¶ 4.1

ENVS 101 B – Lecture 4

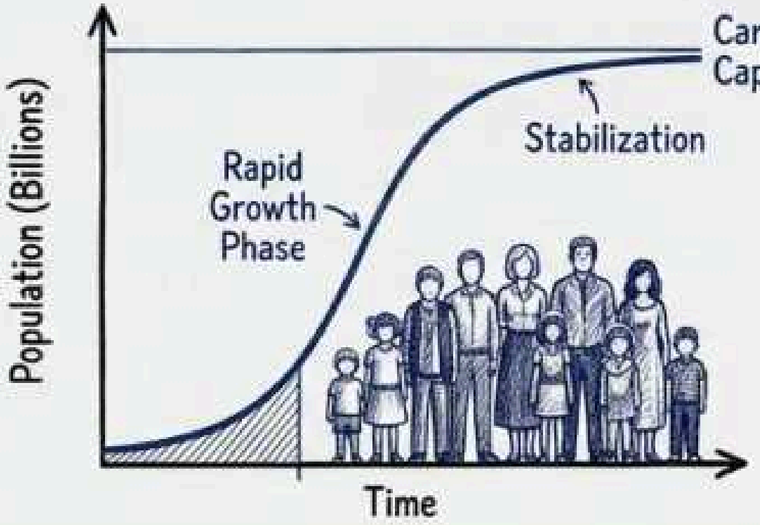
Population, Food, and Land

Gemini Notebook

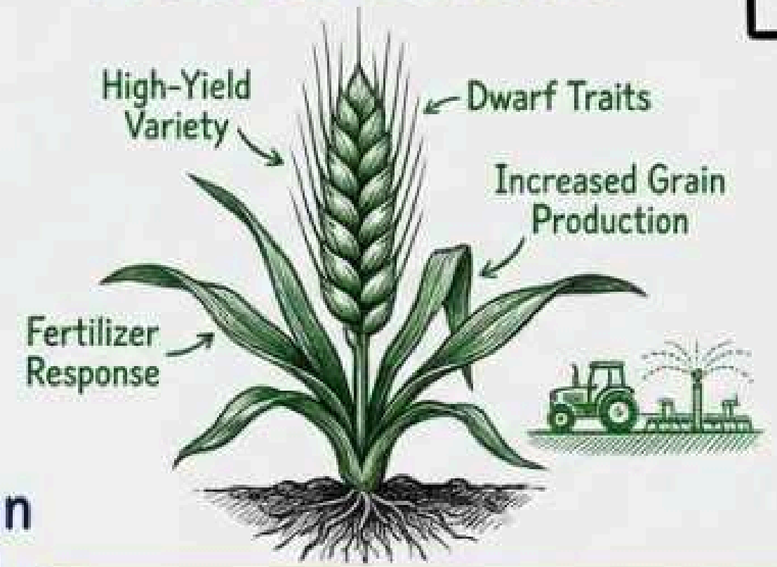
¶ 4.2

How many people can Earth support, and how are they fed?

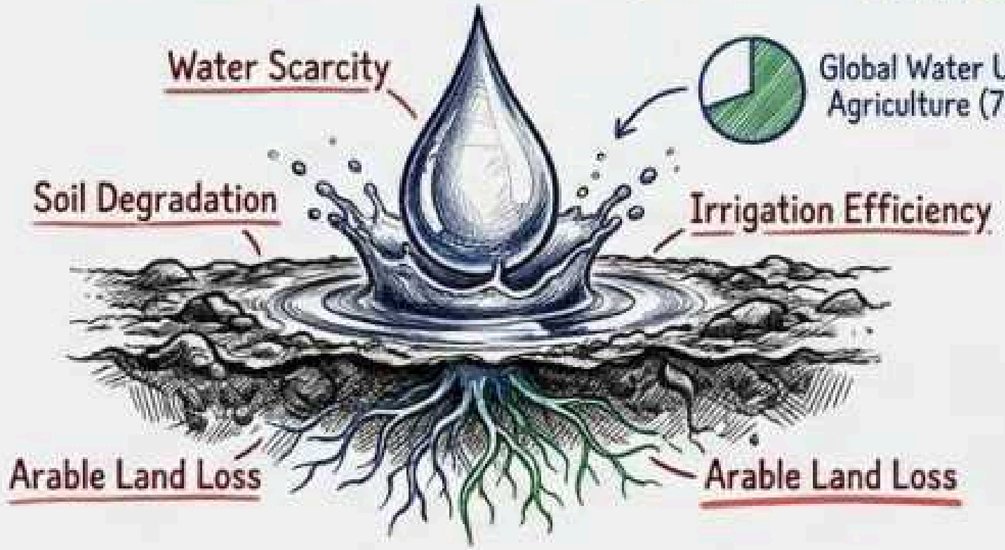
Population Growth & Demographics



The Green Revolution



Land & Water Usage

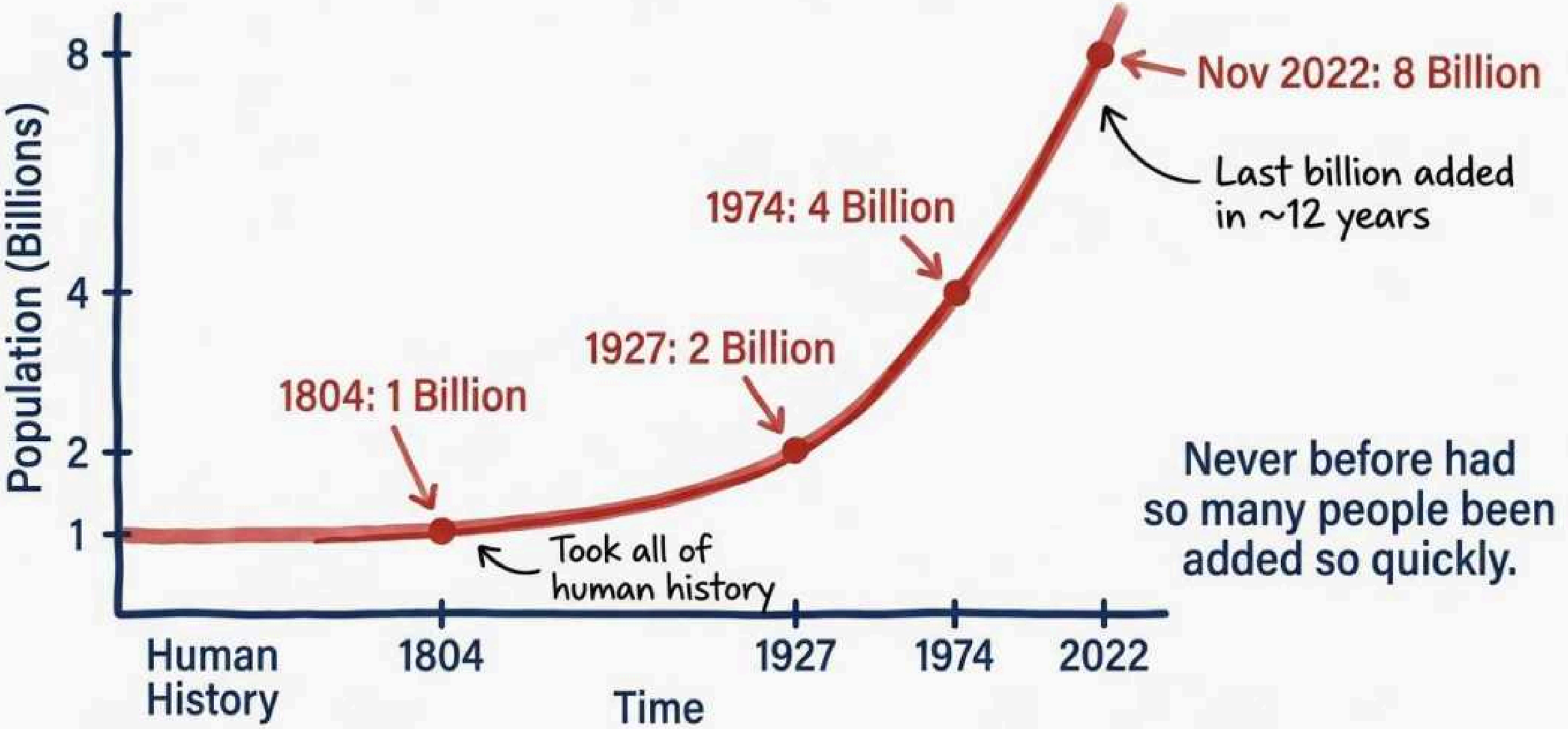


Sustainable Future Options



World Population: A Hockey Stick Growth

¶ 4.3



Gemini Notebook

Exponential Growth & The Rule of 70

¶ 4.4

T_d = Doubling Time (years)

$$T_d \approx \frac{70}{r}$$

r = % Growth Rate

2% rate → Doubles in 35 years (time)
(70/2)

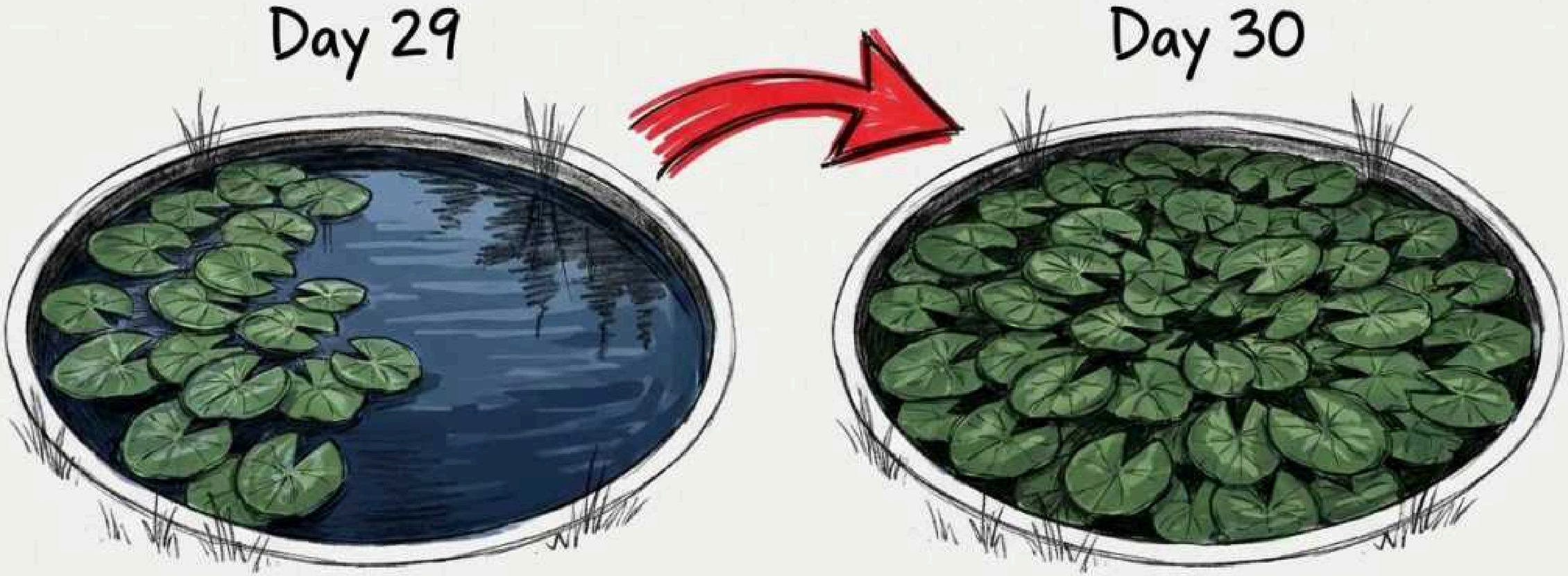
1% rate → Doubles in 70 years (time
(70/1)

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The Deception of Exponential Growth

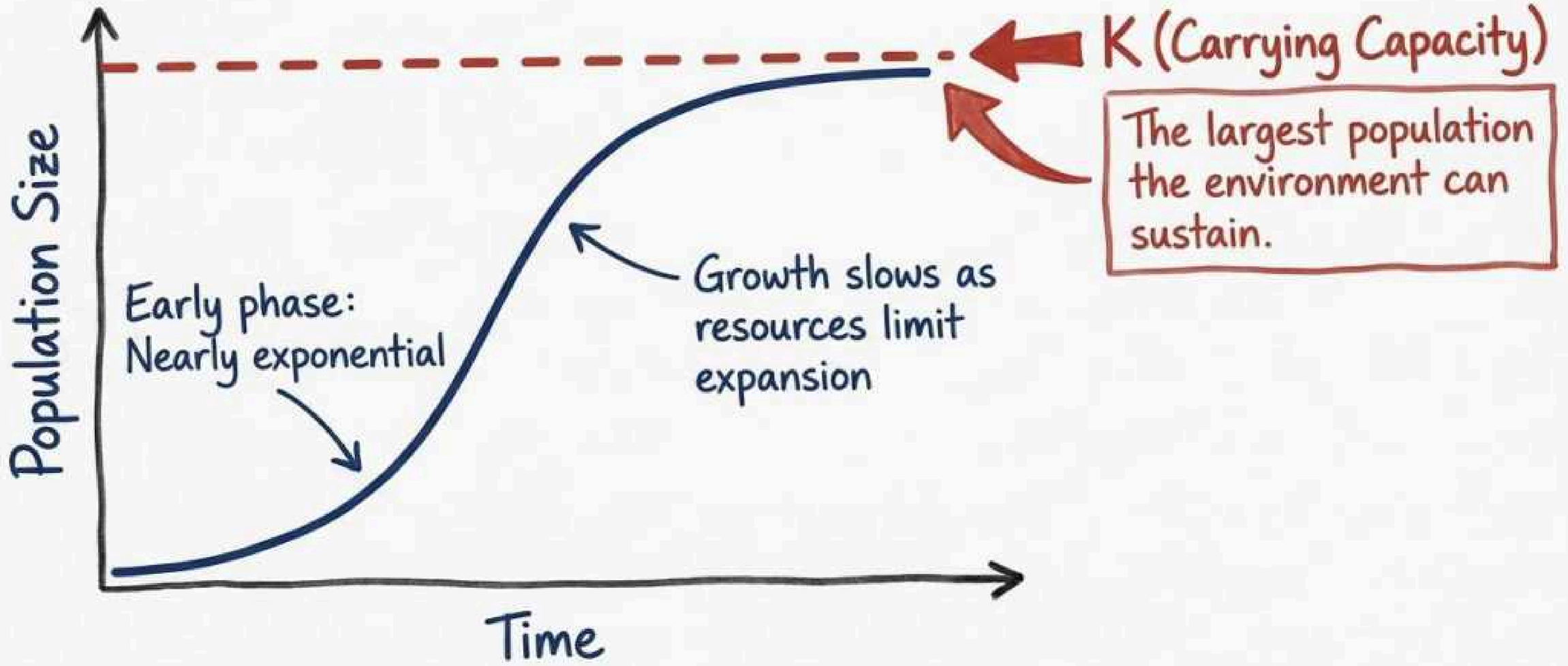
¶ 4.5

At 2% growth/year, population increases 7.4x in a century. It feels slow—until it explodes.



¶ 4.6

Logistic Growth & Carrying Capacity

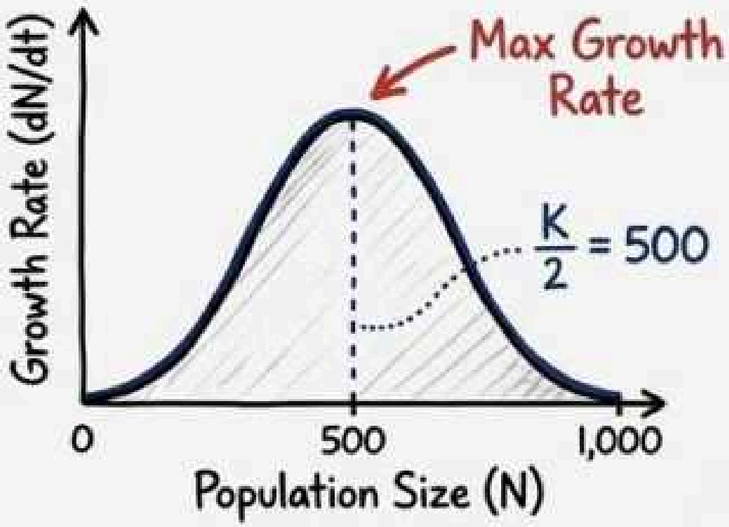


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Starting Pop (N_0) = 10 | Capacity (K) = 1,000 | Growth Rate (r) = 0.5/yr

Year 4:	~69
Year 8:	~355
Year 12:	~803
Year 16:	~968

Population rises fastest in the middle, near half of capacity (500).



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The Malthusian Debate

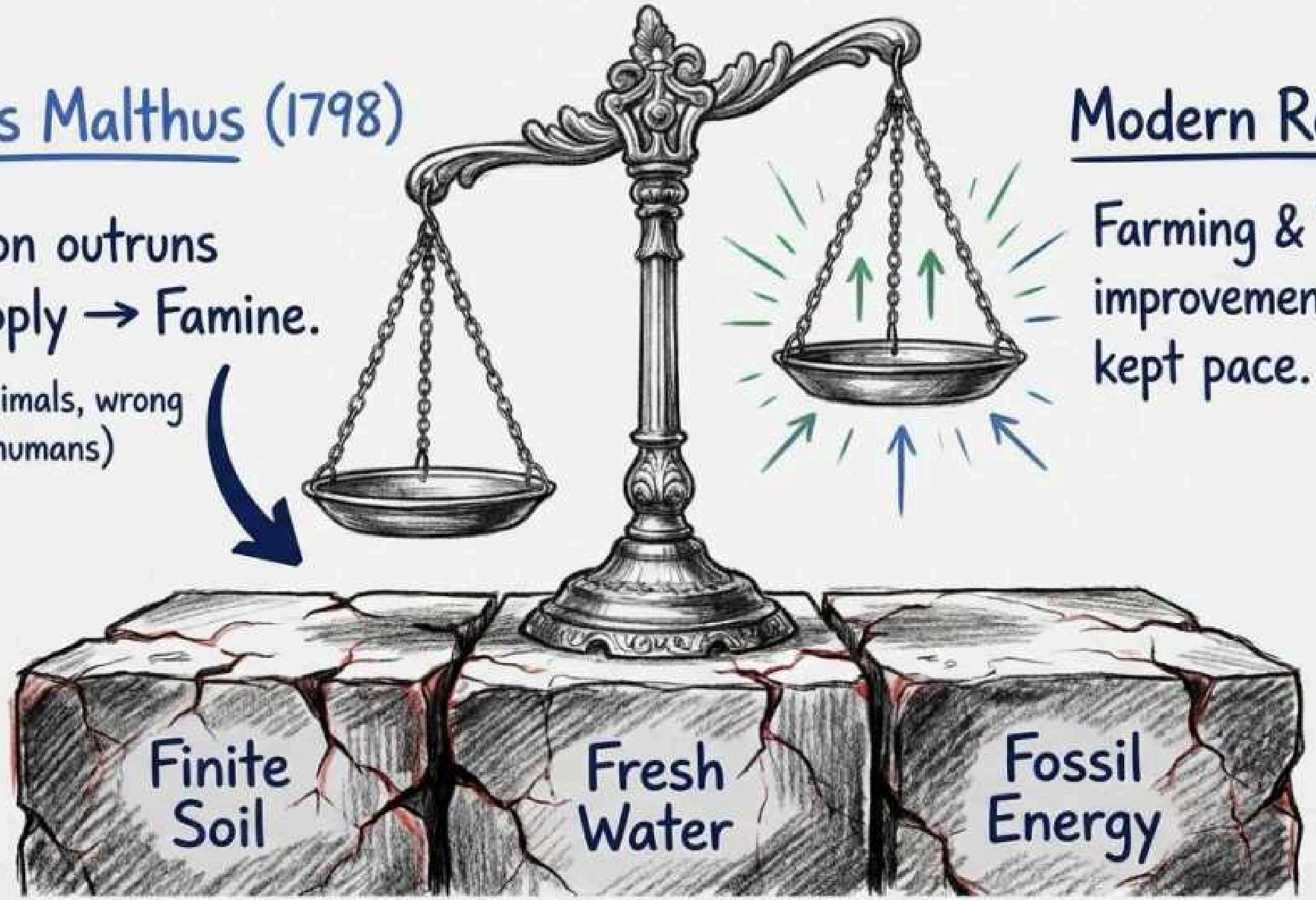
Thomas Malthus (1798)

Population outruns food supply → Famine.

(True for animals, wrong so far for humans)

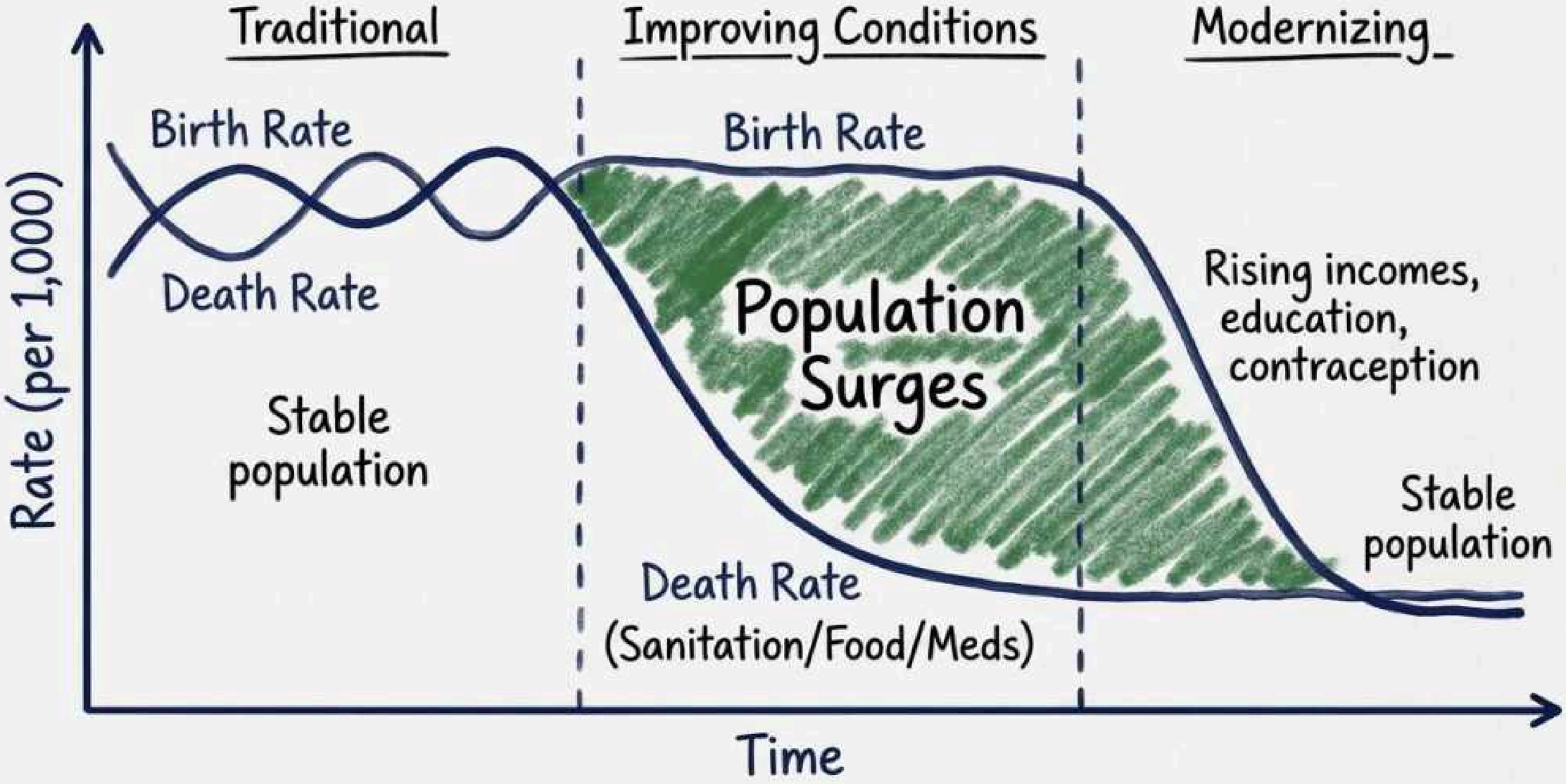
Modern Reality

Farming & Technology improvements have kept pace.



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Birth Rate vs. Death Rate Over Time



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The Global Fertility Decline

¶ 4.10

Average children per woman dropped from ~5 (1950) to >2 (Today)

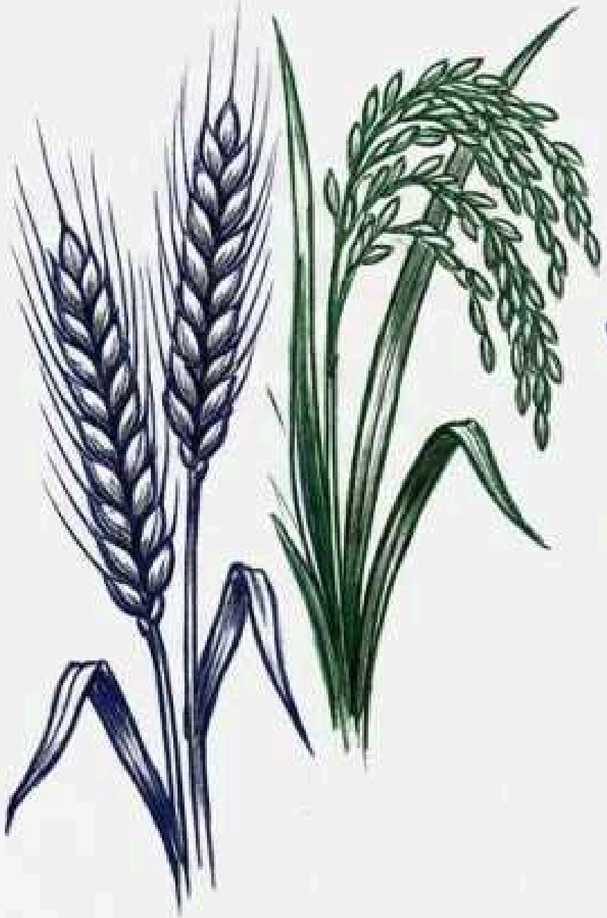


Global population expected to peak in the 21st century (exact date uncertain)

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Norman Borlaug (Nobel Peace Prize, 1970)

¶ 4.11



+



+



+ The Green Revolution

+



= The Green Revolution

(Yields doubled or more in many countries)

Gemini Notebook

¶ 4.12



Fossil Energy

Required for fertilizer, machinery, pumping

Water

Massive consumption

Intensive Farming



Pollution

Nitrogen/phosphorus runoff polluting streams. Harm to non-target species & workers.

Vulnerability

Low genetic diversity increases disease risk.



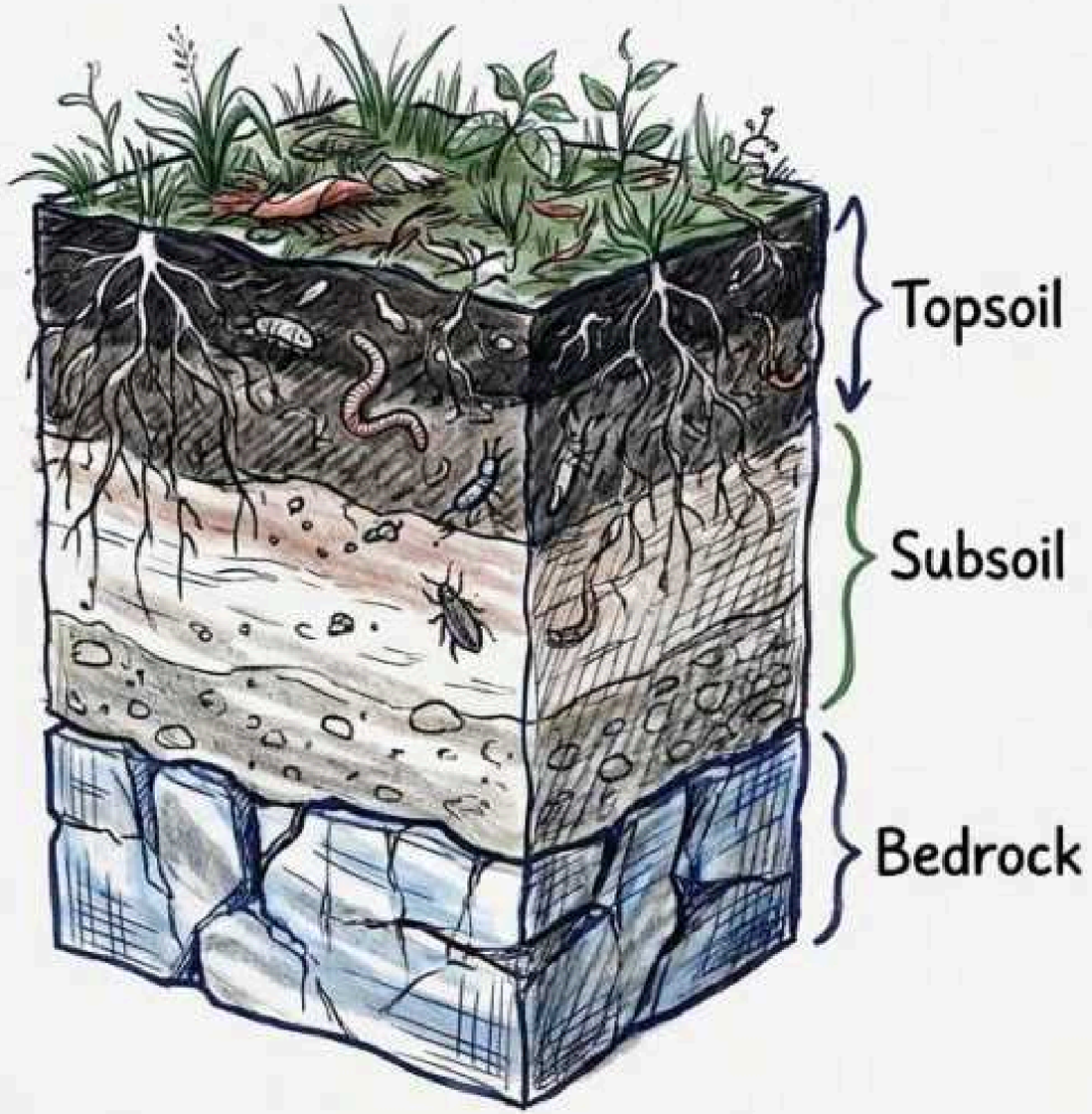
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¶ 4.13

Takes 100s–1000s of years to form 1cm of topsoil

↕

Plowing, overgrazing, clearing strips it away rapidly (e.g., 1930s Dust Bowl)

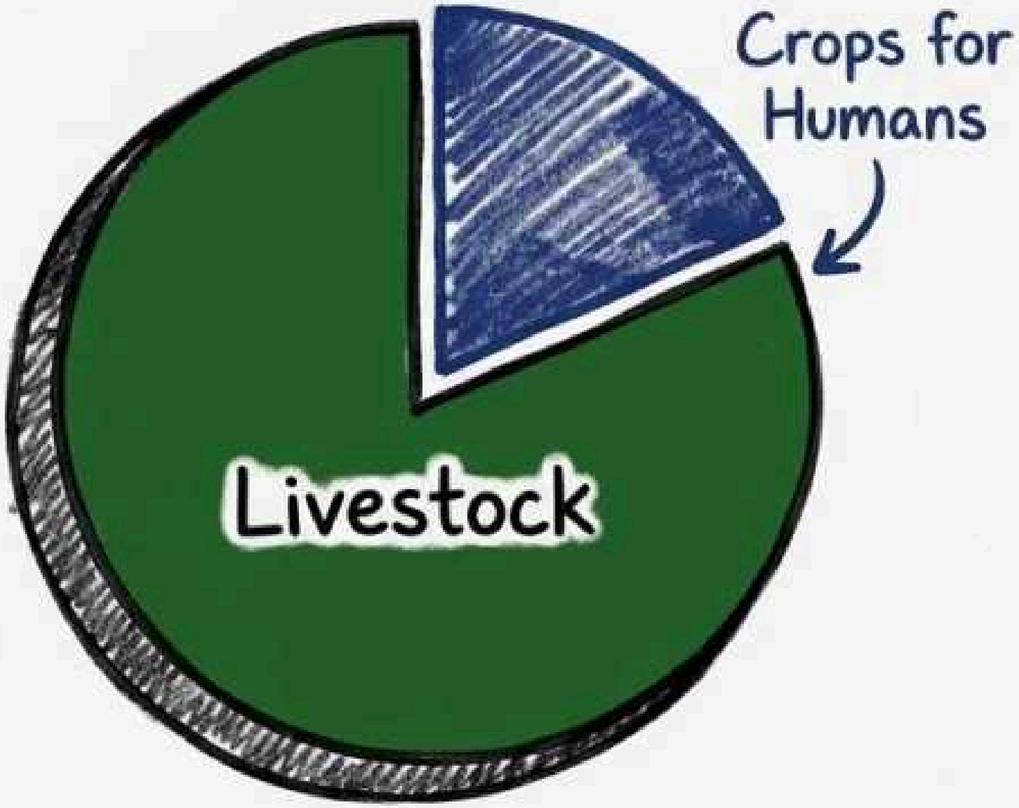


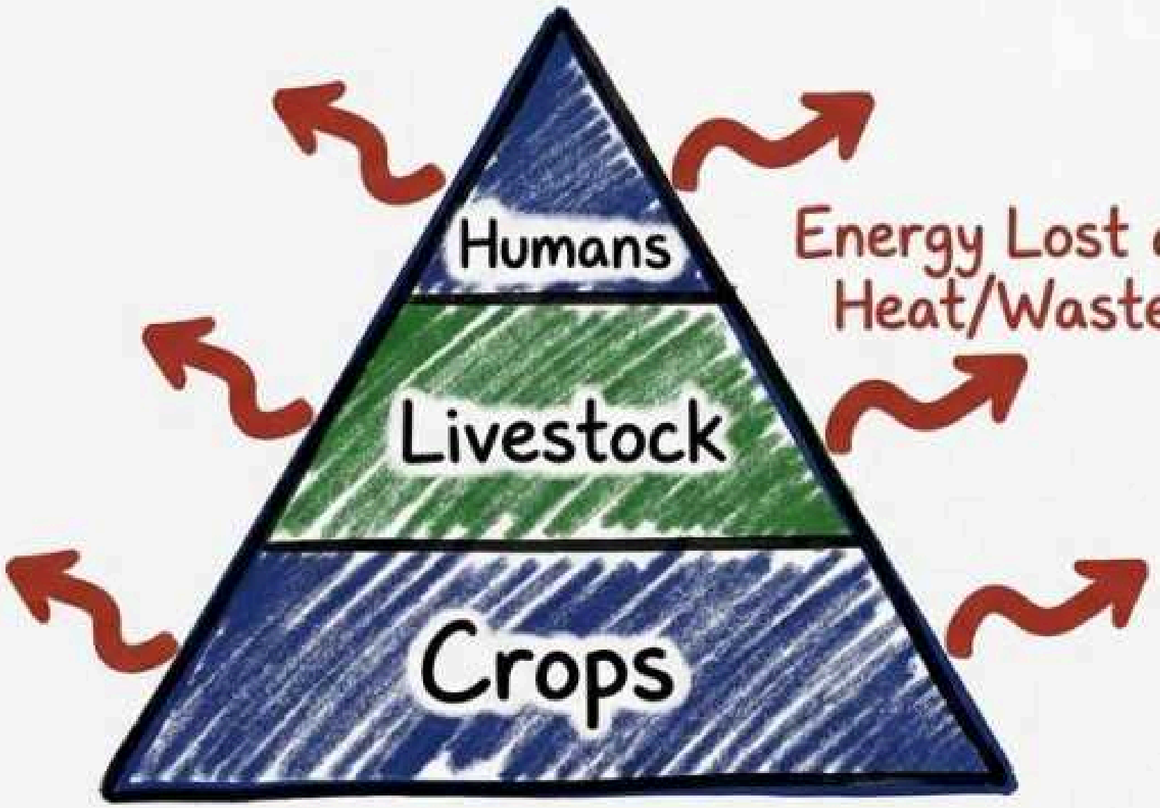
- ✓ No-till planting
- ✓ Cover crops
- ✓ Terracing
- ✓ Crop rotation

Gemini Notebook

¶ 4.14

~50% of habitable Earth is Croplands + Pastures





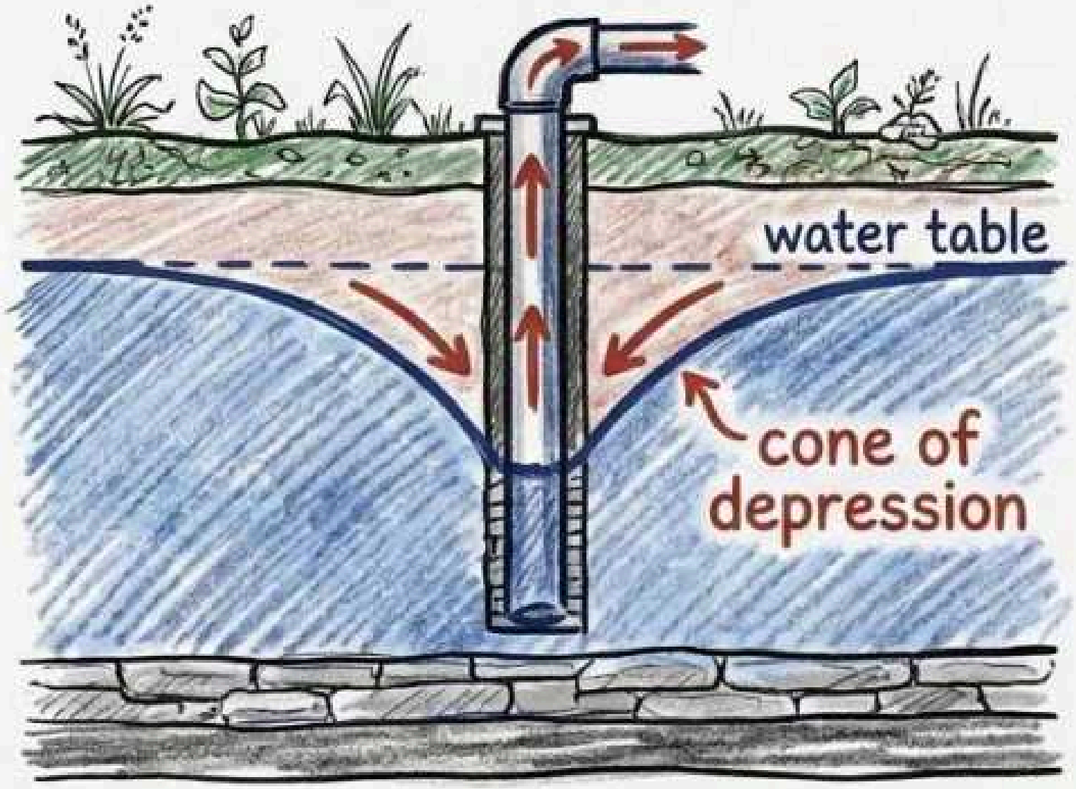
Livestock occupies most agricultural land, yet supplies under 20% of world calories.

Gemini Notebook

~70% of human fresh water withdrawals go to irrigation

¶ 4.15

The Problem



Groundwater pumped faster than rain refills it → wells must go deeper

The Solutions

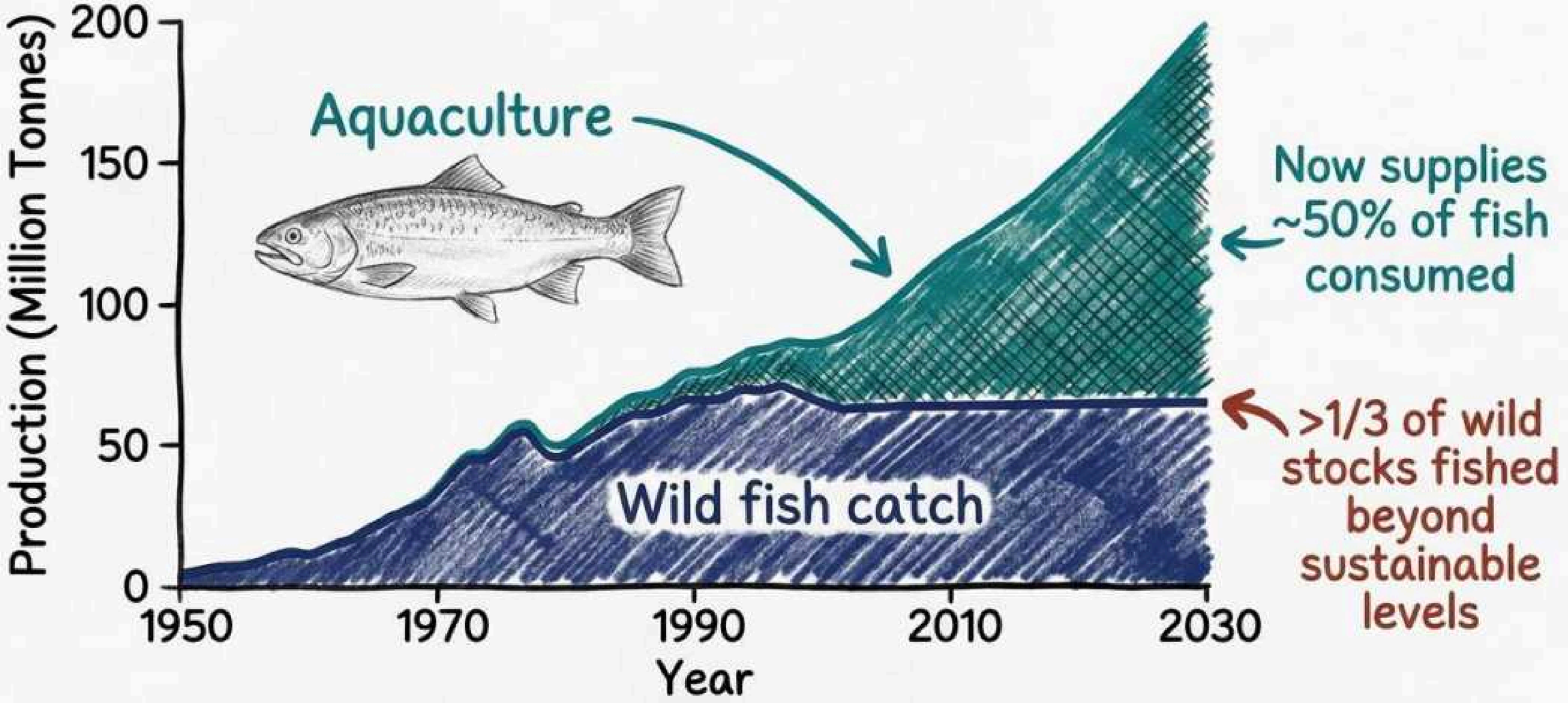


Efficient irrigation & matching crops to local rainfall

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Global Fish Production (Million Tonnes)

¶ 4.16



Quotas, protected areas, gear rules

Gemini Notebook

¶ 4.17

~1/3 of all food produced is lost or wasted

Poorer Countries

Loss occurs at Farm/Storage



Cause: Lack of roads and refrigeration

Richer Countries



Waste occurs at Shops/Households

Cutting waste is the cheapest way to reduce pressure on land and water.

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¶ 4.18

$$I = P \times A \times T$$

I = Impact
Total human impact on environment

P = Population
How many people

A = Affluence
Consumption per person

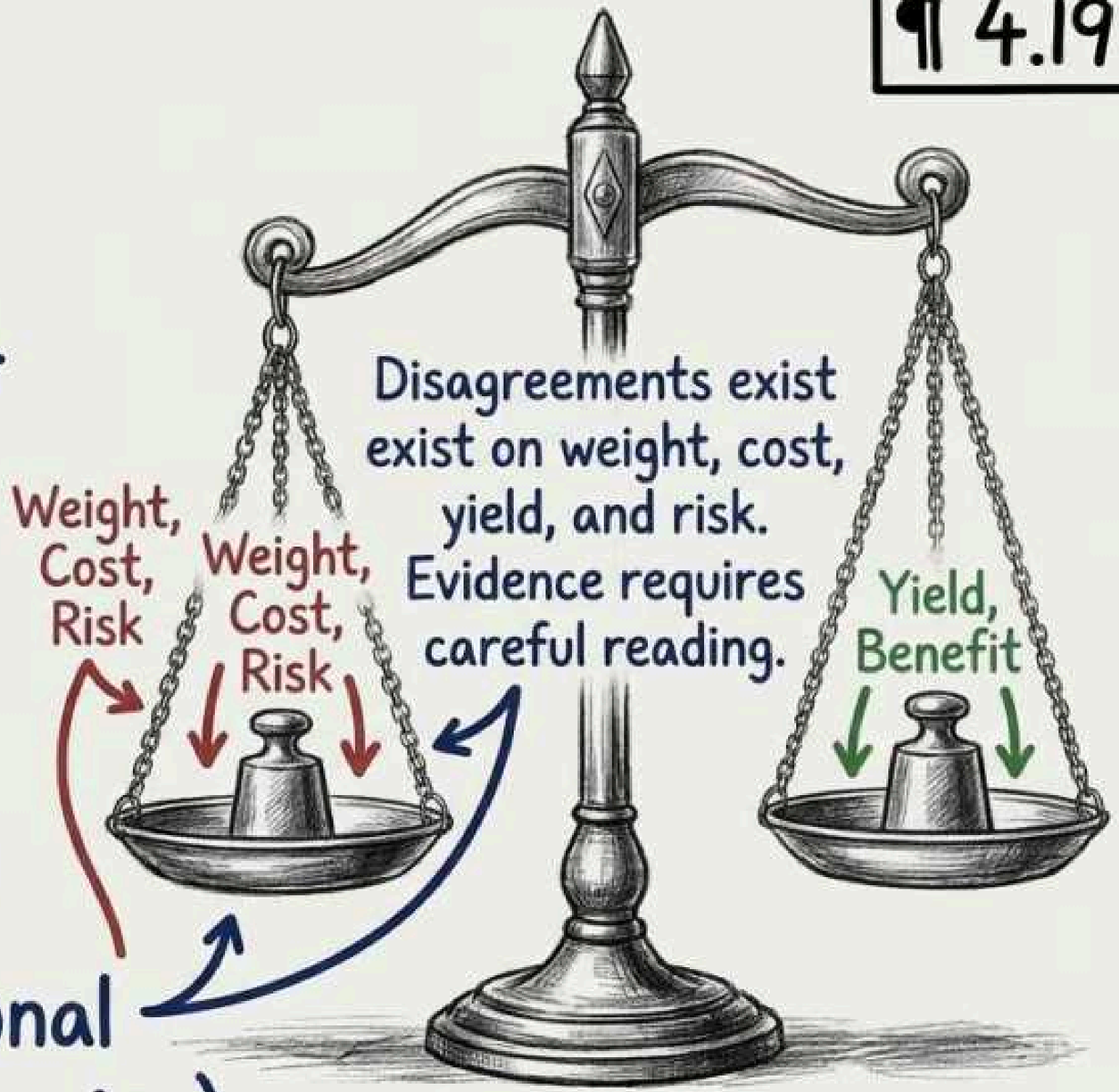
T = Technology
Impact per unit consumed; how "clean" methods are

Reducing any factor lowers the total impact.

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¶ 4.19

- [ ] Raise yields in low-yield areas
- [ ] Protect soil and water
- [ ] Cut food waste
- [ ] Shift diets (less resource-intensive)
- [ ] Improve crops (traditional breeding / genetic engineering)



Application Question

¶ 4.20

Scenario: A city of 2 million grows at 2% a year.

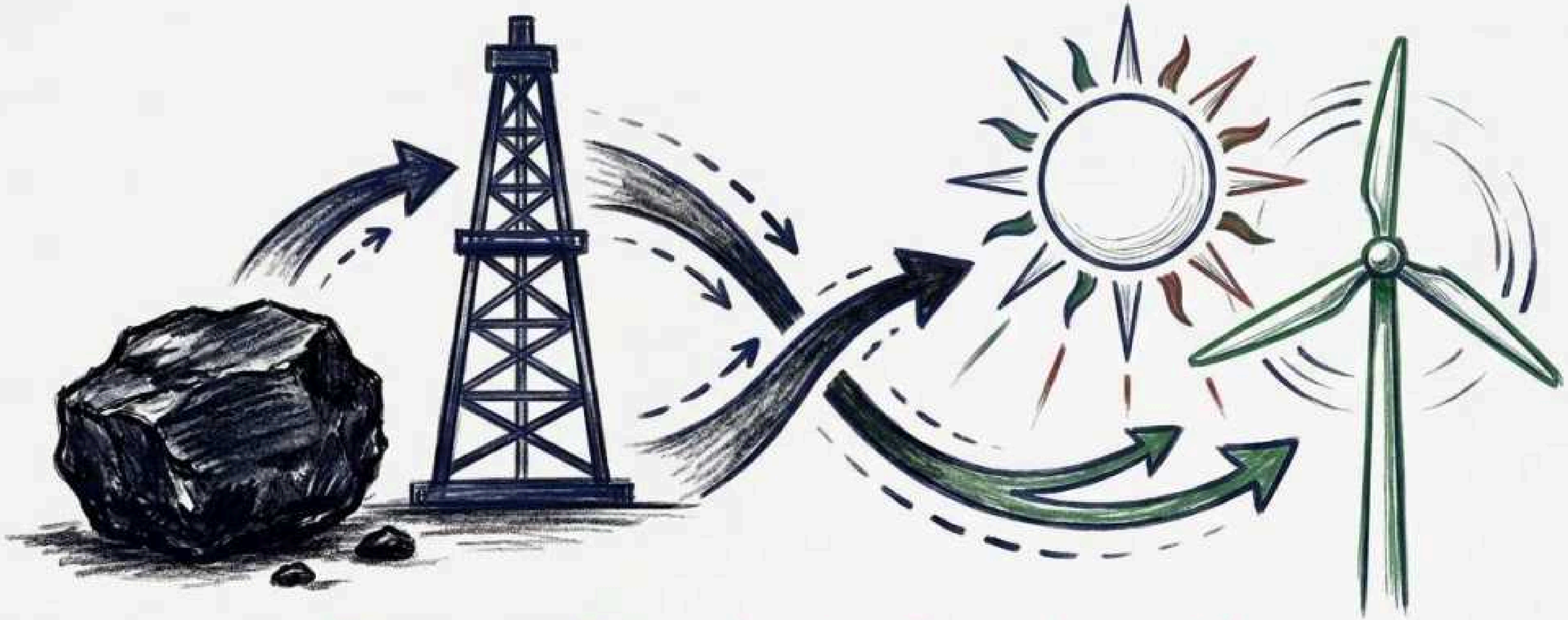
Task 1: Use the Rule of 70 to find its doubling time, and estimate its population in 70 years.

Task 2: Explain, using the logistic model, why the city cannot keep growing at this rate forever.

Gemini Notebook

Looking Ahead to Lecture 5

¶ 4.21



Energy: The fuel of modern life

Climate Change: The consequence of burning fossil fuels

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