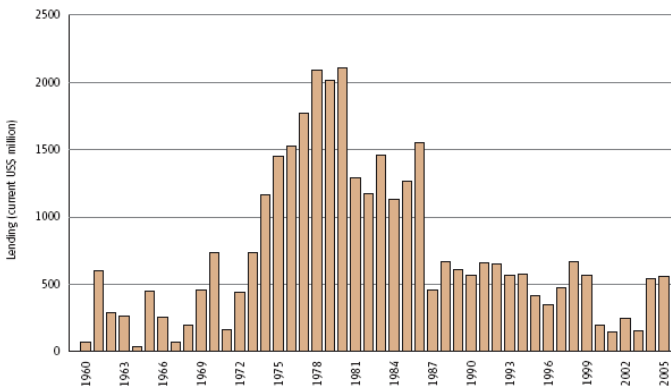
ODA to agriculture by region, 2004 US\$ billions



Official development assistance to agriculture declined sharply between 1975 and 2004

Source: The World Bank (2008)

World Bank lending in irrigation, 1960–2005



Note: World Bank lending in irrigation and drainage in constant dollars peaked between the mid-1970s to the mid-1980s, followed by a sharp decline, as a result of falling prices of main agricultural commodities, increased cost of new irrigation investments and progressive reduction in water availability. The most recent data, however, suggest a renewed interest in rural development, including water management in agriculture.

Source: Based on World Bank data summarized by UNESCO-WWAP 2006.



SOME KEY MESSAGES - 1

- The crisis will not come to an end very soon
 - Declining national and international investments in agriculture
 - One size does not fit all
- Building resilience in vulnerable communities
 - Impacts of malnutrition on children
- Linkages between agriculture, food and nutrition
 - Water, land and environment

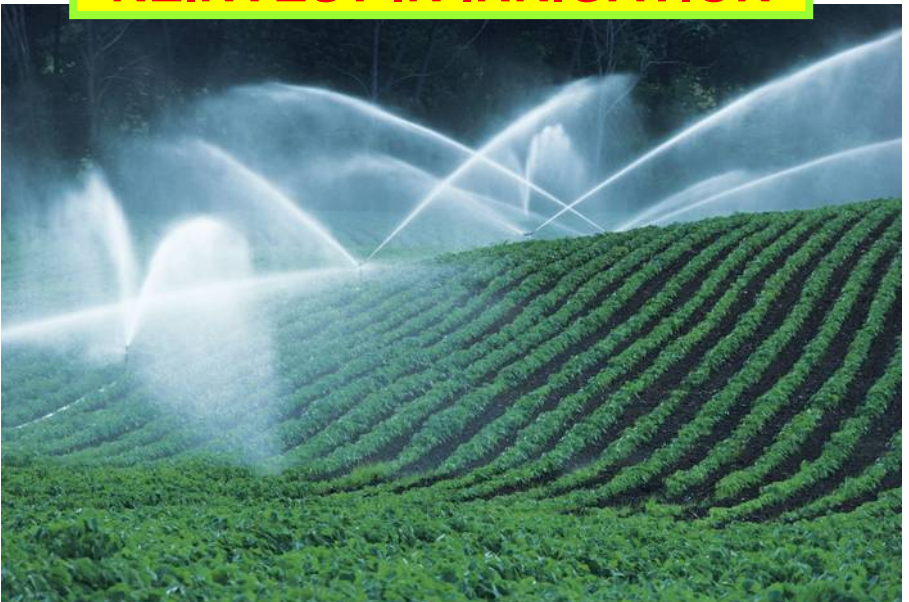


SOME KEY MESSAGES - 2

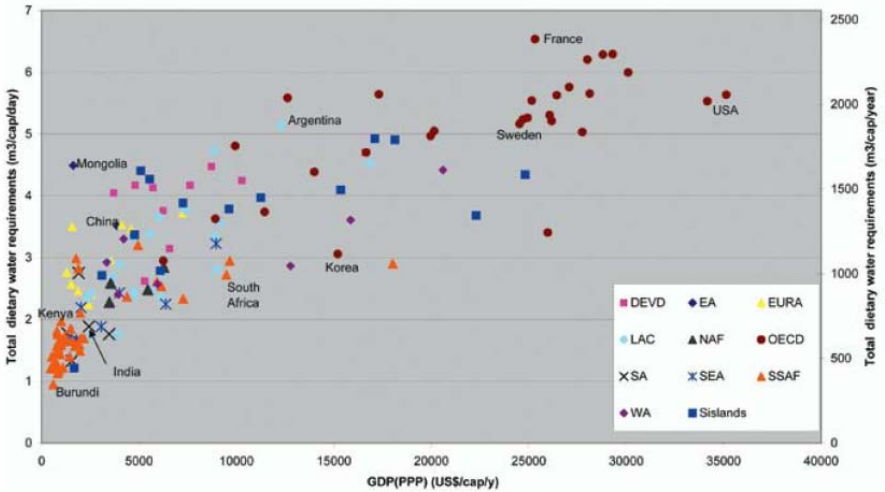
- Breaking the cycle of poverty
- Farmers are the backbone of the economy
- Use the agricultural sector as an engine of growth
- Building institutional support for local, regional and international markets
- Reinvesting in agriculture and associated infrastructure
- Building a rapid innovative research agenda
- Building capacity at all levels



REINVEST IN IRRIGATION



Consumptive use of water for food supply as a function of GDP



Source: (Lundqvist et al., 2007). PPP: purchasing power parity. Source: GDP data from the World Bank (2006); food supply data from FAOSTAT (2006). Regional groups: DEVD=transition countries Europe, EA=East Asia, EURA=transition and developing former USSR, LAC=Latin America and Caribbean, NAF=North Africa, OECD=Members of the Organisation of Economic Cooperation and Development, SA=South Asia, SEA=South-East Asia, SSAF=Sub-Saharan Africa, WA=West Asia, Sislands=Small Islands.

THE WAY FORWARD

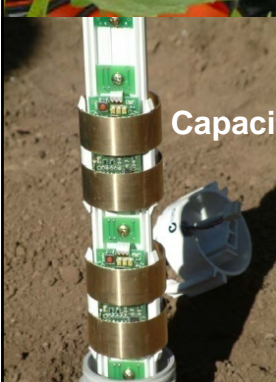


Provide storage

Public-private investments in infrastructure



Invest in water savings technologies

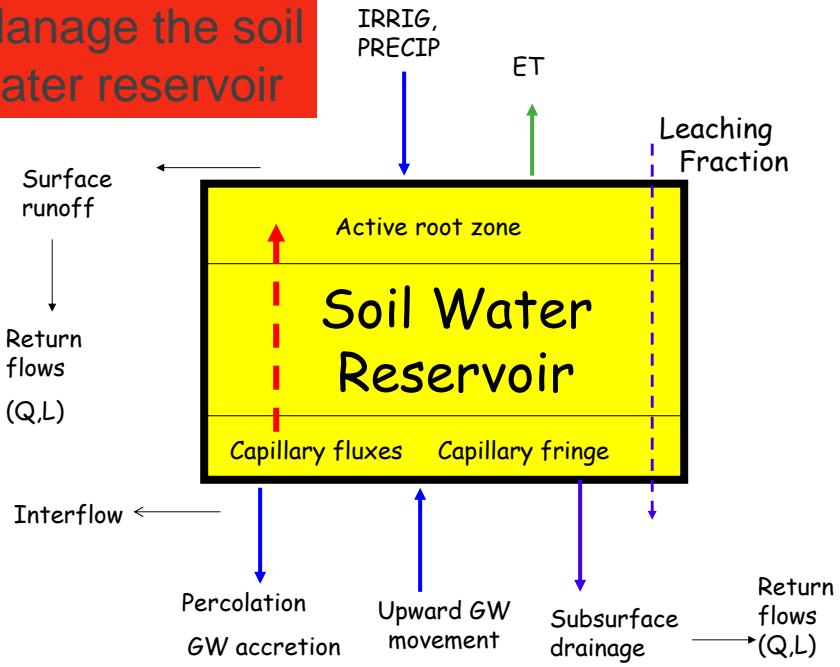


Capacitance probes

Gro-Points

Hortau tensiometers

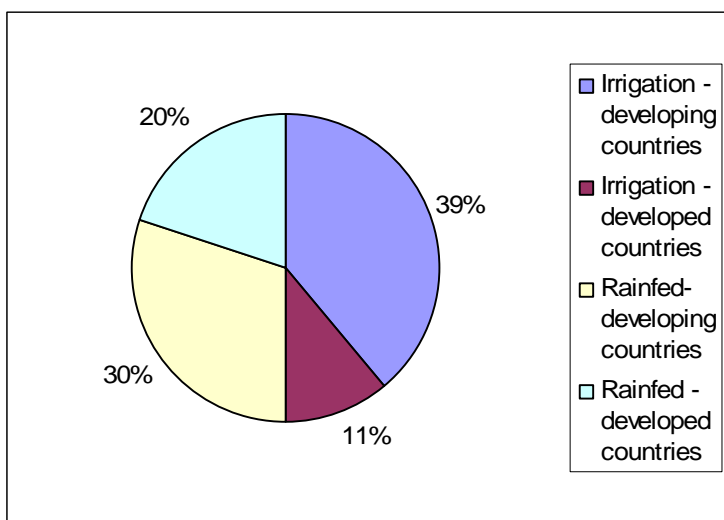
Manage the soil water reservoir



COMBAT THE TWIN MENACE OF WATERLOGGING AND SALINITY



Subsurface pipe drainage installation





Canadian International
Development Agency



ETHIOPIA

Food Security: Issues, challenges and opportunities in Amhara

McGill Conference on Global Food Security
September 25 – 26, 2008

Sustainable Water harvesting and Institutional Strengthening in Amhara (SWHISA)

Dereje Biruk and Dev Sharma, P.Eng
Amhara Partners BOARD BOARD ARARI CPA EPLAUA
SWHISA
Canadian Executing Agency



HYDROSULT Inc.

Consultants, Experts-Consells



agrodev

Canada Inc.

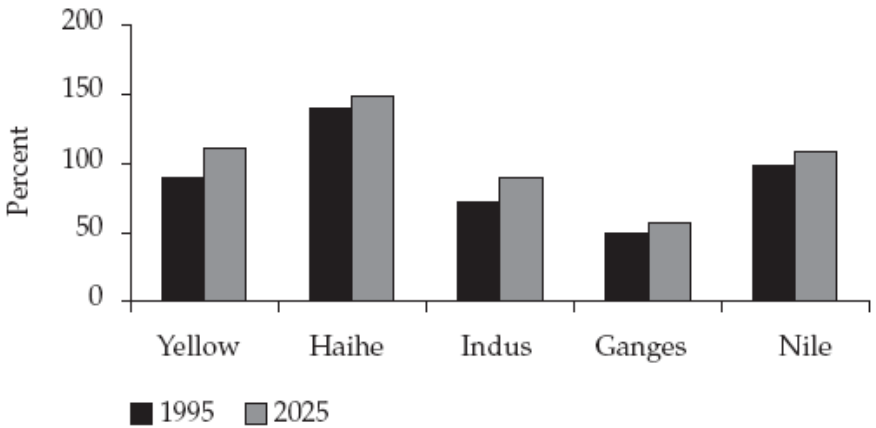


OXFAM CANADA

SWHISA contribution to Food Security Initiatives

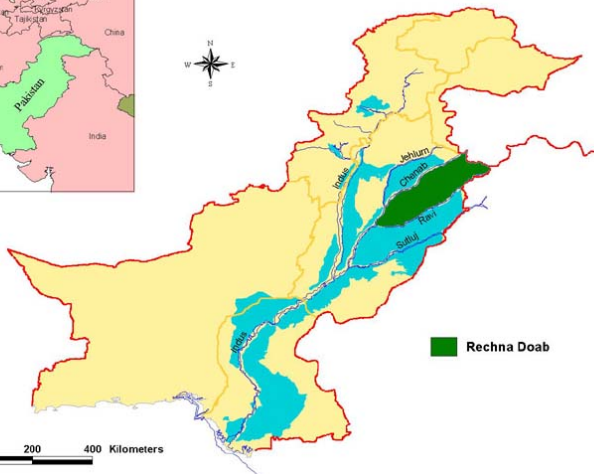
- 90 Pilot household water harvesting systems – results show that HH can earn an income of \$250 to 300 during the dry season from a 85 to 120 m³ storage
- Participatory design and community ownership of irrigation systems
- Demonstration of community watershed management in 6 woredas
- Adaptive on-farm research to technological packages for crop diversification

Withdrawals as percentages of renewable resources in key basins, 1995 and 2025



Source: Rosegrant et al (2002)

MAXIMIZING BASIN WATER PRODUCTIVITY MULTI-OBJECTIVE DECISION MAKING



CONSERVE, REUSE, RECYCLE

GLOBAL JITTERS

CANADIAN OUTLOOK DARKENS As Europeans prop up banks, recession becomes apparent on horizon



NASDAQ Composite Index



(c) www.advfn.com



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Canadian National Committee on Irrigation and Drainage

Comité National Canadien de l'Irrigation et du Drainage

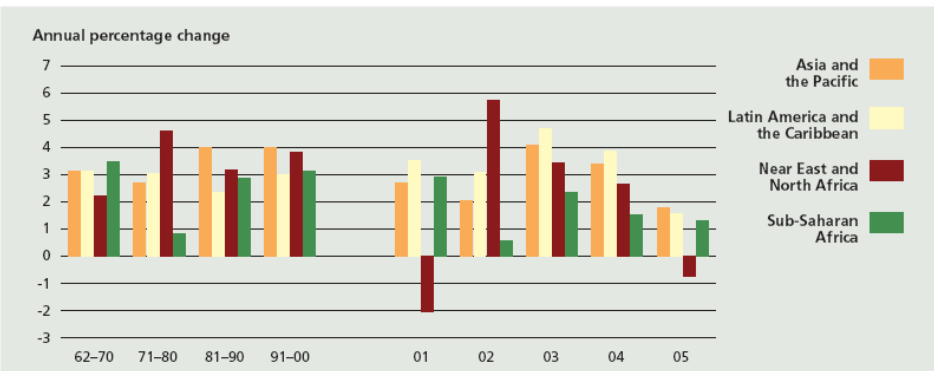
Canadian National Irrigation Association

Association Canadienne des Irrigateurs Professionnels

THANK YOU



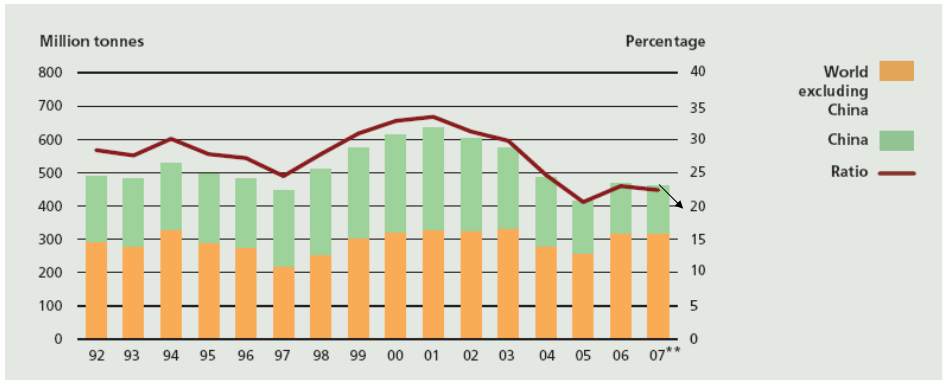
Annual percent change in crop and livestock production



Source: FAO, FAOSTAT.

Source: FAO 2006b

World cereal stocks and stocks-to-utilization ratio*



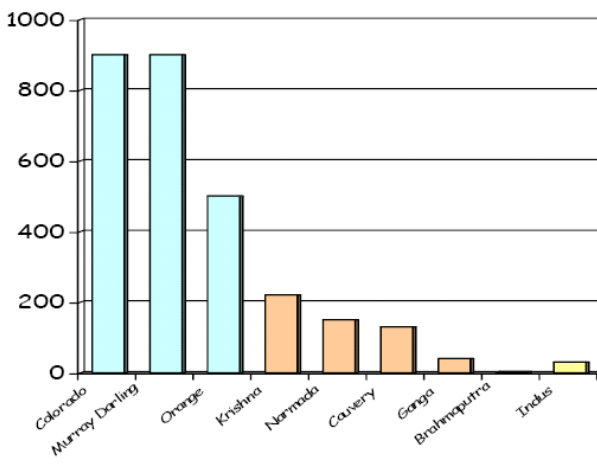
* Stock data are based on aggregate carryovers at the end of national crop years and do not represent world stock levels at any point in time.

Source: FAO.

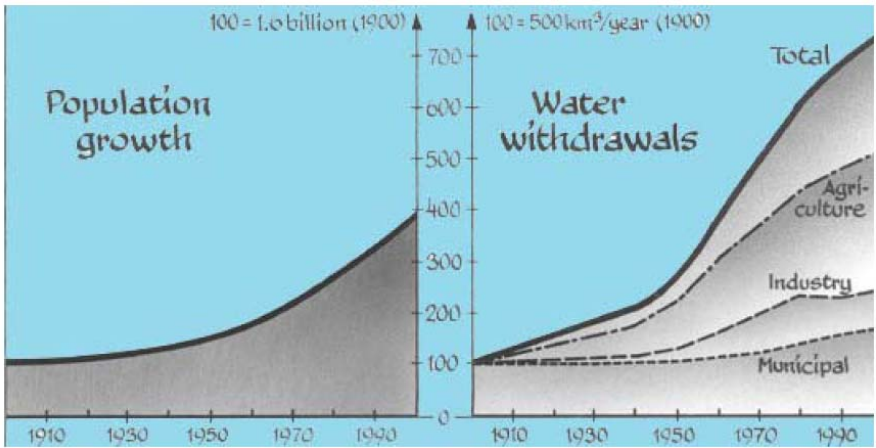
** Forecast

Source: State of Food and Agriculture 2006

Days of average flow which reservoirs in semi arid countries can store in different Basins around the world



Report on India by World Bank 2005 from Gopalakrishnan 2008



Source: SIWI. 2000. Water and Development in the Developing Countries.

Social and Economic Indicators

	Population ¹	Population growth rate ¹	Agricultural Trade Balance ² (exports-imports)	Prevalence of undernourishment in population ³	GDP ¹	GNI per capita ⁴
		%	million US\$	%	\$US	\$US
	2008	2008	2004	2004	2007	2007
China	1,330,044,605	0.63	-24,677 (2005) ³	12	3.25 trillion	2360
India	1,147,995,898	1.58	-210 (2005) ³	20	1.10 trillion	950
Pakistan	167,762,040	1.80	-302 (2005) ³	24	144 billion	870
Egypt	81,713,517	1.68	-1699	4	128 billion	1580
Ethiopia	78,254,090	2.23	-42.4	46	19.4 billion	220
Kenya	37,953,838	2.76	813	31	29.3 billion	680
Uganda	31,367,972	3.60	78.2	19	11.2 billion	340
South Africa	43,786,115	-0.50	771	2.5	283 billion	5760
Canada	33,212,696	0.83	5379	2.5	1.43 trillion	39,420

1. CIA The World Factbook. OER = Official exchange rate;
 2.FAO (2006c). 3. FAO (2006a) 4. World Bank Statistics 2007

Land Resources

	Total land Area ¹	Agricultural area (arable land +permanent crops +permanent pasture) ²	Agricultural area per capita ²	Arable land +permanent crops ²	Permanent Pasture	Irrigated Area ¹	Potential Irrigated Area ³
	1000 ha		ha/person	1000 ha			
	2003	2003	2003	2005	2005	2003	2007
China	932,641	554 851	.42	154 850	400 001	54 596	64000
India	297,319	180 804	.17	169 800	110 040	55 808	113512
Pakistan	77,872	25 130	.16	21 030	41 00	18 230	2000 ⁴
Egypt	99,545	3424	.05	3424	0	3422	4420
Ethiopia	111,968	31769	.44	11 707	20062	290	2700
Kenya	56,925	26512	.82	5212	21300	103	539
Uganda	19,971	12462	.47	7350	5112	9	90
South Africa	121,991	99640	2.2	15 700	83940	1498	1500
Canada	909,350	67505	2.1	521 15	15390	1053	1908

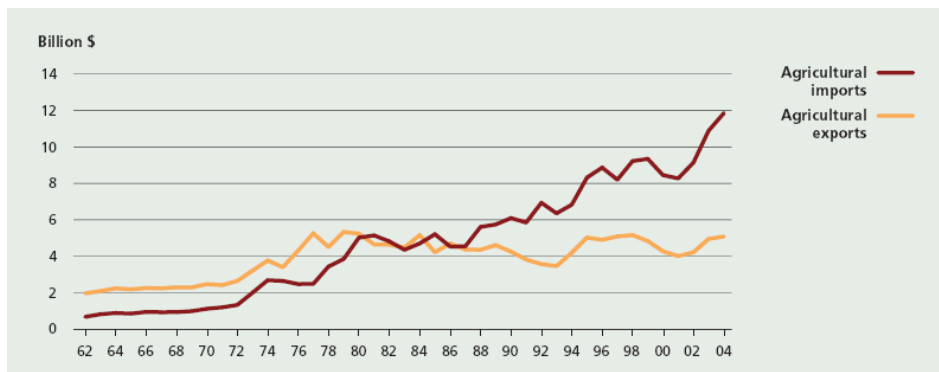
1.CIA The World Factbook; 2, FAO (2006b) 3.FAO Aqustat Database 4.PANCID 2008

Water Resources

	Total Renewable Water Resources (TRWR) (surface +ground-overlap)	Total Surface water	Total Ground water	Total Freshwater Withdrawal (TFW)	TFW/TRWR	Agricultural Water Withdrawal	Per capita Freshwater Withdrawal
	km ³	km ³	km ³	km ³ /y	%	km ³ /y	m ³ /y
		2005	2007	2000		2000	2000
China	2,830 (1999)	2728	828	617	22	427	485
India	1,897 (1999)	1858	419	646	34	558	613
Pakistan	225 (2003)	218	55	169	75	163	1,138
Egypt	58.3 (1997)	56 ⁴	2.3	65.2	111	59	977
Ethiopia	122 (1987)	120	20	5.6	4.6	5.2	77
Kenya	30.7 (1990)	30.2	3.5	2.7	8.8	2.2 (2003)	80
Uganda	66 (1970)	66	29	0.3	0.5	0.12	10
South Africa	50 (1990)	48	4.8	12.5	25	7.9	268
Canada	2902 (1985)	2892	370	44.72	1.5	5.37	1,386

Source of all data: FAO Aqustat Database

Agricultural trade balance of least-developed countries



Source: FAO State of Food and Agriculture 2007

Agricultural and food trade in China 1993-2008

