BODEN
ökologie analytik landschaft
TB UNTERFRAUNER GMBH

BUFFERING SYSTEMS

...more than just a pH value

www.bodenoekologie.com

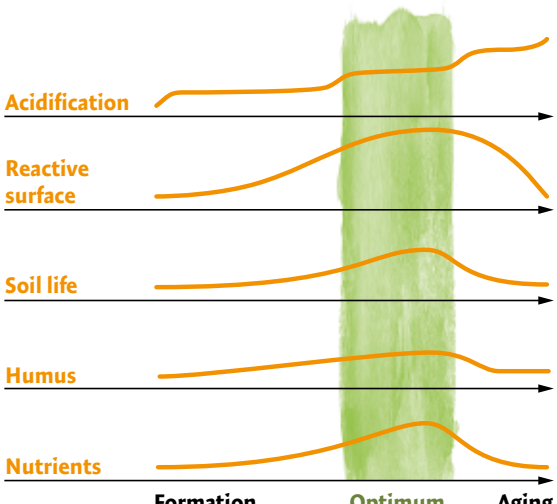
Acidification is vital

Acidification is the driving force behind soil development and affects the availability of nutrients, soil structure and the living conditions of plants and microorganisms.

If acidification **exceeds** a certain limit, soil fertility and other soil functions are at risk!

Knowledge of the buffering system and its targeted influence (e.g. supply of neutralizing or acidic substances) are a key factor in ecological management and economic success!

Soils are dynamic ecosystems



Soils are increasingly under pressure

Society demands a variety of soil services:

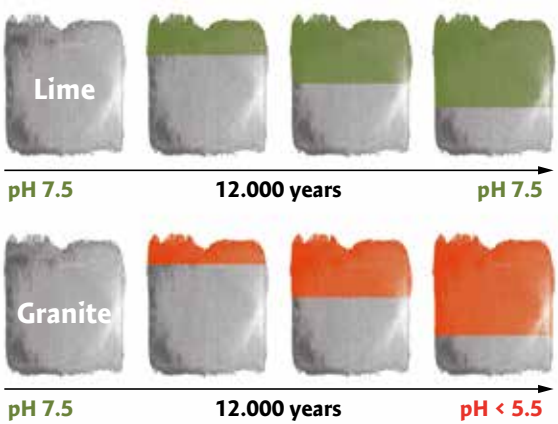
- Production of food
- Production of energy crops
- Buffer for rainwater
- Filter to protect water quality
- Sequestration of carbon

Due to heavy use without adequate care measures, over 80% of the soils are already in the degradation phase!

Often the acid buffering capacity needs to be increased!

Soils are different

Whether and how quickly a soil acidifies depends strongly on the parent material of soil formation.



Buffering capacity

The pH of the soil does not change **linearly**.
Acids but also **bases** can be buffered in the soil.
If one buffering system is exhausted and the soil changes over to the next one, the pH value changes **suddenly**.

Our agricultural soils have been subject to the influence of acids for around 12,000 years.

Soils with a large **buffering capacity** (calcareous soils) are still in the neutral pH range. Soils with low buffering capacity (soils formed on granite, gneiss, sand, ...) often have pH values in the acidic / strongly acidic range.

Acidification sum per hectare and year

Part of the acid load (H^+) in soils comes from atmospheric inputs. The much larger part is created in the soil through biological and chemical processes.

Precipitation	**1 to 5 kg H^+**
Soil respiration	**up to 10 kg H^+**
Root exudates	**0.4 to 2 kg H^+**
Oxidation processes	**1 to 8 kg H^+**
Total acid load	**12 to 25 kg H^+**

Compensatory measure

As a compensatory measure to neutralize the annual acid load, the supply of 360 to 750 kg / ha carbonate (CO_3^{2-}) is necessary. This corresponds to 600 to 1250 kg $CaCO_3$! The mixture of different carbonates has very beneficial effects, e.g. from lime and dolomite.

In the case of soils in a state of equilibrium, the supplementation is sufficient every 3 years.

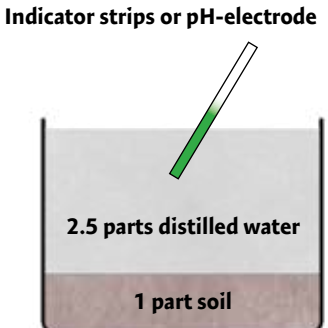
12 to 25 kg H^+ = 360 to 750 kg CO_3^{2-}

↓

600 to 1250 kg/ha

Mixture of lime und dolomite

Soil pH in water



Field method: One volume unit of soil is shaken with 2.5 volume units of distilled water. In the supernatant solution, the pH value is determined.

Significance

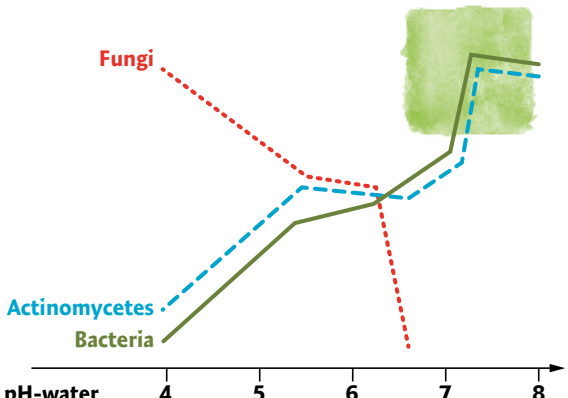
The pH value in the water comprises the sum of the **dissolved acids in the soil solution**, mainly carbonic acid, oxalic acid, malic acid, and citric acid.

Microorganisms live in the water films on the surfaces of mineral and organic soil parts.
The range of species, the number of individuals and their activity depend on the acidic environment.

Nutrient species: Depending on the acidic environment, substances carry a different number of charges. The lower the charge, the easier the nutrient is absorbed by plants (see phosphorus).

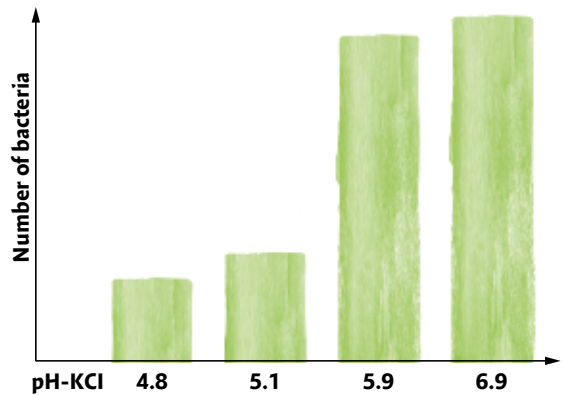
pH in water: optimum 6.5 to 7.5

Soil pH in water and biological activity



pH in water: optimum 6.5 to 7.5

Soil pH in KCl and number of bacteria



pH in KCl: optimum 5.9 to 6.9

Soil pH in neutral salt (KCl or $CaCl_2$)

Field method: The soil sample is flooded with indicator liquid (KCl plus color indicators). The potassium (K) mobilizes exchangeable acid in the soil, which leads to a color reaction.

Significance

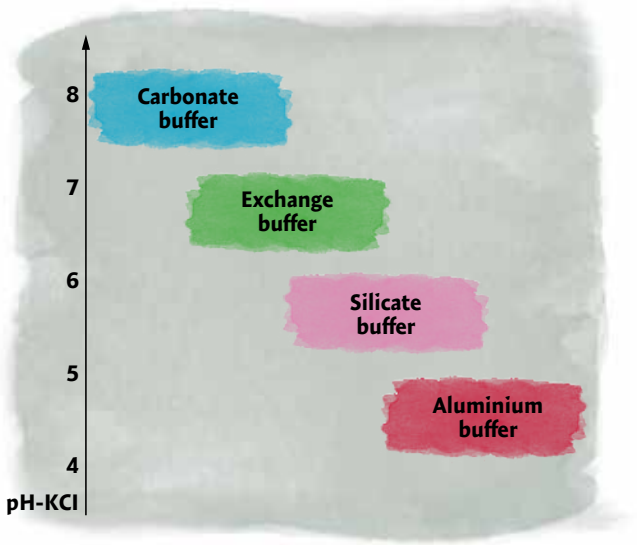
In addition to the dissolved acids (see pH in water), the pH value in neutral salt also includes the exchangeable elements H^+, Al^{3+}, Fe^{2+}, Mn^{2+}, which form acids after the exchange from the sorption sites of the cation exchange complex (exchangeable acids).

The pH in KCl is used to classify the current buffering system of a soil

The determination of pH in KCl is NOT enough for a liming recommendation

Optimum 5.9 to 6.9

Buffering systems act like a cascade



Soil pH buffering systems

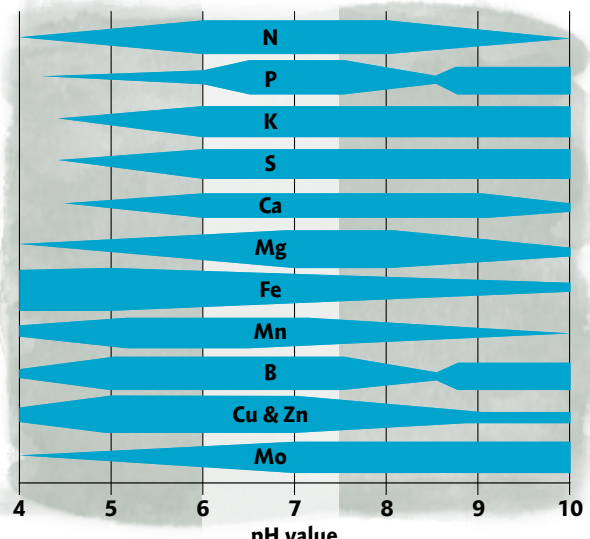
The pH in KCl indicates in which buffering system a soil is located. However, no assumptions can be drawn on the exact buffer capacity!

Carbonate buffer: Carbonates in the soil (calcareous soils) neutralize acids quickly. The dynamic processes are limited. Apply **acidifying** measures!

Exchange buffer: Ideal range to be aimed for / to be maintained, favorable for most soil functions. Acid is attached to the cation exchange complex (buffered) through exchange processes, while nutrients (Ca, Mg, K, ...) become mobilized at the same time.

Silicate buffer: From pH-KCl <5.5, aluminum (Al) begins to loosen from the silicates, clay minerals disintegrate! **Acute** for action!

Availability of nutrients



Soil pH and nutrients

The pH value affects the **availability** and solubility of nutrients and harmful elements as well as their storage and displacement in the soil.

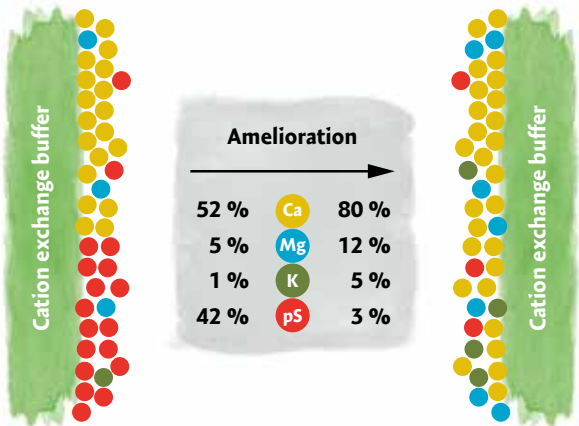
In the **neutral** range, the absorption of calcium, magnesium, phosphorus, nitrogen, sulfur, potassium and boron is very efficient.

In the **acidic** range, iron, copper, zinc and manganese are readily available.

In the **alkaline** range, the availability of molybdenum increases.

The optimal utilization of all nutrients occurs at pH values between 6.0 and 7.5

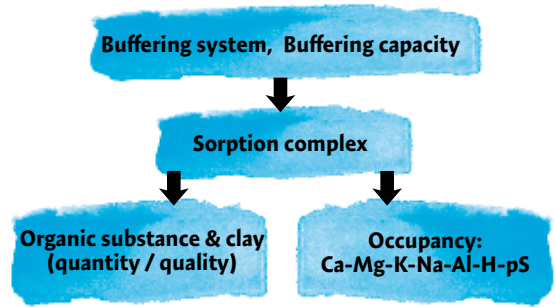
Adjustment to the location



A specific mixture of dolomite / gypsum / calk neutralizes potential acids (pS) and transfers the pH value into optimum ranges for Ca, Mg and K.

Analytical assessment of the acid system

pH values are sum parameters (compared to e.g. corporal temperature in humans). To understand the reactions and derive apt measures, additional parameters must be assessed.



One method particularly suitable for this evaluation is the **Fractionated Soil Analysis**.

Dolomite / gypsum / calc

DGC neutralizes **acids**, optimizes the **sorption complex** and contributes significantly to the calcium, magnesium and sulfur supply of the crops on **lime-free** and **calcareous soils**.

The application can take place year-round, e.g. in autumn on pasture (wintering).

Amelioration

Based on the results of the Fractionated Soil Analysis, an individual mix of finely ground DGC is provided.

Reactivity: The effect occurs through reactions on the surfaces. Finely ground products react much faster than coarser products.

Grain size	Grain size	Grain size
1 - 2 mm	0.1 - 1 mm	< 90 µm
Surface	Surface	Surface
0.00113 m^2/g	0.0113 m^2/g	1.13 m^2/g

Avoiding lime shock: The components of the DGC mixture react at different speeds due to their chemical formulation and thereby prevent overloads.

AKRA
Karner Düngerproduktion

Strengthening the buffering capacity

No general, imprecise liming! The products and quantities must be customized to the respective soil parameters. A specific mixture of high-quality dolomite / gypsum / calcium carbonate promotes and maintains soil fertility.

www.duenger-akra.at

Ecological & Economical

Problem: Acidified, degraded areas hardly produce any yield and are often neglected in the operational plan of agricultural endeavours.

Consultancy / Analysis: Service staff members of the AKRA fertilizer production evaluate the situation on site. A **Fractional Soil Analysis** may be necessary to assess the initial situation.

Implementation: Based on the analysis results, an individual mixture of DGC is calculated and composed for amelioration.

Success: Through the consistent implementation of the AKRA fertilization system, degraded areas can be reconsidered in the operational management plan and deliver high yields.