Lomonosov Moscow State University
Business School

Global Limits of Economic Growth

Lomonosov Moscow State University,
Inter-Departmental Course, 2023-2024, Spring Fall

Course Reader:

Evgeniya Anatolyevna Shvets, PhD.

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Requirements to Pass the Course

1) No less than 50% of sessions are attended (6 out of 12)

2) Individual Project is done properly and delivered in time, i.e. before the end of the course

3) There are no less than 60% of points for the final course test
   - The test will be in Moodle, logins & passwords will be sent in advance to all subscribed students
   - May,8th is supposed to be the final course day. There will be a notification through your personal accounts in the MSU Learning Management System.

General Scheme for Resource Limitations Analysis

Scheme for the Individual Project (1-2 students per 1 project)

Resources	Steps of Analysis					
	Step 1	Step 2			Step 3	Step 4
	Role/ Importance	Limitations produced for			Ways used to overcome existing limitations	Suggestions how to improve these ways of coping with limitations
		World economy	National economy	Industries/ Business		
Unique Resource or Problem selected by you *Scale: world or a country or an industry*	...	...	...	...	...	...

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"Global Limits of Economic Growth"

2023/2024 academic year, spring semester

Module Teacher: Evgeniya Anatolyevna Shvets, Ph.D.

Module teacher's contact details: e.shvets.mgubs@gmail.com, also available for consultations on the day of sessions.

Guidelines for Individual Projects

- ✓ Individual Projects can be made by 1 or 2 students.
- ✓ The electronic final version of the presentation should be sent to the teacher. The last day to do it is the last day of the course when there is a final test. Follow this information from Administration announcements at your personal accounts.

Country or Industry Analysis of Economic Growth Limitations

I. Presentation parameters

- Up to 6-10 slides of Power Point Presentation or up to 2 pages A4 of Word. Better to deliver it in PDF format.
- First slide: title of the project, course title, your name, your department
- Make all necessary references and quotes
- Illustrate your presentations with statistical data, diagrams, schemes or pictures

II. Defining a country and resources for the presentation

- Each student (or 2) selects **one country for the analysis** taking into consideration teacher recommendations. Countries should not be repeated among students.
- For the country selected a group defines **4 types of natural resources representing the greatest interest and priority for the country**. The resources types include the following: Ecology, Climate, Energy, Population, Land Use, Agriculture, Food Production, Water and other types of natural resources that were not covered by the course.
- **Put the list of your resource priorities** in terms of business growth limitations **in accordance with priorities of UN Development Sustainable Goals (DSG) for the specific country/industry.** (http://www.un.org/sustainabledevelopment/sustainable-development-goals/).

III. General Presentation Scheme

#	Resources	Steps of Analysis			
		Step 1	Step 2	Step 3	Step 4
		Importance of the resource for a country/industry	Limitations produced	Ways used to overcome existing limitations	Your suggestions how to improve the situation
	Resource …	…	…	…	…

IV. Steps of Analysis for Each Resource Type

Step 1: An economic role/importance of the resource in the economy of the country (*… is a unique type of resource for the country because it provides … (% GDP, % of industrial output …*). Try to find something peculiar about this kind of resource for your country, compare it with the situation of neighbor countries or international standards whether it's appropriate.
Step 2: Different kind of limitations (problems, risks) that are produced or can be produced by these resources on a national level and on a level of different industries that limit economic growth.
Step 3: Ways how countries are overcoming these limitations (public policy: laws, measures, special instruments, regulation forms, what is reflected in different kind of strategies; adaptation or mitigation schemes, risk management).
Step 4: Your suggestions/recommendations how the current country policy about overcoming resources limitations can be improved (see successful stories of other countries and international experience to formulate your suggestions).

V. Suggestions about resources description

1. **Ecology** (*suggestions:* find some key-information about the ecological situation of the country, pollution level, main sources of pollution, ecological policy, special ecological standards in this country, any ecological ratings in which the country was participating, ecological footprint of the country, ecological catastrophes/disasters on its territory if any, damage evaluation, what was done by the government and companies to minimize this damage, etc.).
   Useful links:
   - http://beta.worldbank.org/climatechange/
   - www.footprintnetwork.org
   - www.wri.org/publications/ecosystems
   - http://www.carbonfootprint.com
   - http://www.un.org/sustainabledevelopment/sustainable-development-goals

2. **Climate** (*suggestions:* show country's position towards Paris Agreement, participation in CO2-trade, what are recent negative and positive impacts of climate change on economy and on certain industries, examples of business climate adaptation/mitigation strategies)
   Useful links:
   - http://beta.worldbank.org/climatechange/
   - http://unfccc.int/kyoto_protocol/items/2830.php
   - http://www.un.org/sustainabledevelopment/sustainable-development-goals

3. **Energy** (*suggestions:* identify main energy sources for the country; show energy balance for the country using data from the latest *BP Statistical Review of World Energy*; ratios of production to reserves, consumption to imports; energy consumption, energy production, energy dependence, energy crises (if any), energy policy, energy saving and energy efficiency measures adopted in the country).
   Useful links:
   - www.bp.com (see Statistical Review of World Energy)
   - www.eia.doe.gov (U.S. Energy Information Administration)
   - www.iea.org (International Energy Agency)
   - http://www.un.org/sustainabledevelopment/sustainable-development-goals

4. **Population** (*suggestions:* general overview of a population as an economic factor, labor market situation, migration problems, labor mobility, ageing of economically active population, nationality pattern, public health, role of cities in the national economy, etc.).
   Useful links:
   - www.ilo.org (International Labour Organization)
   - www.un.org/popin/ (UN Population Information Network)
   - www.gapminder.org (tool similar to WB Data Visualizer)
   - http://www.un.org/sustainabledevelopment/sustainable-development-goals
   - http://www.postcarbon.org/

5. **Land Use, Agriculture, Food Production** (*suggestions:* production and import of agriculture food, food security/insecurity level, problem of GMF (if any), use of fertilizers, soil resources, food crises (if any).
   Useful links:
   - www.fao.org
   - http://www.fao.org/ag/agn/nutrition/profiles_en.stm
   - http://www.fao.org/unfao/govbodies/cfs/country_en.htm
   - http://www.fao.org/hunger/en/
   - http://www.un.org/sustainabledevelopment/sustainable-development-goals
   - http://www.postcarbon.org/

6. **Water** (*suggestions:* focus on water resources, water use by sectors, water management, water price for different consumers, etc.).
   Useful links:
   - http://www.unwater.org/flashindex.html
   - http://www.fao.org/nr/water/aquastat/main/index.stm (and other statistics from this website)
   - http://www.un.org/sustainabledevelopment/sustainable-development-goals

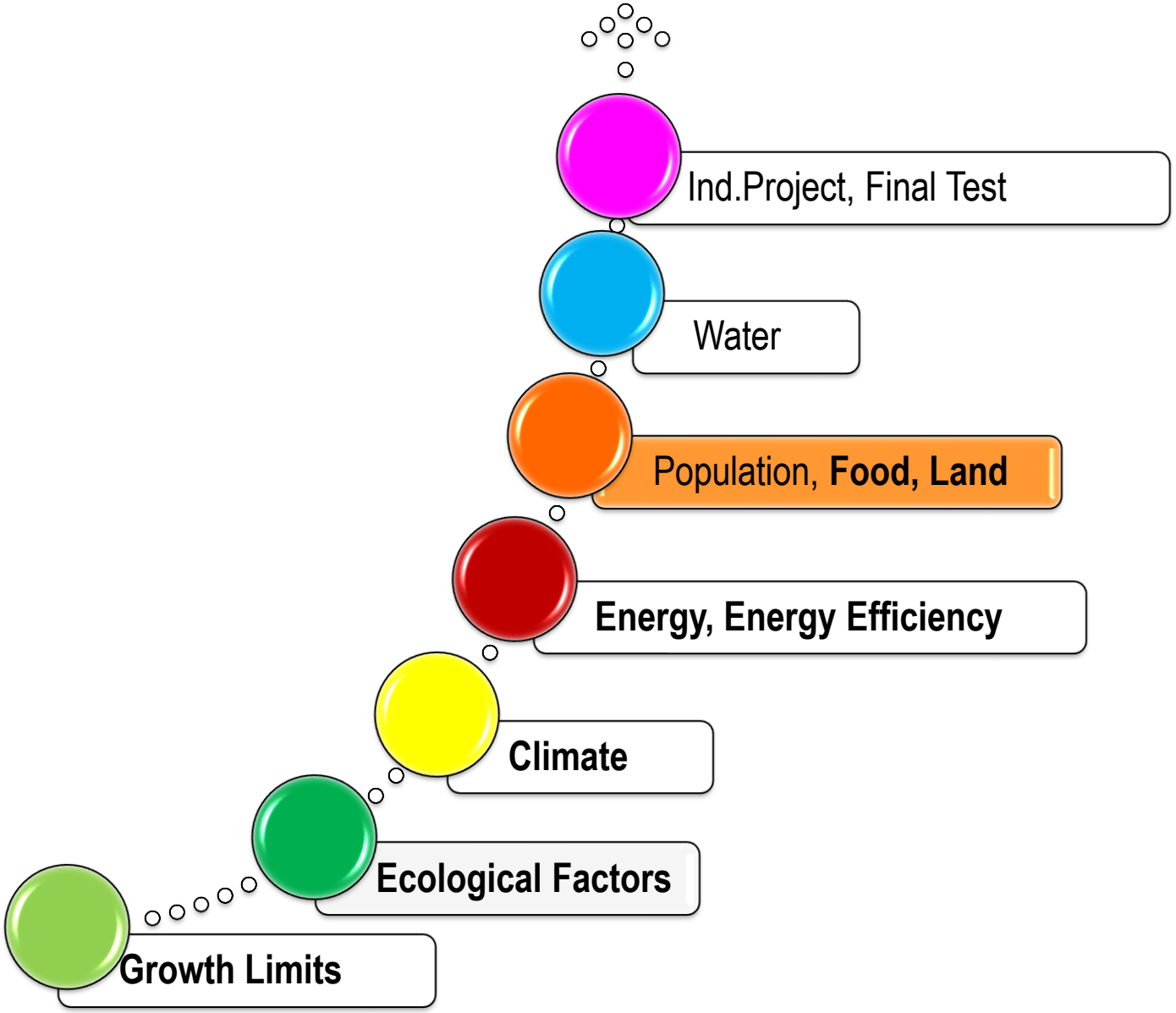
7. **Other types of natural resources**
   Consult relevant links from the general list of recommended web-sites.

For all resources it is recommended to review documents, publications, regional outlooks/ overviews and country profiles of the general list of recommended web-sites.

Learning Schedule

- Our classes will take place on Wednesdays at 15:00 (12 weeks in total)
- Communication with the course reader:
  - During classes
  - Via e-mail: e.shvec@edu.mgubs.ru
- All administrative issues should be addressed via your Personal Account in the MSU Learning Management System
- Before each session you will receive Pre-Reading and Food-for-Thought Assignment through your Personal Account

Course Route



Session 10

Food Production & Food Supply

(continuation)

2024

Aims of Session

1. To know main limitations that can be produced by food production as for business and national economic growth
2. To work out ways how to overcome these limitations

Session Plan

Food Supply

1. Food Security VS Food Self-Sufficiency
2. Public Policy on Food Security
   - Discussion “pro” & ”con”, basing on FAO article
3. Genetically Modified Food
4. Key Challenges for Food Production Companies

World Food Market

- **The food market** covers all edible products that are bought and consumed for nutrient-based purposes. The market includes both fresh and processed foods.

- The market is further differentiated into Dairy Products & Eggs, Meat, Fish & Seafood, Fruits & Nuts, Vegetables, Bread & Cereal Products, Oils & Fats, Sauces & Spices, Convenience Food, Spreads & Sweeteners, Confectionery & Snacks, Baby Food and Pet Food.

- Food market is expected to grow at a CAGR of 6% between 2023 and 2028.

https://www.statista.com/outlook/cmo/food/worldwide#revenue

World Food Market

2011: 1) China ($ 963 bln), 2) USA ($ 907 bln)

2015: 1) China, 2) USA, 3) India, 4) Russia, 5) Brazil

2024: 1) China ($ 1,630 bln)

Russia: 2008-2011 – growth by 2 times ($ 314 bln in 2011)

China: 2006-2015 – growth by 3 times

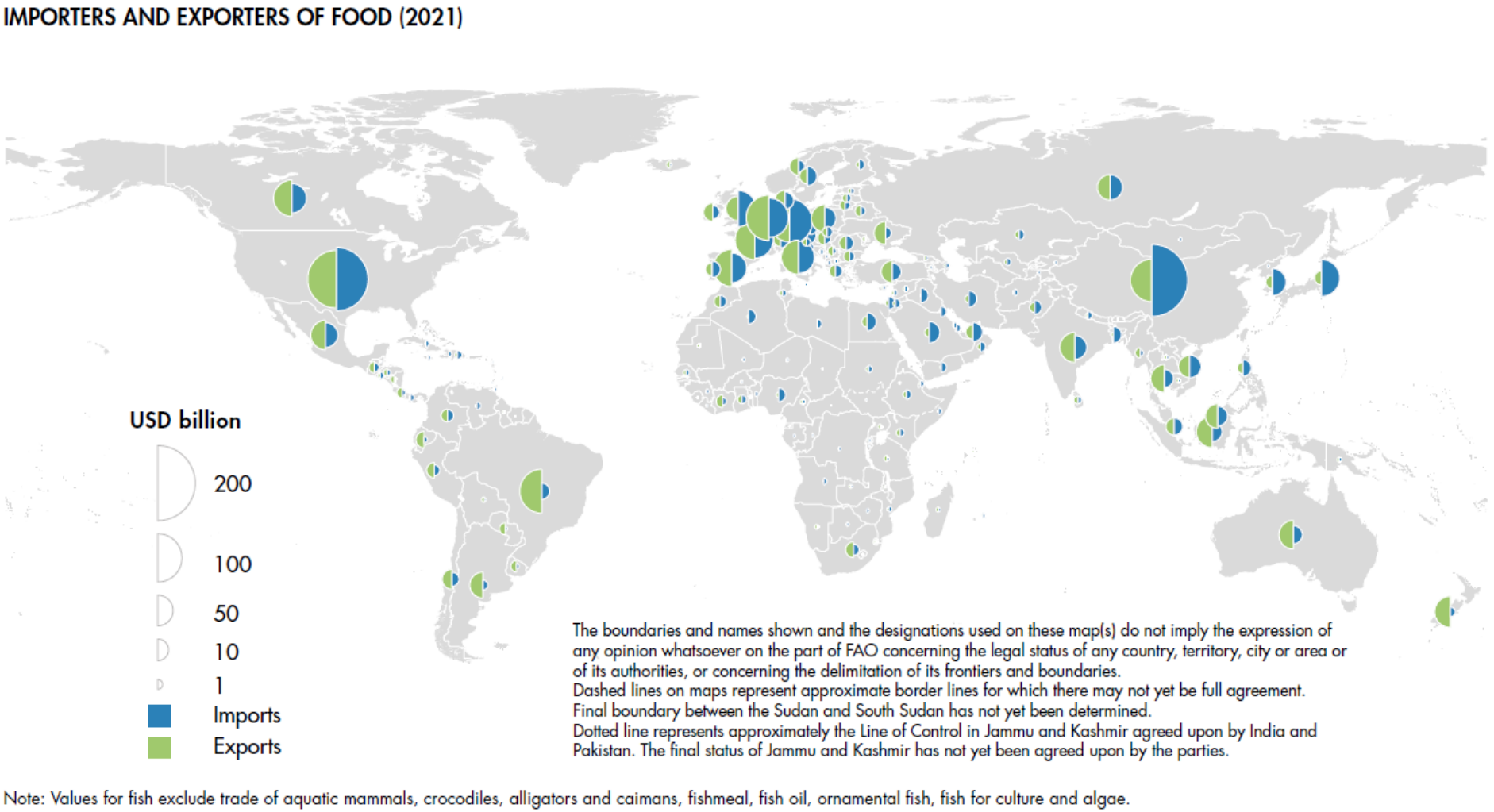
Growth contributing factors - ?

World Food Market Trends

- Revenue in the Food market amounts to US$10.07tn in 2024. The market is expected to grow annually by 6.53% (CAGR 2024-2028).
- The market's largest segment is the segment Confectionery & Snacks with a market volume of US$1.77tn in 2024.
- In relation to total population figures, per person revenues of US$1,299.00 are generated in 2024.
- In the Food market, 6.0% of total revenue will be generated through online sales by 2024.
- In the Food market, volume is expected to amount to 3,118.00bn kg by 2028. The Food market is expected to show a volume growth of 3.9% in 2025.
- The average volume per person in the Food market is expected to amount to 352.30kg in 2024.

https://www.statista.com/outlook/cmo/food/worldwide#revenue

Export & Import of Food



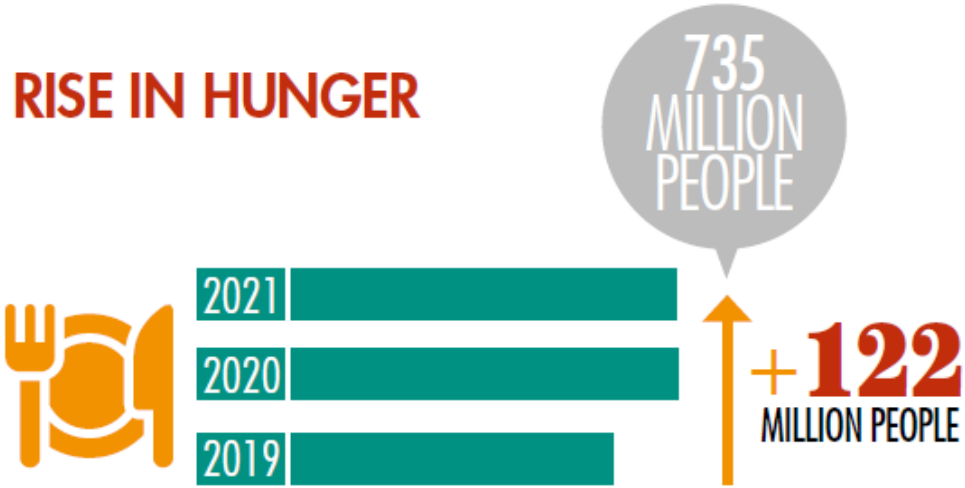
Note: Values for fish exclude trade of aquatic mammals, crocodiles, alligators and caimans, fishmeal, fish oil, ornamental fish, fish for culture and algae.

Source: FAO Statistical Pocketbook 2023

Week Diet of Different Families and Its Cost (Project “Hungry Planet”)

http://ttolk.ru/?p=15825

RISE IN HUNGER



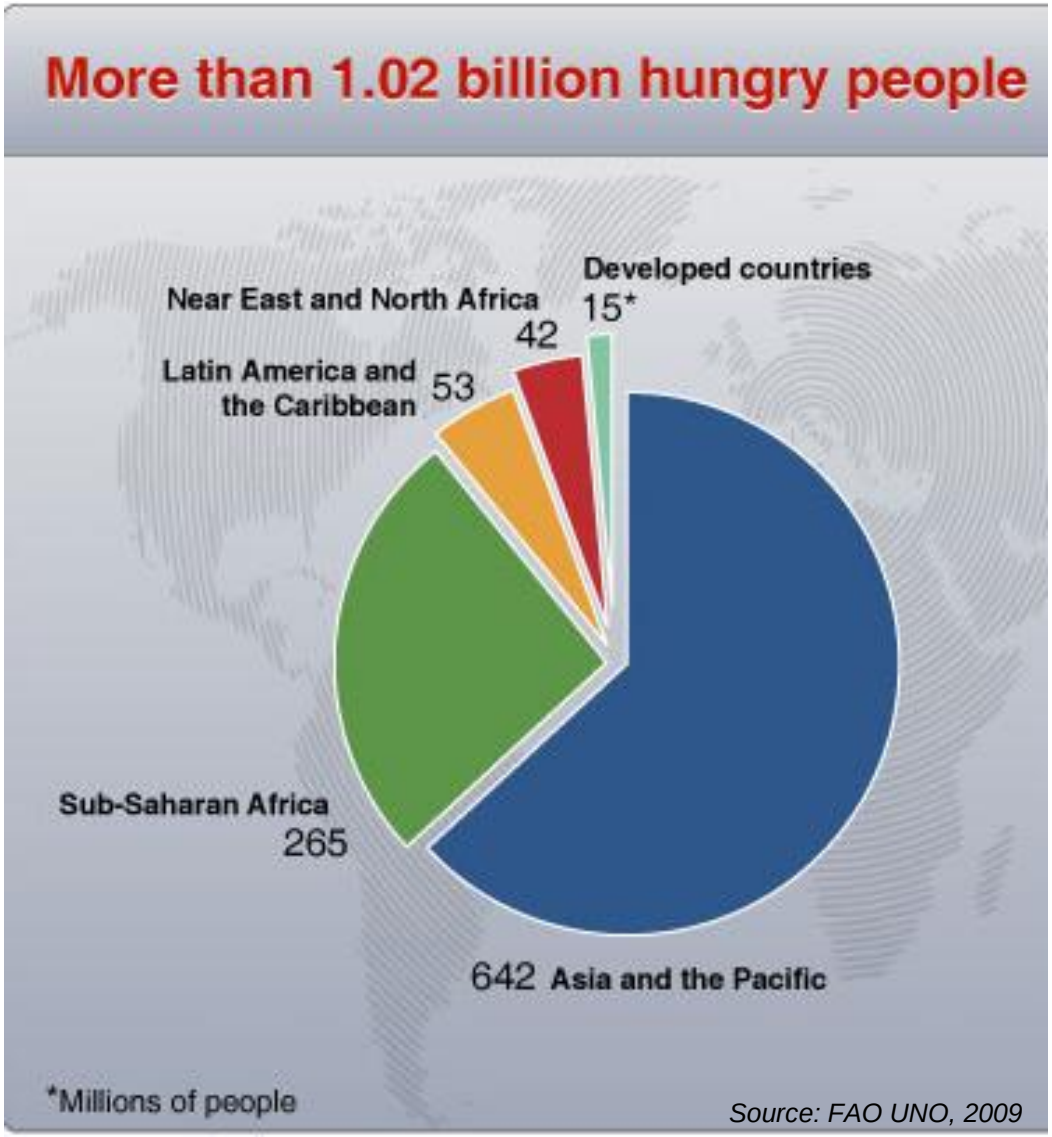
Global hunger, measured by the prevalence of undernourishment, remained relatively unchanged from 2021 to 2022, affecting around 9.2% of the population in 2022, or about 735 million people. This is 122 million more people than in 2019, before the COVID-19 pandemic.

PREVALENCE OF UNDERNOURISHMENT

While most of the undernourished people live in Asia, Africa has the highest prevalence of undernourishment.

Source: FAO Statistical Pocketbook 2023

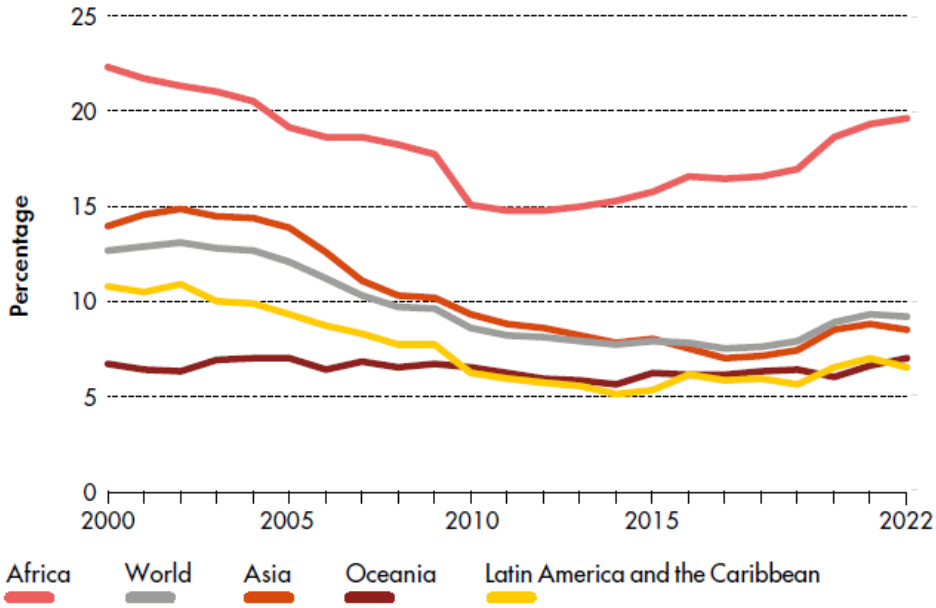
Where the world's hungry people live



- Hunger causes
  - Poor harvests due to unfavorable climate conditions
  - High domestic food prices
  - Lower incomes
  - Increasing unemployment due to the global economic crisis
  - Unfair distribution of food
  - Limited access to fertile lands due to the status of private property
- The rise in food prices in 2007-08, followed by the financial and economic crisis in 2009, has heightened awareness on poverty and hunger issues around the world.

Prevalence of Undernourishment by Region

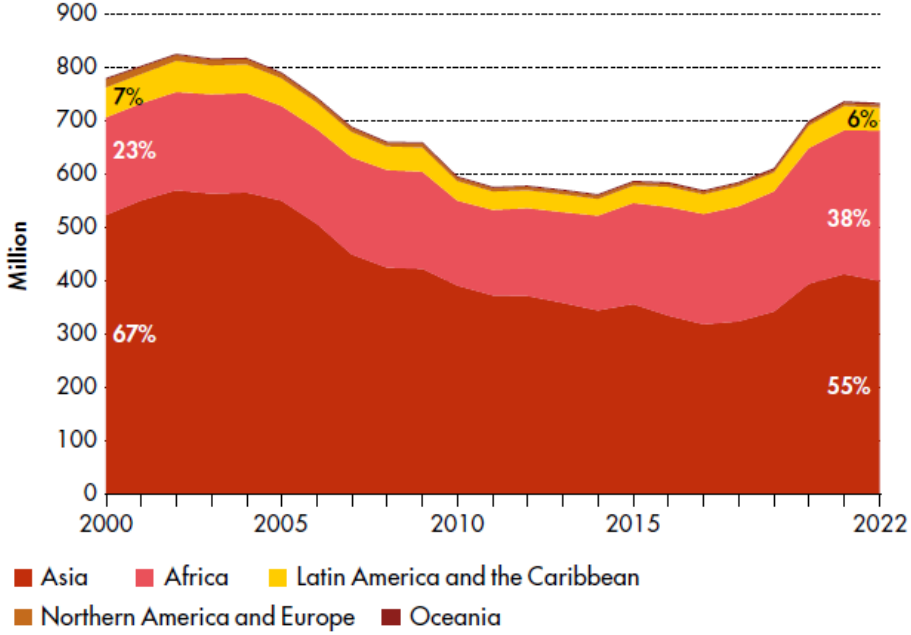
FIGURE 47.
PREVALENCE OF UNDERNOURISHMENT BY REGION



Note: The prevalence of undernourishment for Northern America and Europe is estimated to be less than 2.5 percent. The values for 2020 to 2022 are projections based on the projected midranges.

Source: FAO. 2023. Suite of Food Security Indicators. In: *FAOSTAT*. Rome. [Cited October 2023]. https://www.fao.org/faostat/en/#data/FS
Download: https://doi.org/10.4060/cc8166en-fig47

FIGURE 48.
NUMBER OF PEOPLE UNDERNOURISHED BY REGION



Note: Percentages on the figure indicate the shares in the total; they may not tally due to rounding. The values for 2020 to 2022 are projections based on the projected midranges.

Source: FAO. 2023. Suite of Food Security Indicators. In: *FAOSTAT*. Rome. [Cited October 2023]. https://www.fao.org/faostat/en/#data/FS
Download: https://doi.org/10.4060/cc8166en-fig48

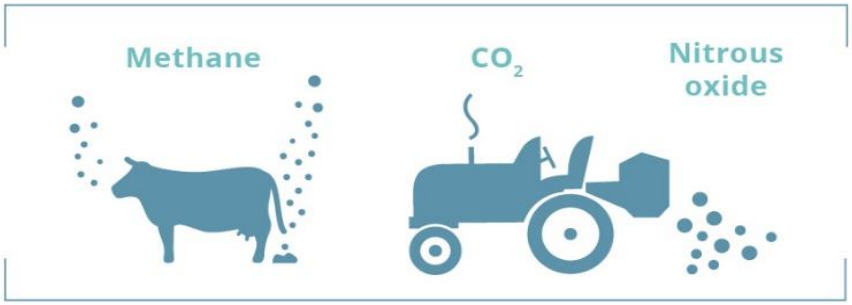
Source: FAO UNO

Climate Change & Food Production

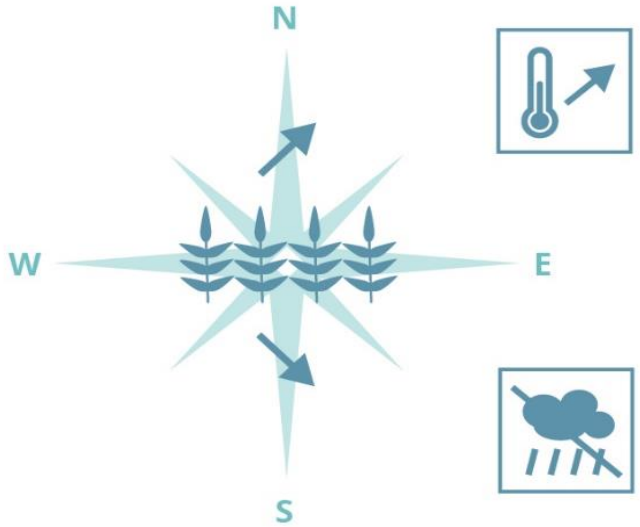
Climate change and agriculture

Agriculture both contributes to climate change and is affected by climate change. The EU needs to reduce its greenhouse-gas emissions from agriculture and adapt its food-production system to cope with climate change. Faced with growing global demand and competition for resources, the EU's food production and consumption need to be seen in a broader context, linking agriculture, energy, and food security.

Agriculture accounts for 10% of the EU's greenhouse-gas emissions.



-24% From 1990 to 2012, greenhouse-gas emissions from agriculture in the EU decreased by 24%.



In southern Europe extreme heat events and reduced precipitation and water availability are expected to reduce crop yields, while the suitability for growing crops may improve in northern Europe.

Climate Change & Food Production

Globally

+14% Between 2001 and 2011, greenhouse-gas emissions from crop and livestock production grew by 14%.

+70% The demand for food is expected to grow by up to 70% in coming decades.

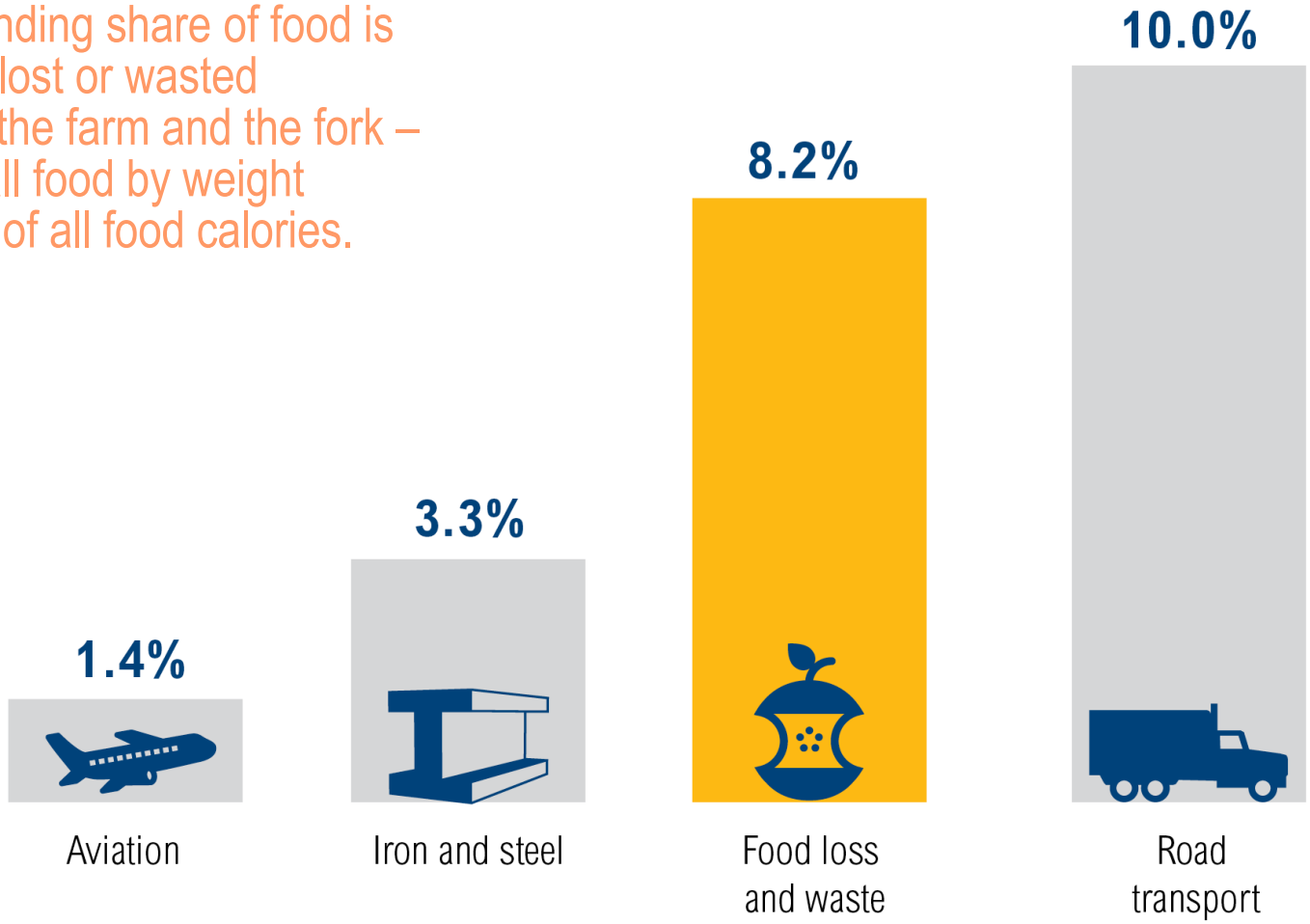
Did you know?

Meat and dairy products have the highest global footprint of carbon, raw materials and water per kilogramme of any food.

Post-farm transport and processing account for only a tiny fraction of the emissions linked to food.

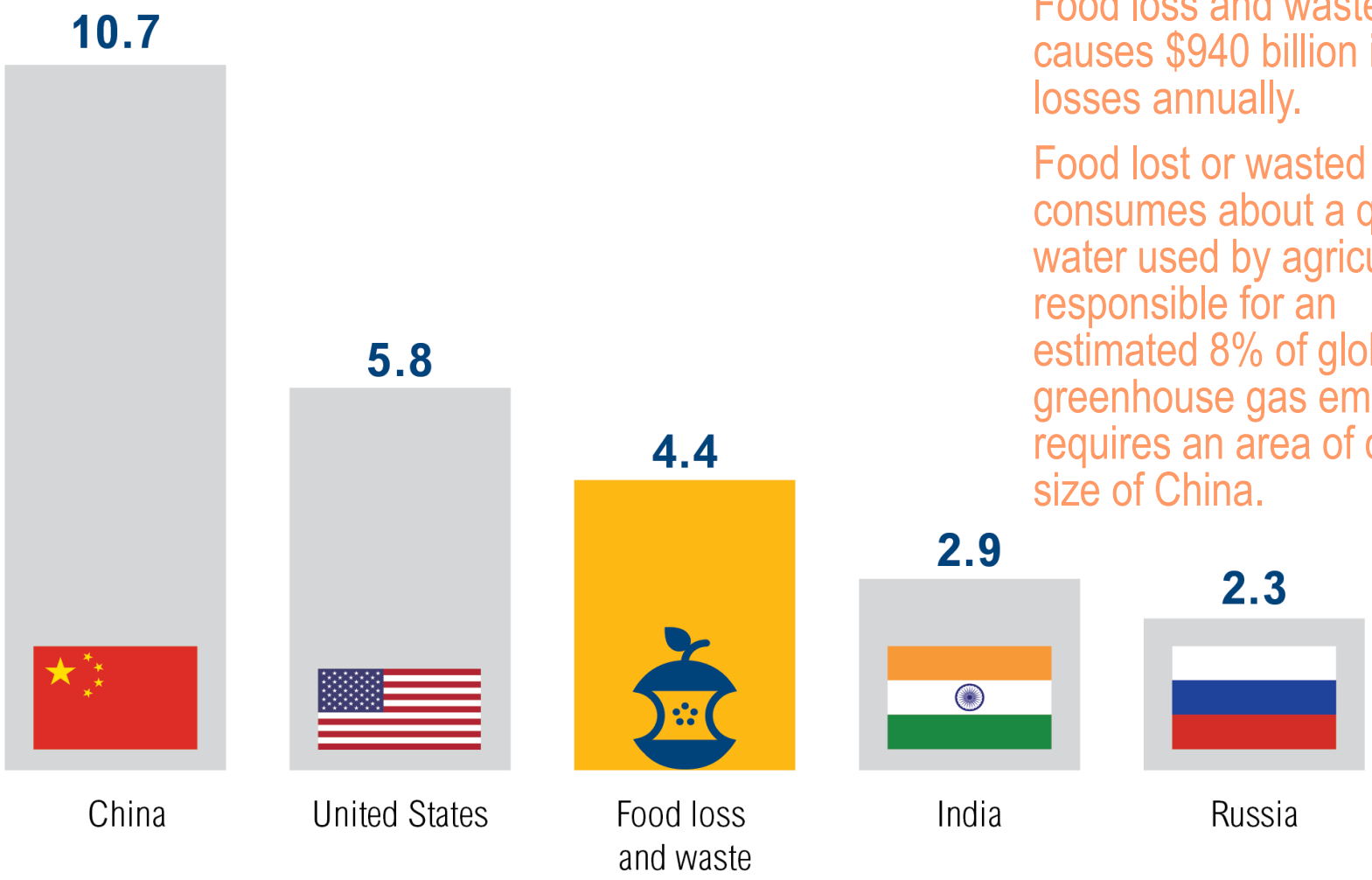
Greenhouse Gas Emissions from Food Loss and Waste Approach the Levels from Road Transport

An astounding share of food is currently lost or wasted between the farm and the fork – 32% of all food by weight and 24% of all food calories.



SHARE OF GLOBAL GREENHOUSE GAS EMISSIONS (2011/12)*

If Food Loss and Waste Were its own Country, it Would Be the Third-Largest Greenhouse Gas Emitter



Food loss and waste causes $940 billion in econ losses annually.

Food lost or wasted consumes about a quarter water used by agriculture, responsible for an estimated 8% of global greenhouse gas emissions requires an area of croplan size of China.

Genetically Modified Food

Who is interested in GM food?

- Big companies
  - GM crops are a way for big companies to take over the livelihoods of small farmers. But 90% of the farmers growing GM crops are comparatively poor.
  - Big firms make a lot of money selling GM seeds. The GM seed market was worth $10.5 billion in 2009, and the crops that grew from that seed were worth over $130 billion.
- National governments (China, India and Brazil) are also developing new GM crops and Charity Foundations.
- Consumers?
  - More food
  - More food resistant to external biological and climate factors
  - Health impacts?
  - Price? Cheaper or more expensive?

There are no scientifically proved facts that GM food affects human health

Long-term Consequences for the Environment and Human Health?

Key Challenges for Food Production Companies

- Standards of food production
  - High quality
- Responsibility
  - People's health
  - Creating certain tradition of nutrition (should be healthy, etc., but not always is) products tastes, consumption, diets
- Adapting to regional cultures in terms of food consumption
- Innovations used have doubtful advantages (GMF, food additives)
- …

The Future of Food Production

- By 2050 there will be another 2.5 billion people on the planet. How to feed them?

- We grow nearly twice as much food as we did just a generation ago, but we use three times as much water from rivers and underground supplies.

How to receive 2 times more food reducing negative impact on the environment produced by the agriculture?

5 steps

- *Not to expand farmland*
- *To get more from existing fields*
- *To use rationally natural resources*
- *To change diet*
  - *Today, only 55% of calories derived from the crop itself fed people in the world; the rest goes to feed livestock (36%) or converted into biofuels and industrial goods (9%).*
- *To reduce waste*
  - *Up to half of the total weight of food is thrown out or deteriorates before people have time to eat it.*

Photo by Foerster/Wikimedia Commons

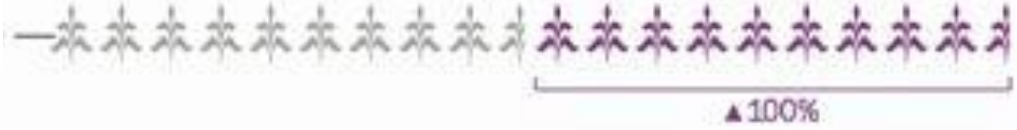
THE WORLD NEEDS MORE

By 2050 population will grow by approximately 35%

1 bln people

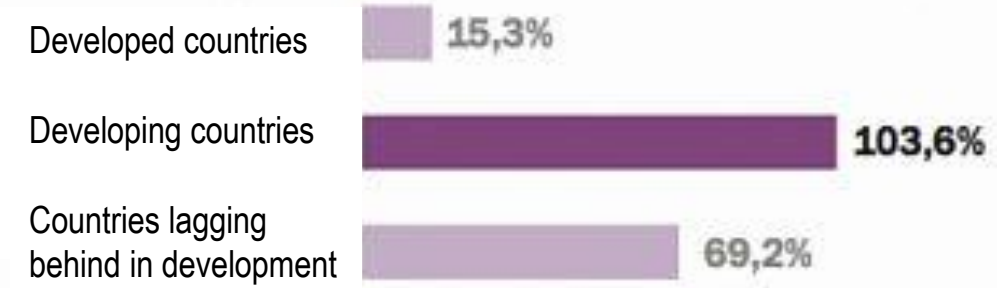
To feed this population the world needs to increase the yields of cereals twice

1 bln tonnes



Why? The growth of agricultural production will have to far exceed population growth, since developing countries are taking a new standard of living when their inhabitants begin to eat more meat.

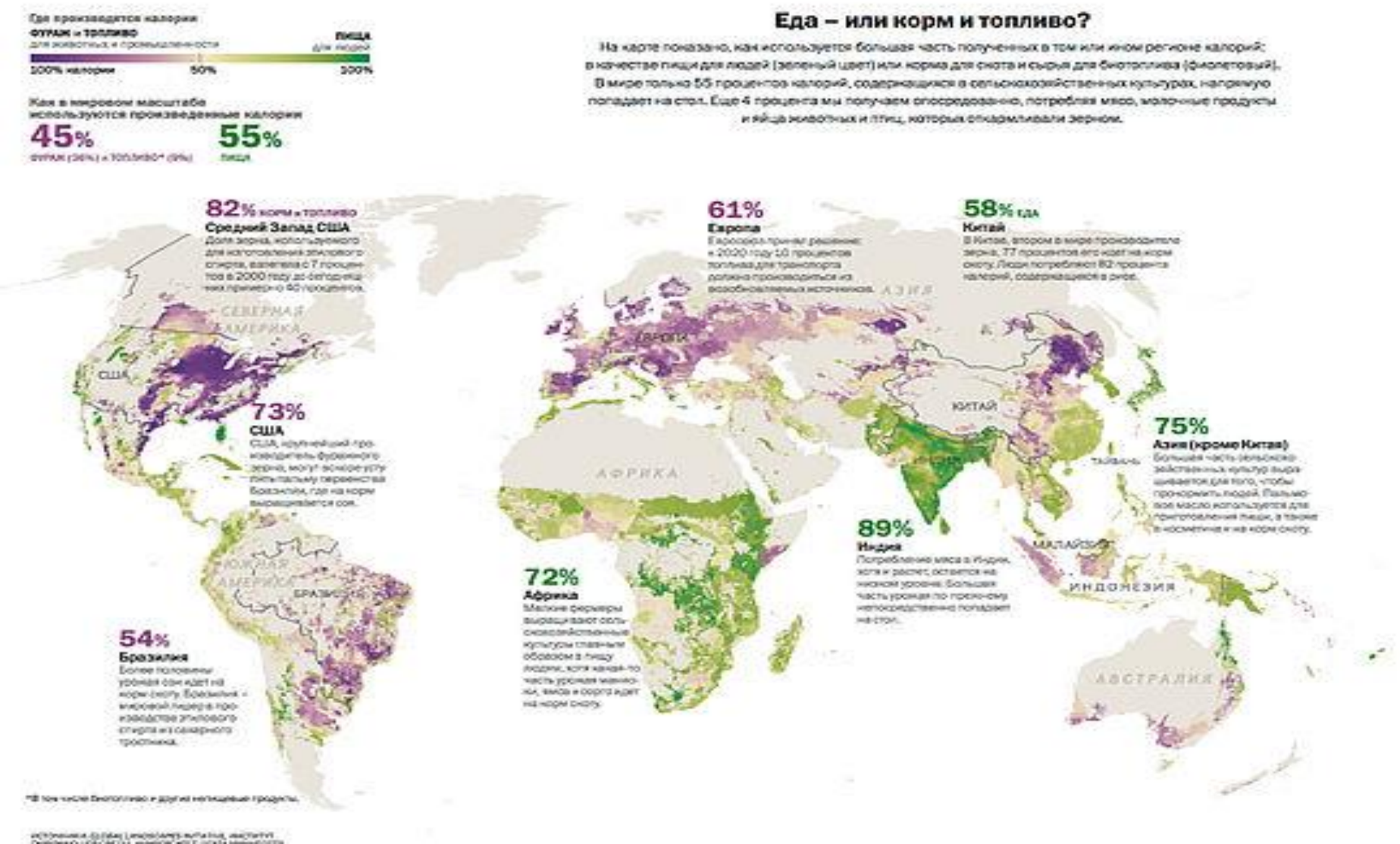
Increase of daily demand for protein foods (per capita by 2050)



ИСТОЧНИК: ДЭВИД ТИЛМАН, УНИВЕРСИТЕТ ШТАТА МИННЕСОТА

The way of using the calories obtained: as food for humans (green) or the livestock feed and raw materials for biofuels (purple).

In the world, only 55% of the calories contained in crops, goes directly to the table.



The Future of Food Production

Algae

Desert greening

Insects

Artificial Meat

Artificial Meet

- In 2013 the cost of the burger with a meatball from the meat grown in the lab was more than $300,000, and now it hardly exceeds $10.
  - The price fell down in 30,000 times in 4 years
- November 2016
  - 1 kg of artificial meat - around **$80**
  - 1 kg of natural beef meat - **$7-8**

- Why the production of natural meat is harmful to the environment?
  - High water footprint (2500 l of water for 1 hamburger)
  - Cows are considered to be the main source of methane gas

- Would the artificial meat save the situation?
  - Lab created beef meat will decrease GHG emissions by 90%, land use by 99%
  - But there are opinions that lab created meat will require more energy expenses

https://hightech.fm/2017/02/22/lab_grown_meat

Ocean Potential in Terms of Food

CHART 52: **Per capita fish food supply**

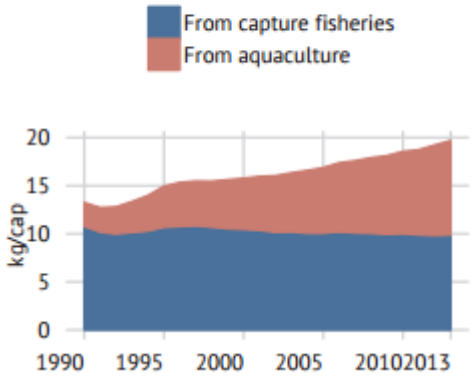


CHART 53: **20 countries with highest value of capture production (2013)**

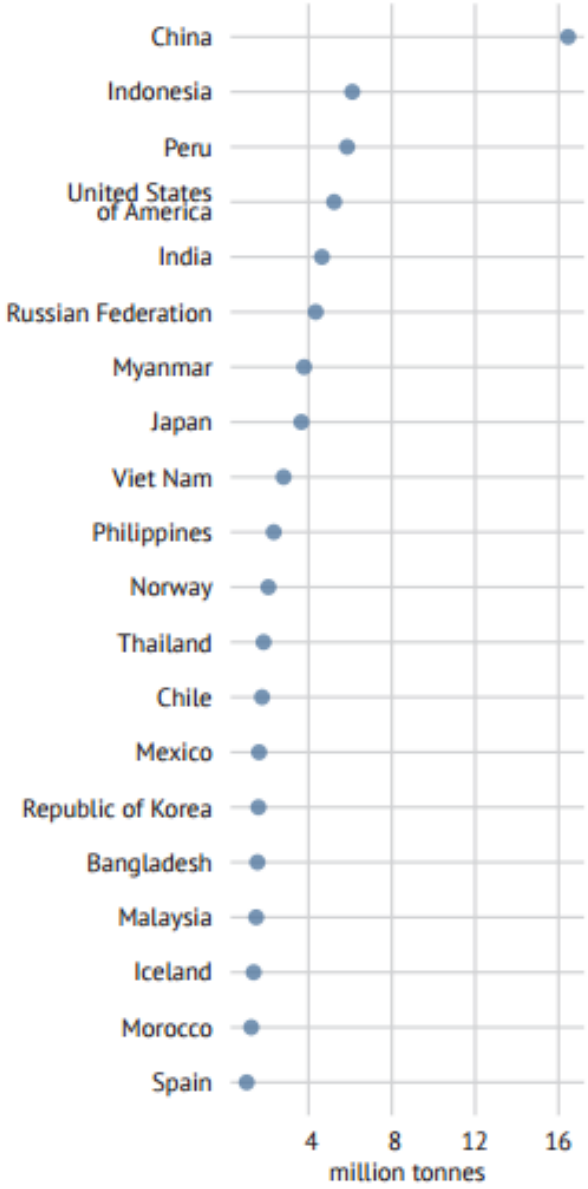
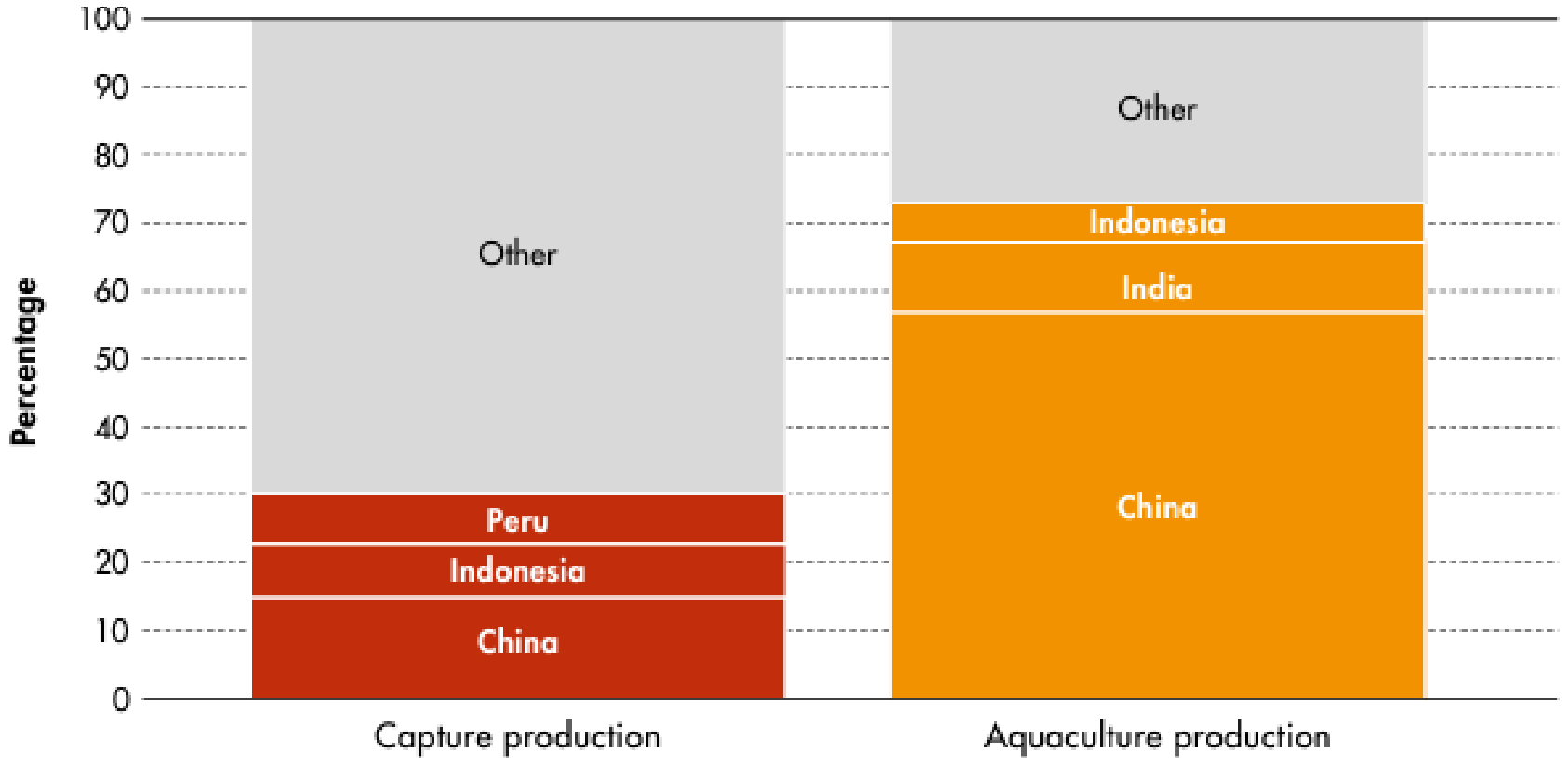


CHART 54: **20 countries with highest value of aquaculture production (2013)**

Ocean Potential in Terms of Food

WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION BY MAIN PRODUCERS (2021)

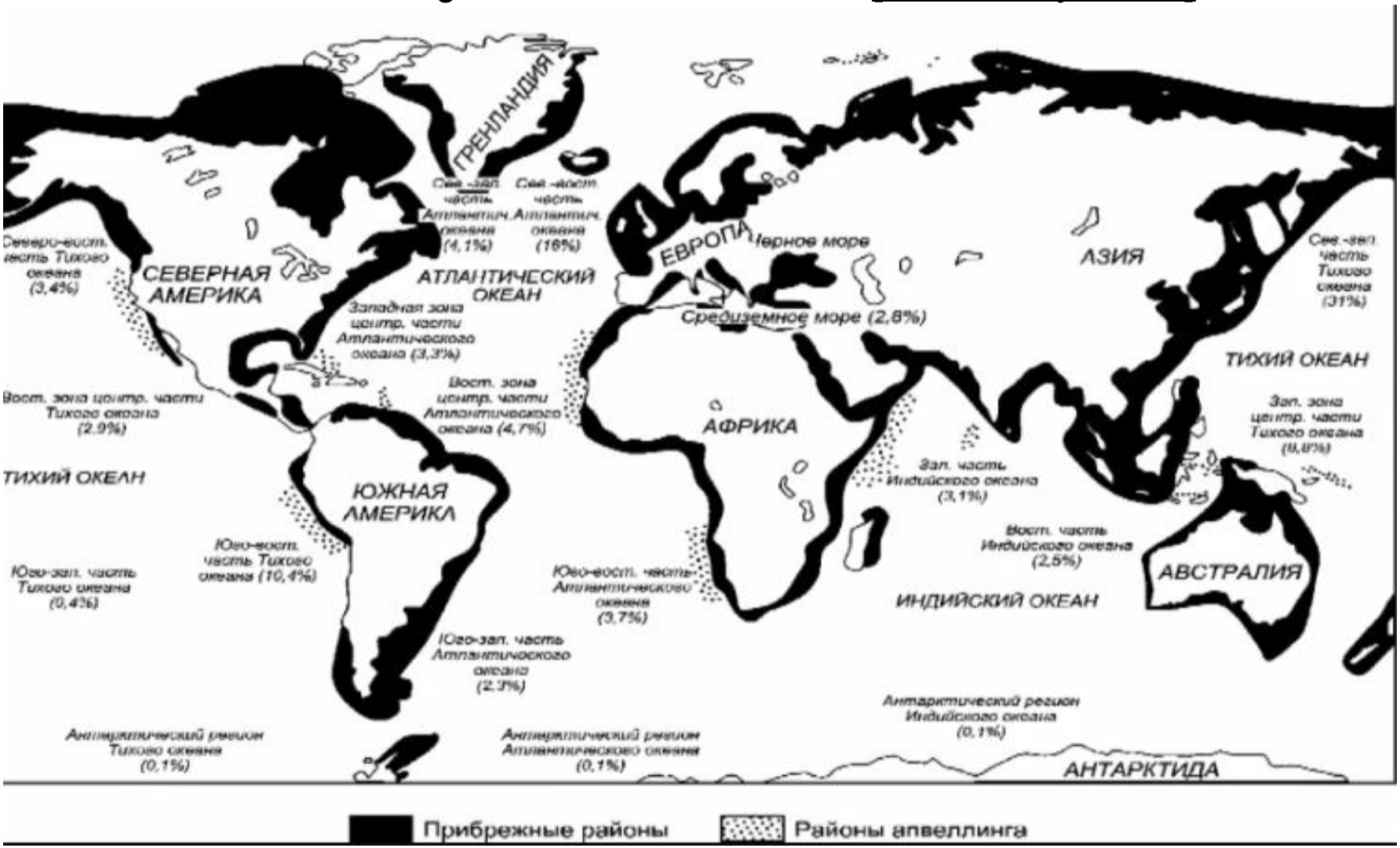


Note: Excludes aquatic mammals, crocodiles, alligators and caimans, pearls and shells, corals, sponges and algae.

Source: FAO. 2023. Fisheries and Aquaculture: Global production by production source Quantity (1950 - 2021). In: *FAO*. Rome. [Cited October 2023]. https://www.fao.org/fishery/statistics-query/en/global_production/global_production_quantity
Download: https://doi.org/10.4060/cc8166en-fig32

Ocean Potential in Terms of Food

Areas with High Productive Potential [marked by black]



Based on OpenEdu.Ru, “Global Ecological Problems and Sustainable Development” by Marfenin N.N., Popova L.V. , 2017

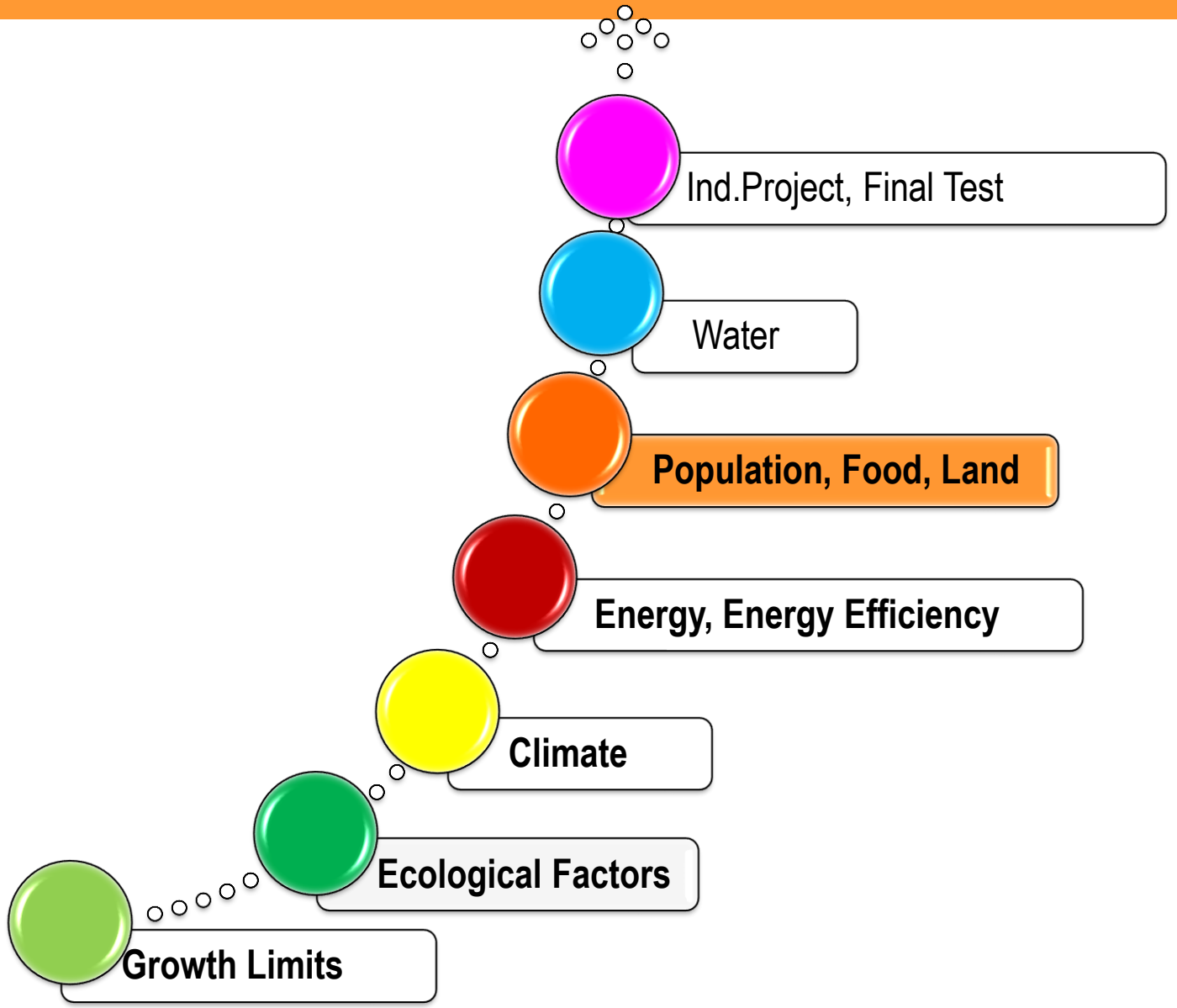
Aquaponia (Mexican case)

https://www.facebook.com/foroeconomicomundial/videos/1500015510091501/

How to feed the growing population?

- Suggest at least one idea

Course Route



Pre-Reading Assignment

World agriculture: towards 2015/2030

Summary report

LAND, AGRICULTURE

- Read Reading Material for the Session 10 (World Agriculture 2015-2030, p.39-44).

Think about:
Is there enough potential cropland for future needs?
Is land becoming scarcer?
Is there enough irrigable land for future needs?
What are the factors that limit the agriculture production?

Session 10

Agriculture and Land Use Issues

2024



Aims

LAND, AGRICULTURE

- To identify main factors limiting agriculture production using statistical data approach (FAOSTAT, AQUASTAT)
- To understand how to overcome these limitations

Content

1. Agriculture as an Economic Sector
2. How to Feed the Growing Population?
3. Trends in Agriculture
4. Green Revolution
5. Sources of Growth in Crop Production and the Consequences of Green Revolution
   - Agriculture Trends
   - Territorial Strategies in Agricultural Business
6. Land Conflicts

Agriculture as an Economic Sector

- Agriculture is a unique sector of economy
- It's a mix of science, art and skills to manage plants' and animals' growth for human needs
- The basic aim is the growth of this production

- *In many low-income countries agriculture generates over 1/3 of GDP*
- *Half or more of population in Asia and Sub-Saharan Africa are directly involved in agriculture*

Challenges for Farmers

Source: Syngenta Corporate Presentation, 2017

syngenta

How will the mankind feed 9 bln people in 30 years?

- Is it possible to expand arable land?
- Is it possible to reach this aim by improvement of technology?
- What are side effects of improving agro-technologies?

Based on OpenEdu.Ru, “Global Ecological Problems and Sustainable Development” by Marfenin N.N., Popova L.V. , 2017

How to feed the growing population?

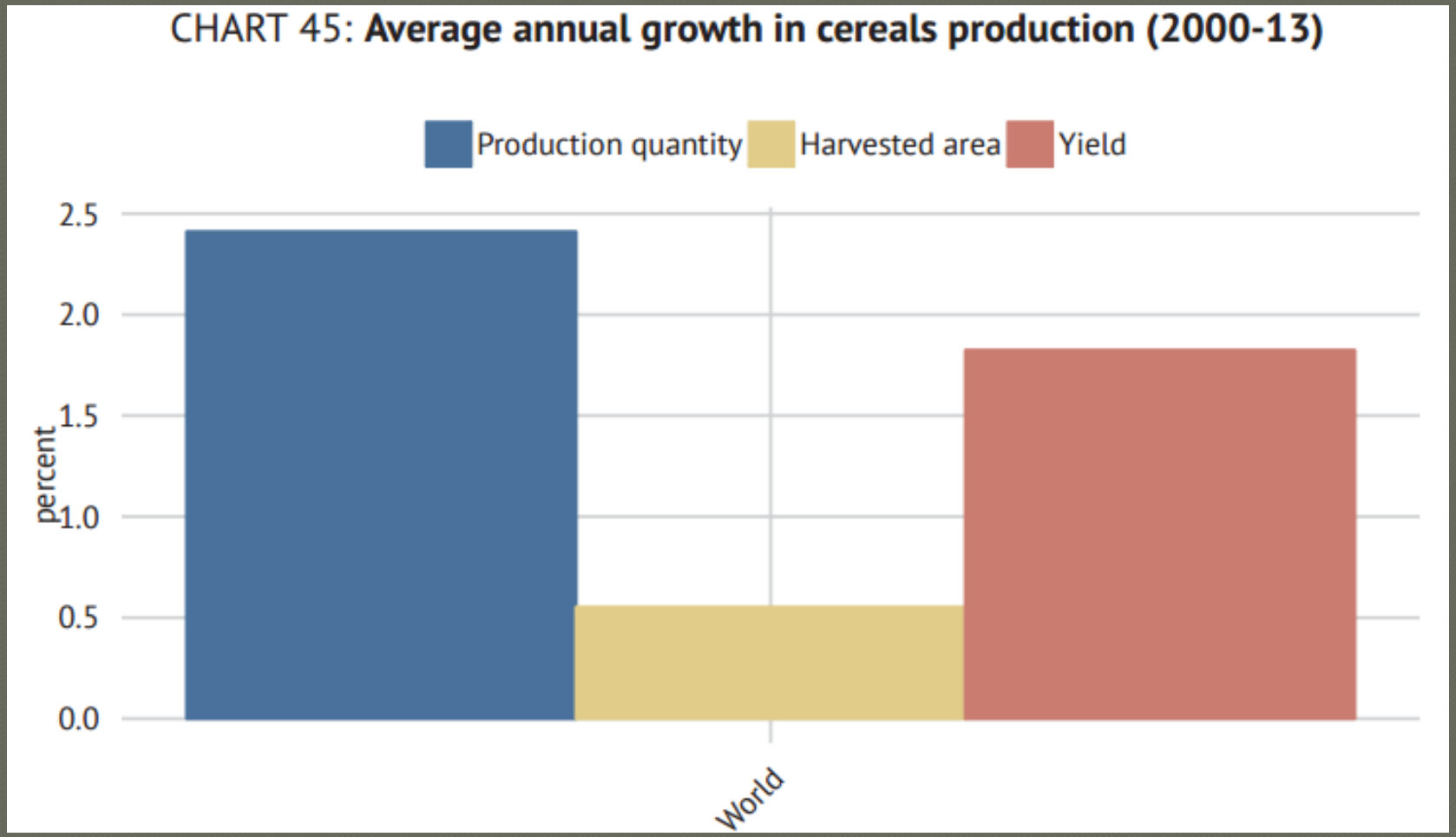
- How many people it will be possible to feed using all existing arable land of 1480 mln ha (2015, FAO), if everywhere we'll use the most efficient agrotechnologies?

Standards of …	**World arable land** (mln ha)		**Arable land/ population** (ha/person)		**Population fed** (mln)
USA	1480	/	0.84	=	1 761
Western Europe	1480	/	0.24	=	6 166
Holland	1480	/	0.06	=	24 666

According to the calculations of the developer of the mathematical model of population growth of the Earth, S.P. Kapitsa, around 2135 there will come a stabilization of the world population with a total population of 12-14 **bln** people. According to UN estimates, stabilization will come about 2100 with a population of 11 bln.

Based on OpenEdu.Ru, "Global Ecological Problems and Sustainable Development" by Marfenin N.N., Popova L.V. , 2017

Trends in Cereals Production



Source: FAO Statistical Pocketbook 2015

Main Trends in World Regional Agriculture

World

	1990	2000	2014
The setting			
Population, total (mln)	5 320.8	6 127.7	7 243.8
Population, rural (mln)	3 033	3 263.4	3 362,5
Govt expenditure on ag (% total outlays)			
Area harvested (mln ha)	1 952	2 061	2 781
Cropping intensity ratio	0.4	0.4	
Water resources (1 000 m^3/person/year)			
Area equipped for irrigation (1 000 ha)			
Area irrigated (% area equipped for irrigation)			
Employment in agriculture (%)	*35.3*	38	*30.7*
Employment in agriculture, female (%)	*9.2*	20.3	*25.2*
Fertilizers, Nitrogen (kg of nutrients per ha)		*64.9*	*85.8*
Fertilizers, Phosphate (kg of nutrients per ha)		*25.9*	*33.2*
Fertilizers, Potash (kg nutrients per ha)		*18.2*	*20.4*
Energy consump, power irrigation (mln kWh)	35 981	130 786	*325 448*
Agr value added per worker (constant US$)			
Hunger dimensions			
Dietary energy supply (kcal/pc/day)	2 597	2 717	2 903
Average dietary energy supply adequacy (%)	113	116	123
Dietary en supp, cereals/roots/tubers (%)	*58*	55	*52*
Prevalence of undernourishment (%)	18.6	15	10.8
GDP per capita (US$, PPP)	8 832	10 241	*13 915*
Domestic food price volatility (index)		3.6	*7.8*
Cereal import dependency ratio (%)	*-0.4*	-0.2	*50.7*
Underweight, children under-5 (%)			
Improved water source (% pop)	78.5	83	*88.7*
Food supply			
Food production value, (2004-2006 mln I$)	1 294 508	1 618 814	*2 246 912*
Agriculture, value added (% GDP)		4	4
Food exports (mln US$)	215 425	276 704	*945 572*
Food imports (mln US$)	237 329	294 271	*966 964*
Production indices (2004-06=100)			
Net food	73	90	*121*
Net crops	72	89	*123*
Cereals	82	92	*123*
Vegetable oils	51	77	*141*
Roots and tubers	74	94	*119*
Fruit and vegetables	58	86	*127*
Sugar	86	93	*132*
Livestock	76	92	*115*
Milk	83	89	*114*
Meat	74	91	*118*
Fish	72	92	*119*
Net trade (mln US$)			
Cereals	-2 447	-4 525	*-6 979*
Fruit and vegetables	-9 430	-7 461	*-5 811*
Meat	-2 574	-682	*5 056*
Dairy products	-663	165	*1 169*
Fish	-3 882	-4 295	*1 257*
Environment			
Forest area (%)	33	32	*32*
Renewable water res withdrawn (% of total)			
Terrestrial protect areas (% total land area)	9	12	*14*
Organic area (% total agricultural area)			*1*
Water withdrawal by agriculture (% of total)			
Biofuel production (thousand kt of oil eq.)	3 987	18 110	*381 064*
Wood pellet prod. (1 000 tonnes)			26 154
Net GHG emissions from AFOLU (CO_2 eq, Mt)	8 075	7 449	*8 165*

Main Trends in World Regional Agriculture

Population growth (% per annum)	1979 to 1999	1989 to 1999	1997-99 to 2015	2015 to 2030	2030 to 2050
World	1.6	1.5	1.2	0.9	0.6
Developing countries	1.9	1.7	1.4	1.1	0.7
Industrial countries	0.7	0.7	0.4	0.2	0.0
Transition countries	0.5	0.1	- 0.2	- 0.3	- 0.4

GDP growth (% per annum)	1997-99 to 2015 total	2015 to 2030 total	1997-99 to 2015 per capita	2015 to 2030 per capita
World	3.5	3.8	2.3	2.9
Developing countries	5.1	5.5	3.7	4.4
Industrial countries	3.0	3.0	2.6	2.8
Transition countries	3.7	4.0	4.0	4.3

Growth in demand for agricultural products (% per annum)	1969 to 1999	1979 to 1999	1989 to 1999	1997-99 to 2015	2015 to 2030
World	2.2	2.1	2.0	1.6	1.4
Developing countries	3.7	3.7	4.0	2.2	1.7
Industrial countries	1.1	1.0	1.0	0.7	0.6
Transition countries	- 0.2	- 1.7	- 4.4	0.5	0.4

Growth in agricultural production (% per annum)	1969 to 1999	1979 to 1999	1989 to 1999	1997-99 to 2015	2015 to 2030
World	2.2	2.1	2.0	1.6	1.3
Developing countries	3.5	3.7	3.9	2.0	1.7
Industrial countries	1.3	1.0	1.4	0.8	0.6
Transition countries	- 0.4	- 1.7	- 4.7	0.6	0.6

Main Trends in World Regional Agriculture

Arable land (million ha)	Total 1997-99	Total 2015	Total 2030	Irrigated 1979-81	Irrigated 1997-99	Irrigated 2015	Irrigated 2030
World	1 608			210	271		
Developing countries	956	1017	1076	151	202	221	242
Industrial countries	387			37	42		
Transition countries	265			22	25		

Crop land and yields in developing countries	Harvested land (million ha) 1979-81	1997-99	2015	2030	Yield (tonnes/ha) 1979-81	1997-99	2015	2030
Wheat	96	111	113	118	1.6	2.5	3.1	3.5
Rice (paddy)	138	157	162	164	2.7	3.6	4.2	4.7
Maize	76	97	118	136	2.0	2.8	3.4	4.0
All cereals	408	465	497	528	1.9	2.6	3.2	3.6
% of total	60	55	53	51				


Green Revolution

- Green Revolution is a broad agricultural movement
  - **Green Revolution** refers to a series of research, development, and technology transfer initiatives, occurring between the 1940s and the late 1970s, that increased agriculture production around the world, beginning most markedly in the late 1960s using **(1) selection, (2) mechanization, (3) irrigation and the use of (4) fertilizers and (5) chemicals.**
  - The term first used in 1968
- It was not a massive transfer of leading technologies from developed countries to the farmers of developing ones

Green Revolution

- **Norman Ernest Borlaug** (1924-2009), the plant scientist
  - Is a central figure of the crop revolution
  - Received the Nobel prize of 1970 for his advances in plant breeding
    - spectacular success in increasing food production in Latin America, Asia and to certain extent in Africa
  - His aim was to feed over 100 mln population of poor countries and to combat famine and starvation in the world


Green Revolution

- Social and environmental consequences of the Green Revolution
  - saved hundreds of millions of lives
  - displaced smaller farmers facilitating greater corporate control of agriculture
  - encouraged overreliance on chemicals and fertilizers
  - led to soil depletion and erosion
  - introduced large scale GM food that reduced biodiversity

Sources of Growth in Crop Production

- What are the main sources (factors) of growth in crop production?

Sources of Growth in Crop Production

- 3 main sources of growth in crop production:
  1. **Expanding the land area**
  2. **Increasing the frequency with which it is cropped (through irrigation)**
  3. **Boosting yields (through fertilizers, chemicals and mechanization)**

We may be approaching the ceiling of what is possible for all three sources

4. **Selection, creation of GM plants**

FAOSTAT & AQUASTAT

Identifying main sources of growth in crop production
(working with FAO STAT at http://www.fao.org/faostat/en/#home and AQUASTAT http://www.fao.org/aquastat/statistics/query/index.html)

Sources of growth in crop production *(for each category 1-4 select one available indicator that would illustrate the situation with the category dynamics, your indicator can differ from the one indicated in the example)*	**COUNTRY: .....**			**REGION(*): .....**		
	Initial year *	**Last year ****	**Change *****	**Initial year ***	**Last year ****	**Change *****
1. Use of fertilizers (→ FAOSTAT) – Select from available items (Nitrogen N, Phosphate 2O5, Potash K2O), *kg/ha* – *If different*:						
2. Arable land (→ FAOSTAT) – Arable land, *% of agricultural land* – *If different*:						
3. Crops: Production Quantity (→ FAOSTAT) – Cereals, *tons* – *If different*:						
4. Water use (→ AQUASTAT) – % of area equipped for irrigation power irrigated *If different*:						

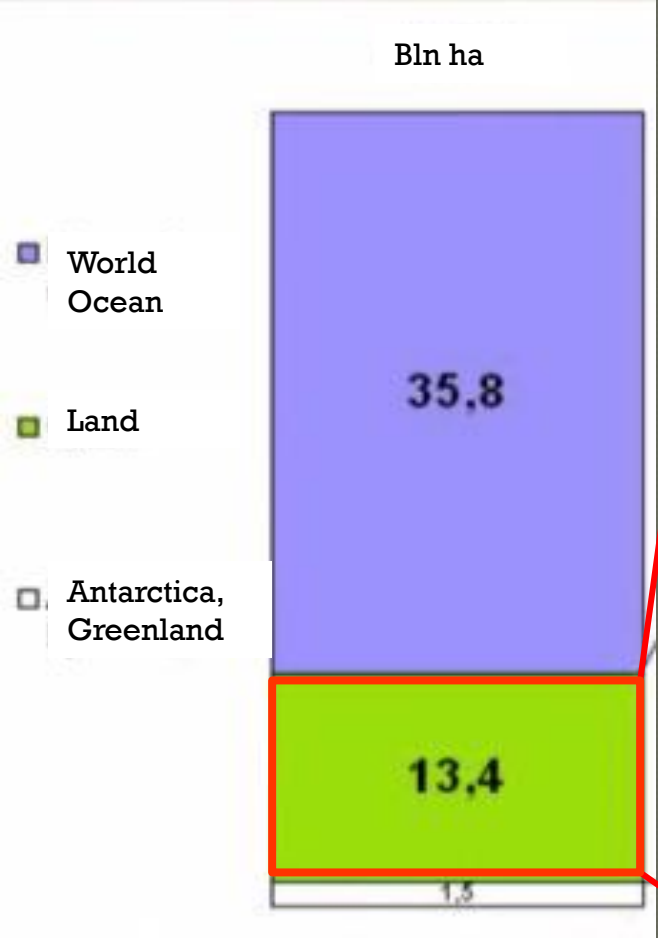
** The earliest year available (both for the country and the region), approximately 2000.*
*** The latest year available (both for the country and the region)*
**** In case of absolute values of indicators:* Divide the last data per initial data = (Last year data / Initial year data). In case of %: (Last year data - Initial year data)
(*) The region where this country is situated.

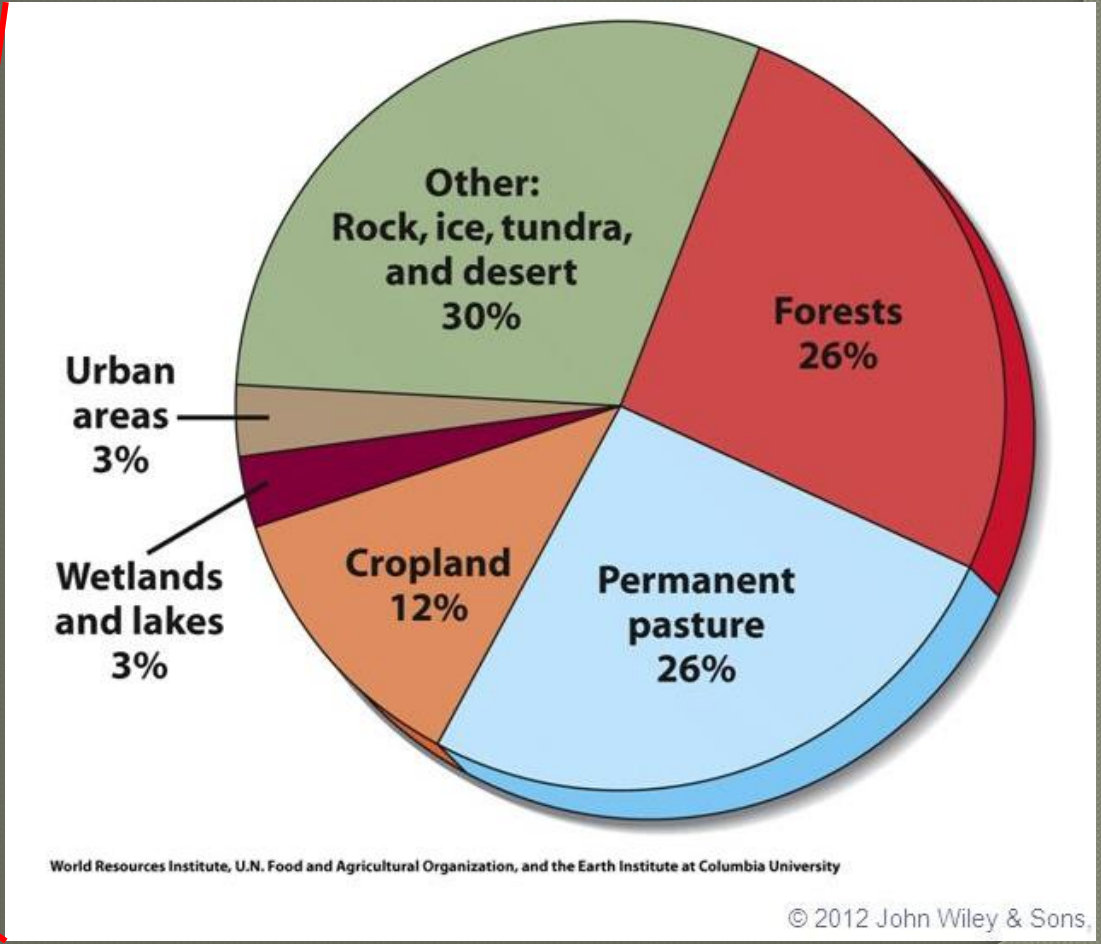
Make a resume of statistics found:

1. What kind of sources of growth in crop production are dominating in terms of their growth rate during the period analyzed in a country selected?	2. How different is the situation with the main sources of growth in crop production in a region where this country is situated?

1. Land Resources

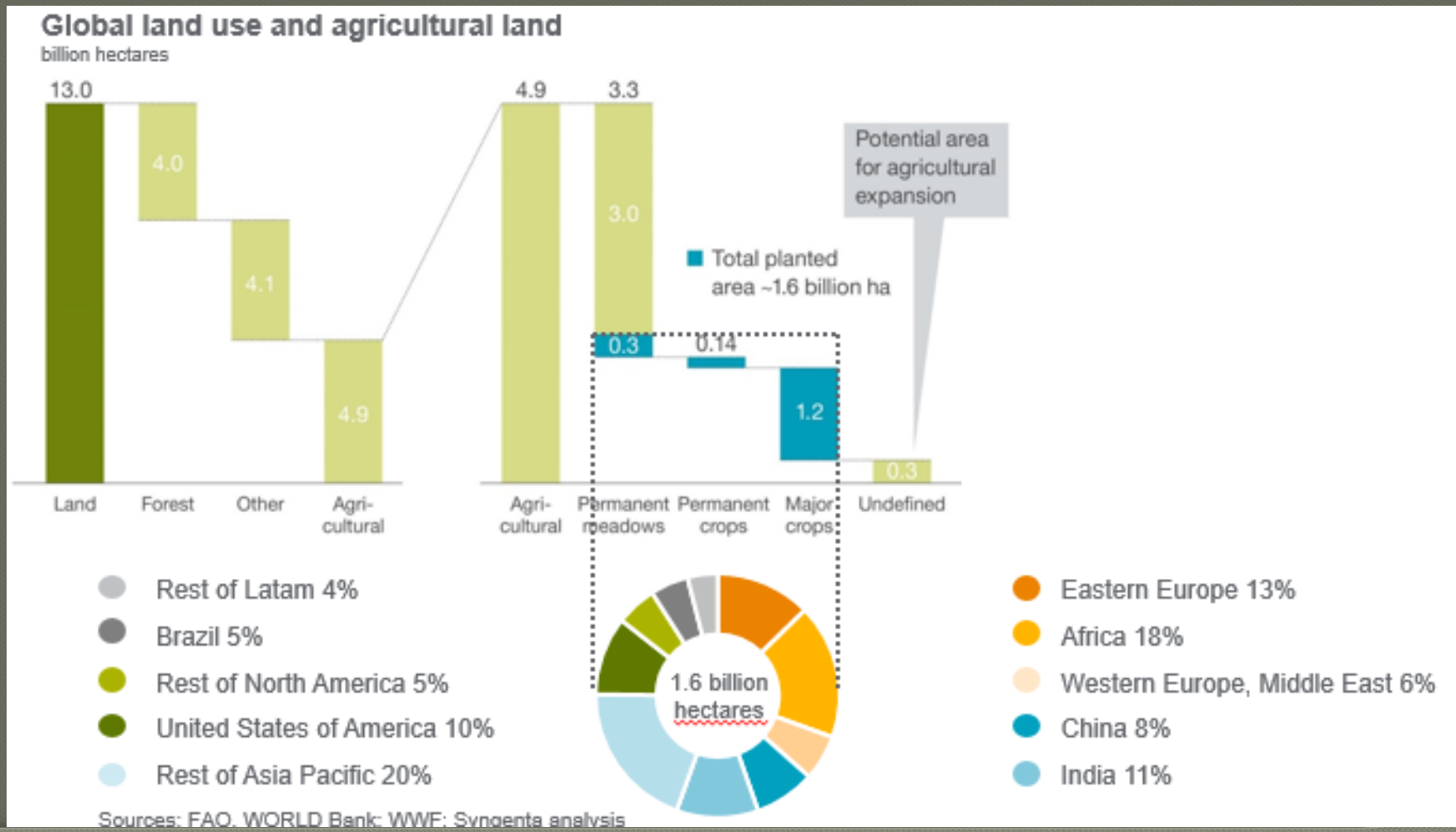
- World Land Use





Limited land for agriculture

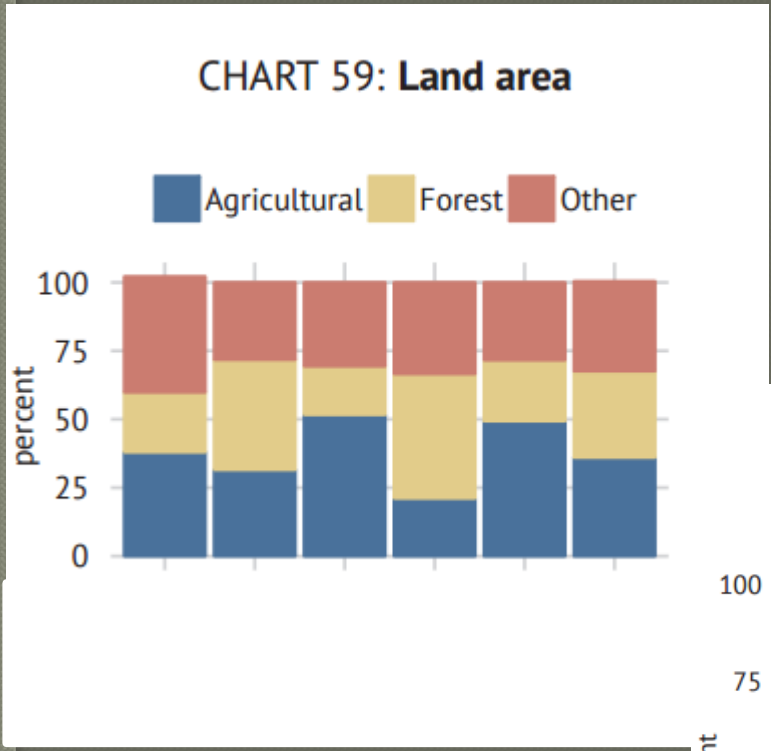
- Within the 13 billion hectares of total land, only 1.6 billion is under farmland production (12% of land surface)



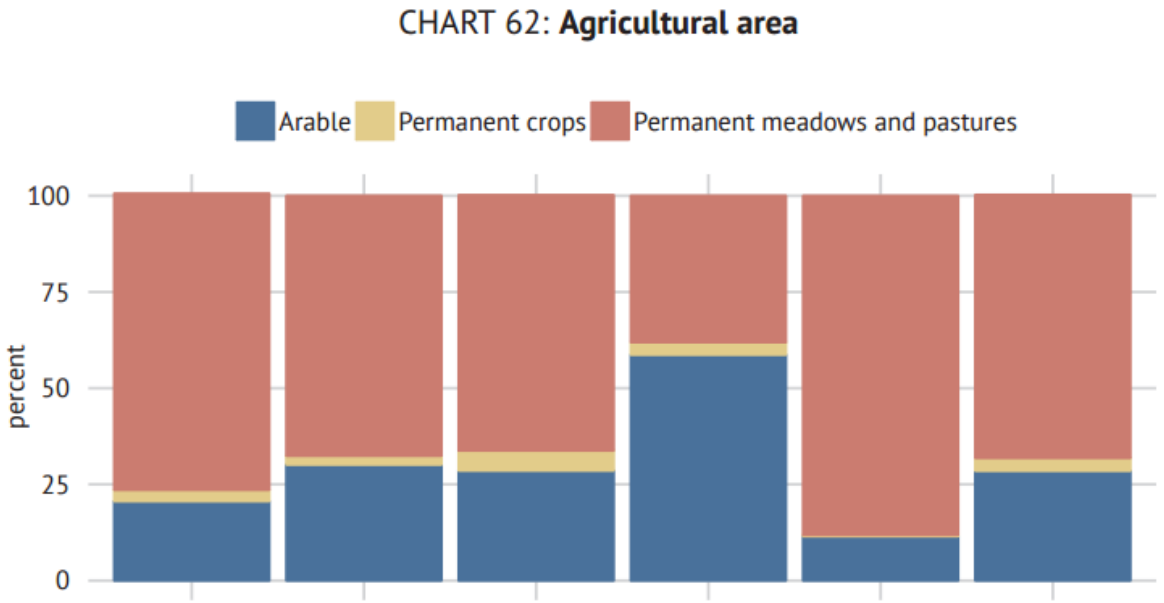
Shortage of Agriculture Land?

the growth rates of world agricultural production and crop yields have slowed

Land Use, Agricultural Land Use



Americas Africa
World Asia
Oceania Europe



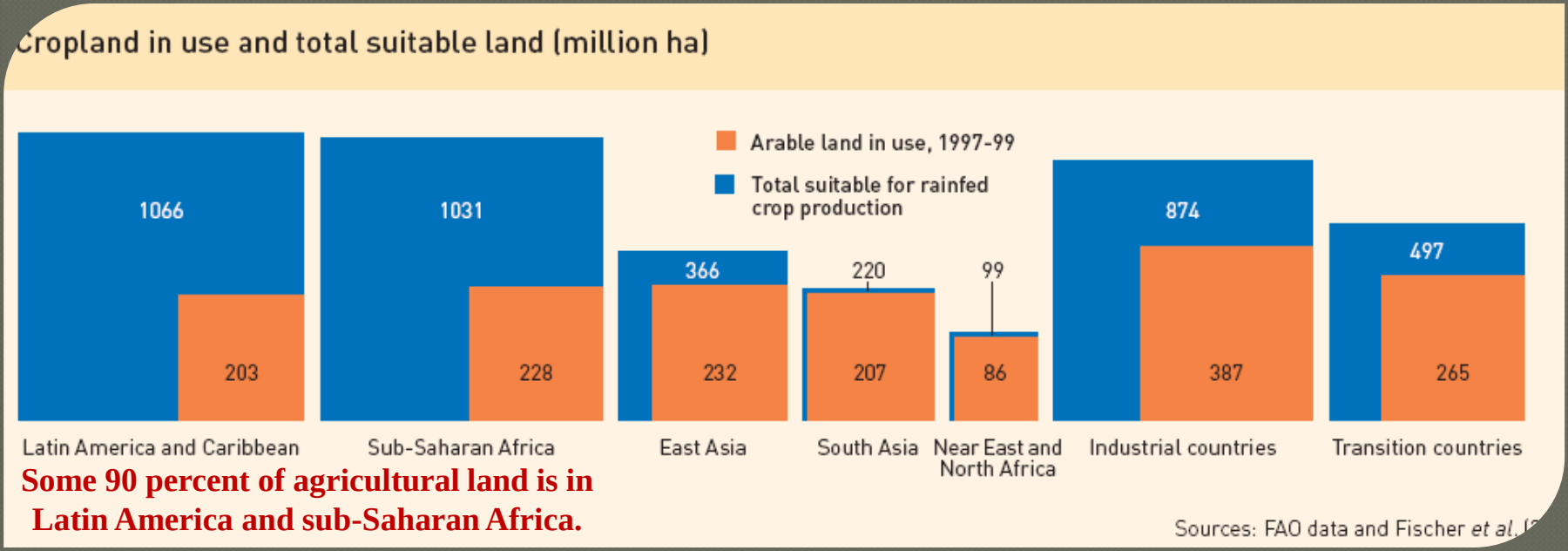
Some 90 percent of agricultural land is in Latin America and sub-Saharan Africa.

Source: FAO Statistical Pocketbook 2015

Land Resources

- What regions are running out of their agricultural land?

FACT: To produce the same amount of food today with yield levels from 50 years ago it would require additional land equivalent in size to the USA



- Some 90% of agricultural land is in Latin America and sub-Saharan Africa.
- There is almost none available for agricultural expansion in Southern Asia, the Western Asia and Northern Africa.

CHART 60: **Arable land per capita, top 20 countries (2012)**

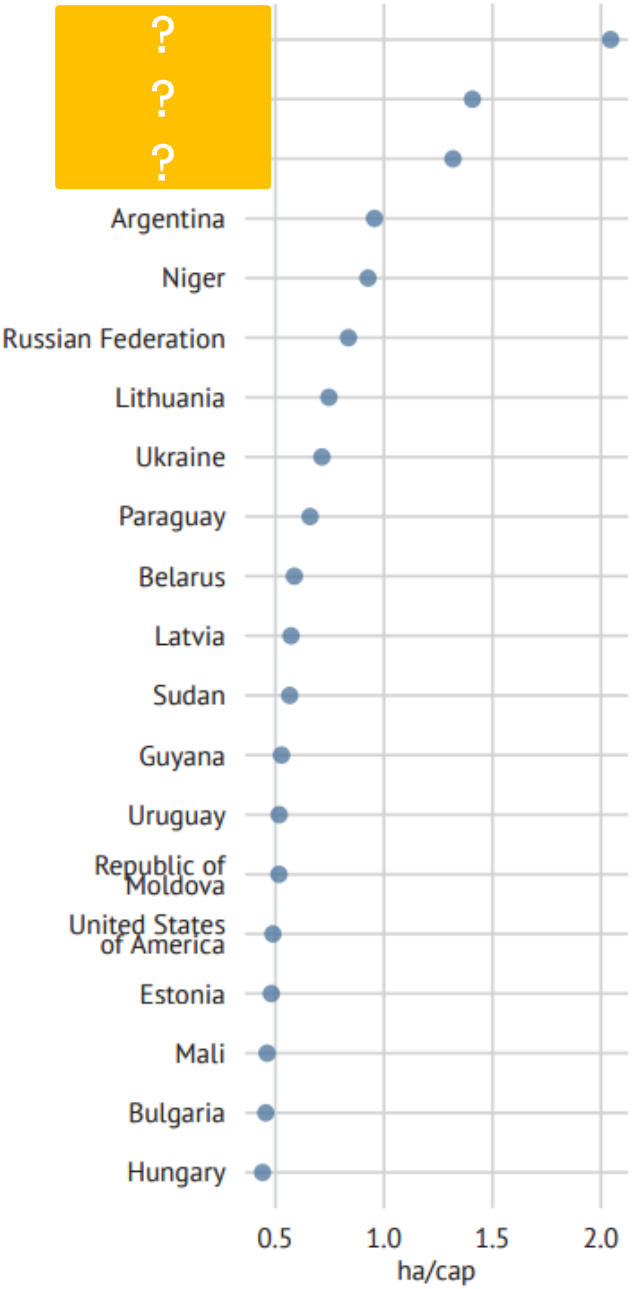
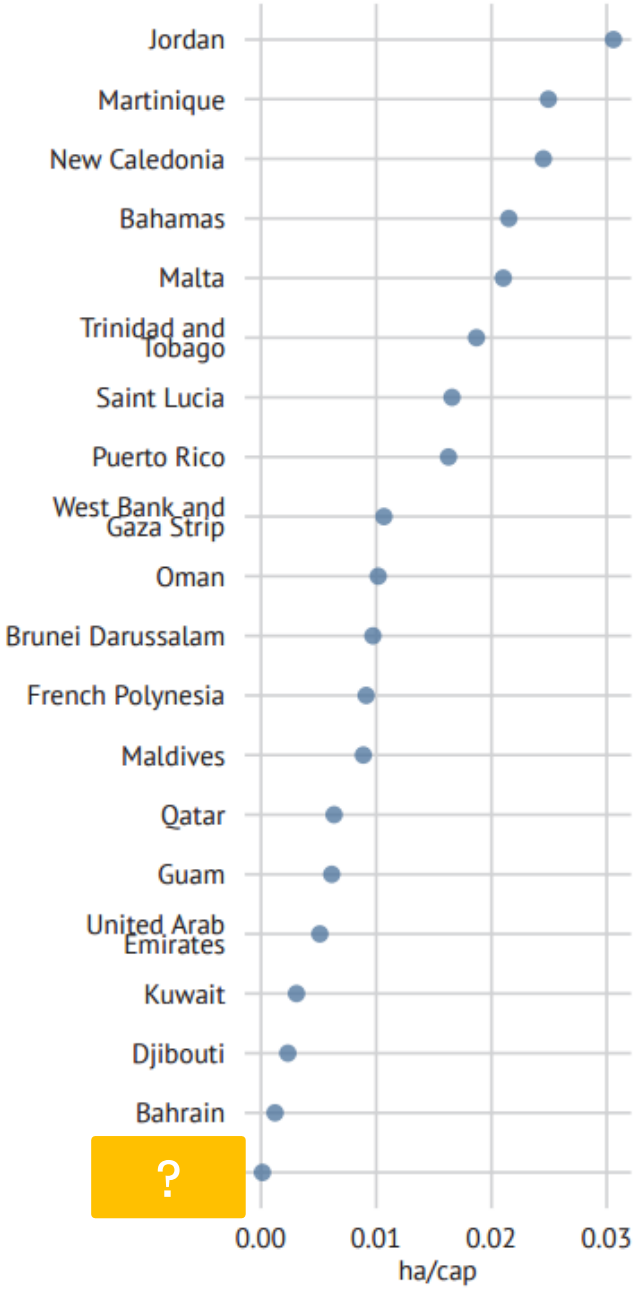
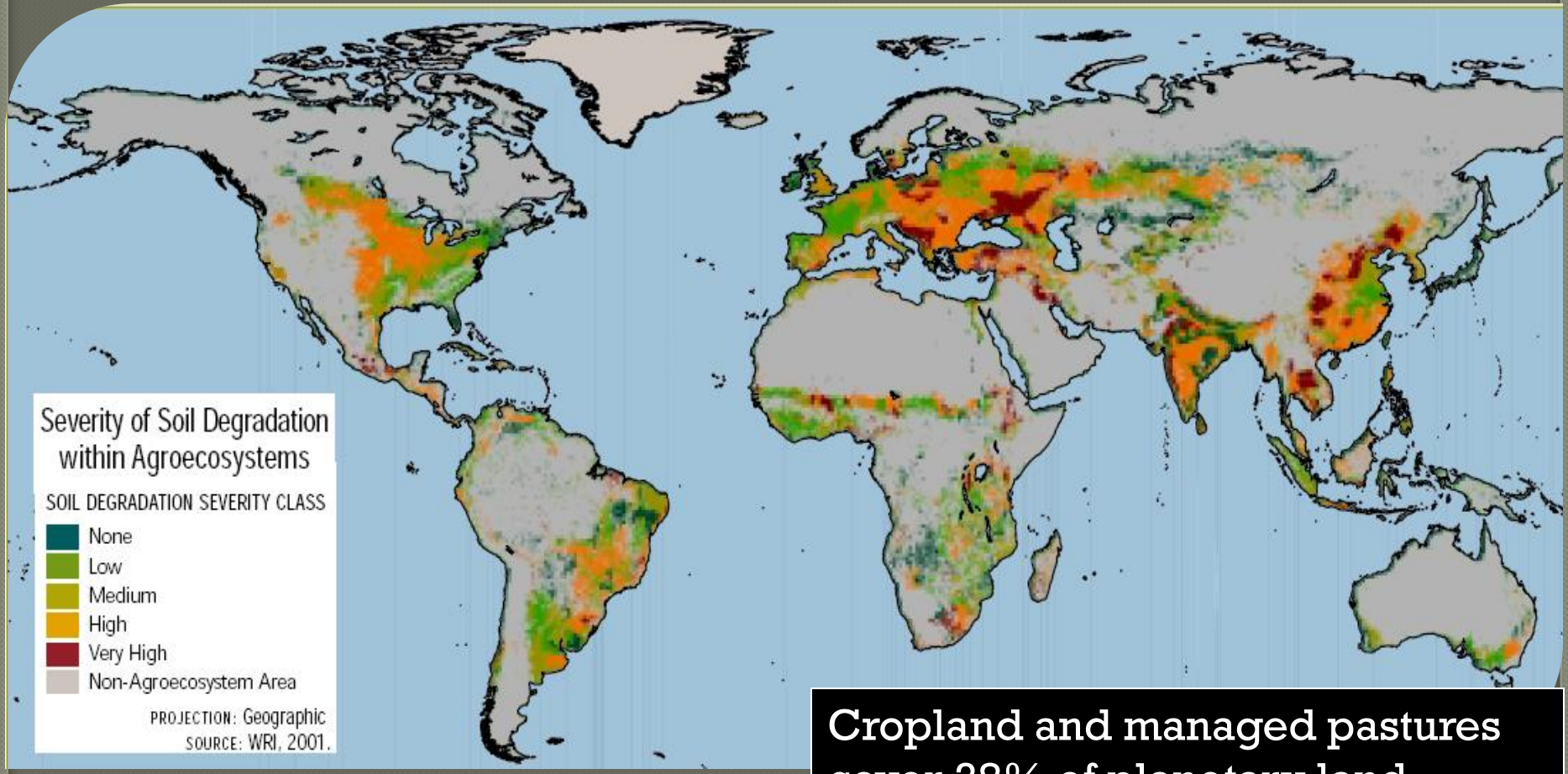


CHART 61: **Arable land per capita, bottom 20 countries (2012)**



Source: FAO Statistical Pocketbook 2015

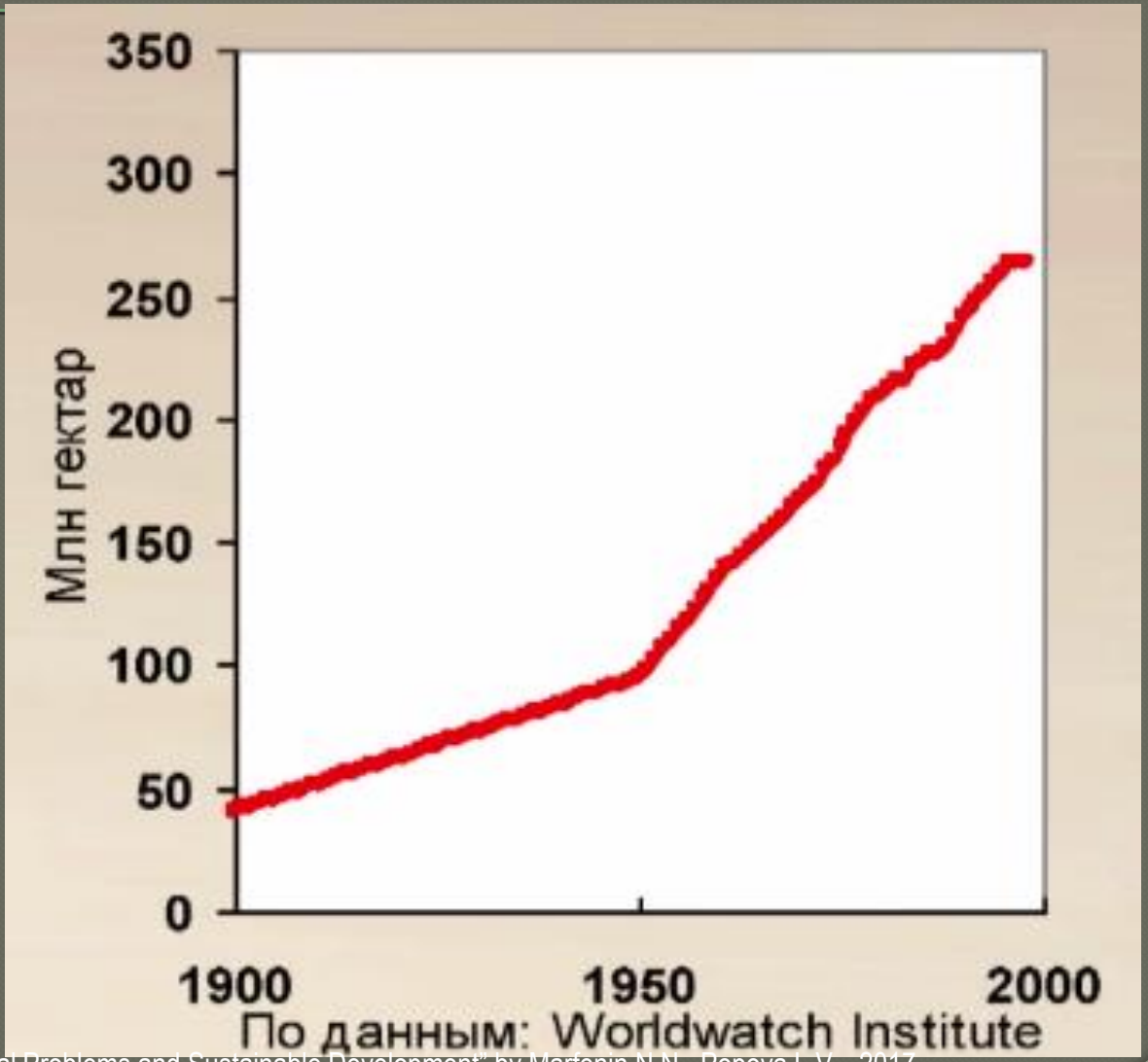
Agriculture Land



Cropland and managed pastures cover 38% of planetary land surface, of which 1/3 is crops and 2/3 - pasture

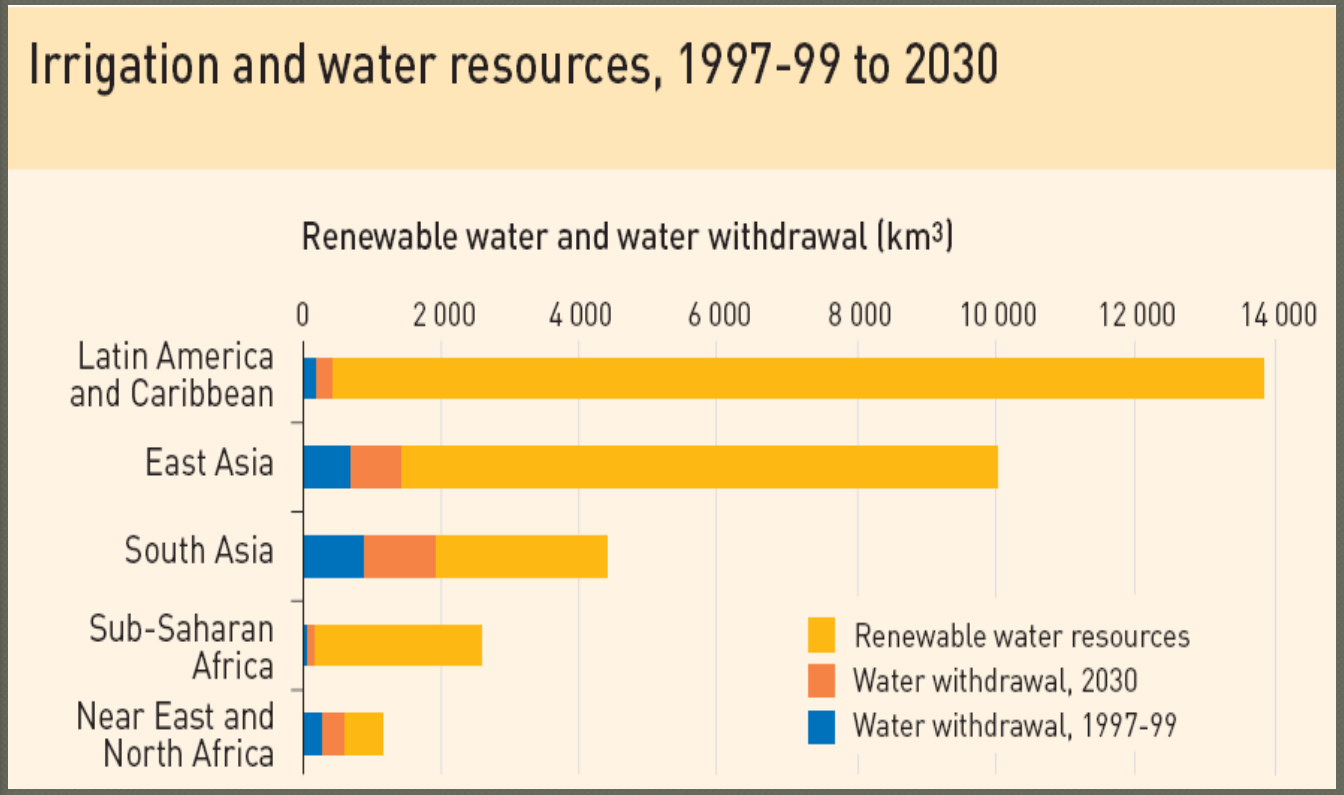
2. Water

- Dynamics of Irrigated Land (1900-1998)



Water

- Irrigation is crucial to the world's food supplies



- The developing countries are likely to expand their irrigated area
- Water resources will be a major factor constraining expansion in South Asia and in Africa

CHART 65: **Freshwater withdrawal by agricultural sector, share of total, highest 20 (1999 to 2013)**

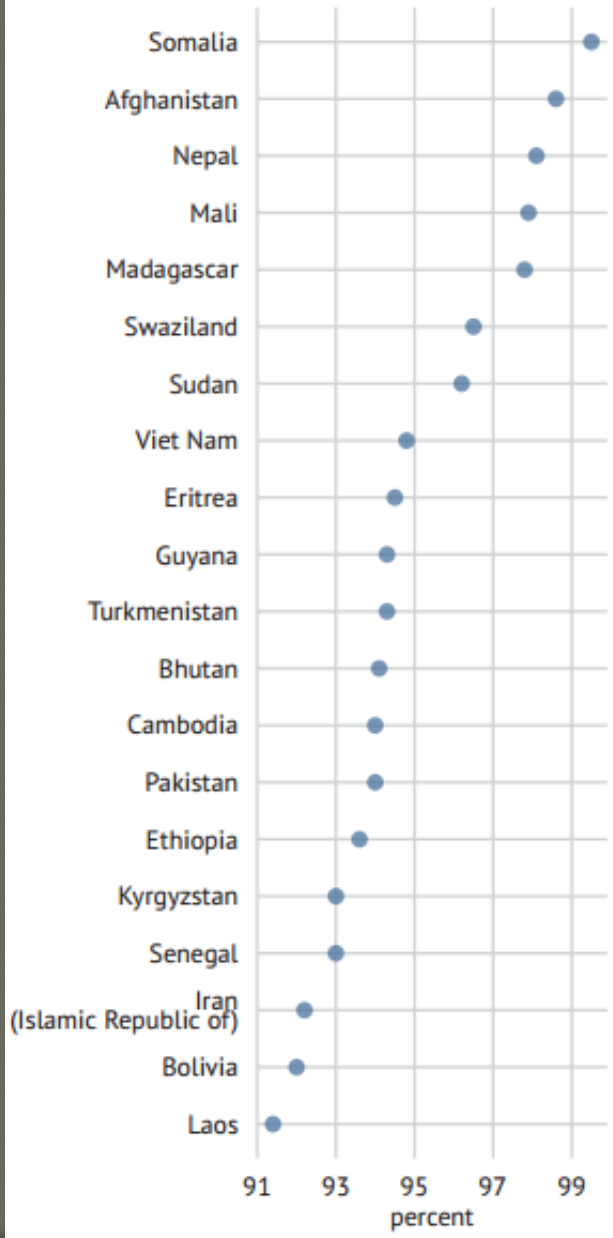


CHART 66: **Countries with the highest renewable water resources per capita**

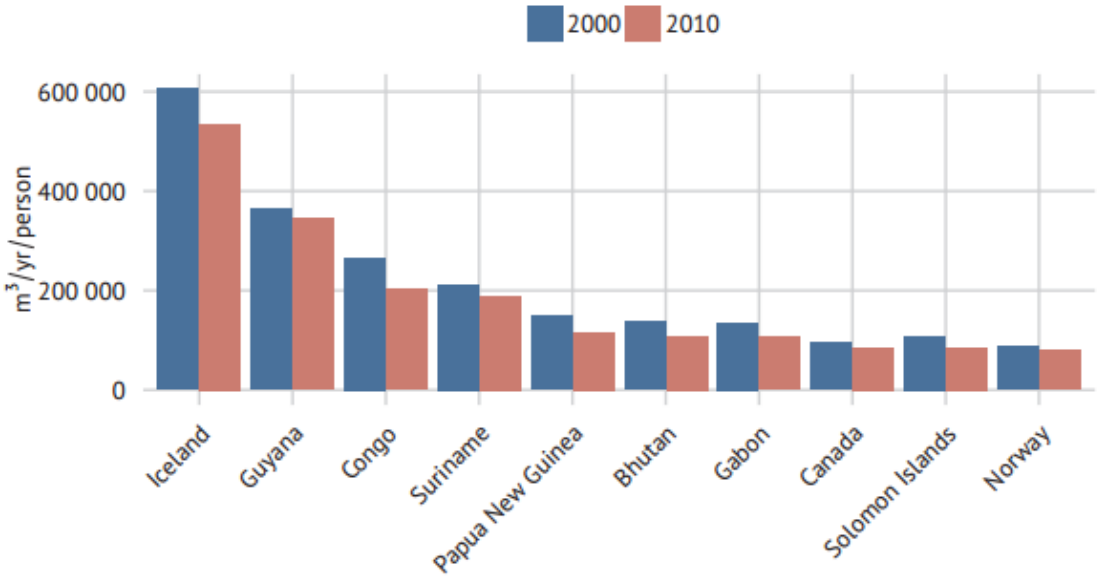
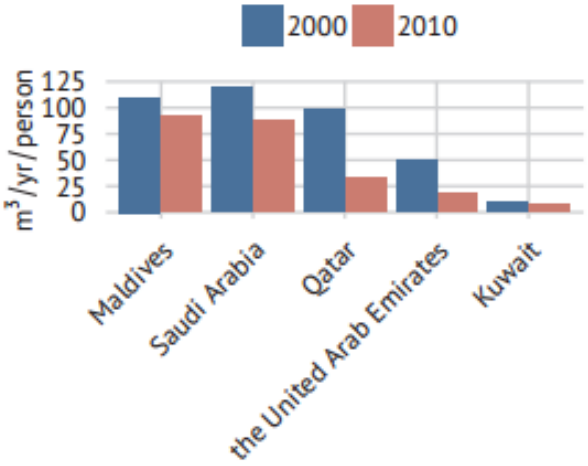


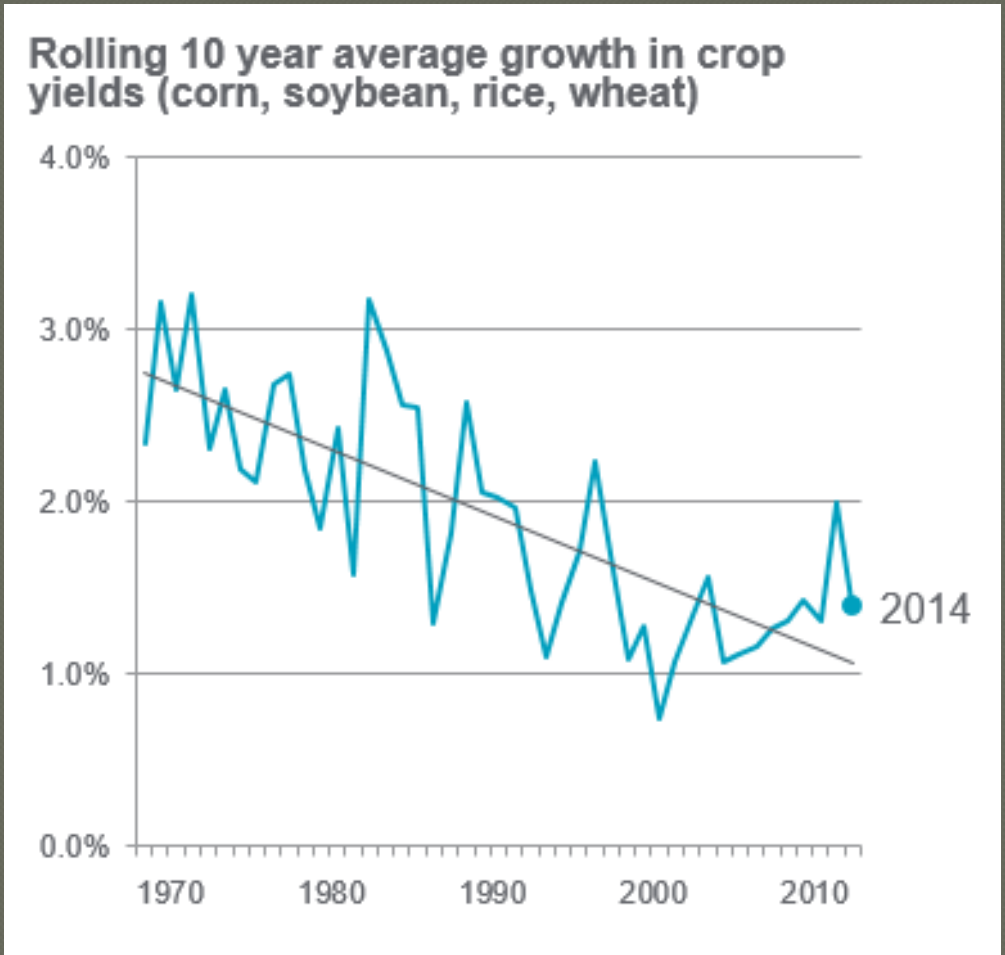
CHART 63: **Countries with the lowest renewable water resources per capita**



3. Yields

- Yield growth will continue to be the dominant factor underlying increases in crop production in the future
  - FERTILIZERS
  - PESTICIDES
  - MECHANIZATION

Yield improvement slowing down in major crops

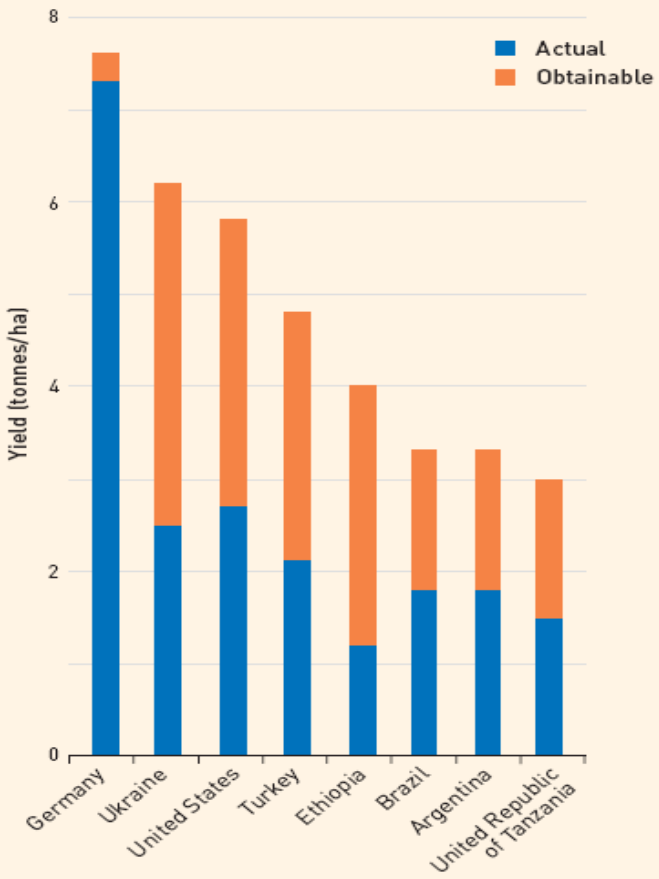


- Reduced yield improvement rate is insufficient to support increasing demand

Source: Syngenta Corporate Presentation, 2017

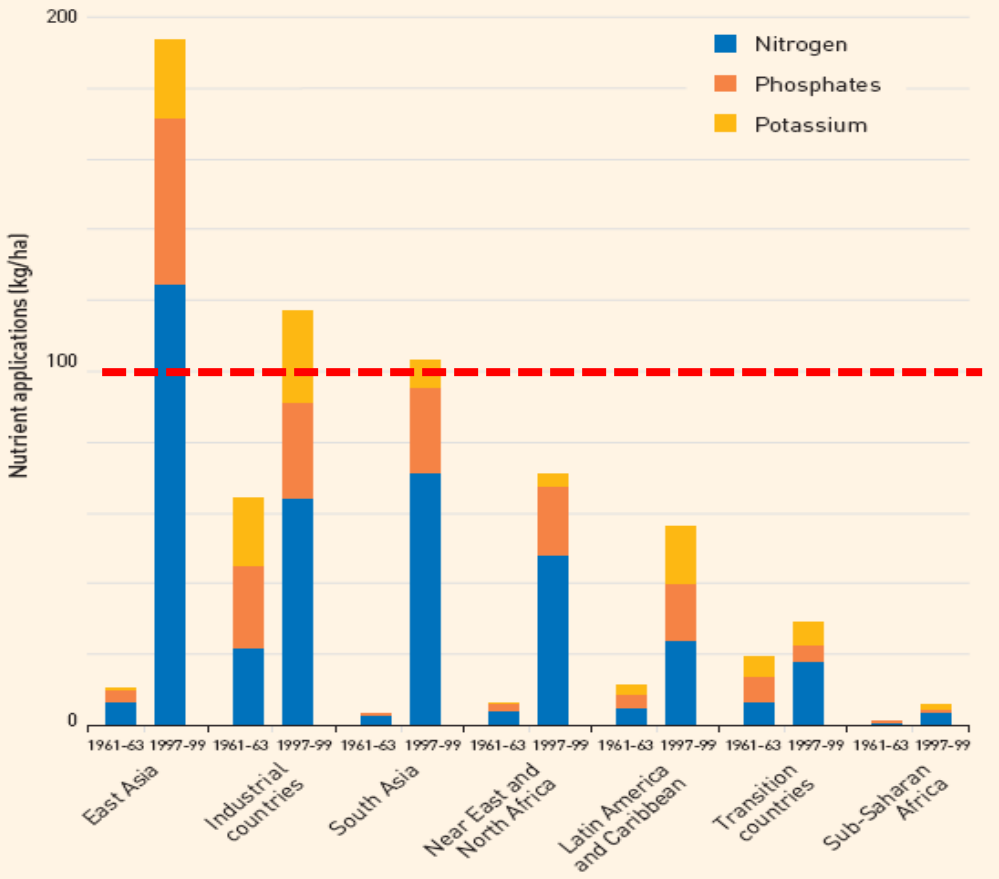
What yield growth is possible?

Exploitable yield gaps for wheat: actual versus obtainable yield



Sources: FAO data and Fischer *et al.* (2000)

Fertilizer use, 1961 to 1999



Source: FAO data

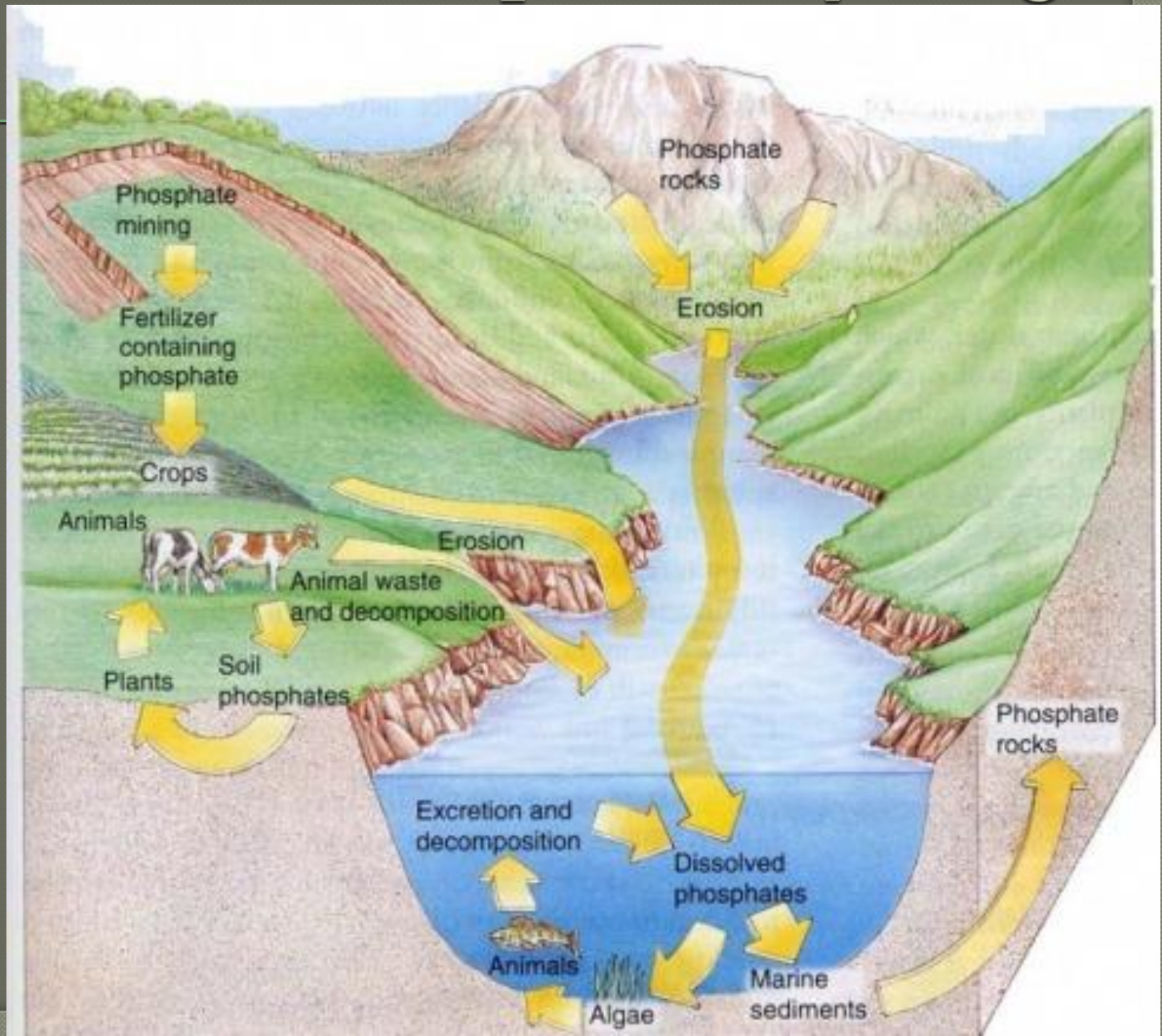
Main Components of Mineral Fertilizers

World	1990	2000	2014
Fertilizers, Nitrogen (kg of nutrients per ha)		*64.9*	*85.8*
Fertilizers, Phosphate (kg of nutrients per ha)		*25.9*	*33.2*
Fertilizers, Potash (kg nutrients per ha)		*18.2*	*20.4*

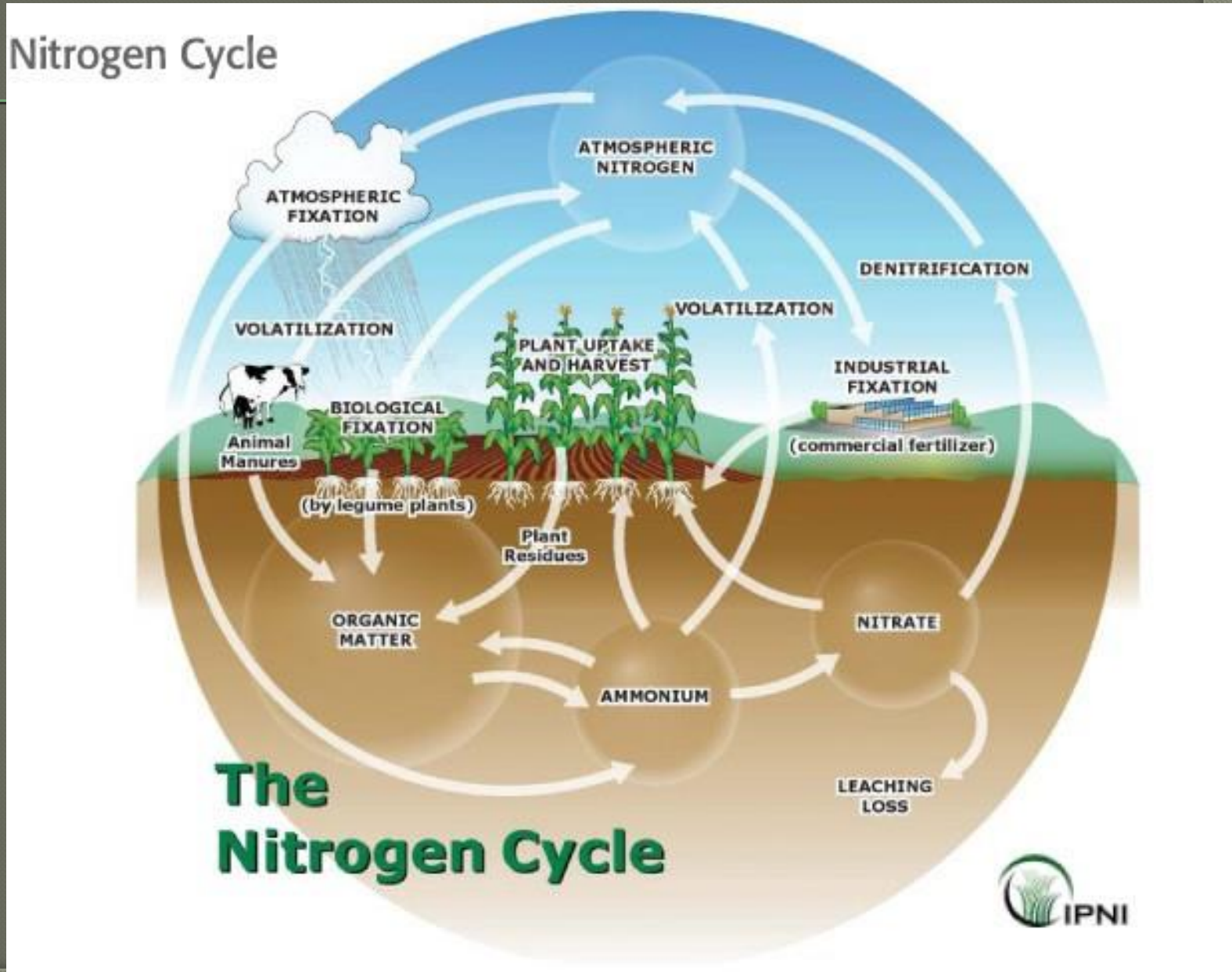
Source: FAO Statistical Pocketbook 2015

- Overuse of mineral fertilizers:
  - Intoxication due to nitrates excess
  - Carcinogenic risk
  - Eutrophication of water
  - Pollution of soils by contaminants

Phosphate Cycling

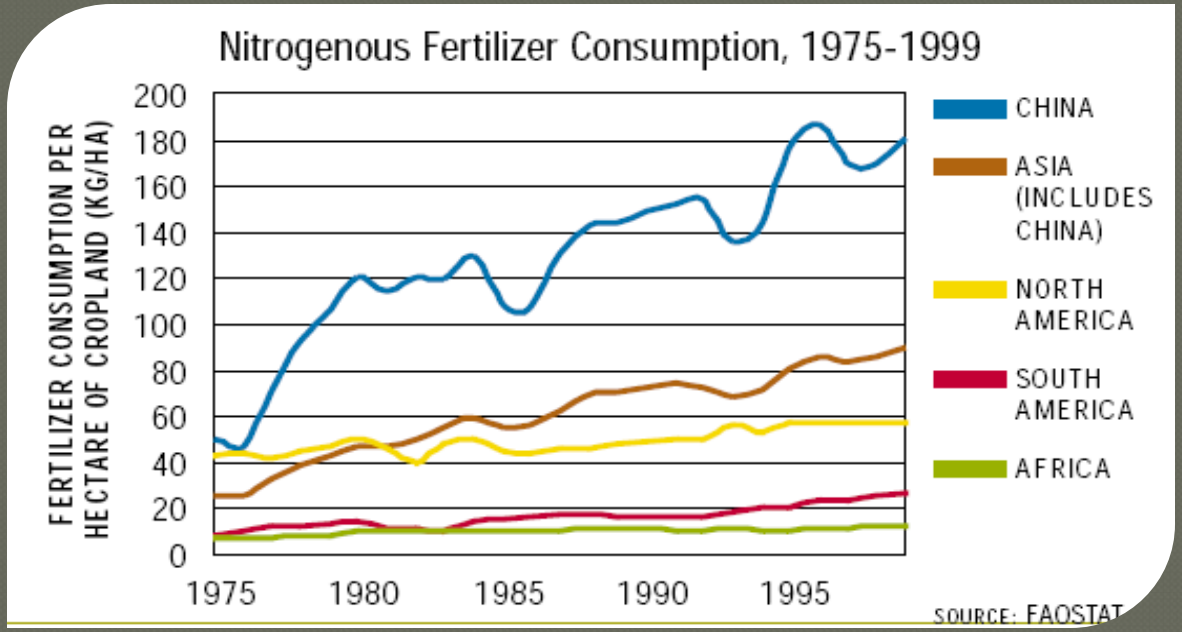


Nitrogen Cycling



Fertilizers in Agriculture

Nitrogen fertilizers and irrigation are being used more and more to raise and maintain crop yields

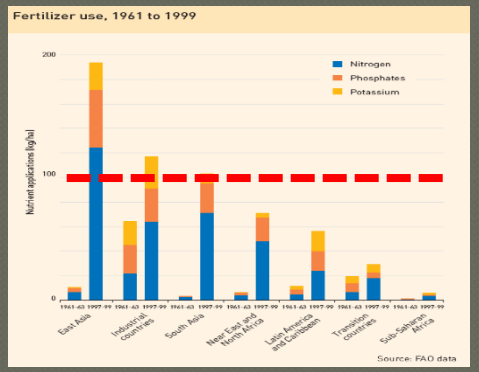


The Monsanto Company

- A US based multinational agricultural biotechnology corporation
- The world's leading producer of the herbicide glyphosate
- The leading producer of genetically engineered (GE) seeds
- Negative case of overuse of fertilizers

Mineral Fertilizers: FACTS

- Nitrates *(нитраты)* → … in human body …→ Nitrites *(нитриты)* → Methemoglobinemia *(метгемоглобинемия)*



Allowable application doses of mineral fertilizers in 1970s**:**

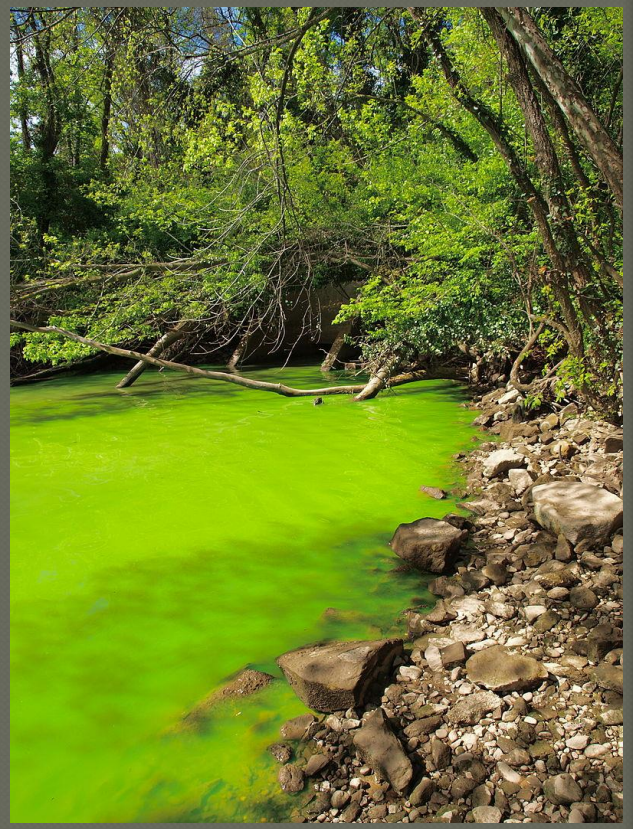
- Western Europe: > **than 100 kg/ha**
- Netherlands: 700 kg/ha
- New Zealand: > than 1000 kg/ha
- USA & USSR: **< than 100 kg/ha**

Consequences of Green Revolution

Nauru Island
in Pacific Ocean:
10 m layer of
Phosphorites

Consequences of Green Revolution

- **Eutrophication** is the enrichment of a water body with nutrients, usually with an excess amount of them.
- This process induces growth of plants and algae and due to the biomass load, may result in oxygen depletion of the water body.



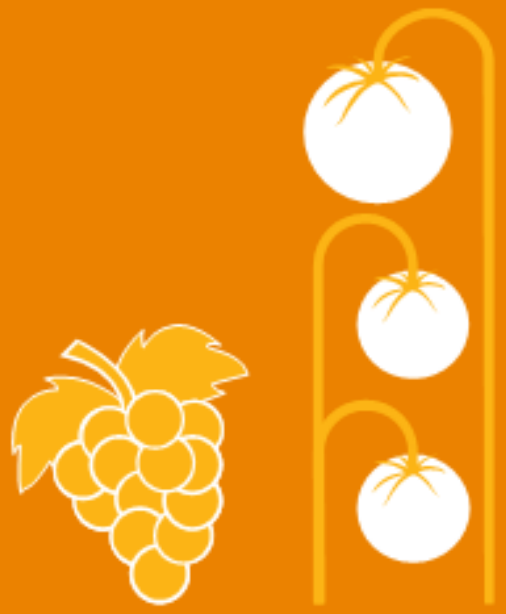
The eutrophication of the Potomac River

Consequences of Green Revolution

- Eutrophication is almost always induced by the discharge of **phosphate** containing detergents, **fertilizers**, or sewage, into an aquatic system.

Consequences of Green Revolution

- PESTICIDES
- **Pesticides** are chemical substances that are meant to control pests or weeds.
- TYPES: herbicide, insecticide, insect growth regulator, nematicide, molluscicide, hermiticide, pesticides, avicide, rodenticide, predacide, bactericide, insect repellent, animal repellent, antimicrobial, fungicide, disinfectant (a ntimicrobial), and sanitizer.
- The most common of these are **herbicides** which account for approximately 80% of all pesticide use.



Without fungicides, yields of most fruits and vegetables would fall by 50–90%, making fresh produce unaffordable to many

syngenta

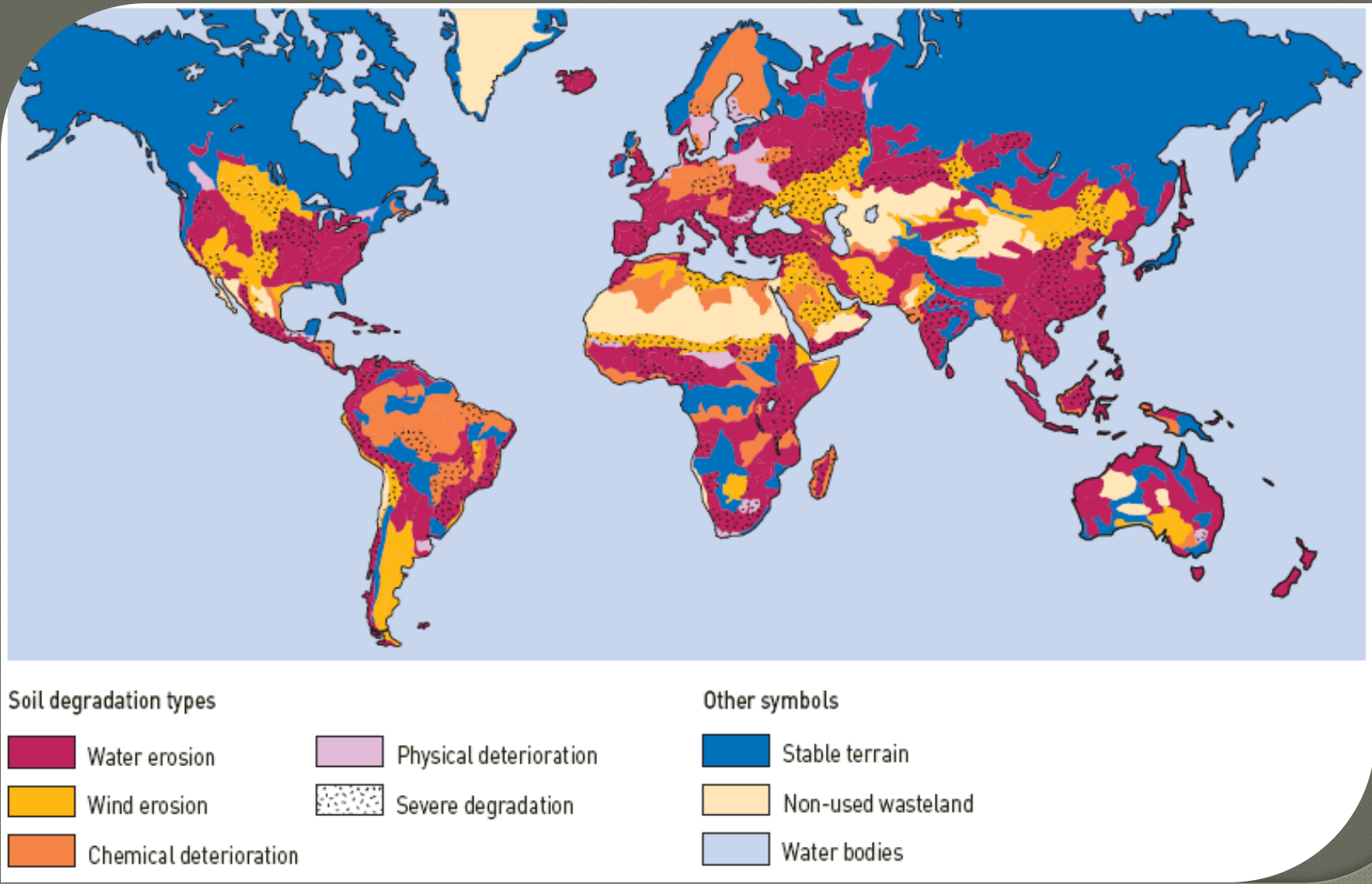
Consequences of MECHANIZATION

- Soil erosion
- Soil compaction
- Increase in energy consumption

Due to drought and desertification each year 12 million hectares of soil are lost (23 hectares/minute!), where 20 million tons of grain could have been grown

syngenta

Human Induced Soil Degradation in the World

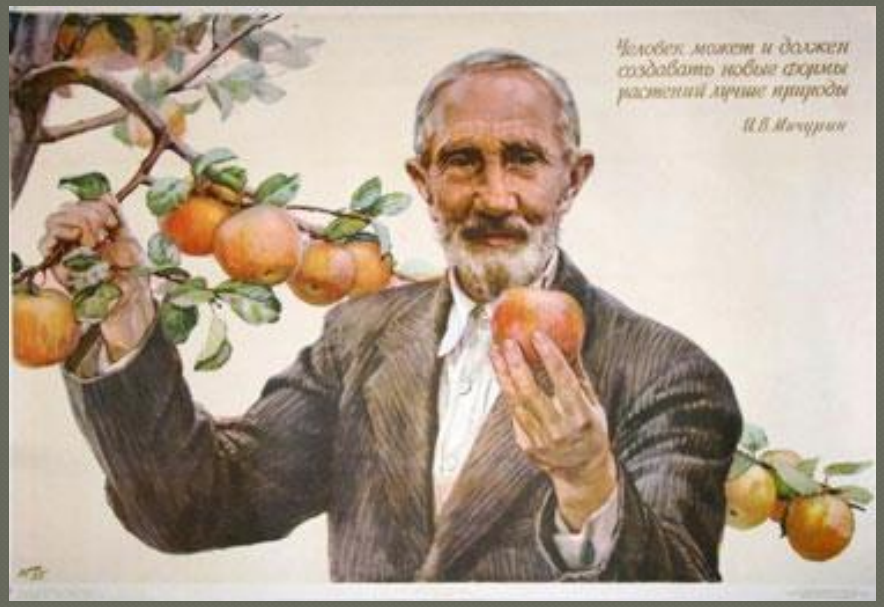


No-Till Agriculture

- No-tillage is a system of farming in which planting is done in a narrow trench, without tillage, and weeds are controlled with herbicide

- What are main advantages and disadvantages of no-till farming?
- In what countries this method of farming is becoming more popular?

4. Selection

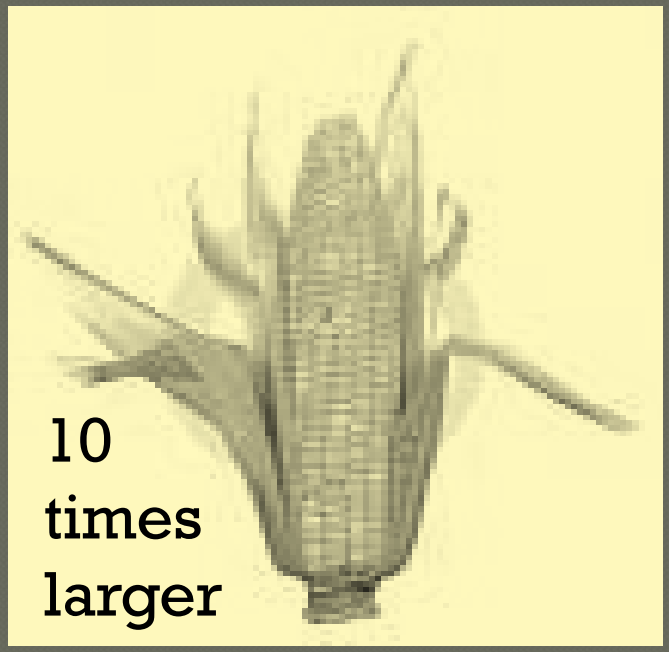
- It is a process of breeding of new varieties and breeds
- 

Michurin I.V. (1855-1935)
- Biotechnology or genetic engineering

Selection: Plant Breeding

- Plant's breeding through the human history
  - To understand it it's sufficient to compare corn ear of today with its analogue of 5.000 years ago

In 5.000 years



BIOTECH CROPS ≈
≈ GM CROPS

Table 1. Global Area of Biotech Crops in 2015: by Country (Million Hectares)**

Rank	Country	Area (million hectares)	Biotech Crops
1	USA*	70.9	Maize, soybean, cotton, canola, sugar beet, alfalfa, papaya, squash, potato
2	Brazil*	44.2	Soybean, maize, cotton
3	Argentina*	24.5	Soybean, maize, cotton
4	India*	11.6	Cotton
5	Canada*	11.0	Canola, maize, soybean, sugar beet
6	China*	3.7	Cotton, papaya, poplar
7	Paraguay*	3.6	Soybean, maize, cotton
8	Pakistan*	2.9	Cotton
9	South Africa*	2.3	Maize, soybean, cotton
10	Uruguay*	1.4	Soybean, maize
11	Bolivia*	1.1	Soybean
12	Philippines*	0.7	Maize
13	Australia*	0.7	Cotton, canola
14	Burkina Faso*	0.4	Cotton
15	Myanmar*	0.3	Cotton
16	Mexico*	0.1	Cotton, soybean
17	Spain*	0.1	Maize
18	Colombia*	0.1	Cotton, maize
19	Sudan*	0.1	Cotton
20	Honduras	<0.1	Maize
21	Chile	<0.1	Maize, soybean, canola
22	Portugal	<0.1	Maize
23	Vietnam	<0.1	Maize
24	Czech Republic	<0.1	Maize
25	Slovakia	<0.1	Maize
26	Costa Rica	<0.1	Cotton, soybean
27	Bangladesh	<0.1	Brinjal/Eggplant
28	Romania	<0.1	Maize
	Total	**179.7**	

* 19 biotech mega-countries growing 50,000 hectares, or more, of biotech crops
** Rounded off to the nearest hundred thousand

Source: Clive James, 2015.

http://isaaa.org/resources/publications/briefs/51/executivesummary/default.asp

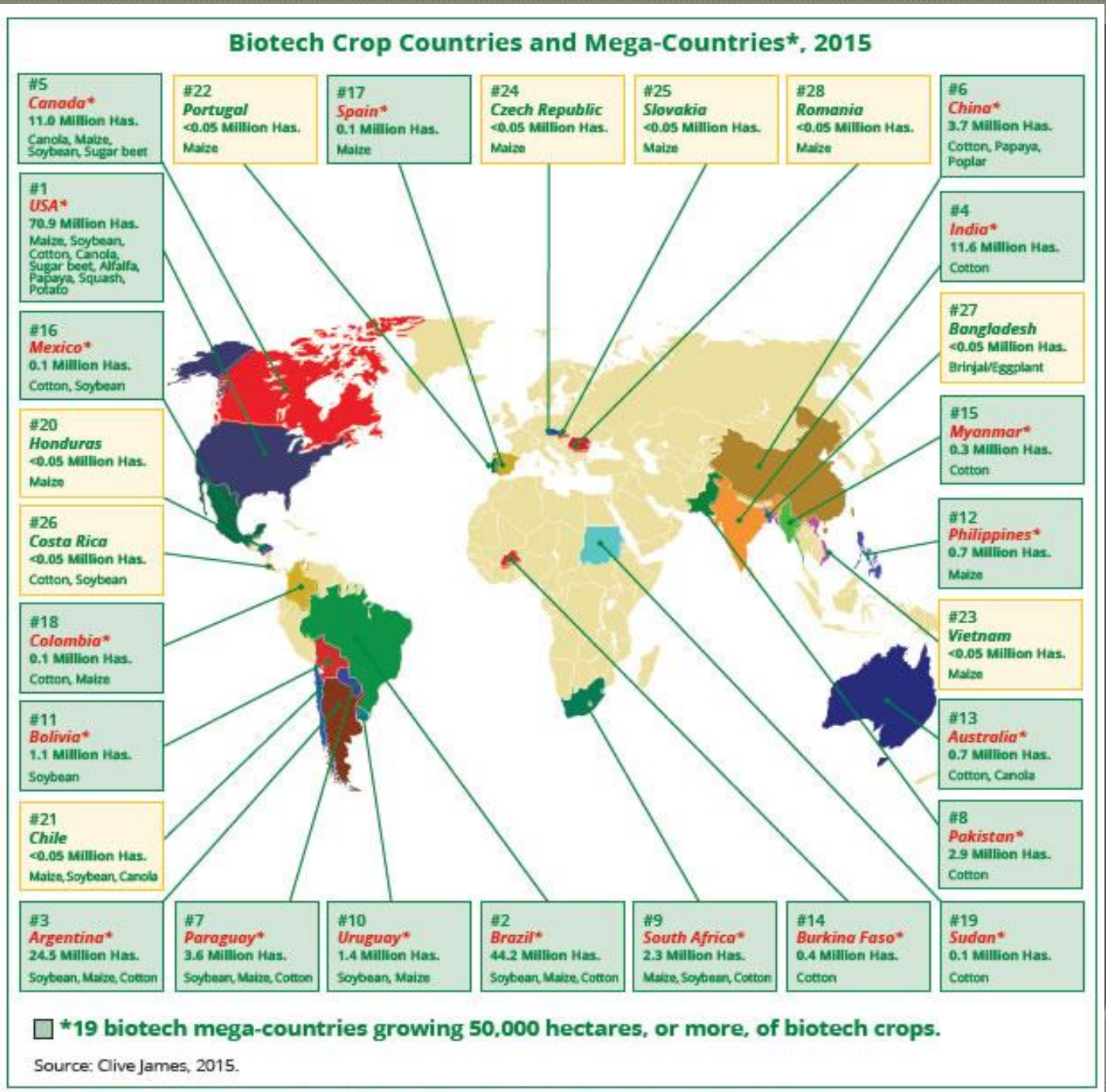


Figure 1. Global Map of Biotech Crop Countries and Mega-Countries in 2015

http://isaaa.org/resources/publications/briefs/51/executivesummary/default.asp

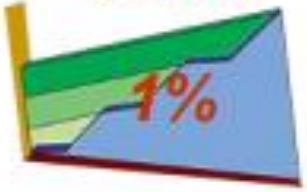
Global Area (Million Hectares) of Biotech Crops, 2015: by Country

SOYBEAN *CORN*
COTTON **RAPE**

28 countries which have adopted biotech crops

In 2015, global area of biotech crops was 179.7 million hectares, representing a marginal decrease of 1% from 2014, equivalent to 1.8 million hectares.

Marginal Decrease from 2014



Source: Clive James, 2015.

Biotech Mega Countries

50,000 hectares (125,000 acres), or more

		Million Hectares
1.	USA	70.9
2.	*Brazil**	44.2
3.	*Argentina**	24.5
4.	*India**	11.6
5.	Canada	11.0
6.	*China**	3.7
7.	*Paraguay**	3.6
8.	*Pakistan**	2.9
9.	*South Africa**	2.3
10.	*Uruguay**	1.4
11.	*Bolivia**	1.1
12.	*Philippines**	0.7
13.	Australia	0.7
14.	*Burkina Faso**	0.4
15.	*Myanmar**	0.3
16.	*Mexico**	0.1
17.	Spain	0.1
18.	*Colombia**	0.1
19.	*Sudan**	0.1

Less than 50,000 hectares

*Honduras**
*Chile**
Portugal
*Vietnam**
Czech Republic
Slovakia
*Costa Rica**
*Bangladesh**
Romania

* *Developing countries*

International Service for the Acquisition of Agri-Biotech Applications (ISAAA)

BIOTECH CROPS [PLANTED OR APPROVED* IN 2014] AND BENEFITS: 2014 ISAAA Global Status Report Updates

UNITED STATES: INNATE™ POTATO APPROVED*

- 4th most important food crop in the world
- Will not discolor when peeled
- Has fewer bruising spots
- Increases shelf-life
- Decreases potential for producing acrylamide (potential carcinogen) when potatoes are cooked at high temperatures

INDONESIA: DROUGHT-TOLERANT SUGARCANE APPROVED*

- Increases availability of valuable food source
- Indonesia is the second-largest sugar importer in the world, importing 2.4M tonnes at $1.6B annually
- Decreases dependency on imported sugar
- In field trials, yield increased markedly
- Public-private partnership with Ajinomoto

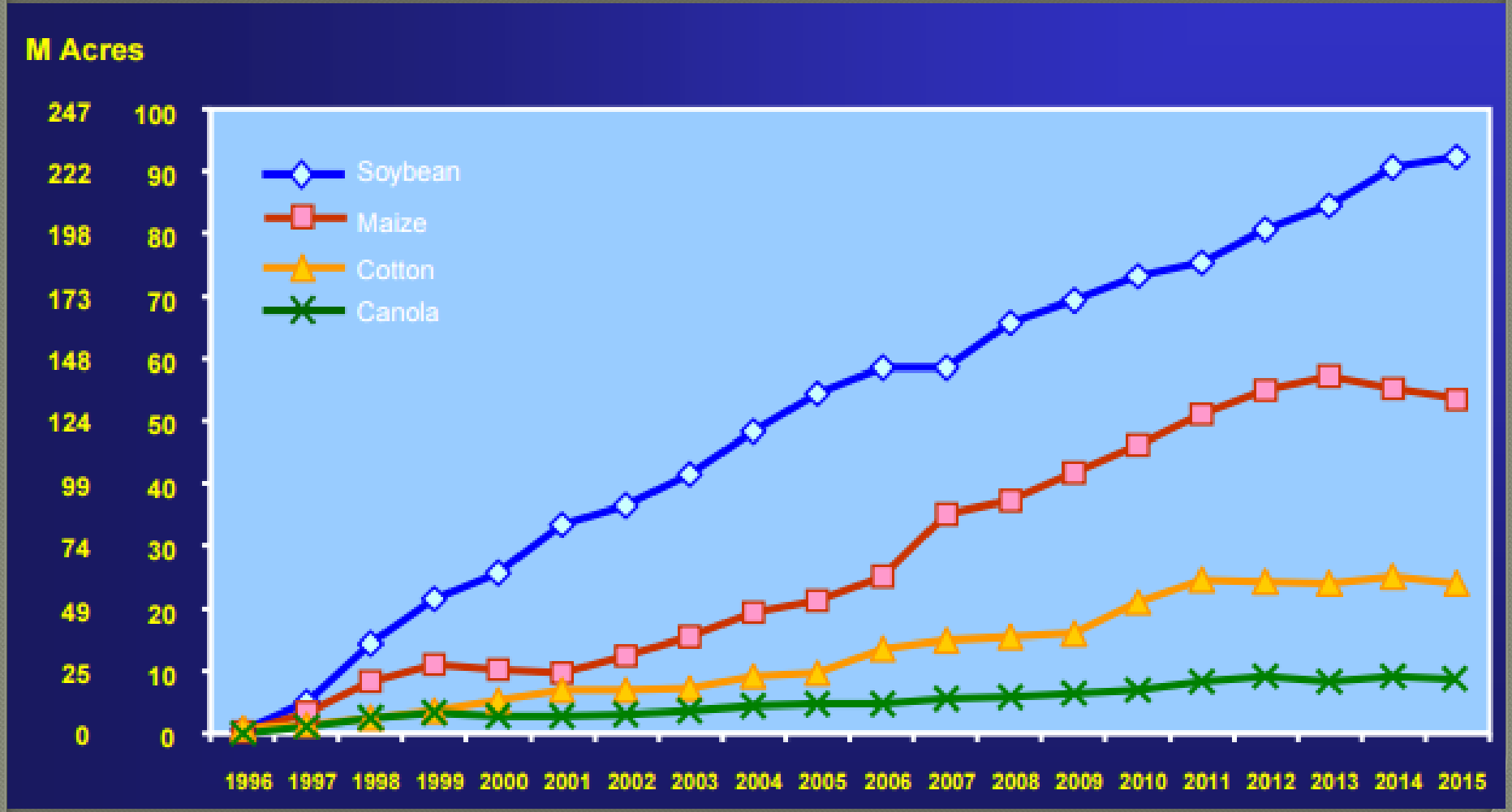
BANGLADESH: TIMELY COMMERCIALIZATION OF *Bt* BRINJAL (EGGPLANT)

- Less than 100 days post-approval
- One of the most nutritious and important vegetables in the country
- Significant opportunity for resource-poor farmers
- 70 to 90% decrease in insecticide sprays on a food crop

*Approved in 2014: potato and alfalfa in the U.S.; sugarcane in Indonesia; and maize in Vietnam. Approved prior to 2014, pending planting in 2015: virus resistant dry beans and HT soybean in Brazil.

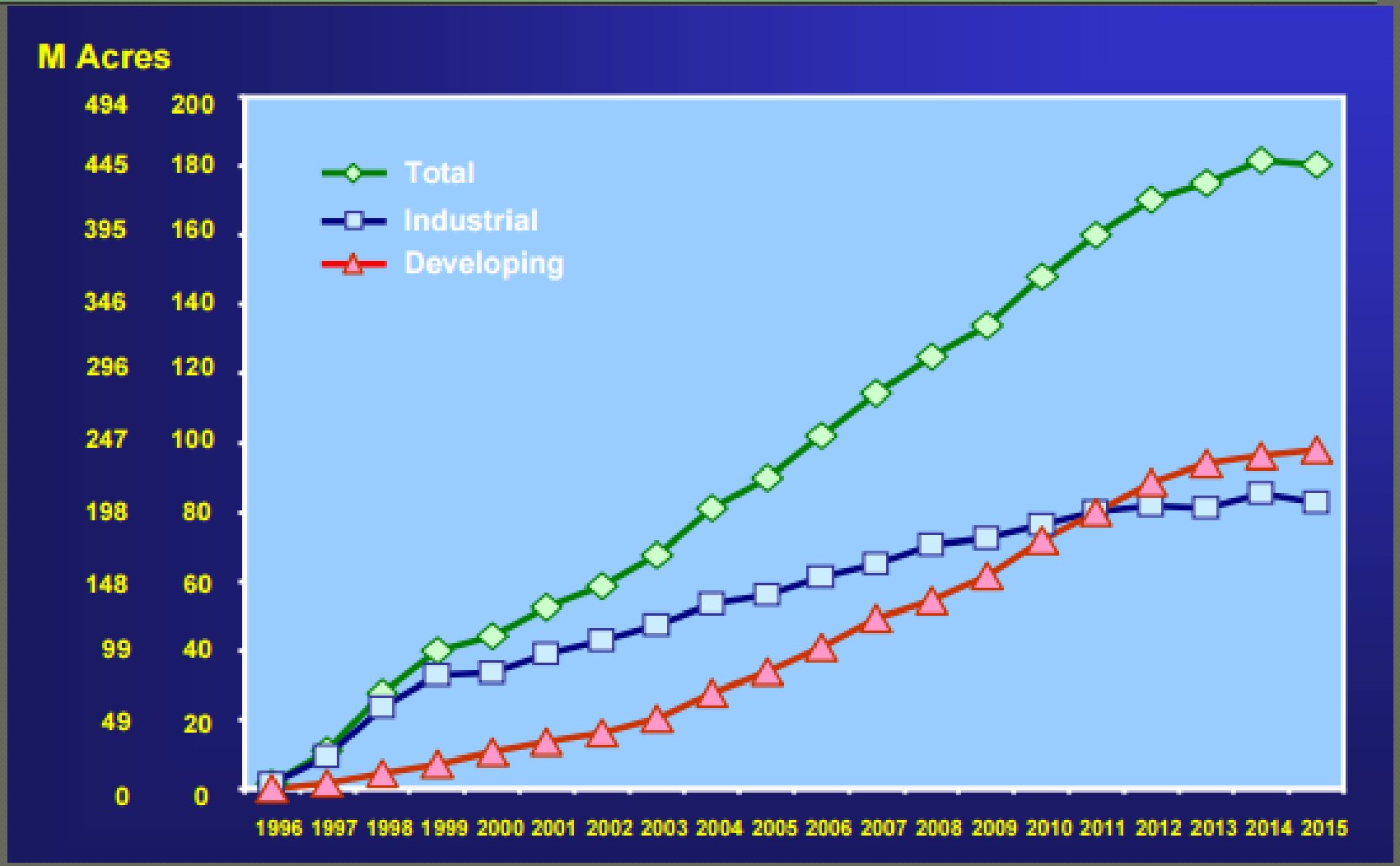
ISAAA

Global Area of Biotech Crops, 1996 to 2015 (mln ha, mln acres)



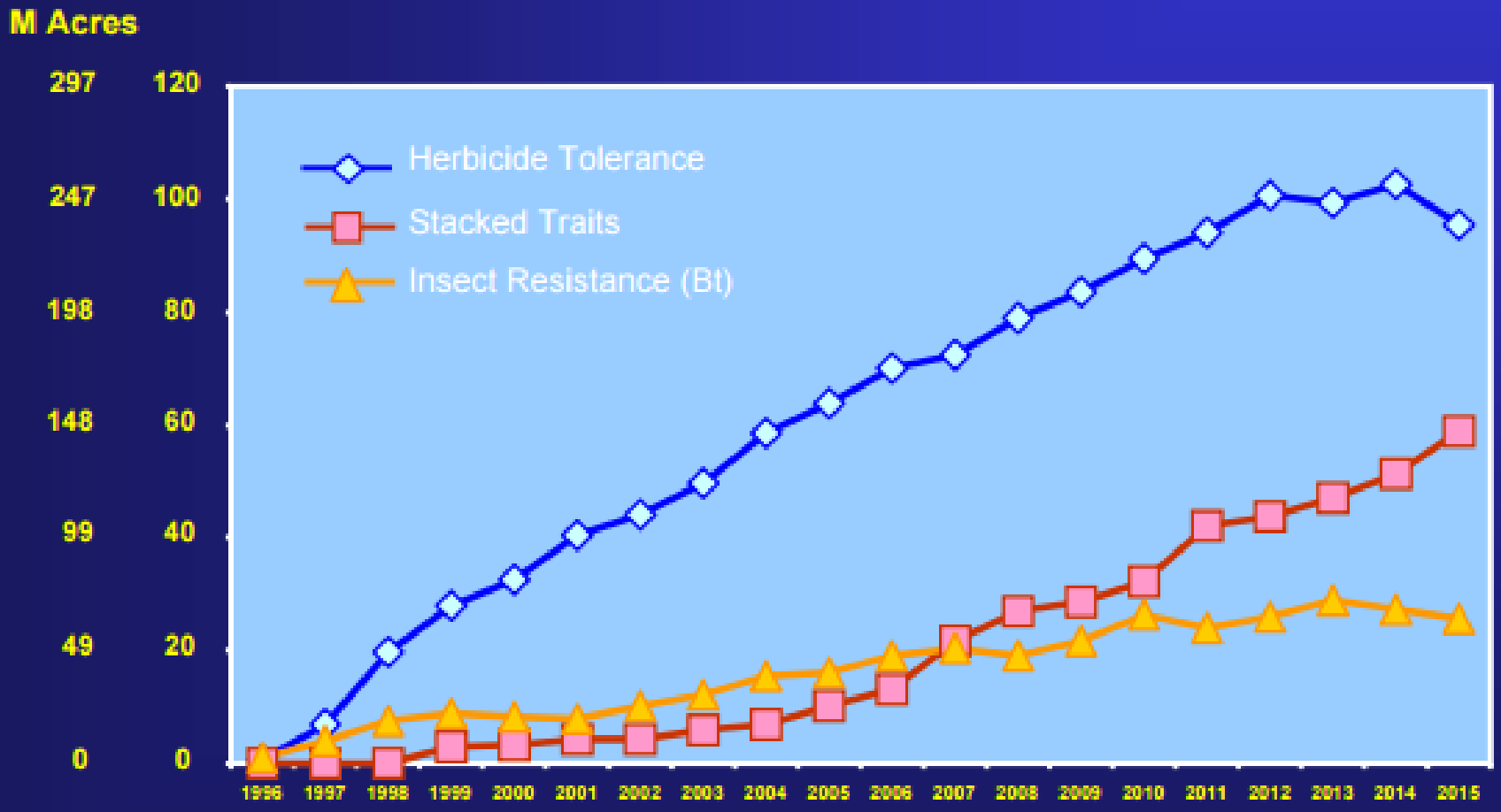
Source: ISAAA cit.by Clive James, 2015

Global Area of Biotech Crops, 1996 to 2015 (M Has, M Acres)



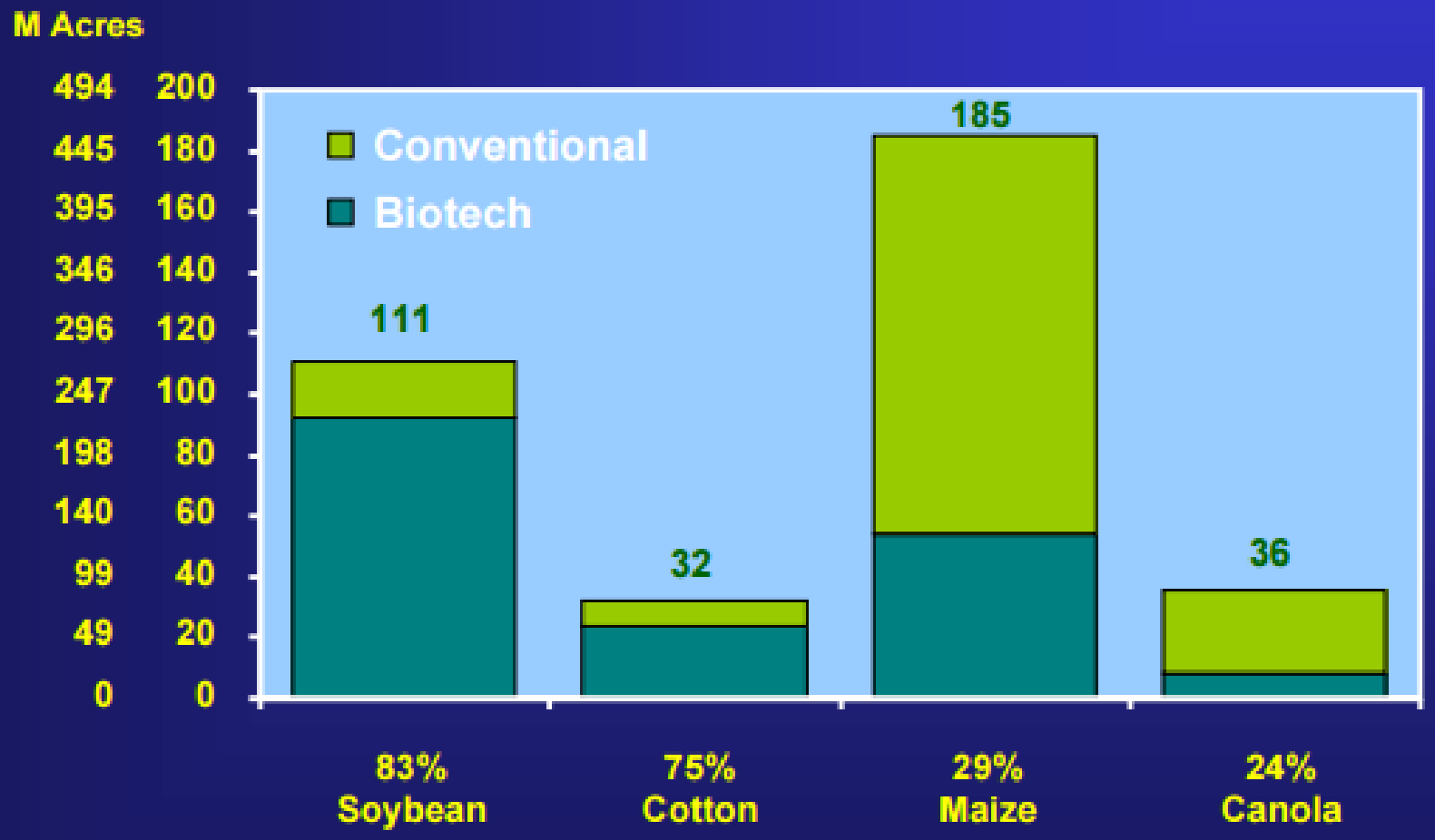
Source: ISAAA cit.by Clive James, 2015

Global Area of Biotech Crops, 1996 to 2015: By Trait (Million Hectares, Million Acres)



Source: Clive James, 2015

Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares, Million Acres), 2015

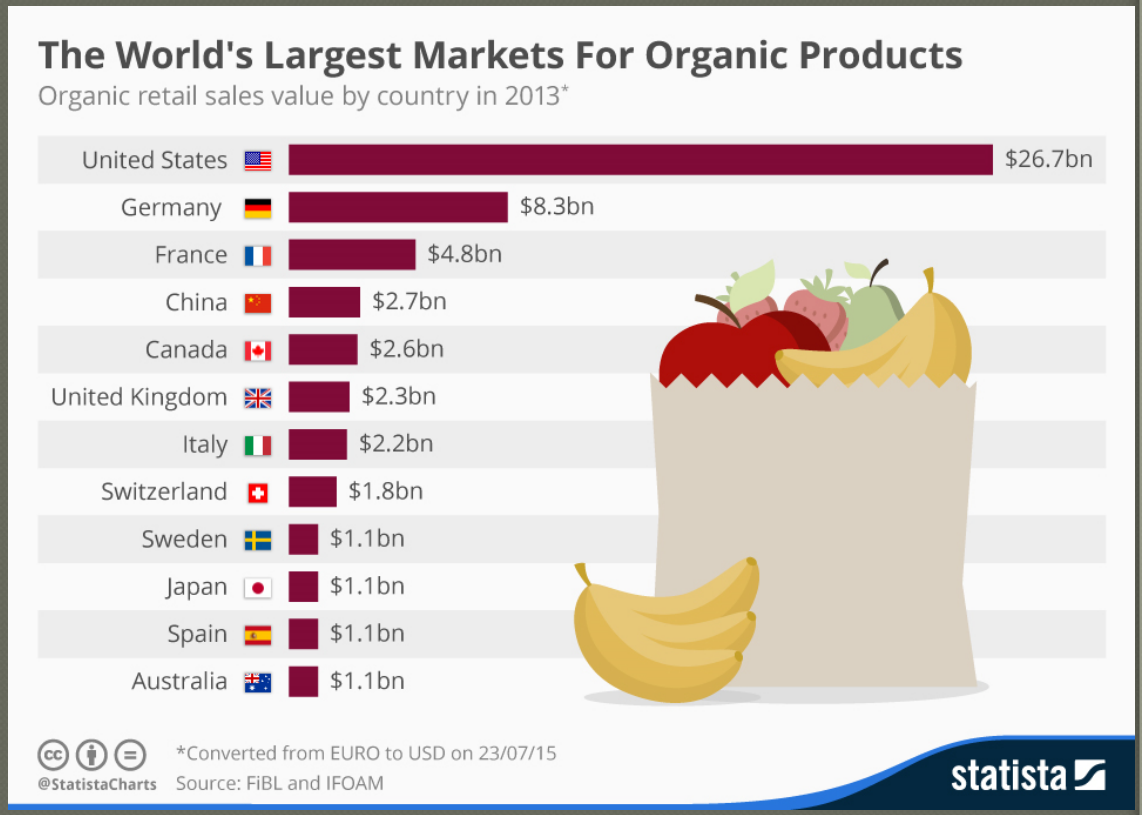


Source: Clive James, 2015
Hectarage based on FAO Data for 2013.

Canola is a genetically engineered plant developed in Canada from the rapeseed plant (canola is not the name of a natural plant but a made-up word, from the words "Canada" and "oil")

Organic Agriculture Products

- Concerned consumers create hot markets
- "Organic" food – food produced without any chemical inputs and to various ecostandards



Annual growth of "organic" food retail market is 10-30% in developed countries

Conclusions

- For the cultivation of agricultural products, mankind uses nearly 1/3 of the land. Further expansion of the land is inappropriate.
- The productivity of agriculture is constantly growing due to the use of sophisticated technologies – "green revolution". Intensification occurs with the use of mechanization, mineral fertilizers, pesticides, irrigation and selection of varieties.
- Each of the listed agrotechnologies has its negative aspects, which are manifested when it is used excessively. Therefore, further growth in agricultural productivity in a limited area is not unlimited and the limit has already been achieved in many countries.
- Among promising developing agrotechnologies are precision farming *(точное земледелие)* and robotics *(робототехника)*

Based on OpenEdu.Ru, "Global Ecological Problems and Sustainable Development" by Marfenin N.N., Popova L.V. , 2017

Types of Territorial Strategies of Agribusiness

- **Expansion**
  - New lands development (ex.: Middle West of the USA, savannas and *serrados* of Brazil)
  - Occupying new market niches («organic products», biofuel)
  - Discovering new markets (globalization of consumption)
- **Production concentration in vertically integrated agricultural business**
  - Agro holdings in Russia
  - Sugar cane agricultural sector in Latin America countries
- **Diversification and creation of multisector companies**

Concentration Case: Global Coffee Chain

Concentration of market power in the global coffee chain

Four companies control almost 40 percent of global trade in coffee and only three roasters (Philip Morris, Nestlé and Sara Lee) control 45 percent of the global market.

Source: UK Food Group

Land Conflicts

- Agricultural land is disputed mainly inside the country
  - Brazilian movement of *people without land*
- Land with mineral resources or access to the sea is disputable mainly internationally
  - Oil conflicts, etc.
- New types of conflict (international)
  - Taking away the upper layer of soil after timber production

Did you know?

We know of 7 000 plant species in the world that are edible, but over 50% of our plant-derived calories come from only **3 species:**

Corn

Wheat

Rice

Syngenta Case

Syngenta has two core businesses

Crop Protection

Selective herbicides
Non-selective herbicides
Fungicides
Insecticides
Seedcare

Seeds

Corn & Soybean
Diverse Field Crops
Vegetables and Flowers

Who we are

A leading agriculture company helping to improve global food security by enabling millions of farmers to make better use of available resources.

- World-class science and innovative crop solutions.
- 28,000 people in over 90 countries working to transform how crops are grown.
- Committed to rescuing land from degradation, enhancing biodiversity and revitalizing rural communities.

90 countries

107 production and supply sites

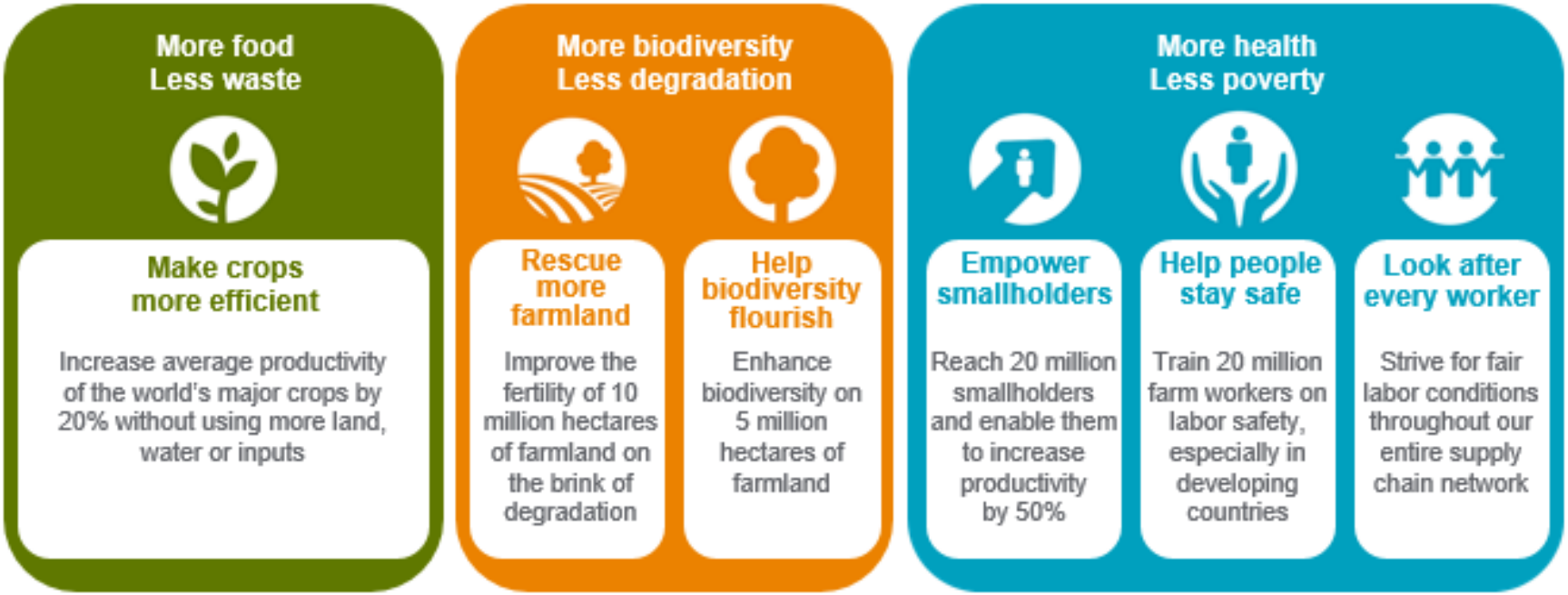
119 research and development sites

27,810 employees

Syngenta Case

The Good Growth Plan

We've made six commitments to help grow more food using fewer resources, while protecting nature, and at the same time helping people in rural communities live better lives



One planet. Six commitments.

Syngenta Case

Keeping our commitments relevant to society

Our six Good Growth Plan commitments help us quantify how we contribute to the Sustainable Development Goals set out in the United Nations Agenda 2030.

SUSTAINABLE DEVELOPMENT GOALS