Food Security for Humankind:

Past, Present and Future

Presentation to the
Canadian Association for the Club of Rome

October 14, 2020
Catherine Cockshutt Smith

Food Security

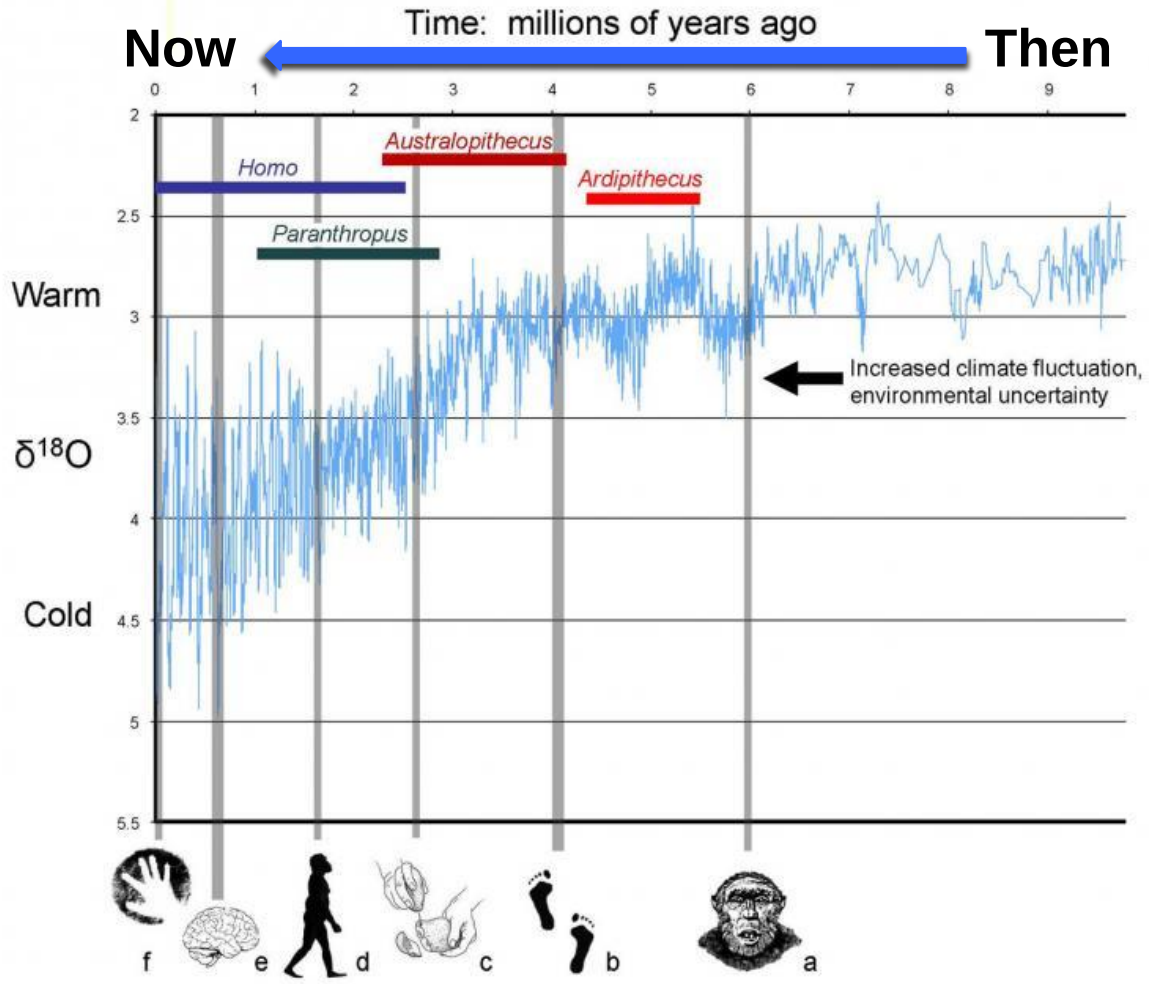
- **"Food security** exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." *--1996 World Food Summit*

- **"Food insecurity** is a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life." *-- FAO*

Overview

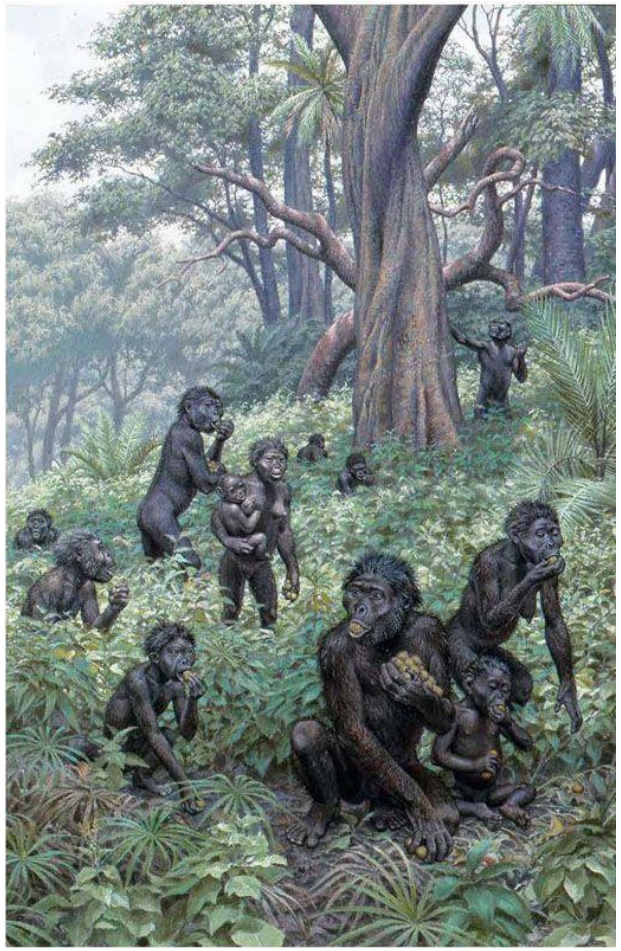
- Many of the most important evolutionary adaptations in humans, both physical and cultural, were driven by **climate change** and the need to **maintain adequate food resources** in the face of a changing environment
- We will first look at how **access to food** shaped our bodies over the past four million years
- We will then assess our current situation with respect to **food security** and examine where we might be headed in the future

The Past: Climate Change



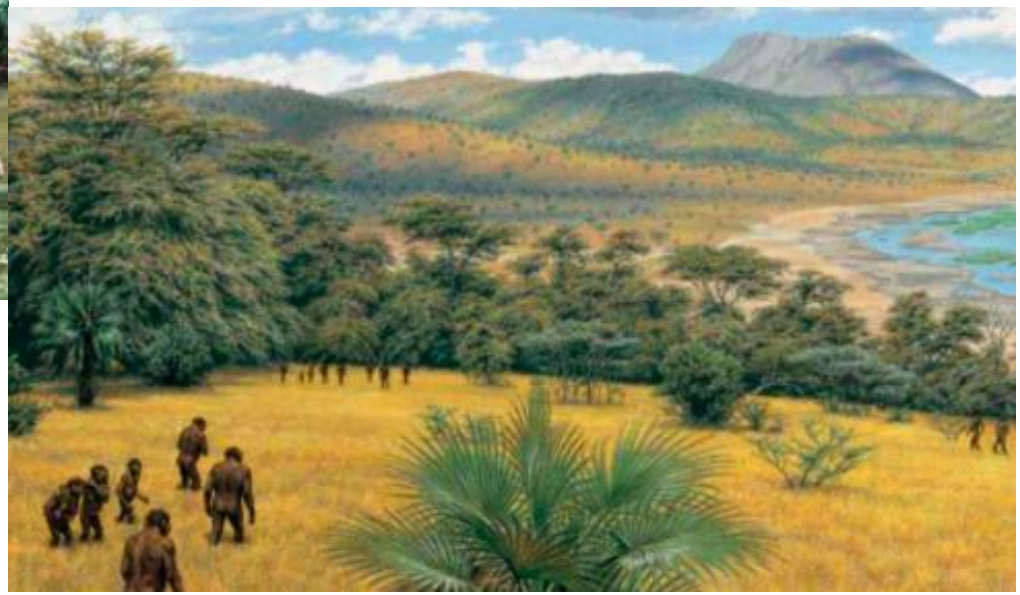
The Past: Walking on Two Legs

The Past: Walking on Two Legs



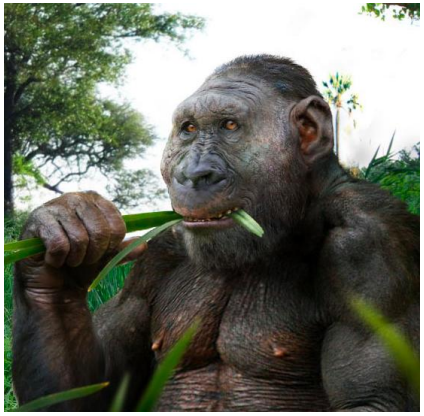
- **Feeding posture:** reaching for fruits or walking on branches, on the ground, or even wading
- **Moving more efficiently between food sources** that are now more widely spaced
- **Carrying foods** for later consumption

The Past: Walking on Two Legs



The Past: Teeth and Tubers

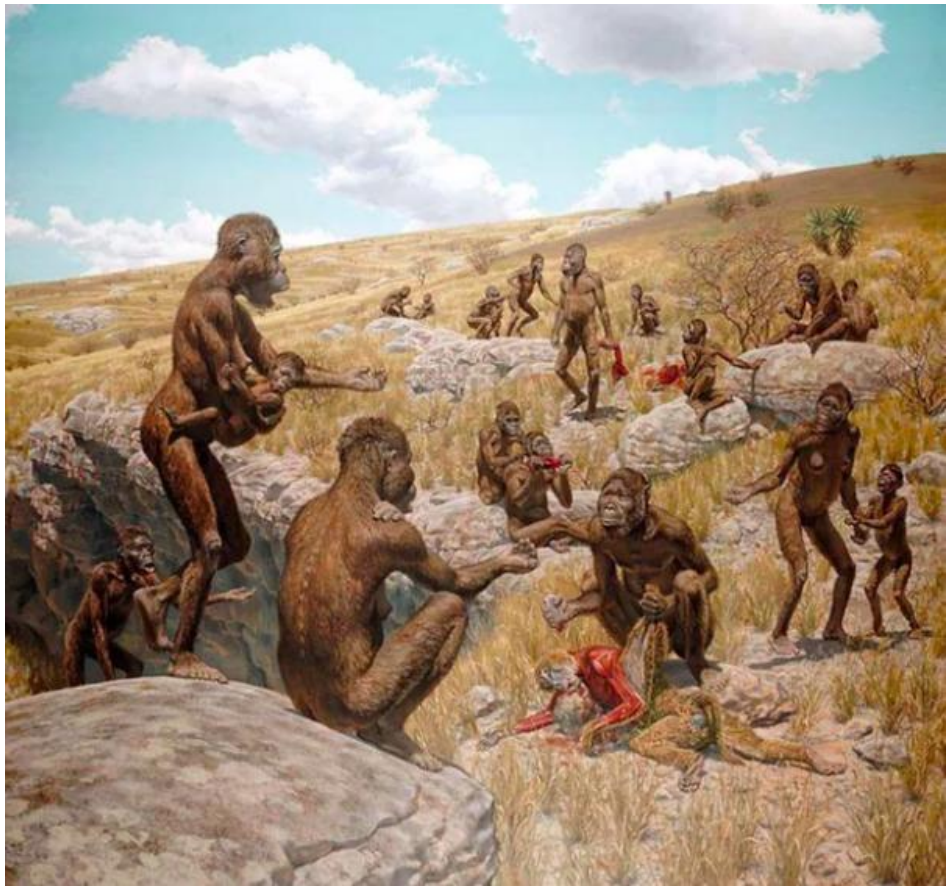
- **Huge Teeth** allowed one lineage (*Paranthropus*) to use tough, fibrous roots and tubers to subsist during leaner seasons
- These were **fallback foods** but they were so important to survival that they caused the dentition to become much larger



The Past: Teeth and Tubers

The Past: Stone Tools and Meat

The Past: Stone Tools and Meat

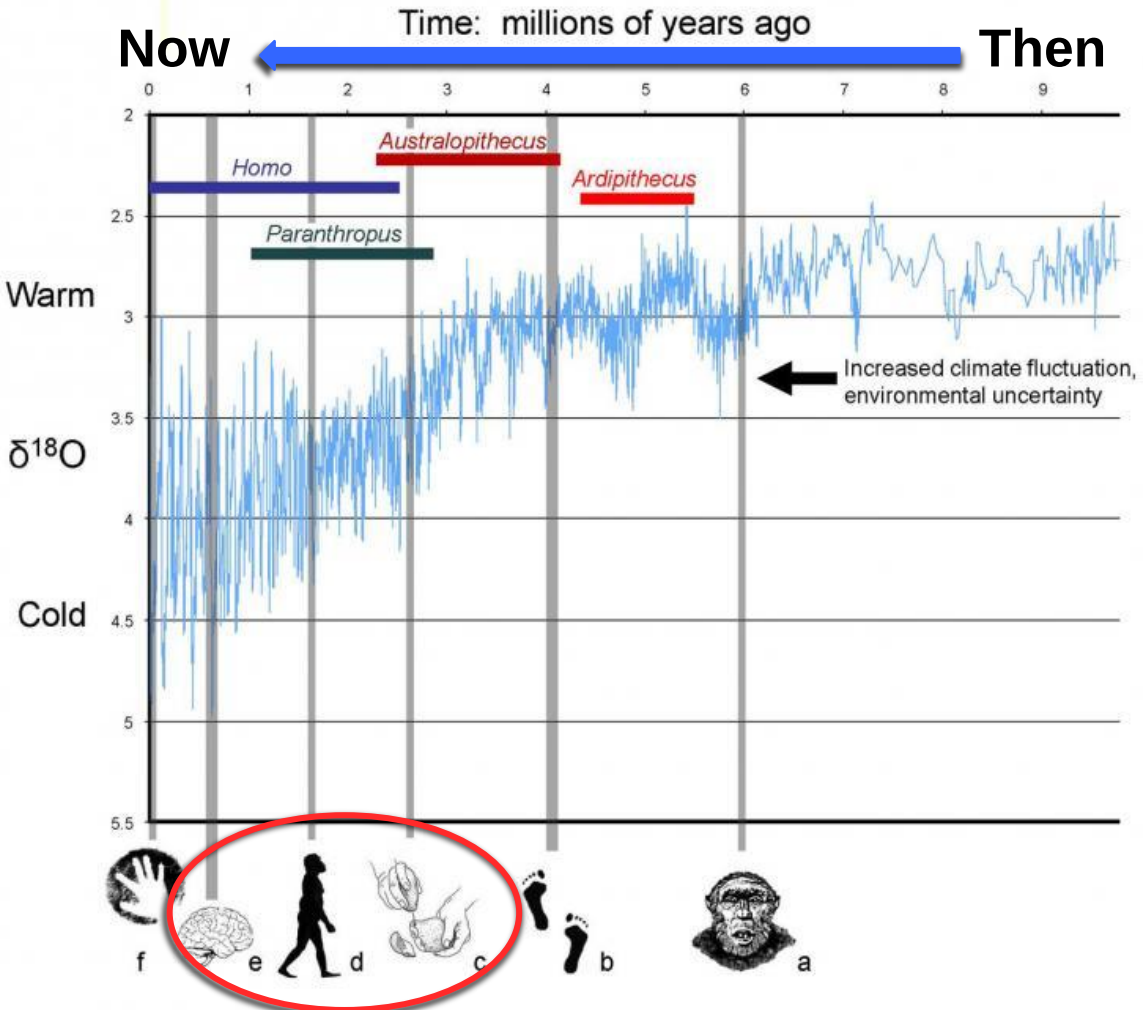


- Meat and marrow were once again likely **fallback foods initially,** but they were so important to survival that they influenced the bodies and brains of early members of the genus *Homo*

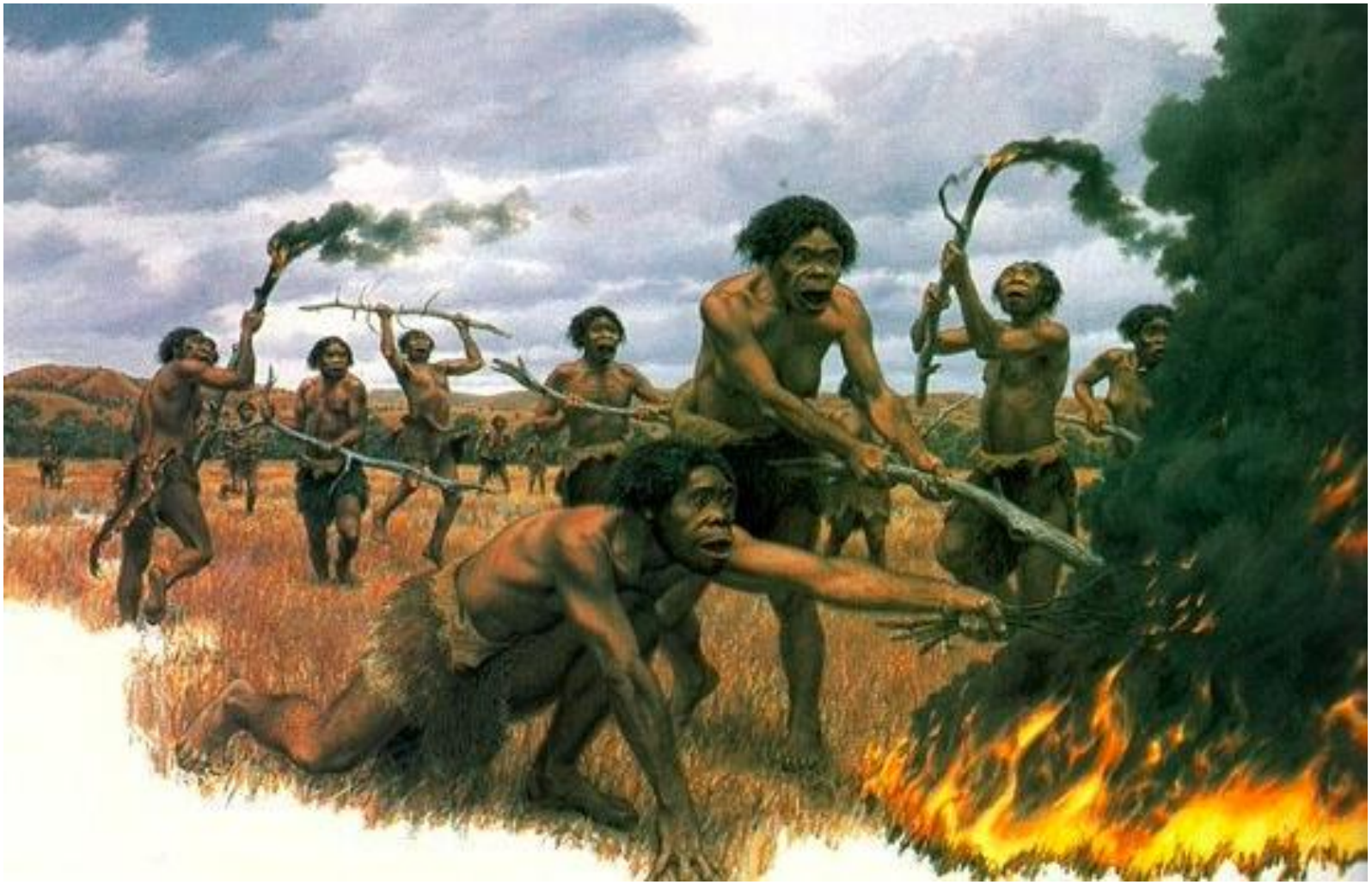
The Past: Stone Tools and Meat

- Meat and marrow, especially from large animals, were more easily extracted using **stone tools**
- These foods were nutritionally rich and allowed **brains to get bigger and teeth to get smaller**
- These early humans began **using their environment very** differently as they traveled much farther for carcasses and began systematic hunting

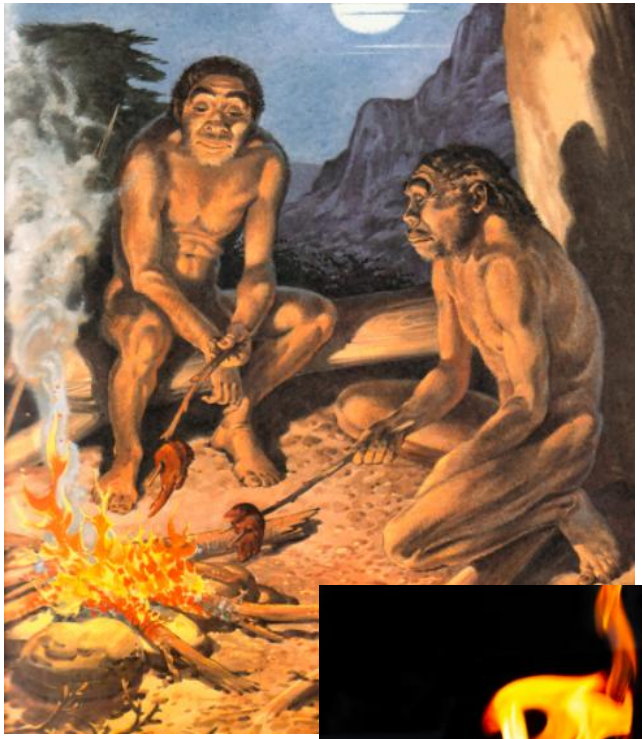
The Past: Stone Tools and Meat



The Past: Fire and Cooking

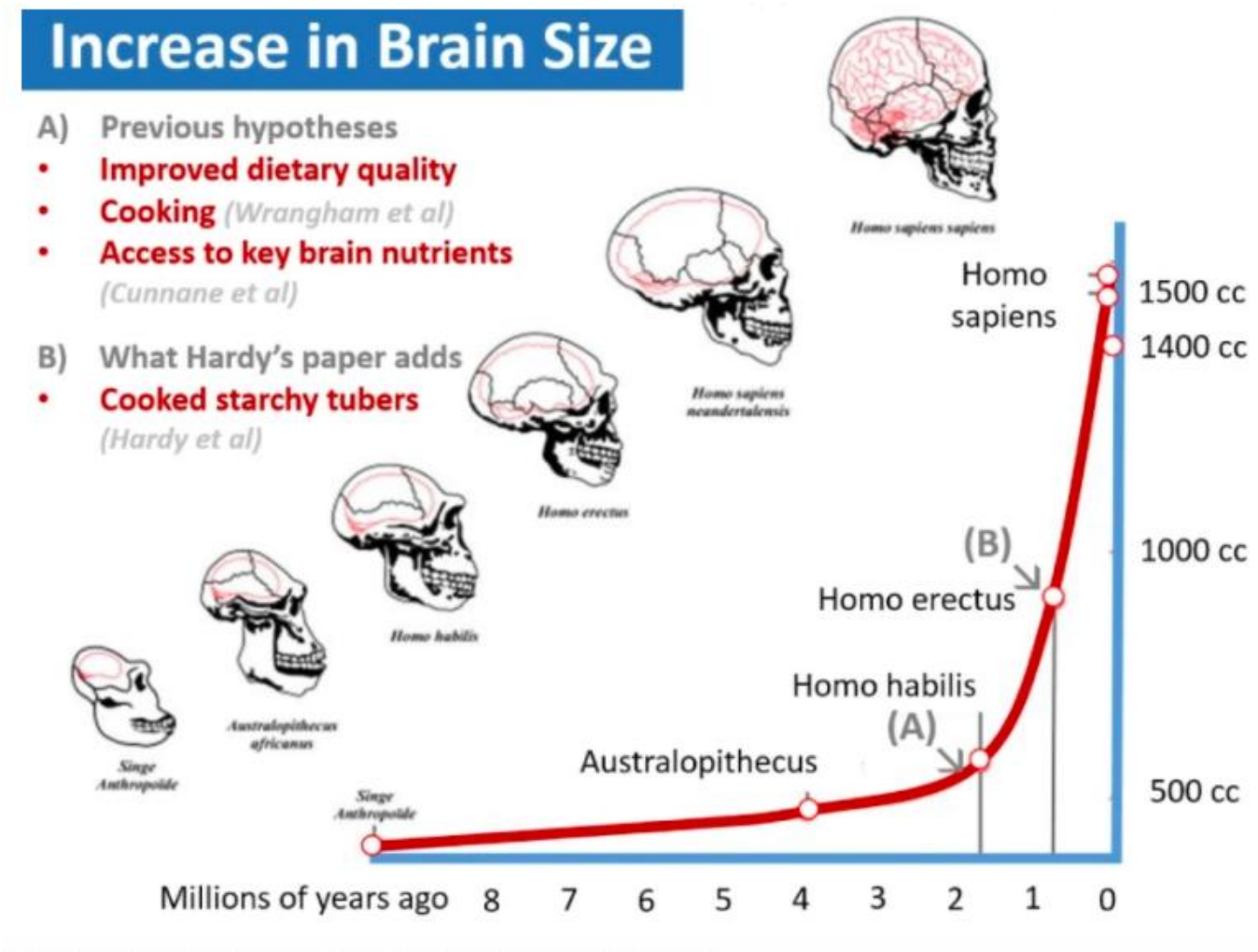


The Past: Fire and Cooking



- Reconstructions often stereotypically show meat being cooked
- But **roasting nuts and tubers** would have greatly increased their nutrient and caloric availability, which isn't true for meat

The Past: Fire and Cooking

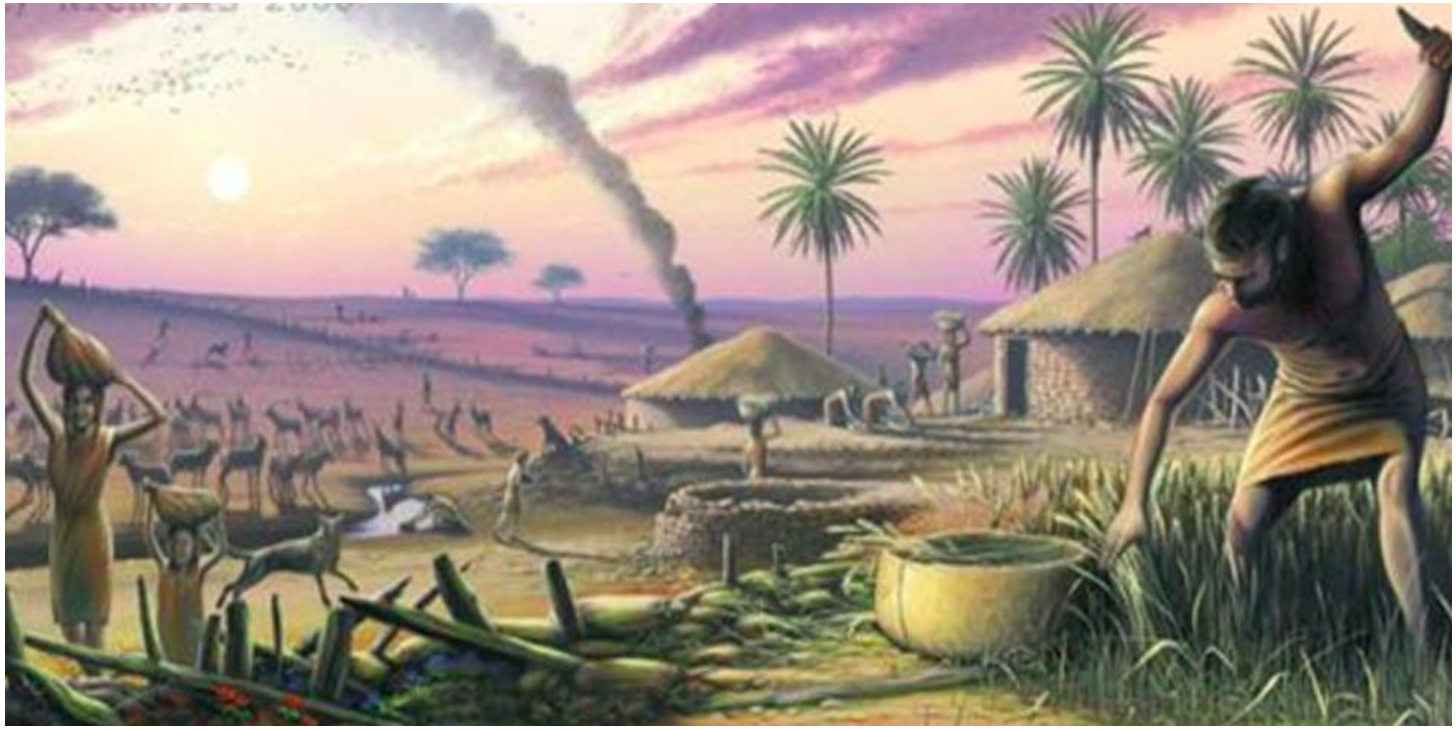


The Past: Summary

- **Environmental change** forced early hominins to adapt biologically and and behaviorally time and again
- The goal was always to **maintain an adequate and predictable diet**
- In our lineage, the result was actually an **increase in dietary quality** with ever-more **nutrient dense** foods being consumed
- This ultimately allowed for a massive increase in **brain size**
- **Technological advances** came along with this and humans began using **culture and behaviour** more and more to solve their dietary challenges rather than relying on natural selection

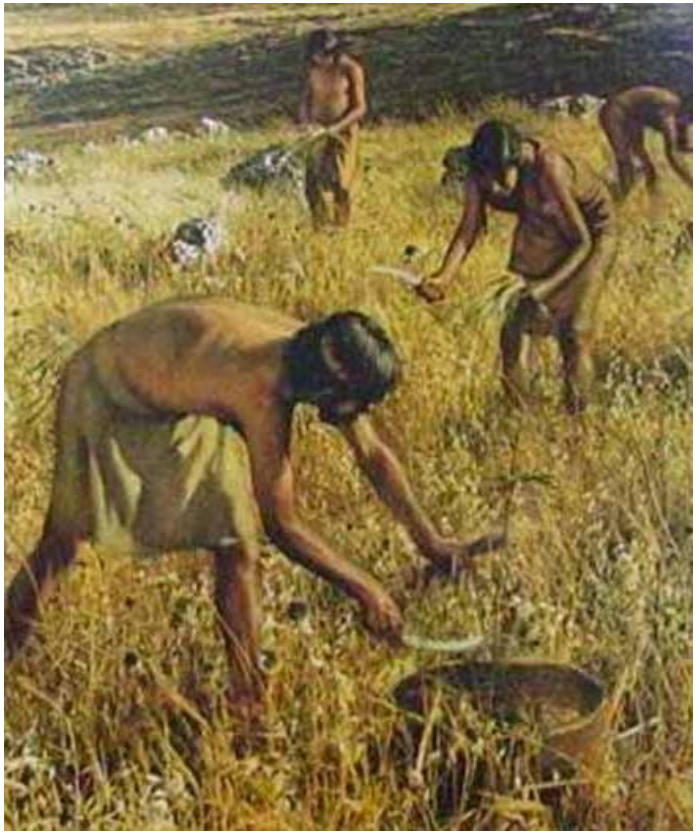
The Present: Agriculture

- Roughly 10-12,000 years ago, humans began **domesticating plants and animals** in various parts of the globe



The Present: Agriculture

- This was a response to a variety of stressors including:
  - Climate Change (end of the Ice Age)
  - Population pressure
  - Competition for food resources
  - Fewer opportunities to migrate to better territory
  - Social pressures from those "in charge"



The Present: Agriculture's Blessings

- The benefits of agriculture seem so numerous and obvious:
  - More people can be fed per unit of arable land (greatly increased productivity)
  - Calories are plentiful in staple grains and tubers
  - The food base is more predictable (or is it?)
  - People can settle down and don't need to move seasonally, which allows for better dwellings
  - Babies can be easily weaned onto starchy staples, which increased the number of offspring per individual

The Present: Agriculture's Curses

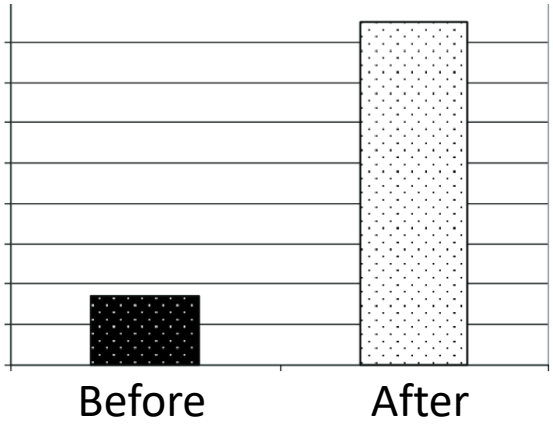
- But agriculture also comes with serious consequences:
  - While calories are plentiful in staple grains and tubers, these foods tend to be **poor in micronutrients and protein** and can lead to malnutrition
  - Babies can be easily weaned onto starchy staples, but often **suffered from poor nutrition**
  - **Overall health declined** with the advent of agriculture (it is hard work too!)

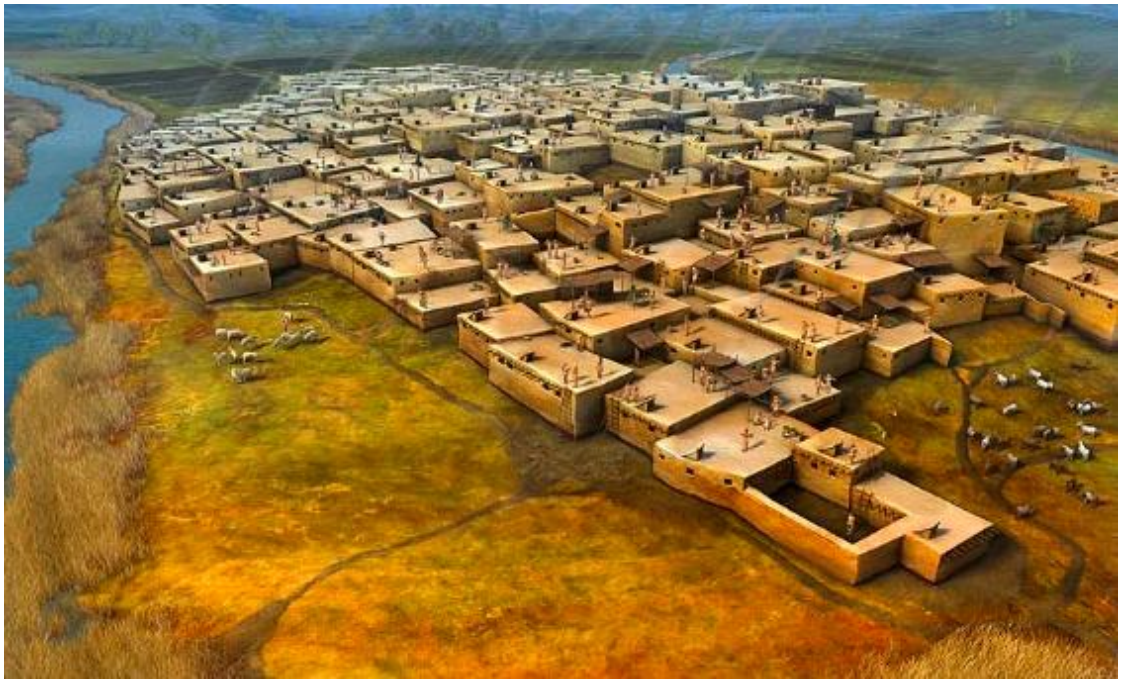
The Present: Agriculture's Curses

- Other serious consequences are :
  - The food base for many is **NOT more predictable**; **famine** is likely a product of dependence on **just a few staple crops** combined with **social inequality**
  - People cannot easily move if crops fail – so what are the fallback foods now?

The Present: Agriculture's Curses

- People who have settled down in permanent dwellings tend to congregate more densely and thus suffer far **more from infectious diseases**





The Present: Still Evolving

- Did the advent of agriculture mean that humans were no longer physically evolving in response to their diet?
- **No!** There is solid evidence that agriculture **has indeed led to new physical traits** in modern humans including**:**
  - **The ability to digest milk into adulthood**
  - **Increase in the *AMY* amylase enzymes needed to digest starch**

The Present: Plentiful Food

- Today, here in Ottawa, most (but by no means all) of us have access to an unprecedented **diversity of nutritious foods** at all times of the year that come from around the world

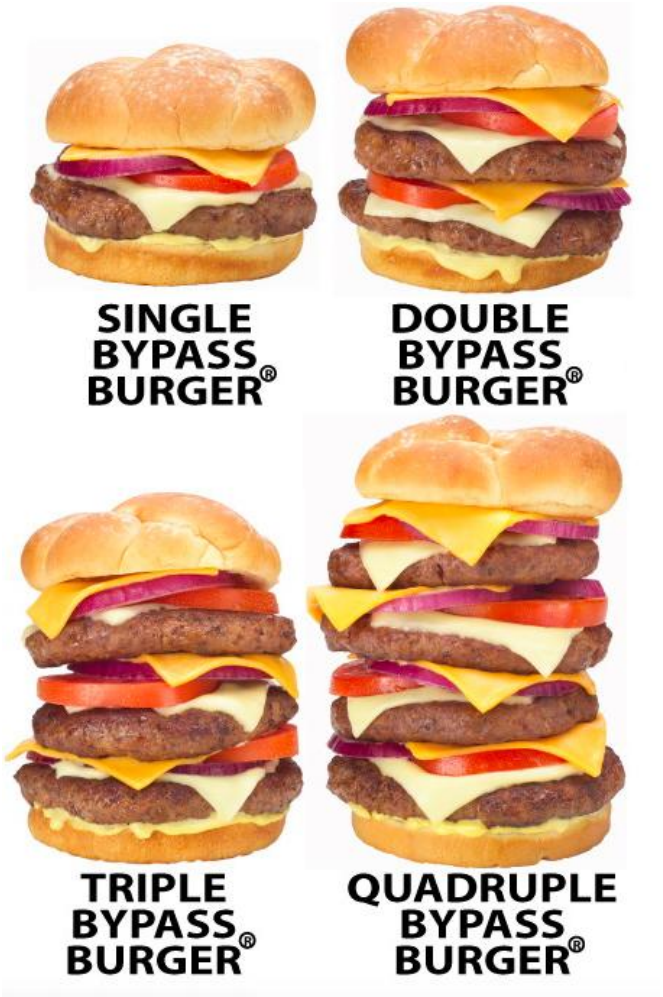
- Likewise, agricultural **productivity continues to increase** due to better land use and advances in technology

The Present: Plentiful Food

- An unintended problem with this bounty is that we have an **overabundance** of food available to us and a significant portion of it is comprised of **refined carbohydrates and added simple sugars**

- In Canada and the US, there is also an **abundance of animal products,** which can enhance childhood growth and development but may not be healthy when consumed by adults in excess amounts.

The Present: Plentiful Food



- These patterns of dietary overconsumption have led to chronic health problems of epidemic proportions including **obesity, diabetes, cardiovascular disease, and certain cancers.**
- These are often called the **“Diseases of Western Civilization”**

The Present: Food Insecurity

- And yet in many parts of the world, there is **serious food insecurity** and its resultant undernutrition and malnutrition**.**
- This is linked to **poverty, social conflict, crop failure, disease and more**
- Crop failure is often caused by **climate change**
- Worldwide, over **100 million people** suffer from severe food insecurity

The Present: The Global Syndemic

- The medical journal *The Lancet* has recently coined the term "**Global Syndemic**" to recognize three epidemics that are currently intersecting and influencing each other synergistically in time and space:
  - **Obesity**
  - **Undernutrition**
  - **Climate Change**

The Present: The Global Syndemic

- **Climate change** can have huge impacts on agriculture and food security because crops can fail due to:
  - Droughts and floods
  - Other extreme weather events
  - New and invasive pests (think 2020's locusts)
  - Changes in patterns of rainfall and temperature

The Present: COVID-19

- **COVID-19** has already had a dramatic impact on supply chains and food availability in many parts of the world
- Those already relying on imported goods or food aid have been left without adequate resources
- Perhaps another **130 million more people** will suffer acute food insecurity by the end of the year due to COVID-19

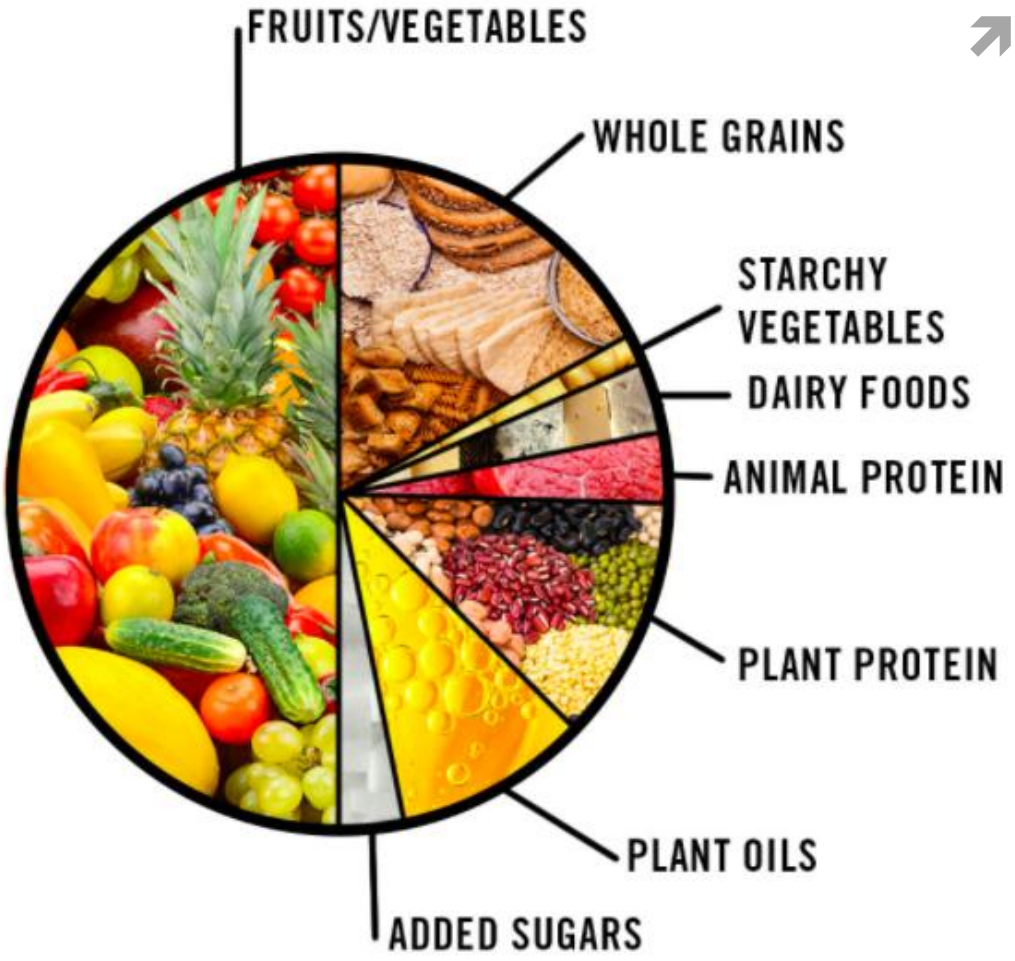
The Present: COVID-19

- This is not just a problem of the developing world: many have lost jobs and are relying more on food banks and other assistance programs to feed themselves.

The Future: EAT-Lancet

- How can we adequately feed a global population that might hit 10 billion by 2050?
- And how can we ensure that can we do this in a way that will not only **improve overall health**, but also be **sustainable** for the planet
  - *The Lancet* has taken a stab at this question with the **EAT-Lancet Commission** and has created the **Planetary Health Diet**

The Future: EAT-Lancet



- The **Planetary Health Diet** is:
  - Very high in plant foods, especially fruits and vegetables
  - Very low in starchy vegetables
  - Very low in animal foods
  - High in plant protein
  - High in whole grains

The Future: EAT-Lancet

- The commission basically undertook a **Pathways-type project to model "what if"** changes to:
  - diet (their Planetary Health Diet)
  - food production (improve cropland use and reduce GHGs),

The Future: EAT-Lancet

- Other changes they modeled include:
  - food waste (reduce on both the production and consumption ends)
  - water use (reduce),
  - fertilizer use (N and P cycling improvements)
  - protection of land and biodiversity (do not expand agricultural land, preserve existing natural ecosystems and lower extinction rates)

The Future: Challenges Ahead

- One major debate that has already arisen out of the EAT-Lancet proposal is **how much meat and other animal products** can we and should we consume moving forward
- There is no doubt that we should reduce highly processed foods but children, at the very least, need high quality animal protein

The Future: Innovations

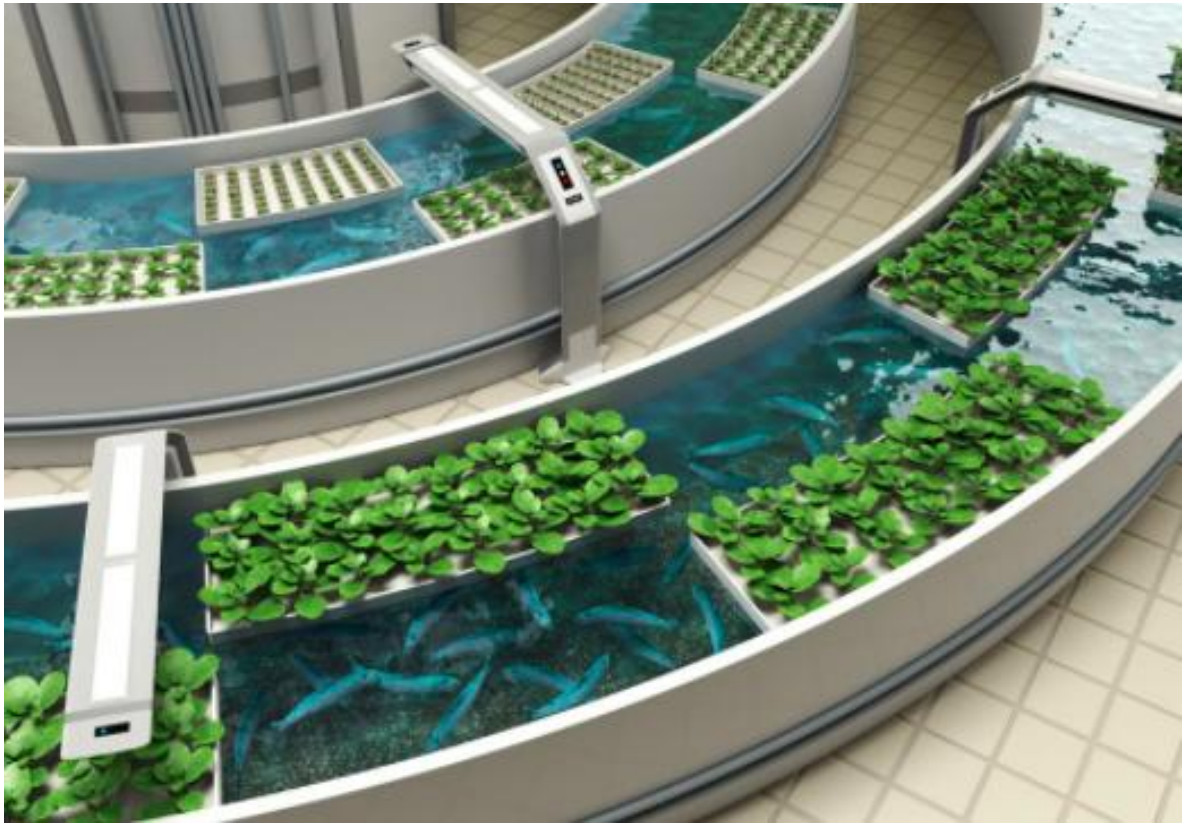
- Can technological innovations solve at least some of our food security problems?
  - Think artificial meat and lab-grown meat

The Future: Innovations

- And what about eating (more) insects?

The Future: Innovations

- Aquaponics and similar cyclical systems may help us too



The Future: Conclusions

- As we look to the future of *Homo sapiens*, we must bear in mind
  - The **nutritional needs** that have shaped our bodies over the past four million years
  - That we now find ourselves in a situation where many have diets that **no longer support their biological health and wellbeing**
  - We can no longer think only about ourselves but must **consider the rest of the planet** and all of the other organisms that share it with us

Questions?

			GHG emissions	Cropland use	Water use	Nitrogen application	Phosphorus application	Biodiversity loss
Food production boundary			5.0 (4.7–5.4)	13 (11.0–15.0)	2.5 (1.0–4.0)	90 (65.0–140.0)	8 (6.0–16.0)	10 (1–80)
Baseline in 2010			5.2	12.6	1.8	131.8	17.9	100–1000
Production (2050)	**Waste** (2050)	**Diet** (2050)						
BAU	Full waste	BAU	9.8	21.1	3.0	199.5	27.5	1,043
BAU	Full waste	Dietary shift	5.0	21.1	3.0	191.4	25.5	1,270
BAU	Halve waste	BAU	9.2	18.2	2.6	171.0	23.2	684
BAU	Halve waste	Dietary shift	4.5	18.1	2.6	162.6	21.2	885
PROD	Full waste	BAU	8.9	14.8	2.2	187.3	25.5	206
PROD	Full waste	Dietary shift	4.5	14.8	2.2	179.5	24.1	351
PROD	Halve waste	BAU	8.3	12.7	1.9	160.1	21.5	50
PROD	Halve waste	Dietary shift	4.1	12.7	1.9	151.7	20.0	102
PROD+	Full waste	BAU	8.7	13.1	2.2	147.6	16.5	37
PROD+	Full waste	Dietary shift	4.4	12.8	2.1	140.8	15.4	34
PROD+	Halve waste	BAU	8.1	11.3	1.9	128.2	14.2	21
PROD+	Halve waste	Dietary shift	4.0	11.0	1.9	121.3	13.1	19

Table 5

Various scenarios demonstrating the environmental impacts of implementing the action outlined in Table 4. The colors illustrate whether environmental impacts transgress food production boundaries: green - below lower range value; light green - below or equal to boundary but above lower range value; yellow - above boundary but below upper range value; red - above upper range value. BAU indicates business as usual scenario.