Chapter 11: Producing Enough Food for the World: How Agriculture

Can We Feed the World?

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- If we do feed the world, is it sustainable?
  - Regions farmed for thousands of years
  - Farming changed local ecosystems
  - Nomadic people would farm an area until it became depauperate before moving on to leave the land “fallow”

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  - Each solution creates new problems
  - Should expect some side effects
  - Multiple pressures on agricultural land

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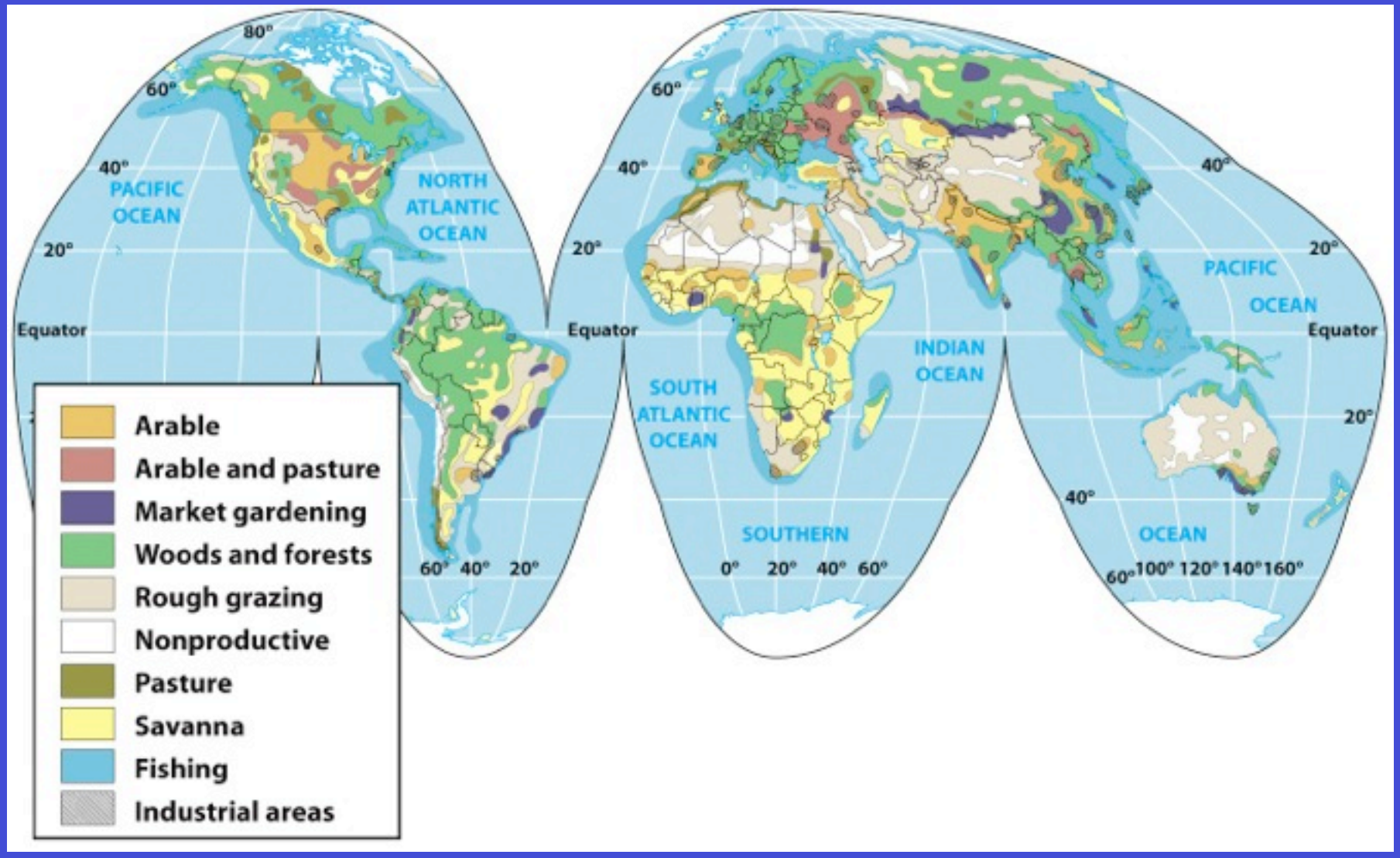
  - Percentage varies by continent
    - 22% in Europe
    - 57% in Australia
    - 44% in US


80°
60°
40°
20°
Equator
PACIFIC
OCEAN
NORTH
ATLANTIC
OCEAN
60° 40° 20°
SOUTH
ATLANTIC
OCEAN
INDIAN
OCEAN
SOUTHERN
0° 20° 40° 60°
PACIFIC
OCEAN
OCEAN
60° 100° 120° 140° 160°
Arable
Arable and pasture
Market gardening
Woods and forests
Rough grazing
Nonproductive
Pasture
Savanna
Fishing
Industrial areas

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  - Marginal land will be put into production to make food available
- Food supply is also influenced by social disruptions and social attitudes (politics).

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    - Requires increased use of water,fertilizers, and pesticides
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    - OR implementation of ecological principles in the use of Organic/ BioDynamic farming
  - Utilizing marginal lands
  - As increased production is demanded there will be increased in environmental degradation

How We Starve

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  - Undernourishment- lack of sufficient calories in available food. One has little or no ability to move or work and eventually dies from lack of energy.
  - Malnourishment- lack of specific chemical components of food, such as protein, vitamins, or other essential chemical elements.

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  - Obvious, dramatic and fast acting

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  - Obvious, dramatic and fast acting
- Malnourishment is long-term and insidious
  - May not dies out right but suffer impairments

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- World food production must provide adequate nutritional quality as well as quantity. Is access to quality food a basic human right? (like clean air and clean water?)

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  - Food distribution major problem
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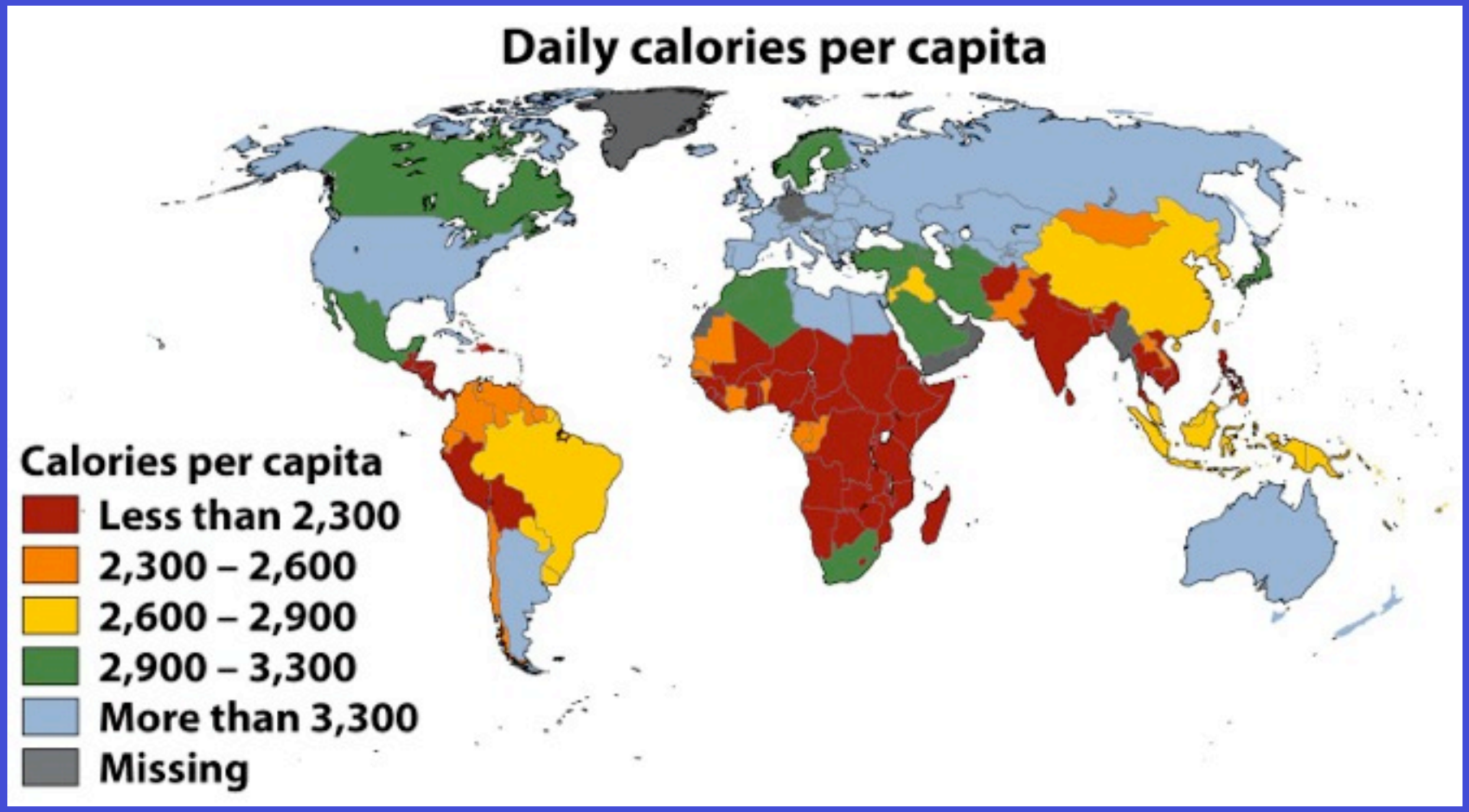
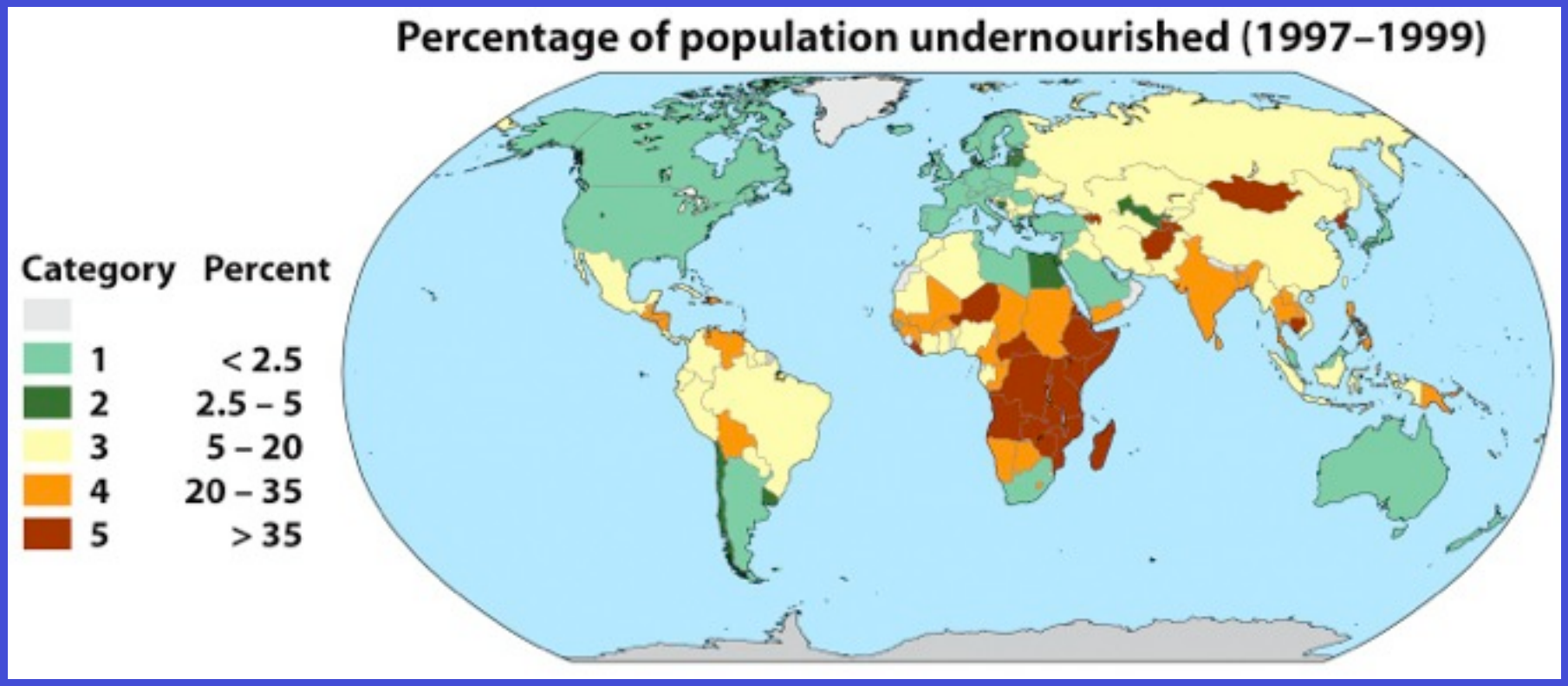
  - Food distribution major problem
  - World food aid does not meet all the caloric need of people
- Best solution is to increase local production


Daily calories per capita
Calories per capita
Less than 2,300
2,300 – 2,600
2,600 – 2,900
2,900 – 3,300
More than 3,300
Missing


Percentage of population undernourished (1997–1999)
Category Percent
1 < 2.5
2 2.5 – 5
3 5 – 20
4 20 – 35
5 > 35

What We Eat and What We Grow

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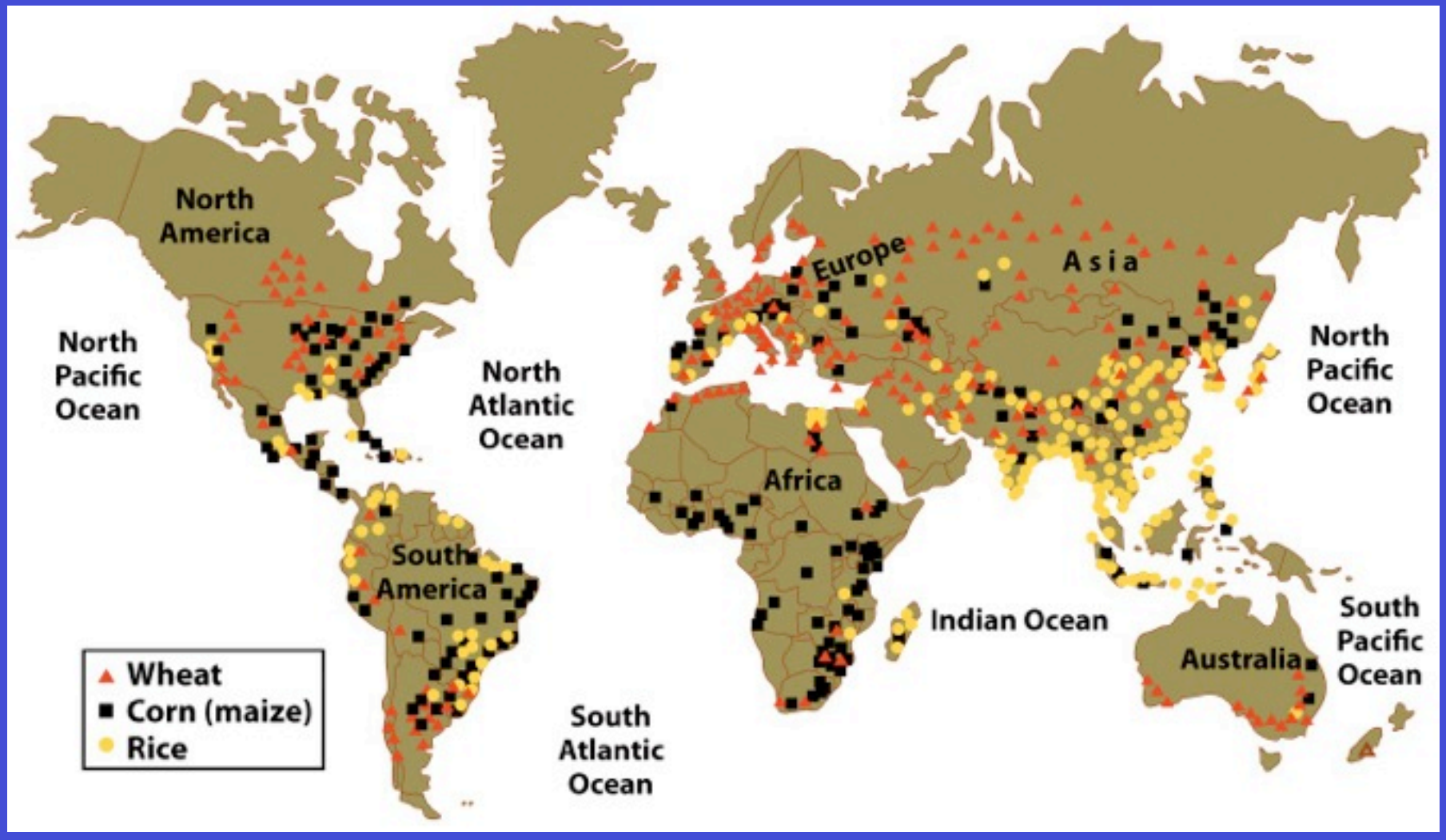
  - 14 crop species provide most of the food consumed in the world
  - 6 plants provide 80% of the total calories for ALL humanity

Wheat

Rice

Soybeans


North America
North Pacific Ocean
North Atlantic Ocean
Europe
Asia
North Pacific Ocean
Africa
South America
Indian Ocean
South Pacific Ocean
Australia
South Atlantic Ocean
Wheat
Corn (maize)
Rice

Crops

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- Forage - crops grown for domestic animals
  - 14 million acres of alfalfa in the US

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- Domestic animals include
  - 14 billion chickens
  - 1.3 million cattle
  - ~1 billion each sheep, ducks and pigs
  - 700 million goats
  - 160 million water buffalo
  - 18 million camels

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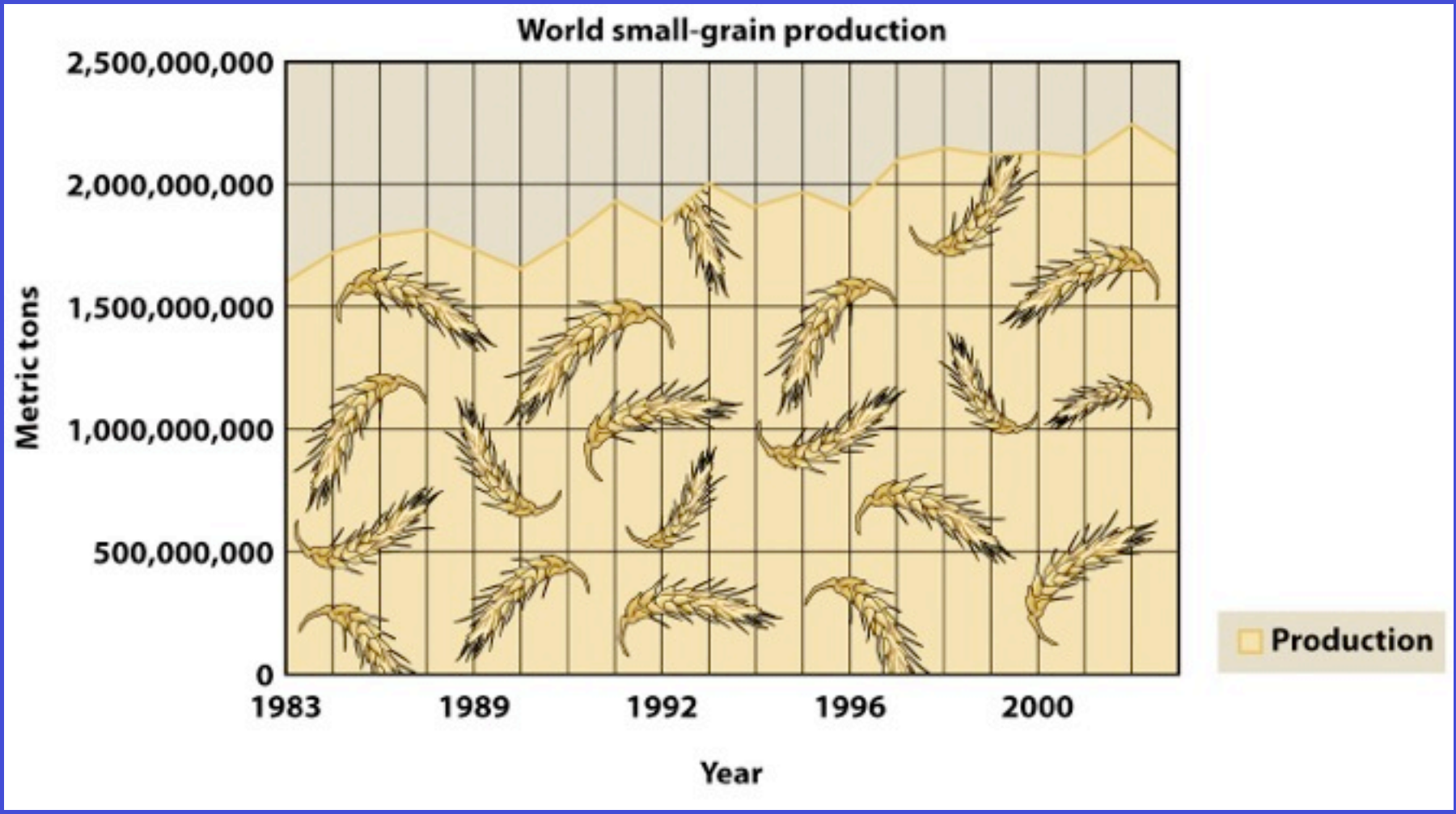
- World market for small grain crops (rice, wheat, soybeans).
  - Production has been flat since 1996


World small-grain production
2,500,000,000
2,000,000,000
1,500,000,000
1,000,000,000
500,000,000
0
Metric tons
1983
1989
1992
1996
2000
Year
Production

Aquaculture

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  - Sustainability – this is NOT sustainable

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- Aquaculture- the farming of food in aquatic habitats
  - Important protein source for many people

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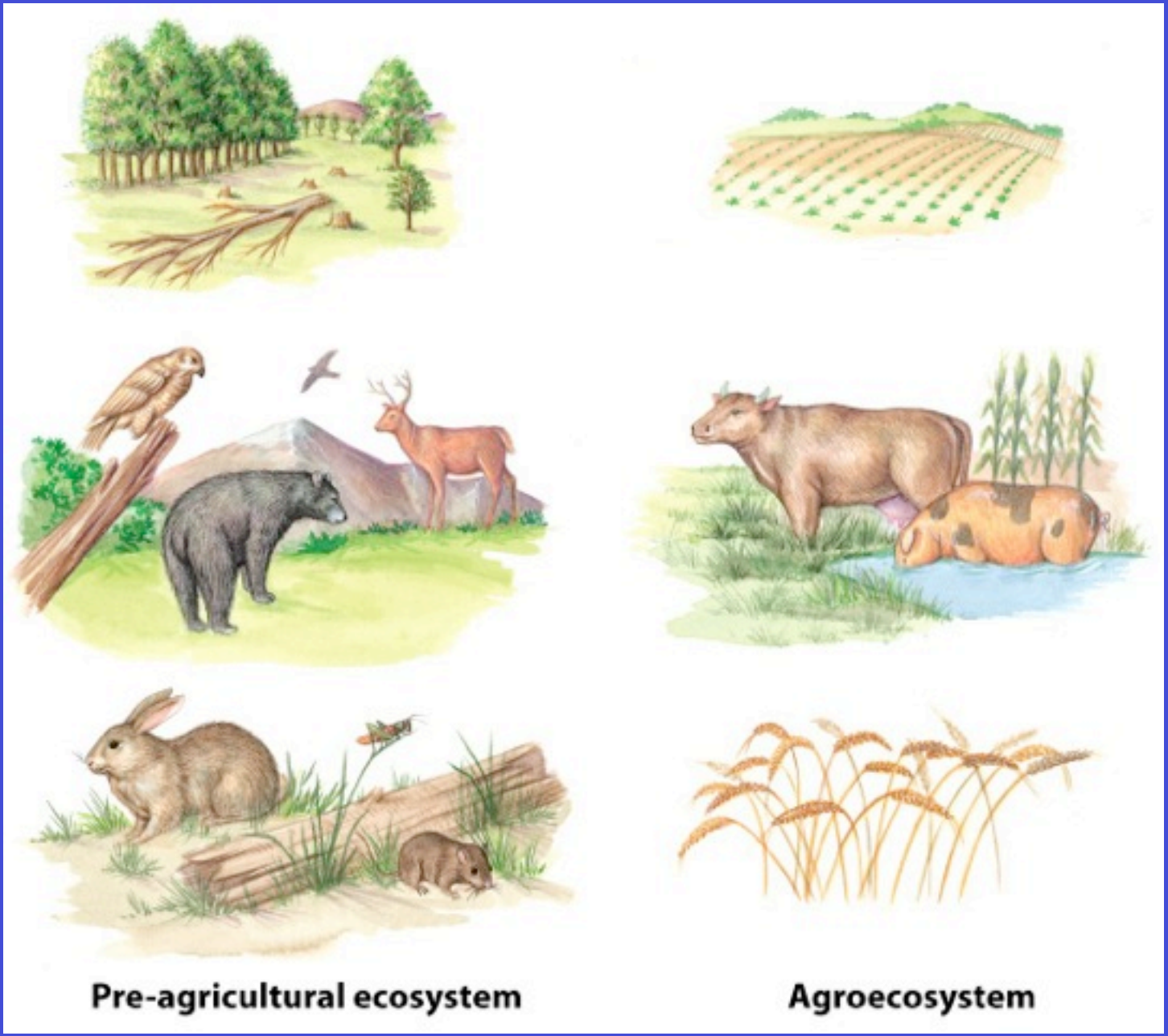
- Mariculture- the farming of ocean fish.
  - Oysters and mussel production has been on the rise and is evident locally in Carlsbad on off shore in Ensenada

An Ecological Perspective on Agriculture

- Farming creates novel ecological conditions
  - Agroecosystem
  - Differ from natural systems in six ways


Pre-agricultural ecosystem
Agroecosystem

Agroecosystem (conventional ag)

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  - Counteracted by crop rotation to avoid pest problems and soil infertility

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- 3. Crops planted in neat rows, which makes life easy for pests.

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- 6. Genetic modification of crops

Limiting Factors

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- High-quality agricultural soil has:

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  - All the chemical elements required for plants

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  - Retains water well
  - Mixture of soil particles with various sizes

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- Liebig's Law
  - Single factor determines the growth and therefore the presence of a species
  - Growth of a plant is affected by one limiting factor (plants can only grow as much as they have the most limiting nutrient present)
  - 20 chemical elements are required plant nutrients
  - Macro- and micro- nutrients

- Two elements may have a synergistic effect
  - A change in the availability of one resource affects the response of an organism to some other resource.

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- Older soils more likely to lack trace elements

The Future of Agriculture

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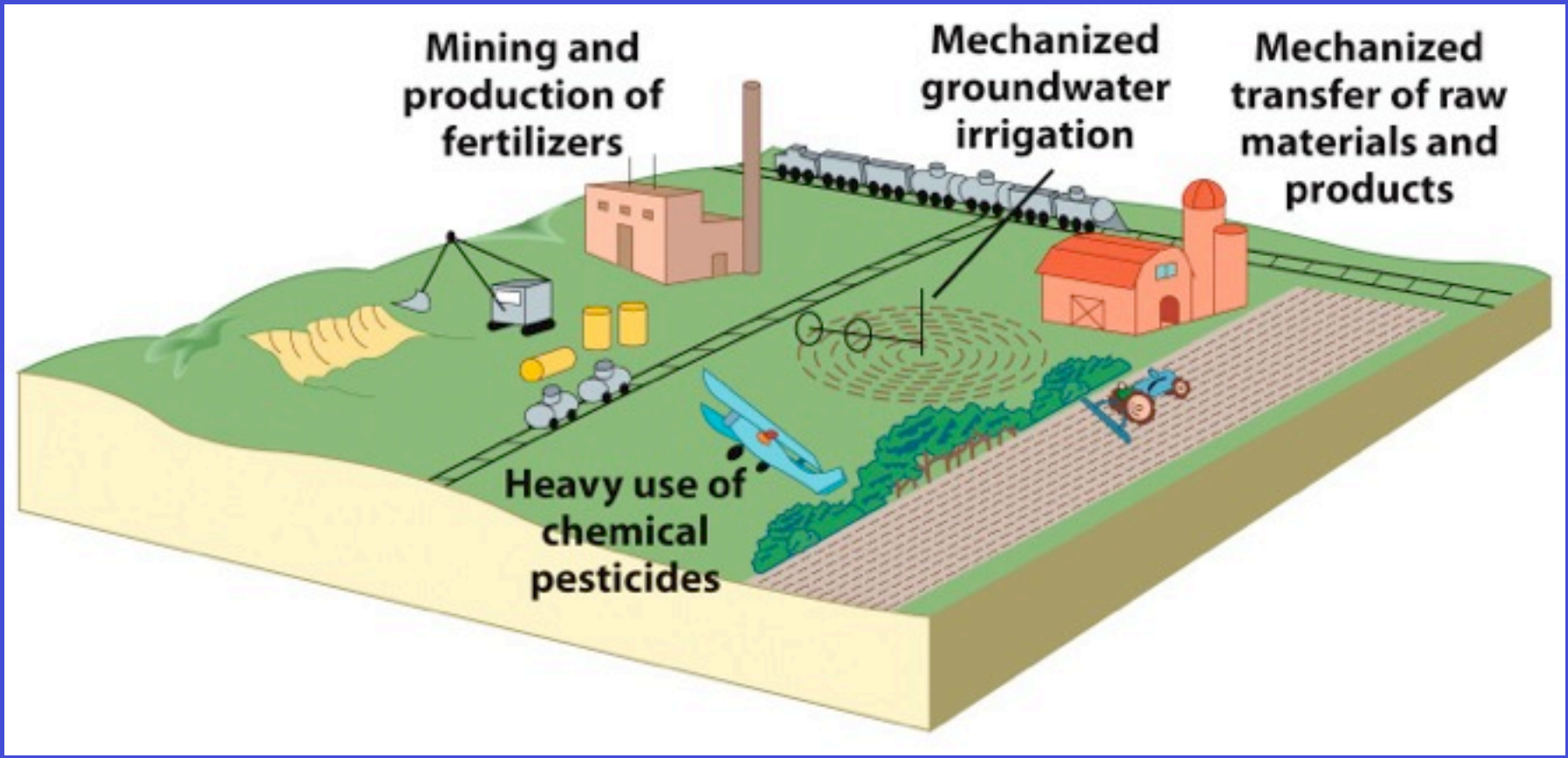
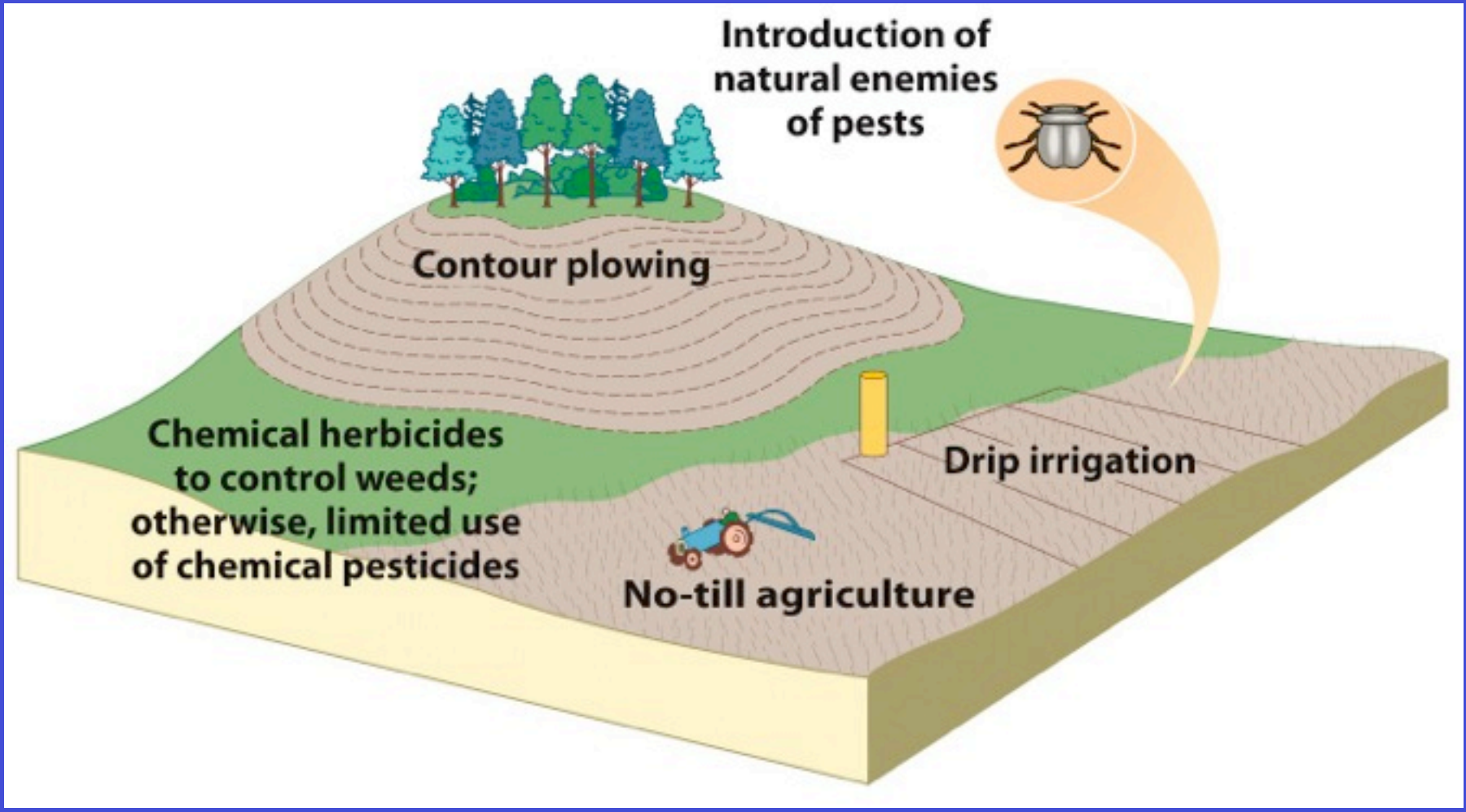
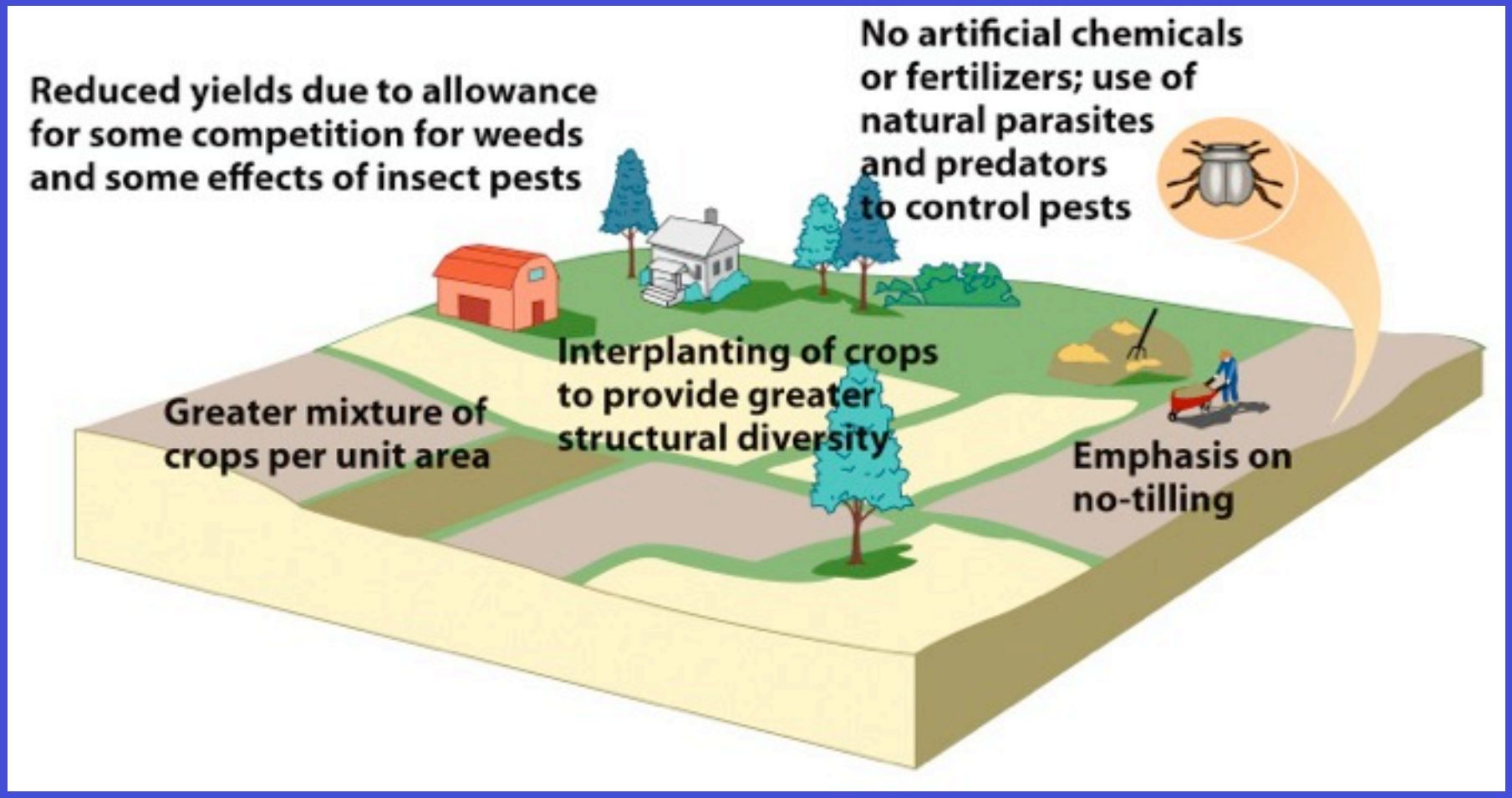
  - 3. Bioengineering



Demand-based agriculture



Resource-based agriculture



An organic farm

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- 4. Today there is a growing interest in organic agriculture as well as use of genetically engineered crops.

The Green Revolution

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Was made possible by availability of large amounts of petroleum for making chemical fertilizers


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NO FERTILIZER N

Improved Irrigation

- Better irrigation techniques could improve crop yield and reduce overall water use by:
  - Drip irrigation
  - Hydroponics

Organic Farming

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  - Doesn't expose workers to harmful chemicals
- One of the fastest growing sectors in US ag

POLYCULTURE

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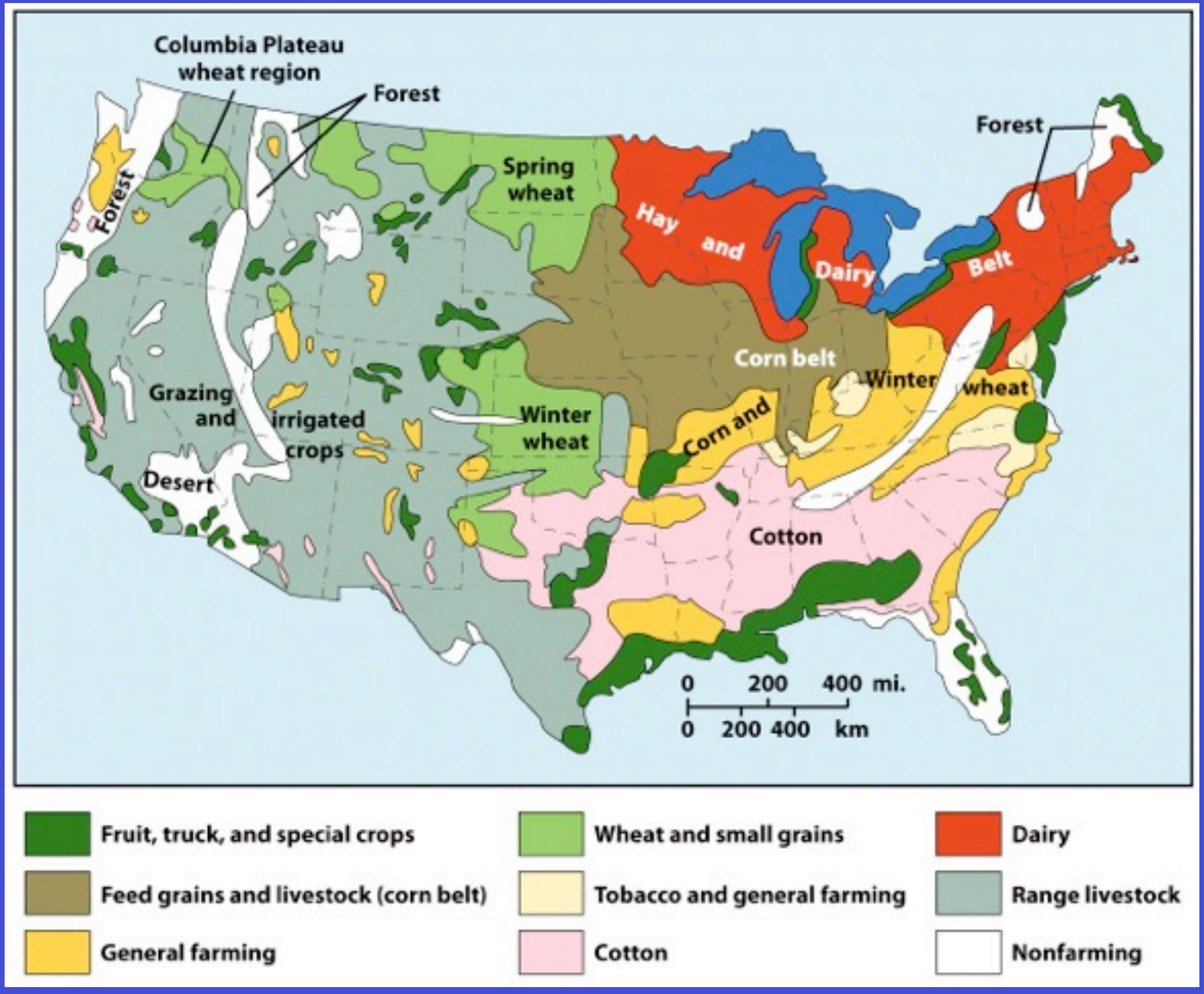
  - Gives lower average yearly production but reduces the risk of very low production years.
  - Labor intense
  - Requires better education in ecology and Integrated Pest Management (IPM)


Columbia Plateau wheat region
Forest
Forest
Forest
Spring wheat
Hay and Dairy Belt
Corn belt
Winter wheat
Corn and
Grazing and irrigated crops
Winter wheat
Desert
Cotton
0 200 400 mi.
0 200 400 km
Fruit, truck, and special crops
Feed grains and livestock (corn belt)
General farming
Wheat and small grains
Tobacco and general farming
Cotton
Dairy
Range livestock
Nonfarming

Eating Lower on the Food Chain

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  - Eating each step up the food chain leaves much less food to eat per acre as a result of trophic level inefficiencies

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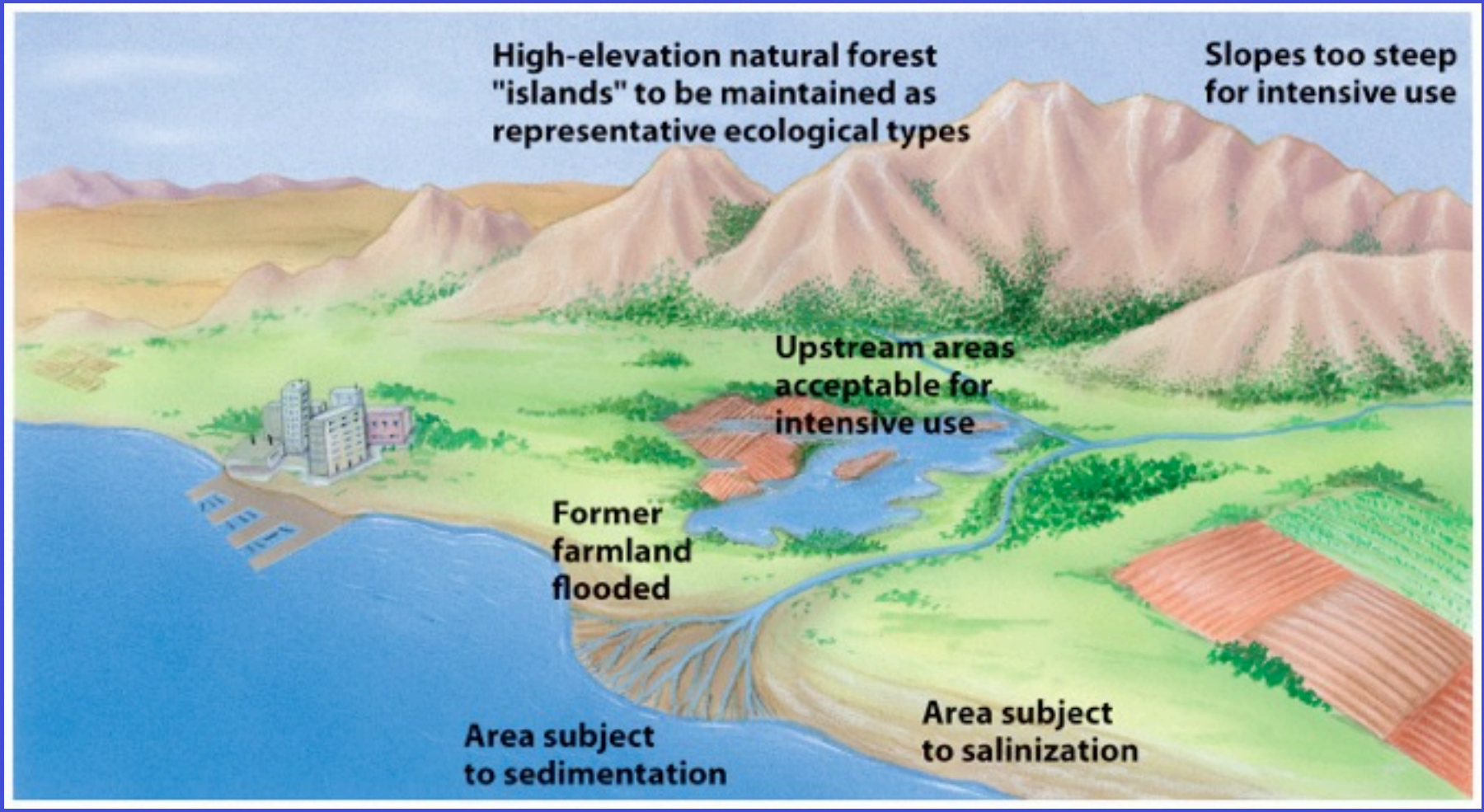
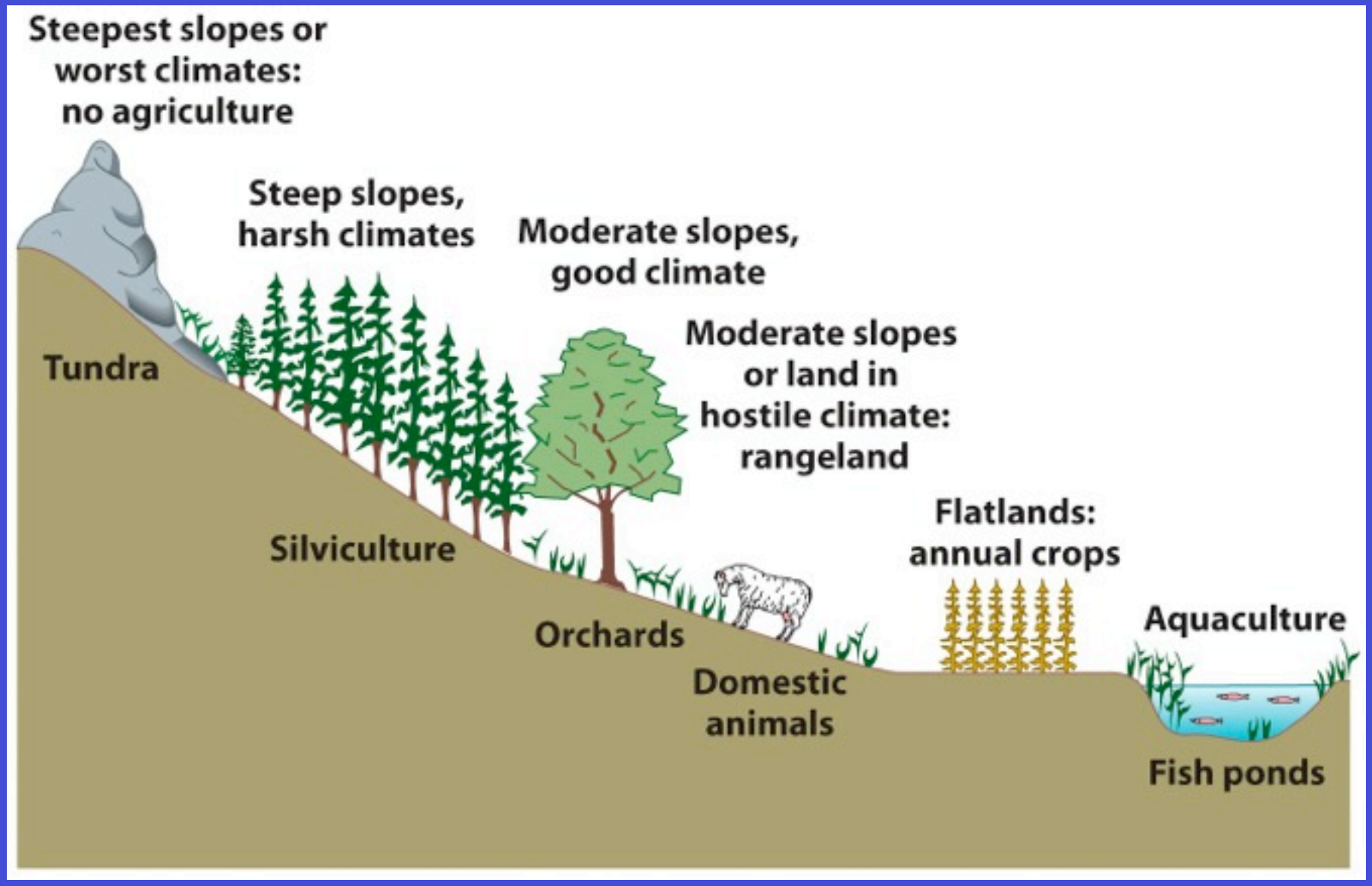
- Some people believe it is ecologically unsound to use domestic animals for food.
  - Eating each step up the food chain leaves much less food to eat per acre as a result of trophic level inefficiencies
- On the best ag land this hold true, but many rangelands are better suited to livestock production
  - These areas are often hilly or mountainous and therefore susceptible to rapid erosion of their thin soils


High-elevation natural forest "islands" to be maintained as representative ecological types
Slopes too steep for intensive use
Upstream areas acceptable for intensive use
Former farmland flooded
Area subject to sedimentation
Area subject to salinization


Steepest slopes or worst climates: no agriculture
Steep slopes, harsh climates
Moderate slopes, good climate
Moderate slopes or land in hostile climate: rangeland
Flatlands: annual crops
Tundra
Silviculture
Orchards
Domestic animals
Aquaculture
Fish ponds

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  - Carrying goods

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  - Carrying goods
  - Wool and leather – source of clothing

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  - Carrying goods
  - Wool and leather – source of clothing
  - Fuel and fertilizer source (excrement)
  - Eventually these animals can be consumed

Religion

- Hindus do not consume meat in India, but this is for religious/cultural reasons and eating at a lower trophic level is not the issue (this culture/religion represents a HUGE fraction of the entire population of the world)

Genetically Modified Food

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- Genetic engineering in ag involves several practices
  - Faster and more efficient ways to develop hybrids
  - Introduction of the terminator gene
  - Transfer of genetic properties from widely divergent kinds of life (antifreeze gene in fish to strawberries and tomatoes – is this a good practice?)

Genetically Modified Food

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  - With entirely new characteristics
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  - With tolerance of drought, cold, heat and toxic chemical elements.

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    - E.g. nitrogen fixation
  - With tolerance of drought, cold, heat and toxic chemical elements.
- Most Genetic engineering of plants to date has involved making them either pest resistant, or herbicide resistant – not making them more productive to provide greater quantities of food to the people of the world


STOP
CONTAMINACIÓN
GENÈTICA
GREENPEACE
syngenta

Climate Change and Agriculture

Climate Change and Agriculture

- Climate change may increase or decrease yield depending on the complex interaction between local weather, evapotranspiration, soil condition, and availability of fresh water

What's your vision for the future?