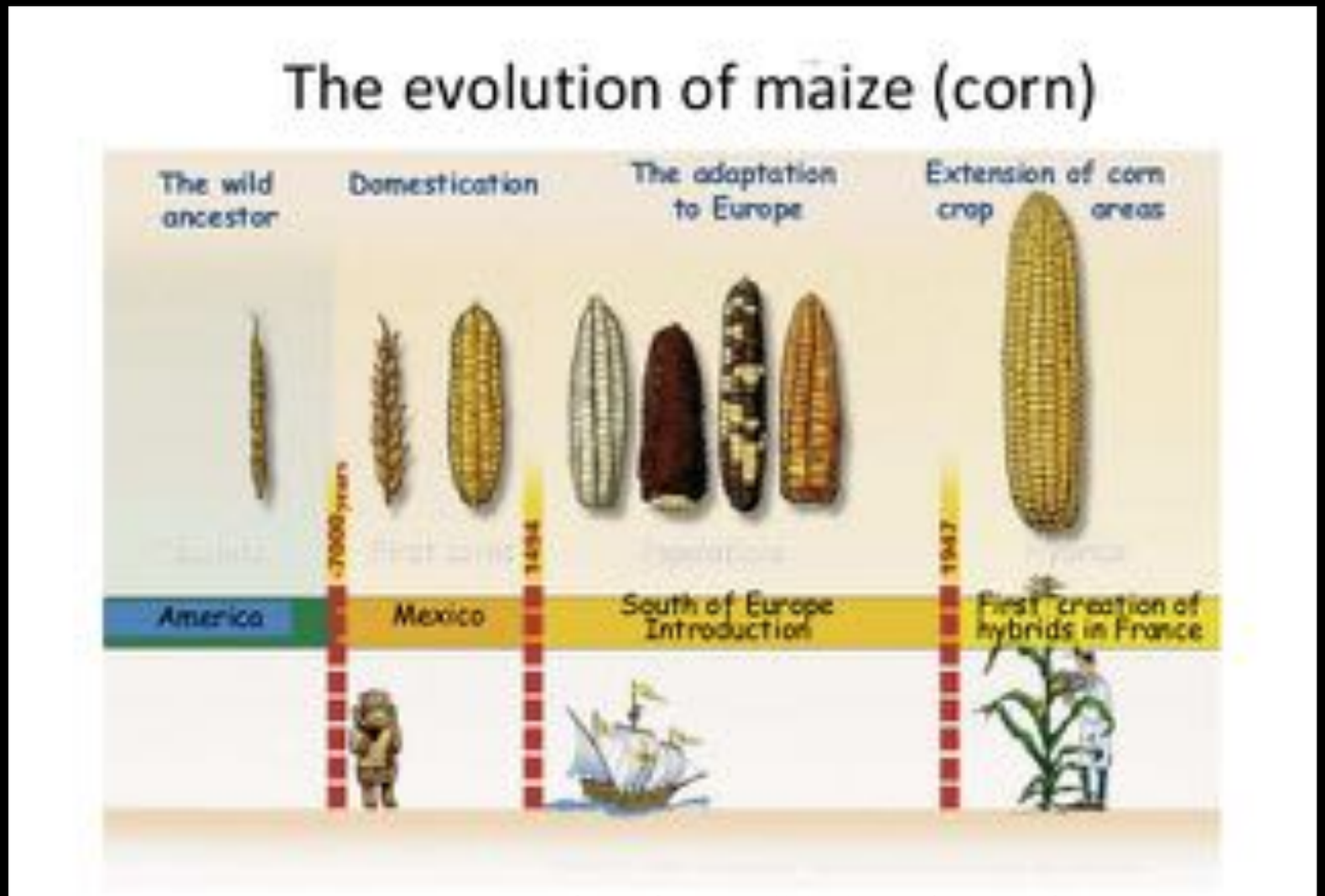
Case Study: Hybrid Maize Production and Climate Change in Zambia

"Maize and traditional agricultural systems in Africa"

Kurt Waldman



Source: Groupement National Interprofessionel de Semences

Crops are amorphous

Ecology of maize

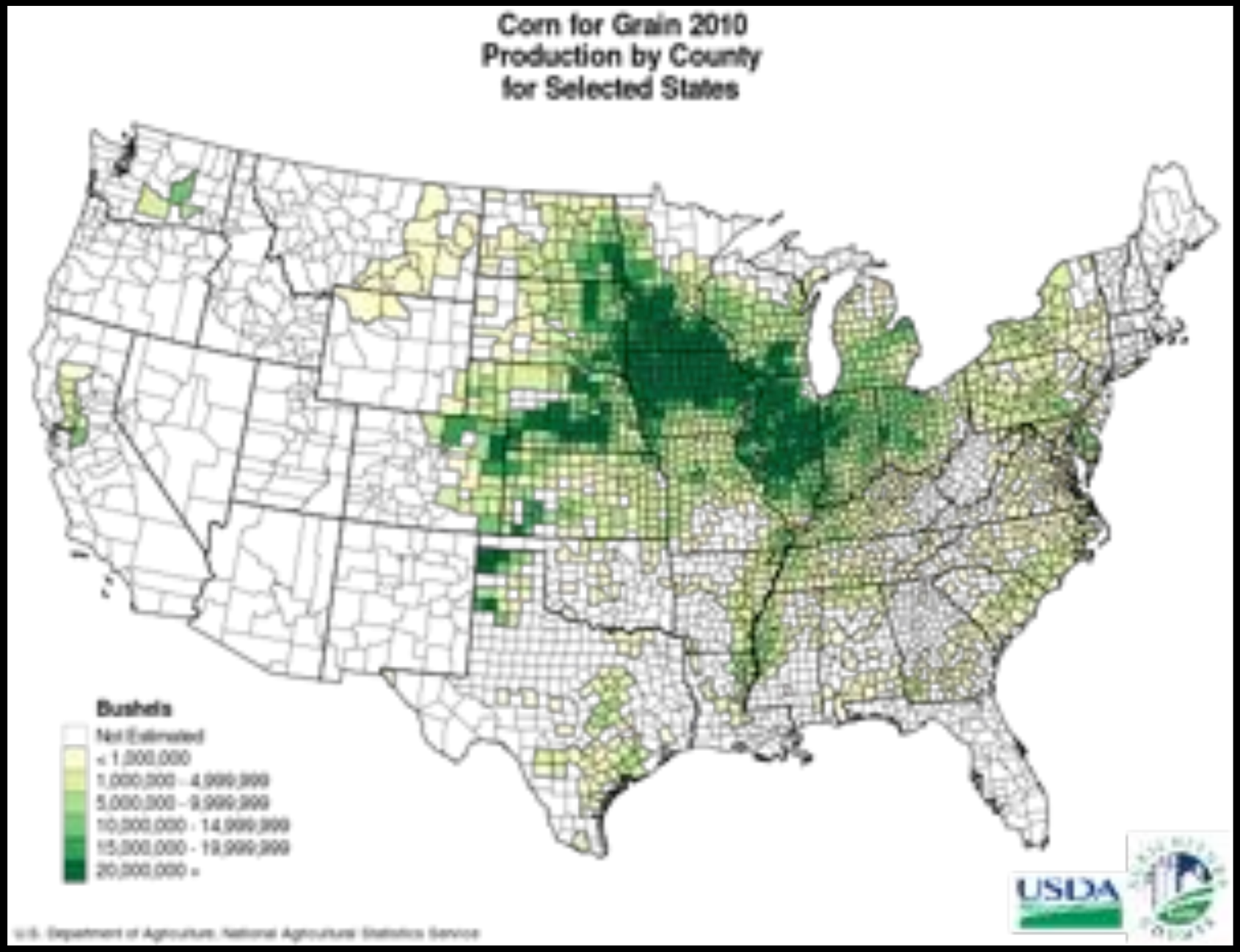
Maize takes various forms: sweet, pop, dent, flint, flour

What are the main uses in the US?

Uses of corn in the US

Use	Amount		
	million bushels	**million tonnes**	**%**
Livestock feed	5,250	133.4	43.4
Ethanol production	3,650	92.7	30.2
Exports	1,850	47	15.3
Production of starch, corn syrup, sweeteners	943	24	7.8
Human consumption—grits, corn flour, corn meal, beverage alcohol	327	8.3	2.7

Maize growing areas in the US



Nature of maize: Open-pollinator

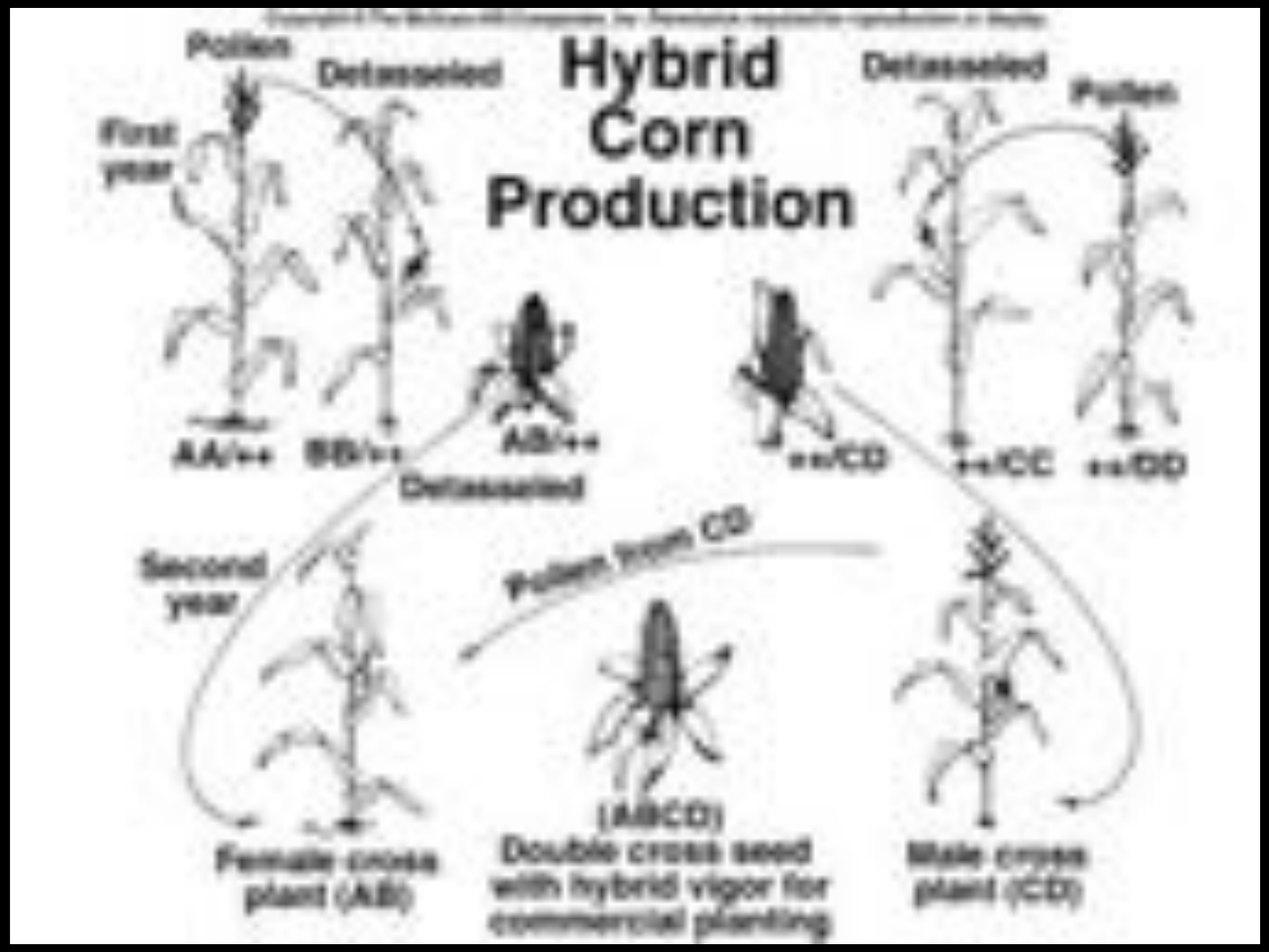
- Stamen and ovaries separated by a meter or more
- Massive amount of pollen
- Exchanges genetic material promiscuously
- And can self-fertilize

Hard to control maize!

What is a hybrid?

- Self-fertilization: dubious traits
- Cross-pollination: new generation has desirable traits
- Breeders allow 2 lines to self-pollinate, then cross in the next generation to create a hybrid.

Hybridization process



Heterosis

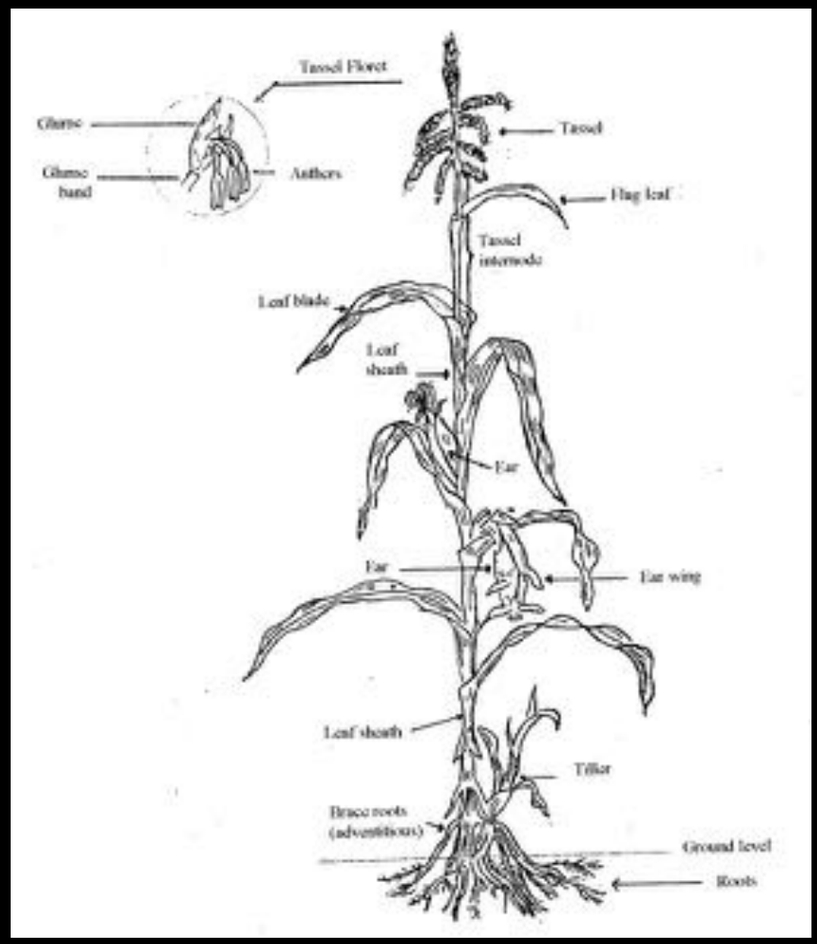
- Hybrid vigor: combining favorable genetic material

- All the features we breed for can exist in single landrace

- Hybrids: crossing 2 or more inbred genetic lines to produce heterosis

Open pollinated variety (OPV)

- Less high tech improved maize composites
- Selection of combination of desired traits from self pollinated plants
- Aim to produce uniform crop
- Rarely as productive as hybrids but can be replanted by farmers



Discussion question

- What do you think of hybrid crops? Why?

Vegetable or grain?

- Depending on its function and how it is grown
- In a nutritional and physiological sense
- High in carbs, low in protein

Advantages of maize

- Yields more food per unit of land and labor
- Every part of the plant can be used
- Variety can be tailored to the usage
- Fits into the growing season in many parts Africa

Disadvantages

- Vulnerable to environmental shocks
  - water, sunlight, and N
- Crop storage is difficult in the tropics
- Not completely nutritious
  - deficient vitamin and protein

"Maize is life"

- Maize spread rapidly in last 500 years

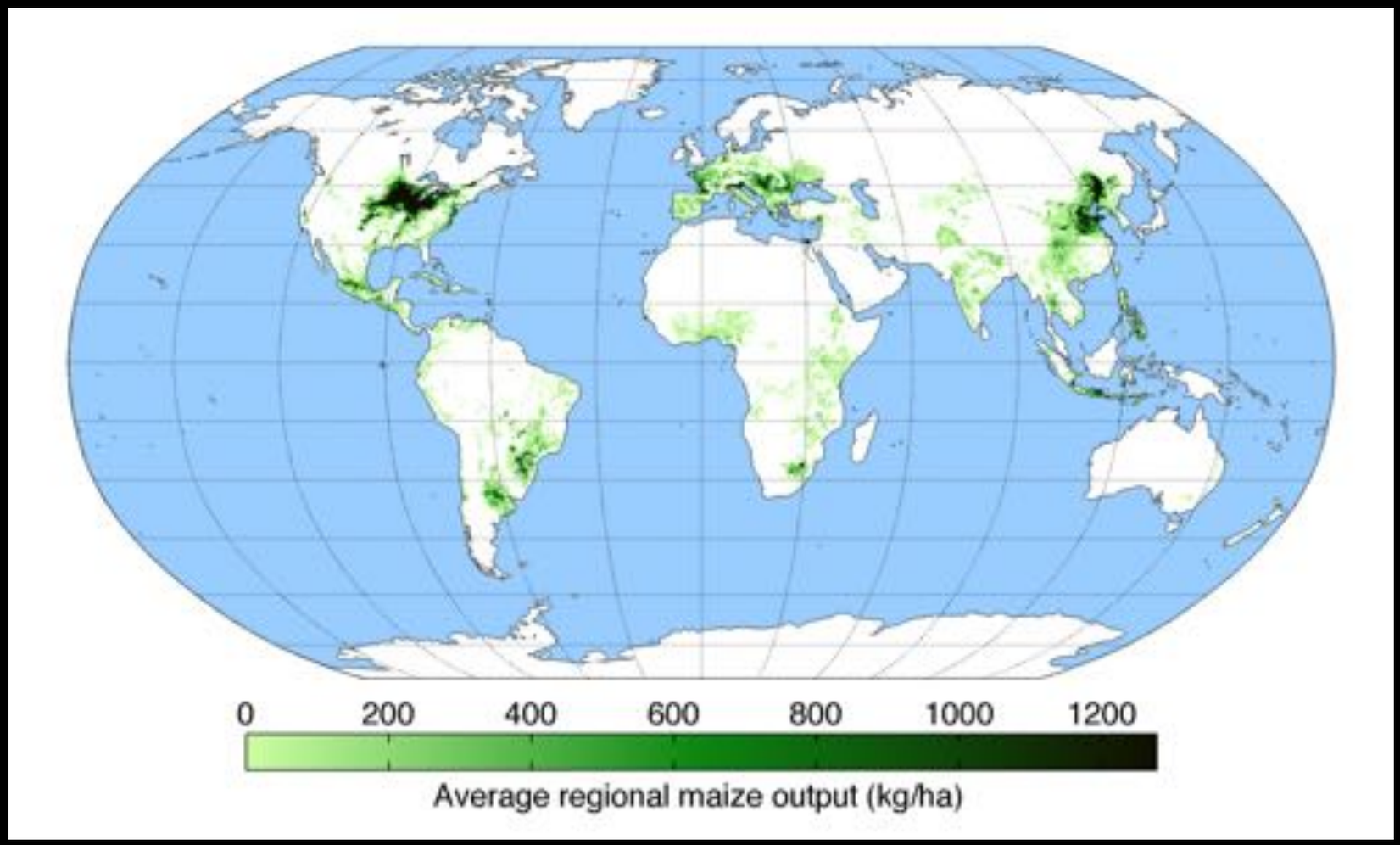
- Supplanted traditional grains (which were well adapted)

- Now makes up 50% of calories and 90% of cultivated land

Average maize yield

African Green Revolution?

1960-90: 1% growth
1991-1997: 3% growth

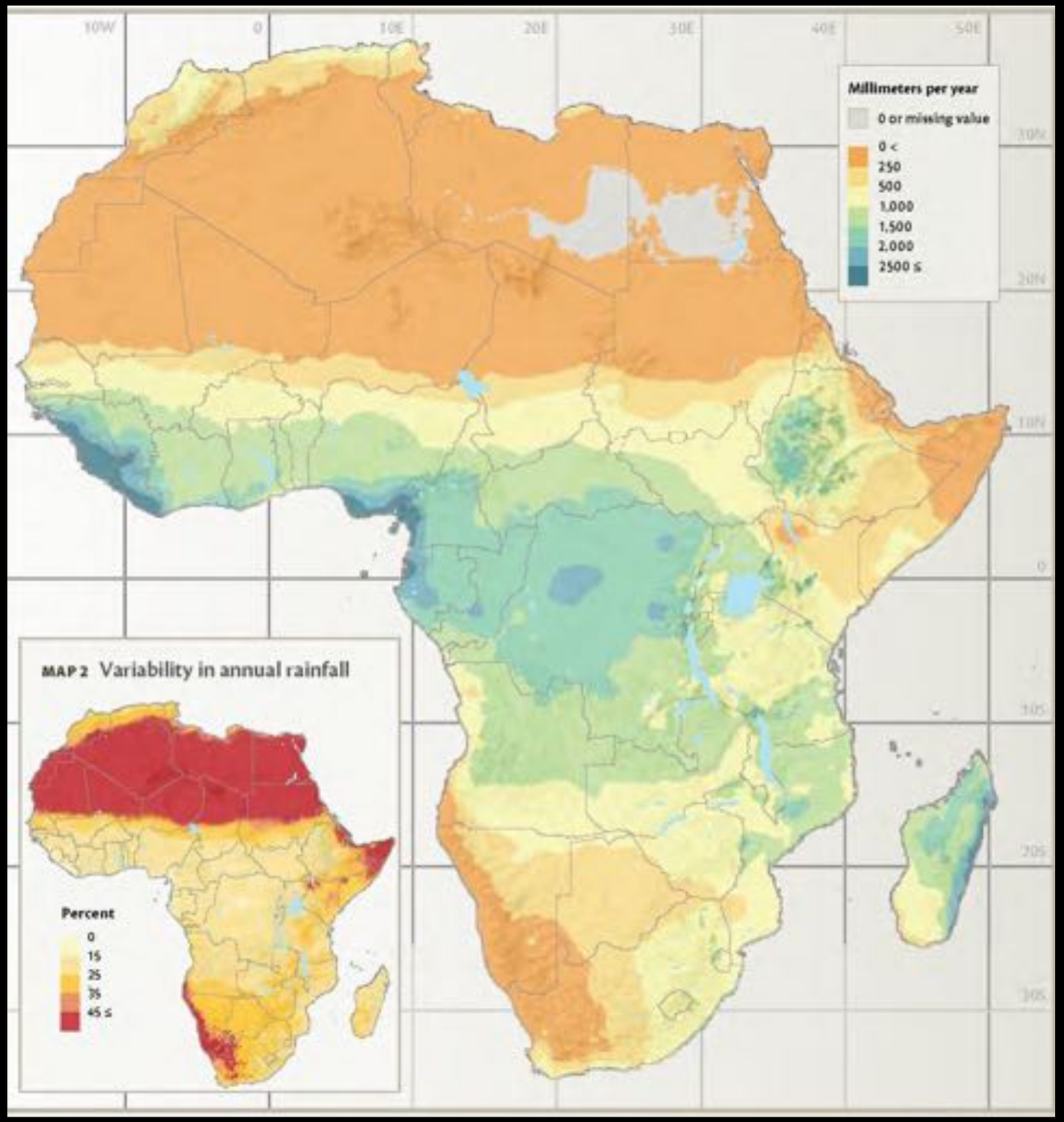


Barriers to maize production in Africa

- 40% of Africa's land is sloping and eroding
- Acidic soil, low in nutrients and liable to lose nutrients
- <u>But</u> main limitations presented by rainfall and moisture

Red porous laterite soils

Average annual rainfall in Africa



Changing patterns of climate

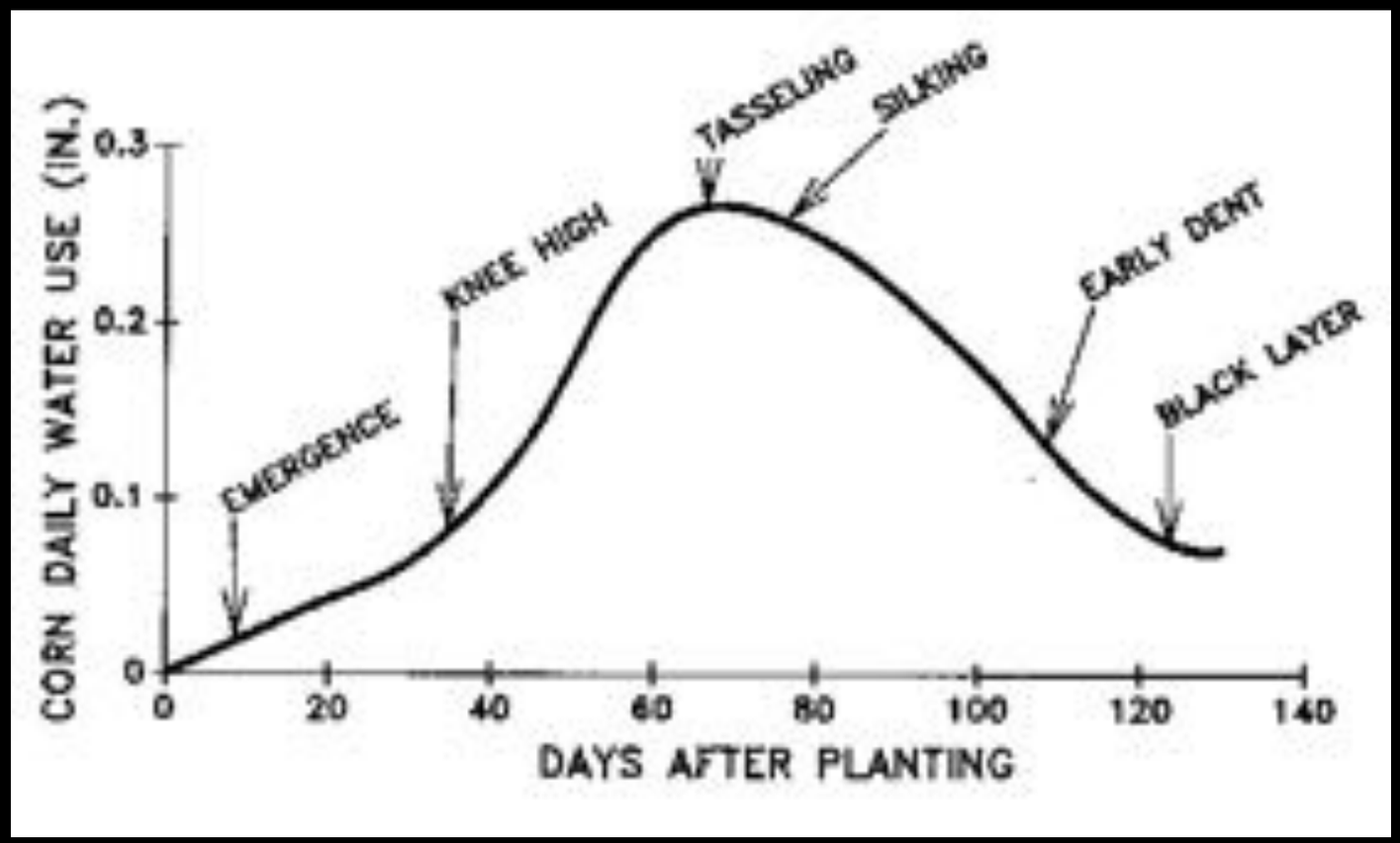
- Bi-modal pattern of seasons (wet/dry)
- ITCZ: Inter tropical convergence zone
- Seasonality produces wide variation from year to year

“shifting rain of beaming turbulence”

Drought in Africa

- Drought is historically common in Africa
- Cumulative effect of short or delayed rains
- Quick maturity of some cultivars allows them to escape drought

Maize growth stages and water use



A few days of drought during tasseling can impact yield

Protensia’s dilemma

- What are all the possible options for Protensia?
- What would you do if you were in his position?

"Hegemonic Leviathan"

- Maize fits into the growing season and is easily manipulated through genetic recombination

- Maize went from a vegetable crop to the dominant staple across the region in a matter of centuries

- Agencies from government to NGO to research all promoting maize via breeding programs