PROAGRO LECTORIUM

Ways of saving soil health in different farming systems

Soil health *is a functional biological category of soil ecosystem characterized by* ***metabolism*** *and* ***catabolism of*** *compounds of biophilic elements, including its* ***self-purification*** *from harmful (for biota) substances and alien geobionts.*

Causes of soil health deterioration

1. ECONOMIC
2. Administrative
3. Informational

Economic causes of soil degradation

1. Oil prices rise =>
=> Diesel and gasoline prices rise

2. Electricity and gas prices rise =>
=> Metal prices rise =>
=> Prices for machinery, spare parts, maintenance rise

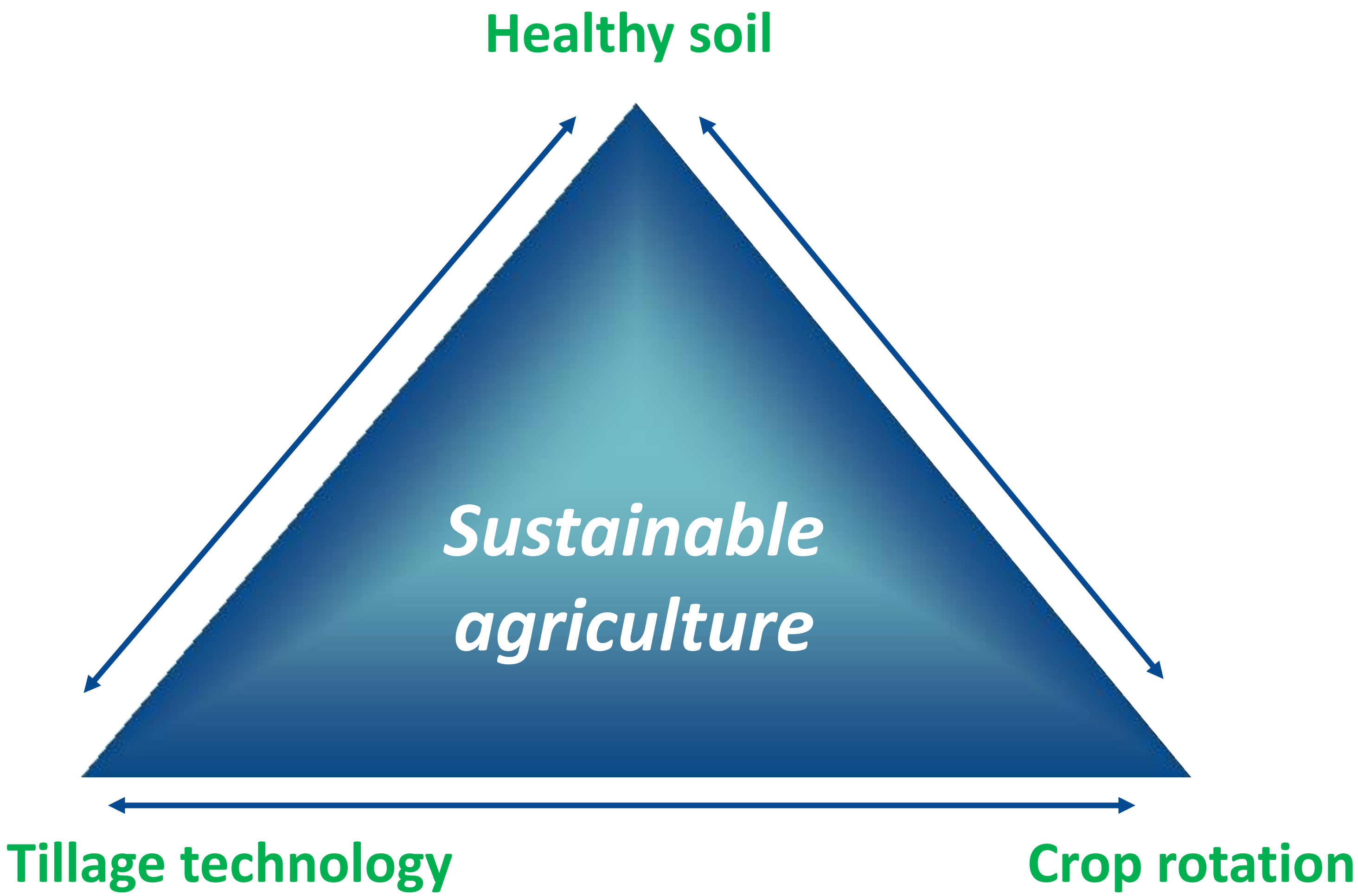
3. Prices for fertilizers and PPA rise

4. Labor prices rise

5. Climate change is rapid =>
=> Droughts frequency increase, periods without precipitation become longer

6. Short-term rotations

BASE FOR SUSTAINABLE AGRICULTURE



Herbicide stress

Herbicides adversely affect plant hormones





Mechanical tillage

- Crop residue embedding
- Seedbed preparation
- Weed control
- Distribution of nutrients in the soil






Tillage technologies

Excessive mechanical tillage damages the soil

Mechanical tillage destroys soil aggregates

Due to excessive mechanical tillage

- Soil pores are reduced
- Infiltration decreases
- Runoff increases

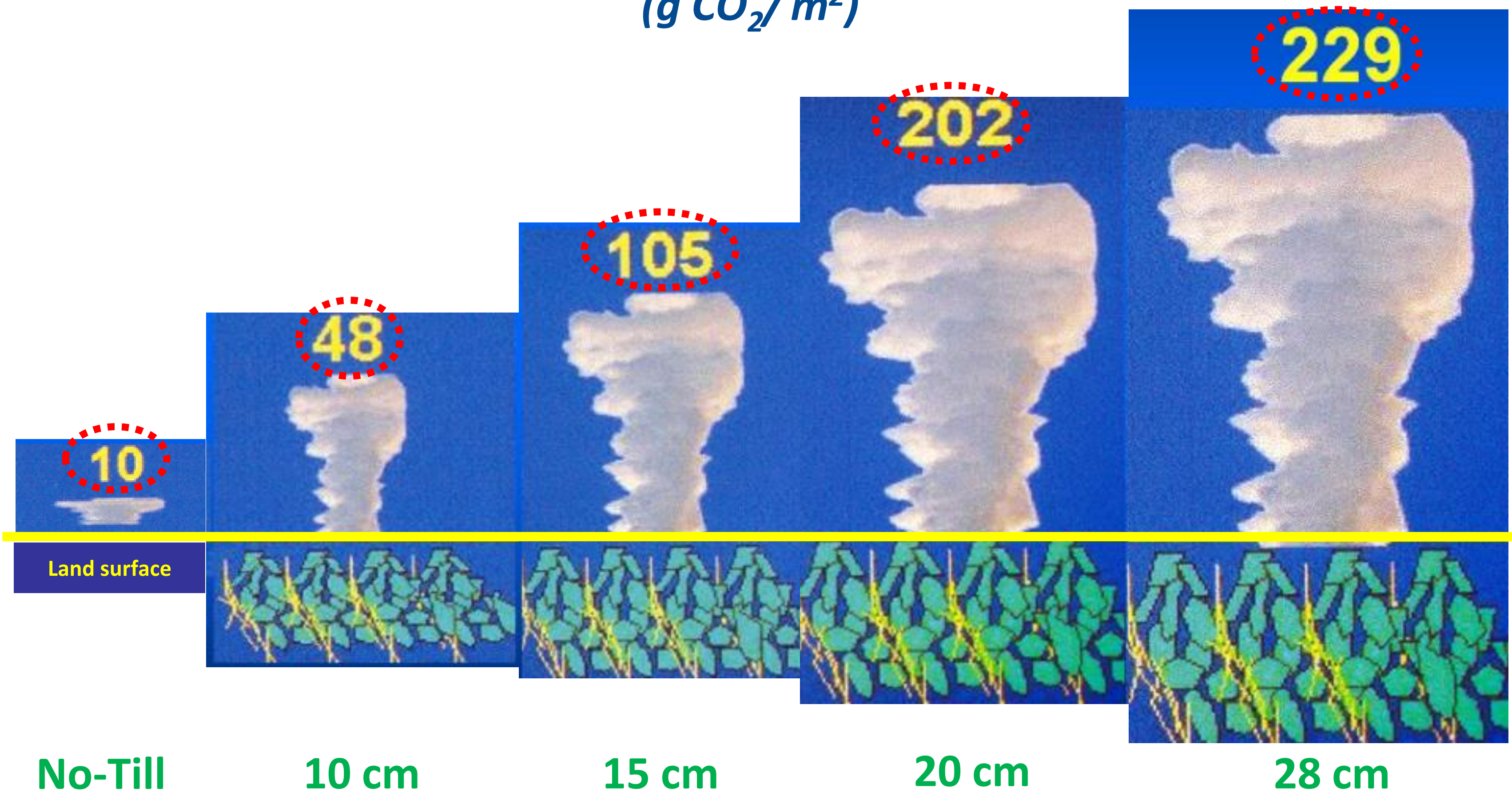
"You cannott make soil with steel." !

David Duke
Farmer, Iowa


20
Plow pan at a depth of 22–23 cm
Compacted, hard to break down clumps

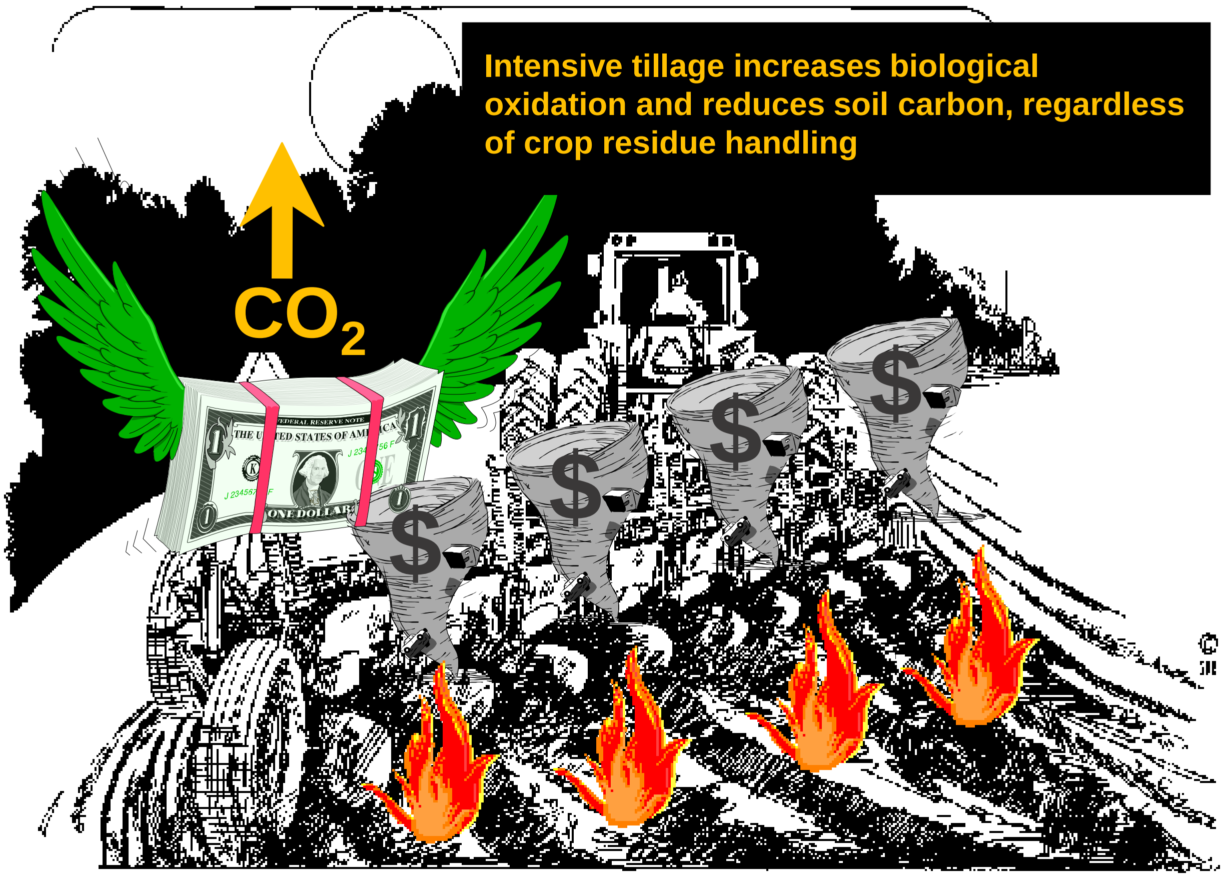
Carbon losses depending on tillage depth

Total carbon dioxide losses during 24 hours
(g CO_2/ m^2)



August 12, 1998. Plowing depth study on a farm in Sven Lake

Soil fertility decrease under intensive tillage



Soil tillage causes biochemical breakdown of organic matter

C accumulation

Loss of C

Under No-tillage carbon is not released to the atmosphere

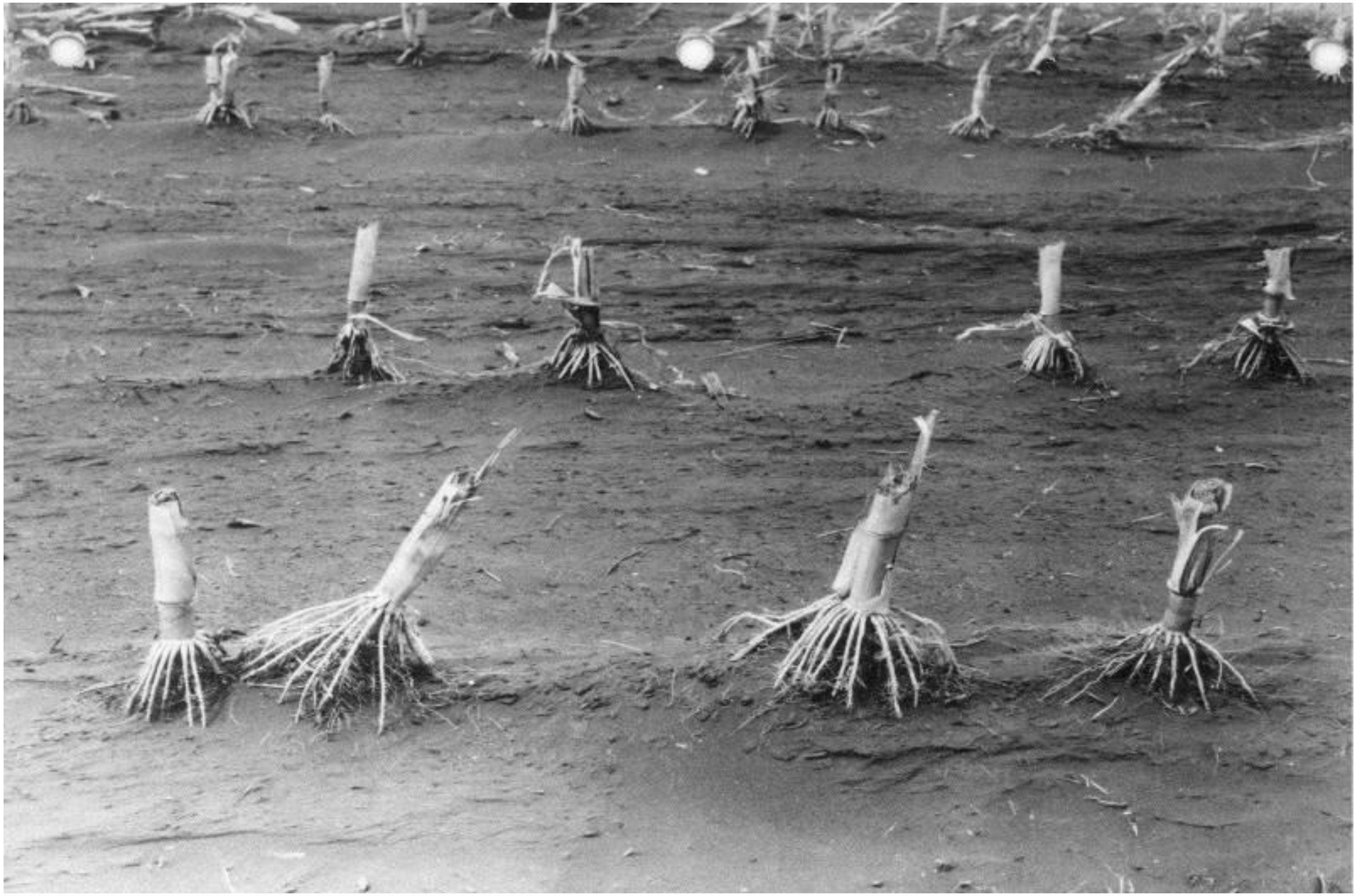
Under mechanical tillage carbon is released into the atmosphere.

(Reicosky, 2005)

Self-recovery capacity and environmental issues

No-till Conference - Kazan, Tatarstan, July 2008

Wind erosion

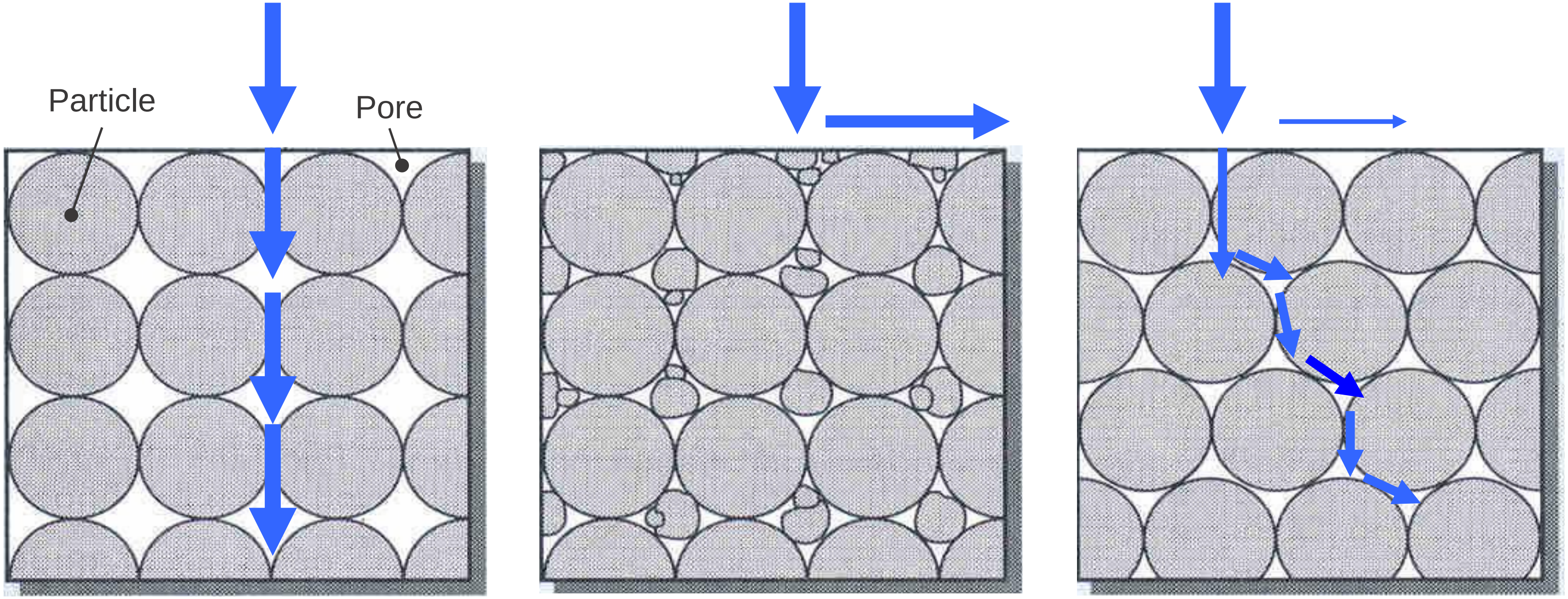


Formation of soil organic aggregates

Necessary conditions for the soil

- Open pores on the soil surface
- Pores remaining open (cloddy-grained soil aggregates)
- Soil surface conditions slowing outflow

Infiltration occurs due to the pores in the soil



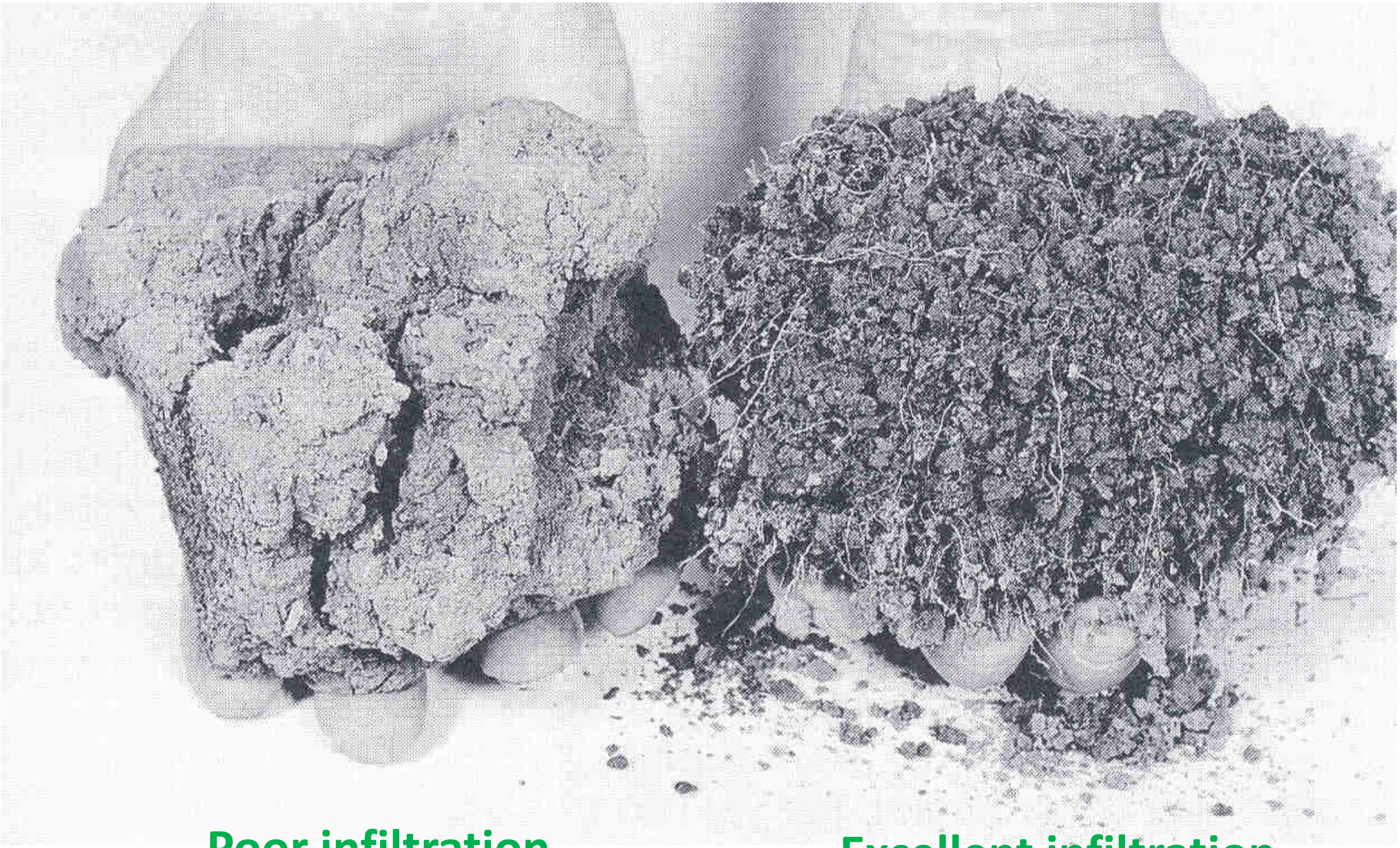
No-Till | Conventional tillage | Minimal tillage

Infiltration is possible | **No infiltration** | **Slow infiltration**

Poor infiltration and drainage lead to crop failure

Damaged soil aggregates

Undamaged soil aggregates



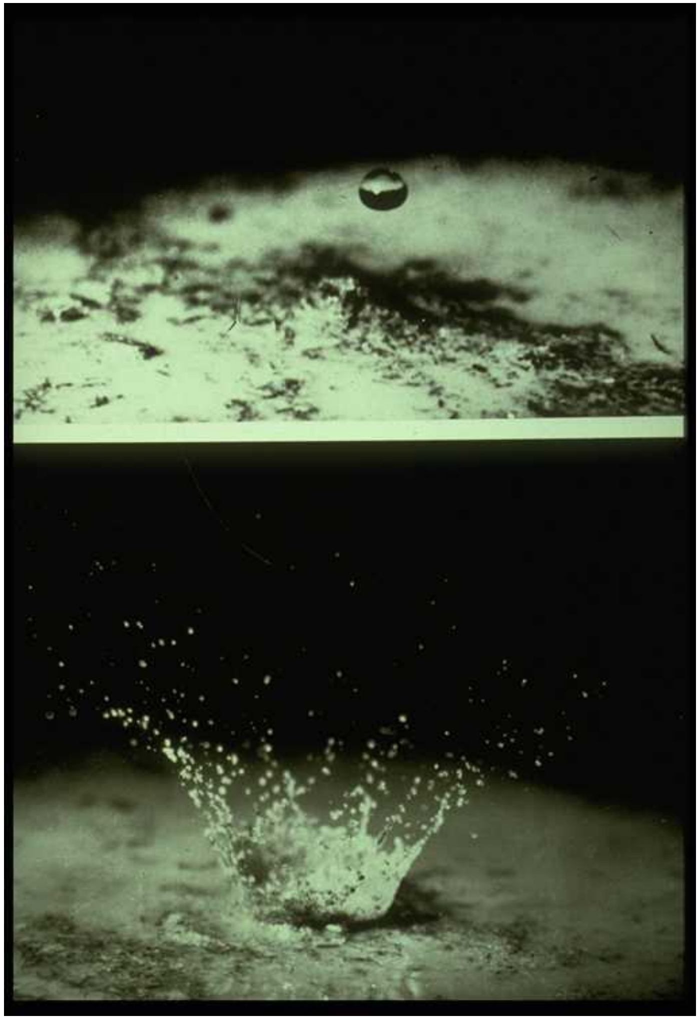
Poor infiltration

Excellent infiltration

Understanding the moisture infiltration process

When it rains, droplets up to 6 mm in diameter bombard the soil surface, falling at speeds of up to 32 km/h. This power scatters soil and water particles in all directions up to a distance of 1 m.

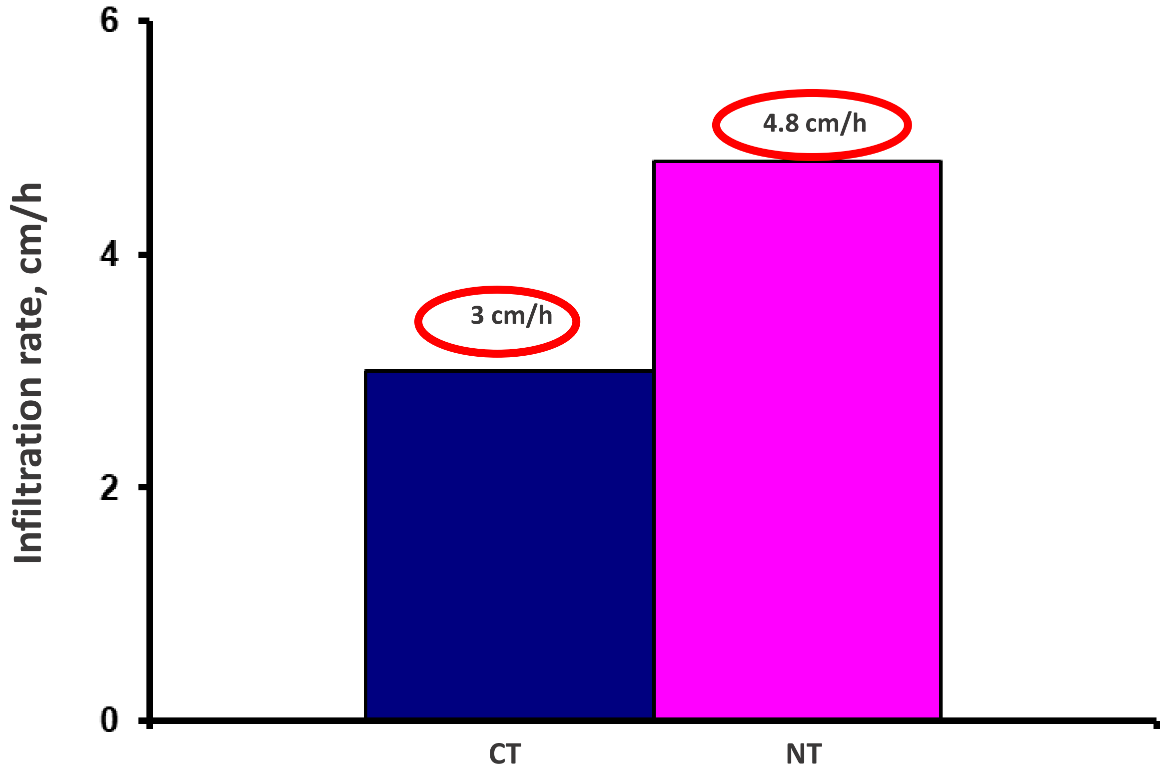
(Derpsch, 2005)



In one year, raindrops transfer energy equal to 50 tons of dynamite (TNT) to one hectare of soil. Falling droplets break down soil aggregates into small particles that clog pores and create a film on the surface that prevents rapid infiltration.

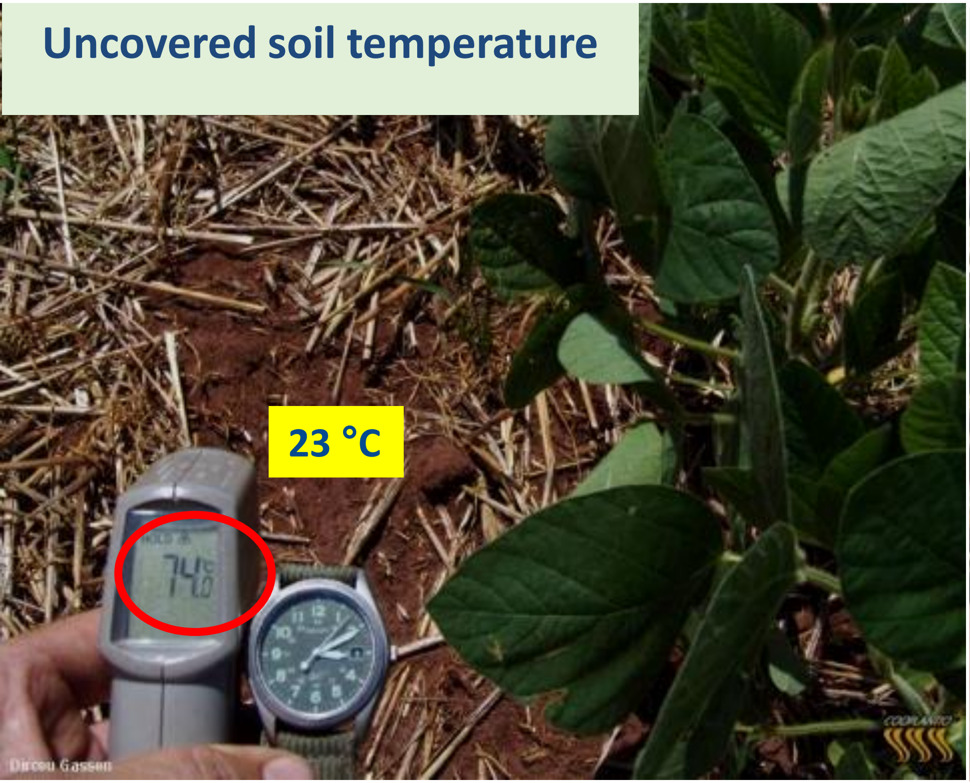
(Meyer and Mannering, 1967 !!!)

Effect of tillage on infiltration



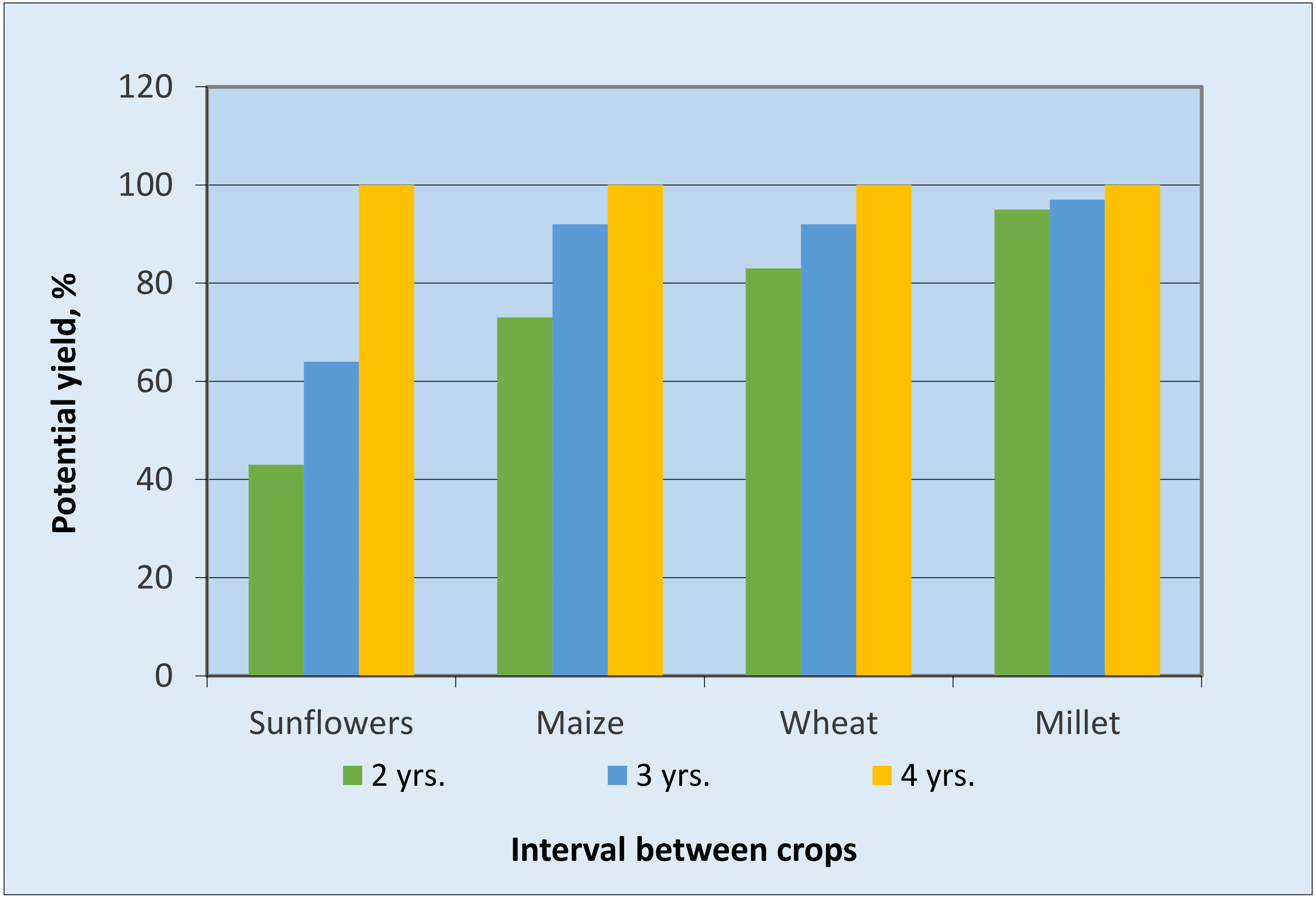
Where ■ CT is conventional tillage and ■ NT is No-Till.

Brian McConkey
Agriculture and Agri-Food Canada
SPARC
Swift Current, SK Canada

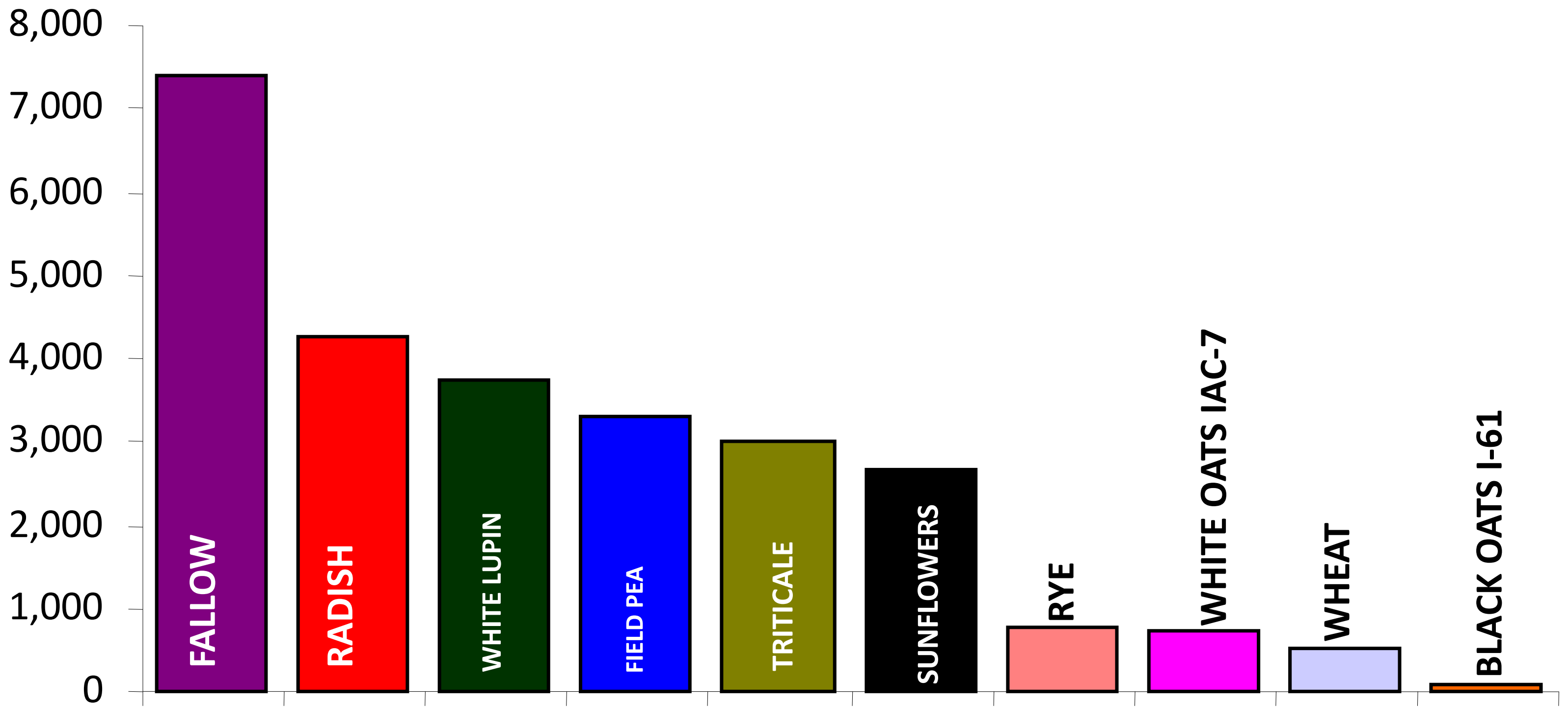

Uncovered soil temperature
23 °C
Dirceu Gassen


Stubble-covered soil temperature
4 °C
Dirceu Gassen

Effect of crop intervals on yields



Effect of green-manure crops for soil cover and fallow on weed growth (dry matter/kg/ha)



COLONIA IGUAZU - PARAGUAY. 1996/97.

Mechanical destruction - fighting the consequences

The Liebig's barrel — the law of the minimum

Liebig's barrel: a deficiency (Liebig's law) or surplus (Shelford's law) of any given factor restricts the action of other components (even if they are in an optimal amount).

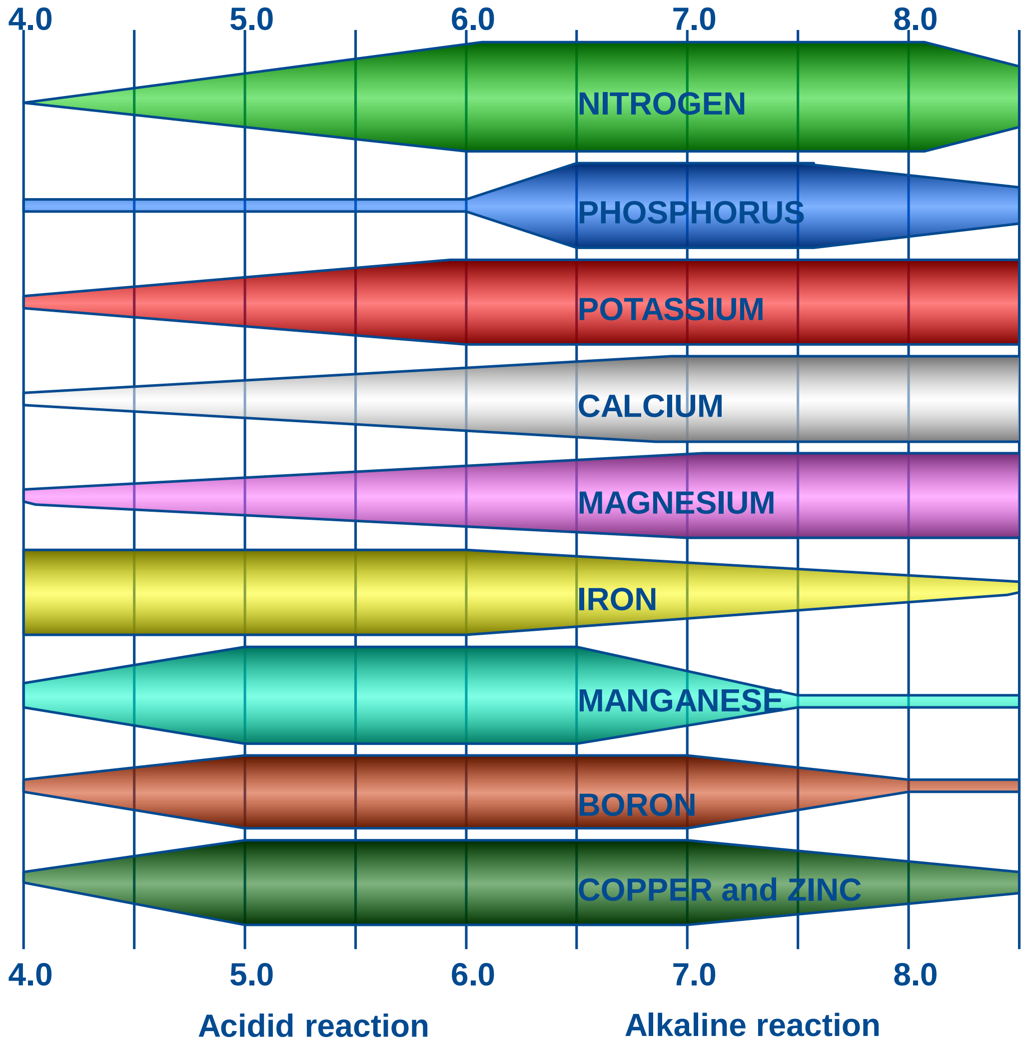
Significant limitation of nutrients' availability

Dependence of basic elements assimilation on soil pH level

pH level	Percentage (%)		
	Nitrogen	Phosphorus	Potassium
4.5	30	23	33
5.0	43	34	52
5.5	77	48	63
6.0	89	52	77
6.5	100	95	100
7.0	100	100	100
7.5	100	70	75
8.0	100	30	45
8.5	78	20	30
9.0	50	5	10

according to the data of Timak Agro Company

Effect of acidity (pH) on the efficiency of crop nutrient uptake by plants



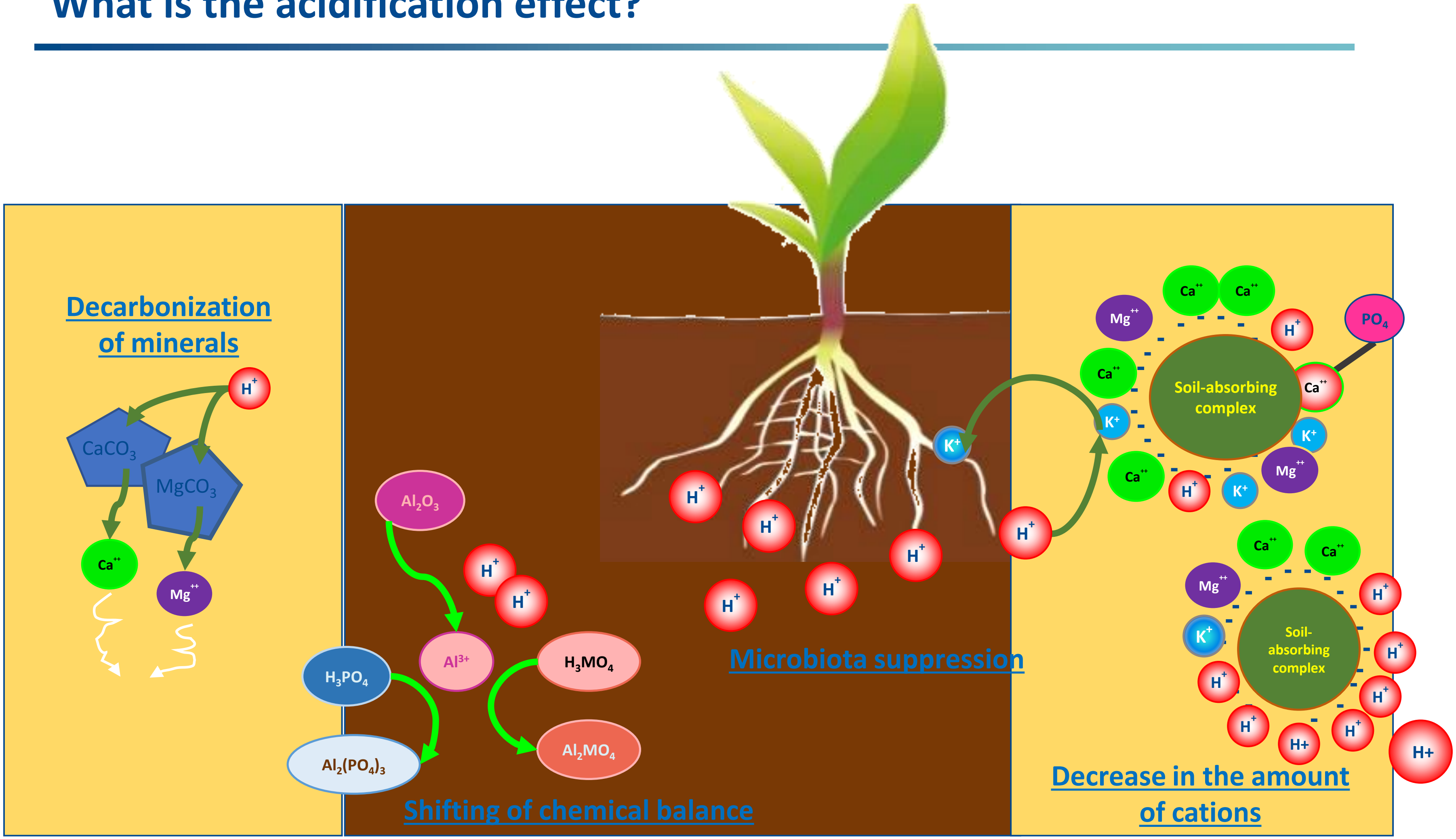
Lime requirements for neutralizing the physiological acidity of fertilizers

Soil acidification due to fertilizer use

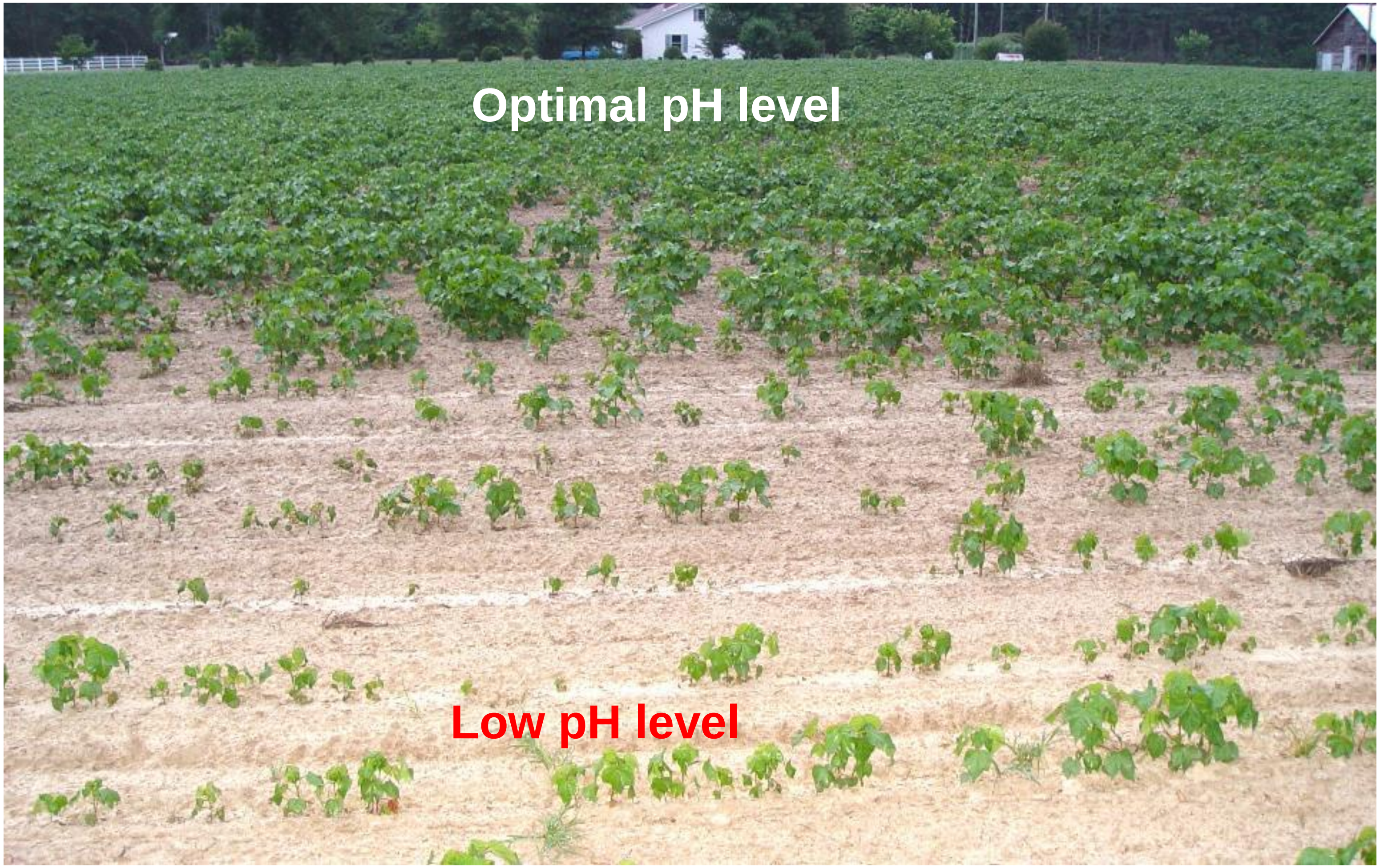
Fertilizer	Nutrient	$CaCO_3$ rate per 1 kg of active substance
Ammonia	82% — N	1.8
Ammonia water	20% — N	1.8
Ammonium nitrate	34,5% — N	1.8
Urea	46% — N	1.8
Ammonium sulfate	20.5% — N	5.4
KCl	60% — K_2O	0
Potassium sulfate	50% — K_2O	0
Superphosphate	20% P_2O_5	0
Triple superphosphate	46% P_2O_5	0

Data by: Bates and Sheard, Universities of Guelph, USA

What is the acidification effect?



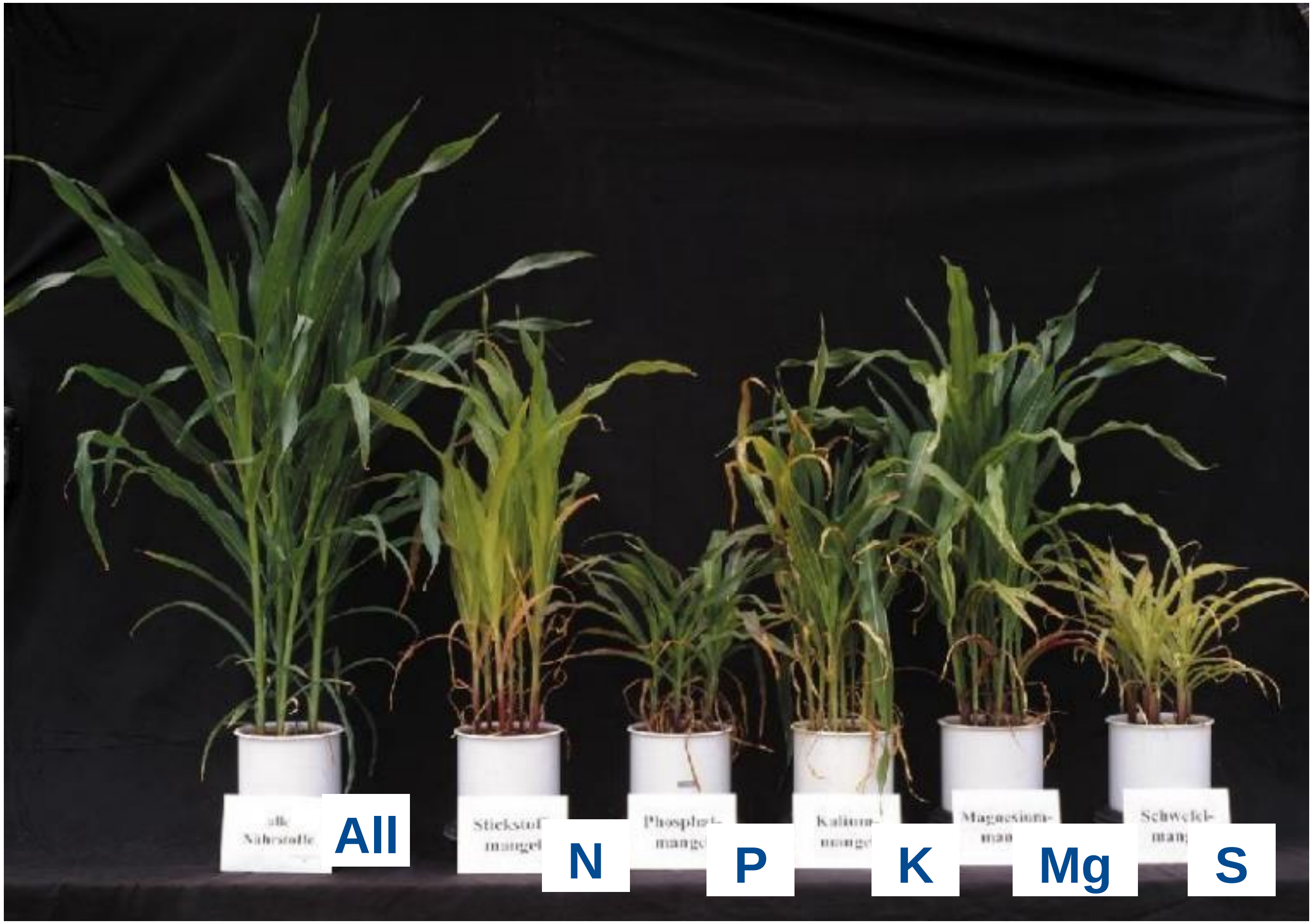
Effect of high soil acidity on cotton growth



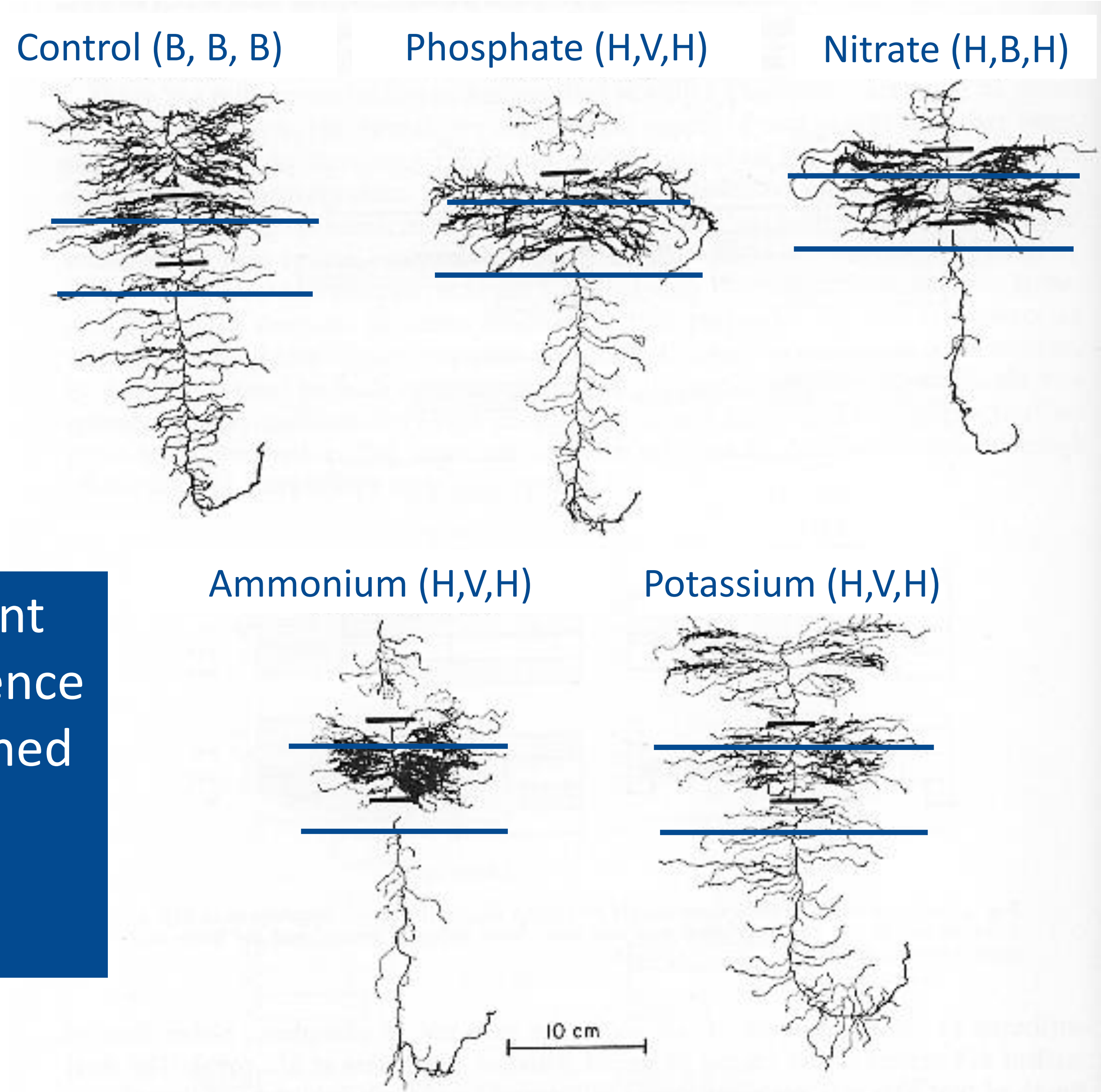
Zinc deficiency due to high soil pH levels

Magnesium deficiency and aluminum toxicity on maize — low soil pH level

A deficiency in any of the elements results in substantial crop loss

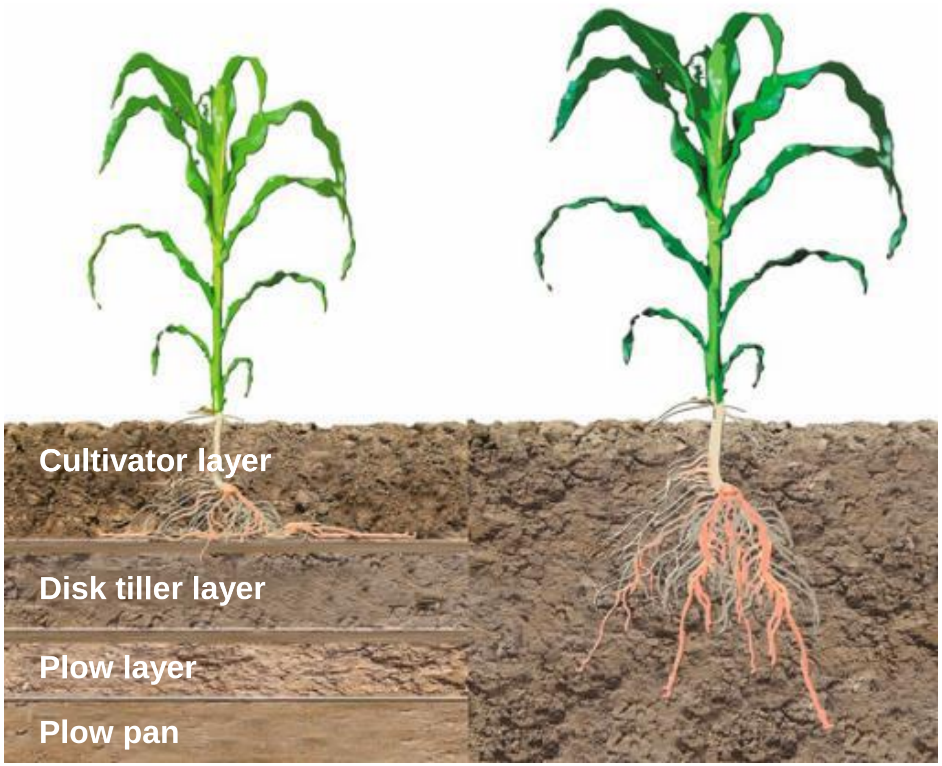


according to YARA



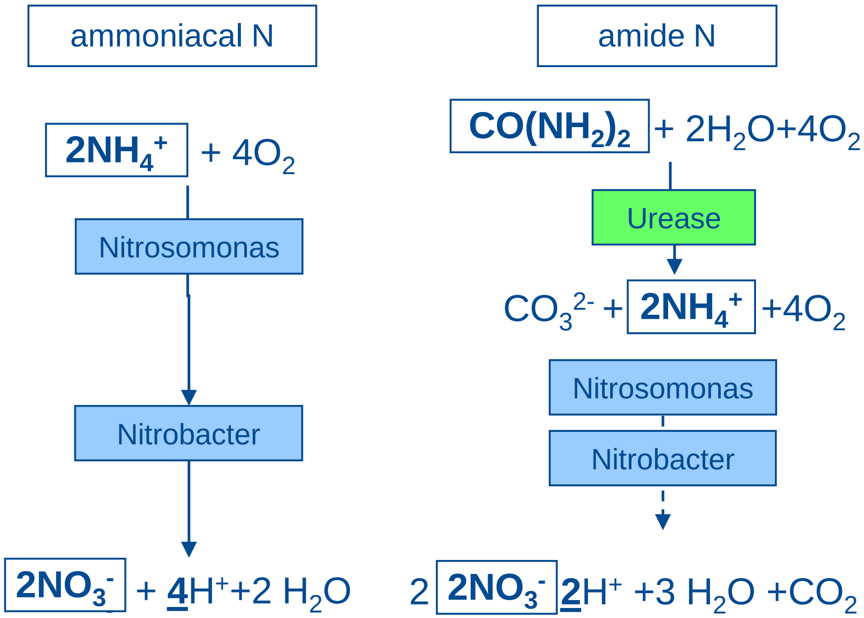
Response of plant roots to the presence of nutrient-enriched areas.
Drew, 1975

Soil compaction issues and root system growth



Nitrogen: Transformation in soil

High rate of transformation compared to plant uptake



Time required for nitrogen transformation

T°	Hydrolysis 100%	Nitrification 100%	NO3 access 100%
< 2 °C	0	0	0
5 °C	14 d	10 d	15–25 d
10 °C	8 d	7 d	8–15 d
15 °C	5 d	5 d	5–10 d
20 °C	4 d	4 d	5–8 d

Source: Remi, INRA 1993 and De Neeve, Gembloux 2002

All forms of nitrogen are transformed into nitrates.

The rate of transformation depends on:

- Temperature
- pH (neutral)
- Soil type and bacterial activity

Application of liquid mineral fertilizers

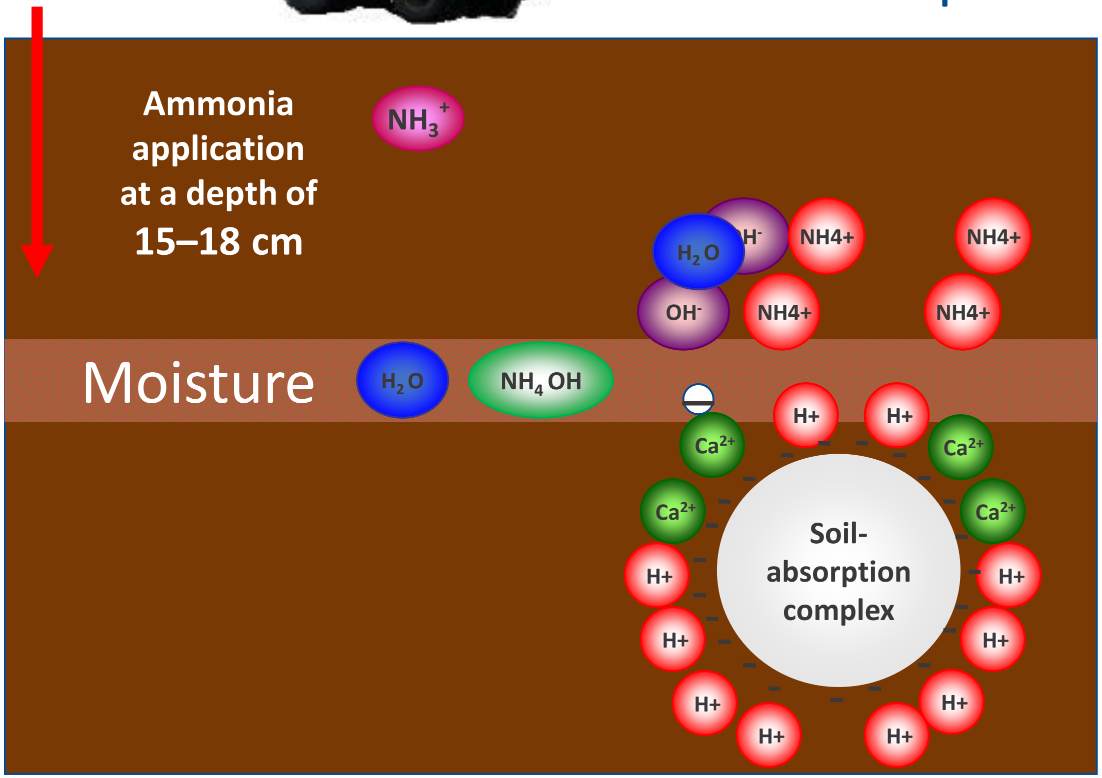
Liquid mineral fertilizers

1. Urea-ammonia mixture — UAN-32
2. Ammonia — 82.3% N
3. Liquid complex fertilizers — LCF 11-37-0

Ammonia utilization concept

Technology of liquid mineral fertilizer application

The application of liquid ammonia fraction allows to expand the possibilities



Addressing the issue of pests in the soil

Fertilizer application with a deep ripper

Application of manure slurry

Solutions

Amelioration

Mechanical break down

Maize responds to lime application on low pH soils

Phosphogypsum application

Issues of moisture preservation and optimal soil density

Issues of moisture preservation and optimal soil density

Moisture horizon 4–5 cm

Moisture horizon 10–12 cm

Field experiment sunflowers the Saratov Oblast Boghara

	Option	Yield, dt/ha	Moisture, %	Yield reduced to 7%, dt/ha
Control phosphogypsum, no fertilizer	1	10.2	6.3	10.3
	2	10.1	6.2	10.2
	3	10.8	6.7	10.8
	4	11.4	6.4	11.5
	5	11.6	6.5	11.7
	6	10.5	6.8	10.5
	7	10.3	6.7	10.3
Average		10.7	6.5	10.8
Control	1	5.2	5.8	5.3
	2	5.6	6.1	5.7
	3	4.3	6.3	4.3
	4	4.7	6.2	4.7
	5	4.9	6.3	4.9
	6	5.4	6.2	5.4
	7	5.7	6.4	5.7
Average		5.1	6.2	5.2

	Yield, dt/ha	Increase (decrease), dt/ha
Control	5.24	
Metabacterin	10.82	5.58
LSD01	0.64	
LSD05	0.42	
LSD10	0.34	

Field experiment maize the Saratov Oblast Boghara

Maize yield tillage 16:20(12) field phosphogypsum				
	Option	Yield, dt/ha	Moisture, %	Yield reduced to 14%, dt/ha
Control with no fertilizer and phosphogypsum	1	10.4	14.1	10.4
	2	11.3	14.7	11.2
	3	7.2	10.2	7.5
	4	11.7	14.7	11.6
	5	12.4	15.1	12.2
	6	12.8	14.9	12.7
	7	8.7	10.8	9.0
Average		10.6	13.5	10.7
16:20(12)+ urea + ammonium sulfate	1	34.4	15.9	33.6
	2	37.2	15.2	36.7
	3	32.4	15.6	31.8
	4	34.9	15.4	34.3
	5	30.1	14.8	29.8
	6	36.4	15.6	35.7
	7	39.3	15.9	38.4
Average		35.0	15.5	34.3

	Yield, dt/ha	Increase (decrease), dt/ha
Control	10.66	
16:20(12)	34.30	23.67
LSD01	4.75	
LSD05	3.14	
LSD10	2.49	

Mazie yield tillage 16:20(12) field with no phosphogypsum				
	Option	Yield, dt/ha	Moisture, %	Yield reduced to 14%, dt/ha
Control	1	10.4	14.1	10.4
	2	11.3	14.7	11.2
	3	7.2	10.2	7.5
	4	11.7	14.7	11.6
	5	12.4	15.1	12.2
	6	12.8	14.9	12.7
	7	8.7	10.8	9.0
Average		10.6	13.5	10.7
16:20(12)+ urea + ammonium sulfate	1	14.8	14.2	14.8
	2	15.2	14.1	15.2
	3	12.8	11.7	13.1
	4	13.9	14.4	13.8
	5	15.7	14.8	15.6
	6	14.1	13.8	14.1
	7	16.1	14.9	15.9
Average		14.7	14.0	14.6

	Yield, dt/ha	Increase (decrease), dt/ha
Control	10.66	
16:20(12)	14.64	3.99
LSD01	2.65	
LSD05	1.75	
LSD10	1.39	

Effect of phosphogypsum on maize yields

Option (v)	Yield due to frequency, reduced to 14%, dt/ha						
Control	0.0	0.0	0	0	0	0	0
Phosphogypsum 4 t/ha	32.5	45.7	38.4	44.8	44.3	47.1	42.2
phosphogypsum 10 t/ha	51.7	59.4	53.2	59.7	55.8	57.6	55.1

	Yield, dt/ha	Increase (decrease)
Control	0.00	
Phosphogypsum 4 t/ha	42.14	42.14
phosphogypsum 10 t/ha	56.07	56.07
LSD01	4.42	
LSD05	3.12	
LSD10	2.56	

Self-recovery through ensuring soil health

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