



Vincent Van Gogh, Wheatfield with crows, 1890

Environmental aspects of Agriculture

Food security

X

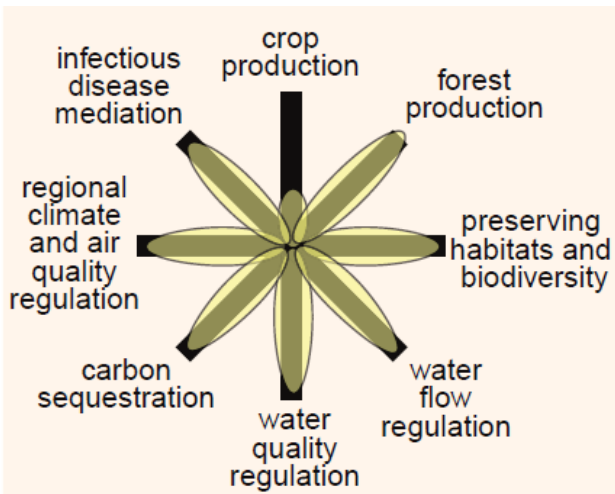
Biodiversity

Food security

Intensive agriculture + and - X Extensive agriculture + and -

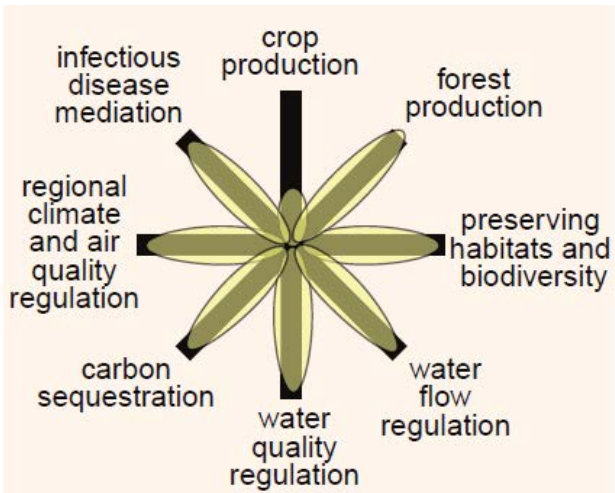
Biodiversity

Biodiversity



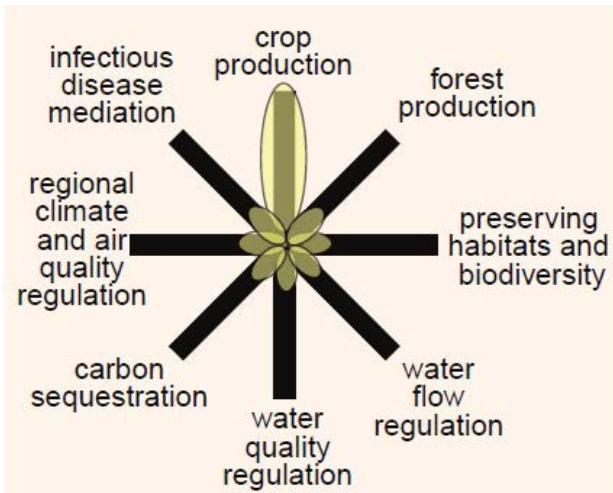
natural ecosystem

Biodiversity



natural ecosystem

Food security



intensive cropland

Agriculture x Agro-ecosystem - overview

Agriculture (economy view)

- the primary sector of the economy
- providing food and materials for production



Agriculture x Agro-ecosystem - overview


Agriculture (economy view)

- the primary sector of the economy
- providing food and materials for production

Agroecosystem (ecological view)

- a specific type of planetary ecosystems
- a functional unity of economically important organisms and environment
- narrower view - field; wider view - river basin, landscape, region
- originally, the most productive ecosystems





What are functions (importance) of an agriculture?

Importance of Agriculture

Productive function

- foodstuffs, industrial raw materials (textile and the leather industry, fats ...), and energy



Importance of Agriculture

Productive function

- foodstuffs, industrial raw materials (textile and the leather industry, fats ...), and energy

Non-productive functions

- creation and maintenance of the typical cultural landscape - *Genius loci*
- maintaining functioning agroecosystems with specific biodiversity
- self-supply of the region with food, employment
- the environment of people and other organisms
- conservation of rural settlements, recreation





Vincent Van Gogh, Wheatfield with crows, 1890



1915
Václav Špála, Landscape, 1915



Otakar Kubín, Landscape with cornfield, cca 1940

Food security

- corresponds with population growth, but necessarily?

1798 **T. R. Malthus** - *An Essay on the Principle of Population*

- warning against food shortages in the future "*human population grows exponentially, food production only linearly*"

- in the history, frequent famines that limited the growth of population

Food security

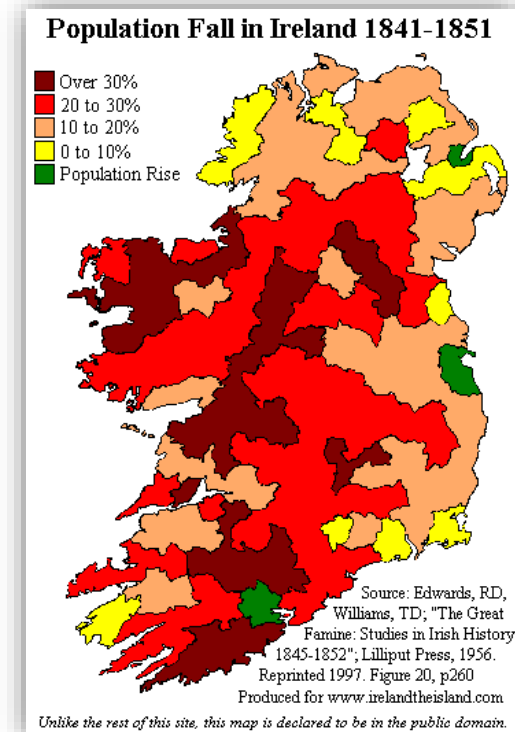
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1845-1850 - Irish famine

- 1,000,000 victims, many others emigrated
- the primary source of food for the poor - potatoes
 - the potato mold destroyed the crop
- lack of food + loss of land (they did not pay the rent)
- the spread of cholera and typhoid exacerbated the destruction of the population



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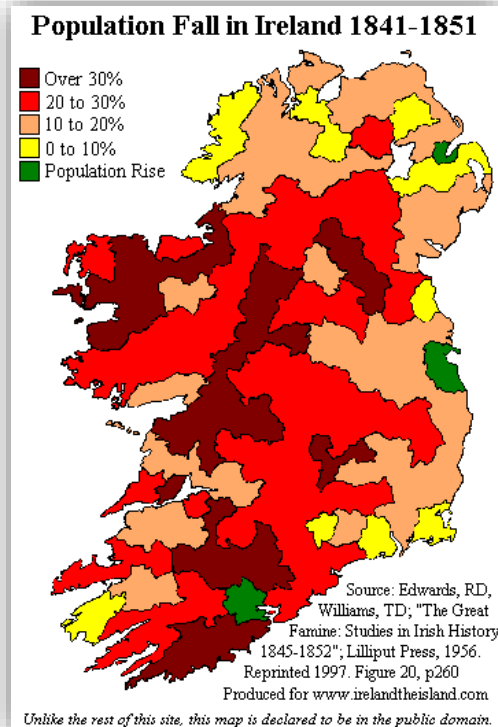
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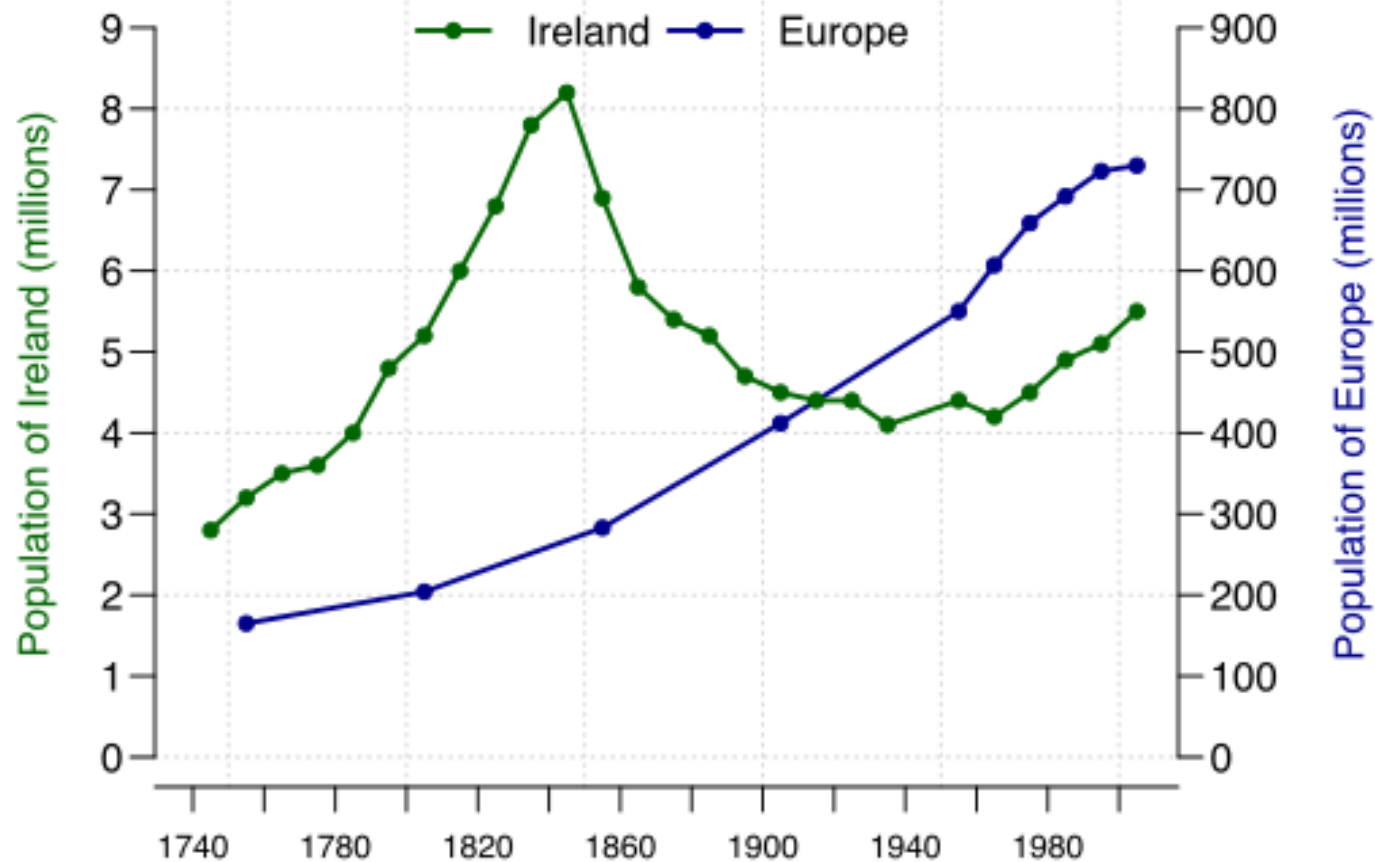
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BUT - there was **enough food in Ireland** - corn, wheat, oats!

- the were sold to the UK at a much higher price than poor farmers could afford, according to rational calculations



The Almighty, indeed, sent the potato blight, but the English created the Famine. John Mitchel





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Lack of food x famine – causes

Bengal Famine 1943 1-4,000,000 Victims - **Why?**

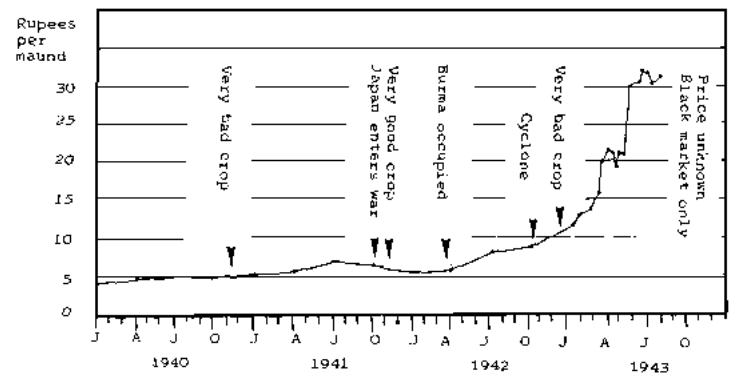


Figure 1: Wholesale price of coarse rice on the Calcutta market, 1940-1943. Source: Famine Inquiry Commission, 1945.





What was the cause of the Bengal famine?

Lack of food x famine – causes

Bengal Famine 1943 1-4,000,000 Victims - **Why?**

- there was a crop failure in Bengal, but this is a periodic phenomenon
- however, the war was raging (GB x J) and it was necessary to supply cities (soldiers) first
- grain prices have risen significantly - **poor people could not afford it**

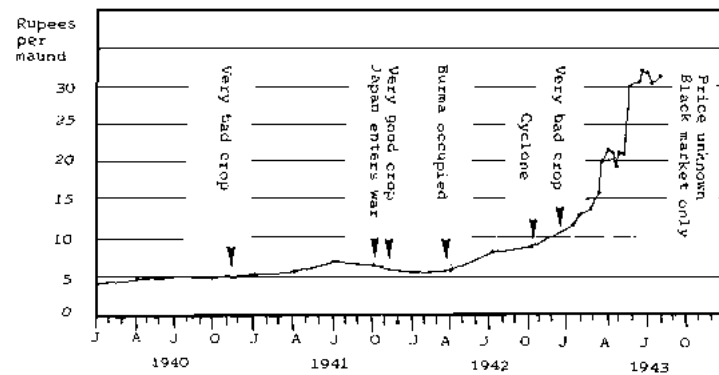


Figure 1: Wholesale price of coarse rice on the Calcutta market, 1940-1943. Source: Famine Inquiry Commission, 1945.

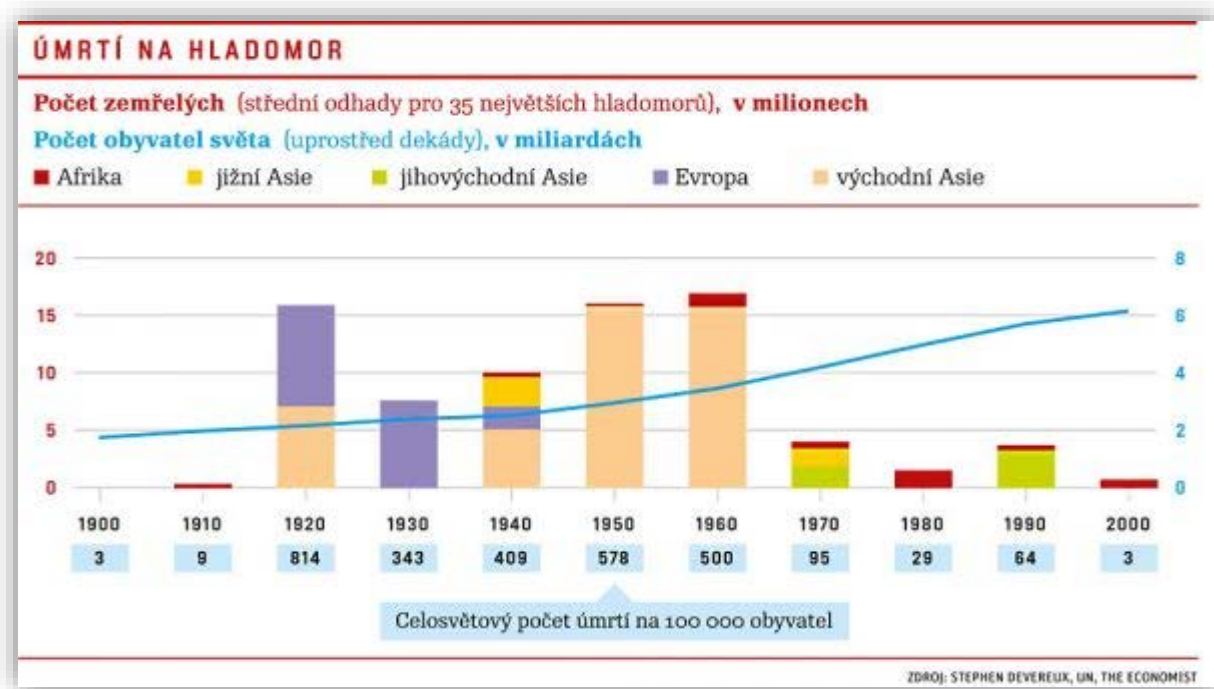


Famines – causes

Ukrainian famine (1932-1933) 2.7-7 000 000 victims - Why?

Chinese famine (1959-1961) 20-40,000,000 Victims - Why?

Ethiopian famine (1984) - 1,000,000 Victims - Why?

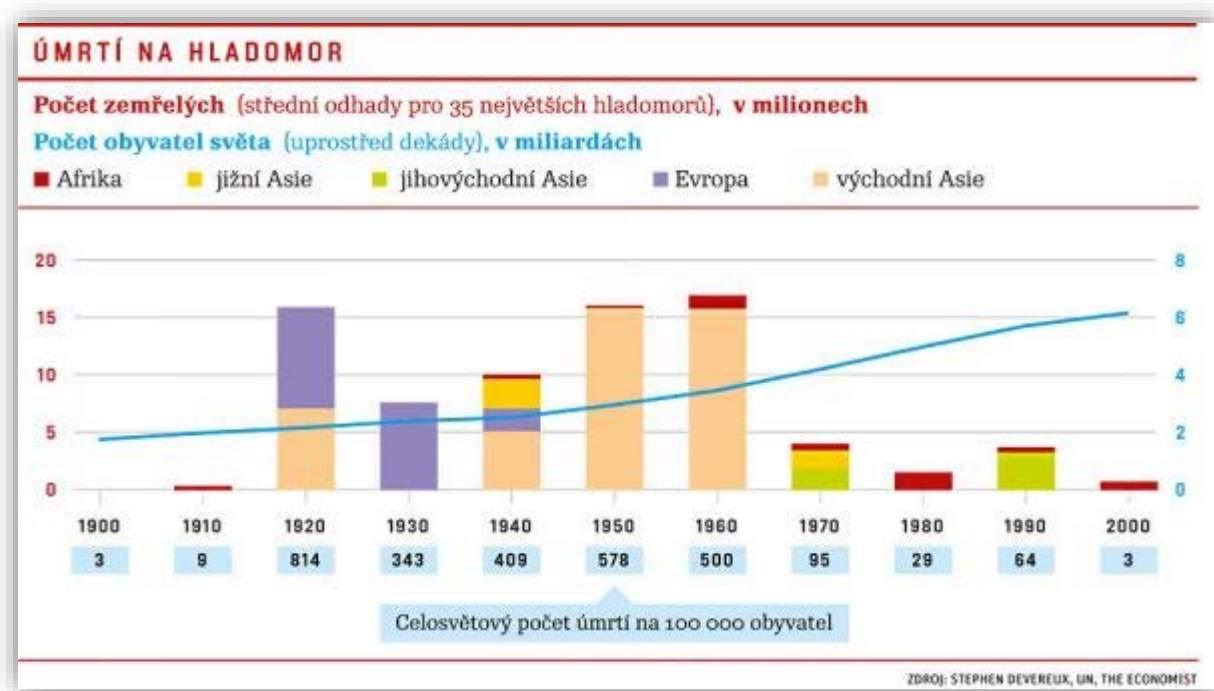


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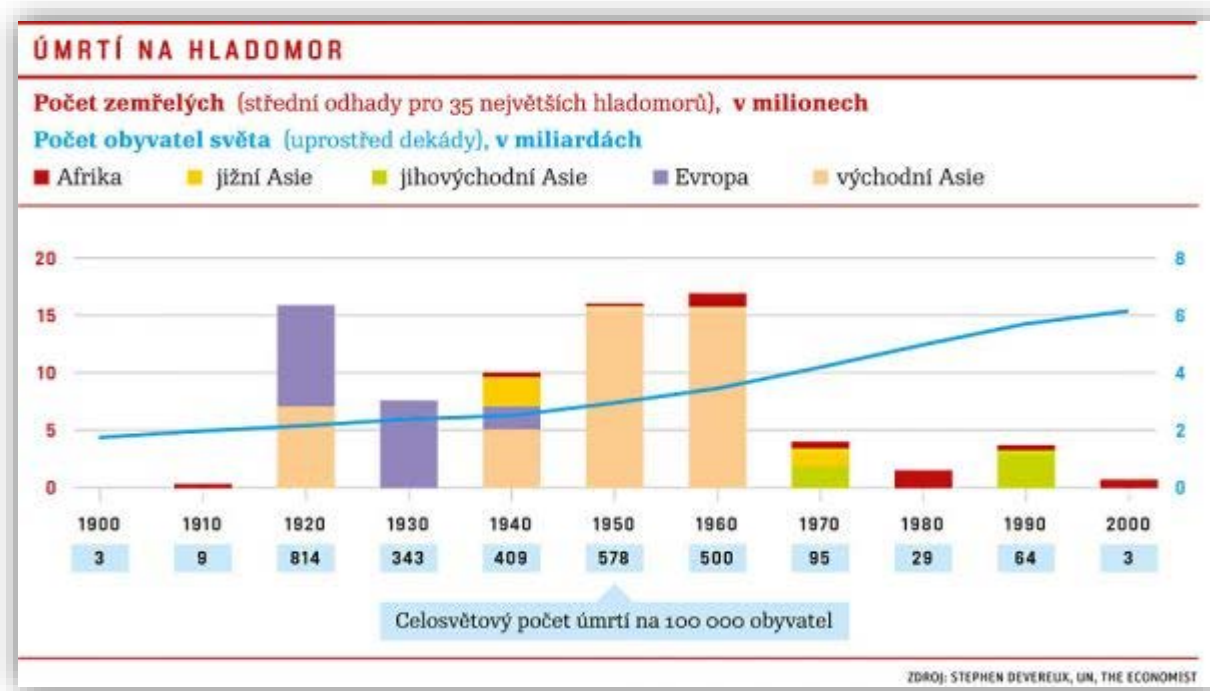
**What is the most significant (and common)
cause of these great famines?**

Famines – causes

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The most of the greatest famines in the 20th century were the result of political decisions in undemocratic dictatorships!

Green Revolution

- after WW2 population in SE Asia – ↓ mortality = ↑ population
- after **Bengal famine** - introduction of **new varieties + industrialization**

Objective: to significantly increase agricultural production

- 60s - the beginning of the Green Revolution in India
- introduction of HYV crops – e.g. drought resistant rice IR8 with yield 5 t / ha (x 1.5 t / ha earlier), moreover grown for a shorter time
- possible two harvests per season
- modern agricultural machinery (plows, tractors, harvesters ...)



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↑ harvest = ↑ demand for soil fertility and water resources



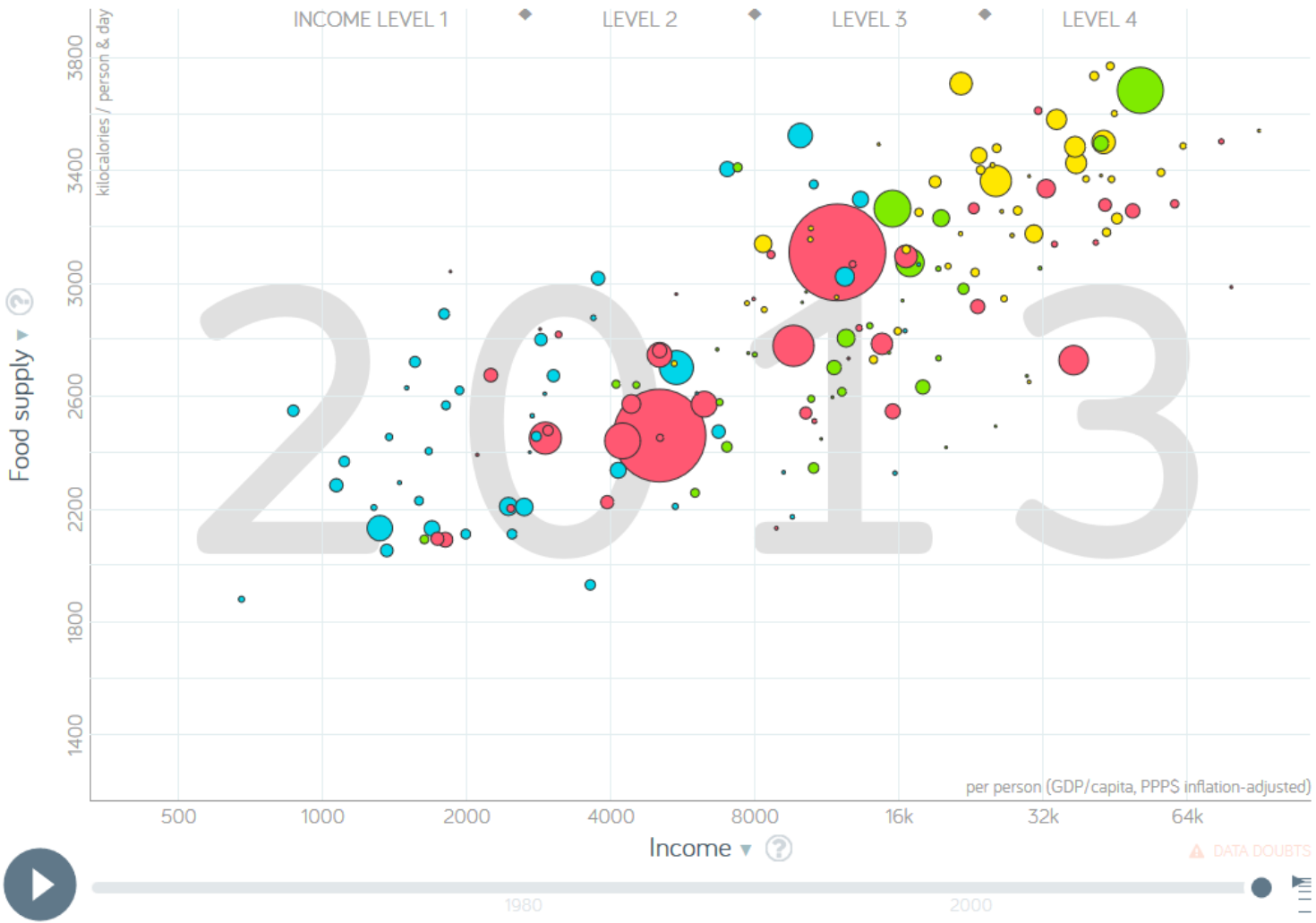
The hands of Resham Singh, a 59-year-old carpenter in Punjab, are gnarled from arthritis. Doctors say it may have been caused by exposure to water tainted by fertilizers and pesticides. Heavy use of chemicals in the 1960s to late 1970s brought India out of famine and into its green revolution, but Singh's village, Mari Mustafa, has high cancer rates.

Industrial (intensive) agriculture

Pros

- high production = food security!





Color World Regions [Dropdown]



Select Search... [Input]

- Afghanistan
- Albania
- Algeria
- Angola
- Antigua and Barbuda
- Argentina
- Armenia
- Australia
- Austria
- Azerbaijan
- Bahamas
- Bangladesh

Size Population [Dropdown]

Zoom [Icons] 100%

OPTIONS PRESENT EXPAND [Icons]

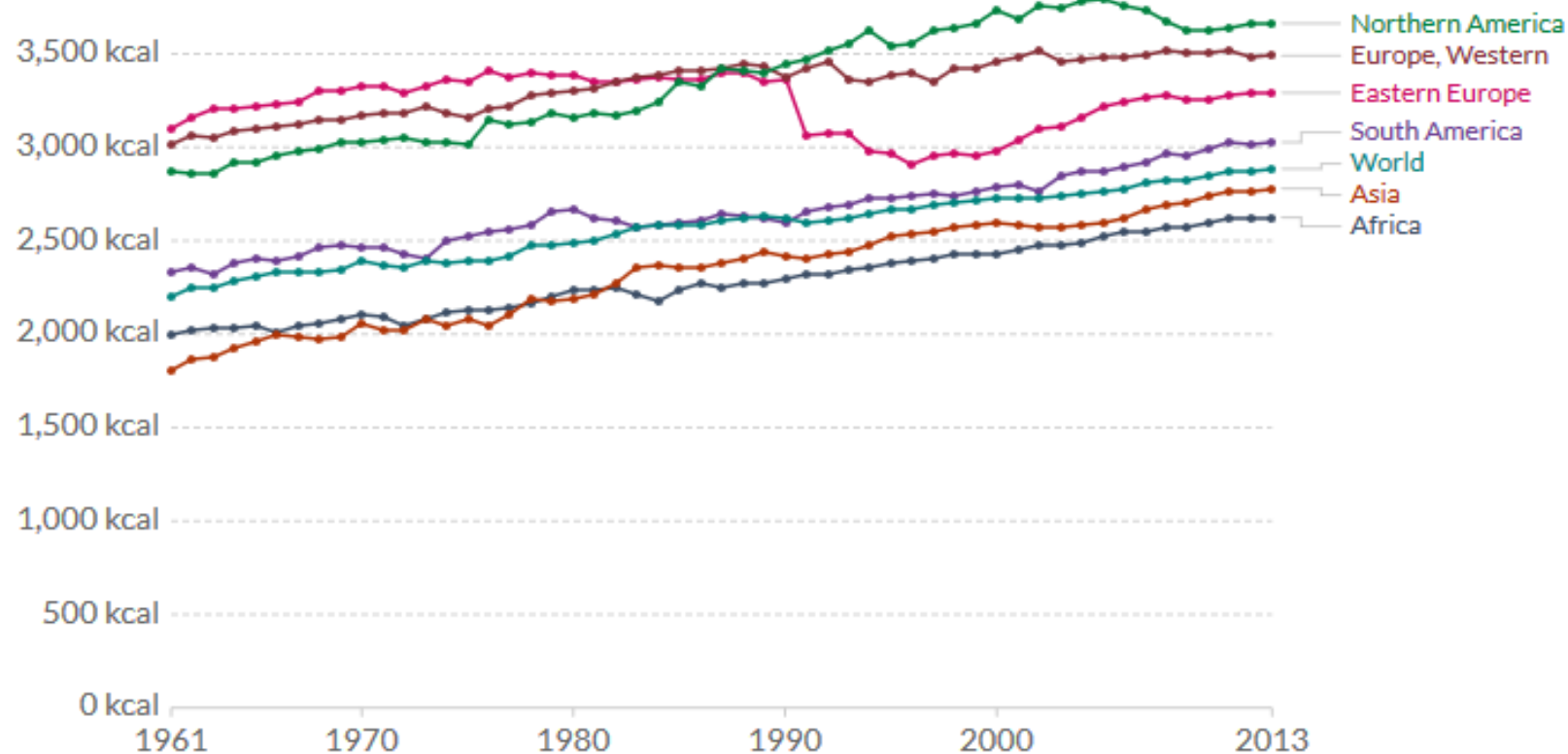
DATA DOUBTS

Daily supply of calories, 1961 to 2013

Caloric supply is measured in kilocalories per person per day.

Our World
in Data

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Source: UN Food and Agriculture Organization (FAO)

Note: Data measures the food available for consumption at the household level but does not account for any food wasted or not eaten at the consumption level.

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CHART

MAP

TABLE

SOURCES

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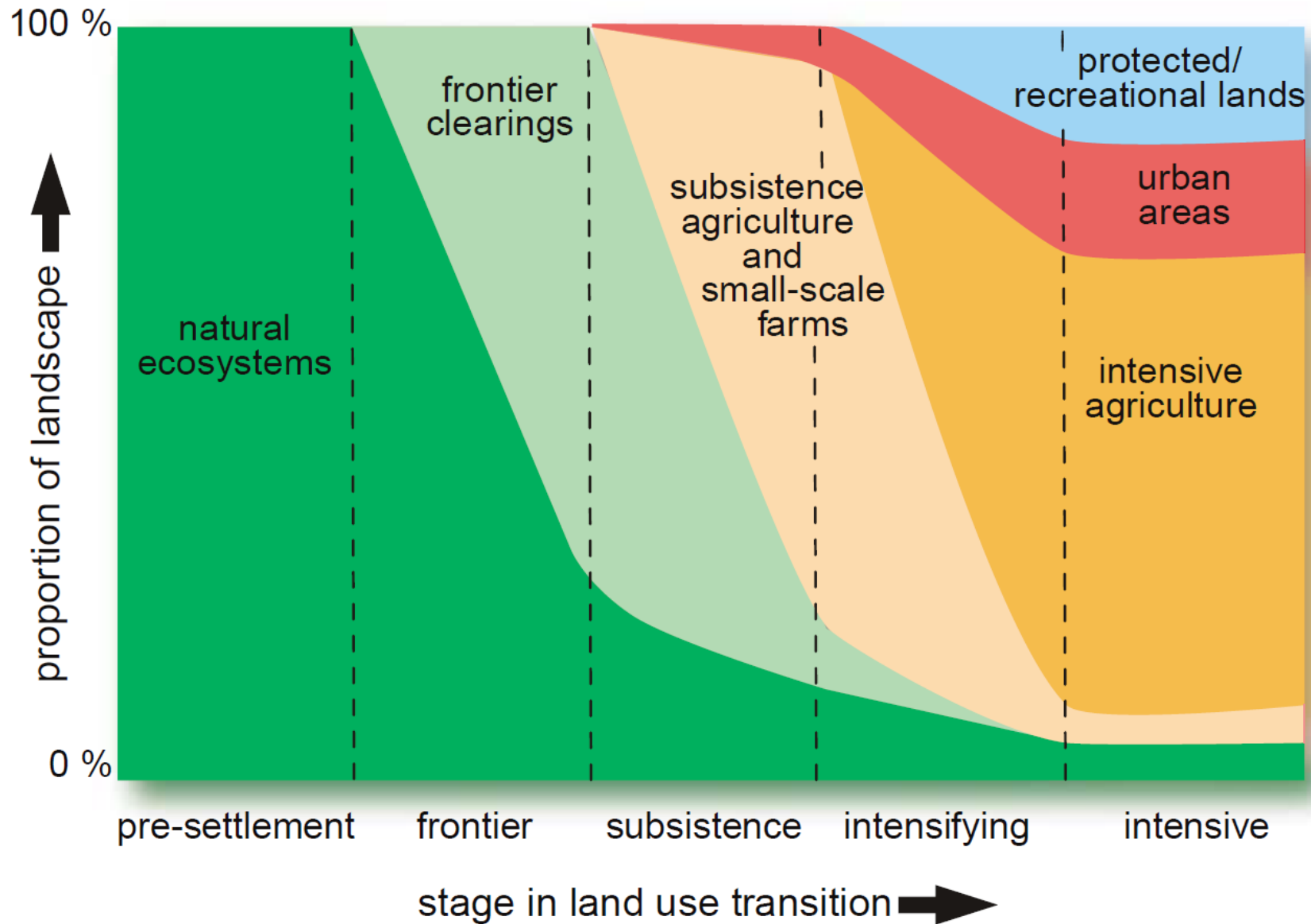
Industrial (intensive) agriculture

Pros

- high production = food security!
- less land use!



Global consequences of land use

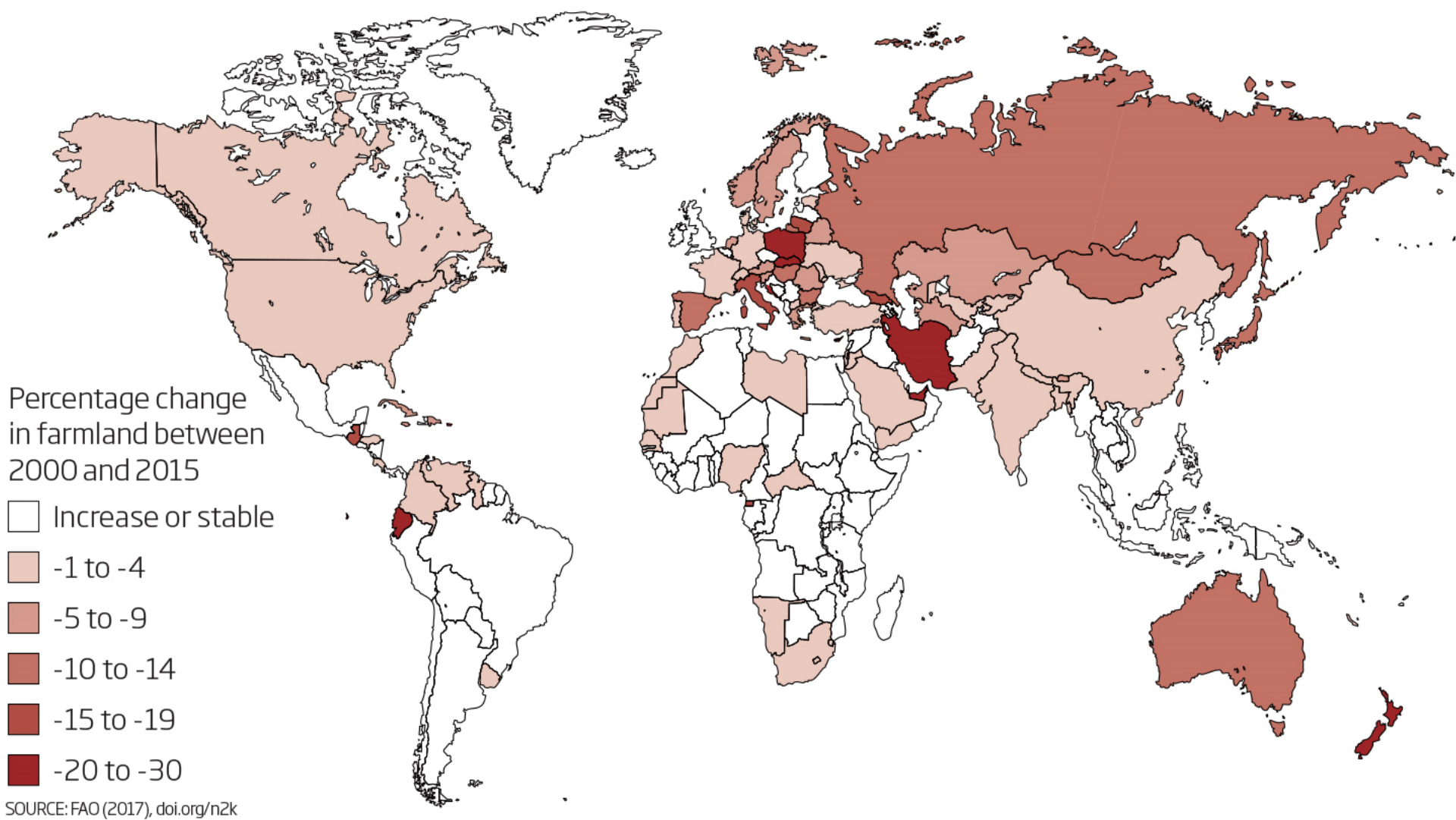




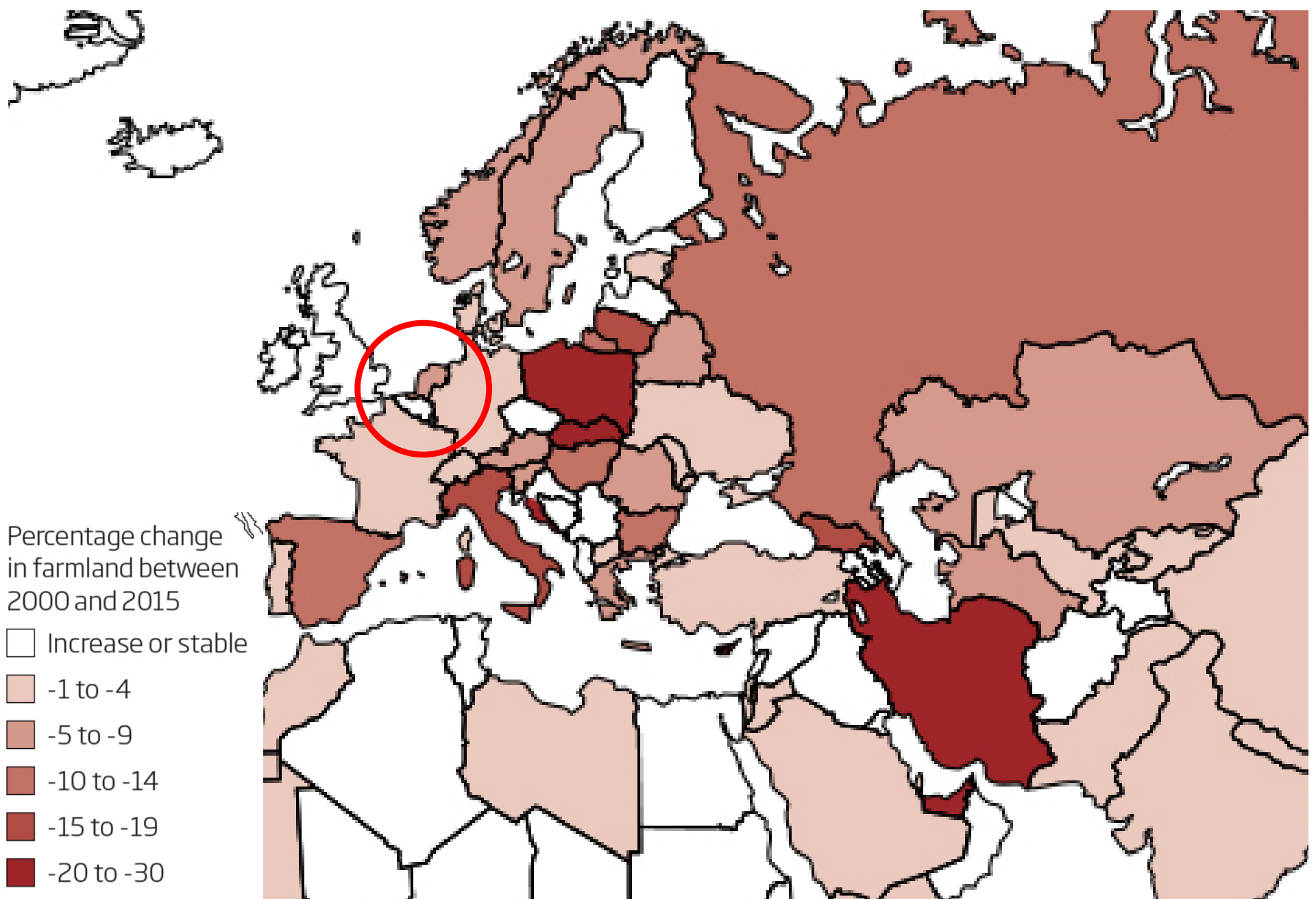
Stephen Wilkes/Getty

Shrinking farmland

For the first time, more land is being left to return to nature than is being cleared for agriculture



SOURCE: FAO (2017), doi.org/n2k



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Punching above its weight

The tiny Netherlands has become an agricultural powerhouse—the second largest global exporter of food by dollar value after the U.S.—with only a fraction of the land available to other countries. How has it achieved this? By using the world's most efficient agricultural technologies.

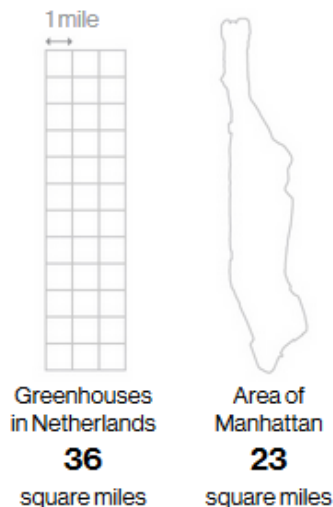
Growing under glass

Dutch horticulture relies heavily on greenhouses, allowing farmers to closely control growing conditions and use fewer resources like water and fertilizer.

Change from 2003-2014

Vegetable production	▲ 28%
Energy used*	▼ 6%
Pesticides	▼ 9%
Fertilizer	▼ 29%

*Latest available data (2012)

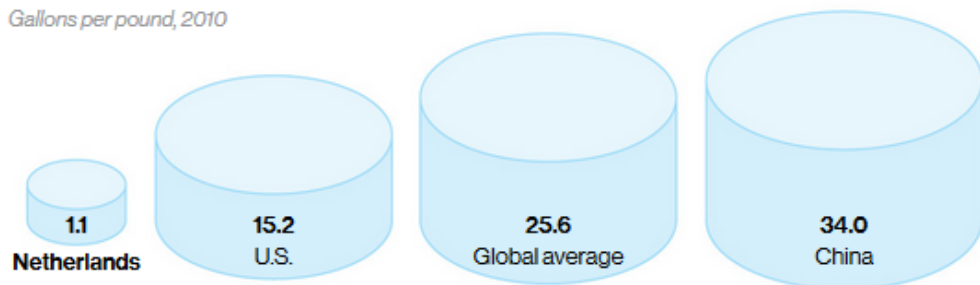


Doing more with less

Utilizing innovations on a large scale, like hydroponic farming—growing plants without soil in nutrient-rich solutions—reduces runoff, saving both water and money.

Total water footprint of tomato production

Gallons per pound, 2010



JASON TREAT, NGM STAFF; KELSEY NOWAKOWSKI. SOURCES: FAOSTAT; ARJEN HOEKSTRA, UNIVERSITY OF TWENTE; STATISTICS NETHERLANDS (CBS)

Tomato production
No. 22 globally
 992,080 tons

Punching above its weight

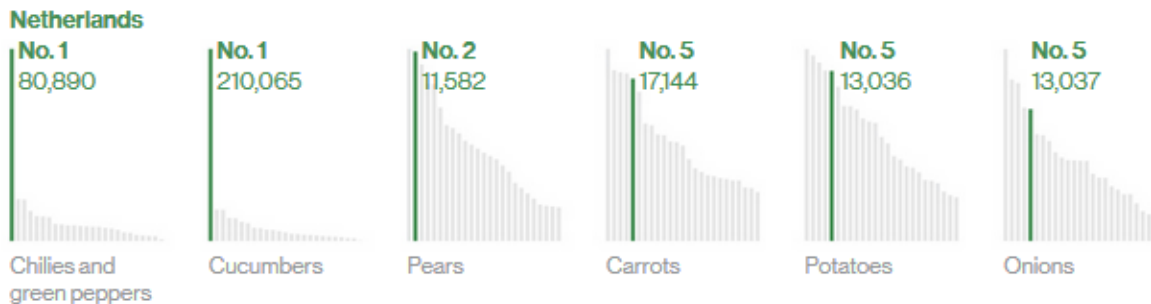
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Yield
No. 1 globally
 144,352 tons per square mile

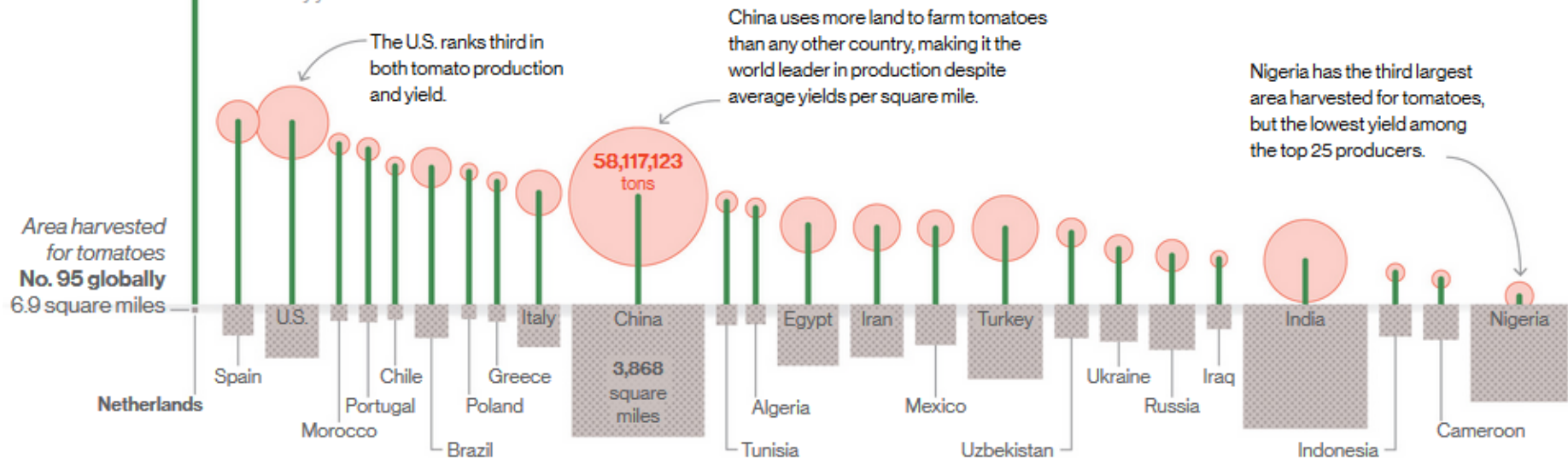
Harvesting impressive yields

Over the past 30 years, the Dutch tomato industry has become the world leader in yield, producing more tomatoes per square mile than anywhere else; the Netherlands enjoys high yields in other staple crops (right) as well.

Top 25 producers by yield, 2014 in tons per square mile



Top 25 tomato producers, 2014 ranked by yield





| MAGAZINE |

THIS TINY COUNTRY FEEDS THE WORLD

The Netherlands has become an agricultural giant by showing what the future of farming could look like.



Characteristics of intensive agriculture





What is typical for the industrial (intensive) agriculture?

Characteristics of intensive agriculture

Agrochemicals

- use of mineral fertilizers (N, P, K)
- excessive use of synthetic pesticides
- production, distribution and application of agrochemicals, storage and liquidation of stocks



Characteristics of intensive agriculture

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- production, distribution and application of agrochemicals, storage and liquidation of stocks



Meat production

- livestock breeding ([Baraka movie](#))
- breeding, transport, slaughter (unnatural conditions, stress, abuse)



- use of industrial feedstuff
- controlled reproduction, one-sided breeding

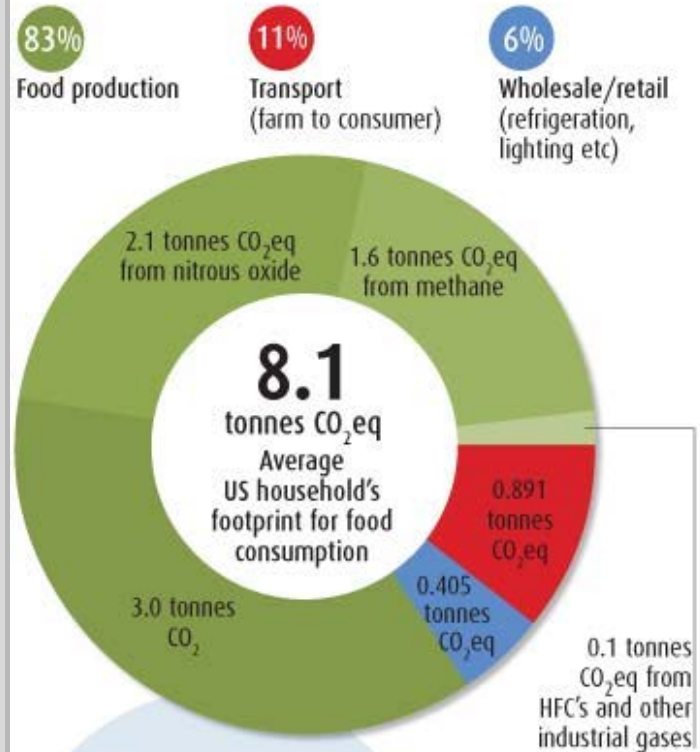
Characteristics of intens. agriculture

Food storage

- reduction of direct collection → transport distances are increasing
- the need for long durability
- chemical treatment, cooling

FOOD FOR THOUGHT

Household greenhouse gas emissions from food account for almost twice those produced by driving. Most of this comes from the food production process itself, rather than food-miles, as is often believed



CO₂eq:
The amount of CO₂ that would have to be released into the atmosphere to produce the same warming (over 100 years) as the greenhouse gas in question

60 tonnes CO₂eq The average US household's greenhouse gas emissions per year

Characteristics of intens. agriculture

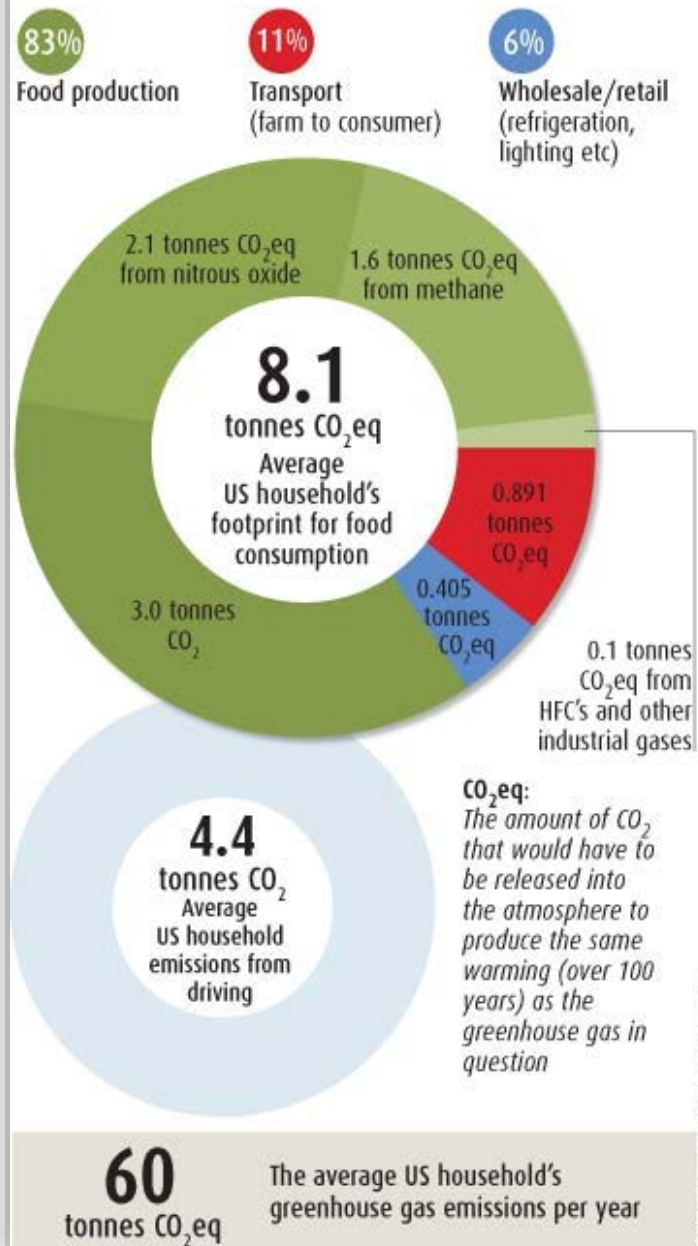
Food storage

- reduction of direct collection → transport distances are increasing
 - the need for long durability
 - chemical treatment, cooling
- from the place of production to an American consumer plate ~ 2400 km
 - transport as a whole ~ 11% of CO₂ emissions from total food production (USA)



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Characteristics of intens. agriculture

EROEI – *energy return on energy invested*

- industrialization of agriculture decreases EROEI
- increasing amount of auxiliary energy

Auxiliary energy (AE)

- all E invested in the agri. production **except of natural E** (sun)



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AE in crop production

- agrochem. 46%, fossil E 22%, machines 13%, seeds 10%, work 9%
- ↑ share of AE in agrochemicals. given by high E intensity of N **fertilizers**
 - 80 GJ / t (P fertilizers 6 times less, K fertilizers 9 times less)
 - N fertilizers highest consumption
- the most demanding for AE is sugar beet: 40 GJ/ha, alfalfa: 13 GJ/ha
- the largest E output - sugar beet: 214 GJ/ha, alfalfa 107 GJ/ha



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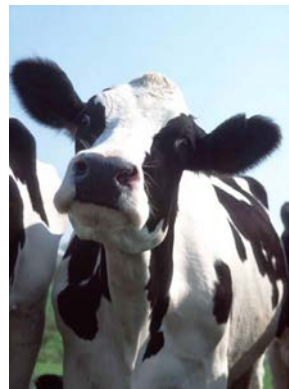
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Energetic balance

- specific consumption per GJ produced:
lucerne 0.12, sugar beet 0.19, potatoes 0.43, meat 0.9
- = per 1 GJ DE there are 1,1 GJ livestock products = **EROEI**





Negative aspects of intensive agriculture

Social

- marginalization of agriculture as a part of economy (belongs to the groups with the lowest life-standard)
- now - circa 4% of the population; circa 3% of GDP
- before 1940 - 35% of the population (product. age), the strongest political party in Czechoslovakia

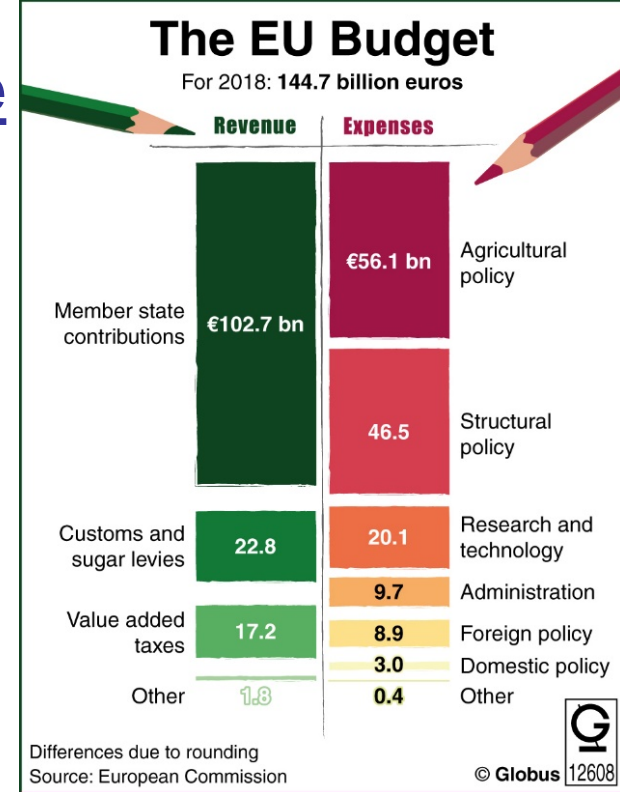
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Economical

- high state subsidy (EU)
- concentration of sales into large chains → dependence of private households on agro-concerns, pressure to increase revenues
- exports to world markets are growing - subsidies
- self-insufficiency



Negative aspects of intensive agriculture

Social

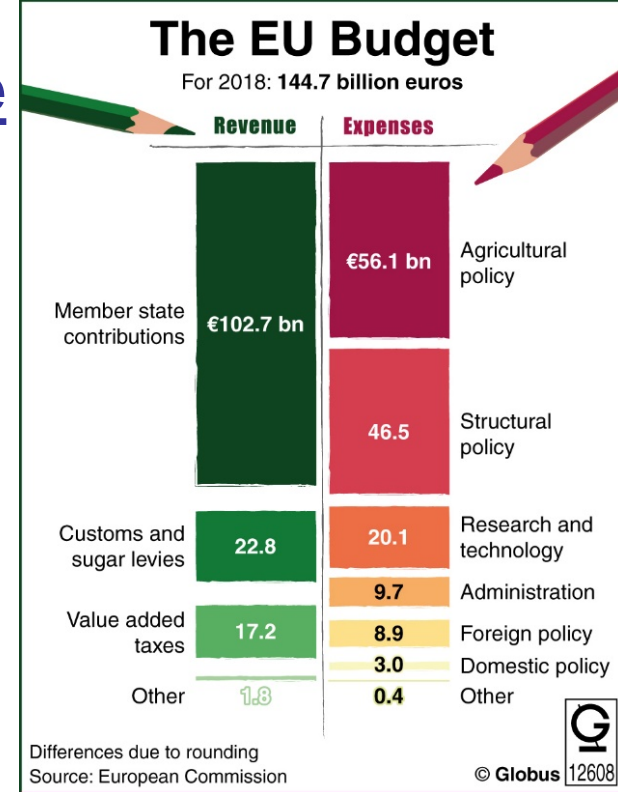
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Ethical

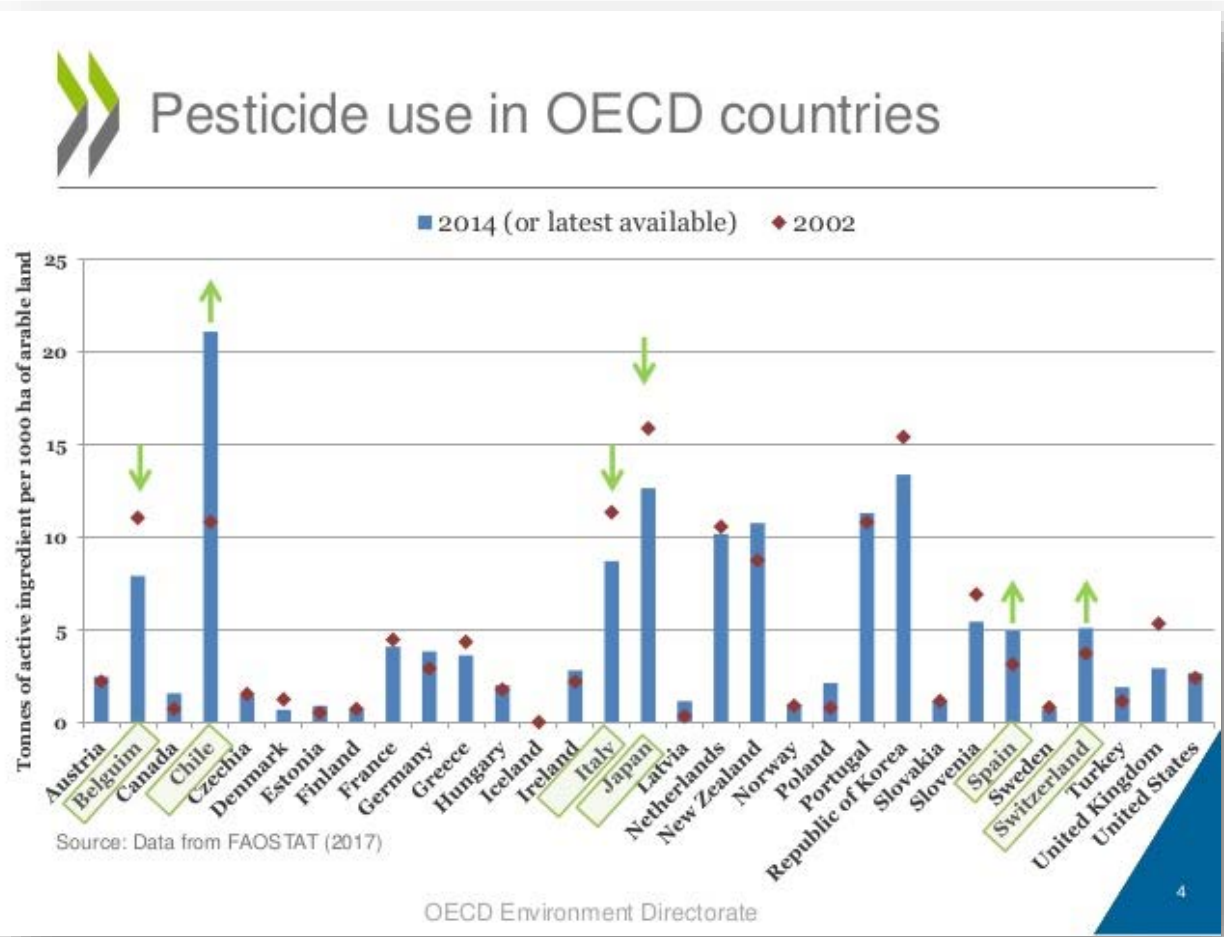
- poor handling with animals
- intensive use of resources (v, p) at the expense of other ecosystems.



Negative aspects of intensive agriculture

Environmental and Health

- globally, the intensity of non-renewables use increases
- soil, water and crop contamination, reduced soil fertility
- reducing biodiversity, increasing pest and disease resistance



Negative aspects of intensive agriculture

Environmental and Health

- globally, the intensity of non-renewables use increases
- soil, water and crop contamination, reduced soil fertility
- reducing biodiversity, increasing pest and disease resistance
- landscape damage, erosion











How to deal with these negatives of industrial agriculture?

Sustainable agriculture

„A type of agricultural production that meets the needs of the present and does not limit the needs of future generations“ (OECD)

- Protects the land used for agricultural production, water, genetic resources
- It does not degrade the environment
- A manageable, economically self-sufficient and socially acceptable system in practice

Sustainable agriculture

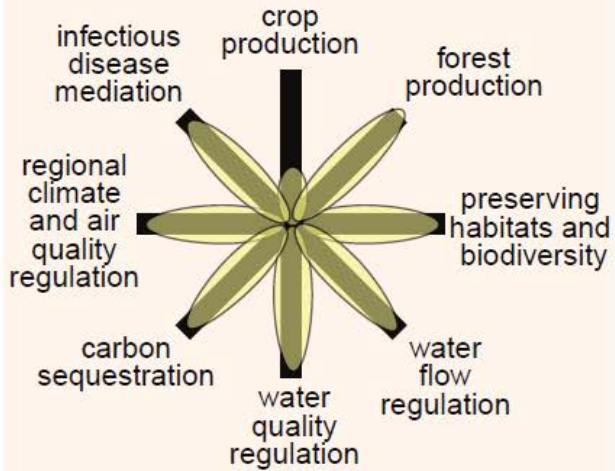
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Necessary aims to reach a sustainable agriculture

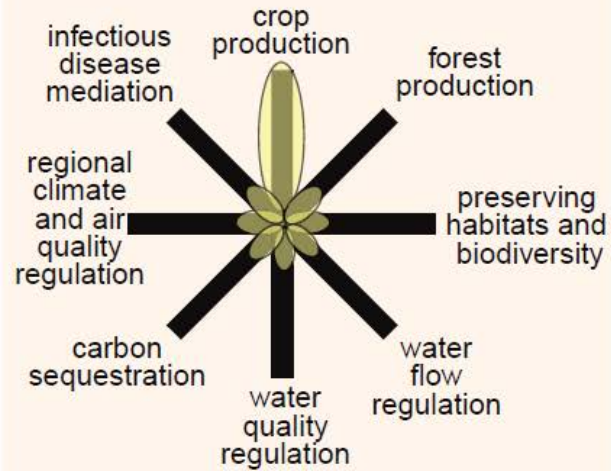
- 1) Higher diversity of flora and fauna on arable land and permanent grassland
- 2) Increased crop diversity.
- 3) Creating conditions leading to the protection of non-productive ecosystems and wild organisms

Biodiversity



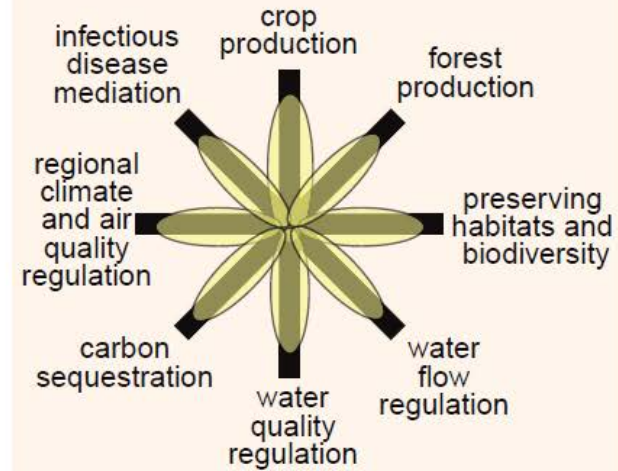
natural ecosystem

Food security



intensive cropland

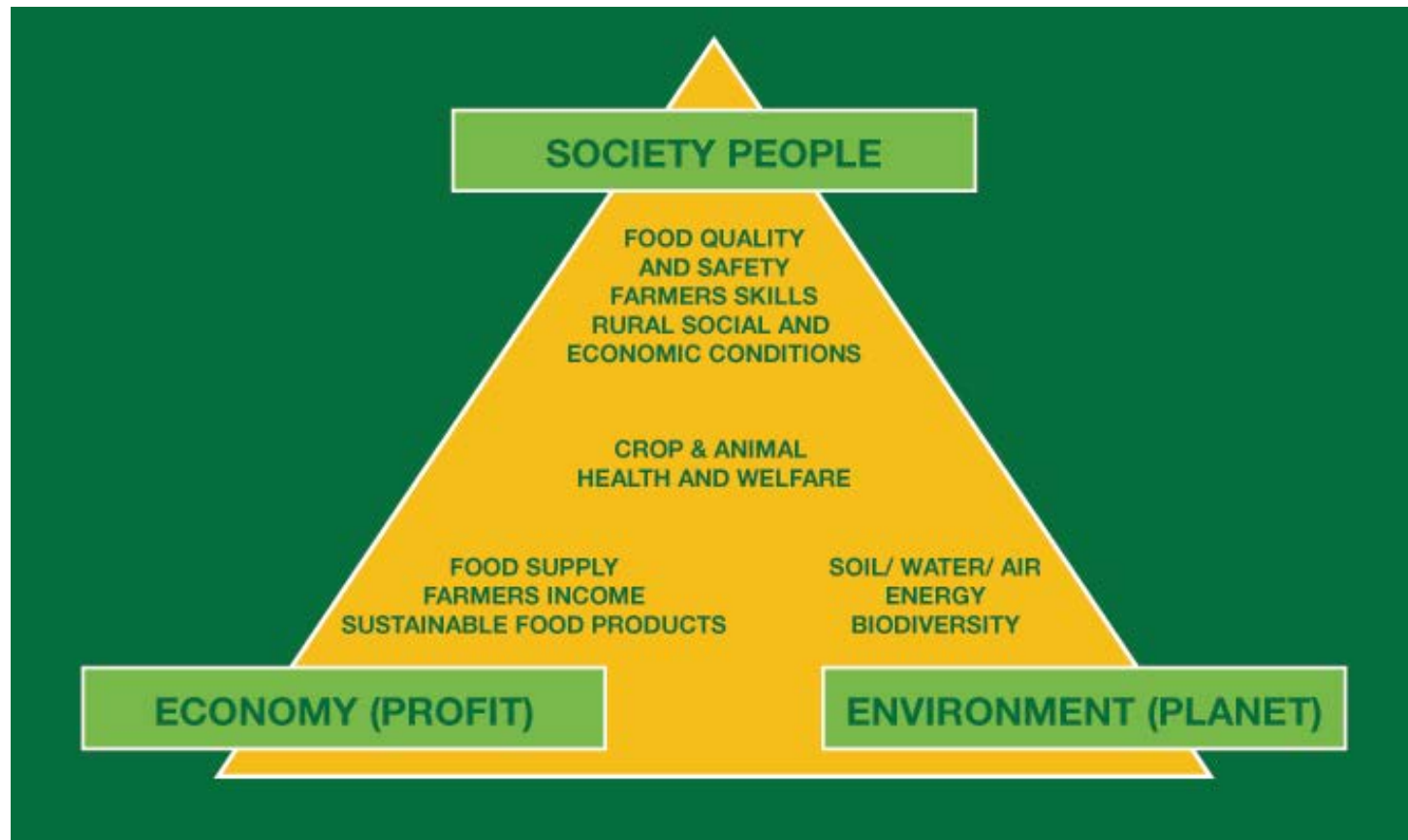
Biodiversity + Food security



cropland with restored ecosystem services

Sustainable agriculture

- Creating and maintaining rural communities and traditions.
- Economic stability of rural areas.
- Protection of existing and planting of new habitats (shrubs, bands of shrubs or grasslands), forest edges, wet habitats, flowering bands.





Organic farming (agriculture)

- alternative to industrial (intensive, conventional) agriculture
- **law 242/2000 Col. on Organic farming**

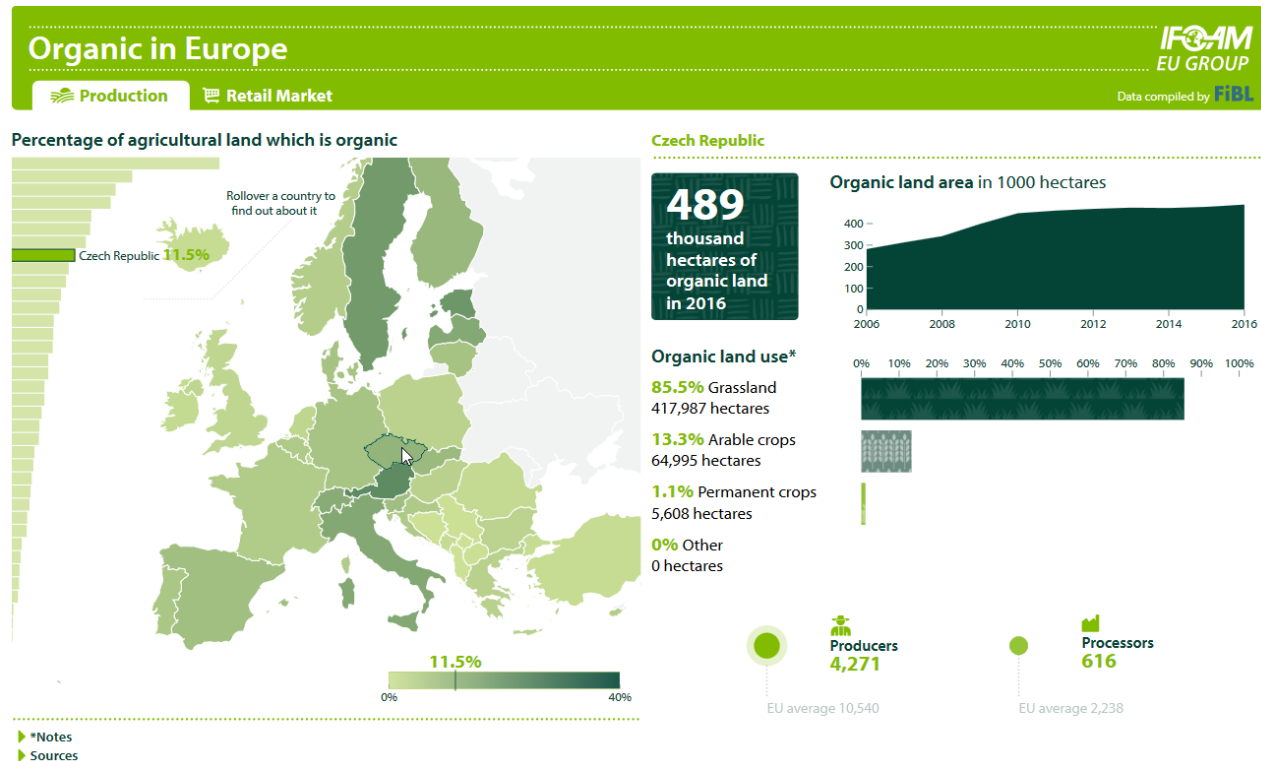
„A special type of farming that respects the environment and its constituents by restricting or prohibiting the use of substances and practices that burden and pollute the environment or increase the risk of contamination of the food chain, and that pay increased attention to the external manifestations and welfare of farmed animals.“ (Law 242/2000 Col.)

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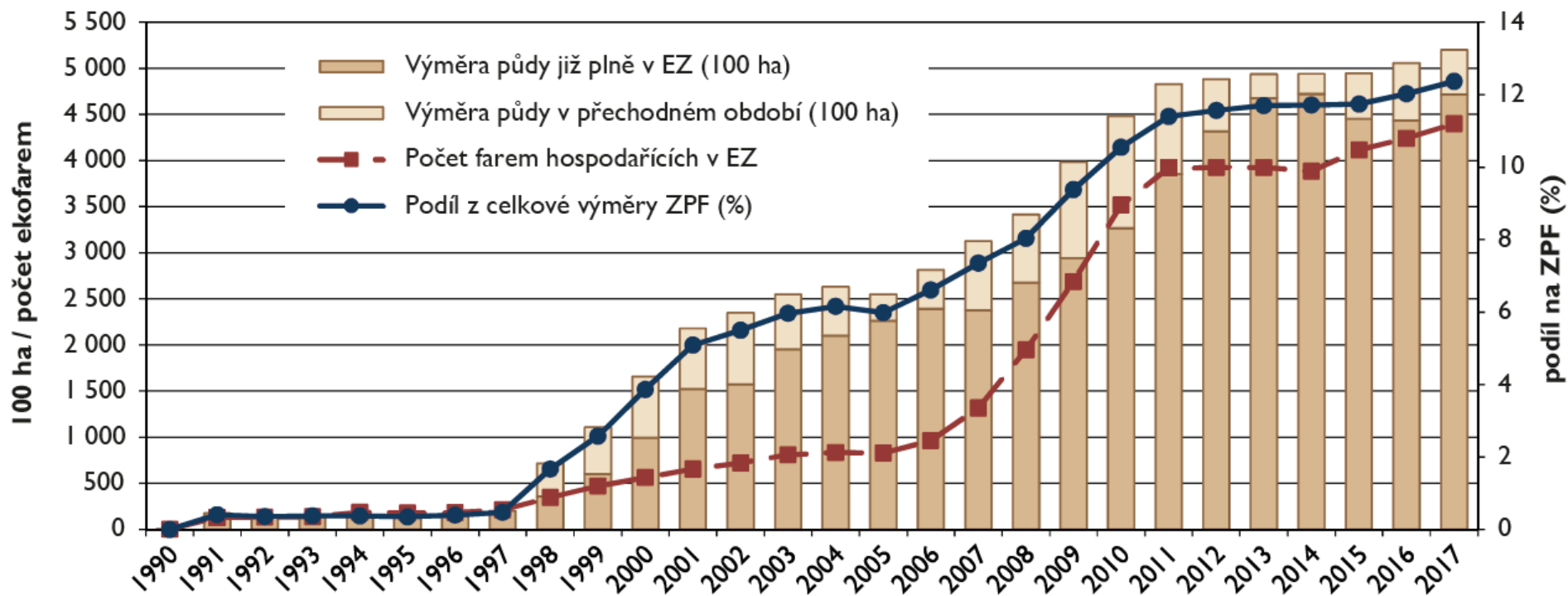
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70' – IFOAM
International Federation
of Organic Agriculture



Organic farming in Czechia

Graf I Vývoj celkové výměry půdy a počtu farem v EZ a podílu na celkovém ZPF (1990–2017)



Zdroj: MZe a REP (údaje vždy k 31. 12. daného roku); zpracoval ÚZEI.

Rules of Organic Farming

- **without the use of agrochemicals**, except for some gentle inorganic substances (eg. blue vitriol) in a special circumstances
- preservation of **greenery** (chains, alleys)
- measures **against erosion**, eg postponing plowing after the winter
- exclude the cultivation of **GM crops**



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- measures **against erosion**, eg postponing plowing after the winter
- exclude the cultivation of **GM crops**
- **space** for lying, rest, stable with straw, range including grazing and **natural food**
- the **prohibition of caging** and housing cattle and pigs on steel grates
- ban on the addition of **growth promoters**, meat-and-bone meal, synthetic substances to feed
- **hormonal synchronization** of rut or embryo transfer





With demand for chicken increasing, Dutch firms are developing technology to maximize poultry production while ensuring humane conditions. This high-tech broiler house holds up to 150,000 birds, from hatching to harvesting.

Organic farming could feed the world

13:46 12 July 2007 by [Catherine Brahic](#)

A switch to organic farming would not reduce the world's food supply and could also increase food security in developing countries, say the authors of a new study.

They claim their findings lay to rest the debate over whether organic farming could sustainably feed the world. [Organic farming](#) avoids or heavily restricts the use of synthetic pesticides and fertilisers, as well as livestock feed additives.

Numerous studies have compared the yields of organic and conventional methods for individual crops and animal products (see [20-year study backs organic farming](#)).

Now, a team of researchers has compiled research from 293 different comparisons into a single study to assess the overall efficiency of the two agricultural systems.

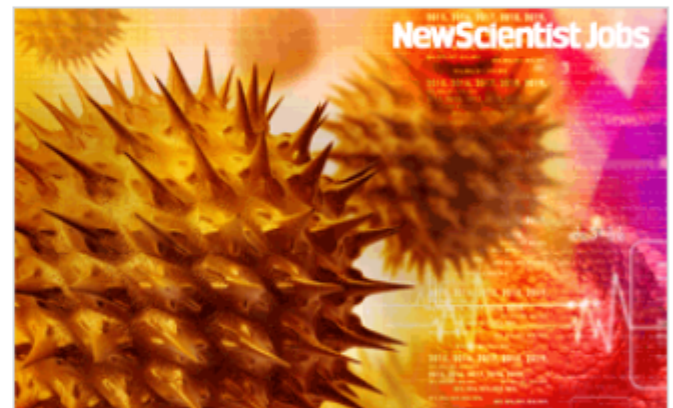
Available materials

Ivette Perfecto of the University of Michigan in the US and her colleagues found that, in developed countries, organic systems on average produce 92% of the yield produced by conventional agriculture. In developing countries, however, organic systems produce 80% more than conventional farms.

Perfecto points out that the materials needed for organic farming are more



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18:45 15 April 2015

20-year study backs organic farming

19:00 30 May 2002 by **Fred Pearce**

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The world's longest running experiment in comparing organic and conventional farming side-by-side has pronounced chemical-free farming a success.

"We have shown that organic farming is efficient, saves energy, maintains biodiversity and keeps soils healthy for future generations," says Paul Mader of the Research Institute of Organic Agriculture in Frick, Switzerland, which carried out the 21-year study.

Although crop yields on organic plots in the experiment were on average 20 per cent lower than those on conventional plots, the ecological and efficiency gains more than made up for it, Mader says.

Soils nourished with manure were more fertile and produced more crops for a given input of nitrogen or other fertiliser. "The input of nutrients like nitrogen were as much as 50 per cent lower, so overall the organic system was more efficient," he told **New Scientist**.

Not all crops did equally well. Potato yields on organic plots were only 60 per cent of those on conventional plots. But organic winter wheat achieved 90 per cent, and grasses fed on manure did just as well as those fed on fertiliser.

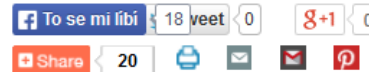
Mader argues that the biggest bonus is the improved quality of the soil under organic cultivation, which should ensure good crops for decades to come.

Earthworms and fungi

Organic soils had up to three times as many earthworms, twice as many insects and 40 per cent more mycorrhizal fungi colonising plant roots. Soils microbes went into overdrive, transforming organic material into new plant biomass faster than microbes in conventional plots.

More predictably perhaps, organic plots contained up to 10 times as many weed species as conventional plots sprayed with herbicides.

"Under European conditions, we can clearly grow our food with much less



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Think organic food is better for you, animals, and the planet? Think again

BJØRN LOMBERG

12 JUNE 2016 • 5:33PM



The organics hype is just that - hype CREDIT: WAYNE FARRELL/ALAMY

What we eat is seen as more important than ever. And everywhere we are urged to go organic: we are told it is more nutritious, it improves animal welfare and helps the environment. In reality, that is mostly marketing hype.

In 2012 Stanford University's Centre for Health Policy did the biggest

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A large background image showing a field of purple flowers, possibly lupines, under a sunset sky. The sun is low on the horizon, casting a warm glow over the landscape. The field is divided into two sections by a dark, rectangular overlay on the left side, which contains the main title.

Telegraph attacks organic...Again!

 Print  2  1

Telegraph attacks organic

 13 June 2016

Bjørn Lomborg wrote in the Telegraph over the weekend that what we eat is more important than ever. Great, couldn't agree more – but unfortunately, the agreements stopped there. He then went on to suggest, among other things, that 'going organic would kill more than 13,000 people in the US each year'.

[Think organic food is better for you, animals, and the planet? Think again. Is this pure fantasy?](#)

Of course, his wildly inaccurate criticisms of organic food and farming ignore recent and comprehensive research, including three [international meta-analyses](#) published in the British Journal

INSIGHT 25 May 2016

What does 'natural' mean? Time to ditch a dangerous concept



Free from...science?
Patrick T. Fallon/Bloomberg via Getty

By Clare Wilson

The Green movement has done much good in raising awareness of the dangers of global warming, but it often falls into the trap of thinking that Mother Nature is always best.

Its blanket opposition to GM food makes no sense. We have been genetically modifying our crops for millennia; current GM food presents no threat to health and could help solve nutritional deficiencies. It's vital to step back from using antibiotics in farming, but many people would not be alive today if not for modern agriculture.

Recent approach – obsolete?

Food security

Intensive agriculture + and - X Extensive agriculture + and -

Biodiversity

A modern approach - better?

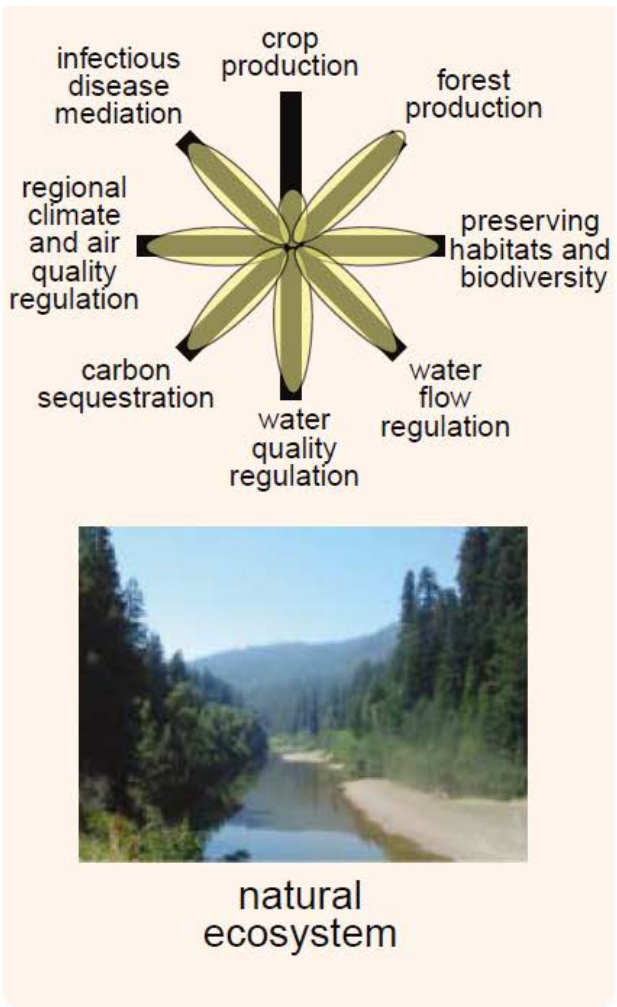
Food security

Intensive agriculture + and - X Extensive agriculture + and -

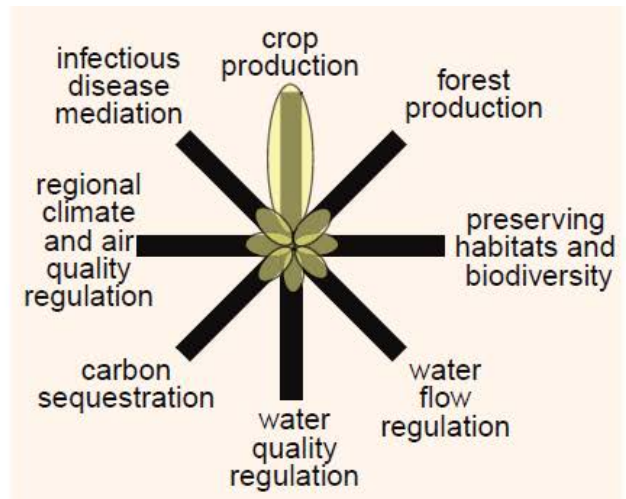
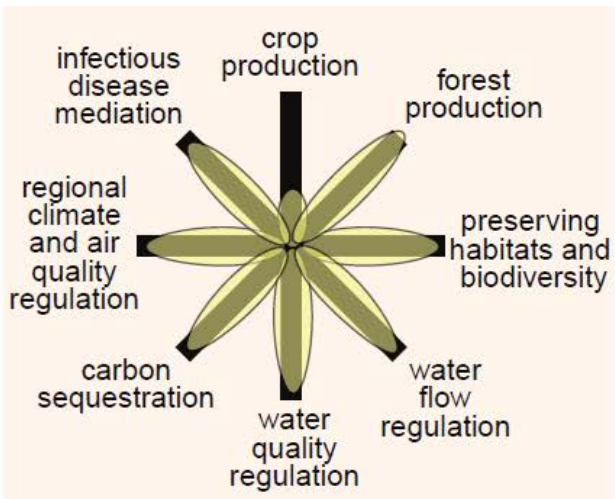
Biodiversity

Separation of an intensive food production
from the extensive farming in the landscape?

Biodiversity



Biodiversity + Food security



natural ecosystem



intensive cropland

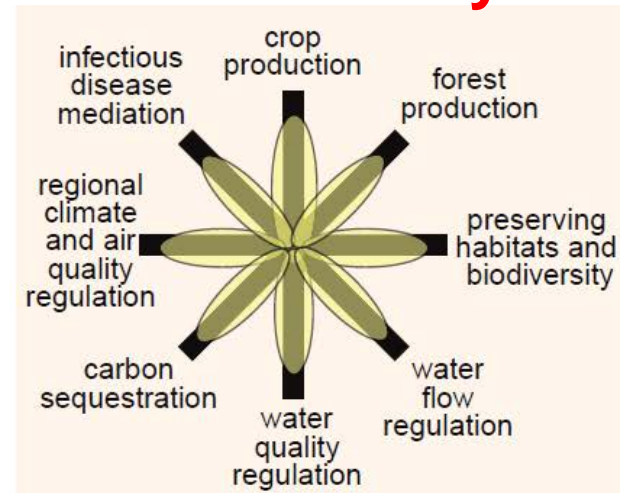
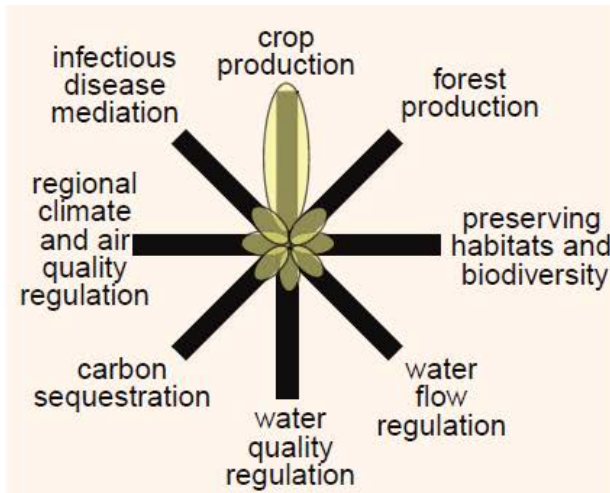
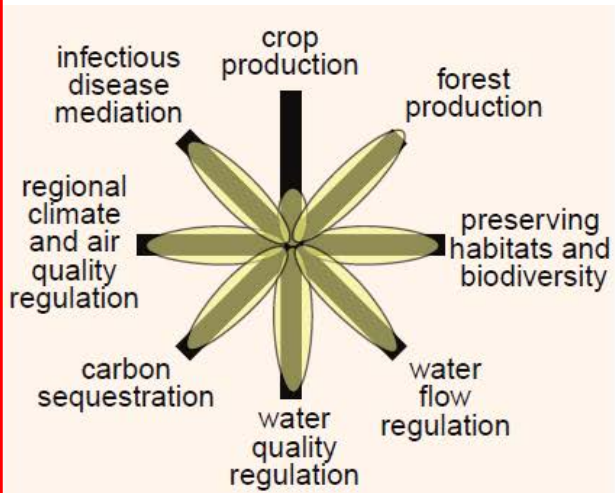
Biodiversity

+

Food security

+

**Biodiversity
+
Food security**



natural ecosystem



intensive cropland



cropland with restored ecosystem services