

Agriculture

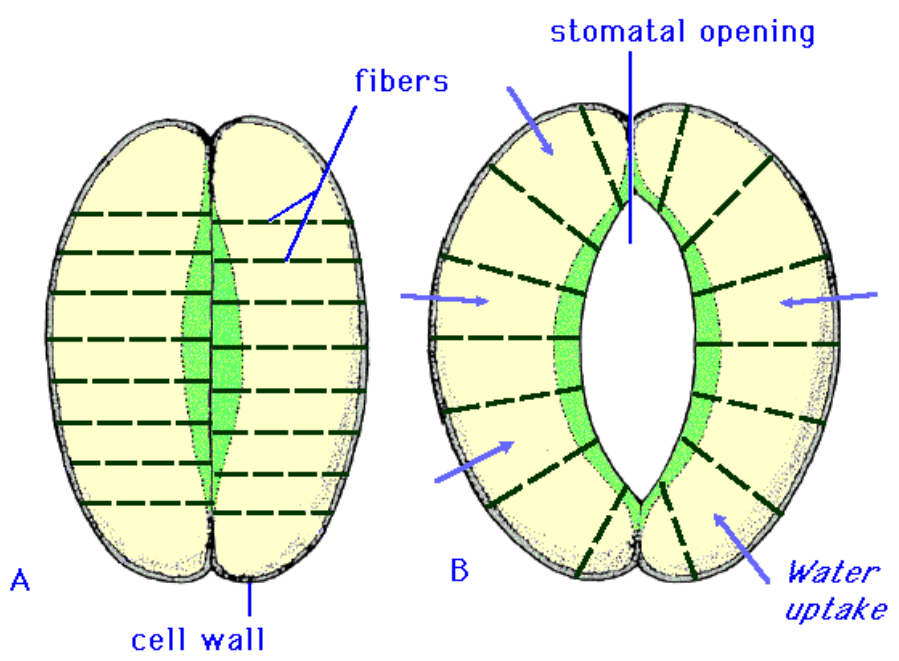
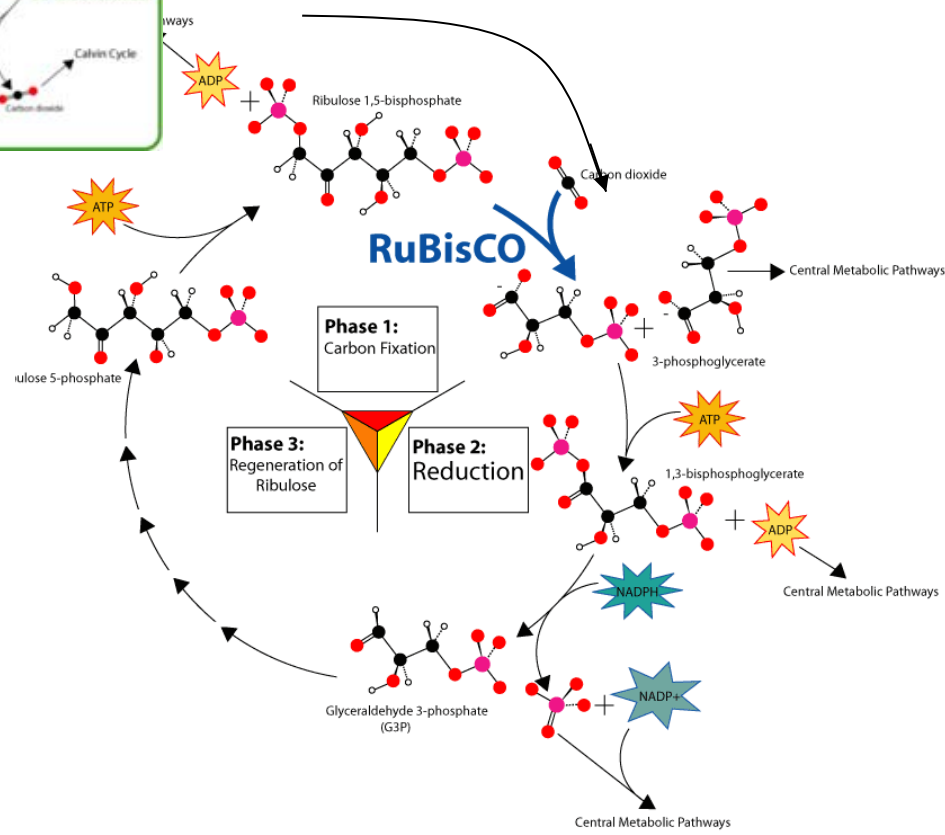
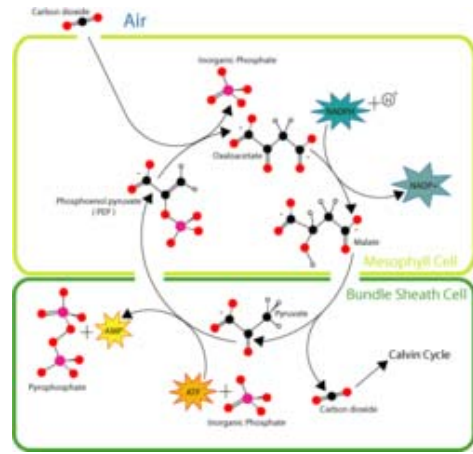


Allan Ross Mackenzie

University of the Highlands and Islands of Scotland



Photosynthesis C3-C4

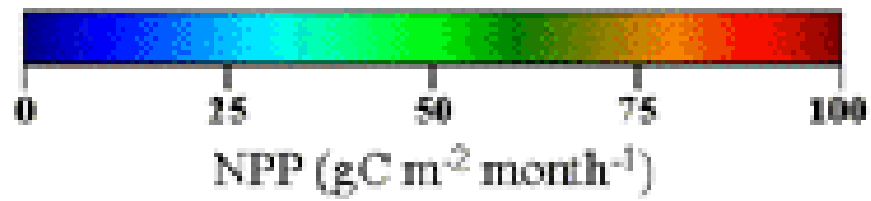
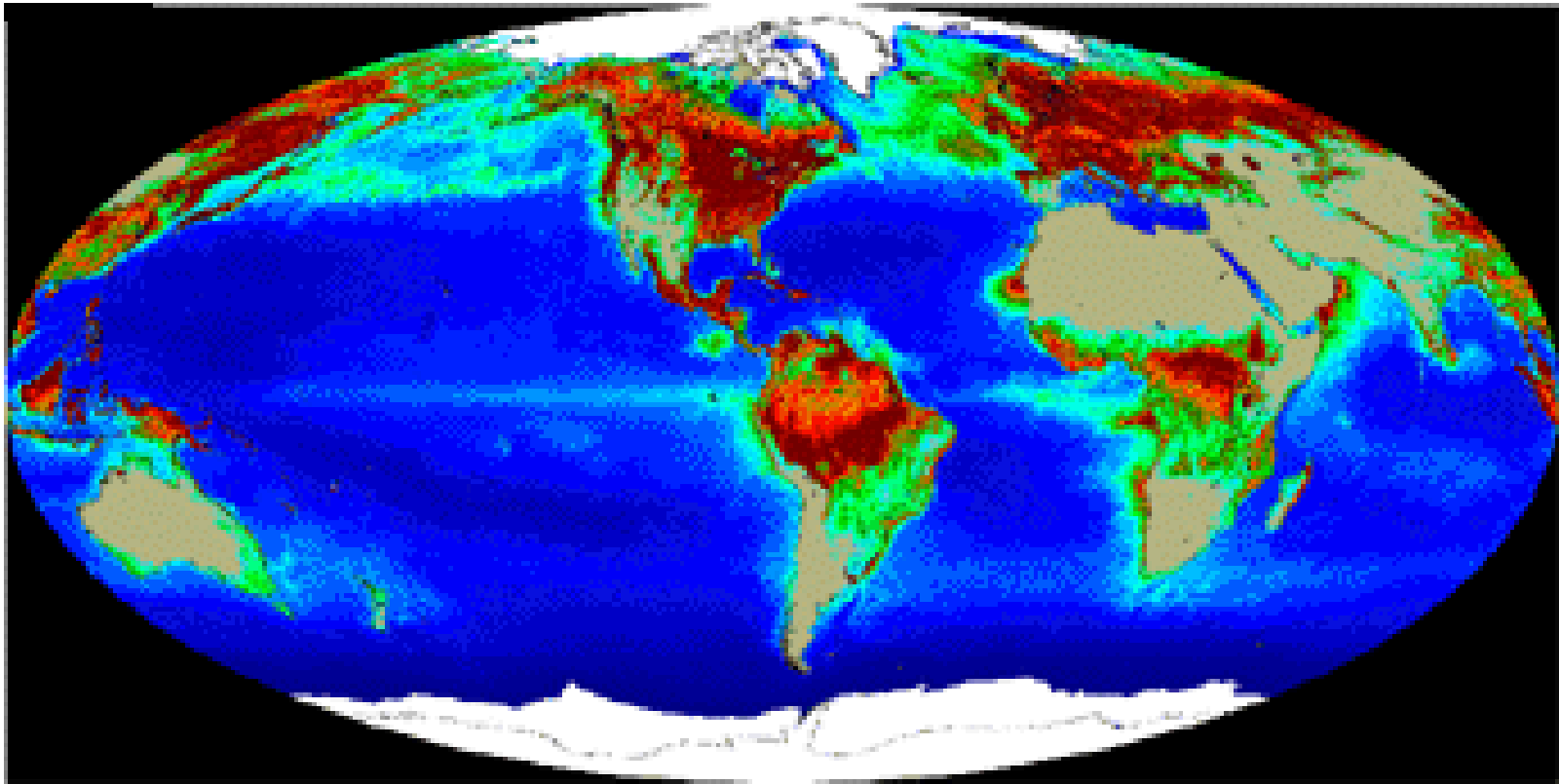


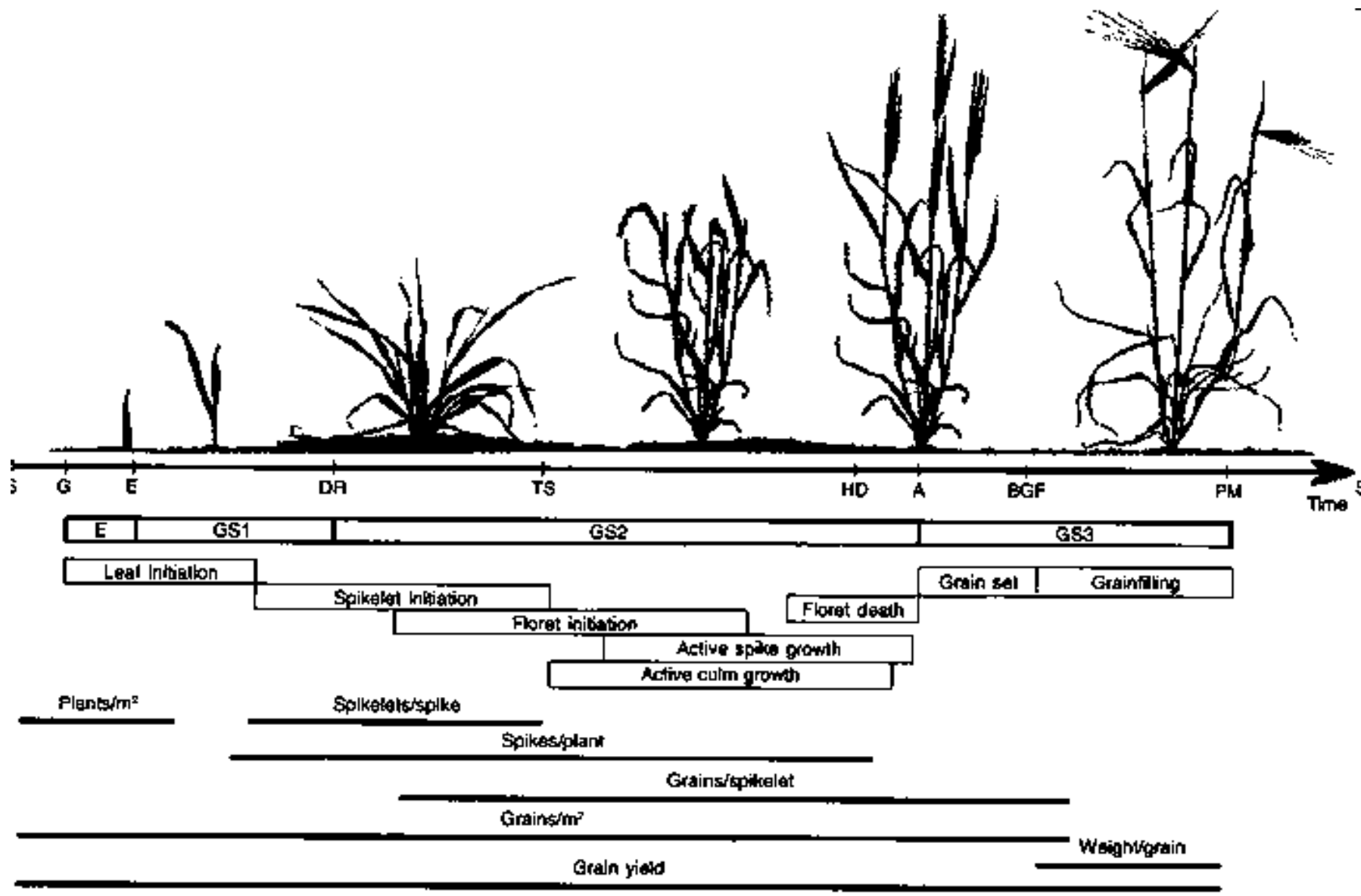


**Oil palm Hawaii
production 220 GJ/ha
(0,7W m²)**

solar energy 230W m²







Crops

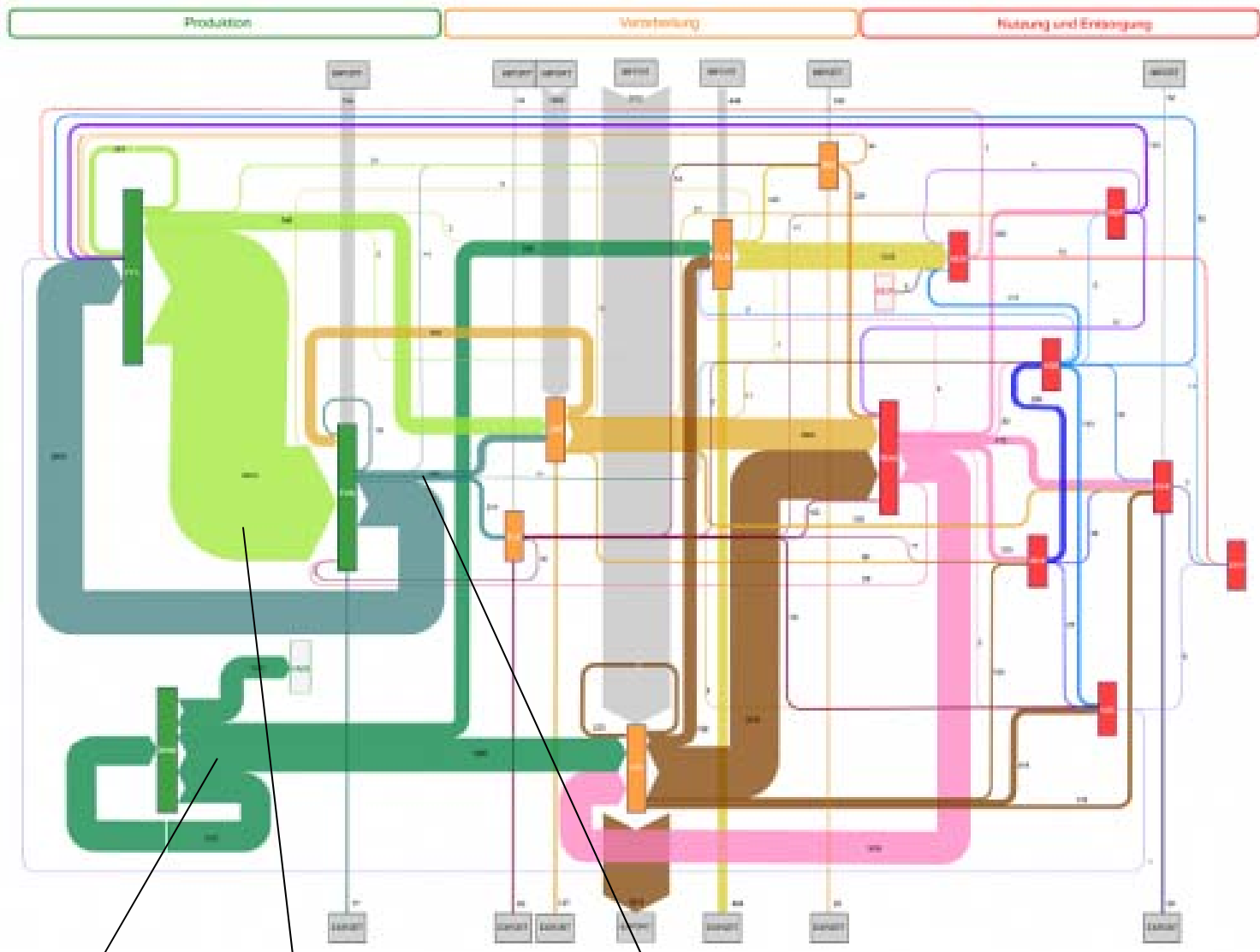
300 000 species of plants

about 10 000 used by men

12 species denerate 70% of production

Majority of plant production
generated by agriculture is not
consumed as a human food

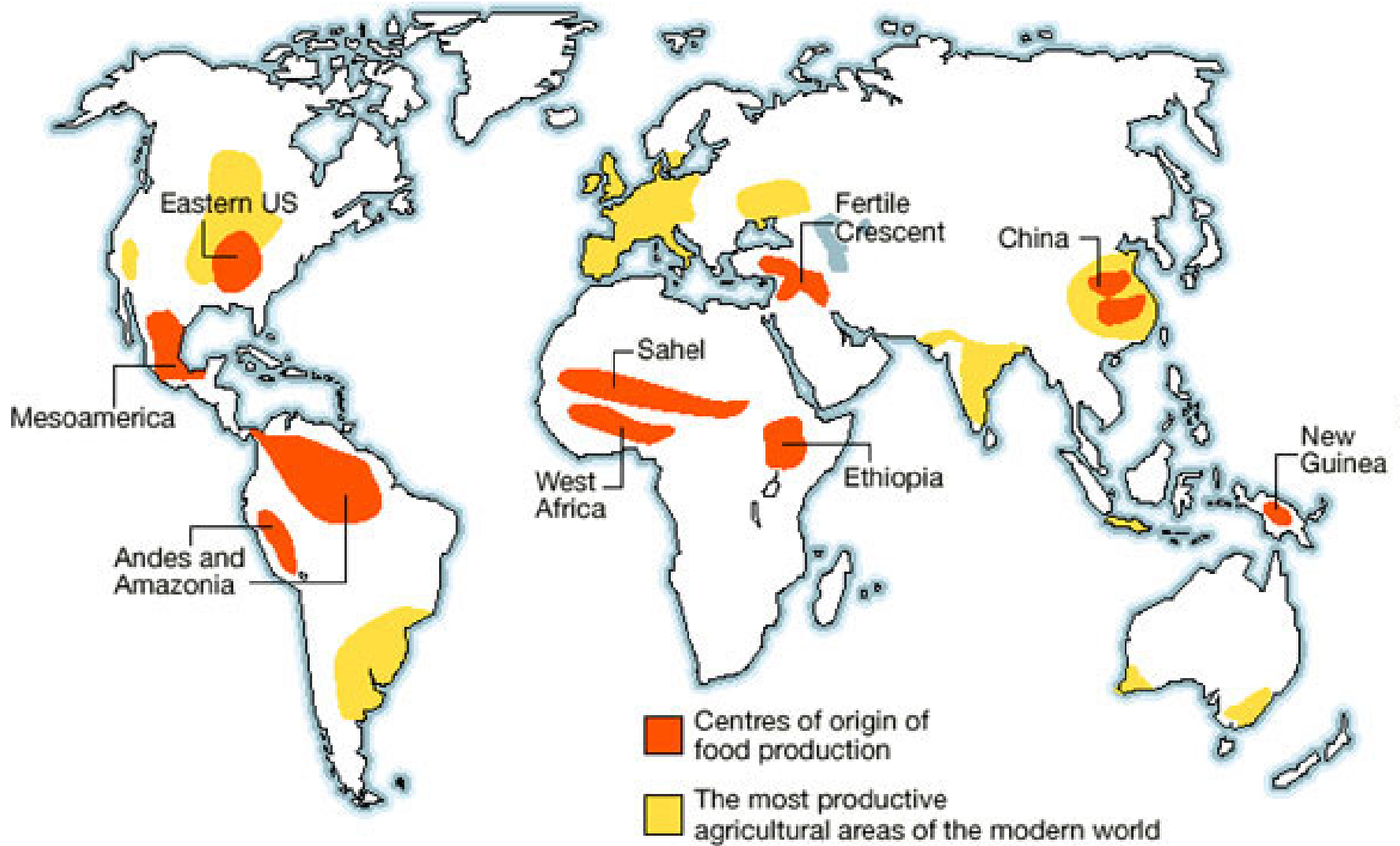
			millions t	
			sugar cane	1,324
			corn	721
			wheat	627
			rice	605
			potatoes	328
			sugar beat	249
			soya	204
			oil palm	162
			barley	154
			tomatoes	120
			FAO 2004	



Forest production

Plant production

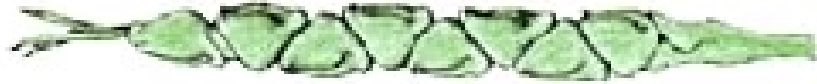
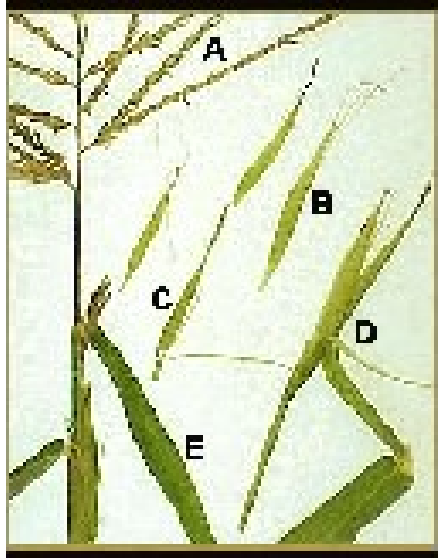
Animal production





Note: The pointer locations indicate general regions where crops are believed to have first been domesticated. In some cases, the center of origin is uncertain. Other geographic regions also harbor important genetic diversity for these crops.







Source: This map was developed by the General Accounting Office using data provided by the National Plant Germplasm System's Plant Exchange Office.



What is cultivar how we get them

- clon
- linie
- population
- F1 or F2 hybrid
- natural mutation
- hybridization
- polyploidie (kolchicin)
- artificially stimulated mutation
- GMO

Toxin content – Bt corn agroecosystem

Cry 3Bb1							
	Root	Leaf	Root after harvesting	Leaves after harvesting		Root soil	Bulk soil
Scale	100µg/g (10 ⁻⁴)	10 µg/g (10 ⁻⁵)	1 µg/g (10 ⁻⁶)	0,1 µg/g (10 ⁻⁷)	10 ng/g (10 ⁻⁸)	1 ng/g (10 ⁻⁹)	0,1 ng/g (10 ⁻¹⁰)
			LD 50 for the Western corn rootworm	no effect in ground beetles	no effect in sciarid fly larvae		

Cry3Bb1 concentrations in different plant parts and soils

Advantages and disadvantages of monocultures

- Monocultures maximize yield by better usage of space to reduce competition among varieties
- At harvest it is easy to separate products. Their processing is more feasible.
- *It is easier to optimize nutrient requirements by fertilizing*
- *Protection focuses on one type of plants only*
- Higher requirements for nutrients and water (uptake is synchronized)
- Higher susceptibility to pests and diseases
- Umonoculture maintenance requires conditions adjustments and protection againts weeds.
- Protection may affect non-targeted species
- Biological diversity of landscape is compromised

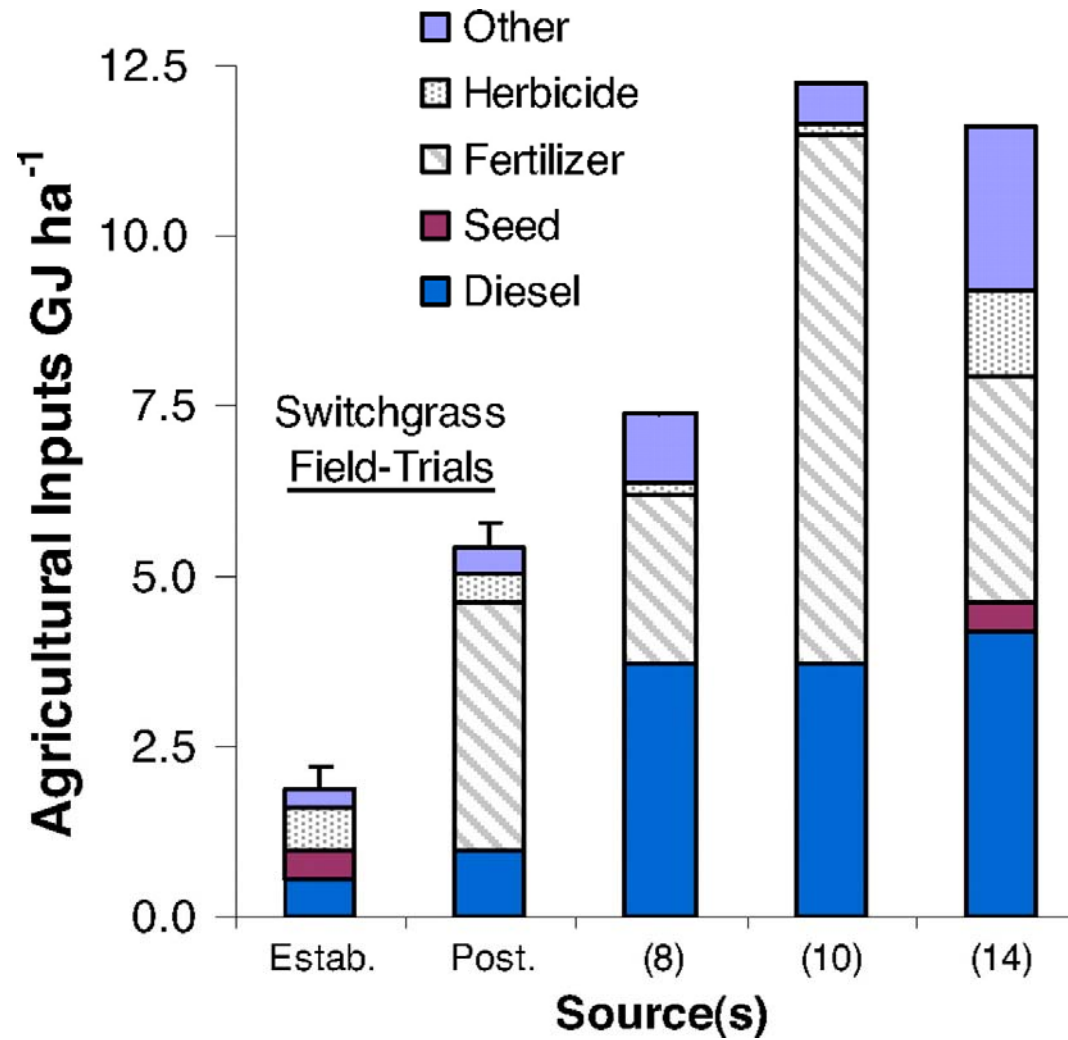
How the plants change with intensity

- Communities - Monocultures
- populations cohorts
- perennials (K) annuals (r strategs)

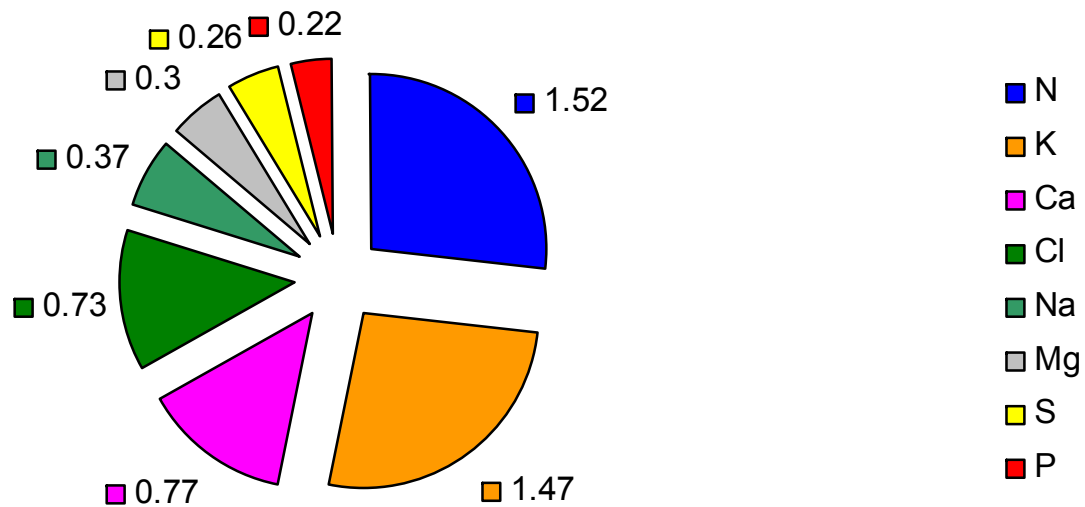
Environment modification

- Fertilizers
- Cultivation
- plant protection
- irrigation drainage

Switchgrass agricultural inputs (GJ·ha⁻¹) from the establishment year (Estab.) and postplanting harvest years (Post.) in a multilocation farm trial using known farm inputs



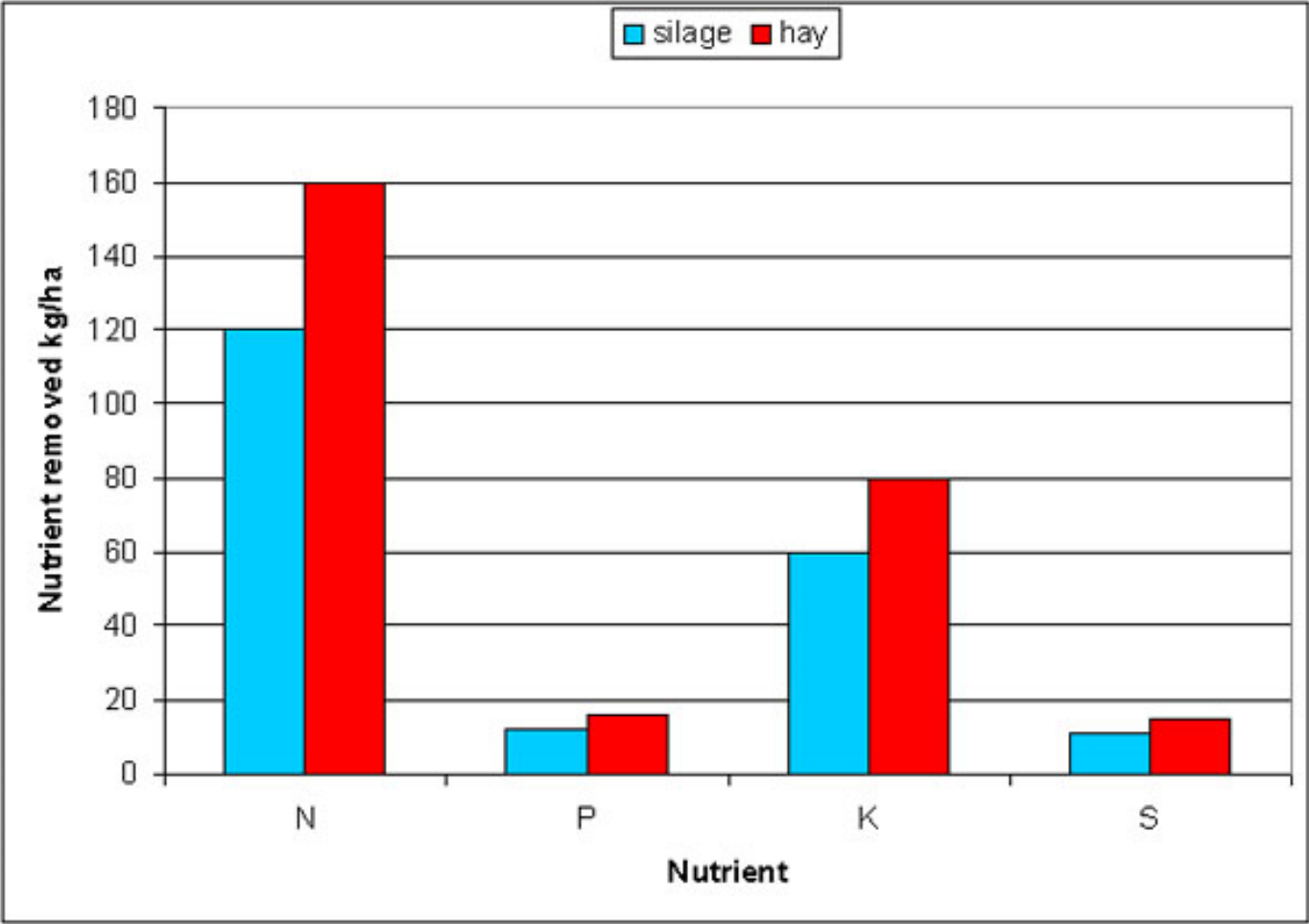
Schmer M R et al. PNAS 2008;105:464-469



Plant tissue composition

Table 3.2. Average content of mineral elements (in g kg^{-1} dry matter) in the soil and in the phytomass of land plants, together with the average mineral nutrient requirements. (Epstein 1972, 1994; Bowen 1979; data for various plant groups are given by Altman and Dittmer 1972; Baumeister and Ernst 1978; Lieth and Markert 1988)

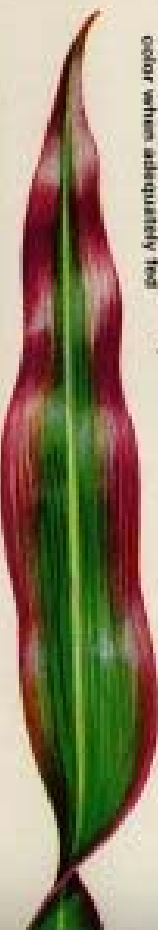
Element	Soil mean	Plants' range	Requirements
Si	330	0.2 – 10	
Al	70	0.04 – 0.5	
Fe	40	0.002 – 0.7	ca. 0.1
Ca	15	0.4 – 15	3 – 15
K	14	1 – 70	5 – 20
Mg	5	0.7 – 9	1 – 3
Na	5	0.02 – 1.5	
N	2	12 – 75	15 – 25
Mn	1	0.003 – 1	0.03 – 0.05
P	0.8	0.1 – 10	1.5 – 3
S	0.7	0.6 – 9	2 – 3
Sr	0.25	0.003 – 0.4	
F	0.2	up to 0.02	
Rb	0.15	up to 0.05	
Cl	<0.1	0.2 – 10	>0.1
Zn	0.09	0.001 – 0.4	0.01 – 0.05
Ni	0.05	up to 0.005	
Cu	0.03	0.004 – 0.02	0.005 – 0.01
Pb	0.03	up to 0.02	
B	0.02	0.008 – 0.2	0.01 – 0.04
Co	0.008	up to 0.005	
Mo	0.003	up to 0.001	<0.0002



Guide to Nutrient Deficiency Symptoms



HEALTHY leaves shine with a rich dark green color when adequately fed.



PHOSPHATE shortage marks leaves with reddish-purple, particularly on young plants.



POTASH deficiency appears as a ring or drying along the tips and edges of lower leaves.



NITROGEN hunger sign is yellowing that starts at tip and moves along middle of leaf.



MAGNESIUM deficiency causes whitish strips along the veins and often a purplish color on the underside of the lower leaves.



DROUGHT causes the corn to have a greyish-green color and the leaves roll up nearly to the size of a pencil.

Drawings: Maynard Dixon



DISEASE, *Helminthosporium blight*, starts in small spots, gradually spreads across leaf.



CHEMICALS may sometimes burn tips, edges of leaves and at other contacts. Trause diox. leaf becomes whitcap.

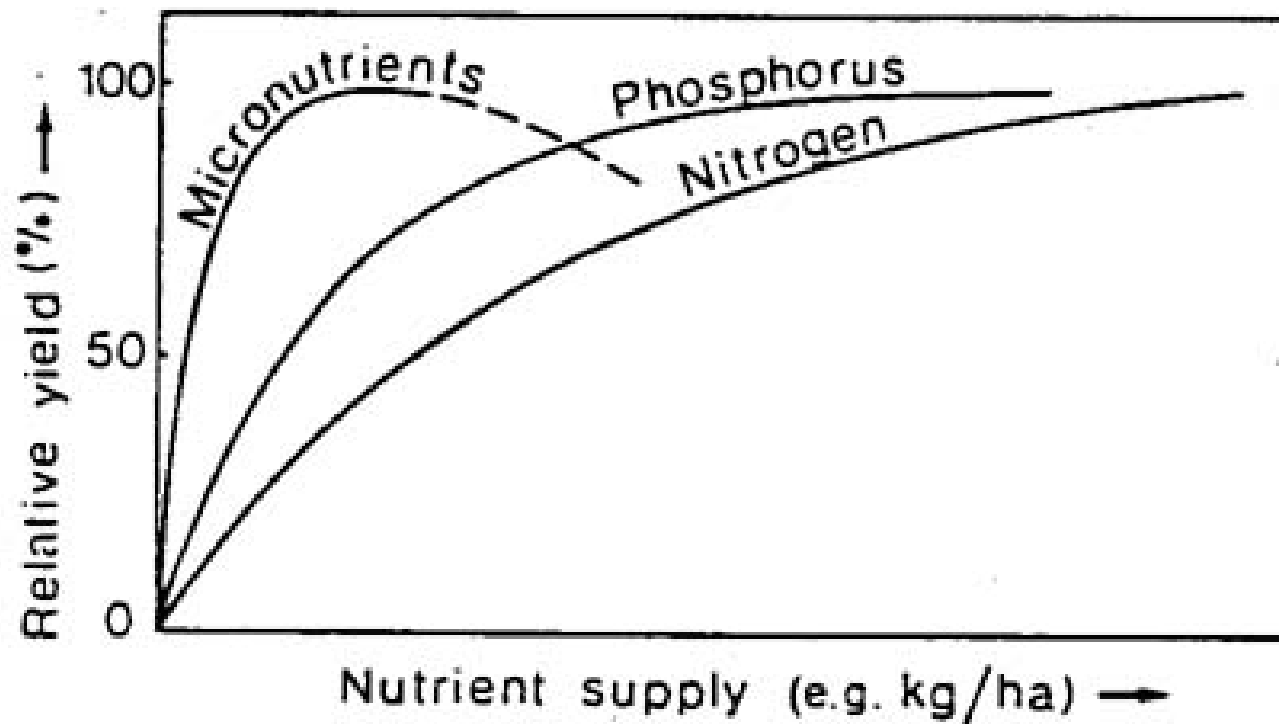
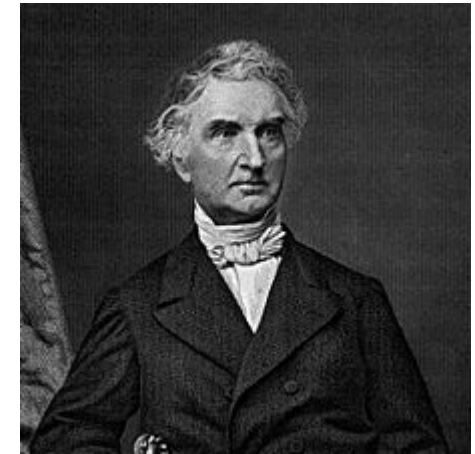
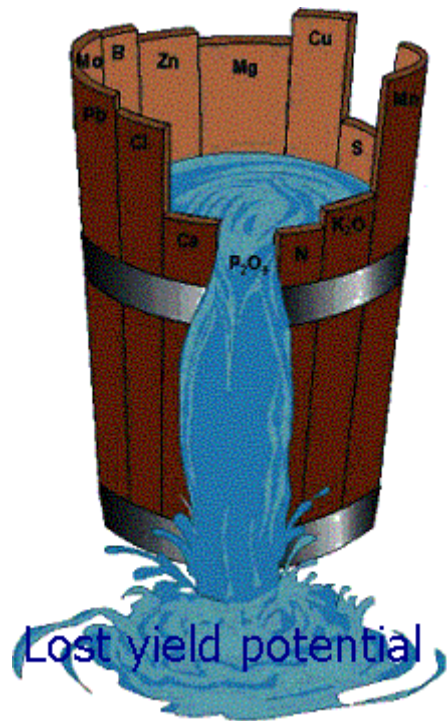


Fig. 6.1 Yield response curves for nitrogen, phosphorus, and micronutrients.



Justus von Liebig



Photo by Gokhan Okur

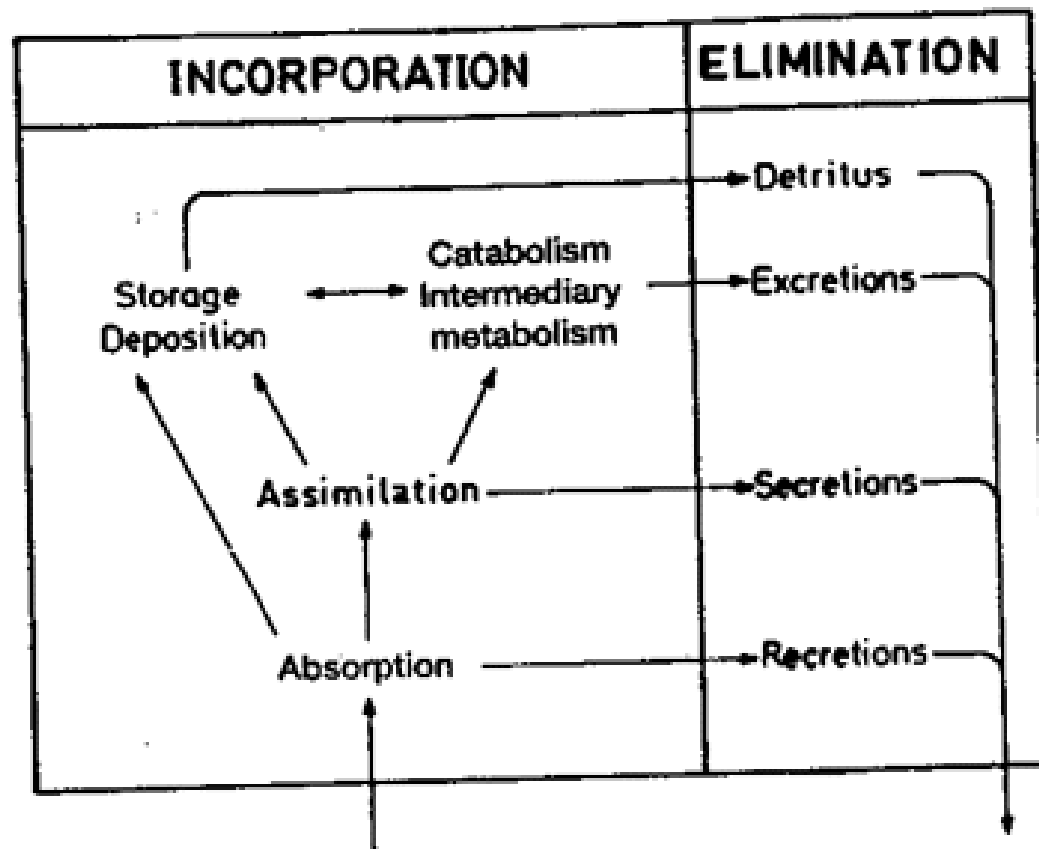


Fig. 3.12. Diagram of the turnover of inorganic matter in plants. (Based in part on Frey-Wyssling 1949)

Release of nutrients from insoluble forms (P)

Exchange link on absorption complex (cations).

Release of nutrients from decomposing organic mass.

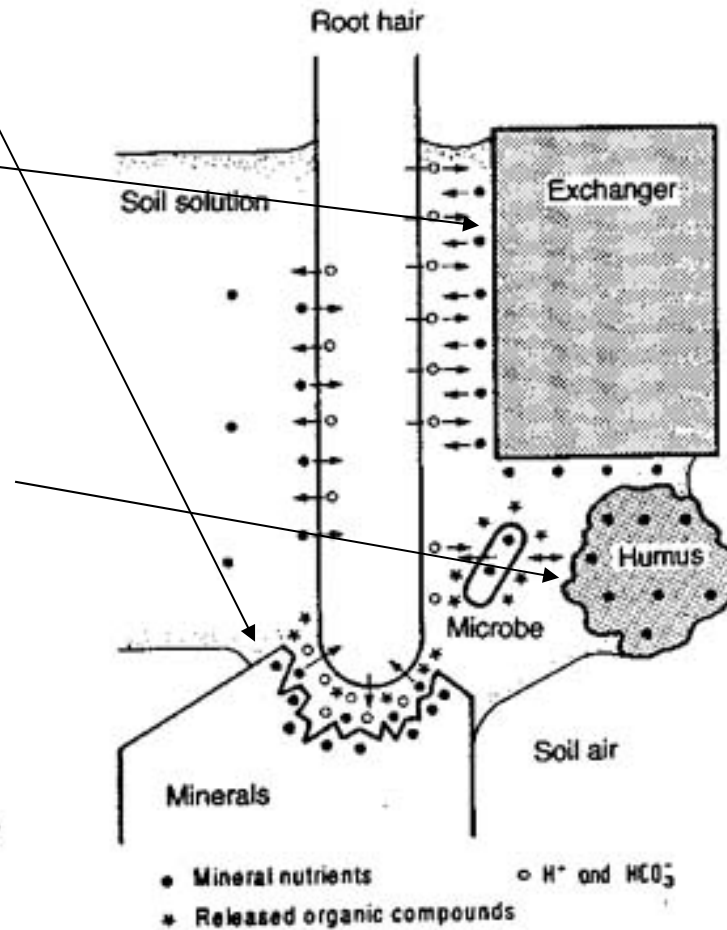
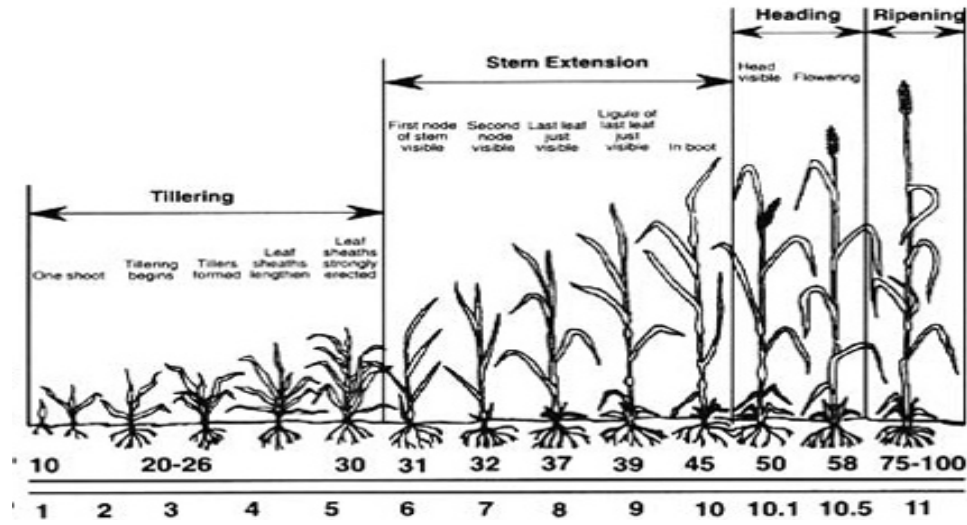
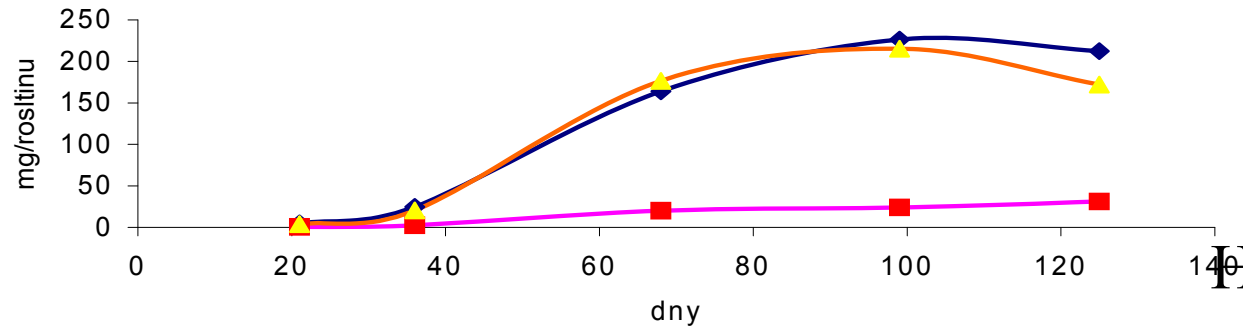
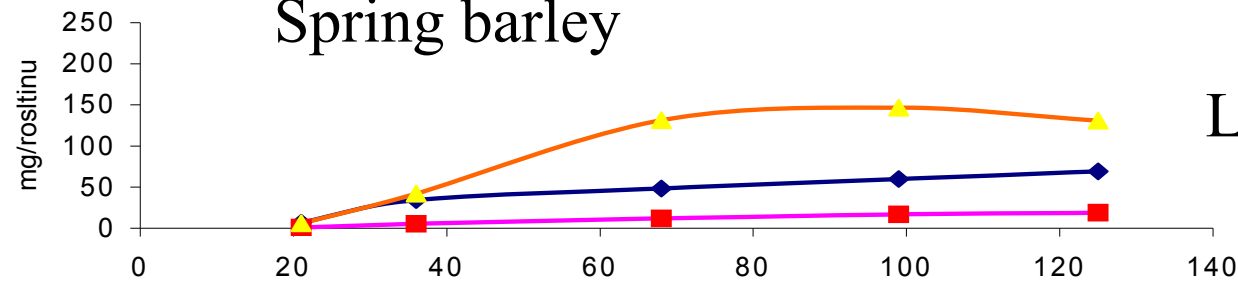


Fig. 3.1. Mobilization of mineral nutrients in the soil and the uptake of mineral elements by the root. (After Finck 1969, modified)



Spring barley



◆ dusík ■ fosfor ▲ draslik

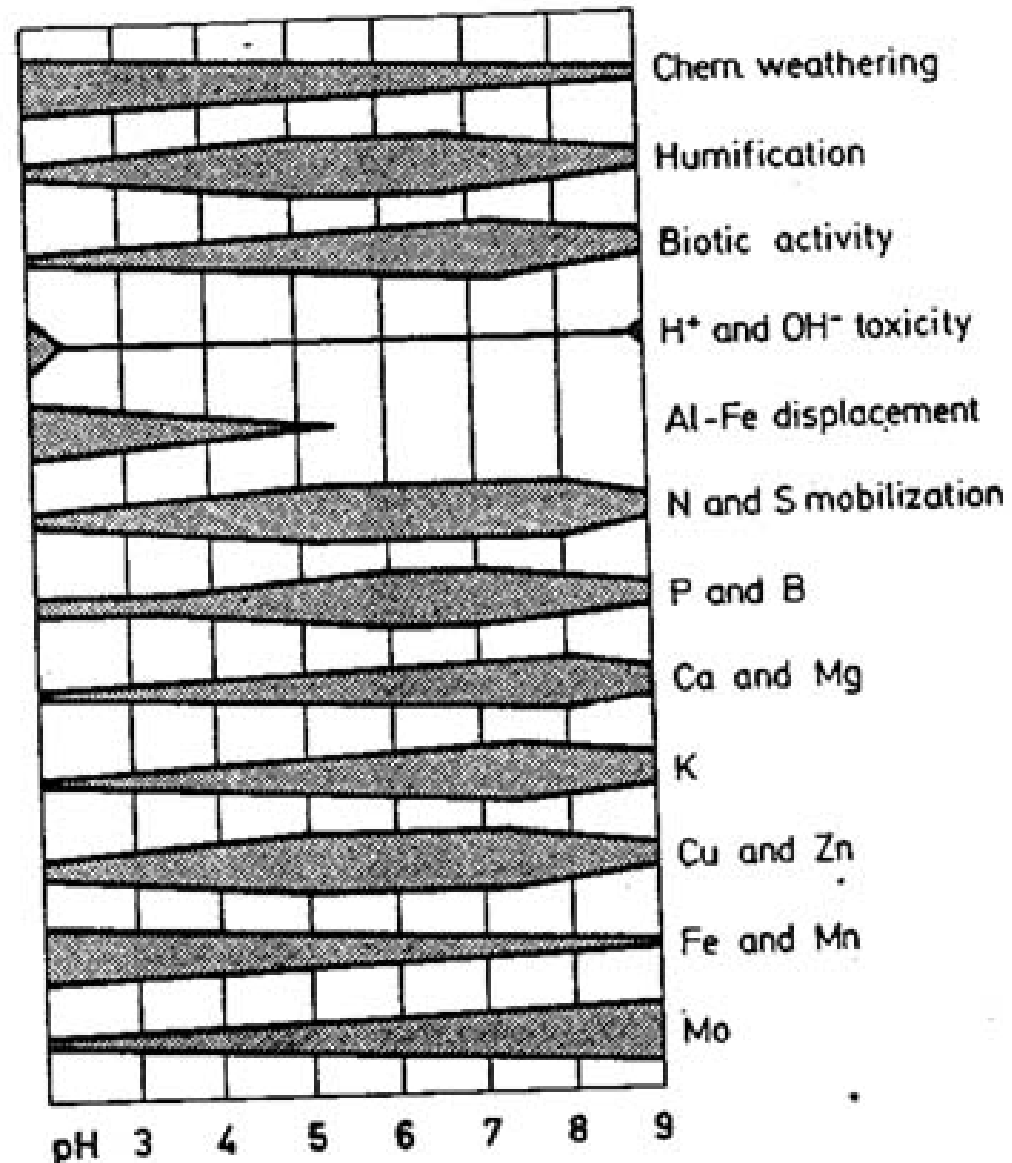
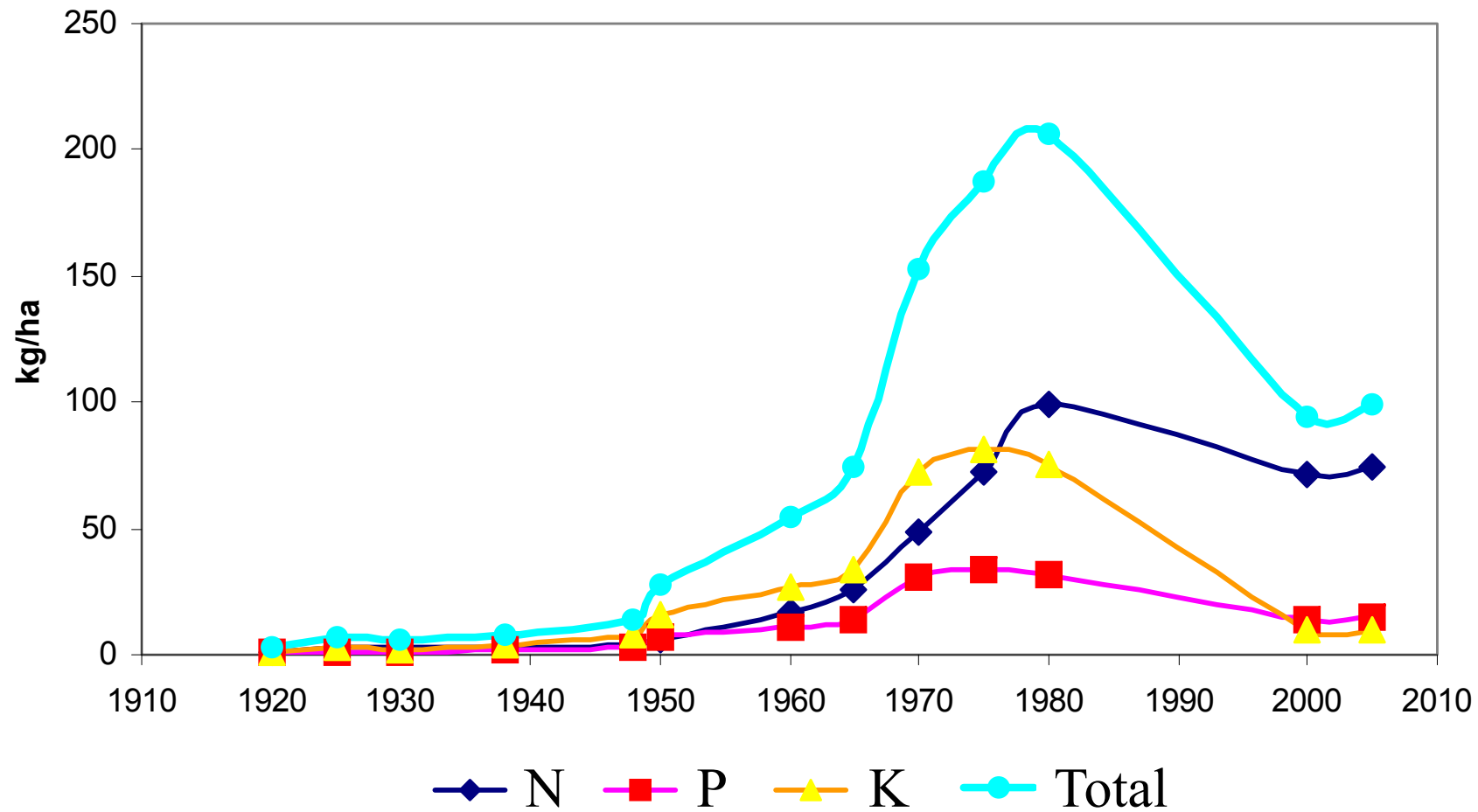
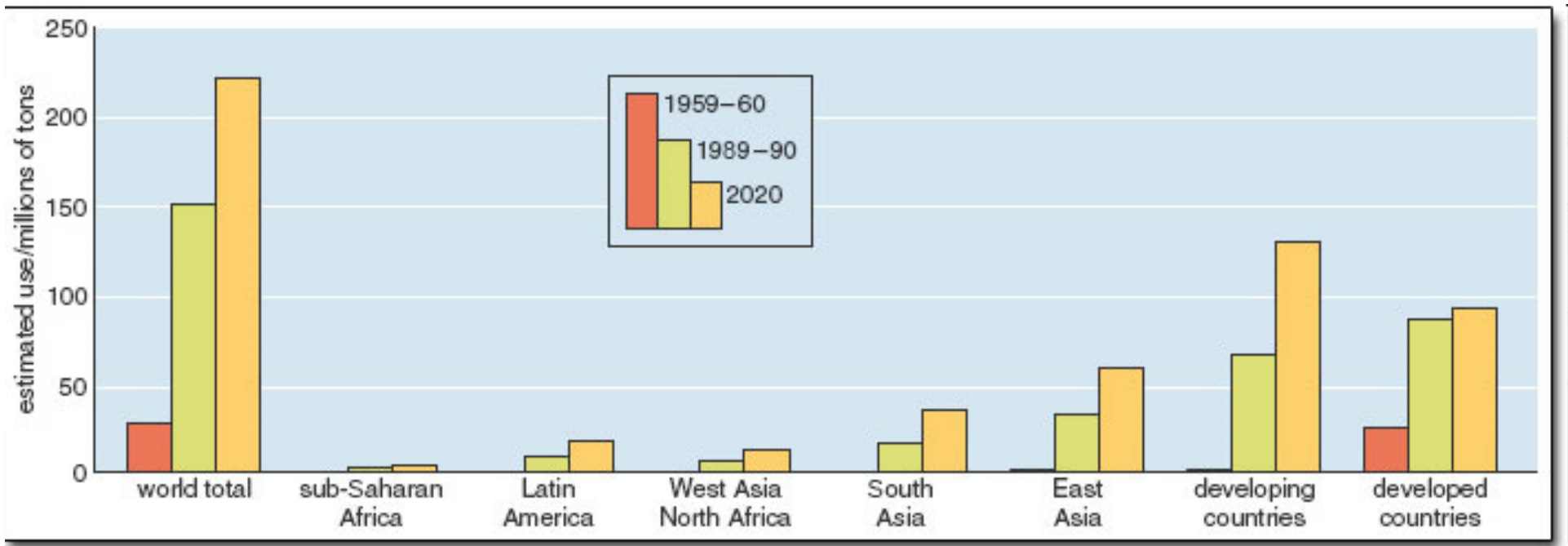


Fig. 3.20. Influence of soil pH on soil formation, mobilization and availability of mineral nutrients, and the conditions of life in the soil. The *width of the bands* indicates the intensity of the process or the availability of the nutrients. (After Truog, from Schroeder 1969)

Consumption of industrial fertilizers in Scotland





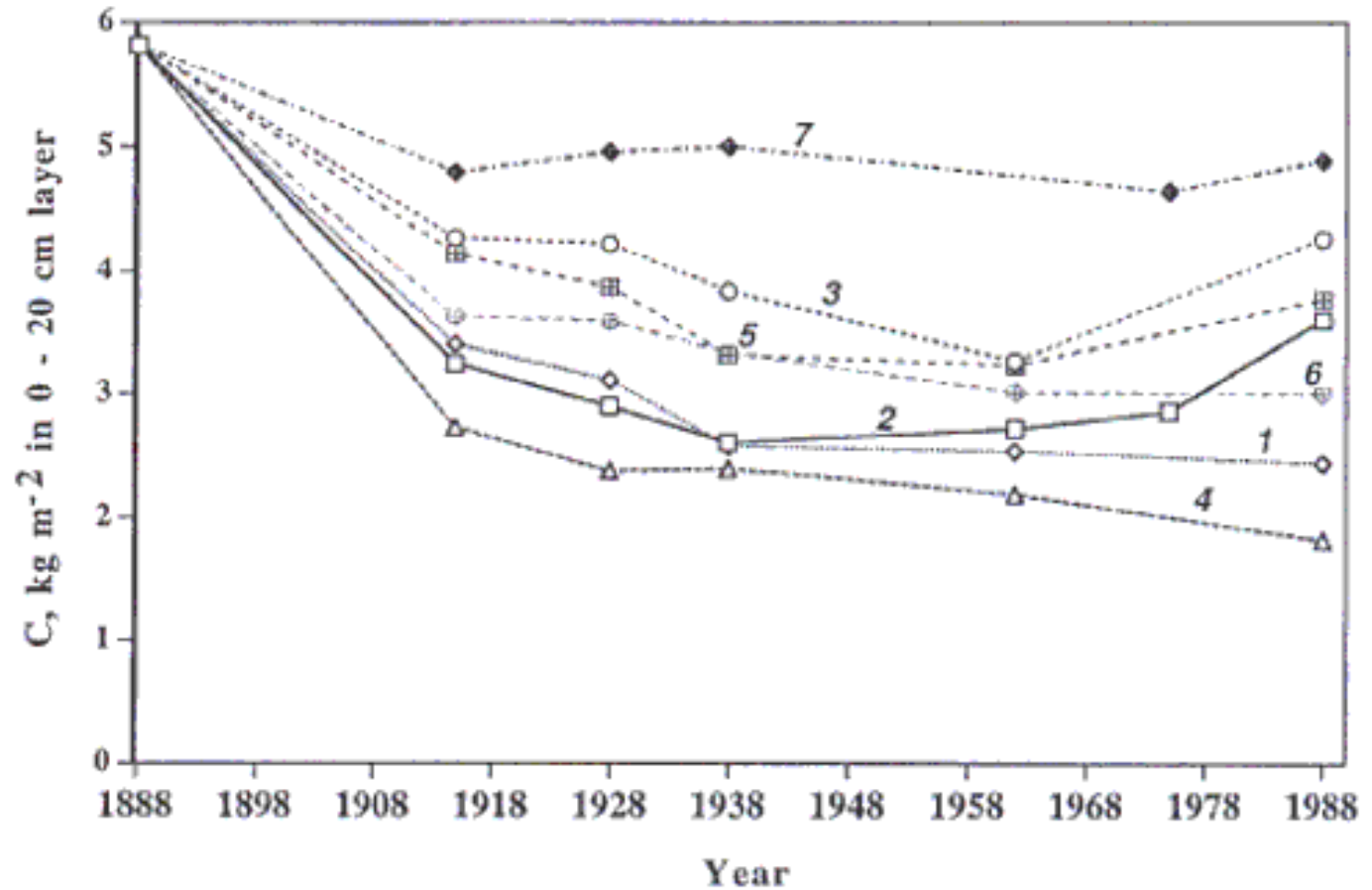
Organic fertilizers

- manure
- suage
- compost





Soil organic matter carbon dynamics in some Sanborn Field plots, Missouri, with common monocrops: (1) wheat with no treatment; (2) wheat full fertilizer application; (3) wheat with 6 ton/acre manure; (4) continuous corn with no treatment; (5) continuous corn with 6 ton/acre manure; (6) timothy grass; and (7) timothy grass with 6 ton/acre manure. Source: G. Buyanovsky and G. Wagner, 1998. "Carbon cycling in cultivated land and its global significance." *Global Change Biology* 4:131–141.



Fertilizers amonunm



catalizator Fe_2O_3

300-550°C 15-25 MPa



Fritz Haber

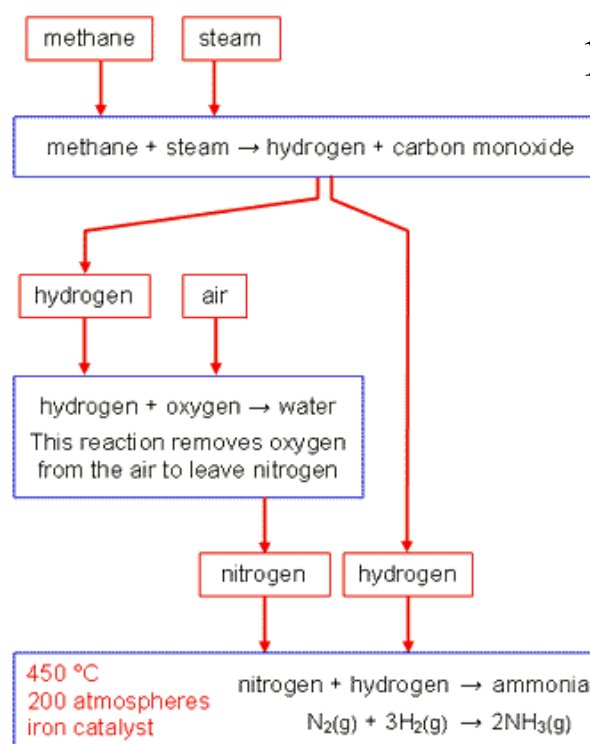


Carl Bosch

- nobel price

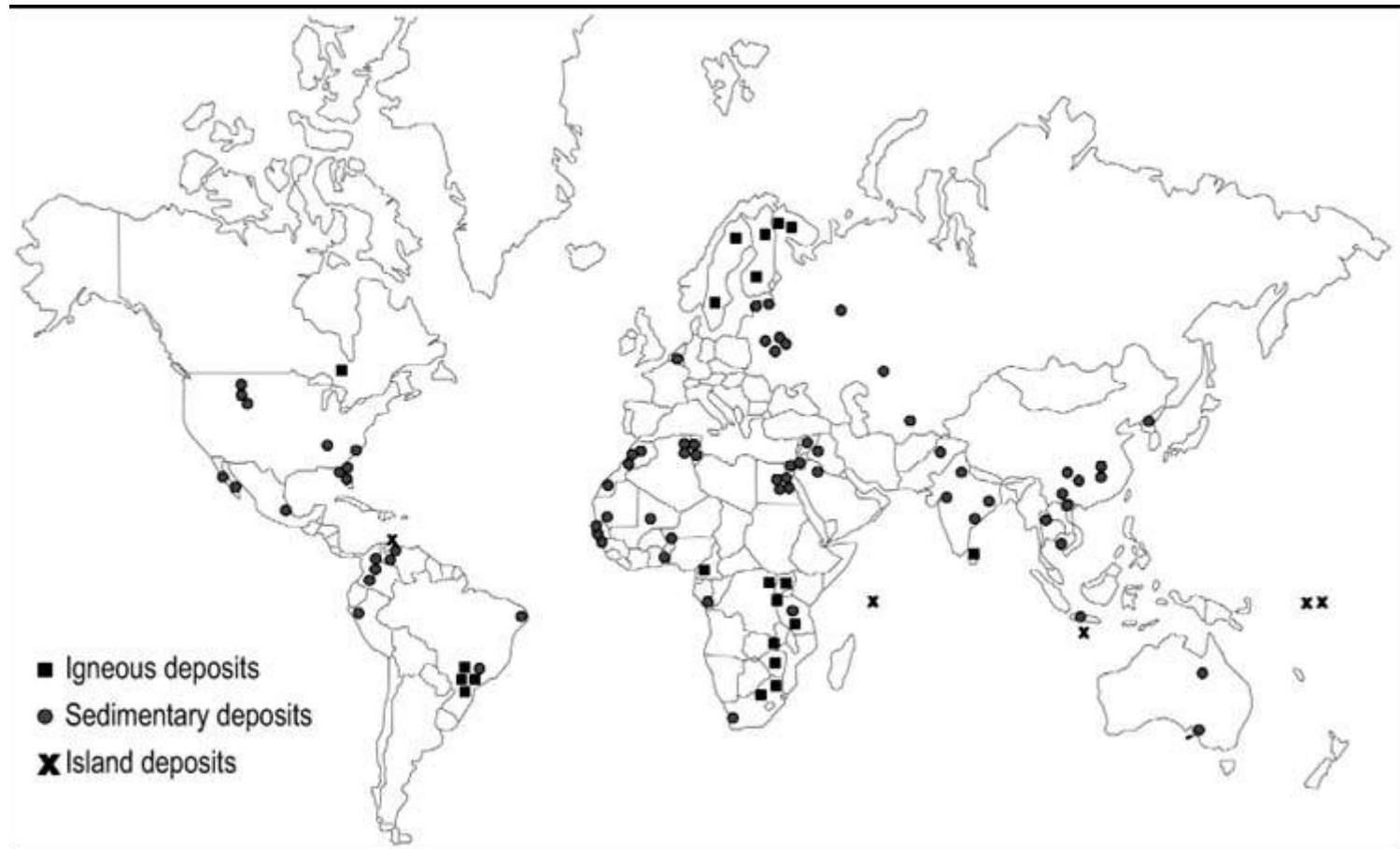
1918

1931



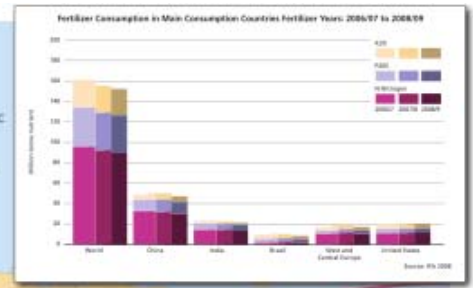
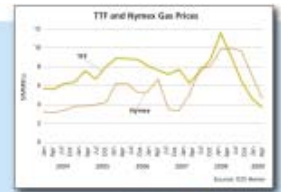
Mining K a P





UNIT PRICE (Million US Dollars per 1000 metric tons)

Product	Unit	Price
Ammonia	1000 metric tons	100.00
Urea	1000 metric tons	100.00
Phosphate Rock	1000 metric tons	100.00
DAP	1000 metric tons	100.00
Potash	1000 metric tons	100.00



Key

- Ammonia
- Urea
- Phosphate Rock
- DAP
- Potash

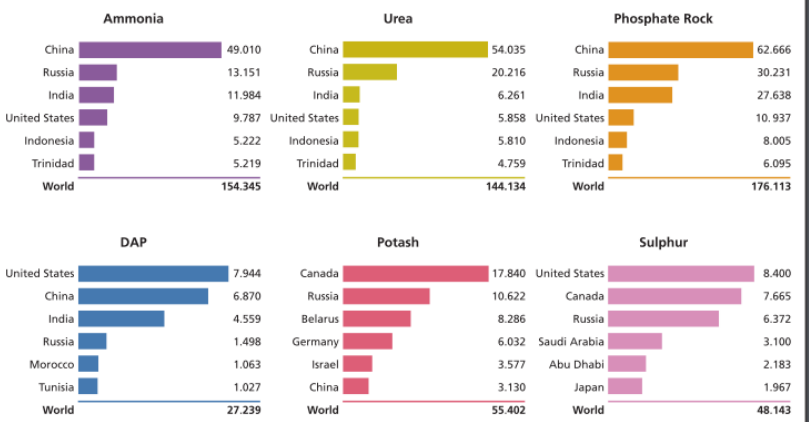
The width of the arrows indicates the relative size of trade flows; the arrows' positions of origin and destination do not indicate the path's location.

Cut-off tonnage for trade flow is 400,000 tonnes product

Conversion Factors

Origin	Product	Unit	Factor
Ammonia	US	1000 metric tons	0.92
	EU	1000 metric tons	0.96
Phosphate	Phosphate Rock	P ₂ O ₅	0.38
	DAP	P ₂ O ₅	0.52
	DAP	P ₂ O ₅	0.38
	Potash	Potash (KCl)	K ₂ O

World Major Producing Countries of Fertilizers and Raw Materials 2007

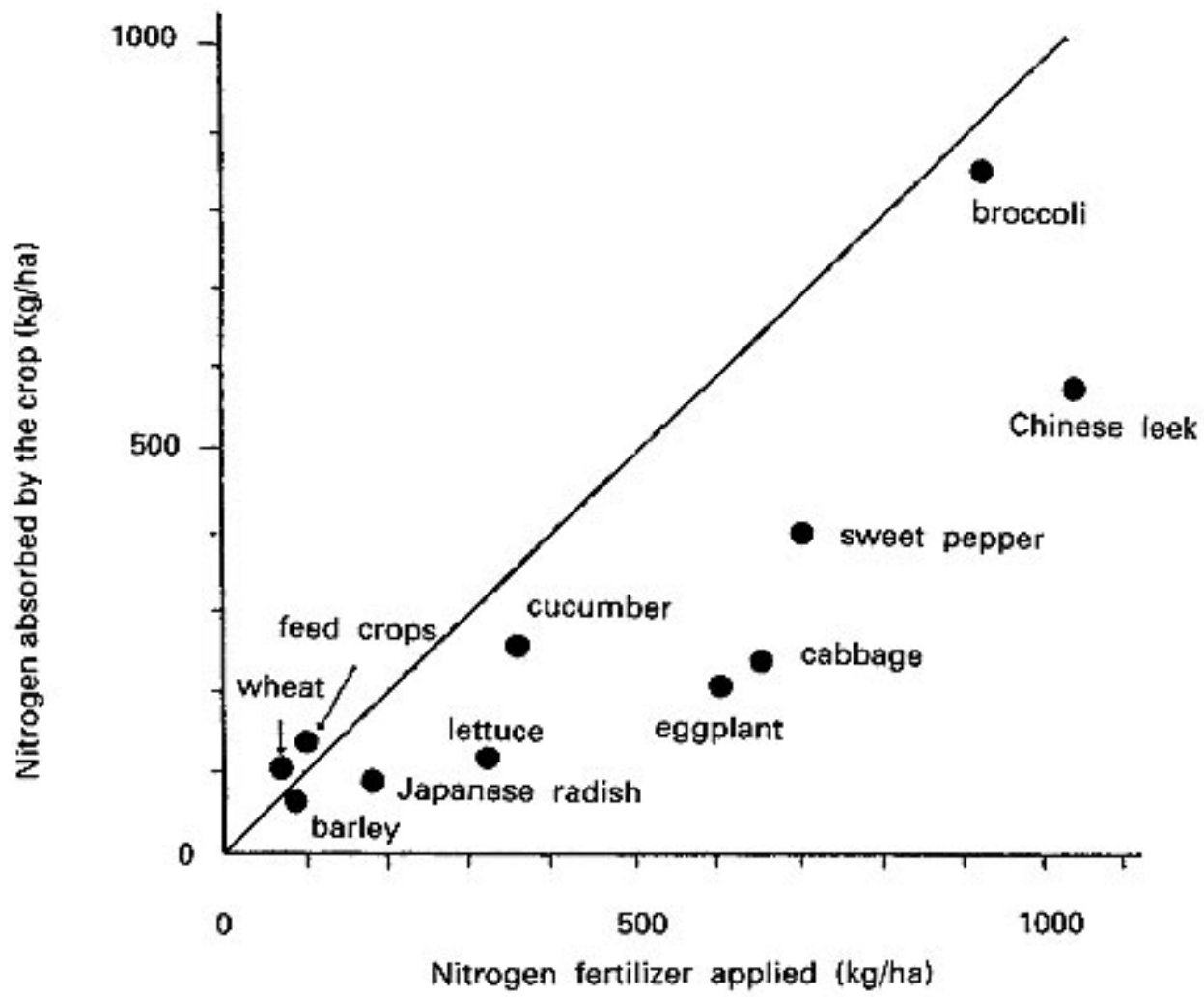


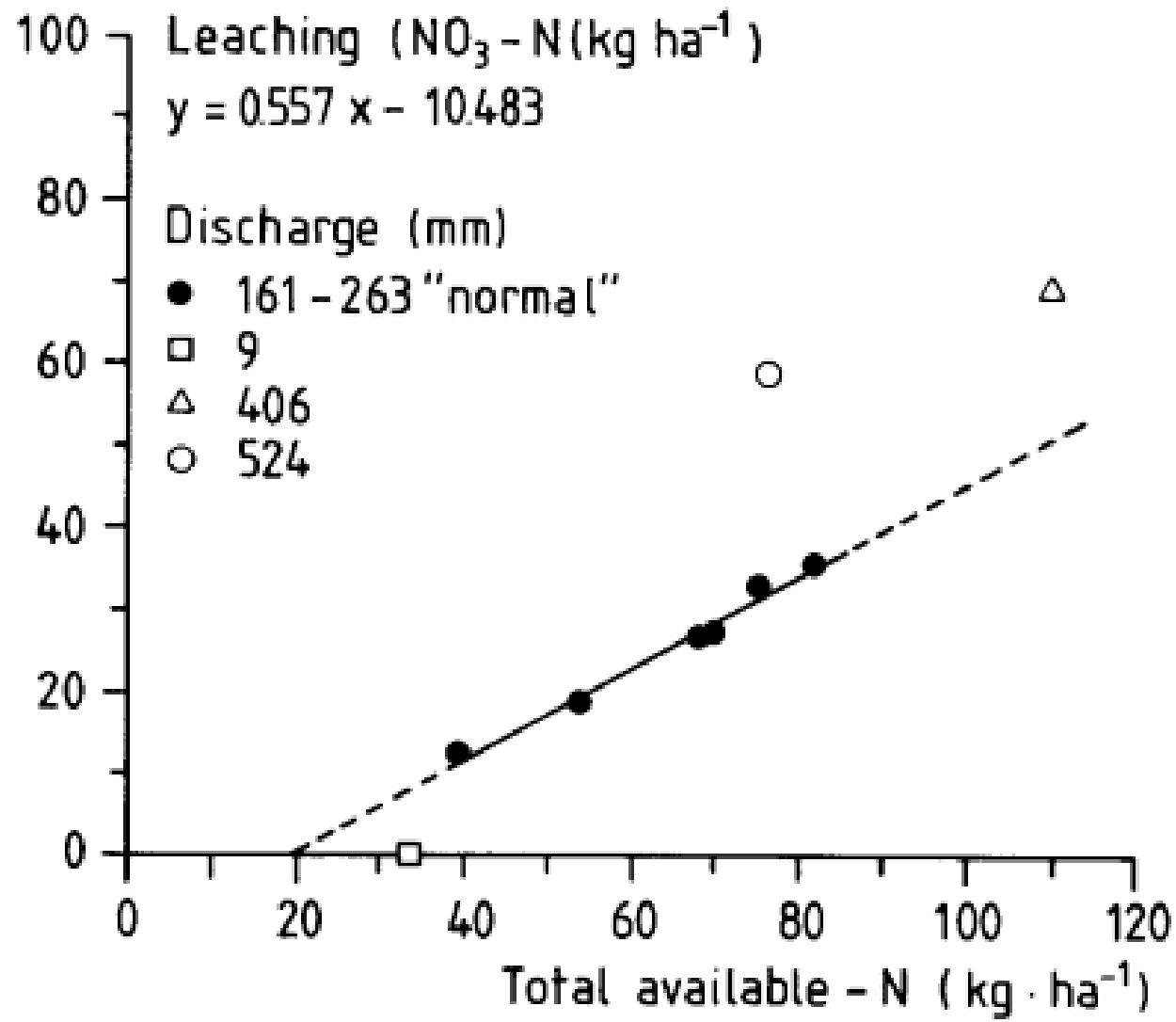
Million tonnes product

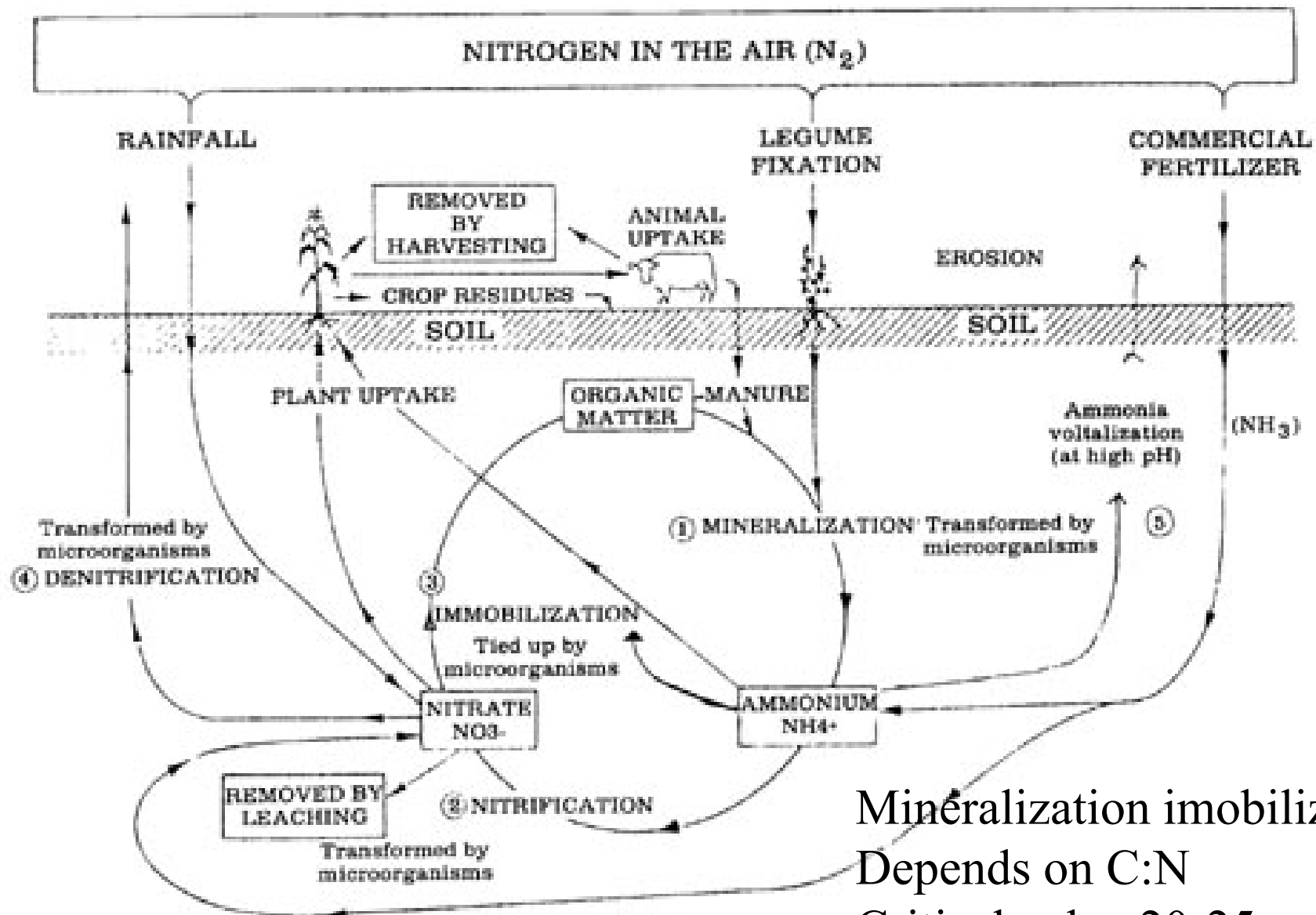
Source: IFA



Source	As	Cd	Cr	Cu	Pb	Hg			
	----- mg kg ⁻¹ of PR -----								
Russia (Kola)	1	0.1	13	30	3	0.01			
USA	12	11	109	23	12	0.05			
Morocco	11	30	225	22	7	0.04			
Other N. Africa	15	60	105	45	6	0.05			
Middle East	6	9	129	43	4	0.05			
	----- mg kg ⁻¹ of PR -----								
Average	11	25	188	32	10	0.05			
	-----g ha ⁻¹ -----								
20 kg P ha ⁻¹	1	3.3	25	4	1	0.01			
	----- mg kg ⁻¹ of soil -----								
Tolerable limit (Finck, 1992)	-	2	100	100	100	2			





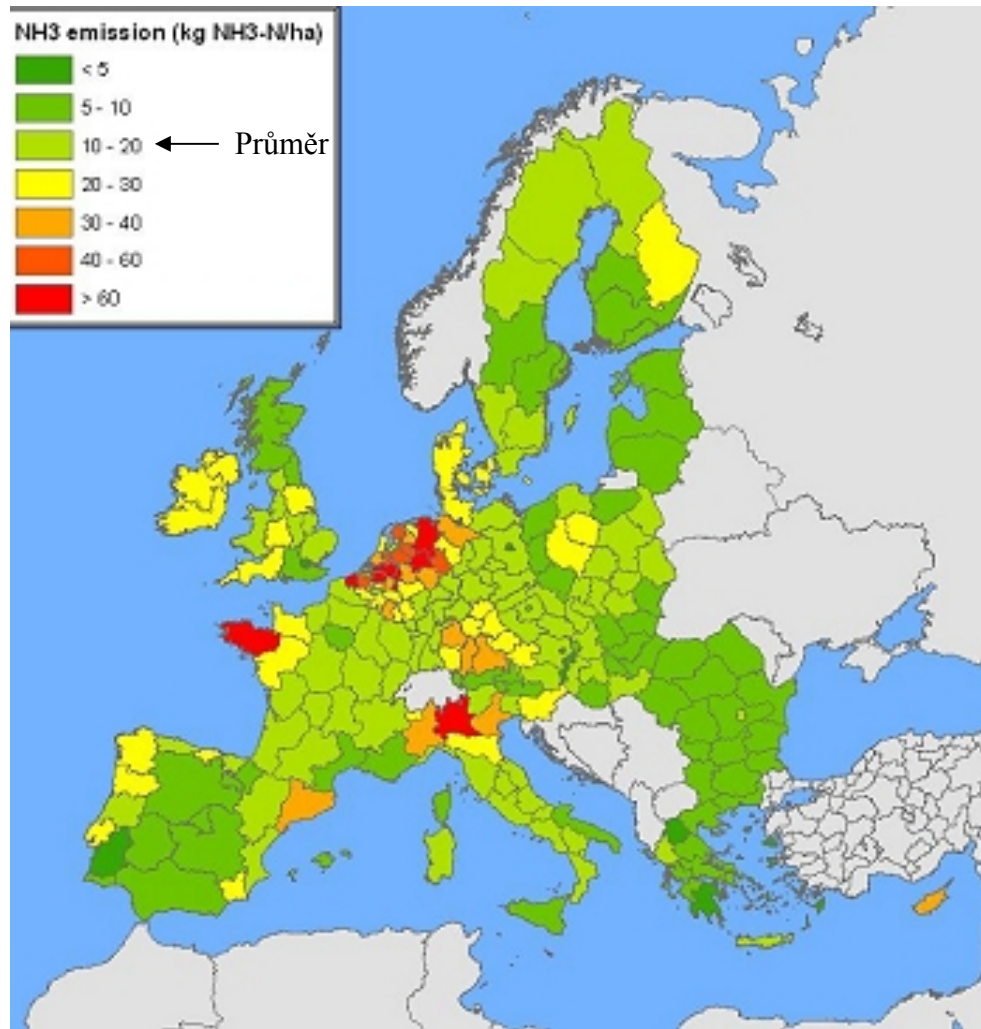


Mineralization immobilization
 Depends on C:N
 Critical value 20-25

Crop	Sandy soil			Clay soil		
	L	D	Total	L	D	Total
kg N/ha						
Brussels sprouts						
From soil	84	5	89	68	8	74
From crop residues	-3	26	23	-8	25	17
Total	81	31	112	58	33	91
Cabbage						
From soil	90	5	95	77	8	85
From crop residues	41	11	52	30	10	40
Total	131	16	147	107	18	125
Leek						
From soil	160	5	165	177	8	185
From crop residues	24	5	29	19	4	23
Total	184	10	194	196	12	208
Spinach						
From soil	223	5	228	215	8	223
From crop residues	28	0	28	27	0	27
Total	251	5	256	242	8	250

L = leaching losses (defined as losses below 90 cm).

D = denitrification losses



N losses in EU [kg ha^{-1}]

Denitrification 44

Flooding 16

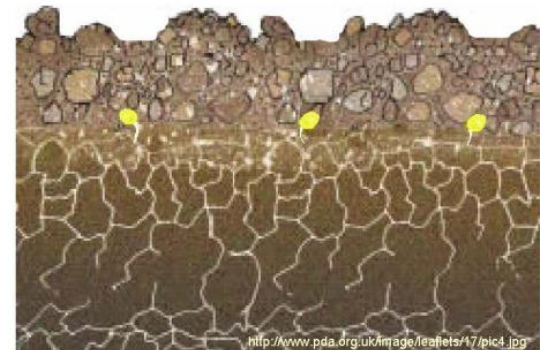
Volatilization of ammonia 17

NO_2 2

Skim plowing



Tillage can prepare a favorable seed bed



<http://www.pda.org.uk/image/leaflets/17/pic4.jpg>

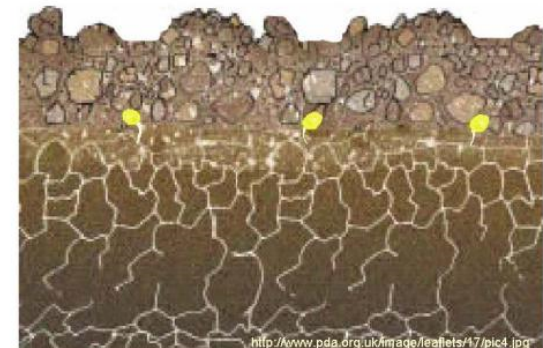
Plowing



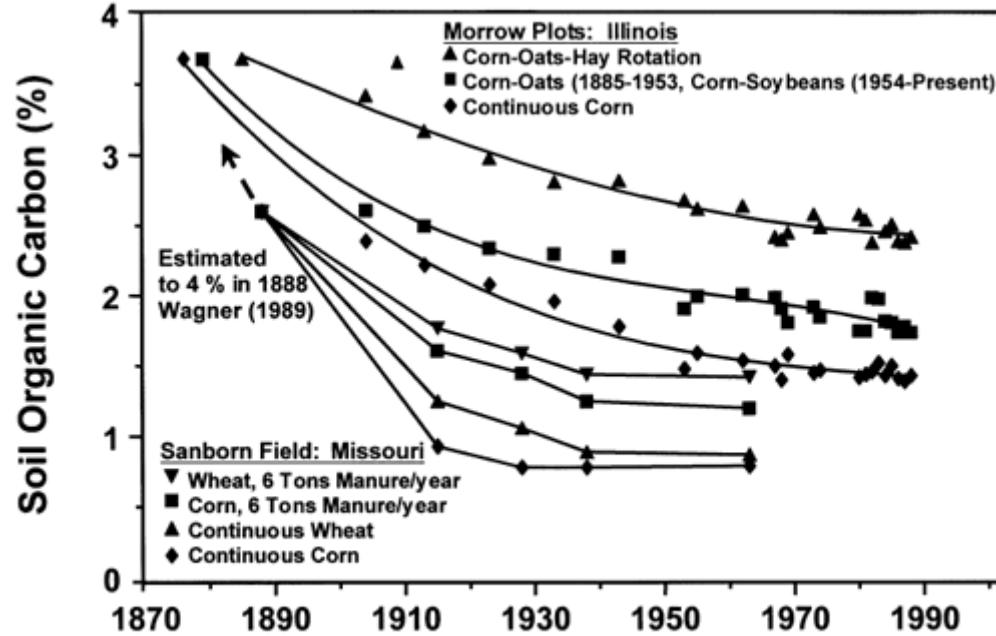
Preparation prior to sowing



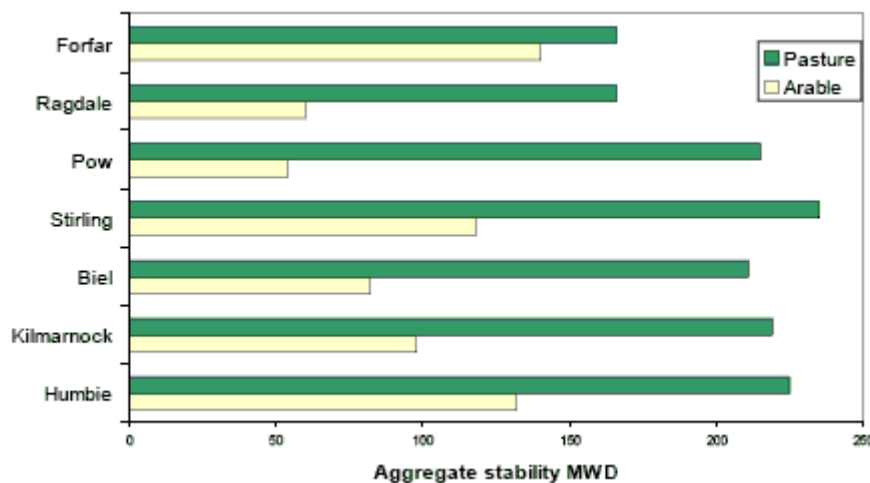
Tillage can prepare a favorable seed bed

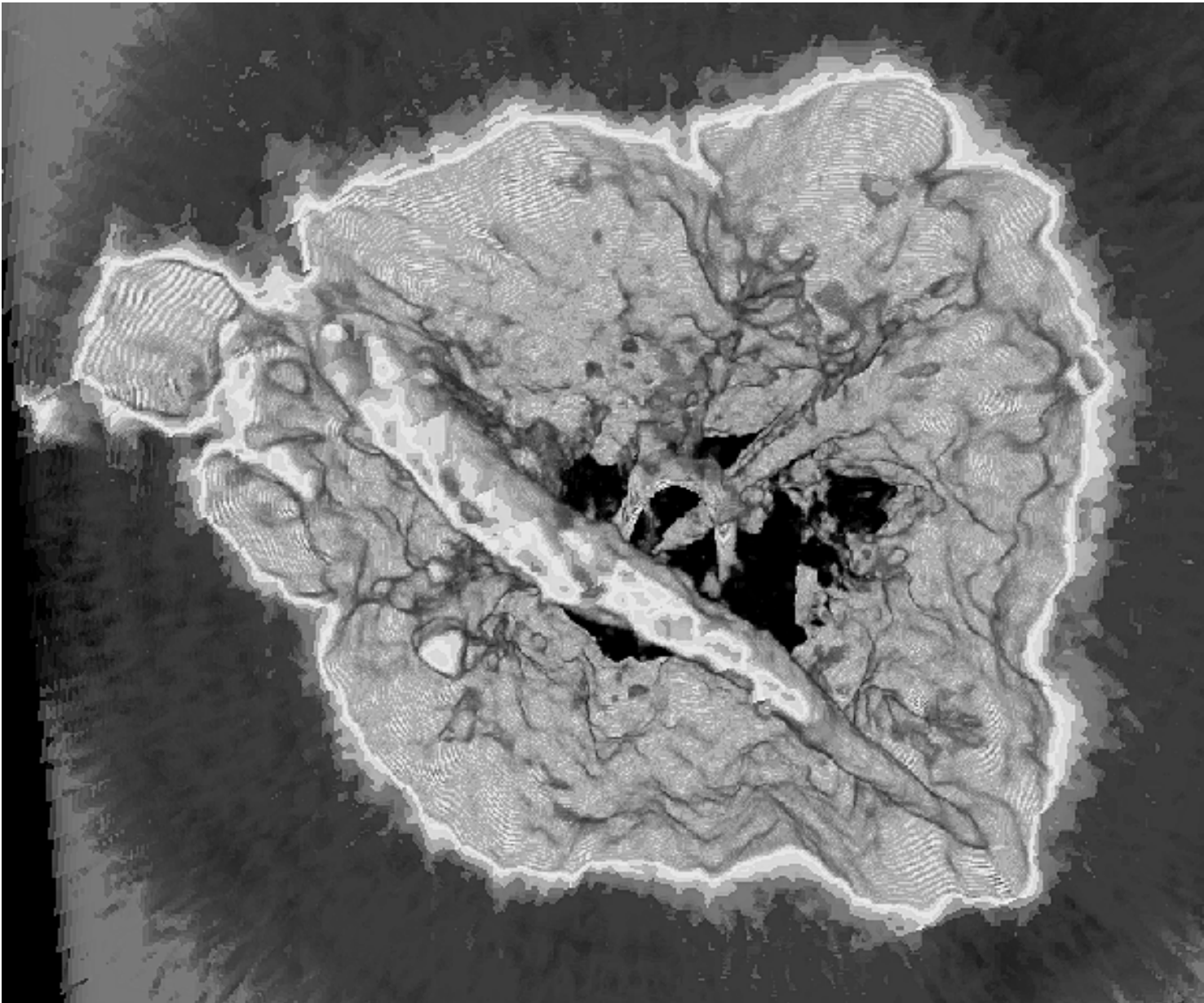


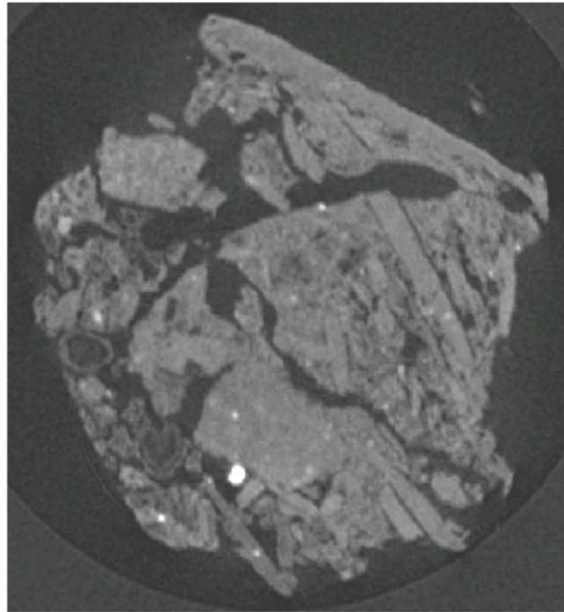
Dangers of cultivation



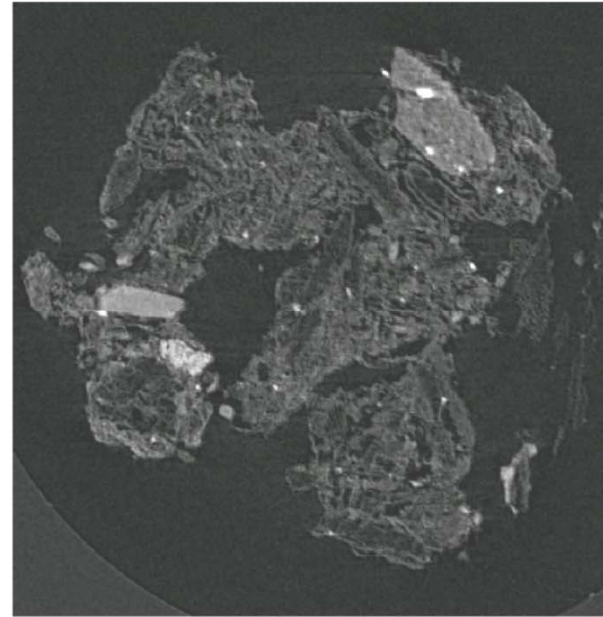
- Loss of organic mass
- Reduction of edaphon activity
- Loss of soil structure
- Thickening
- Sealing
- Erosion





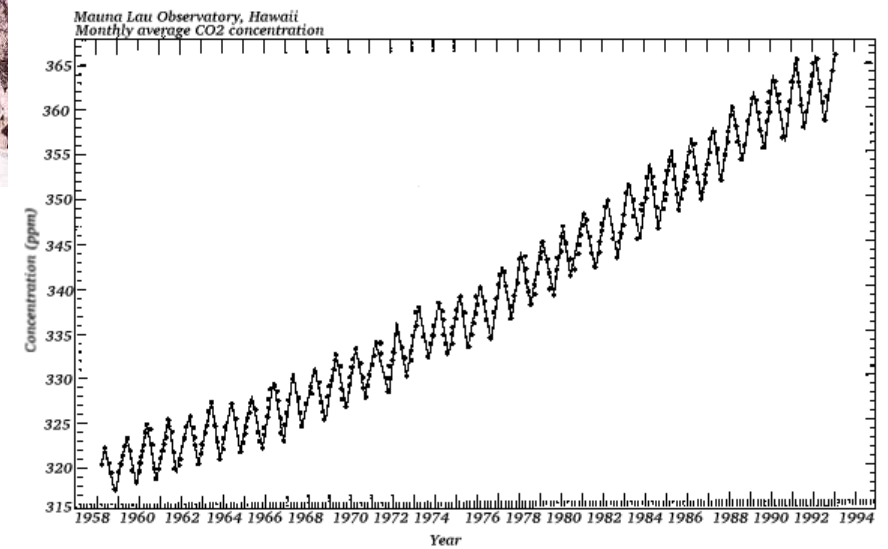
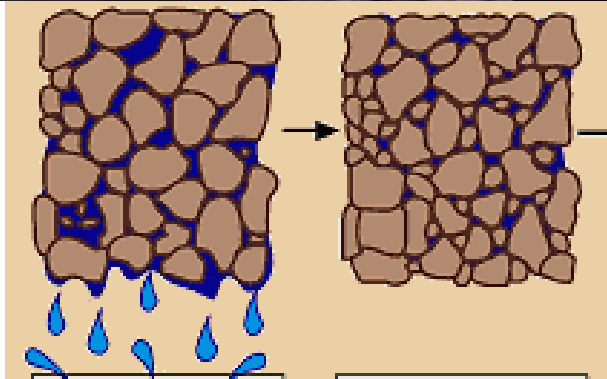
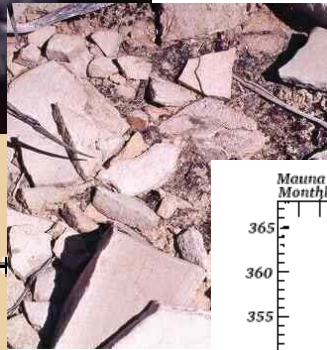
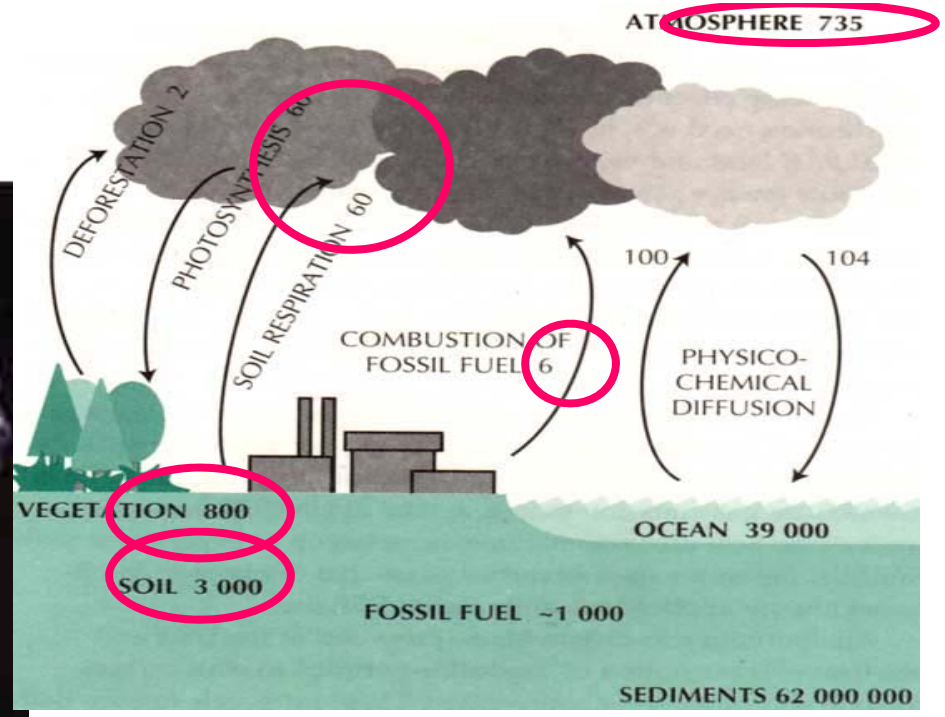
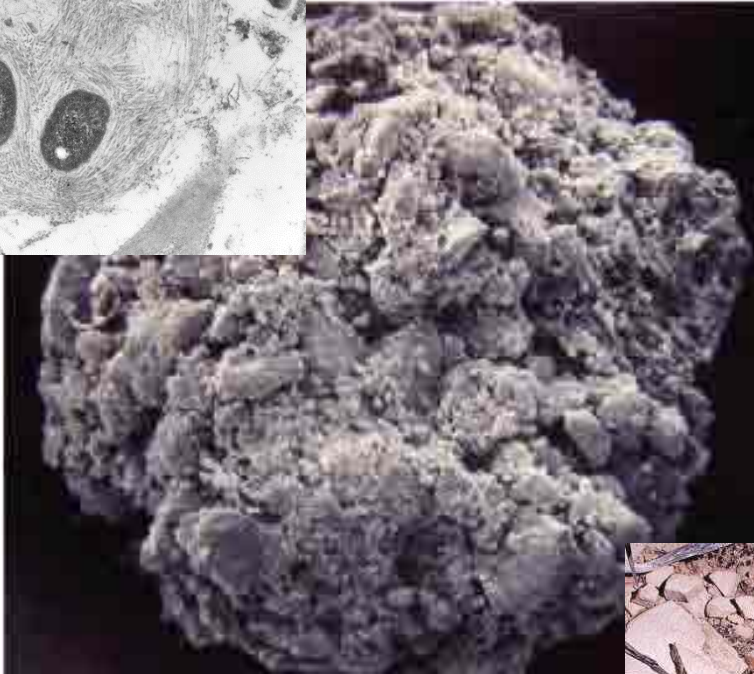
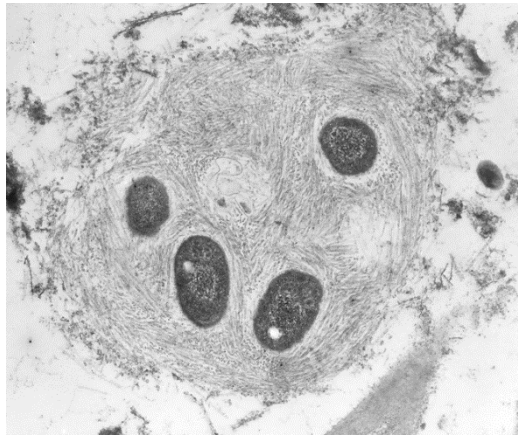


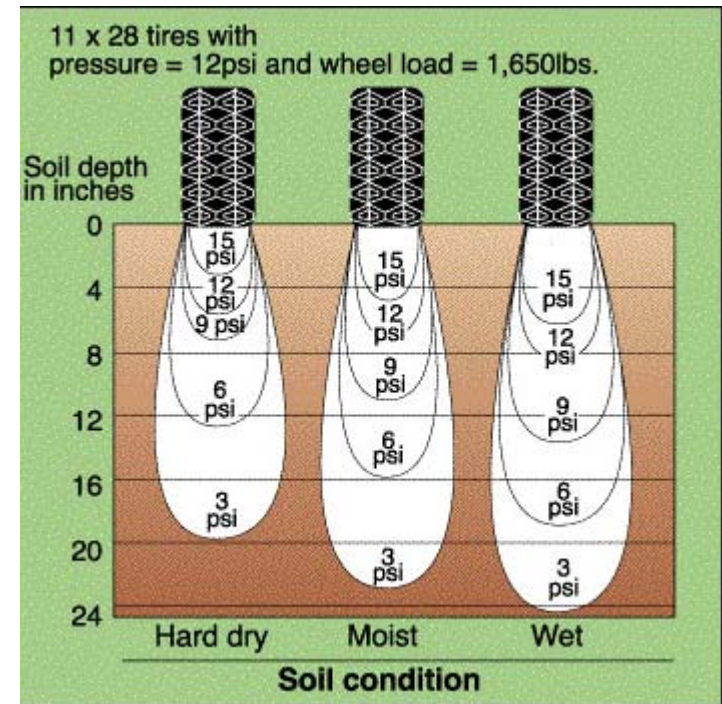
Other aggregates



Earthworm created aggregates

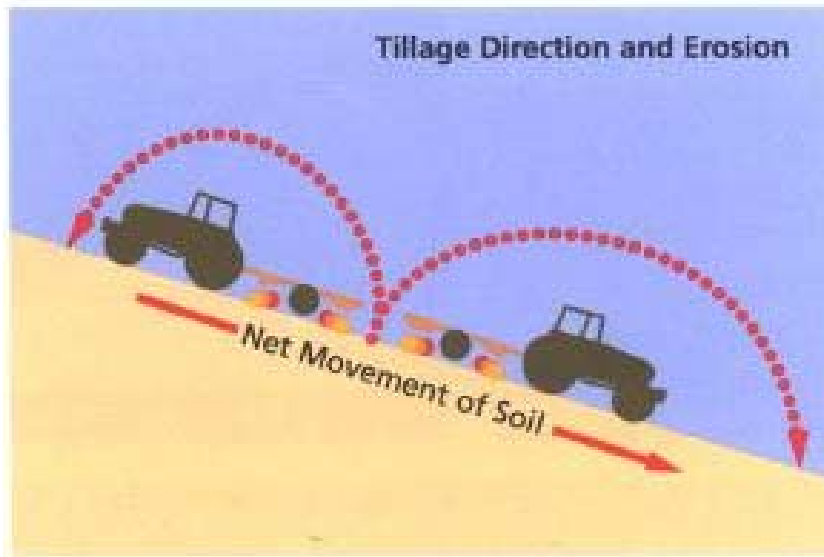
	prismatic	spherical
Light POM	0.34 ± 0.21	0.84 ± 0.55
Bounded light POM	$0.18 \pm 0.12^*$	$1.34 \pm 0.43^*$



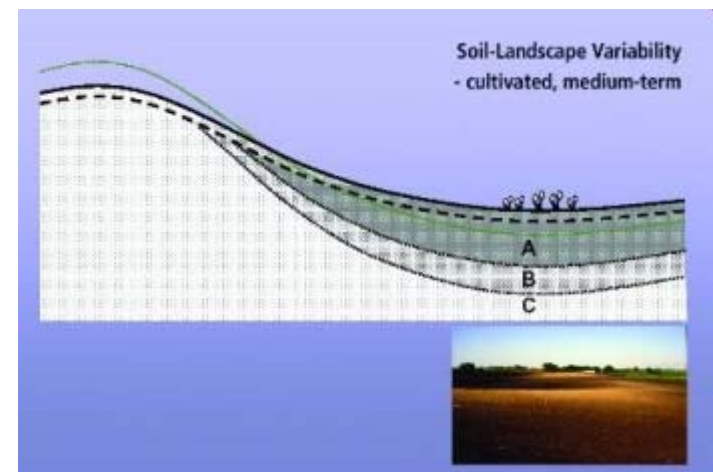
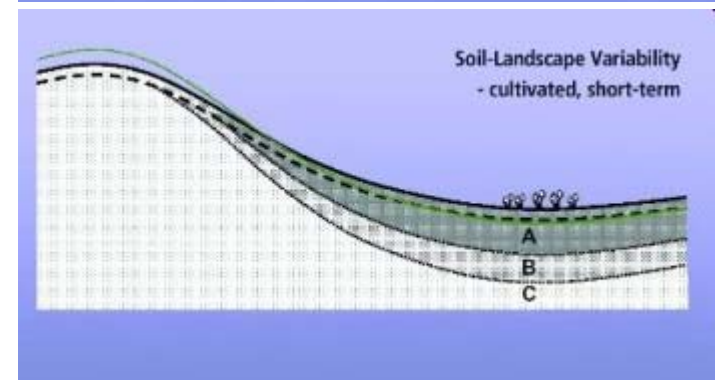
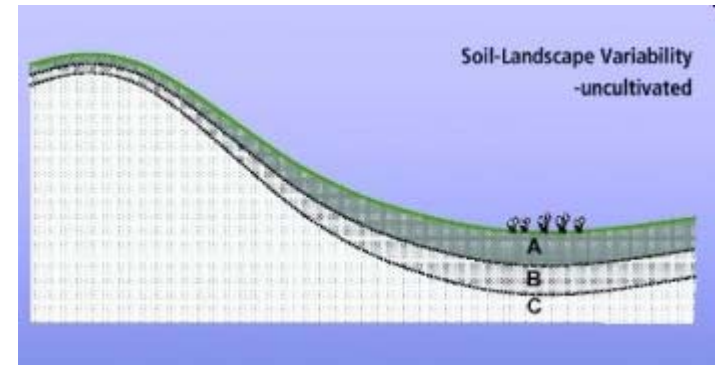


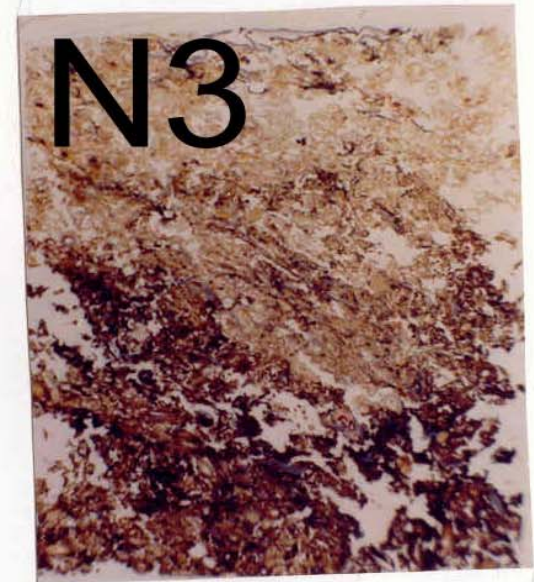
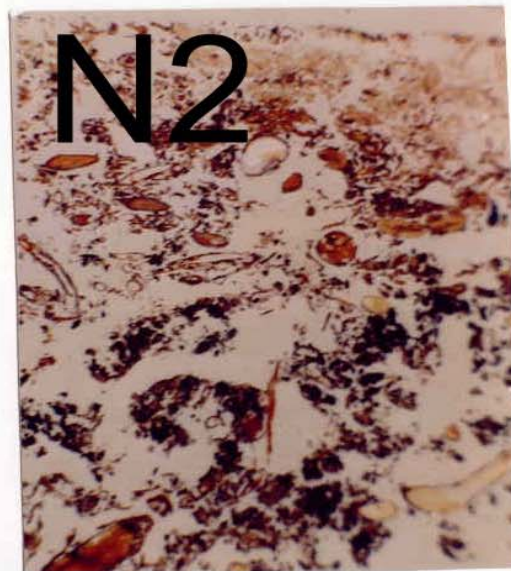
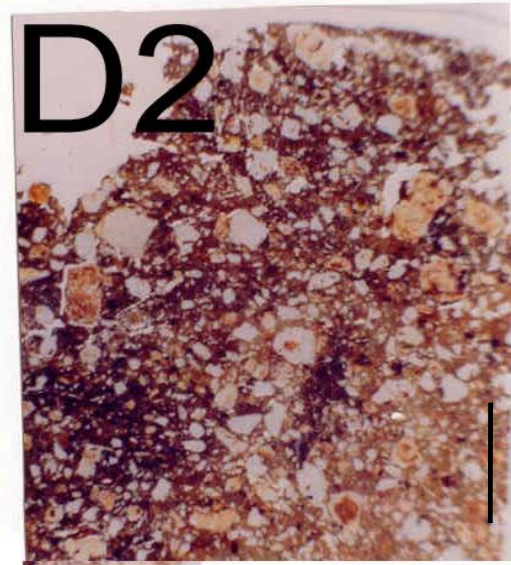
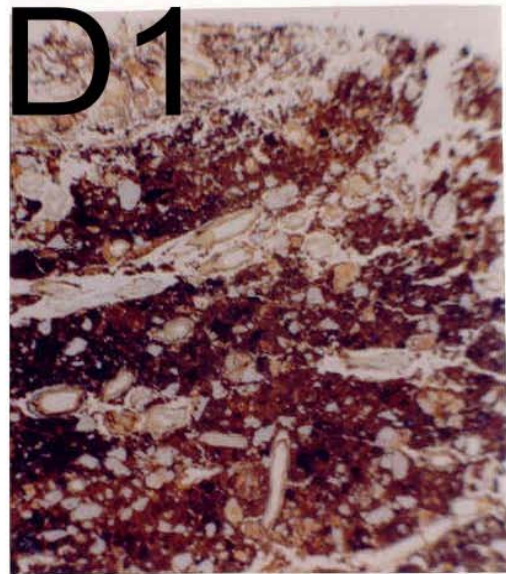
149/2008 Coll. Government regulation on conditions of providing diversification subsidy for sugar beet growers

.. whose measurable pressure on soil does not exceed 200 kPa...



Downhill tillage $25\text{-}30 \text{ kg m}^{-2}$
 Uphill tillage 5 kg m^{-2}

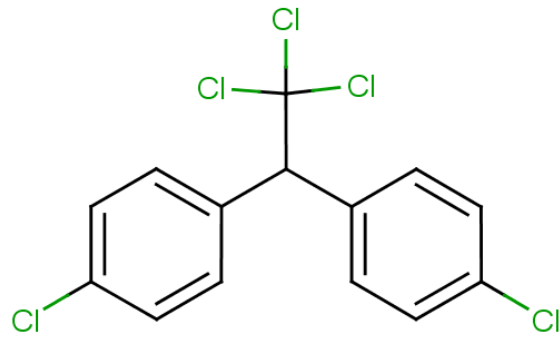




Irrigation



DDT



Paul Herman Muller
Nobel Prize 1948

