



Vincent Van Gogh, Wheatfield with crows, 1890

# **Environmental aspects of Agriculture**

**Food security**

**X**

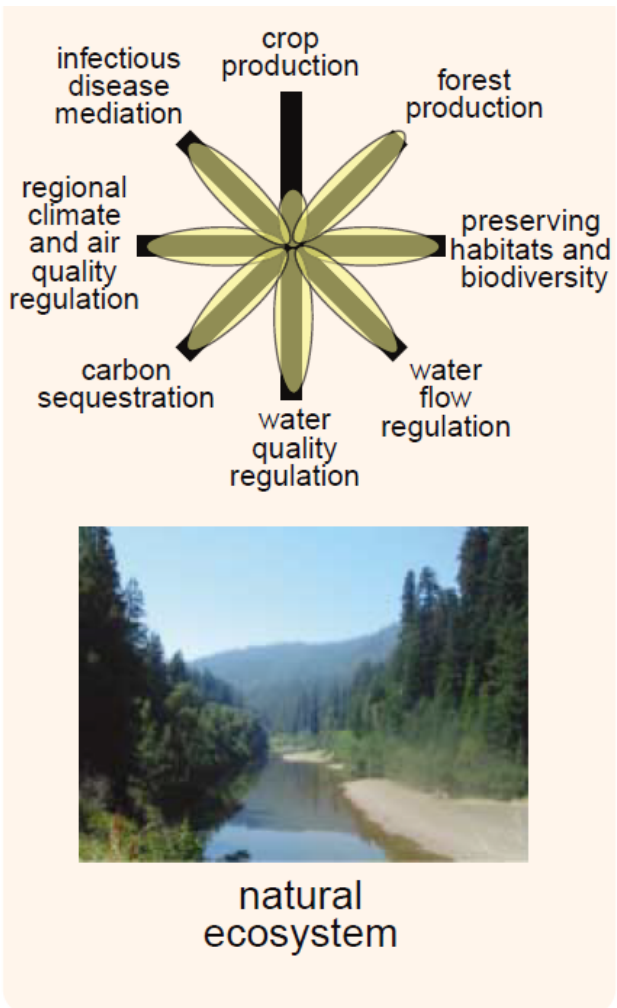
**Biodiversity**

**Food security**

**Intensive agriculture + and - X Extensive agriculture + and -**

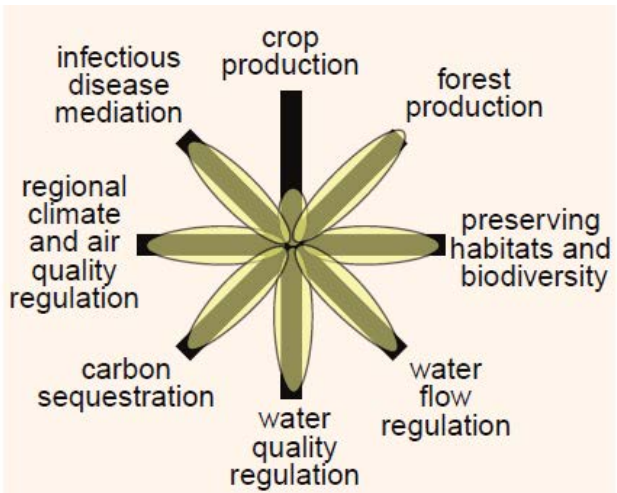
**Biodiversity**

# Biodiversity



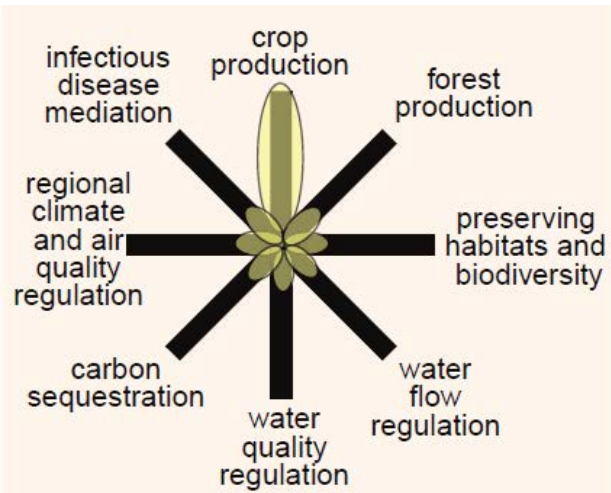


# Biodiversity



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

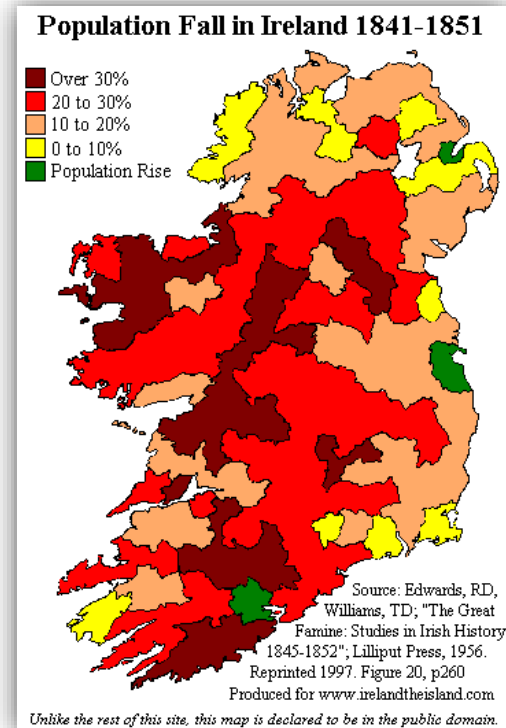
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## 1845-1850 - Irish famine

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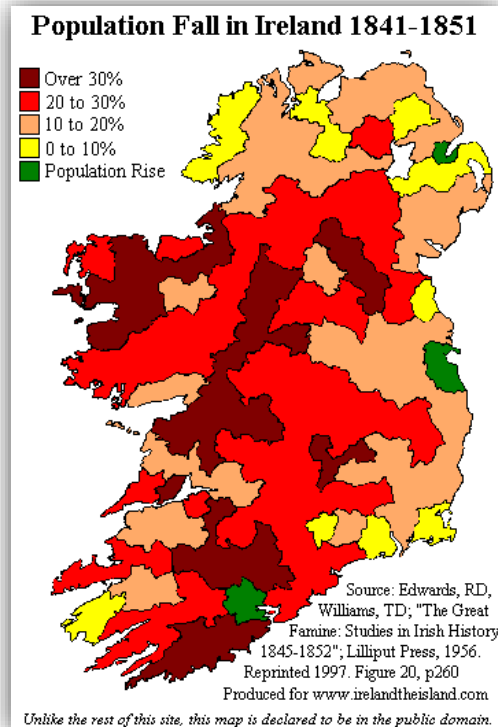
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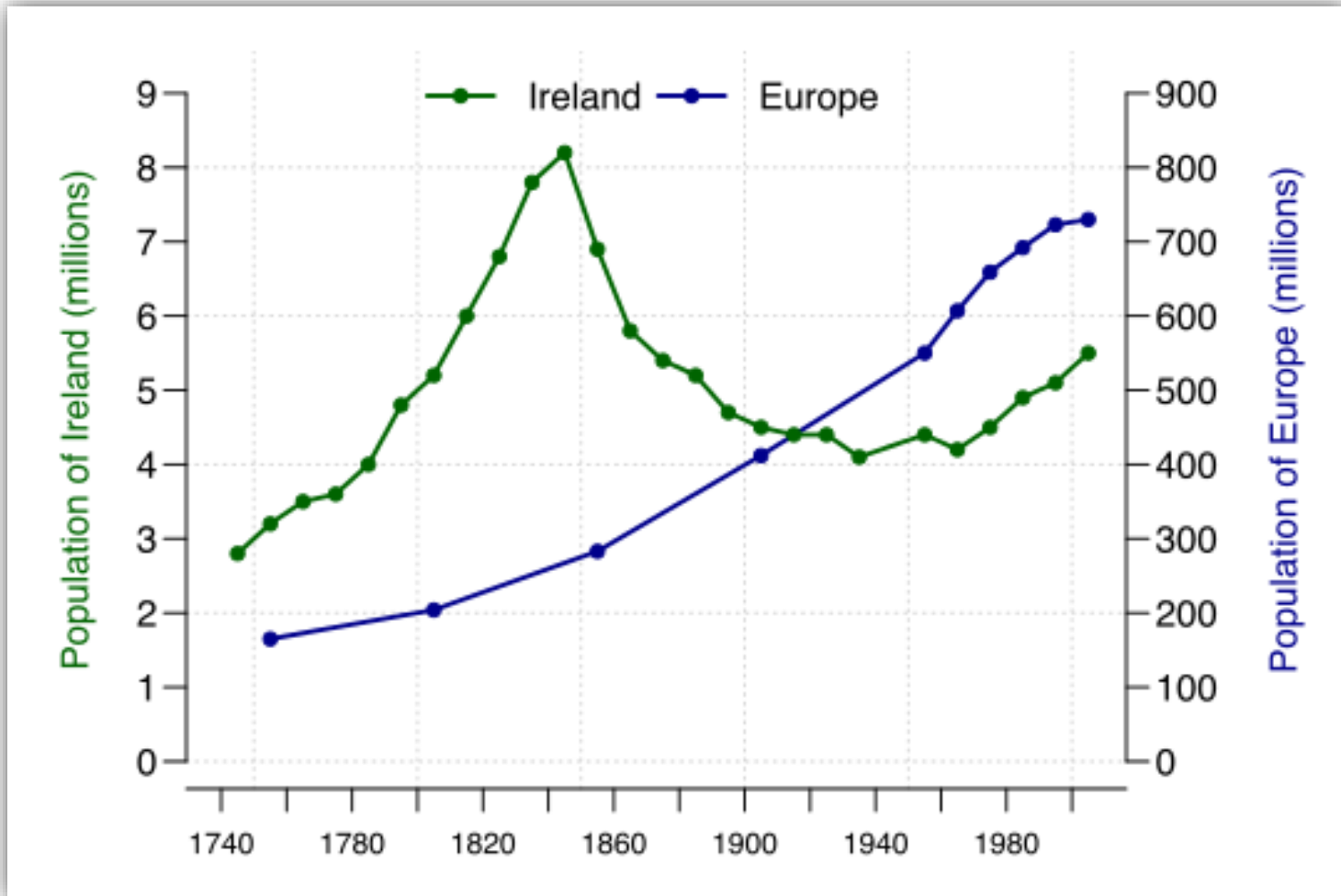
**BUT** - there was **enough food in Ireland** - corn, wheat, oats!

- 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





Sprint

T-E-LEVEN

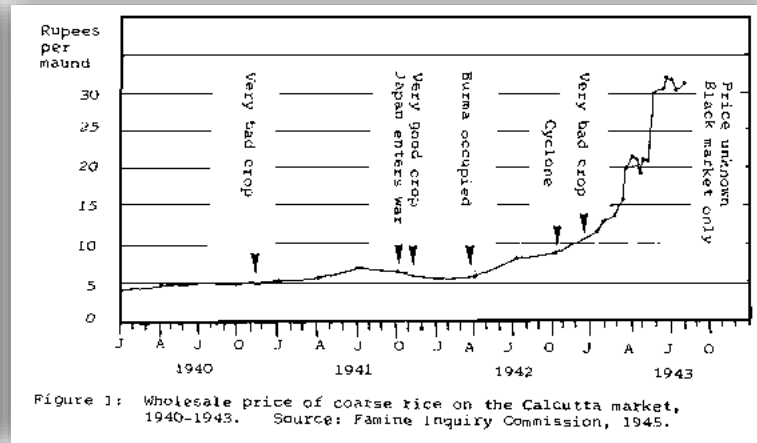
WHO BUT  
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# Lack of food x famine – causes

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





# 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**

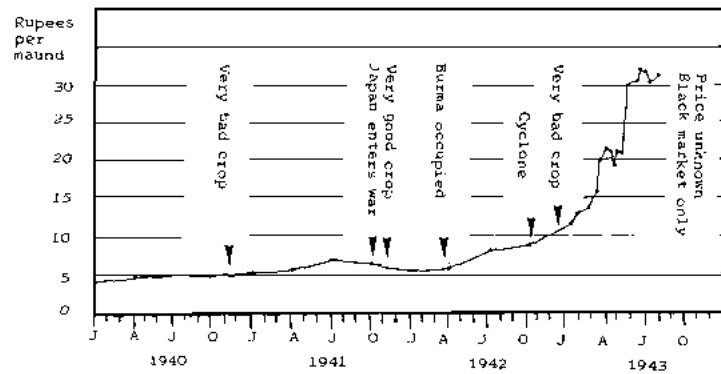


Figure 1: Wholesale price of coarse rice on the Calcutta market, 1940-1943. Source: Famine Inquiry Commission, 1945.

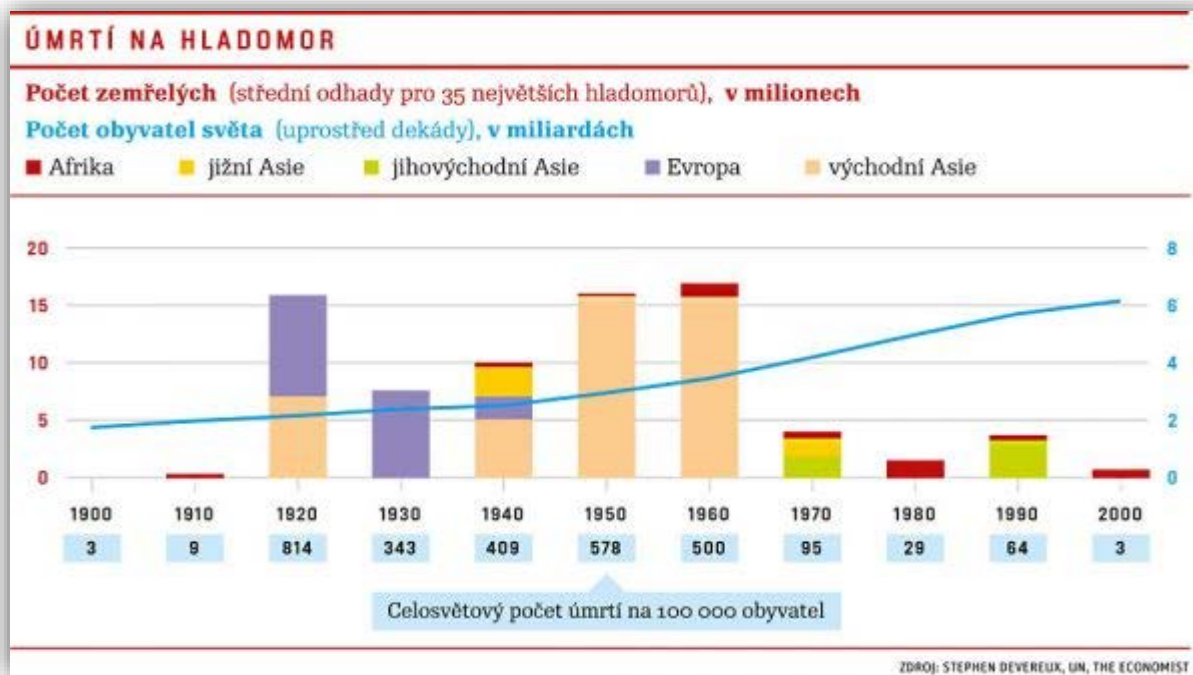


# Famines – causes

**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?

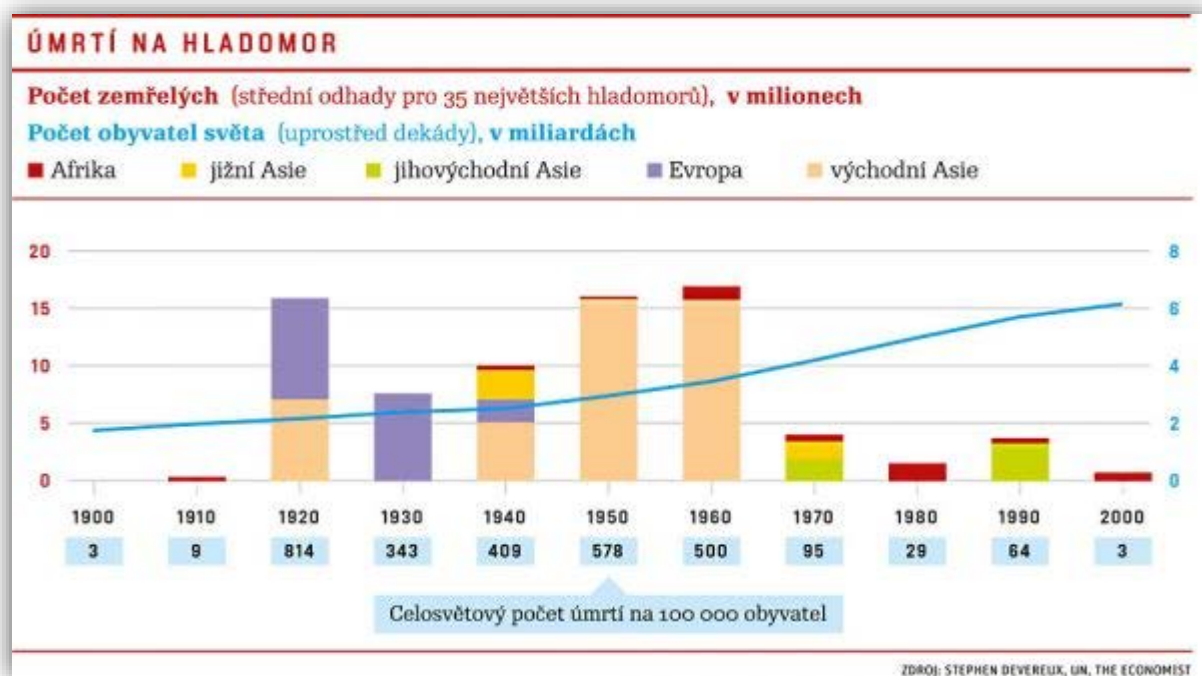


# Famines – causes

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

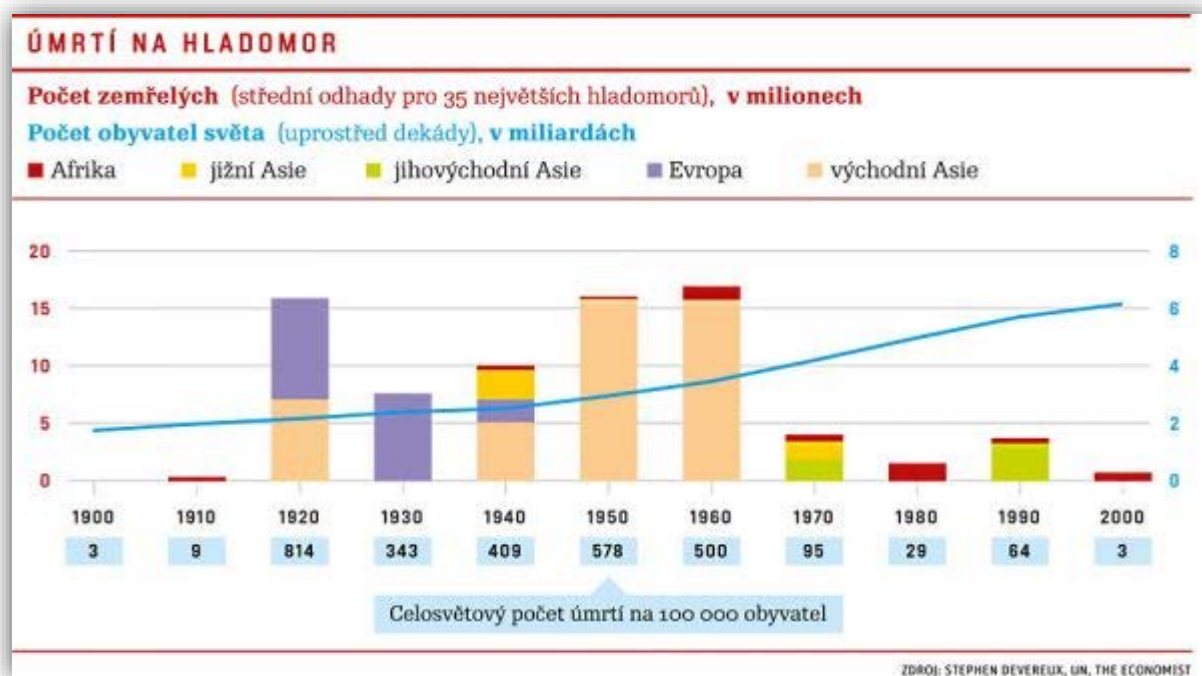


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**The most of the greatest famines in the 20th century were the result of political decisions in undemocratic dictatorships!**

# 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





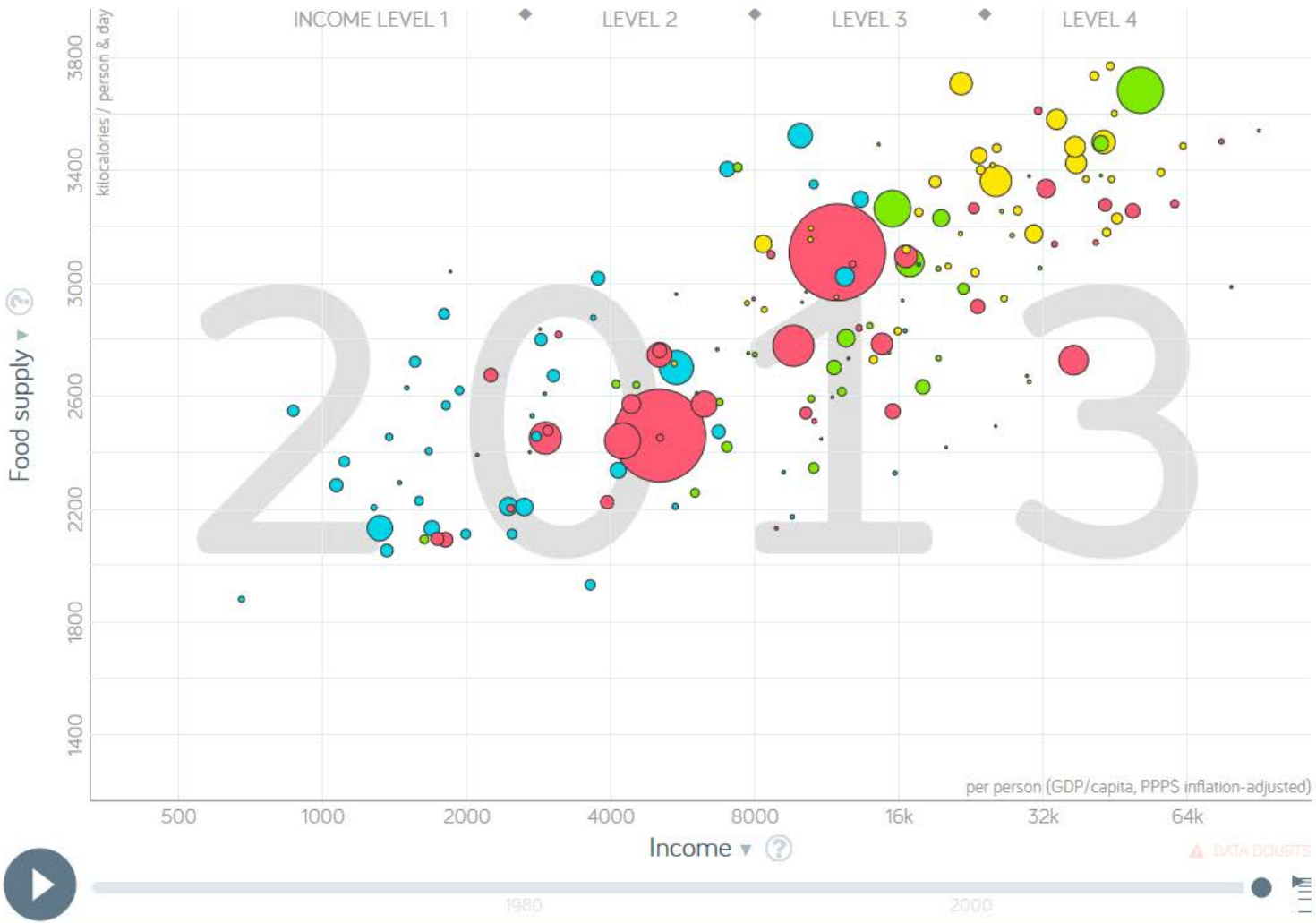
The hands of Resham Singh, a 59-year-old carpenter in Punjab, are gnarled from arthritis. Doctors say it may have been caused by exposure to water tainted by fertilizers and pesticides. Heavy use of chemicals in the 1960s to late 1970s brought India out of famine and into its green revolution, but Singh's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

# Industrial (intensive) agriculture

## Pros

- high production = food security!





Color World Regions [Dropdown]



Select Search... [Input Field]

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

Size Population [Dropdown]

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DATA DOUBTS

OPTIONS PRESENT EXPAND [Icons]

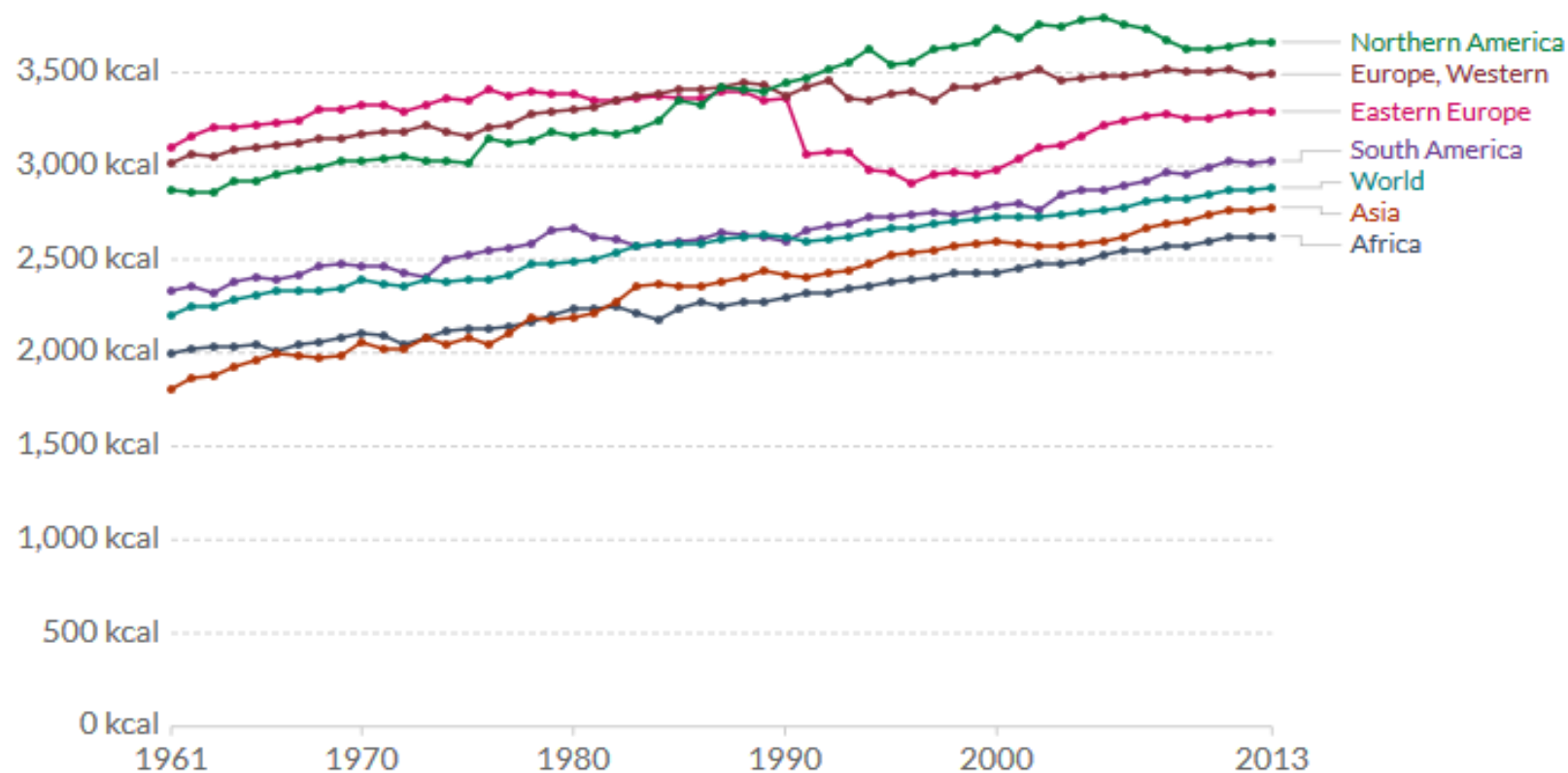


# Daily supply of calories, 1961 to 2013

Caloric supply is measured in kilocalories per person per day.

Our World  
in Data

[+ Add region](#)



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.

CC BY

1961  2013

CHART

MAP

TABLE

SOURCES

[↓](#) DOWNLOAD



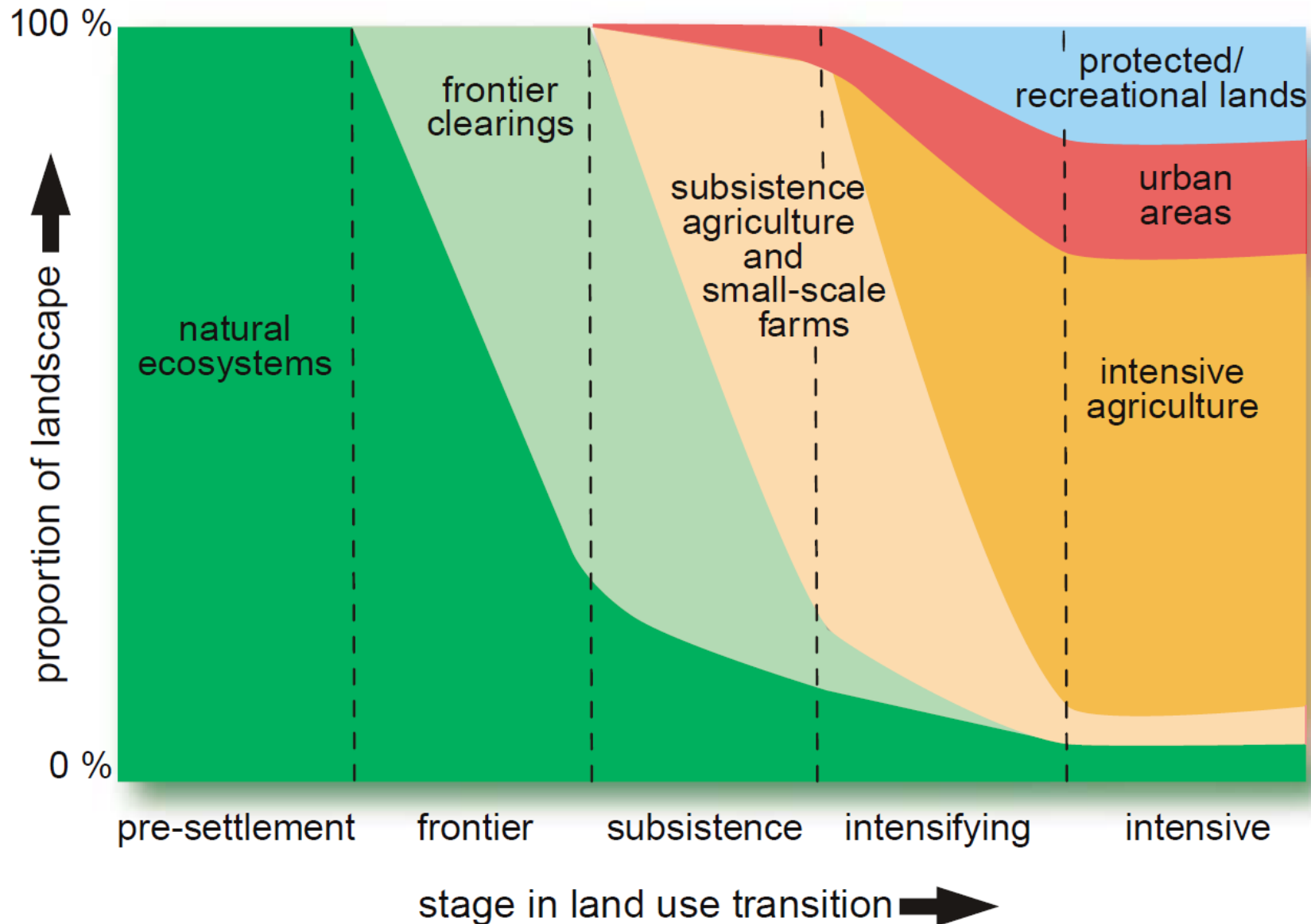
# Industrial (intensive) agriculture

## Pros

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



# Global consequences of land use







Stephen Wilkes/Getty







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



# 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.

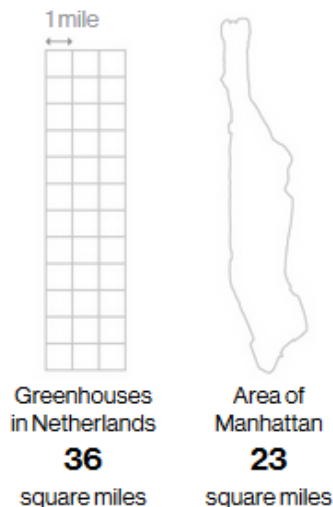
## Growing under glass

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)

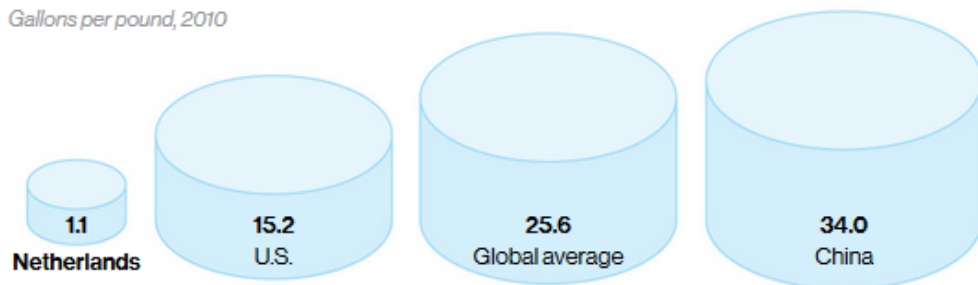


## Doing more with less

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

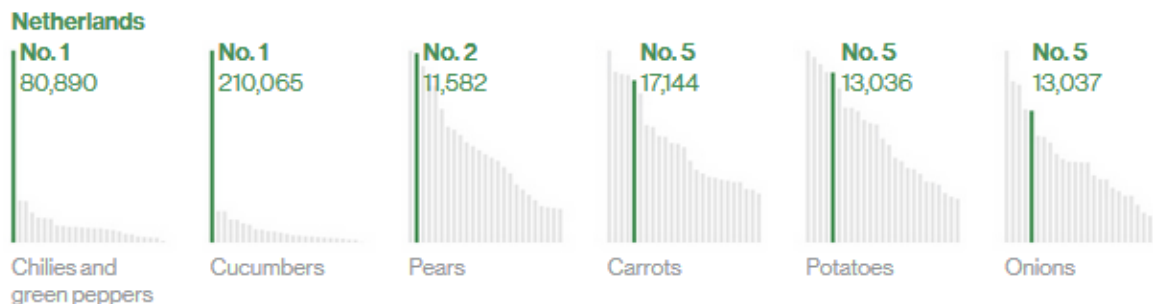
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## Harvesting impressive yields

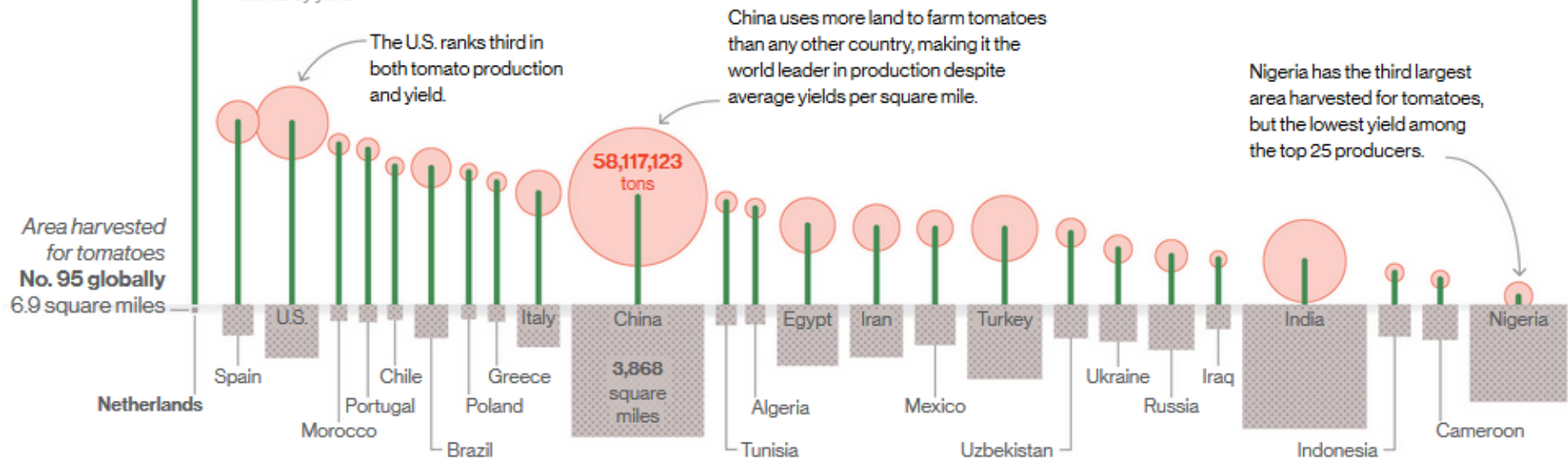
Over the past 30 years, the Dutch tomato industry has become the world leader in yield, producing more tomatoes per square mile than anywhere else; the Netherlands enjoys high yields in other staple crops (right) as well.

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

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





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## Meat production

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



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

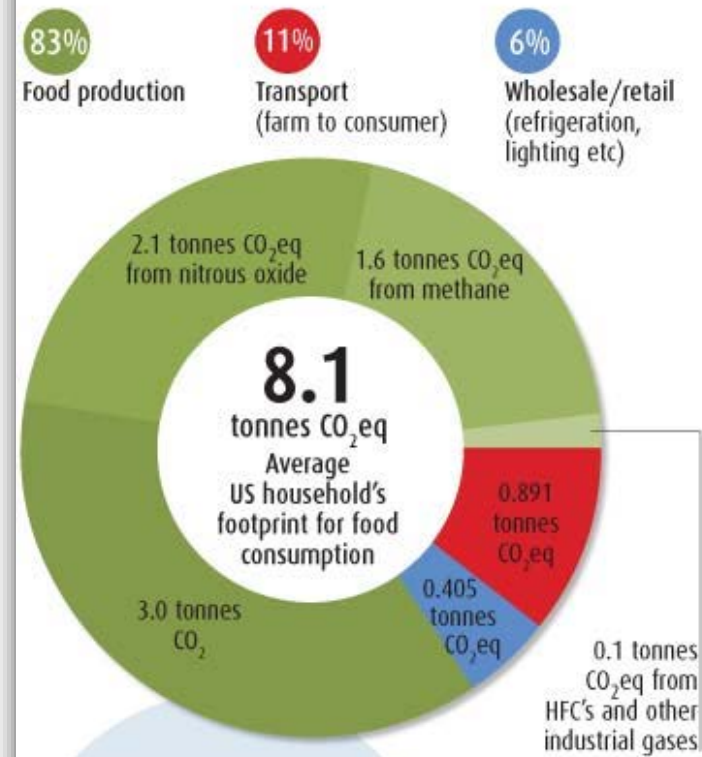
# Characteristics of intens. agriculture

## 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



**CO<sub>2</sub>eq:**  
*The amount of CO<sub>2</sub> 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 CO<sub>2</sub>eq  
The average US household's greenhouse gas emissions per year

# Characteristics of intens. agriculture

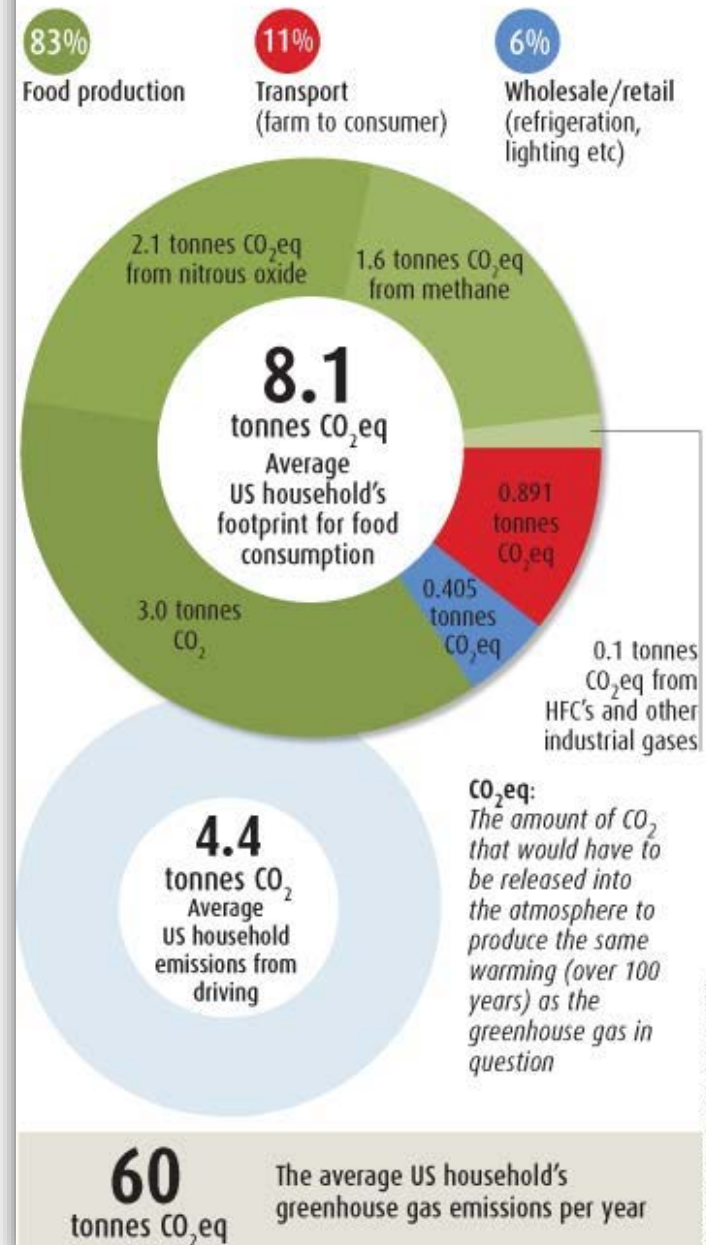
## Food storage

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  - 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 CO<sub>2</sub> 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)



When poll is active, respond at [pollev.com/lindan443](https://pollev.com/lindan443)

**EROEI (Energy return on energy invested) in intensive agriculture growth.**

---

True

False

# Characteristics of intens. agriculture

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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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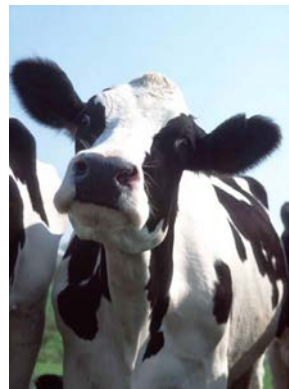
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## **Energetic balance**

- 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

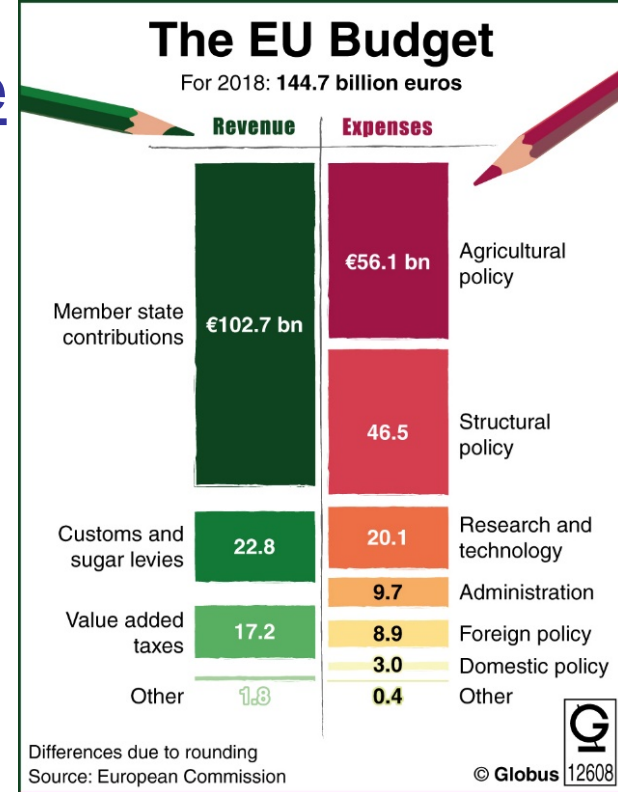
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## Economical

- 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

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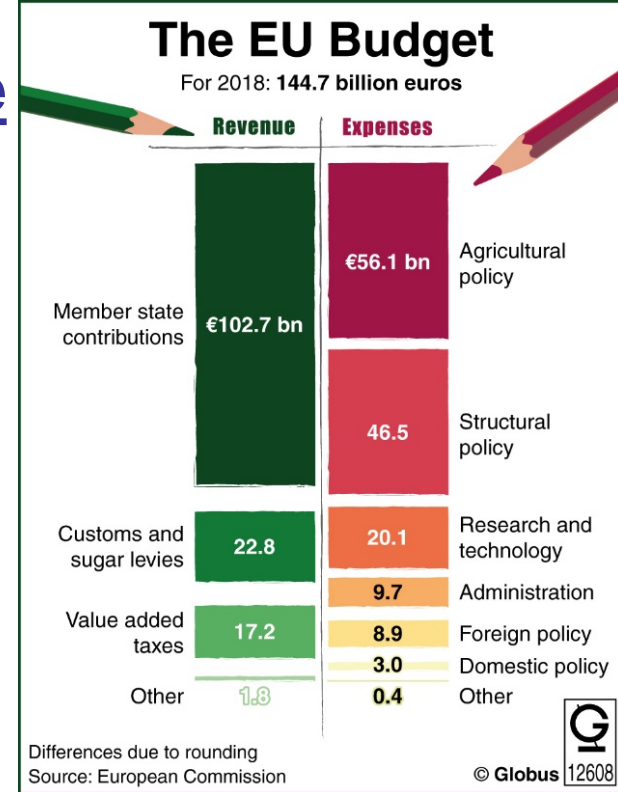
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## Ethical

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



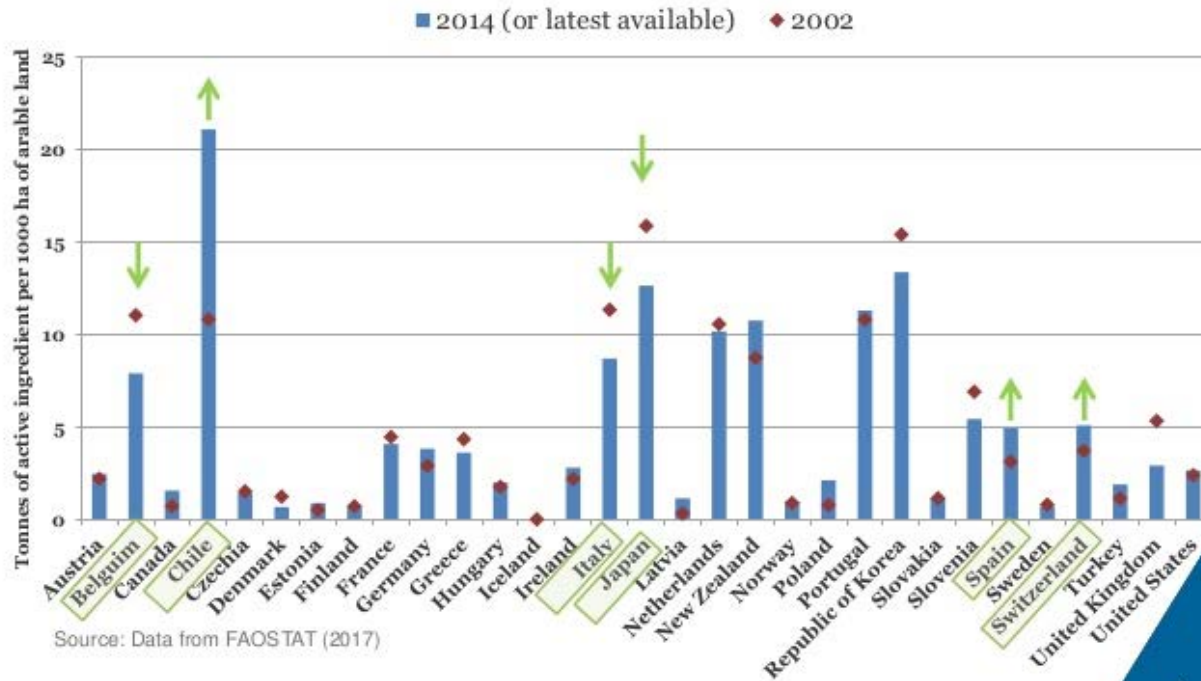
# Negative aspects of intensive agriculture

## 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



### Pesticide use in OECD countries



# 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

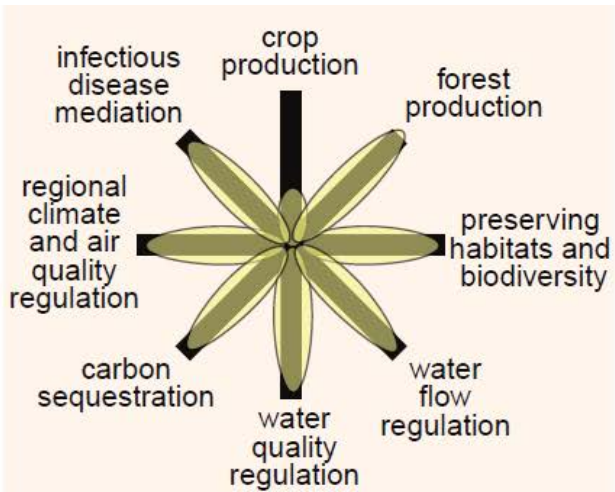
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## **Necessary aims to reach a sustainable agriculture**

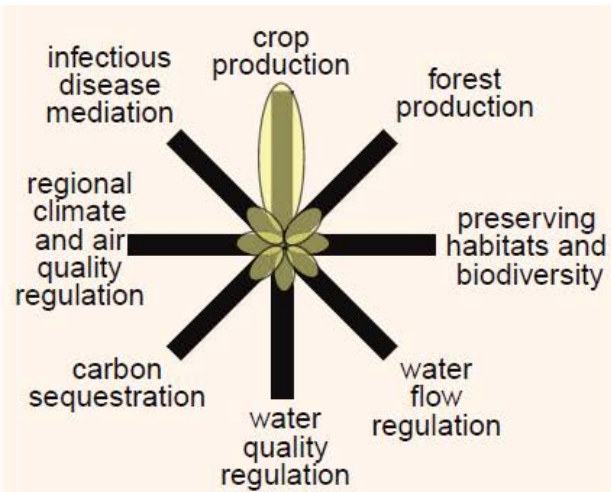
- 1) Higher diversity of flora and fauna on arable land and permanent grassland
- 2) Increased crop diversity.
- 3) Creating conditions leading to the protection of non-productive ecosystems and wild organisms

# Biodiversity



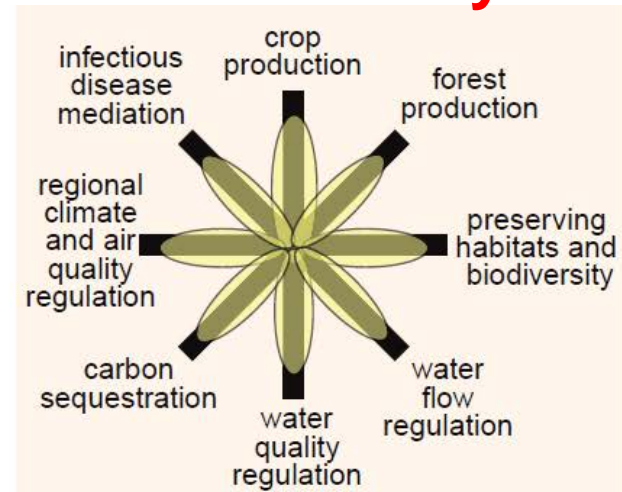
natural ecosystem

# Food security



intensive cropland

# Biodiversity + Food security

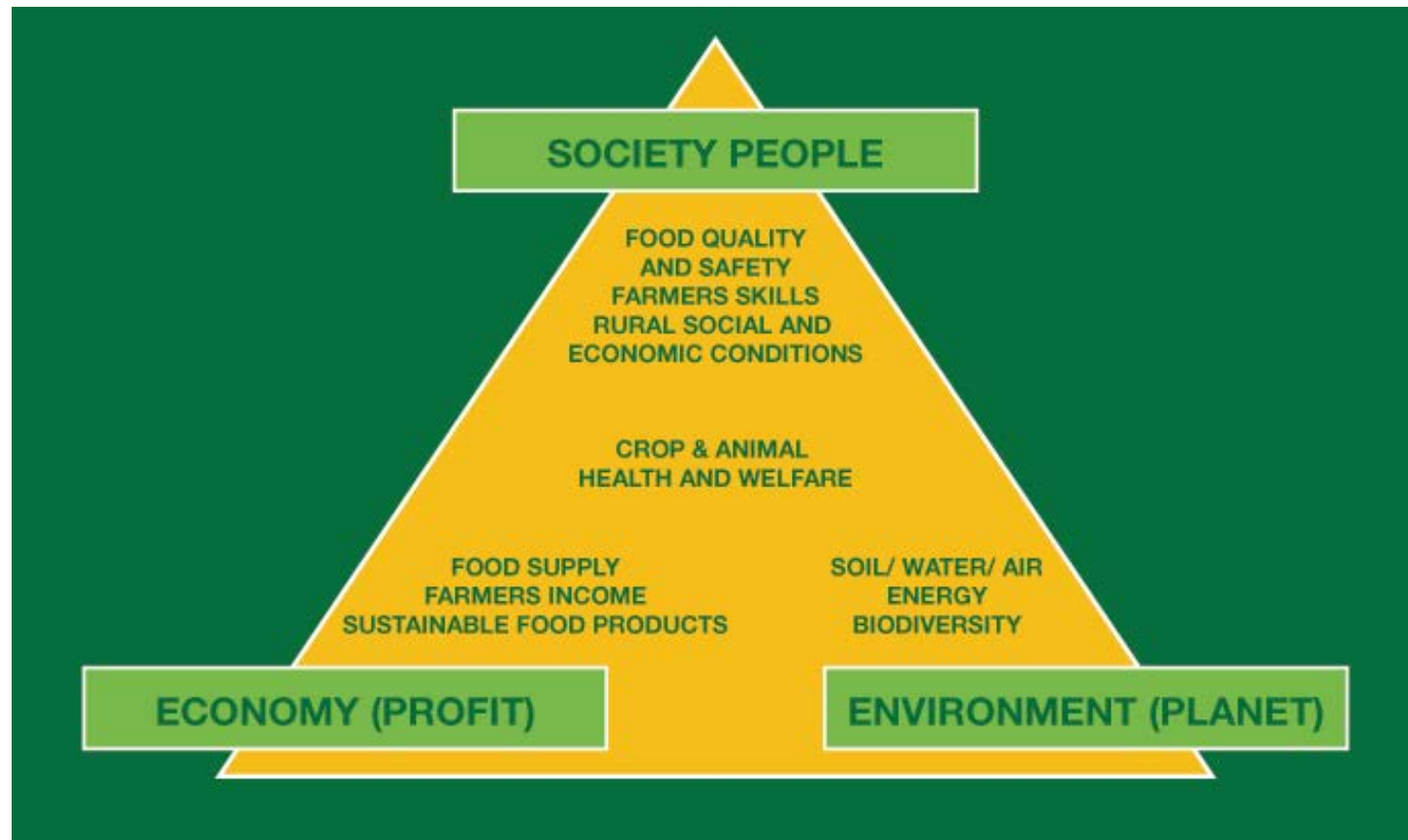


cropland with restored ecosystem services



# 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**

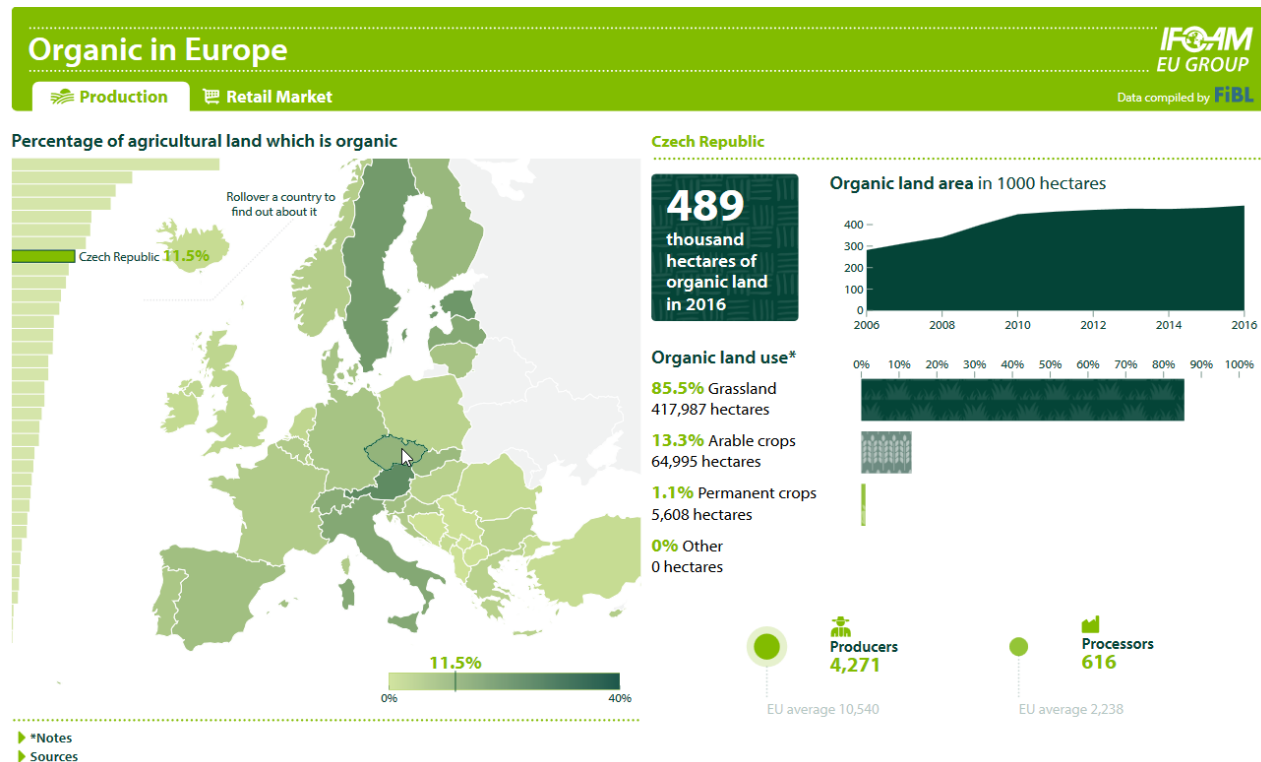
*„A special type of farming that respects the environment and its constituents by restricting or prohibiting the use of substances and practices that burden and pollute the environment or increase the risk of contamination of the food chain, and that pay increased attention to the external manifestations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

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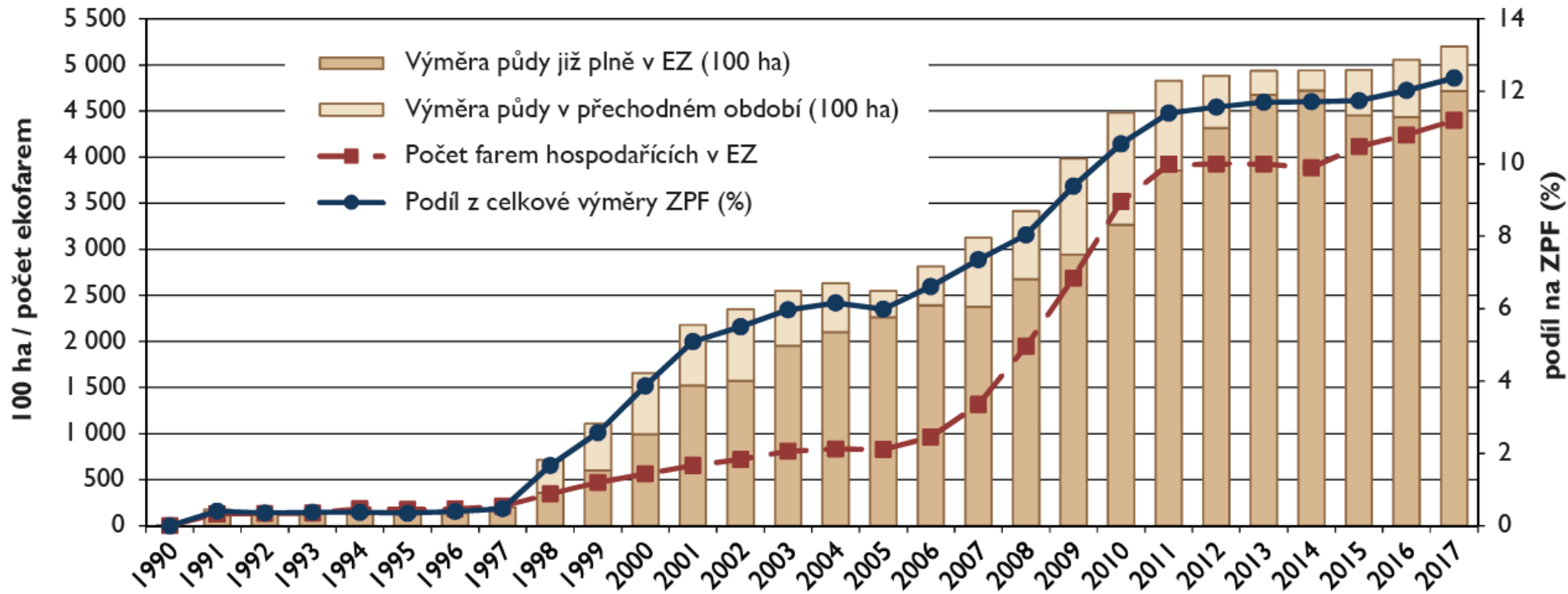
70' – IFOAM  
International Federation  
of Organic Agriculture





# 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.

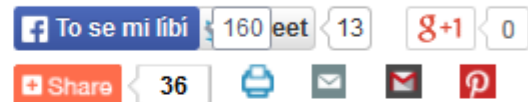
Numerous studies have compared the yields of organic and conventional methods for individual crops and animal products (see [20-year study backs organic farming](#)).

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.

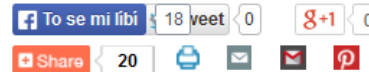
Mader argues that the biggest bonus is the improved quality of the soil under organic cultivation, which should ensure good crops for decades to come.

### 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



ADVERTISEMENT

An advertisement for the Sahara Forest Project. It features the logo at the top right, which consists of the text "SAHARA FOREST PROJECT" next to a stylized green leaf. The main text in the center reads: "Profitable and innovative environmental solutions within the food, water and energy sector". The background is a gradient from light to dark.

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18:45 15 April 2015

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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

**W**hat 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 photograph of a field of purple flowers, likely lavender, at sunset. The sun is low on the horizon, casting a warm glow over the field. The flowers are in various stages of bloom, and the overall scene is peaceful and scenic.

# 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?

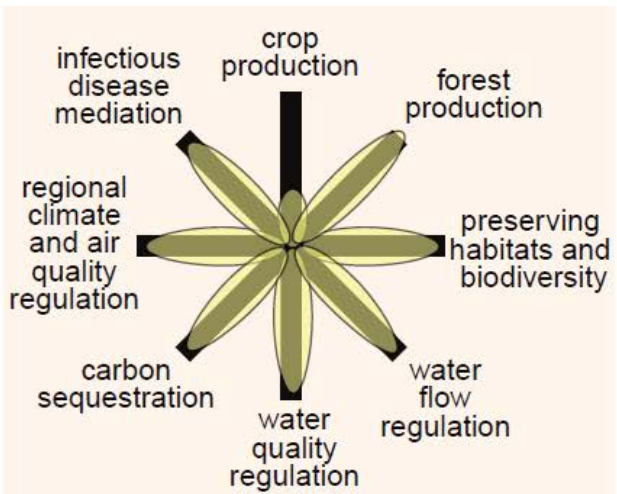
**Food security**

**Intensive agriculture + and - X Extensive agriculture + and -**

**Biodiversity**

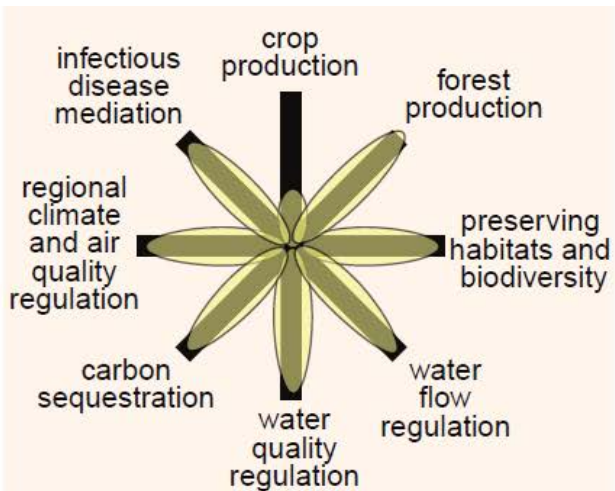
Separation of an intensive food production  
from the extensive farming in the landscape?

# Biodiversity

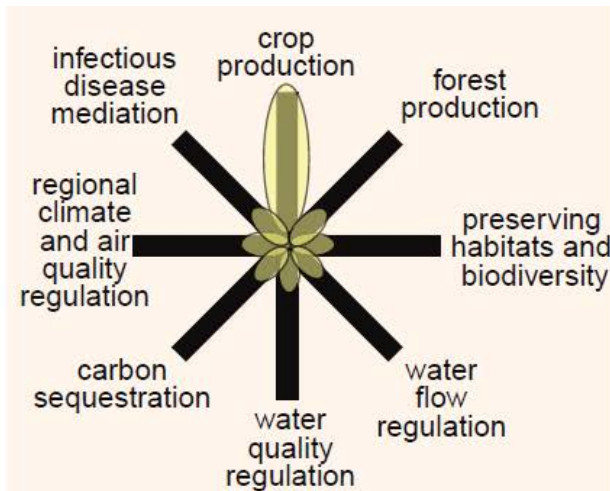


natural ecosystem

# Biodiversity + Food security



natural ecosystem



intensive cropland



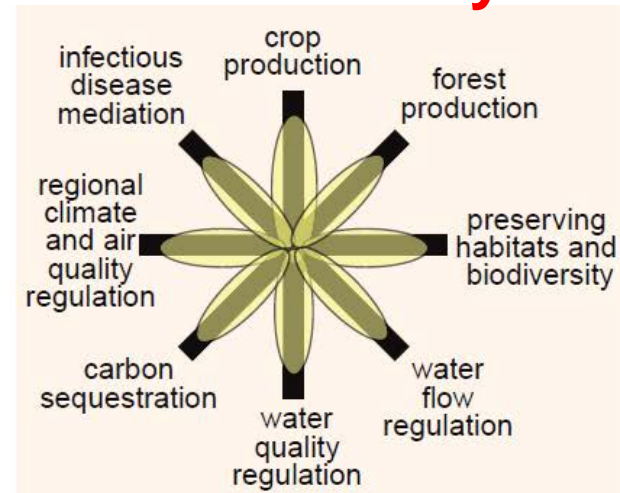
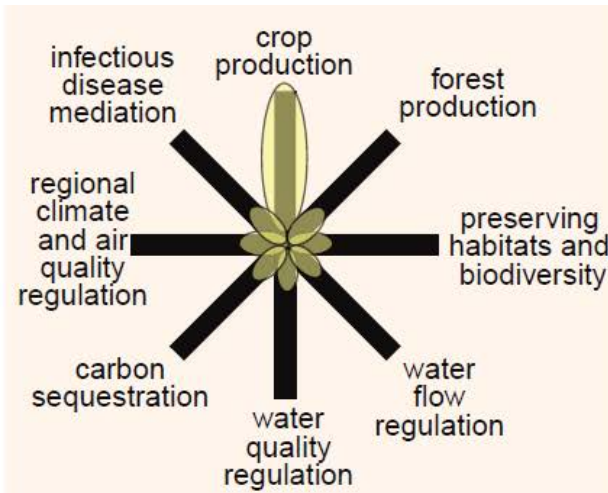
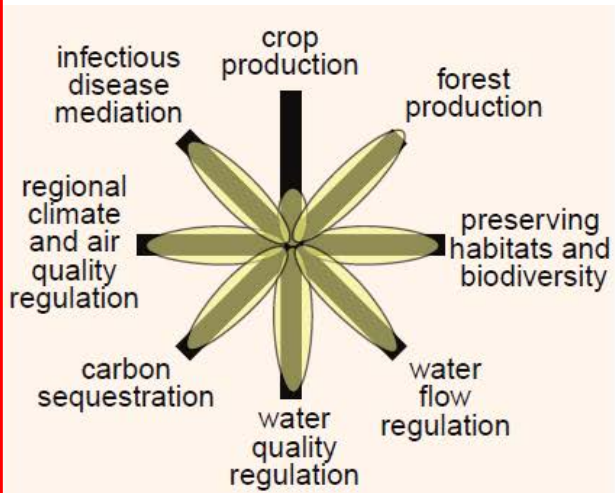
# Biodiversity

# +

# Food security

# +

# Biodiversity + Food security



natural ecosystem



intensive cropland



cropland with restored ecosystem services