Water for Food, Virtual Water for Food Security

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Water for Food: Are We Heading for a Crisis?

Projections:
At least 50% increase in food production is needed over the next 40 years.

Why?
2 Billion new pople
0.8 Billion have not enough
1 Billion is changing diets
3 Billion move into cities
10-20% of food biomass for ethanol & biodiesel

Water Use by Agriculture:

Agriculture uses about 70% of all fresh water

40% of all food comes from 19% irrigated land
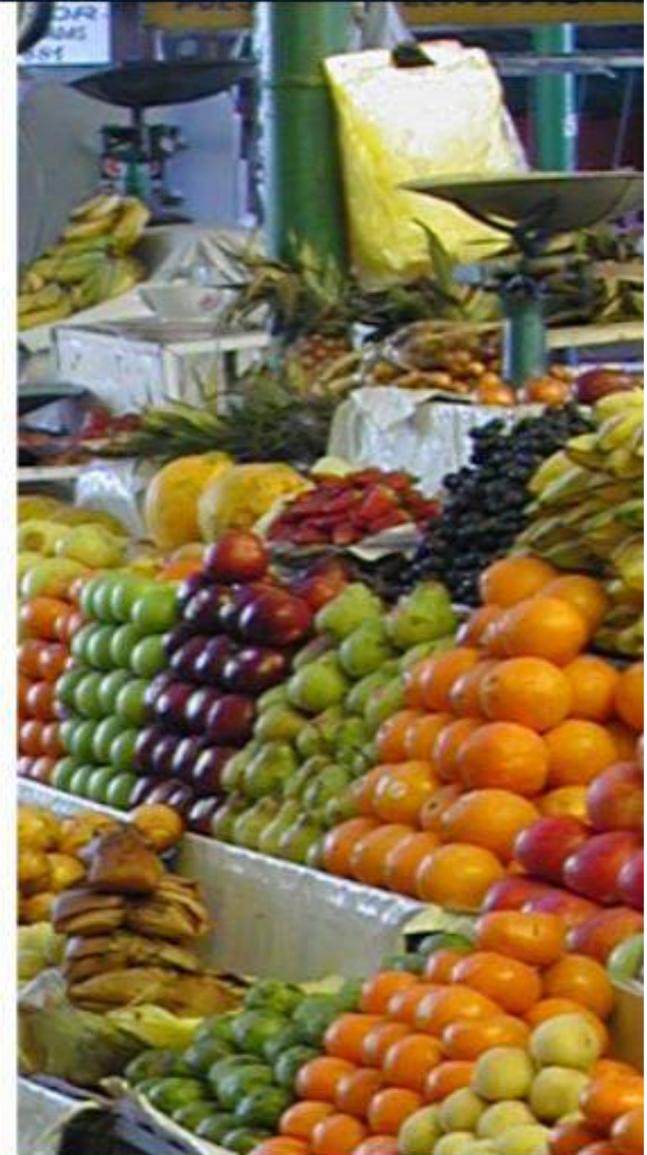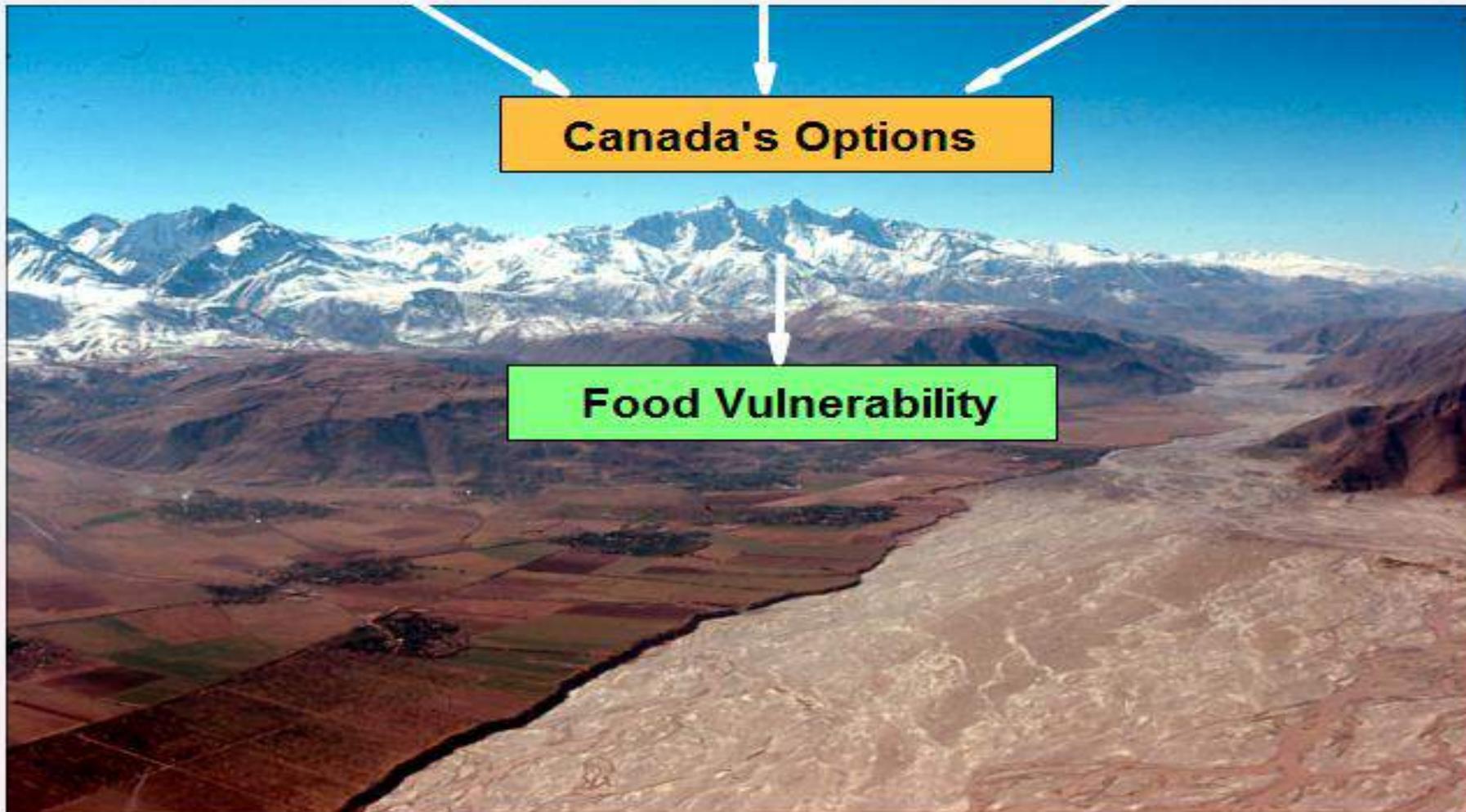
Change in the Global Urban Rural and Total Population 1980-2050
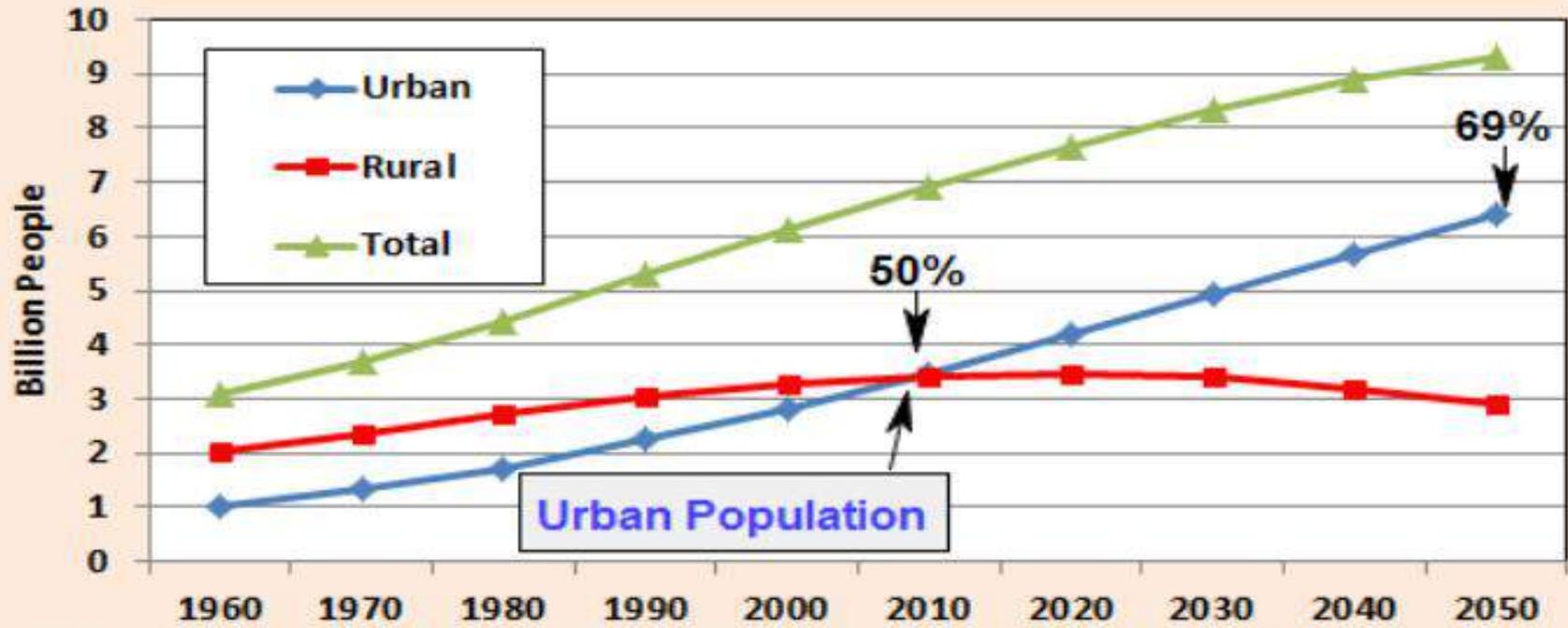
Over the next 35 Years 3 Billion People will move into Cities

Population

Urbanization

- Globally
- Agriculture Uses 70% of all Water

- Only 20% of the Ag-Land is Irrigated
- But Produces 40% of all Food

Agriculture uses 43% of the Terrestrial Land Surface
87% is used for Food Production
13% is for Non-Food (Biofuel, Textiles, Wool & Leather)

Environmental Impacts:

13% of Global GHG is Generated from Food Production

26% of Global GHG is Generated from Production & Consumption

32% of Terrestrial Acidification is from Agriculture

78% of Eutrophication is from Agriculture

45-50% of Water is used for Irrigated Agriculture

Agriculture GHG Emission By Key Countries in giga grams / year
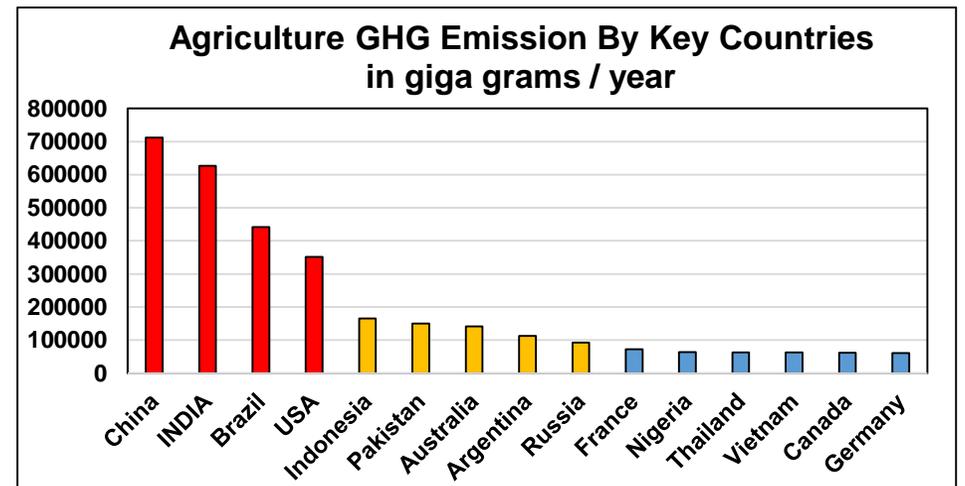
According to Poore & Nemecek 2016. Reducing Food's Environmental Impacts Through Producers & Consumers. Science 360, 987-992

Global Production	2017
	Million Tons
Sugar	2143
Maize	1135
Wheat	772
Rice	770
Cow Milk	676
Potatoes	388
Soybeans	353
Oil palm fruit	318
Cassava	292
Vegetables	291
Tomatoes	182
Barley	147
Pork	120
Watermelons	118
Bananas	114
Sweet potatoes	113
Chicken	109
Onions	98
Cucumbers	84
Apples	83
Rapeseed	76

% Increase	2010-2017
	% Change
Oil palm fruit	42
Cucumbers	34
Maize	33
Soybeans	33
Onions	24
Cassava	22
Rapeseed	22
Rice	21
Barley	20
Tomatoes	19
Potatoes	17
Watermelons	17
Apples	17
Pork	13
Sugar	12
Cow Milk	12
Vegetables	12
Wheat	10
Chicken	9
Sweet potatoes	6
Bananas	5

Amount of Food Produced that is Exported (%)

	Maize	Potatoes	Rice	Wheat	Soybeans
2006	13.5	4.9	4.8	20.6	30.6
2008	12.3	4.7	4.4	19.3	34.2
2010	12.8	5.2	4.8	22.8	36.7
2012	13.8	4.7	5.4	24.5	40.2
2014	13.6	4.8	5.8	23.7	38.7
2016	13.9	5.1	5.4	24.5	40.3

	Beef	Pork	Sheep	Chicken	Cotton
2006	8.4	4.5	12.2	11.2	37.1
2008	8.0	5.3	12.0	12.9	28.6
2010	8.4	5.3	11.5	13.4	32.9
2012	8.0	4.2	11.3	13.4	36.0
2014	8.9	4.1	13.2	13.0	29.8
2016	8.7	4.6	11.8	12.2	30.0

Wheat

Average Wheat Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Maize

Average Maize Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Rice

Average Milled Rice Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Potatoes

Average Potatoe Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Beef

Average Beef Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Legend: 2001 2003 2005 2007 2009 2011 2013

Pork

Average Pork Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Legend: 2001 2003 2005 2007 2009 2011 2013

Poultry

Average Poultry Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Legend: 2001 2003 2005 2007 2009 2011 2013

Sheep & Goat

Average Mutton & Goat Meat Supply in Different Regions of the World 2001-2013 (kg/capita/year)

Legend: 2001 2003 2005 2007 2009 2011 2013

Changes in Global Number of Livestock 1990-2016

Cattle, Pigs, Sheep, Goats
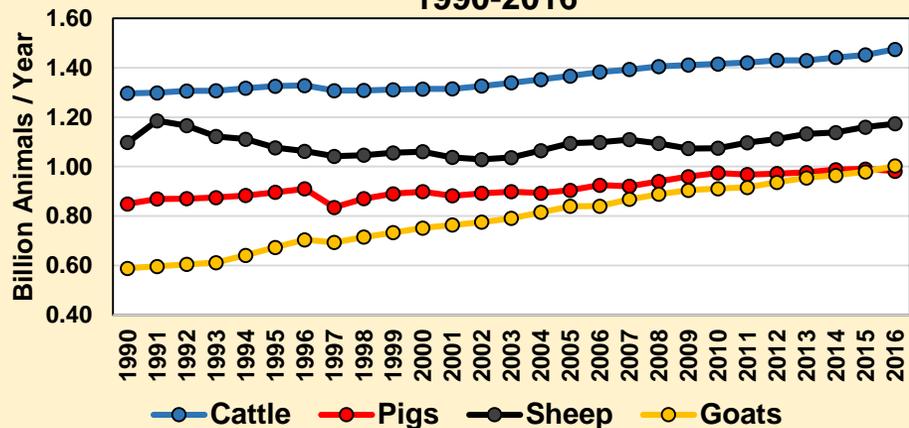
Changes in the Global Number of Chickens 1990-2016
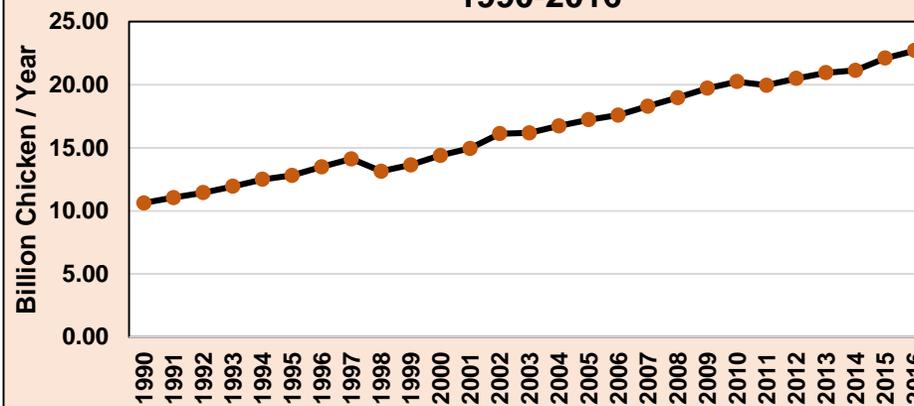
Changes in Global Production of Maize, Wheat, Potatoes, Rice & Soybeans 1990-2016

Maize, Potatoes, Rice, Wheat, Soybeans

Differences in Meat Consumption in Kg/Capita/Year in 2013

Increases or Decreases in Meat Consumption in Kg/Capita/Year Between 2000-01 and 2012-13
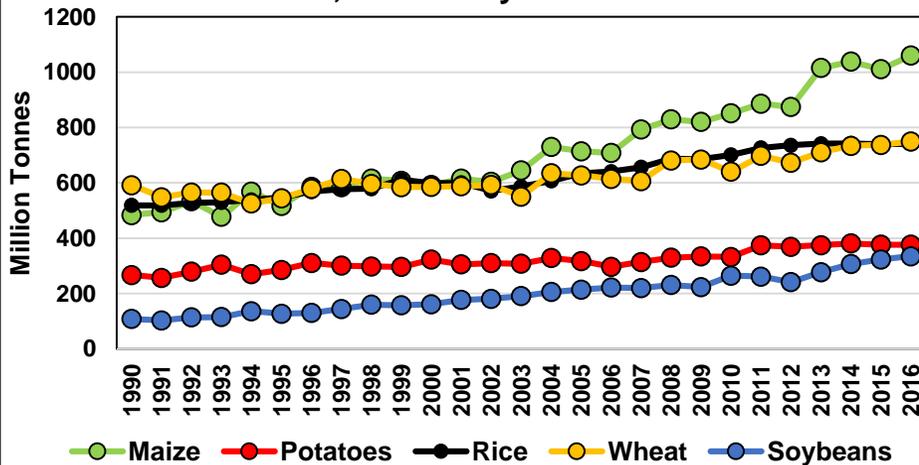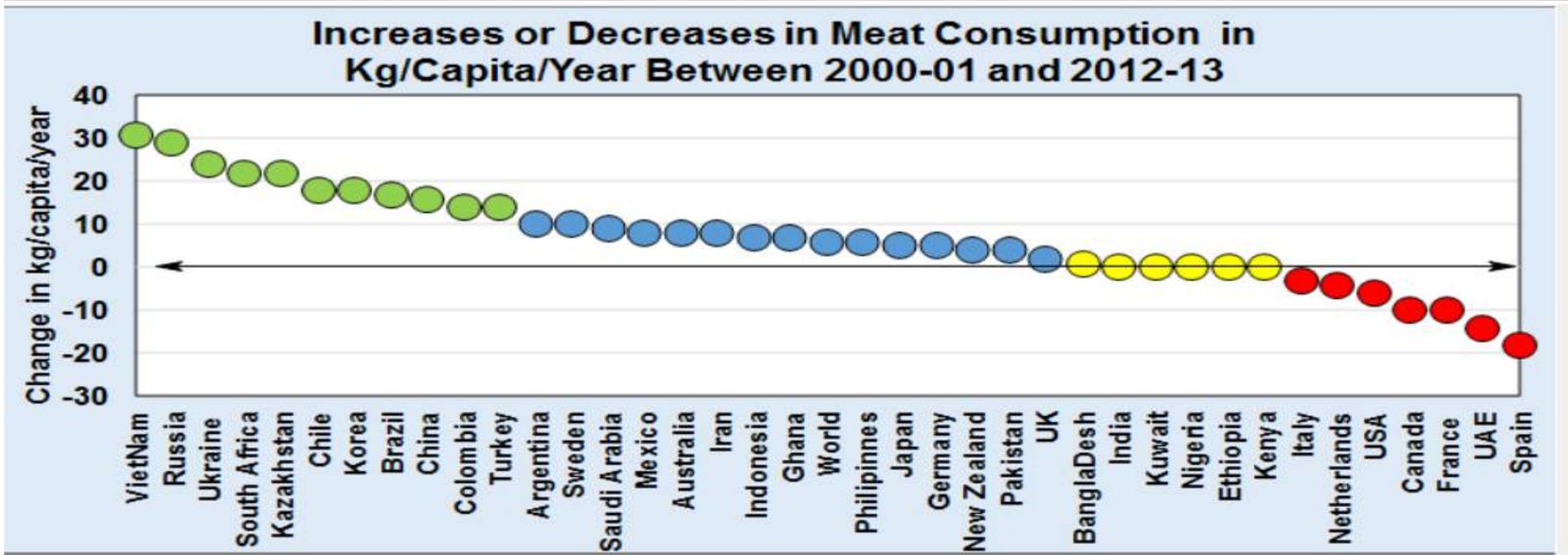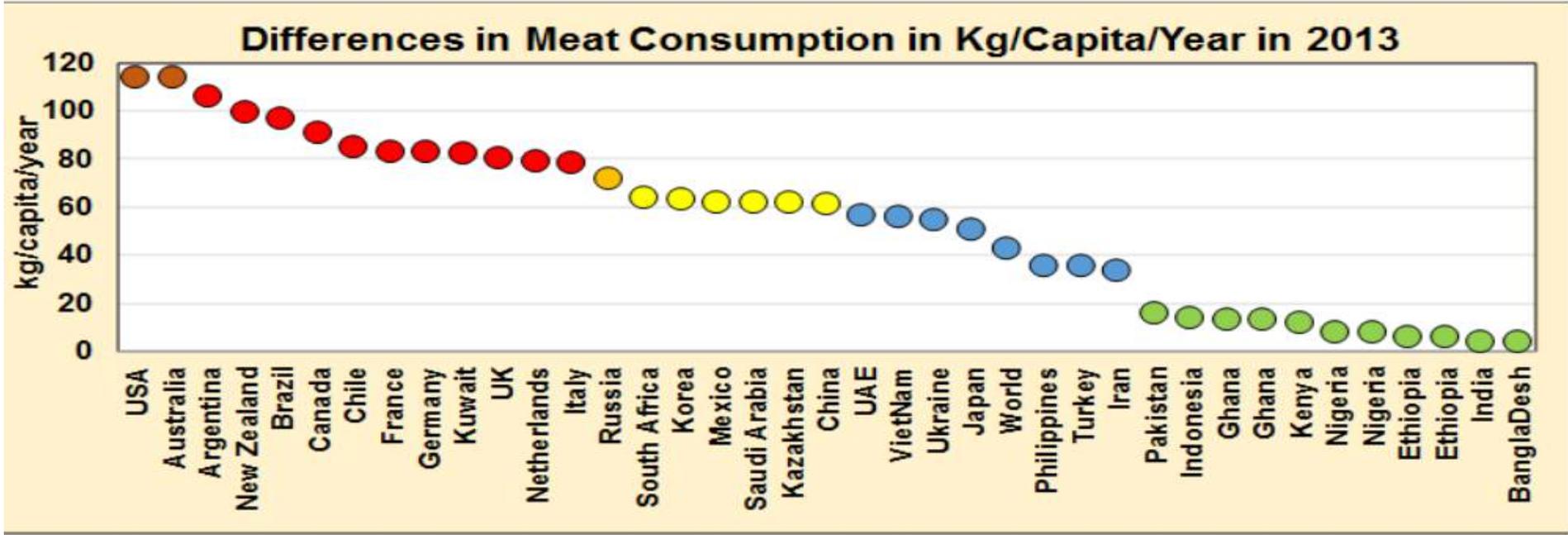
% of Global Number of Live Animals in Key Countries

	China	India	USA	Indonesia	Brazil	Pakistan	Mexico	Bangladesh	Nigeria
Cattle	5.6	12.4	6.3	1.1	14.4	3.0	2.1	1.6	1.4
Goats	13.5	12.4	0.2	1.8	0.9	7.0	0.8	5.8	7.5
Sheep	13.4	5.2	0.4	1.4	1.5	2.5	0.7	0.2	3.5
Pigs	45.5	0.9	7.6	0.8	4.2		1.8		0.8
Chicken	21.8	3.4	8.6	9.5	6.8	2.2	2.4	1.7	0.6
Population	19.1	17.7	4.3	3.5	2.8	2.6	1.7	2.2	2.5

China:
1.44 Billion People
0.91 Billion Livestock
4.97 Billion Chicken

India:
1.34 Billion People
0.39 Billion Livestock
0.78 Billion Chicken

USA:
0.33 Billion People
0.17 Billion Livestock
1.97 Billion Chicken

China   3 Chicken   0.8 Livestock/Person
India   0.6 Chicken   0.3 Livestock/Person
USA   6 Chicken   0.5 Livestock/Person

% of Global Production by China & India in 2016

Product	% of Global Production in 2016
Beef	12
Chicken	16
Milk	17
Eggs	42
Pork	47
Milk	52
Soybeans	8
Sugar	22
Maize	24
Wheat	30
Rapeseed	32
Potatoes	38
Rice	50

China & India = 37% of Global Population

% of Global Production in 2016
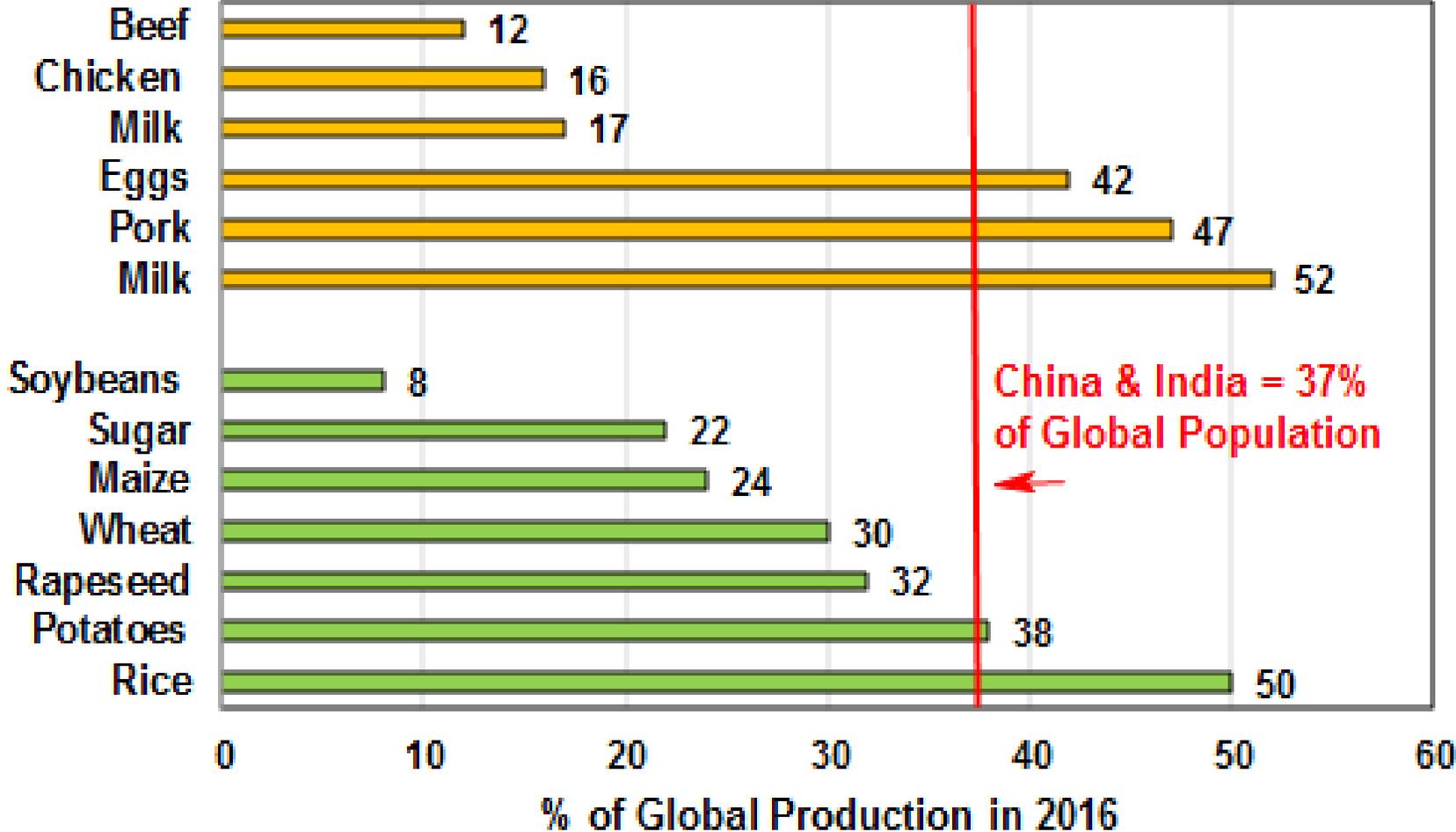
% of Global Production by 11 Countries in 2016
(Argentina, Australia, Brazil, Canada, France, Kasakhstan, Russia, Paraguay, Ukraine, USA, Uruguay)

Product	% of Global Production in 2016
Milk	52
Chicken	56
Beef	60
Eggs	62
Pork	68
Rice	4
Potatoes	25
Wheat	38
Rapeseed	44
Sugar	46
Maize	53
Soybeans	89

13% of Global Population by 11 Countries
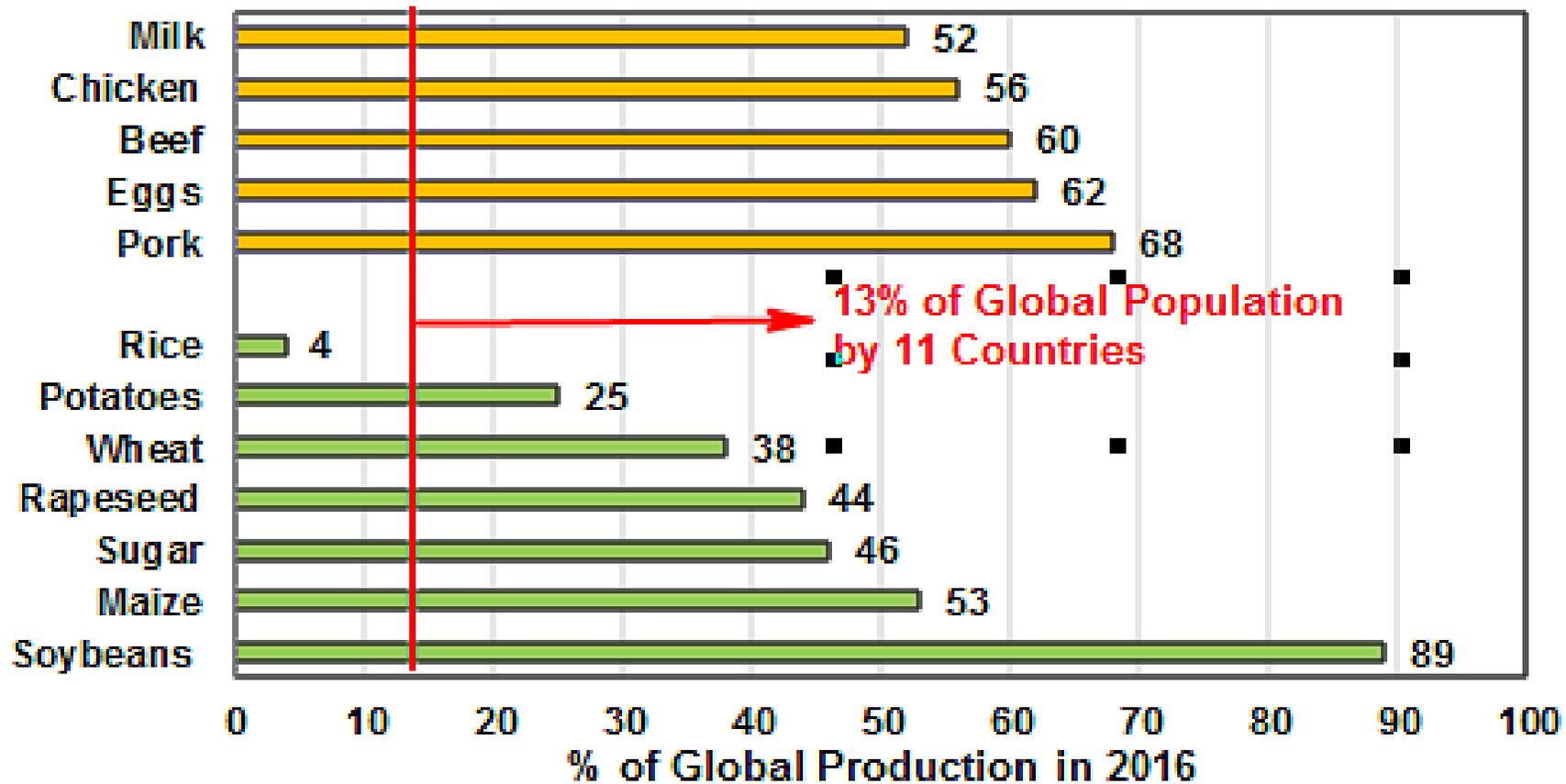
Available Arable Land and Annually Renewable Water Resources

Arable ha/Person in Different Countries

Y-axis: Arable ha/Person (0, 0.5, 1, 1.5, 2, 2.5)

- Egypt: 0.03
- Japan: 0.03
- China: 0.08
- Indonesia: 0.09
- India: 0.12
- Nigeria: 0.2
- France: 0.28
- Brazil: 0.36
- USA: 0.48
- Ukraine: 0.72
- Russia: 0.84
- Argentina: 0.93
- Canada: 1.31
- Kazakhstan: 1.73
- Australia: 2

World Average 0.2 ha/Person

Data Source: World Bank
http://data.worldbank.org/indicators/AG.LND.ARBL.HA.PC/countries
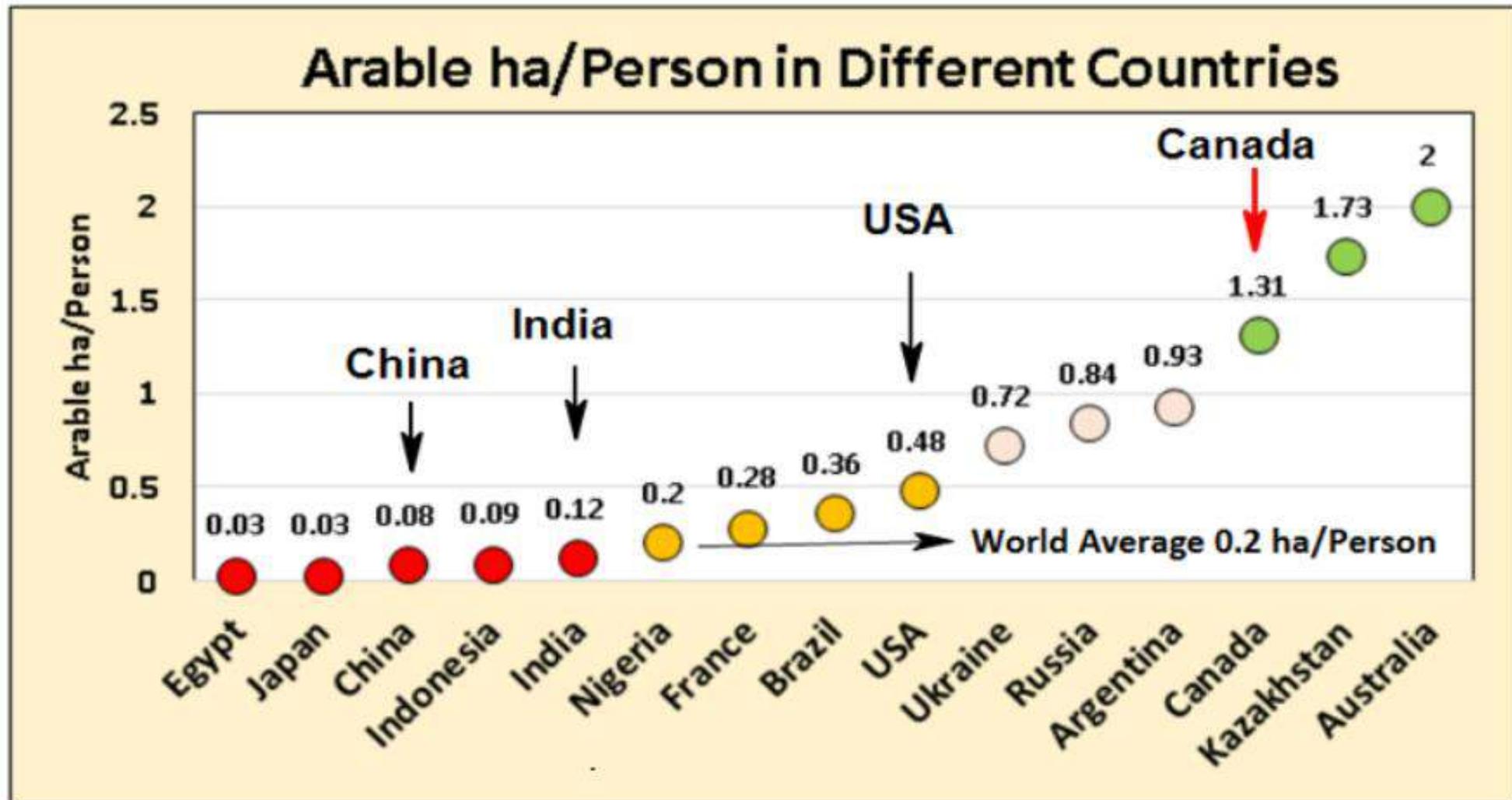
Changes in Arable Land / Person 2016-2050

Arable ha / Person

2016 | 2050

Country	Value
France	0.28
Brazil	0.39
USA	0.47
Uruguay	0.70
Paraguay	0.71
Ukraine	0.74
Russia	0.86
Argentina	0.89
Canada	1.21
Kazakhstan	1.63
Australia	1.91
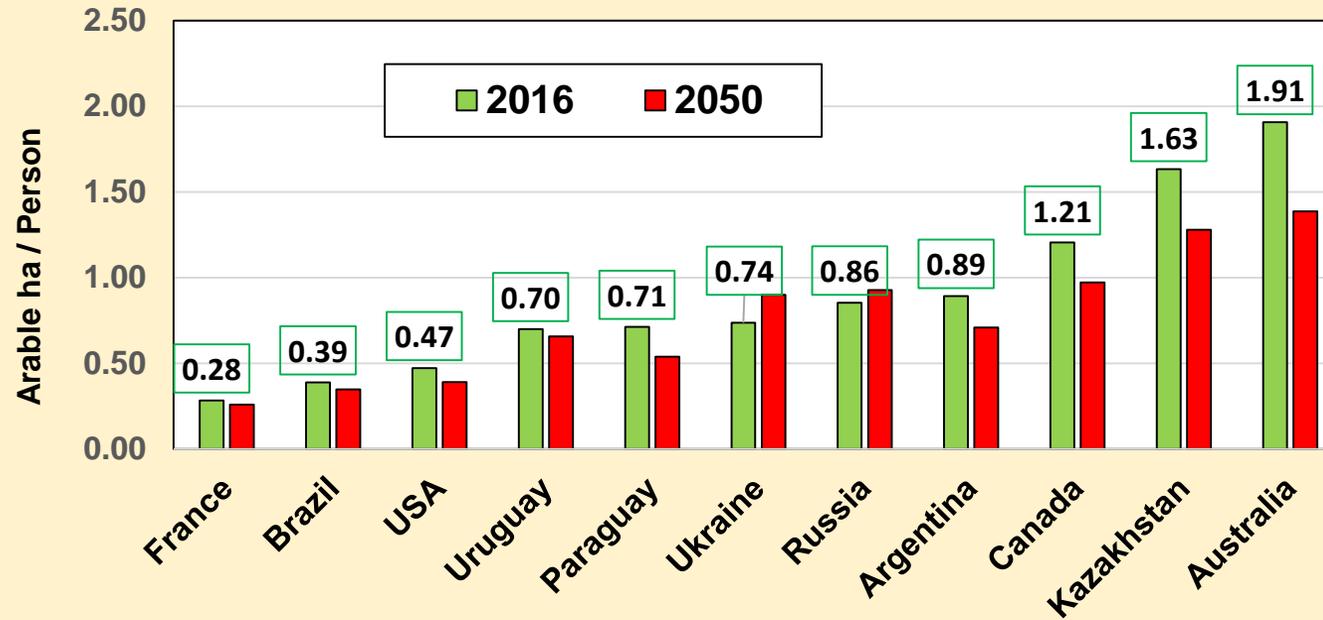
Countries with the least amount of Arable Land / Person 2016 -2050 (< 0.2 ha/Person)

ha / Person

2016 | 2050

Egypt, Japan, Banglade..., Philippines, Viet Nam, China, Indonesia, India, Ethiopia, Pakistan, Mexico, Nigeria, Iran
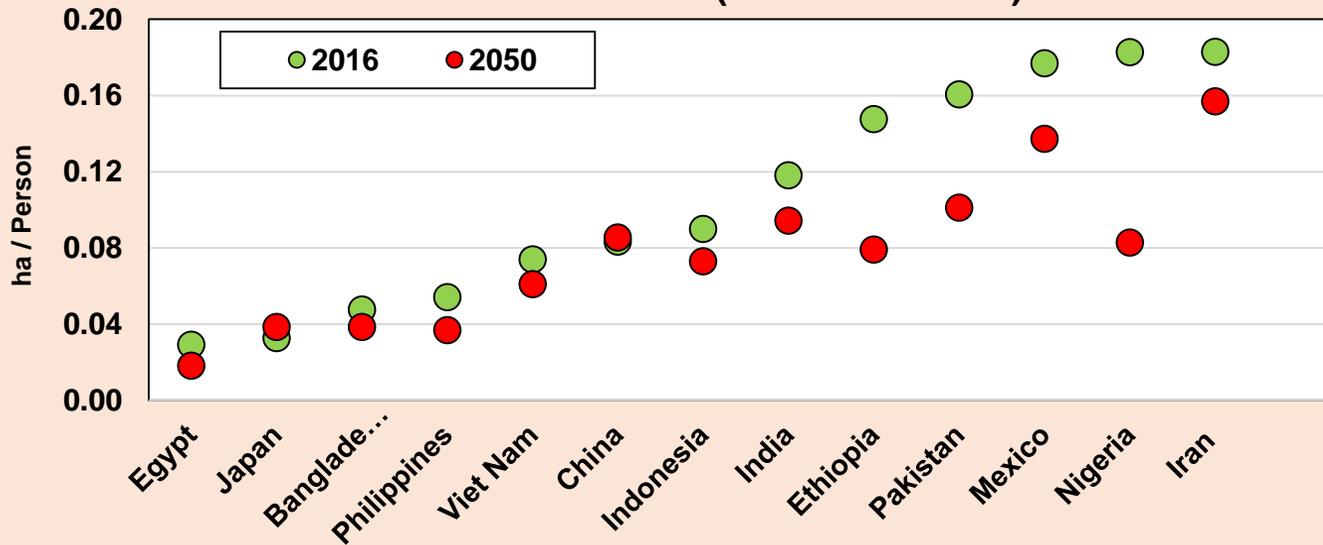
Annually Renewable Water and Arable Land per Person

Y-axis: Annually Renewable water Km3/Year (0 to 9000)
X-axis: Hectars of Arable Land / Person (0 to 2.5)

Data points:
- Brazil
- Russia
- USA
- Canada
- Paraguay
- Uruguay
- Argentina
- France
- Ukraine
- Kasakhstan
- Australia
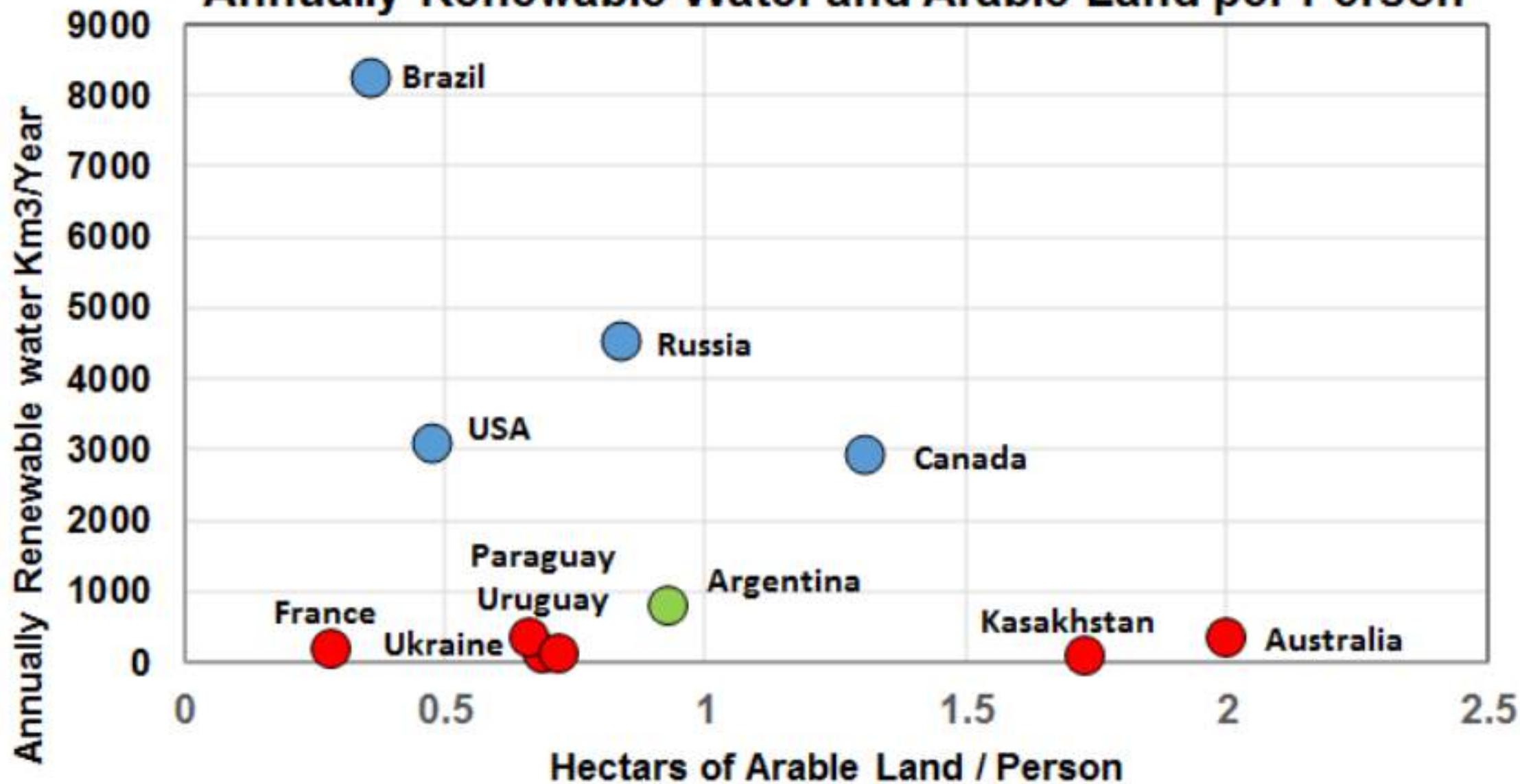
Who are the 10 most important Exporting Nations (Ranks 1-10) in 2013?

	Argentina	Brazil	USA	Canada	France	Australia	Russia	Ukraine	Paraguay	Uruguay
Maize	3	1	2	9	5	10	7	4	6	
Wheat	10		1	2	3	4	5	6		
Soybeans	3	1	2	6				7	4	5
Rice	7	10	8			8				5
Potatoes	8		7	9	1	10				
Beef	8	1		10		2			7	5
Pork		4	1	3						
Chicken	5	1	2		9	10		8		

Who are the Most Important Importing Nations (Rank 1-10) in 2013

	China	S-Korea	Japan	Egypt	Russia	Mexico	France
Wheat	3	8	6	1			
Maize	3	2	1	5		4	
Soybeans	1		6	9		3	
Rice	1						
Potatoes					8		7
Beef	2	10	4	7	3		8
Chicken	1		5		4	3	6
Pork	3	4	1		2	8	

How much Water does it take to Maintain you Daily Diet?

What food do you like most?

And how much water is required to produce different Food Items?

How much water does it take to maintain a Canadian Daily Diet

Virtual Water Needs to Maintain a Daily Diet (L/Day)

Water Needed for Average Daily Diet L/Day
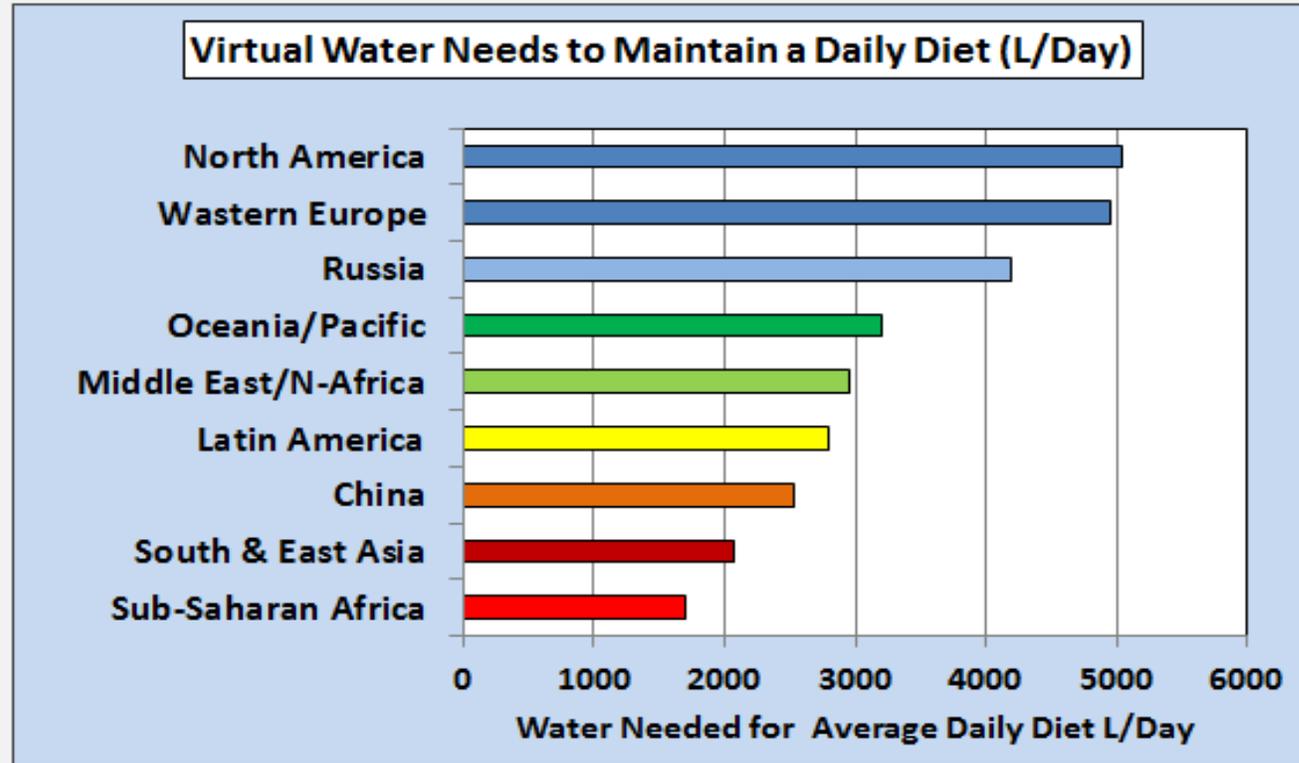
The Average Canadians Food Consumption in 2010:
Daily Diet: 5000 L of Water/Day
Meat Consumption: 95kg/Capita/Year
Kcal Consumption: 3500 kcal/Day

Water Requirements to Produce Different Food Commodities

Water Use in m3/Ton

Commodity	m3/Ton
Rice	2291
Soybeans	1789
Wheat	1334
Maize	909
Potatoes	755

Water Requirements in m3/Ton

Commodity	m3/Ton
Beef	16000
Pork	4900
Chicken	3900
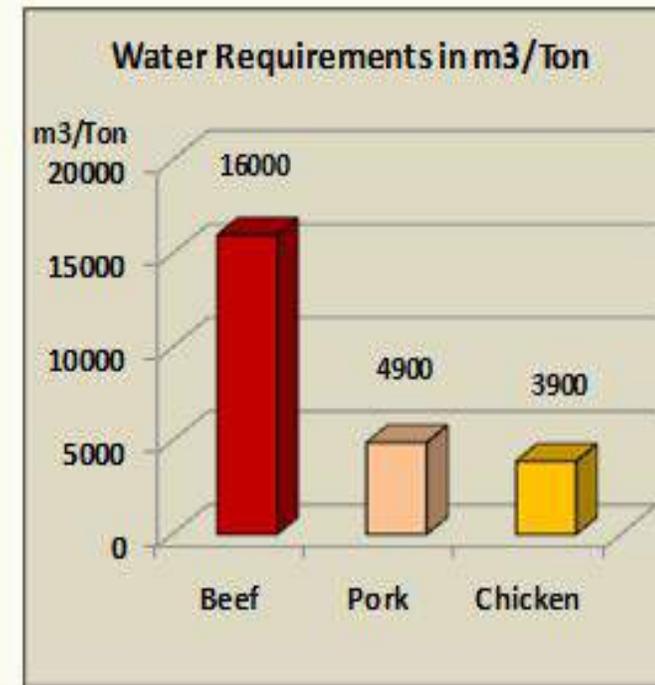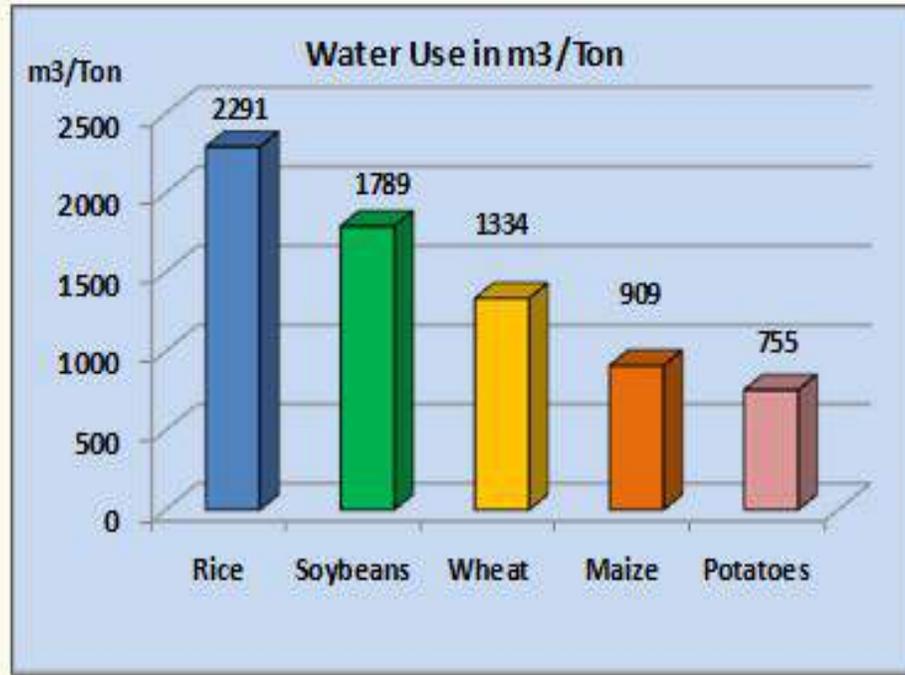
Water Requirements for Different Beverages
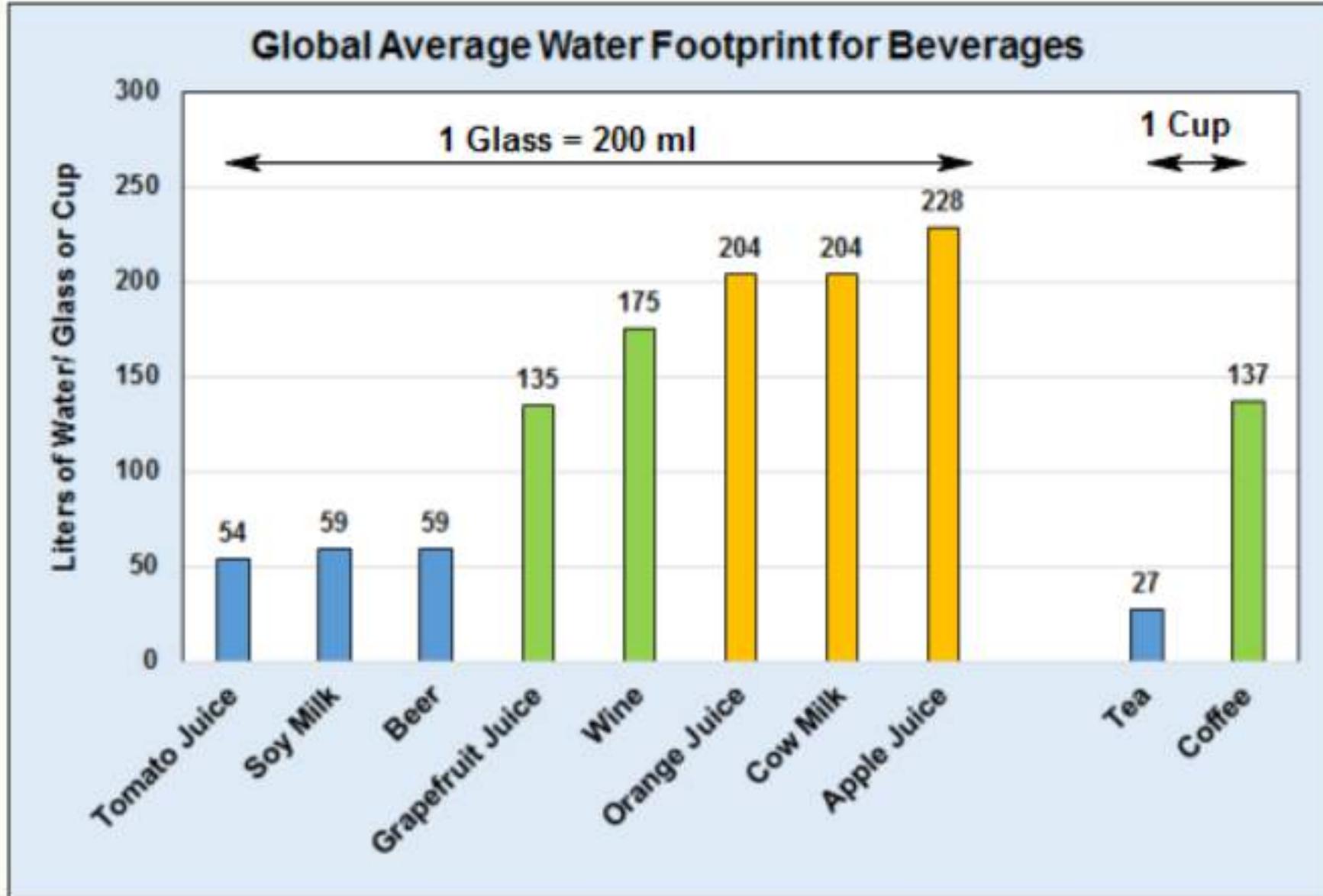
The Water needed to produce a Food Commodity that is exported

That water cannot be used for other purposes

Countries that are water short will rely on water intensive food imports to save water for demestic and industrial purposes
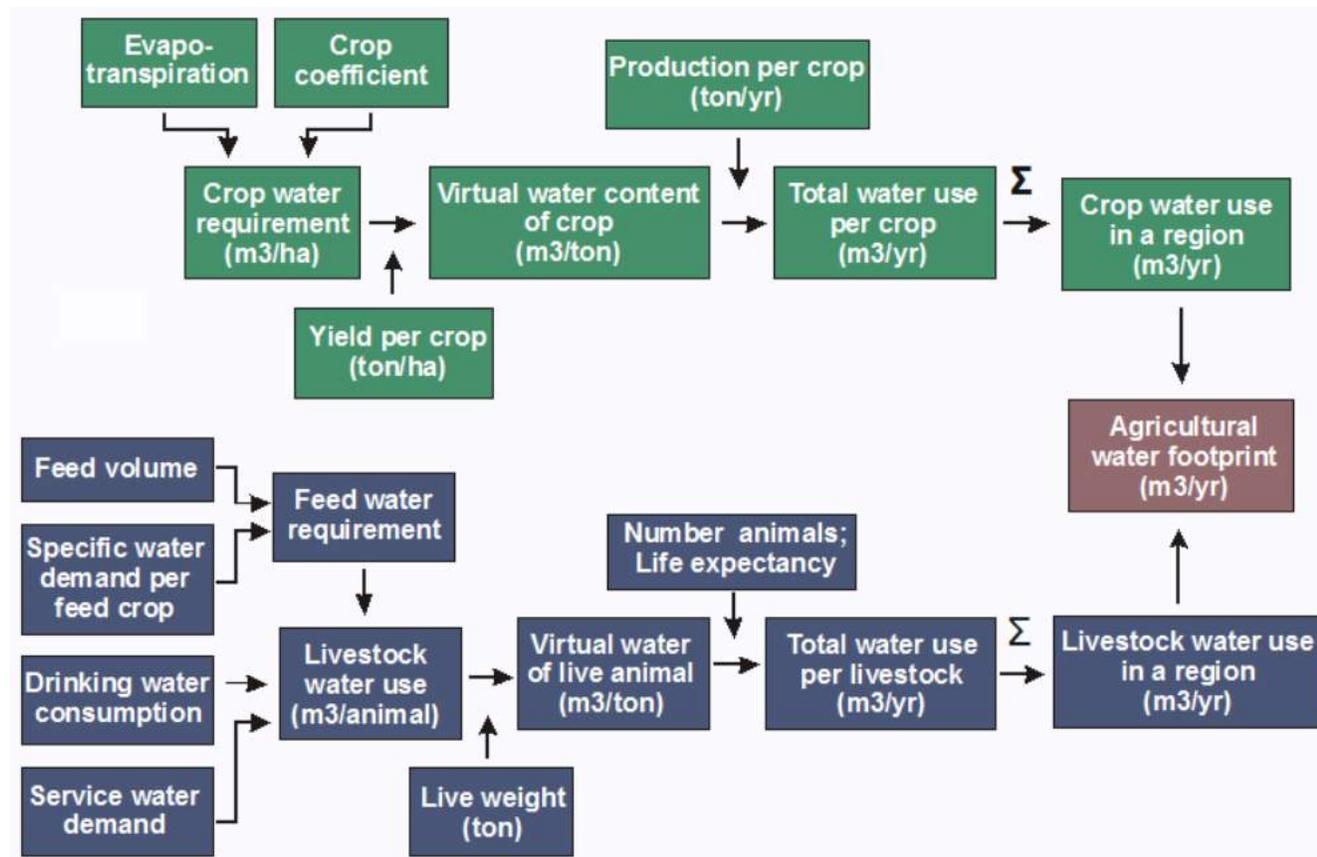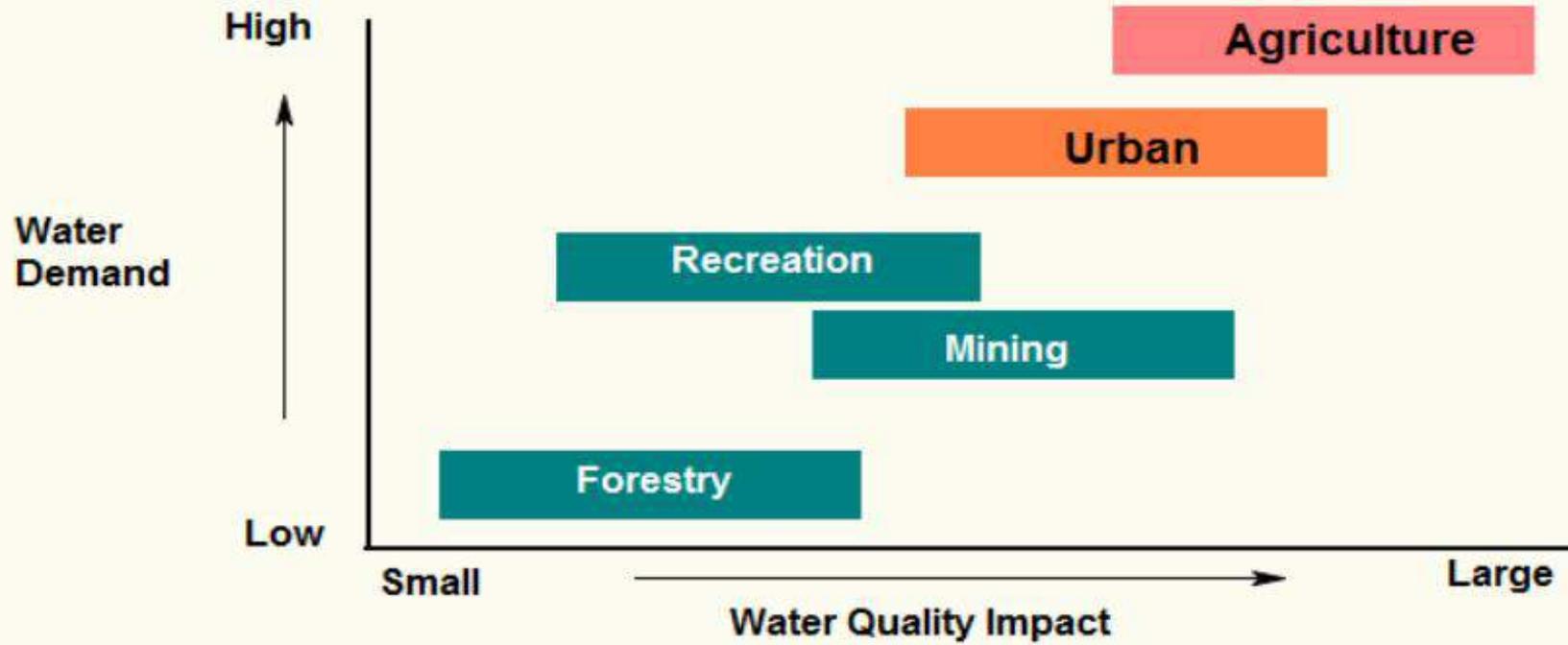
Intensive Agriculture

Dry Season | **Wet Season**

Annually Renewable Water and Arable Land /Person
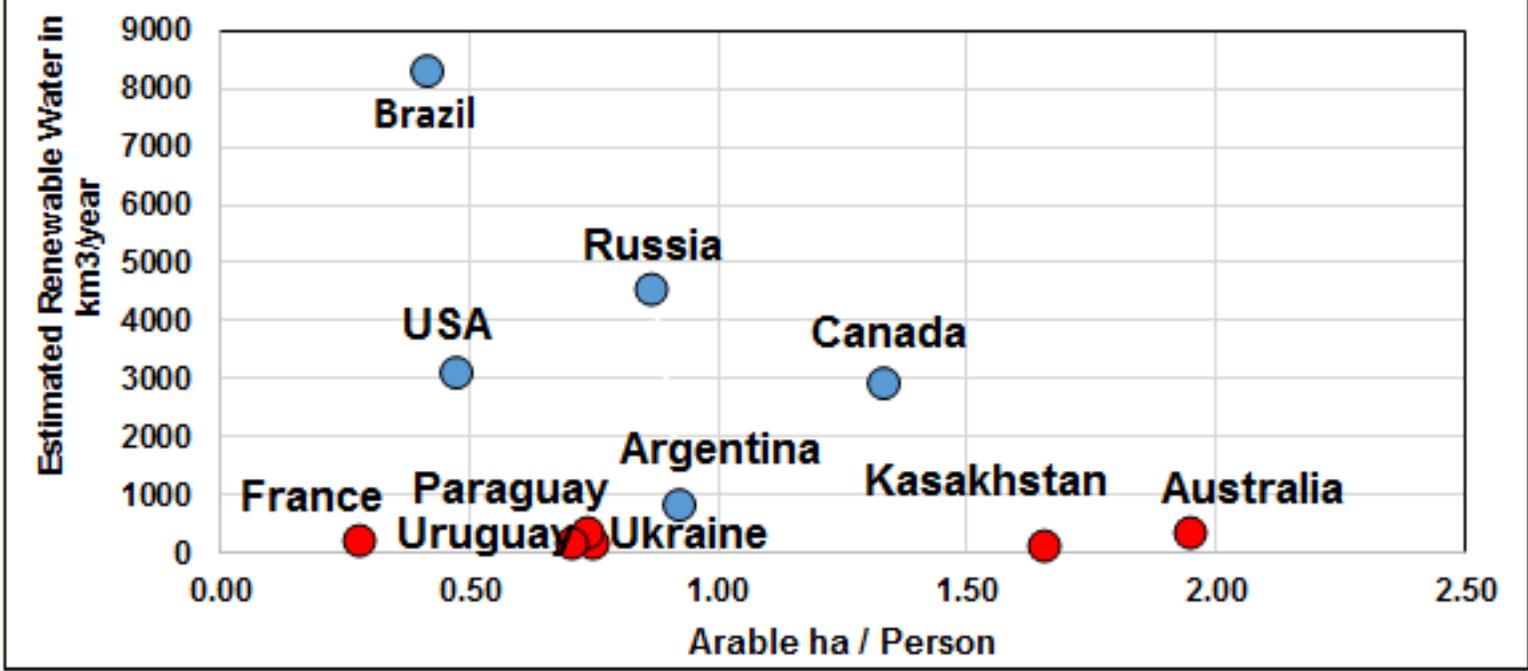
% of Global Exports Concentration in 2018
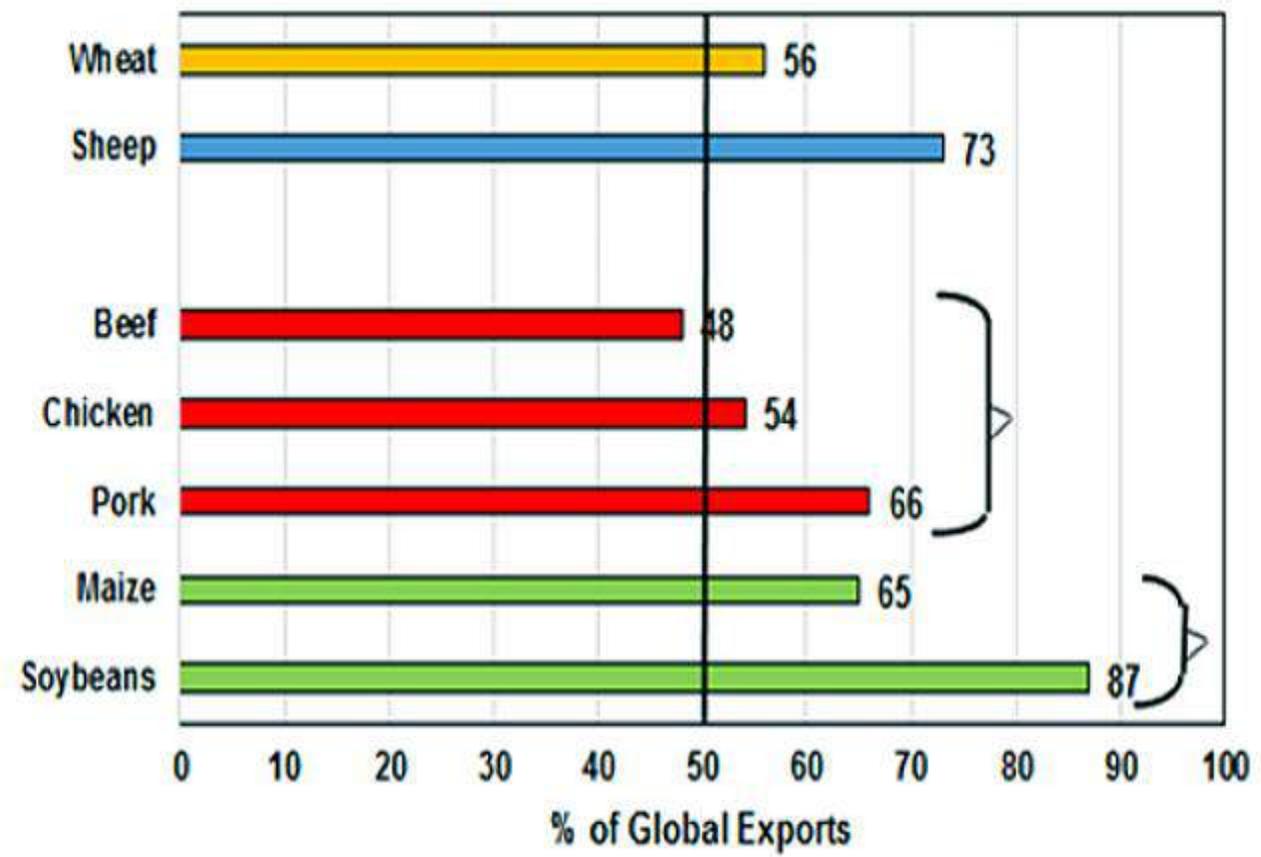
Commodity	% of Global Exports	Countries
Wheat	56	USA, Russia, Canada, France, Australa
Sheep	73	Australia, New Zealand
Beef	48	USA, Brazil
Chicken	54	USA, Brazil
Pork	66	USA, Brazil
Maize	65	USA, Brazil, Argentina
Soybeans	87	USA, Brazil, Argentina
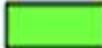
Water for Crops m3/Ton

Crop	m3/Ton
Sorgum	2850
Rice	2300
Soybeans	1800
Barley	1400
Wheat	1300
Maize	900
Potatoes	255

Water for Meat m3/Ton

Meat	m3/Ton
Beef	15500
Sheep	6100
Pork	4850
Goat	4000
Chicken	3900
Milk	1000
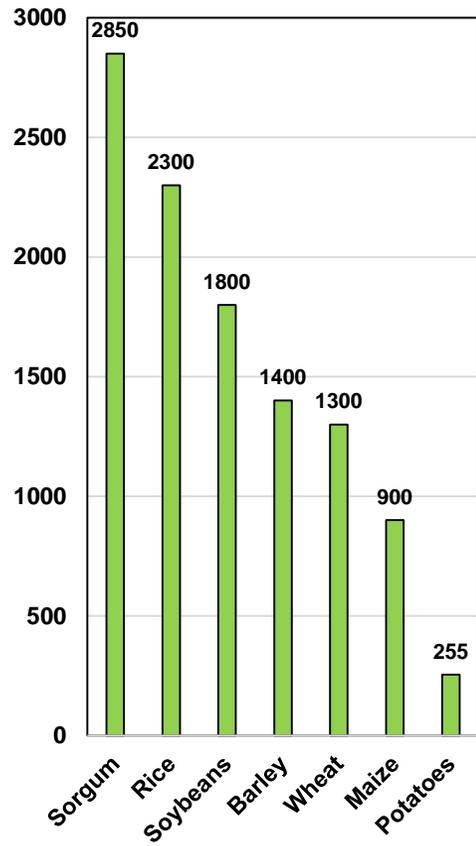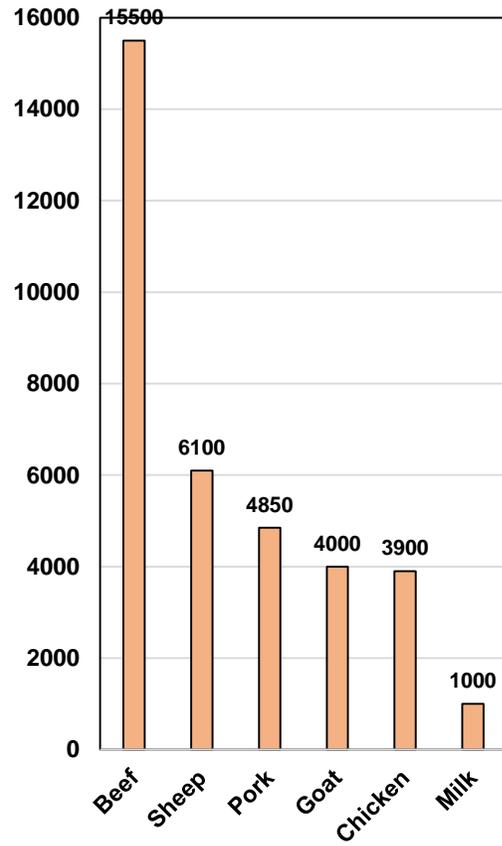
Water Requirement for Global Production and Exports in 2016 in Km³

Water Requirement in Km3

	Production	Export
Rice	1698	92
Wheat	1000	244
Maize	964	134
Soybeans	599	241
Rapeseed	111	35
Potatoes	96	5
Beef	1023	89
Milk	659	13
Pork	573	26
Chicken	418	51
Sheep	57	7
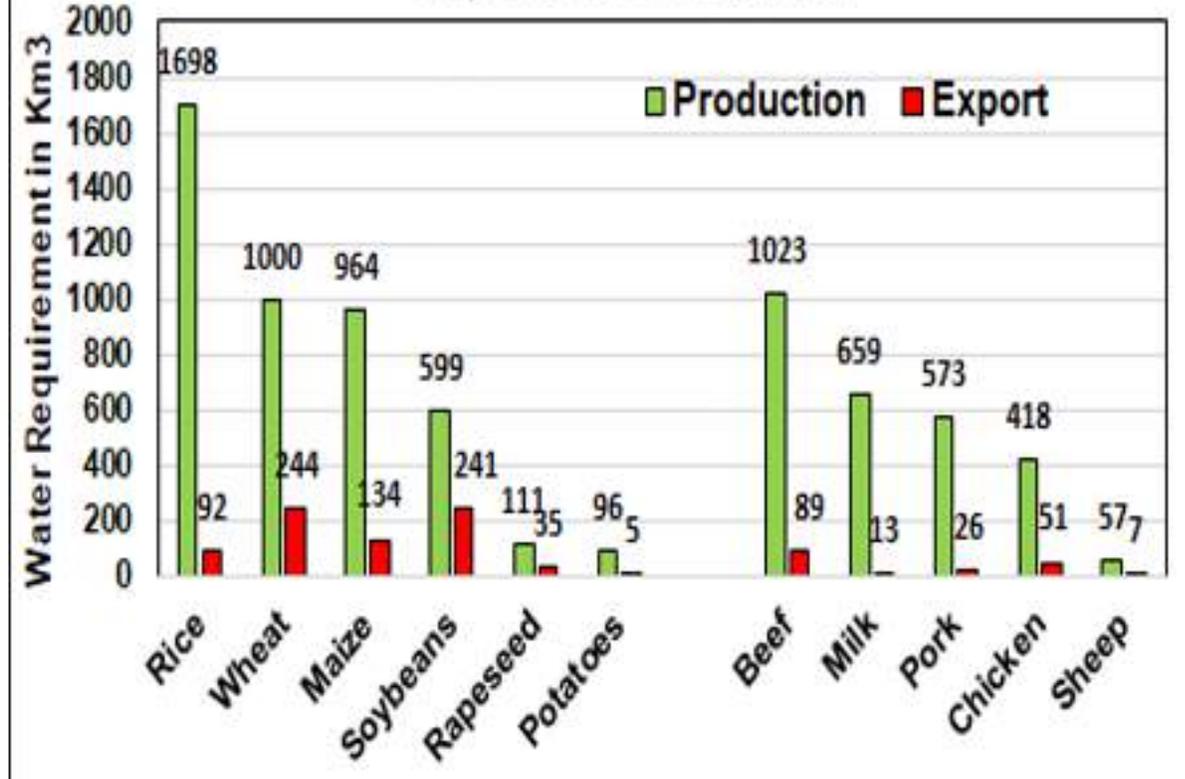
Largest Crop Importing Countries in 2016 by Rank

	Wheat	Maize	Rice	Soybeans	Legend	Rank
China	10	5	1	1		1-5
Japan	8	1	14	5		6-10
Spain	5	7		4		11-15
Indonesia	1		2	8		16-20
Mexico	20	2	12	2		> 20
Italy	4	10		12		
Egypt	2	6		16		
Iran	25	8	5	11		
S-Korea	13	3		14		
Vietnam	9	4		13		
Saudi Arabia	18	14	4	21		
Netherlands	14	13		3		
UK			21	19		
Malaysia	31	15	9	18		
UAE	44		10			
China Taiwan		11		7		

% of Globally Traded Crops Imported by Countries in 2016

	Wheat	Maize	Rice	Soybeans	Potatoes	Legend	%
China	2.6	5	8.6	64			64
Japan	3	10.4	1.6	2.3	2		5-10.4
Spain	3.7	4		2.4	3.6		3-4.9
Indonesia	5.7	0.9	3.2	1.7	0.4		2-2.9
Mexico	1.7	8.4	1.6	3	1.4		0.1-1.9
S-Korea	2.4	6.6	0.8	1	0.7		
Vietnam	2.6	5.5		1	0.6		
Italy	3.9	3		1.1	4.1		
Egypt	4.7	4		0.7			
Iran	0.9	3.8	2.6	1.1			
Saudi Arabia	1.9	2.4	3.1	0.4	1.5		
Netherlands	2.4	2.6	0.3	2.6			
Malaysia	0.8	2.4	1.9	0.5	1.5		
UK		1.0	1.2	0.5	2.3		
UAE	0.9	0.4	1.9		1.6		
China Taiwan	0.7	2.9	0.1	1.8	0.5		

Largest Meat Importing Countries in 2016

	Beef	Pork	Sheep	Chicken
China	1	2	1	3
Japan	2	1	12	4
S-Korea	5	3	17	20
Russia	4	4		14
France	9	9	3	
UAE	18		4	5
Saudi Arabia			5	1
UK	10	7		13
Singapore		10	16	15
Malaysia	8		7	
Mexico		11		2
Germany	19		6	12
China Taiwan	12	17	14	11
Philippines	11	14		8
Viet Nam	15			6

Legend	Rank
	1-5
	6-10
	11-15
	16-20

% of Globally Traded Meat Imported in 2016

	Beef	Pork	Sheep	Chicken
China	14.8	10.9	21.6	5.9
Japan	8.7	15.8	1.8	4.1
S-Korea	4	8.5	1	0.6
France	2.2	1.6	7.2	
Saudi Ara	0.8		3.4	6.5
Mexico	0.2	1.2	0.9	5.9
UAE	1.3		4	3.7
UK	2	2.1	0.9	1
Malaysia	2.3		3	
Russia	4.4	3.9		1
Viet Nam	1.5	0.1		3.5
Germany	1.3		3.1	1.1
Egypt	3			0.8
China Tai	1.9	0.8	1.4	1.2
Philippin	1.9	1		1.8
Singapor	0.4	1.2	1.2	1

Legend	%
	10-22
	5-9.9
	2-4.9
	0.1-1.9

Virtual Water Imported by Key Countries (Net Imports) in 2016 in Km3/Year					
	Beef	Pork	Sheep	Chicken	Total
China	10.69	1.31	1.12	2.84	15.96
Japan	5.5	4.26	0.07	1.61	11.44
S-Korea	3.56	2.25	0.07	0.33	6.21
Russia	5.31	1.82	0.01	0.77	7.91
France	1.97	0.41	0.49	0.17	3.04
Saudi Arabia	0.68	-	0.23	3.35	4.26
Mexico	0.43	0.44	0.06	3.05	3.98
UAE	1.19	-	0.27	1.89	3.35
Viet Nam	1.38	0.03	-	1.78	3.19
Egypt	2.68	-	-	0.39	3.07
UK	1.78	0.56	0.06	0.53	2.93
Philippines	1.68	0.27	-	0.94	2.89
Malaysia	2.06	-	0.20	0.24	2.5
Italy	1.01	0.86	0.19	-	2.06
China Taiwan	1.25	0.10	0.08	0.56	1.99
Iran	1.49	-	0.03	0.01	1.53
Indonesia	1.54	-	0.01	-	1.55
Singapore	0.31	0.33	0.08	0.51	1.23
Germany	-	-	0.21	0.56	0.77
Spain	0.23	-	0.15	-	0.38
Netherlands	-	-	-	0.03	0.03

Virtual Water Imported by Key Countries (Net Imports) in 2016 in Km3/Year						
	Wheat	Maize	Rice	Soybeans	Potatoes	Total
China	3.3	5.92	4.55	225.7	-	239.4
Japan	4	22.91	0.81	7.29	0.04	35.1
Spain	8.28	3.8	-	8.62	0.14	20.8
Indonesia	14.03	1.44	2.76	4.59	0.02	22.8
Mexico	3.38	21.68	1.45	12.83	0.06	39.4
S-Korea	4.38	10.2	0.4	4.45	0.02	19.5
Vietnam	6.32	9.97	-	2.09	0.03	18.4
Italy	17.43	2.34	-	2.15	0.16	22.1
Egypt	8.09	6.08	-	2.53	-	16.7
Iran	2.31	6.57	3.41	8.03	0.01	20.3
Saudi Arabia	7.11	25.77	3.99	1.07	0.14	38.1
Netherlands	2.69	1.53	0.31	6.2	-	10.7
Malaysia	1.76	5.01	2.29	1.3	0.07	10.4
China Taiwan	0.93	3.37	0.05	6.37	0.02	10.7
Philippines	6.17	0.71	1.02	0.23	0.03	8.16
UAE	1.06	3.41	2.42	0.01	0.08	7.0
Germany		0.82	0.72	6.32	-	7.86
Russia	-	-	0.05	7.32	0.05	7.43
UK	-	1.4	1.14	1.28	0.03	3.8
France	-	-	0.77	1.71	-	2.48
Singapore	0.27	0.03	0.61	0.04	0.02	0.97

Summary: Total Virtual Water Imported in 2016 by Key Countries in km3/Year			
	Meat	Crops	Total
China	15.96	239.4	255.38
Japan	11.44	35.05	46.49
Mexico	3.98	39.40	43.38
Saudi Ara	4.26	38.08	42.34
S-Korea	6.21	19.45	25.66
Indonesi	1.55	22.84	24.39
Italy	2.06	22.10	24.16
Iran	1.53	20.33	21.86
Vietnam	3.19	18.41	21.6
Spain	0.38	20.84	21.22
Egypt	3.07	16.70	19.77
Russia	7.91	7.43	15.34
Malaysia	2.50	10.43	12.93
China Tai	1.99	10.74	12.73
Philippin	2.89	8.16	11.05
Netherla	0.03	10.73	10.76
UAE	3.35	6.98	10.33
Germany	0.77	7.86	8.63
UK	2.93	3.82	6.75
France	3.04	2.48	5.52
Singapor	1.23	0.97	2.2

Meat: Beef, Pork, Sheep, Chicken

Crops: Wheat, Maize, Rice, Soybeans, Potatoes

Virtual Water Exported by Key Countries in Crops in Km3/Year in 2016

	Maize	Wheat	Soybeans	Total
Argentina	11.49	7.58	9.90	28.97
Australia	0.10	25.64	0.10	25.84
Brazil	25.81	1.15	55.50	82.47
Canada	0.62	29.38	5.32	35.32
France	2.62	16.418	0.19	19.23
Paraguay	3.51	1.78	7.78	13.07
Russia	7.44	60.15	1.66	69.25
Ukraine	15.00	8.42	5.38	28.81
USA	27.38	20.41	107.97	155.76
Uruguay	0.00	0.55	3.18	3.73

Virtual Water Exported by Key Countries in Meat in Km3/Year in 2016

	Beef	Pork	Chicken	Sheep	Total
Argentina	2.32	0.00	0.72	0.01	3.05
Australia	17.02	0.00	0.09	2.88	19.99
Brazil	18.12	2.85	15.49	0.00	36.46
Canada	4.28	3.70	0.39	0.00	8.37
France	0.63	0.46	1.23	0.05	2.37
Paraguay	4.28	0.01	0.01	0.00	4.30
Russia	0.03	0.02	0.46	0.00	0.52
Ukraine	0.07	0.00	0.34	0.00	0.41
USA	9.18	4.21	7.44	0.02	20.84
Uruguay	3.99	0.00	0.02	0.05	4.06

Virtual Water Exports by Key Countries in Km3/Year

	Crops	Meat	Total
USA	155.76	20.84	176.61
Brazil	82.47	36.46	118.93
Russia	69.25	0.52	69.77
Australia	25.84	19.99	45.84
Canada	35.32	8.37	43.69
Argentina	28.97	3.05	32.02
Ukraine	28.81	0.41	29.22
France	19.23	2.37	21.60
Paraguay	13.07	4.30	17.37
Uruguay	3.73	4.06	7.79

Exporting Countries

	Annual H2O Withdrawals	Virtual H2O Exported	% of Annual Withdrawals
USA	482.2	176.6	37
Brazil	58.1	118.9	>100
Russia	76.7	68.8	90
Australia	59.8	45.8	77
Canada	45.1	43.7	97
Argentina	32.6	32	98
Ukraine	19.2	29.2	>100
France	31.6	21.6	68
Paraguay	0.5	17.4	>100
Uruguay	3.7	7.8	>100

Importing Countries

Importing Countries	Annual Withdrawals	Virtual Water Imported	% of Available
	Km3	Km3	%
China	579	255	44
Japan	88.4	46.5	53
Mexica	72.2	43.4	60
Saudi Arabia	23.7	42.3	>44
S Korea	28.5	25.7	90
Indonesia	82.8	24.4	29
Italy	42.7	24.2	67
Iran	93.3	21.9	23
Vietnam	169.4	21.6	13
Spain	37.3	21.2	57

Based on Total Wheat, Maize, Rice, Soybeans, Potatoes, Beef, Pork, Sheep, Chicken Imports
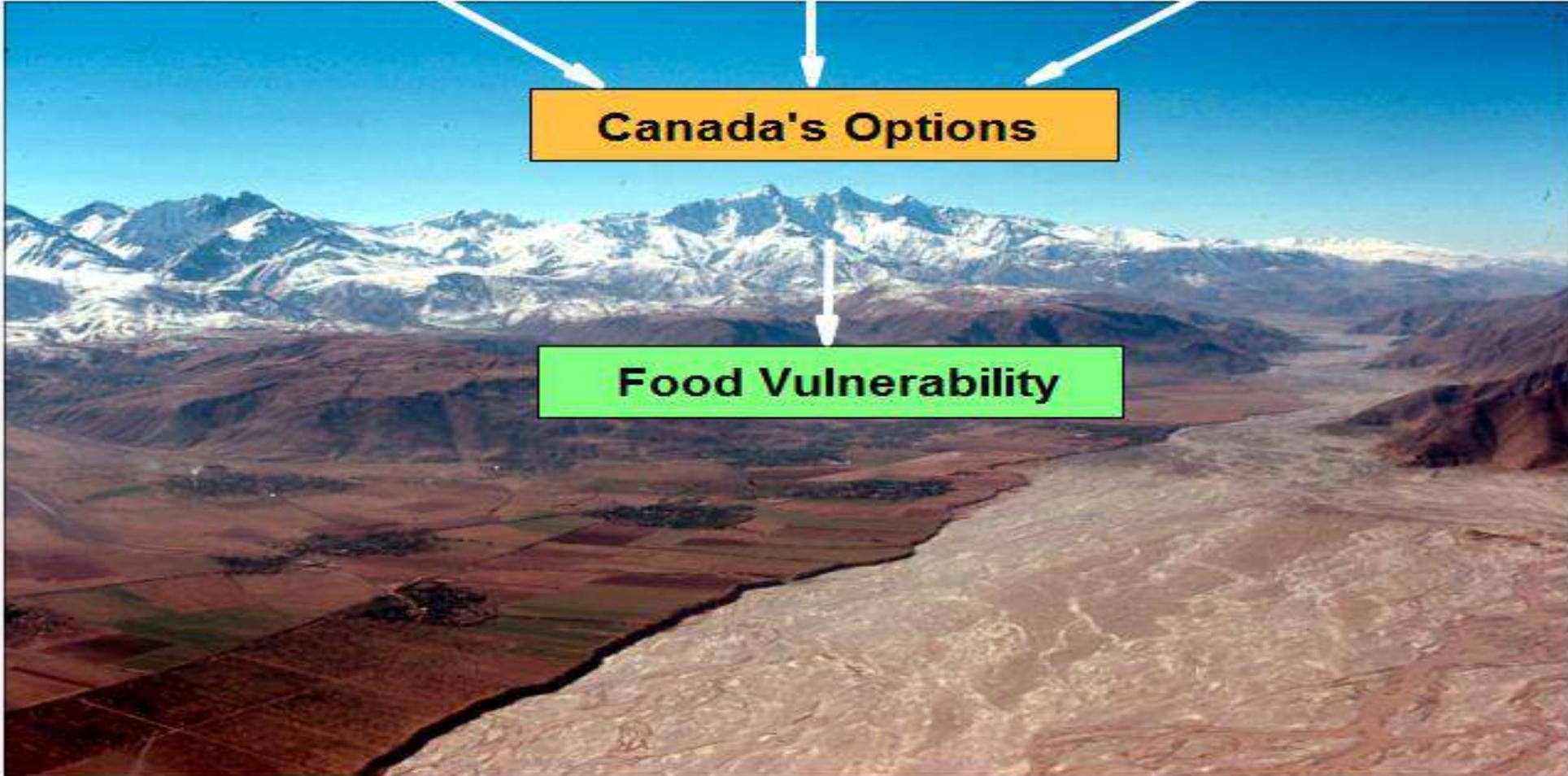
Case Study

China's Food Challenge
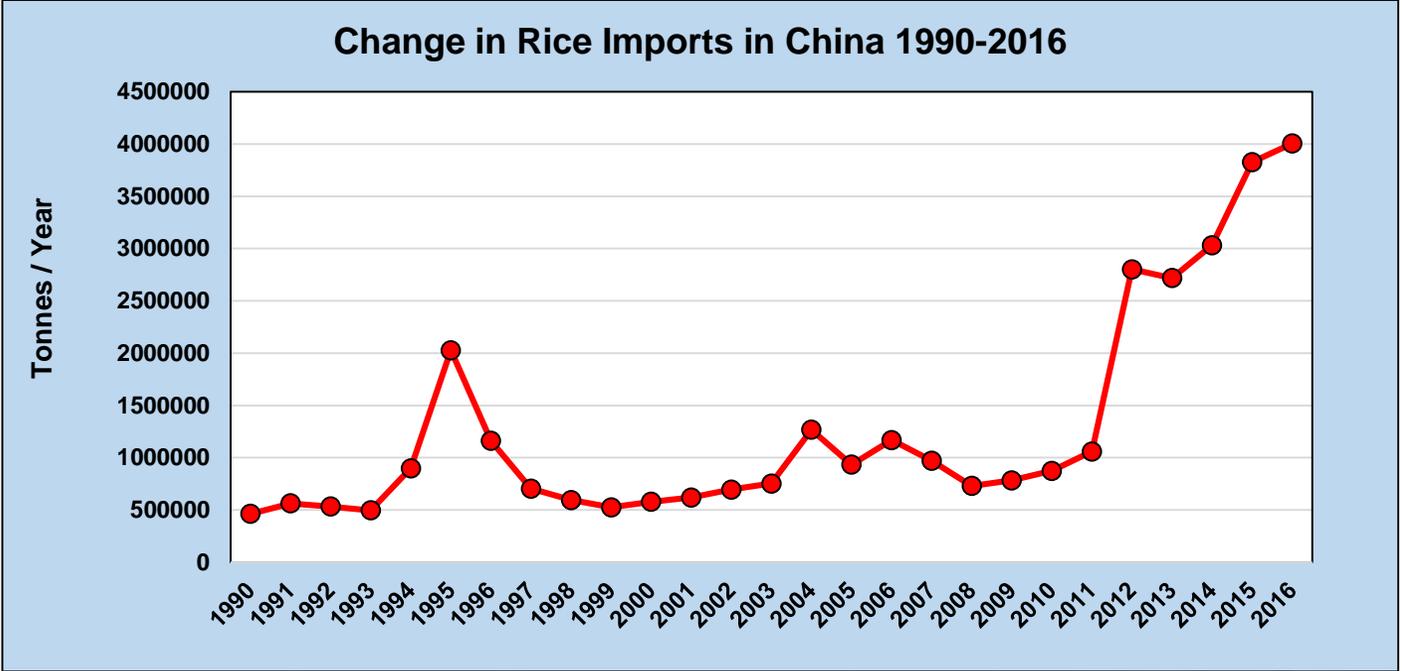
% of Global Crop Production and Exports - China 2016

	% of Export	% of Production
Vegetables		59
Rice		28
Potatoes		26
Maize		24
Rapeseed		19
Wheat		18

% of Global Production & Exports
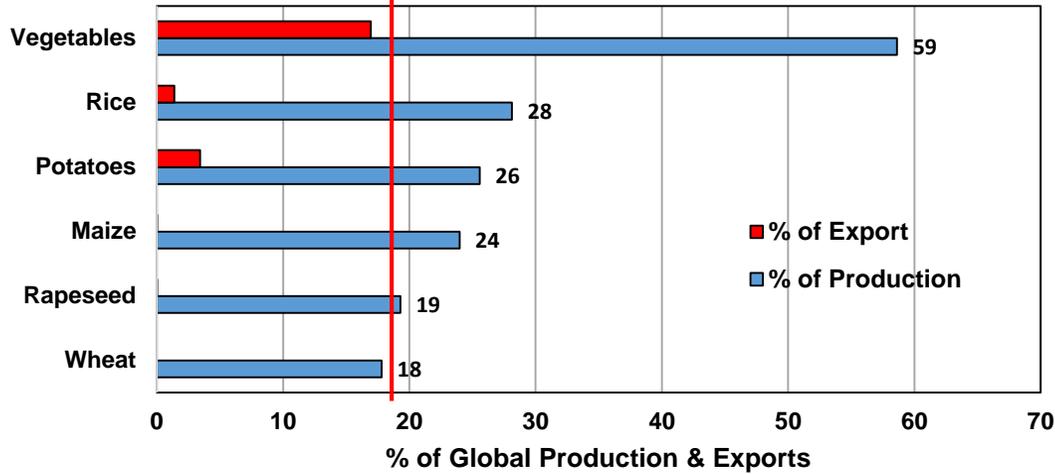
% of Global Meat Production & Exports - China 2016

	% of Export	% of Production
Pork		46
Eggs,		40
Goats		39
Sheep		25
Chicken		13
Beef		10
Cow Milk		5

% of Global Production & Exports
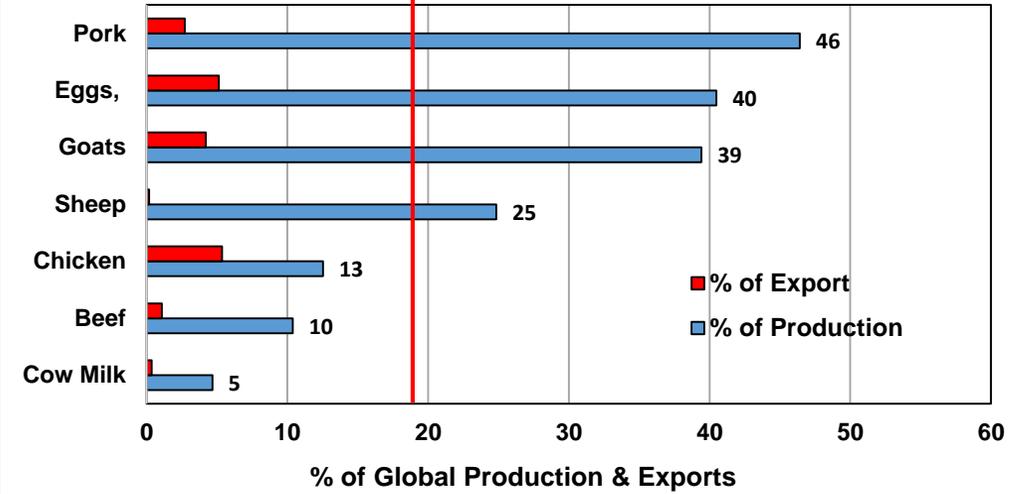
China's Population 19% of the World

% of Global Fruit Production & Exports - China 2016

	% of Export	% of Production
Pears		68
Peaches		58
Kiwi fruit		56
Plums		56
Tangerines		54
Grapefruit		51
Apples		47
Grapes		17
Lemons		14
Oranges		11
Bananas		10
Mangoes		10

% of Global Production & Exports
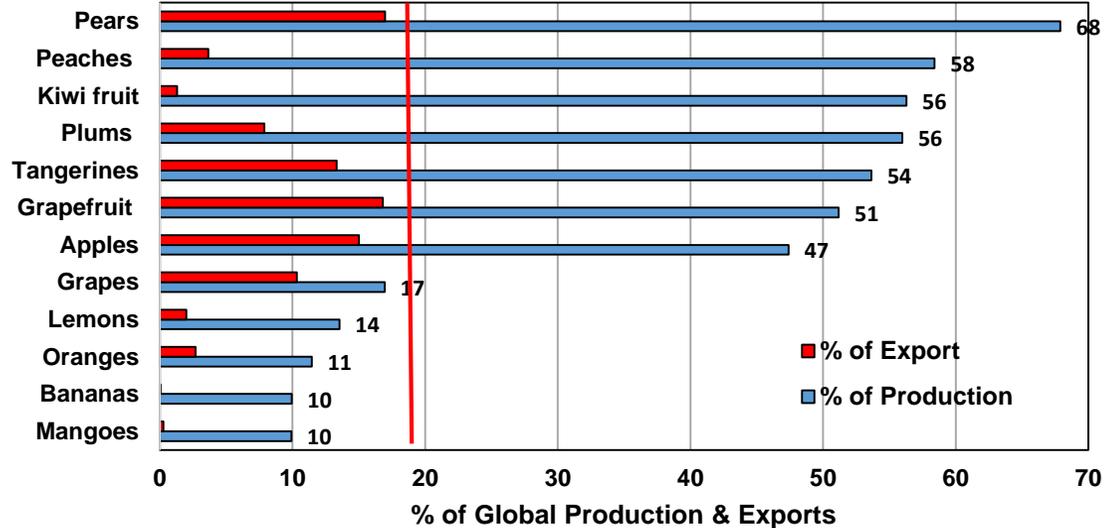
% of Global Food Production & Exports - China 2016

	% of Export	% of Production
Beans, green		79
Mushrooms		76
Walnuts		48
Tobacco		40
Tea		39
Tomatoes		32
Honey,		30

% of Global Production & Exports
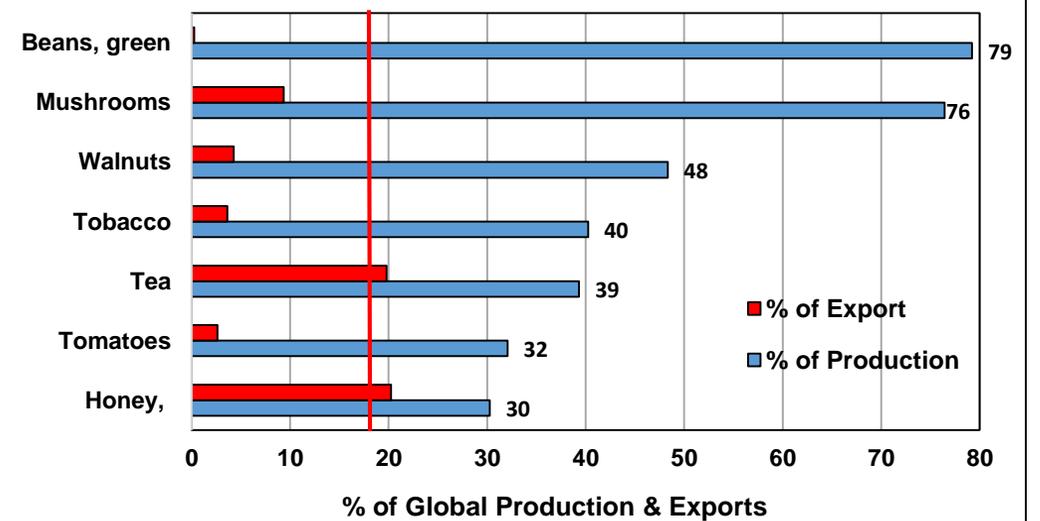
China's Global Food Import Rank
Tonnes Imported in 2013
## Water Water Requirements for the Imported Food

China	Rank		Million Tonnes				m3/Ton
			GLOBAL IMPORT RANK				Water
			Rank 1	Rank 2	Rank3		Needed
Wheat	3		10.23	7.27	6.83		690
Maize	3		14.44	8.72	7.34		801
Soybeans	1		65.55	0.36	0.36		2617
Rice	1		2.72	2.18	2.17		1972
Potatoes							
Beef	2		0.66	0.61	0.56		12560
Chicken	1		1.39	0.83	0.66		3652
Pork	3		0.73	0.49	0.48		2211

Net Import of Soybeans in China 2000-2016

Million Tonnes/Year
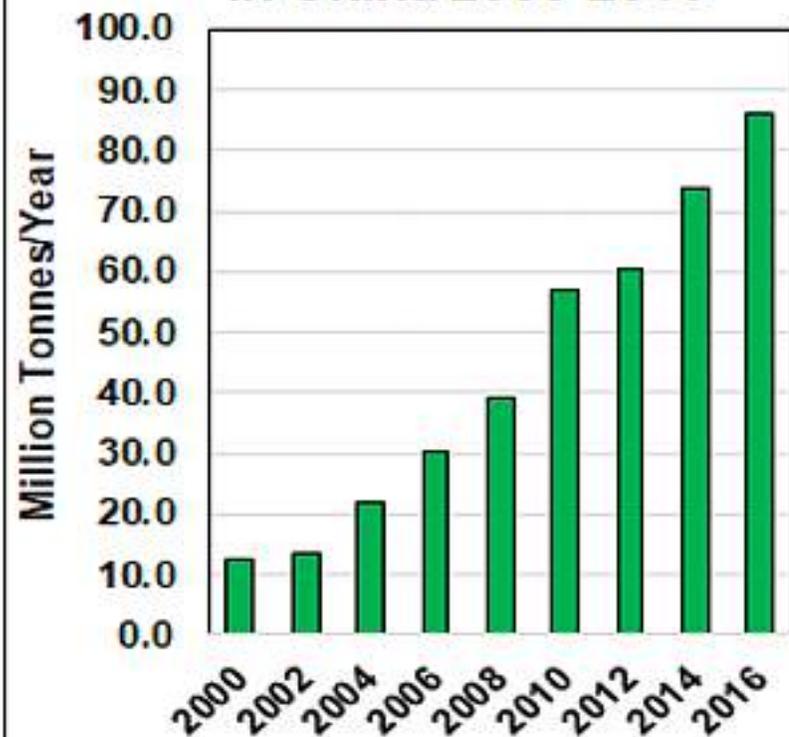
Net Imports of Crops in China 2000-2016

Million Tonnes/Year

■ Barley ■ Maize ■ Rice ■ Rapeseed □ Wheat □ Sorgum
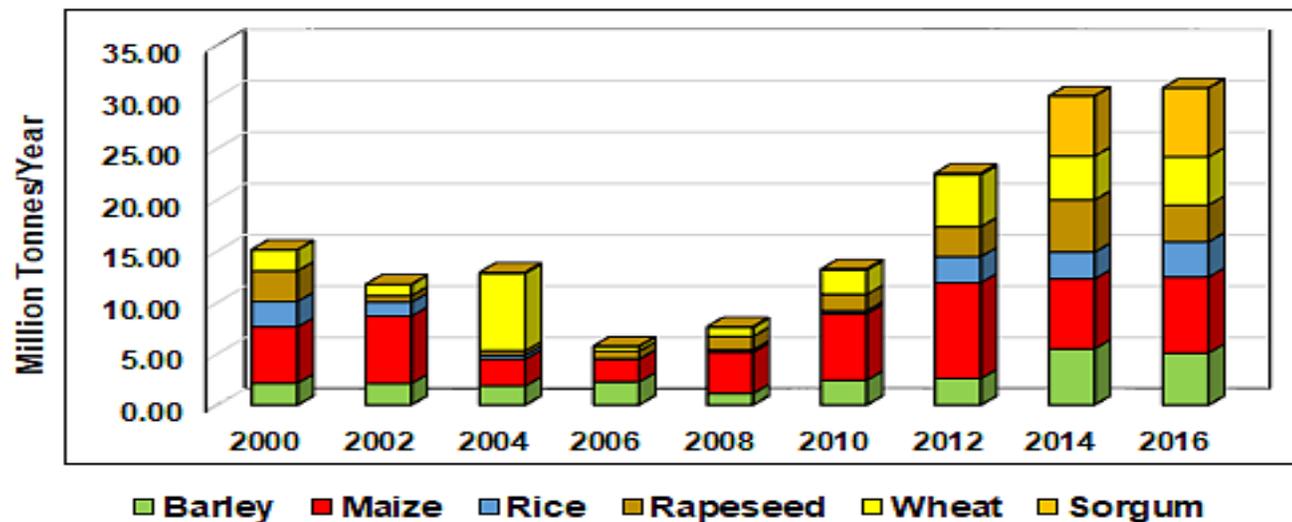
Net Imports of Livestock Products in China 2000-2016

Million Tonnes/Year

■ Beef □ Pork □ Chicken □ Sheep ■ Milk Dried
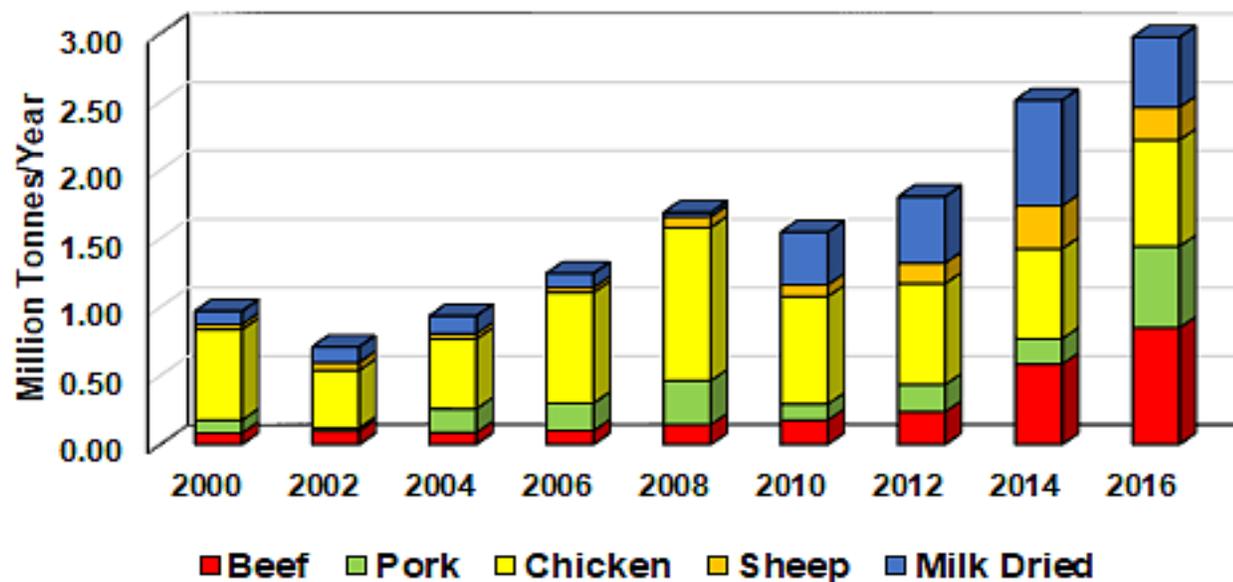
Changes in Chinese Imports 2006-2016

% of Global Trade Imported by China

	Sorghum	Soybeans
2006	1.7	32.3
2016	77.1	63.9

■2006 ■2016
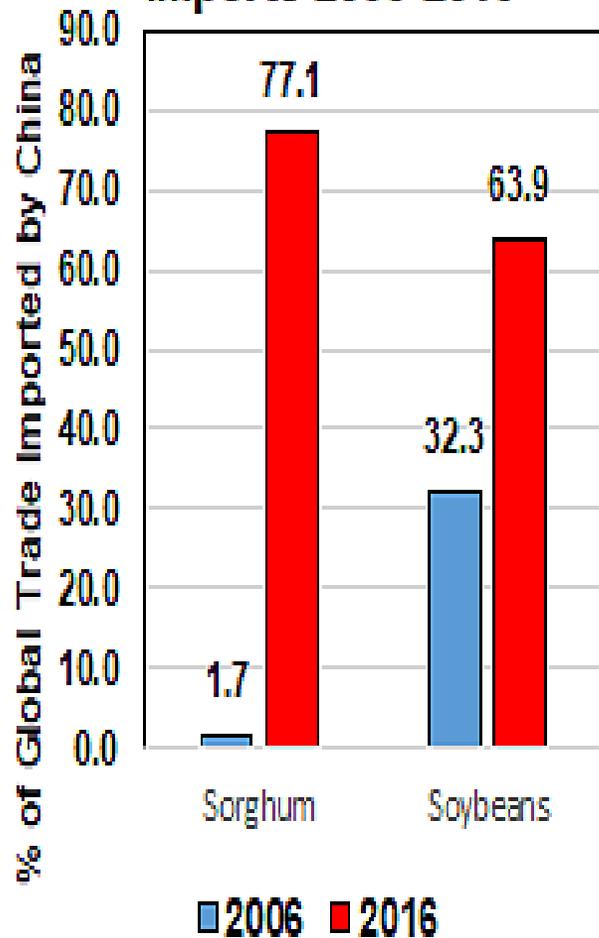
Changes in Chinese Imports as a % of Global Trade Between 2006 and 2016

% of Global Trade Imported by China

■2006 ■2016

	Sheep	Milk, dried	Rapeseed	Barley	Beef	Pork	Rice	Sugar Raw	Chicken	Maize	Bananas	Wheat
2006	3.8	6.0	7.0	9.4	1.7	3.9	0.2	5.5	2.8	2.3	2.3	0.4
2016	21.6	18.4	16.4	15.9	14.8	10.9	8.6	7.7	5.9	5.0	4.6	2.6
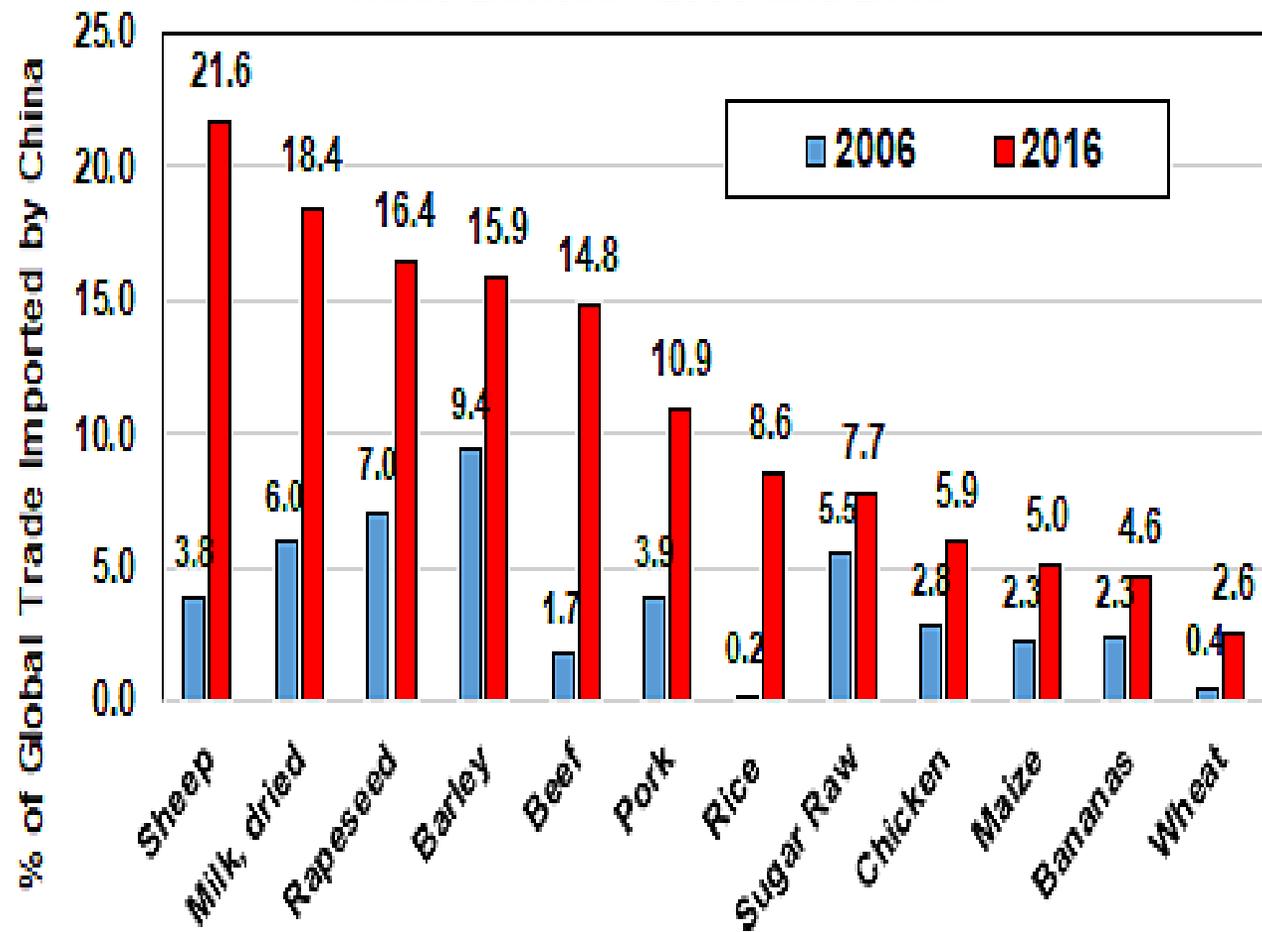
Water Requirements	
	m3/ton
Soybeans	2617
Sorgum	863
Sheep	5202
Milk, dry	4648
Rapeseed	907
Barley	848
Beef	12560
Pork	2211
Rice	1321

China Exports Crops with Low Water Requirements


Changes in Net Food Export by China 2000-2016

Low Water Requirements in m3/Tonne
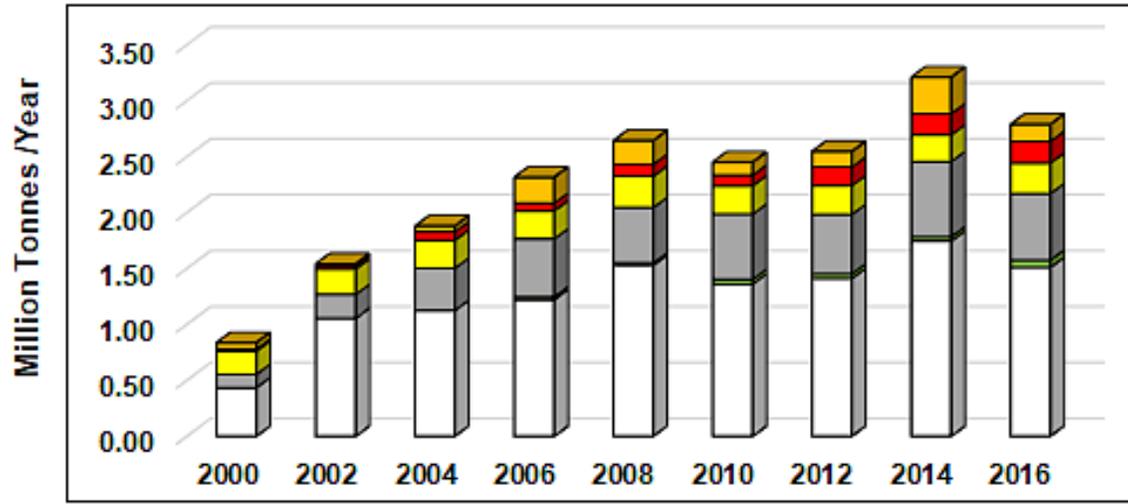
Garlic	Melons	Dry Onions	Tea	Tomatoes	Potatoes
365	113	245	High	168	276

Meat		Water Requirement for Food Produced in China						
		Crops High		Crops Moderate		Crops Low		
	m3 / tonne		m3 / tonne		m3 / tonne		m3 / tonne	
Beef	12560	Tea	11110	Rapeseed	907	Garlic	369	
Sheep	5202	Cotton	3210	Pears	866	Grapes	326	
Milk, dry	4648	Soybeans	2617	Sorghum	863	Potatoes	276	
Chicken	3652	Rice	1321	Barley	848	Onions, dry	245	
Eggs	3550	Peas, green	2188	Apples	803	Tomatoes	168	
Pork	2211	Beans, green	1867	Maize	801	Sugar Cane	117	
Milk	1000	Millets	1863	Tangerines	712	Melons	113	
				Wheat	690			

China's Slope Production Initiatives

Changes in Net Export of Fruit in China 2000-2016

803   700   800   866   712

Moderate Water Requirements in m3/Tonne
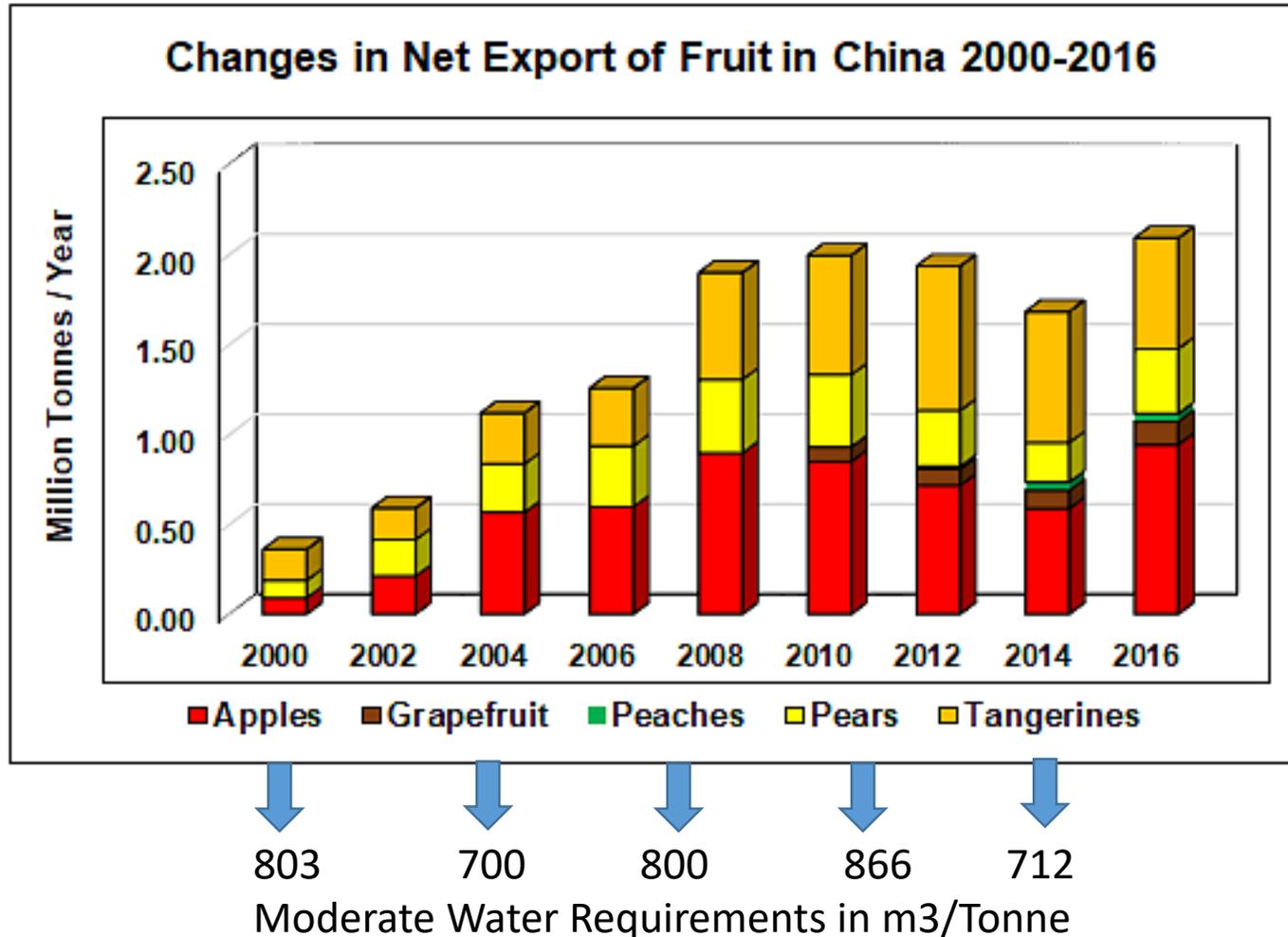
Changes in Virtual Water Imports Km3/Year			
Food Item	2000	2010	2016
Soybeans	32.79	149.70	225.7
Beef	1.04	2.23	10.69
Sorghum	0.02	0.09	5.79
Maize	4.40	5.19	4.92
Rice	3.28	0.34	4.55
Barley	1.79	2.05	4.28
Cotton	0.44	9.84	3.30
Rapeseed	2.69	1.13	3.23
Wheat	1.41	1.63	3.25
Chicken	2.42	2.87	2.84
Total	50.28	175.08	268.55

Changes in Virtual Water Imports by China 2000-2016

Legend: Soybeans, Beef, Sorghum, Maize, Rice, Barley, Cotton, Rapeseed, Wheat, Chicken
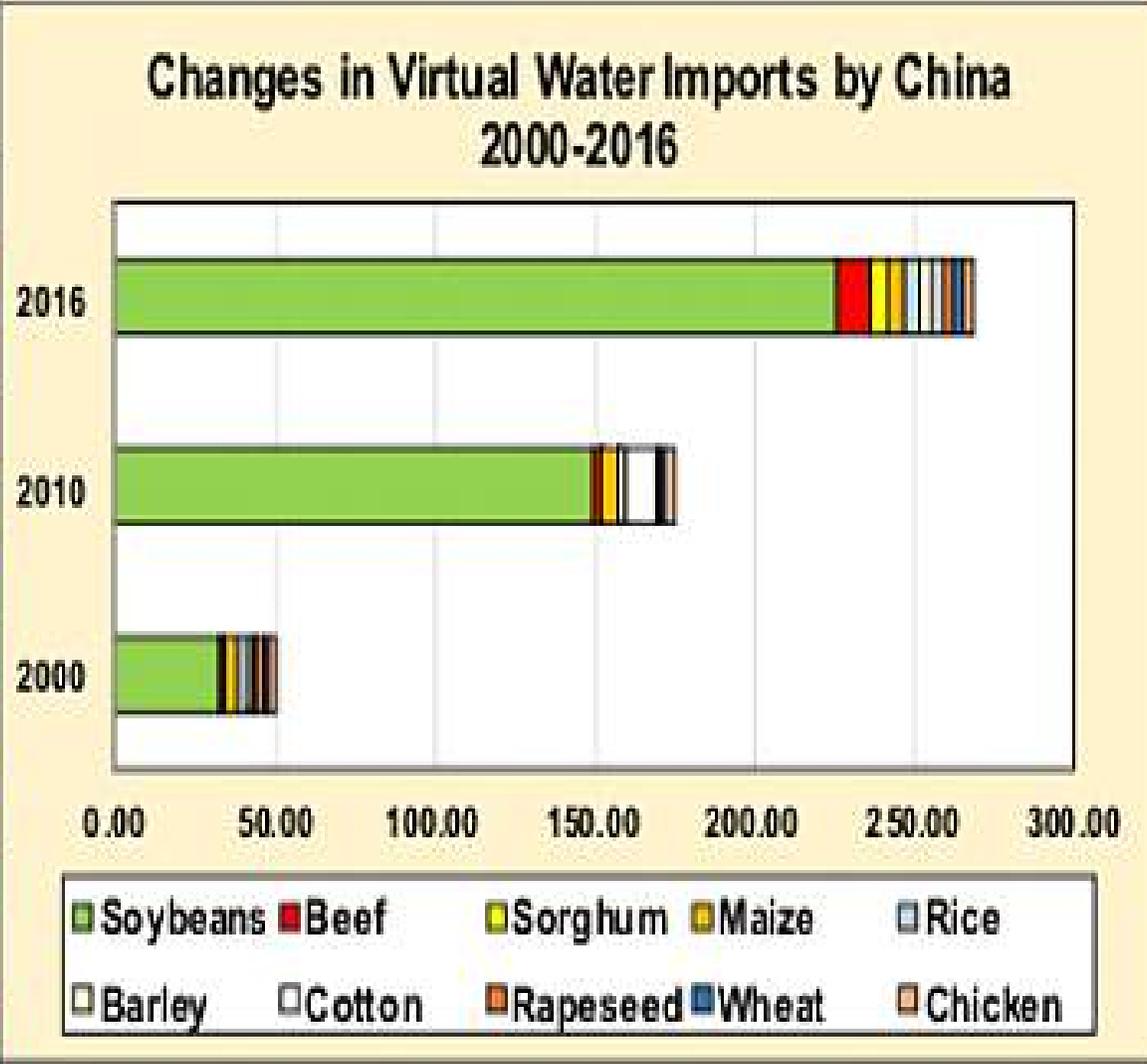
Estimated Water Use		Comparison
	Km3	
Domestic	69	4 Times
Industrial	133	2 Times
Agriculture	377	75% of Agric. Use
Total Use	579	
Virtual Water		
Imported	285	49% of Total Use

Middle East & North Africa (MENA Countries)

Changes in the MENA Population 2000-2050

Year	Population
2000	381
2010	461
2016	516
2013	624
2050	748
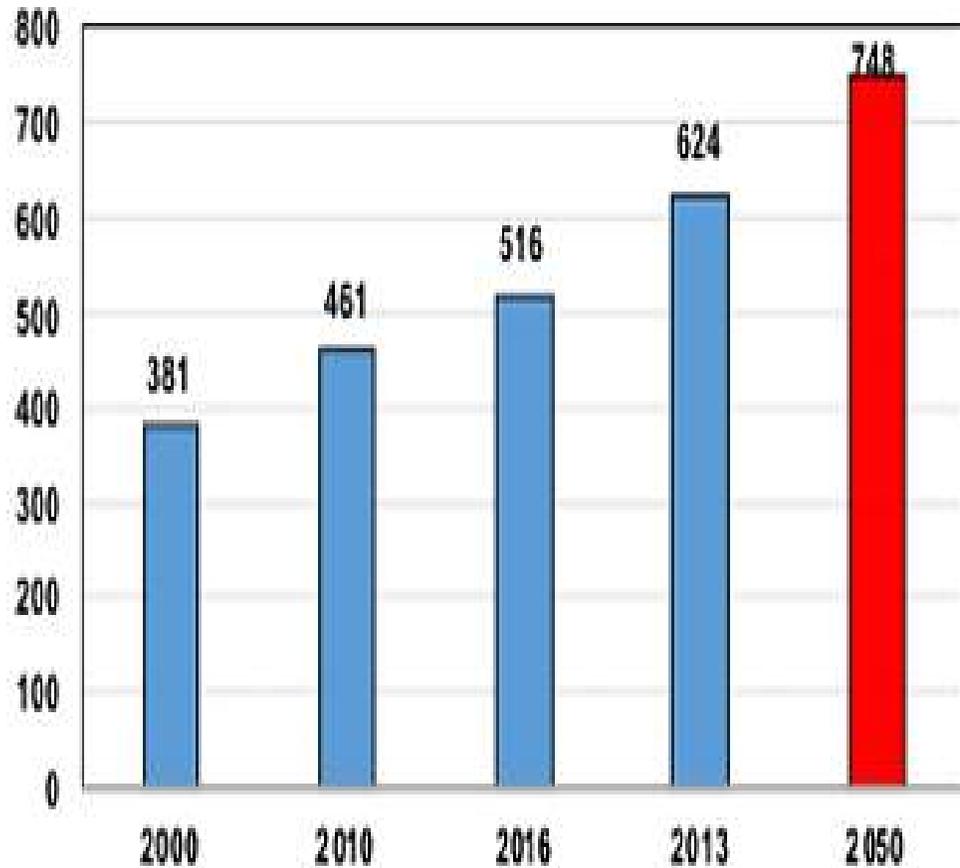
MENA Cuntries	
Algeria	Azerbaijan
Bahrain	Egypt
Iran	Iraq
Jordan	Kuwait
Lebanon	Libya
Morocco	Palestine
Oman	Qatar
Syria	Saudi Arabis
Tunisia	Turkey
UAE	Yemen

Arable Land/Person in MENA Countries 2016 & 2050
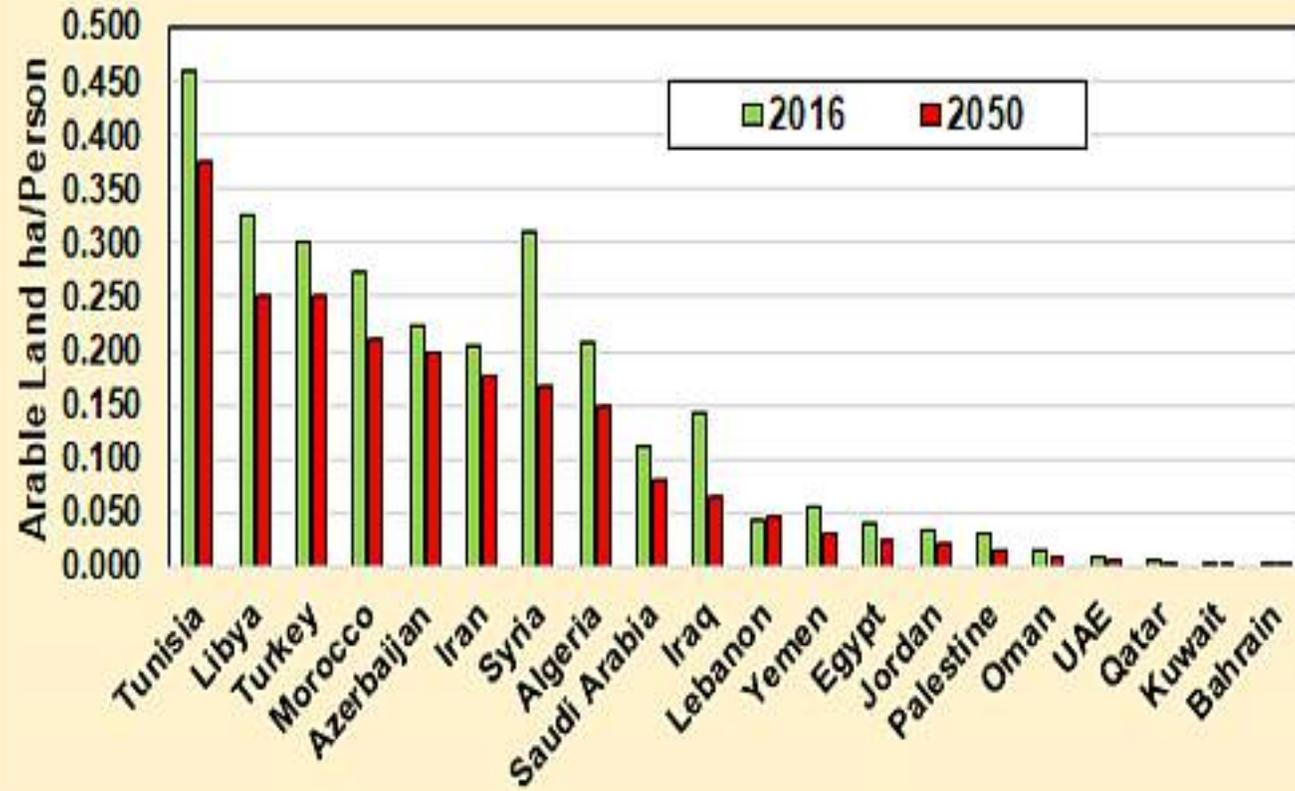
Wheat Consumption in Middle Eastern Countries 1993-2013

Legend: 1993, 1998, 2003, 2008, 2013

Y-axis: Kg/Capita/Year (0–400)

Countries: Algeria, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Morocco, Oman, Saudi Arabia, Tunisia, Turkey, UAE, Yemen
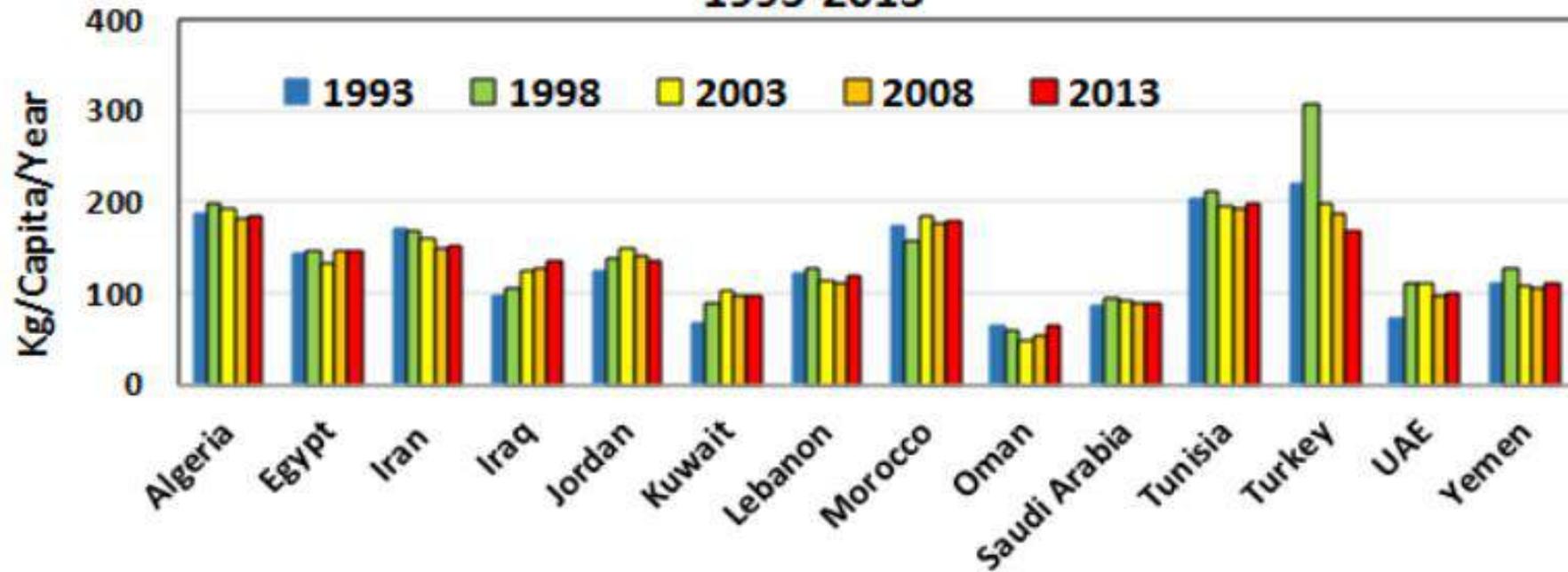
In 2013 the 19 MENA Countries Imported:

27 % of the Globally Exported Wheat
18 % of the Globally Exported Maize

% Of Freshwater used for Domestic, Industrial and Agricultiral Purposes
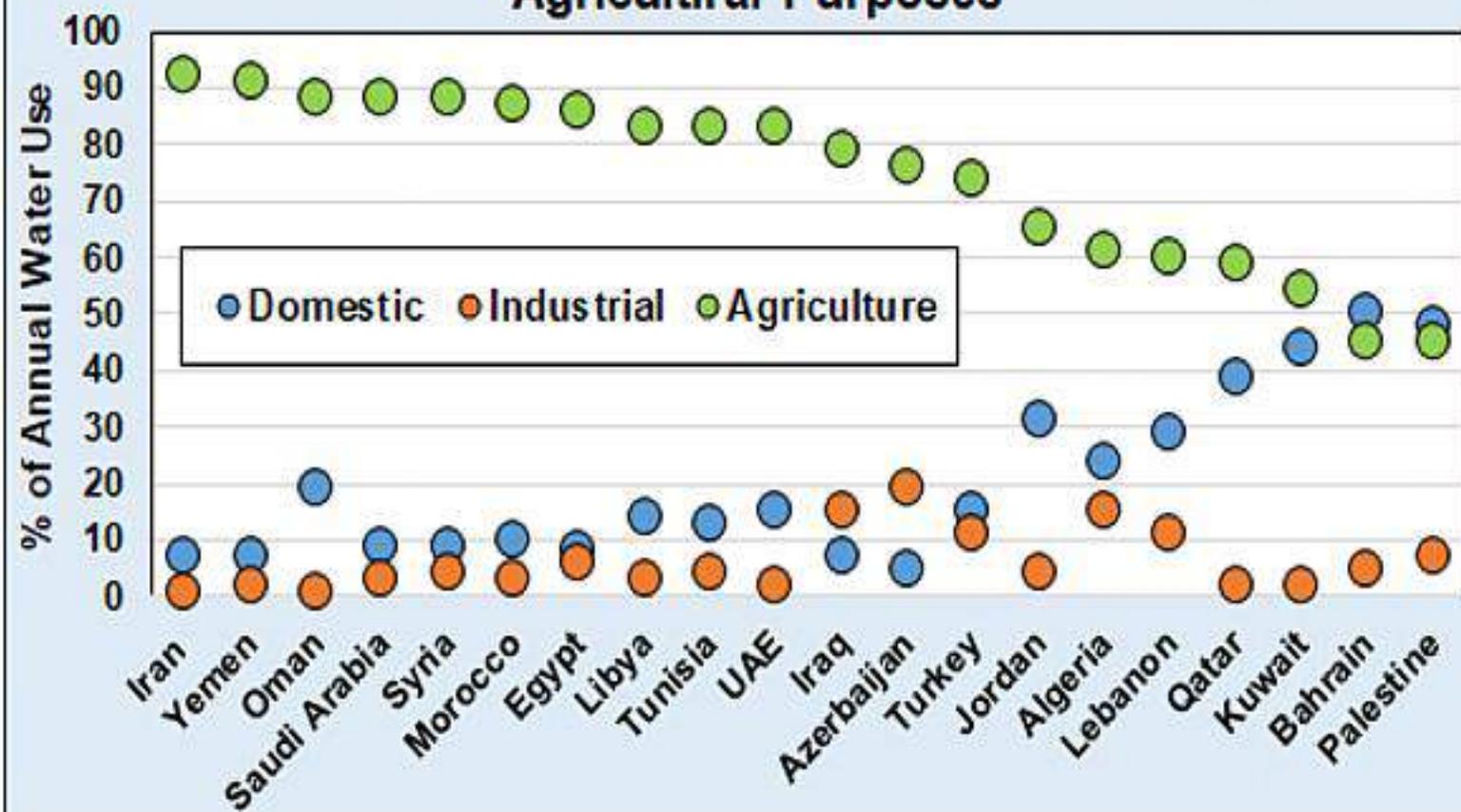
Wheat Production and Import Trends in 20 MENA Countries 1990-2016
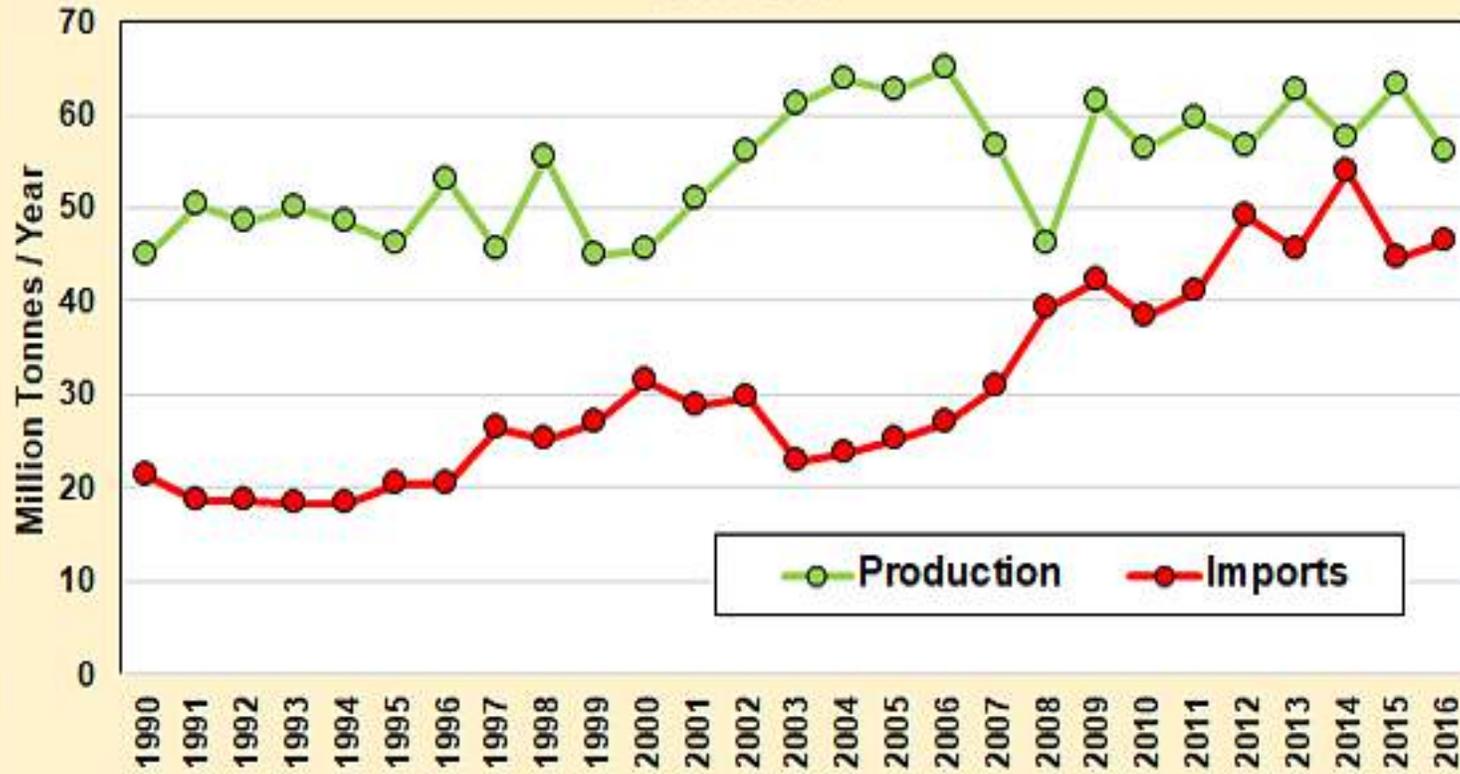
**% of Global Population and % of Global Imports in 2016 by the MENA Countries**

Category	Value
Population	7
Soybeans	4.5
Wheat	25.2
Rice	16.8
Maize	18.1
Sheep	16.8
Chicken	20.2
Beef	7.8

% of Global Imports in 2016
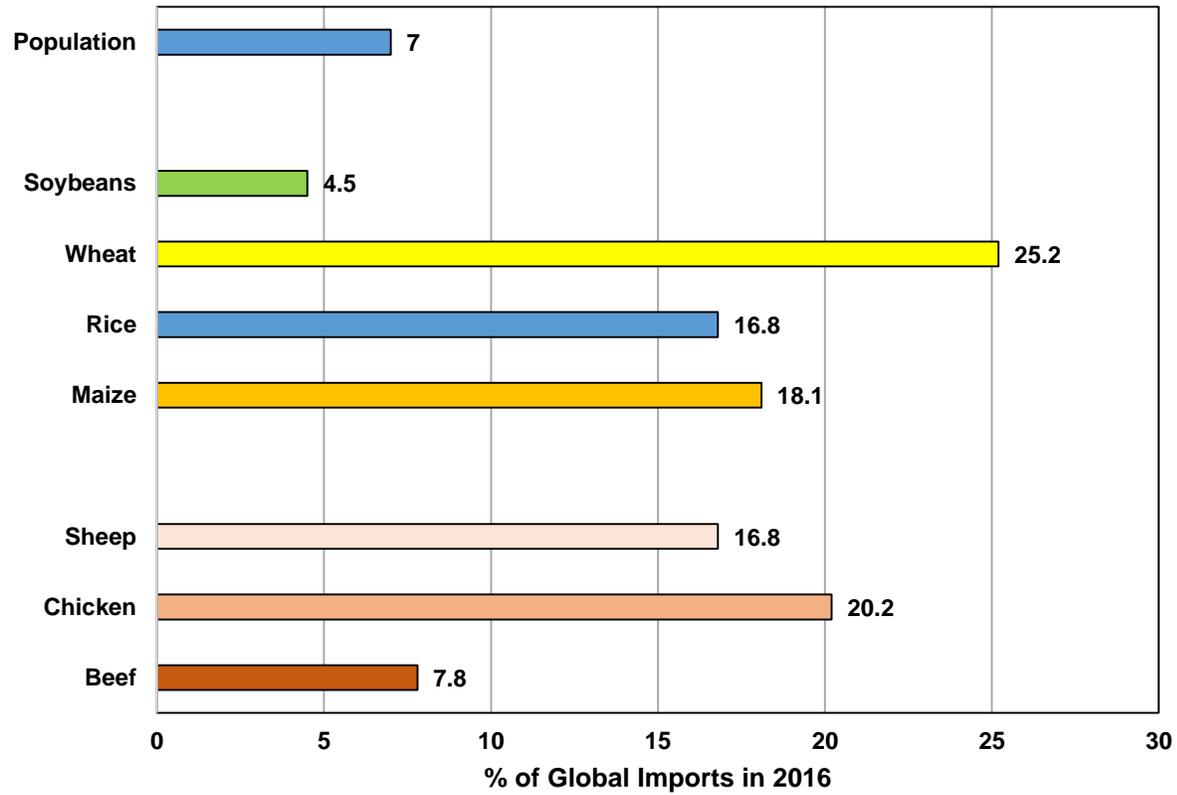
Projection Scenarios to 2050			
		Scenario A	Scenario B
	2016	2050	2050
Wheat	Million Tonnes		
Production	55.9	55.9	67.1
Imported	46.3	99.4	88.2
Total Wheat	102.2	155.3	155.3
Virtual Water		Km3	
Production	143.6	143.6	172.4
Imported	178.3	382.8	339.7
Annual H2O			
Withdrawals	359.1	359.1	359.1

The Case of Egypt

Changes in Wheat Production & Imports in Egypt 1990-2016
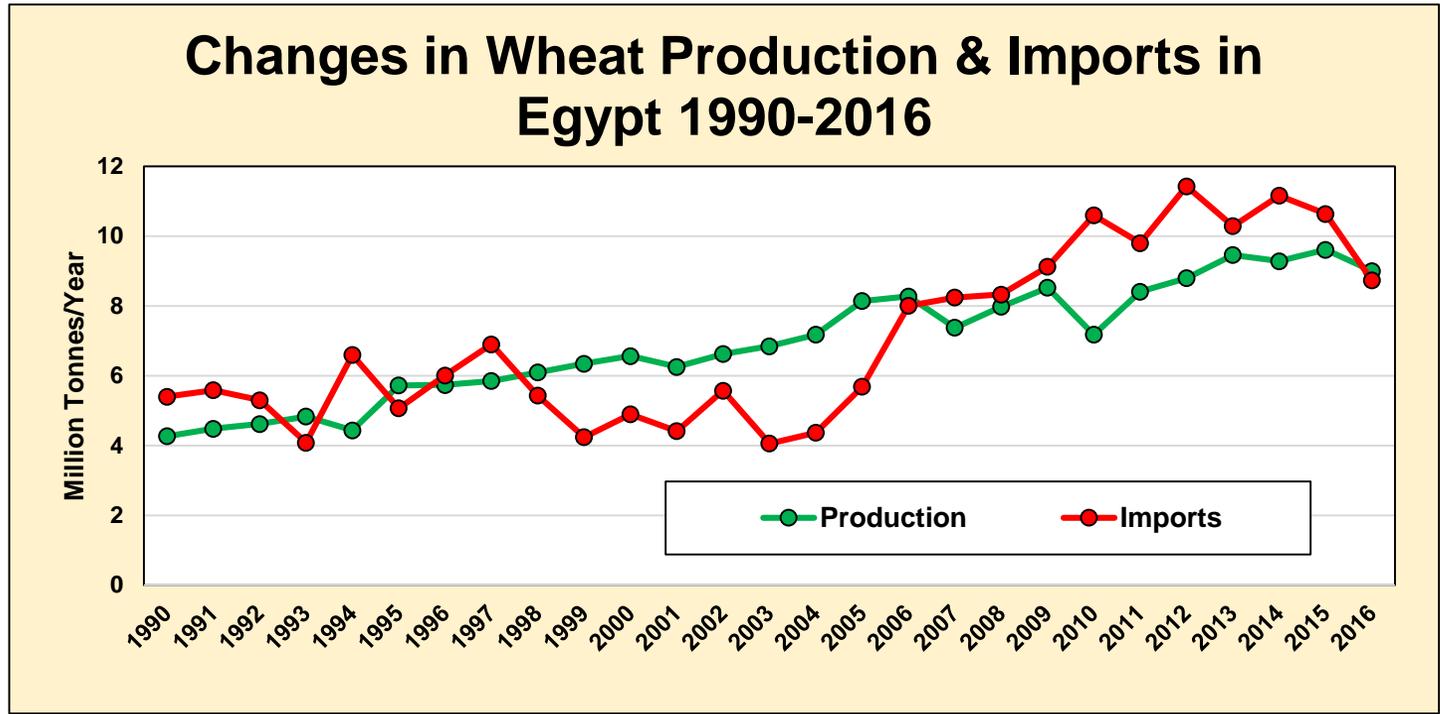
Annually Available Water in Egypt in 2016: 68.3 Km3
Virtual Water Imported in Wheat in 2016 :   8.1 Km3 = 12% of Available Water
Virtual Water Imported in Wheat in 2050 :   13.1 Km3 = 19% of Available Water (BAU)

Virtual Water Imported in Maize in 2016 :   6.1 Km3 = 9% of Available Water
Virtual Water Imported in Maize in 2050 :   13.0 Km3 = 19% of Available Water (BAU)

VW in Wheat and Maize Imports = 21% of available water but 38% of in 2050 (BAU)

**Maize Production & Imports in Egypt** — Production, Import (Million Tonnes/Year, 2000–2016)

Wheat Production & Imports in Egypt — Production, Import (Million Tonnes/Year, 2000–2016)

Soybean Production & Imports in Egypt — Production, Import (2000–2016)

Potatoe Production & Exports in Egypt — Production, Exports (Million Tonnes/Year, 2000–2016)

Rice Production & Exports in Egypt — Production, Exports (2000–2016)

Rice Imports and Exports in Egypt 2000-2016 — Rice Imports, Rice Exports (Tonnes/Year, 2000–2016)

Egypt

Annual Water Withdrawals	68.3 Km3
Virtual Water Imported	28.2 Km3
Domestic Water Used	5.5 Km3

Virtual Water = 40% of Annually Used Water

5 Times more Water than Domestic Use

Population in 2016   96 Millions
Projected Population 2050   154 Millions

Arable Land / Person in 2016   0.03 ha
Arable Land / Person in 2050   0.03 ha

Case Study Saudi Arabia

Population in 2016 = 32.3 Millions
**Population in 2050 = 45.1 Millions**

Arable Land / Person in 2016 = 1.10 ha / Person
Arable Land / Person in 2050 = 0.07 ha / Person

Wheat Production, Imports & Exports in Saudi Arabia 1980-2016
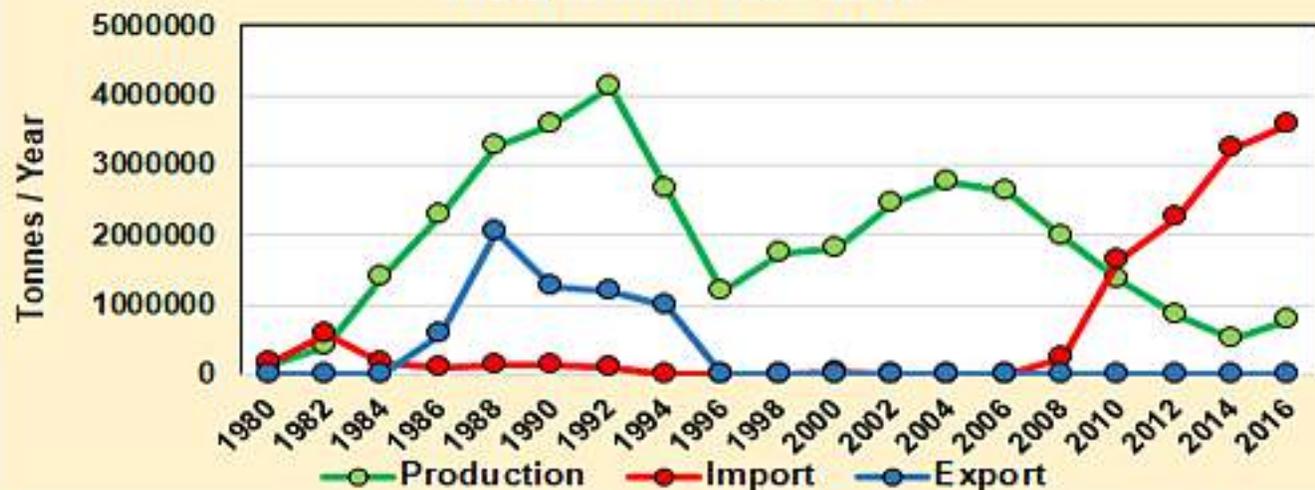
Maize Production, Imports & Exports in Saudi Arabia 1980-2016
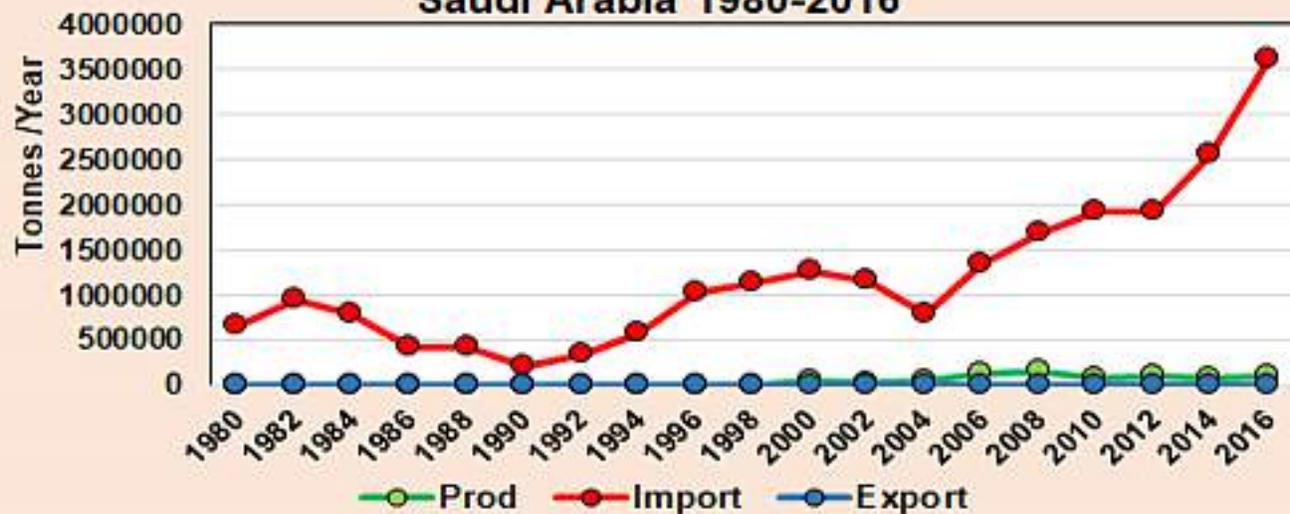
Saudi Arabia

Annual Water Withdrawals	23.7 Km3
Virtual Water Imported	31.8 Km3
Domestic Water Used	2.1 Km3

**Virtual Water = 25% More than Annually Used Water**

16 Times more Water than Domestic Use

Estimated Desalinated Water Available = 1.1 Km3/Year

**By 2050 the Reliance on Food Imports will increase by 39%
In a Business as Usual Scenarios**

MENA Regional Summary

% of Imported Virtual Water (RED) versus Annual Water Withdrawals (Blue) in the MENA Countries (Numbers = km3 of Water / Year in 2016)

Country	Virtual Water Imported	Annual Water Withdrawals
Jordan	8.1	0.9
Algeria	43.8	5.7
Qatar	2.6	0.4
UAE	20.7	4
Kuwait	4.3	0.9
Bahrain	1.5	0.4
Palestine	1.5	0.4
Lebanon	4.0	1.3
Oman	3.7	1.3
Tunisia	7.5	2.9
Yemen	6.9	3.6
Saudi Arabia	31.8	23.7
Morocco	16.0	12.6
Libya	4.2	4.3
Turkey	30.5	40.1
Egypt	28.2	68.3
Iran	22.6	93.3
Azerbaijan	2.5	12.2
Iraq	13.5	66.0
Syria	3.0	16.8

■ Annual Water Withdrawals ■ Virtual Water Imported

| Regional Projection to 2050		
		Scenario BAU
	2016	2050
Wheat	Million	Tonnes
Production	55.9	55.9
Imported	46.3	99.4
Total Wheat	102.2	155.3
Virtual Water	Km3	Km3
Production	143.6	143.6
Imported	178.3	382.8
Annual H2O		
Withdrawals	359.1	359.1
Imported VW as a %		
of Available Water	49%	106%

	2020 - 2029	2090 - 2099
Low Emission Scenario B1 = 1.8 °C		
Moderate Emission Scenario A1B = 2.8°C		
High Emission Scenario A2 = 3.4°C		
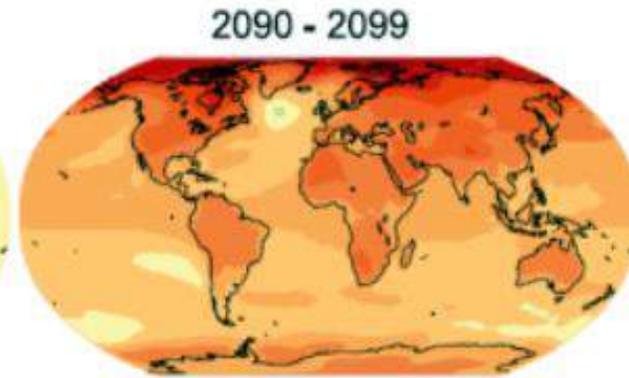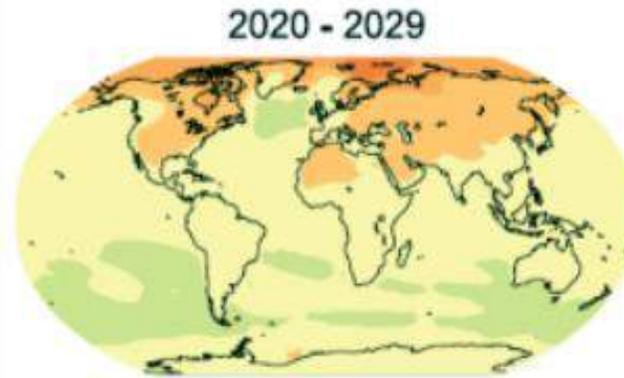
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5

©IPCC 2007: WG1-AR4
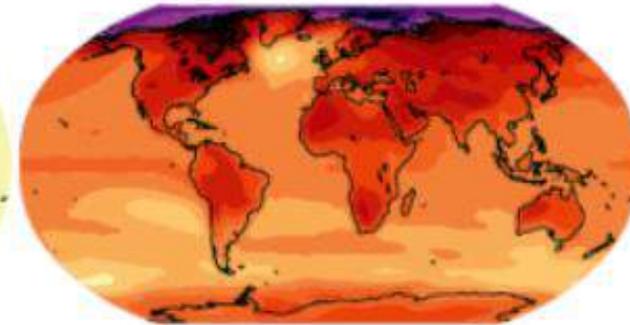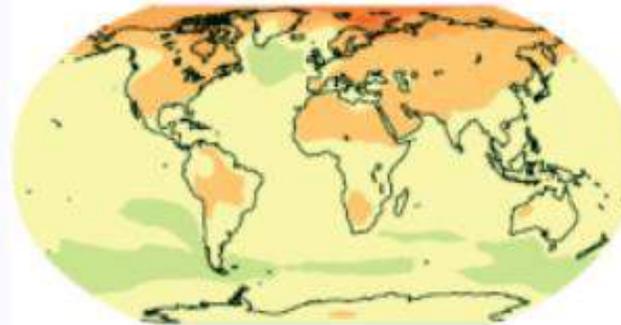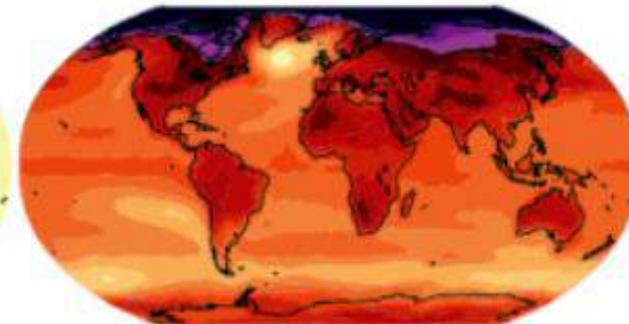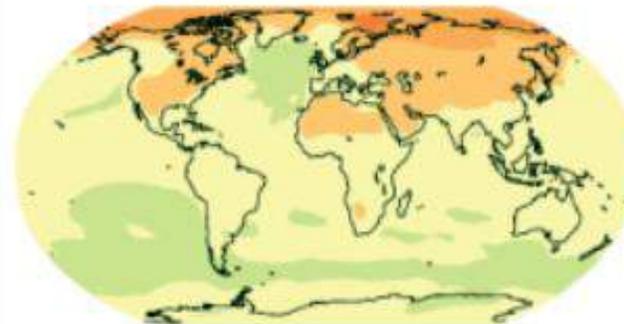
Precipitation Projections to 2099
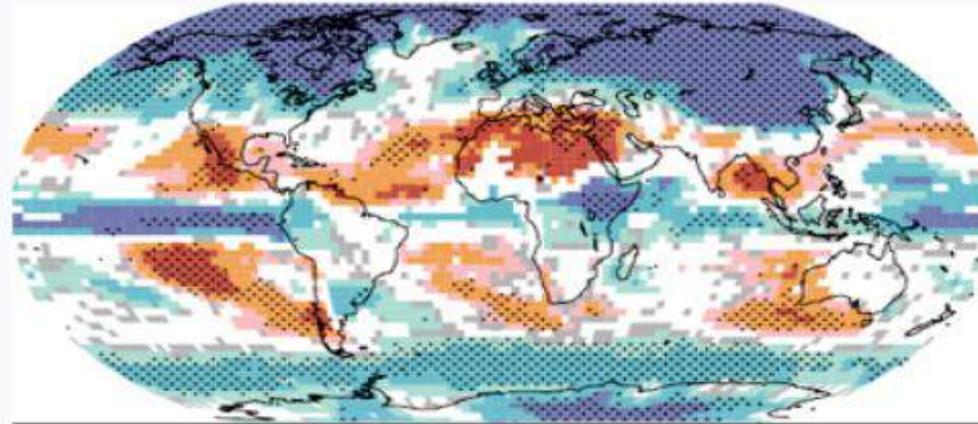
A1B High Emission Scenario

Dec-Feb
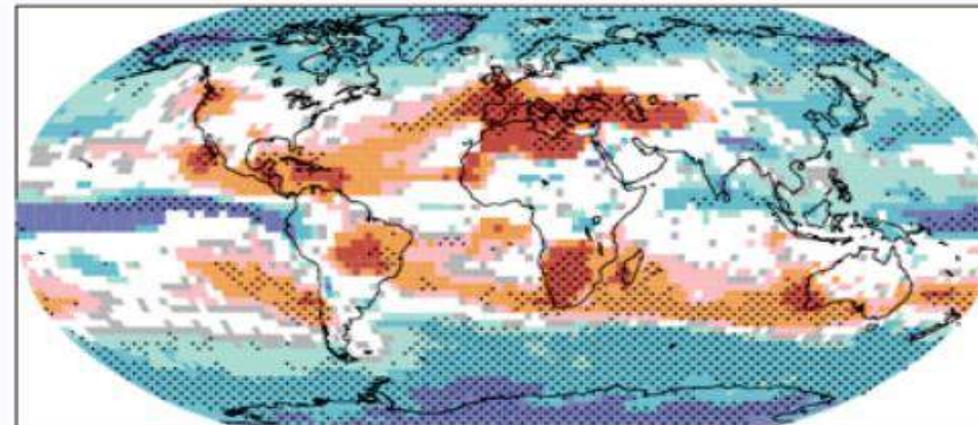
Jun-Aug

Note:
Arab Middle East

A 20% Reduction in Precipitation

%   -20   -10   -5   5   10   20

Green Water Management:
Holding back the runoff from rainfall to infiltrate into the soil is sufficient to grow a crop of barley in Egypt

According to NOAA 3220 Record High Temperature Were Broken in June & July 2018

GFS/CFSR 1-day Avg
1979-2000 base

2m T Anomaly (°C)
Monday, Jul 23, 2018

ClimateReanalyzer.org
Climate Change Institute | University of Maine
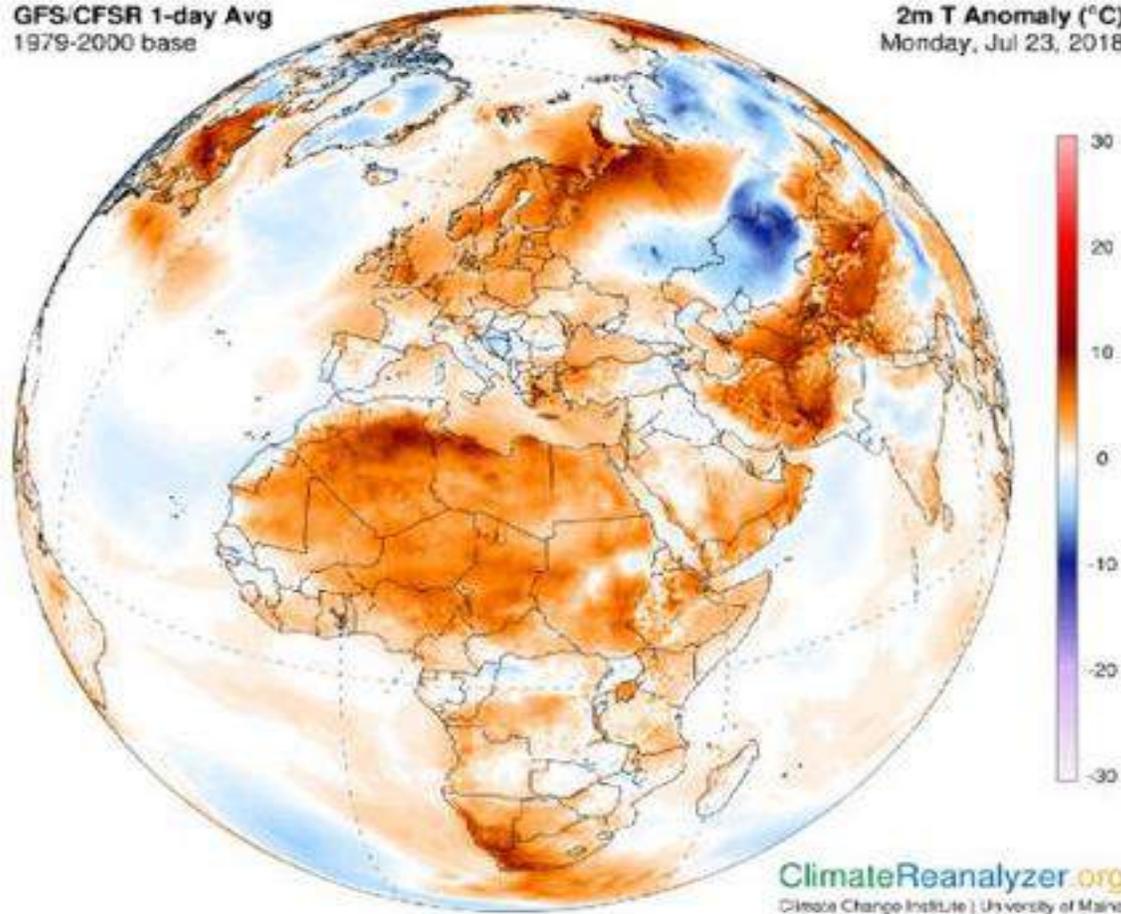
Worst Case Scenario for a Drought

High Temperatures
Low Precipitation
Low Moisture Holding Capacity in Soil
Over Extended Time Period

Maintain Mean Warming below 2 Degrees ====   Challenge: Worry about Extremes Events

# Regional Concentration of Crop Production Destined for Export.
The Increase in Extreme Climatic Events Increases the Global Food Security Risk

State	Million Bushels
New Jersey	10.0
Oklahoma	17.1
South Carolina	21.5
Delaware	23.7
California	27.8
Washington	28.1
Alabama	28.5
Virginia	40.1
Georgia	42.7
Maryland	46.9
North Carolina	68.5
Arkansas	73.8
Louisiana	77.0
New York	82.5
Mississippi	94.7
Tennessee	96.3
Pennsylvania	106.6
Texas	136.7
Colorado	172.5
Kentucky	180.7
North Dakota	216.3
Michigan	335.1
Missouri	350.0
Kansas	449.4
Ohio	508.8
Wisconsin	517.9
South Dakota	653.4
Indiana	836.5
Minnesota	1201.2
Nebraska	1536.0
Illinois	1946.8
Iowa	2356.4

Corn for Grain 2011
Production by County
for Selected States

2011

Bushels
- Not Estimated
- < 1,000,000
- 1,000,000 – 4,999,999
- 5,000,000 – 9,999,999
- 10,000,000 – 14,999,999
- 15,000,000 – 19,999,999
- 20,000,000 +

U.S. Department of Agriculture, National Agricultural Statistics Service

USDA

## 48% of all Maize exported globally comes from the Green Area

Regional Concentration of Crop Production Destined for Export.
The Increase in Extreme Climatic Events Increases the Global Food Security Risk

State	Million Bushels
Texas	1.7
Georgia	3.0
New Jersey	3.2
Oklahoma	3.4
Delaware	6.6
South Carolina	9.0
Alabama	9.7
New York	11.9
Maryland	17.9
Virginia	21.5
Pennsylvania	21.6
Louisiana	34.3
Tennessee	40.0
North Carolina	40.8
Kentucky	57.7
Mississippi	70.2
Wisconsin	73.6
Michigan	85.4
Kansas	101.3
North Dakota	112.6
Arkansas	124.3
South Dakota	150.6
Missouri	189.8
Ohio	215.7
Indiana	238.1
Nebraska	258.4
Minnesota	270.3
Illinois	416.4
Iowa	466.1

Soybeans 2011
Production by County
for Selected States

2011

Bushels
Not Estimated
< 250,000
250,000 - 749,999
750,000 - 1,999,999
2,000,000 - 3,999,999
4,000,000 - 7,999,999
8,000,000 +

U.S. Department of Agriculture, National Agricultural Statistics Service

USDA

45% of all Soybeans Exported Globally come from the Green Area

Change in the % of Global Export in Maize & Soybeans from the USA 2000-2013
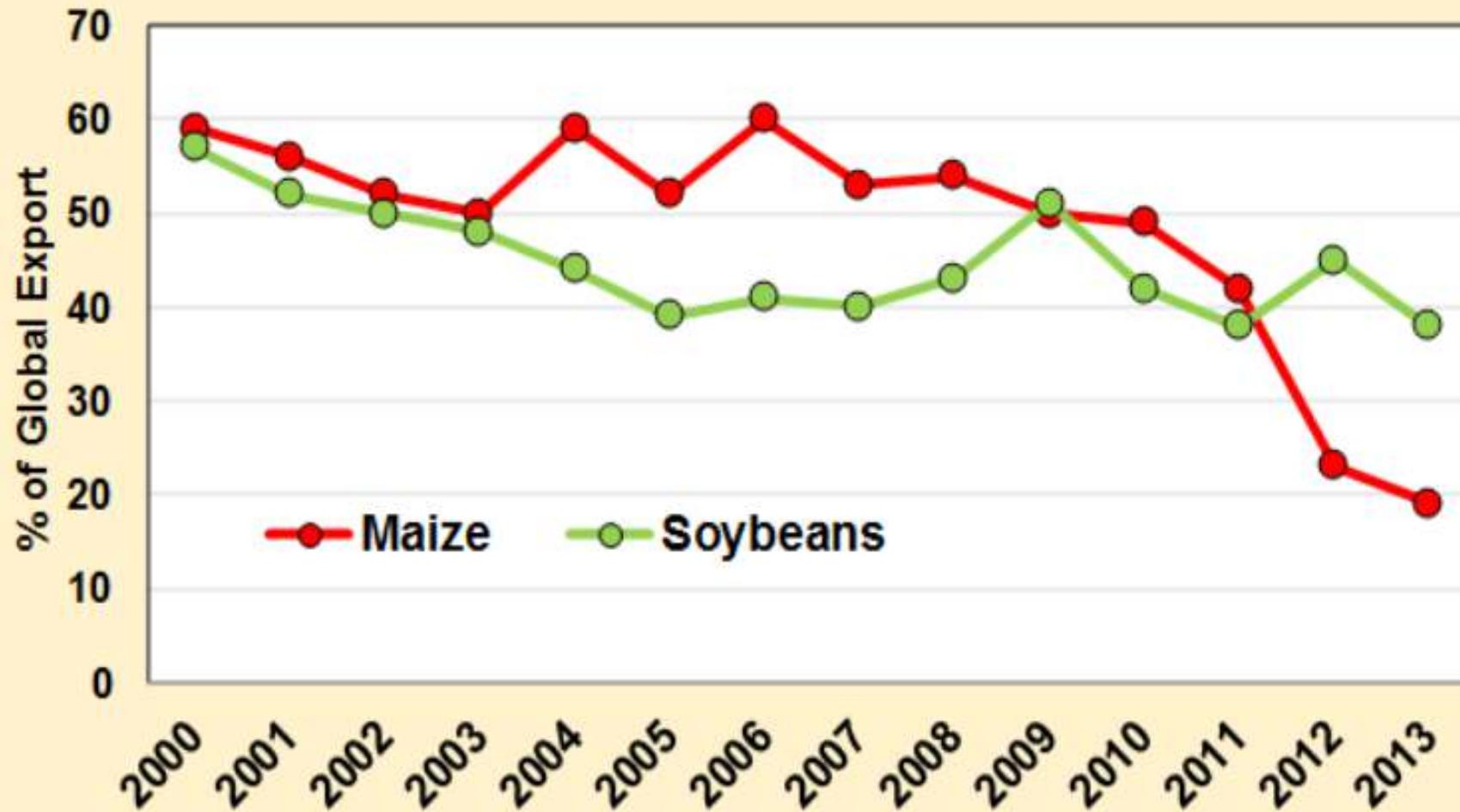
Other USA Export

% Of Global Export in 2013

Chicken 28%
Pork 22%
Beef 13%

Wheat 20%

Water Requirements for Crops used for Biofuel Production

Water Requirement for different Crops used for Biofuel (Ethanol & Biodiesel) m3/Tonne

m3/ Tonne

- Sugar Cane: 155
- Sugar Beets: 63
- Maize: 353
- Wheat: 1491
- Soybeans: 1203
- Rapeseed: 1765
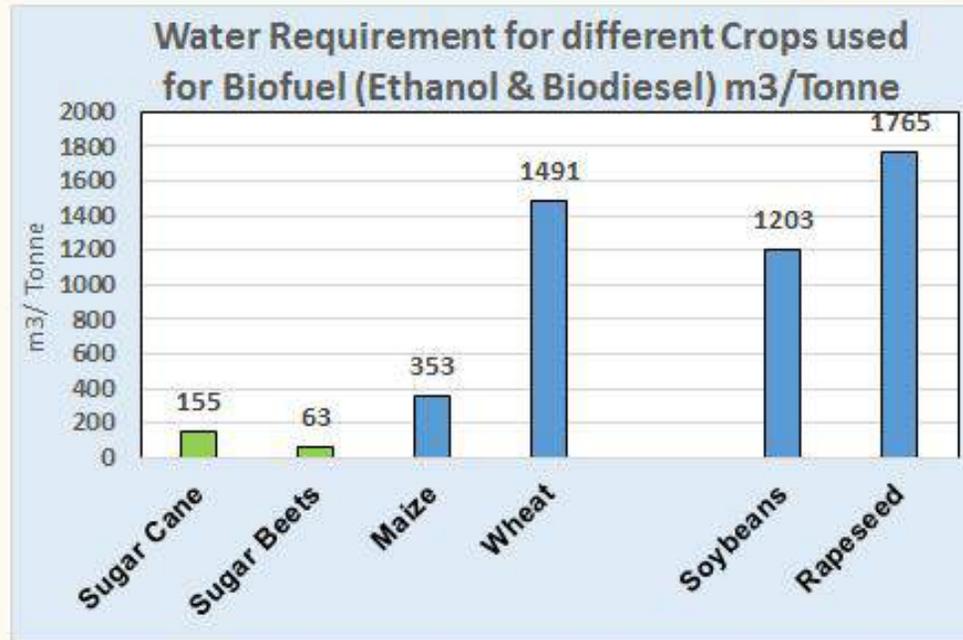
% of Global Export from Canada from 2 Provinces
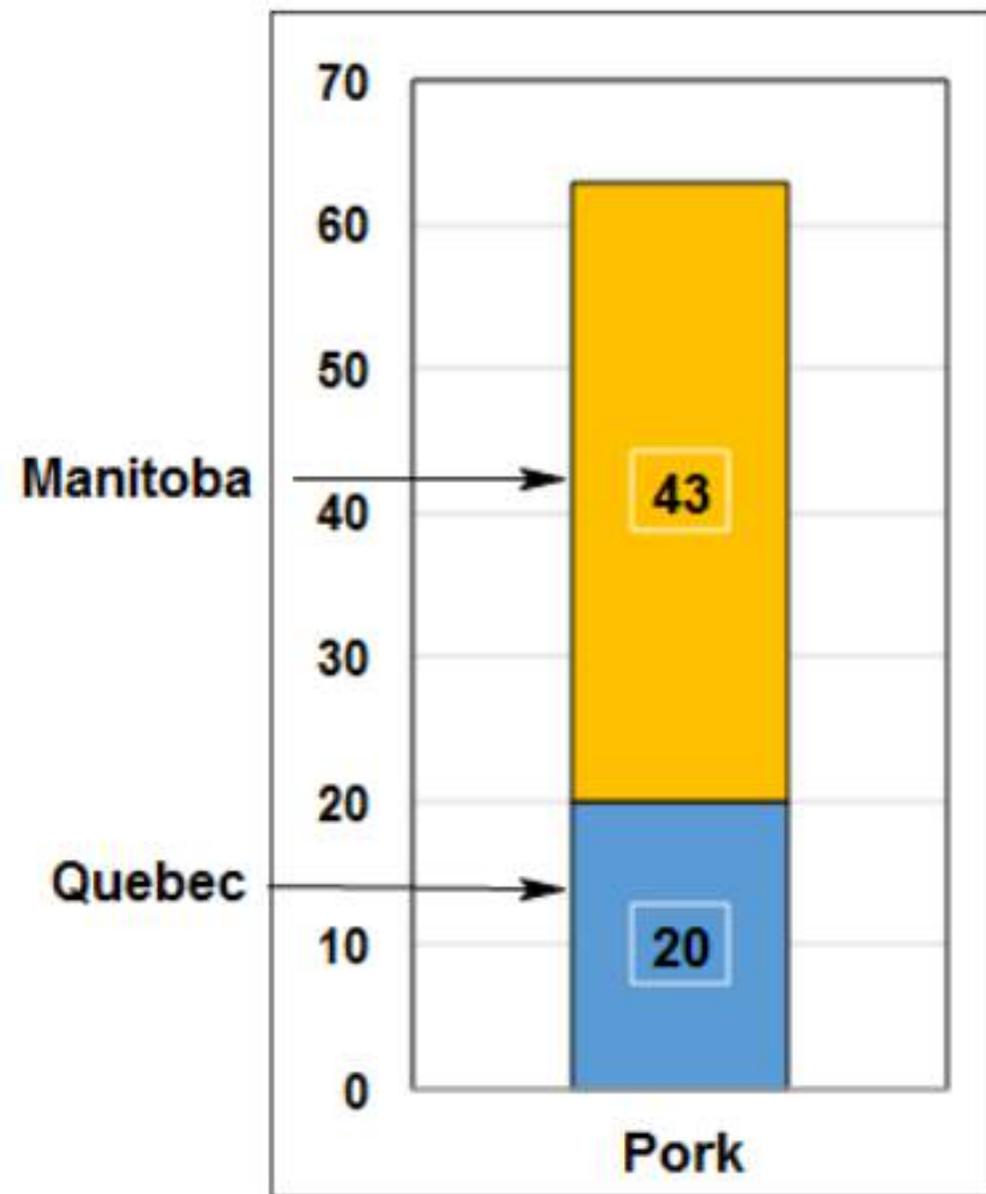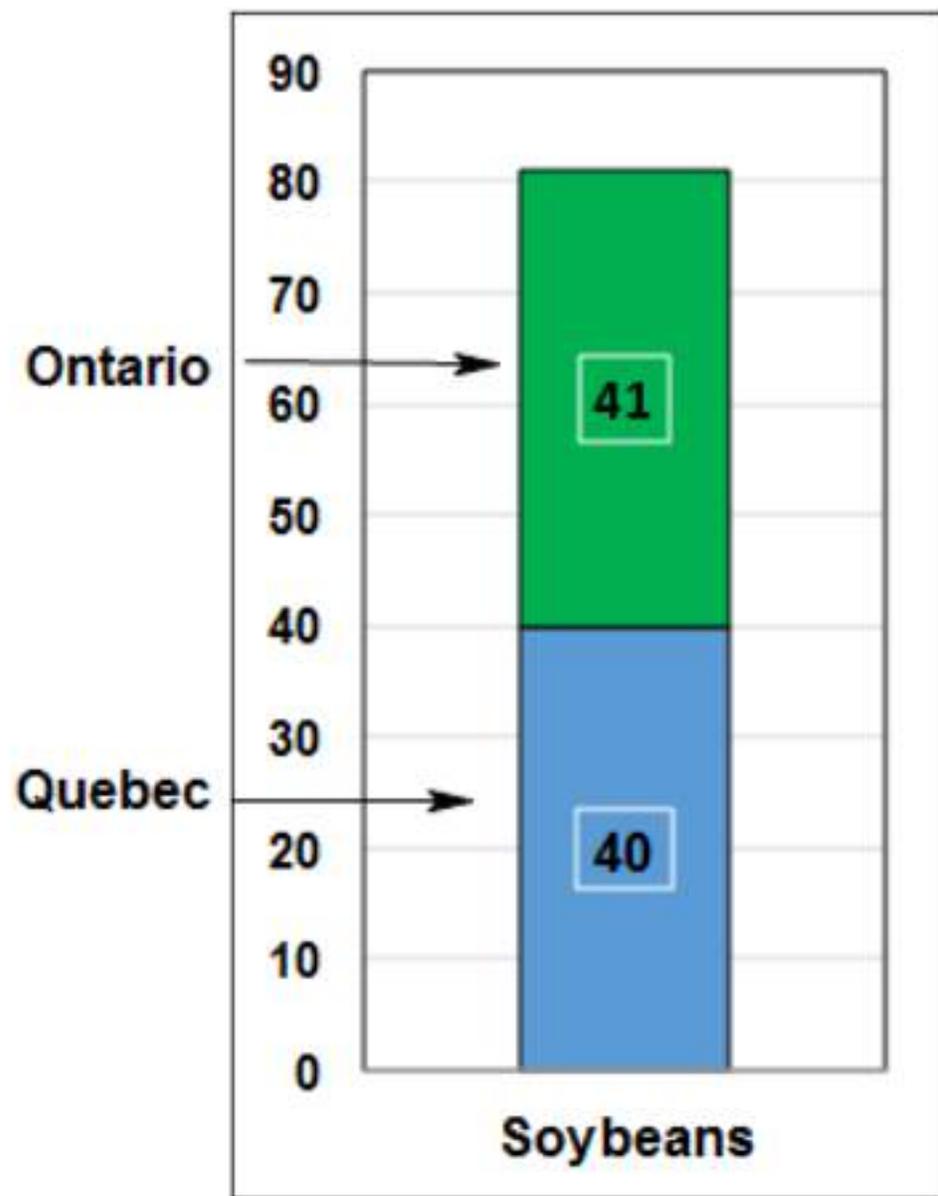
Summary:

Canada has an opportunity and responsibility to play a key role in food export

Canada's Priority for Food Exports should be on:

1. Growing water efficient crops of high value & low environmental impact

2. The value of water can become a good indicator of what to export

3. Diversify crops for export as a hedge against increased climatic variability (droughts and floods)

4. Reduce meat production for exports (particularly beef) because........

For More on Virtual Water See: http://wmc.landfood.ubc.ca/webapp/VWM
http://blue-economy.ca/reports/better-by-the-drop

Reasons to Reduce Meat Consumption

It saves Large Amount of Water ⟶ Beef: 15000 L /kg, Chicken 3700 L/kg

Reduces Widespread Water Pollution ⟶ Eutrophication: 80% from Cattle

Reduces Greenhouse Gases ⟶ 4% of GHG from Cattle (8% Agricult.)

Least Efficient Way to Grow Food ⟶ Low conversion of Feed to Meat

Health Issues Eating too Much Meat ⟶ Obesity Problem in North America

For More on Virtual Water See: http://wmc.landfood.ubc.ca/webapp/VWM

http://ubclfs-wmc.landfood.ubc.ca/webapp/VWM