16. P-K Symposium 2020

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Situation of agriculture
Soil – Climate - Water
Fractionated analysis
Sulfur - nitrogen - slurry application
AKRA in practice

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Situation of agriculture

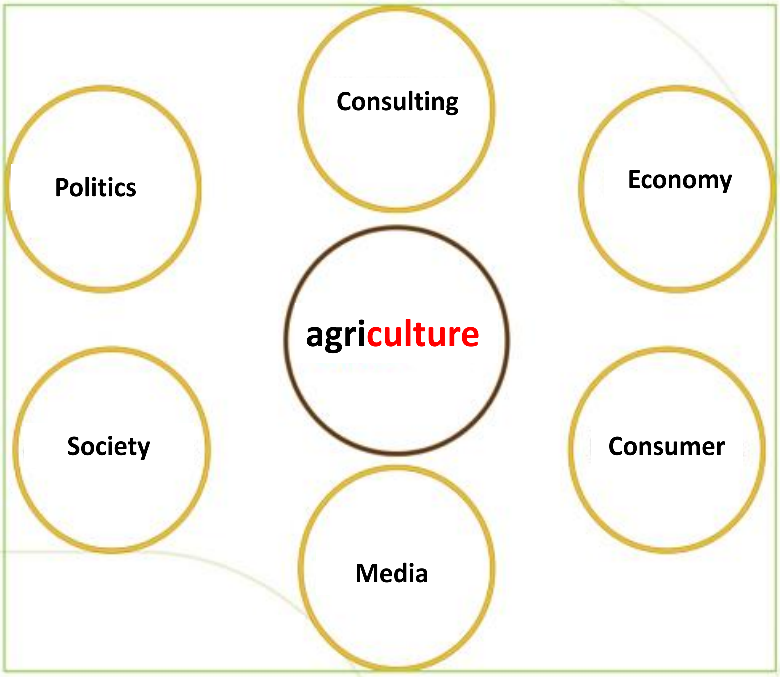


Figure 1: Agriculture between the poles

In the last ~ 40 years, **politics, consulting and economy** have deliberately manoeuvred AGRICULTURE to where it is today through various steering measures (e.g. promotions, subsidies, consulting,...)! In the **media**, agriculture is often portrayed negatively. **Consumers** have no relation to the production of food anymore and in society, agriculture is often blamed for climate change, water contamination etc. in a generalized manner.
Discussions are not conducted on a professional basis, but on an emotional level; blaming and discrediting an entire profession. The challenges of the future (e.g. climate change, water balance, food security...) can only be mastered successfully if all the groups involved deal with each other "fairly" and respectfully again and visions for the future are worked out together!
Karner Fertilizer Production and ***TB Unterfrauner*** support the agricultural enterprises with **solution approaches** in this difficult situation!

Soil – Climate – Water

In **Austria**, **olives, rice, turmeric** and **ginger** have been successfully grown for a few years! **Climate change is taking place**! The cultivated landscape will change decisively in the next decades: common crops will move further north or to higher altitudes while crops from southern regions will replace them! Especially in the precipitation and temperature regime, serious changes can be expected. Winters will become wetter, summers drier, dry periods become longer and precipitation events more severe. This will result in **risks** (e.g. invasive occurrence of harmful organisms), but also **opportunities** (e.g. cultivation of "new" crops, increased yields in grassland,...).
The company ***Karner*** has proven with its ***AKRA*** product line that even in **acute situations** the farms are not left alone, but are offered **solutions**! Thus, **grubs in grassland**, mice in **agriculture and viticulture** as well as the **beet weevil** in sugar beet cultivation could be successfully pushed so far below the damage threshold that good yields could still be achieved! In some cases, livelihoods were saved!

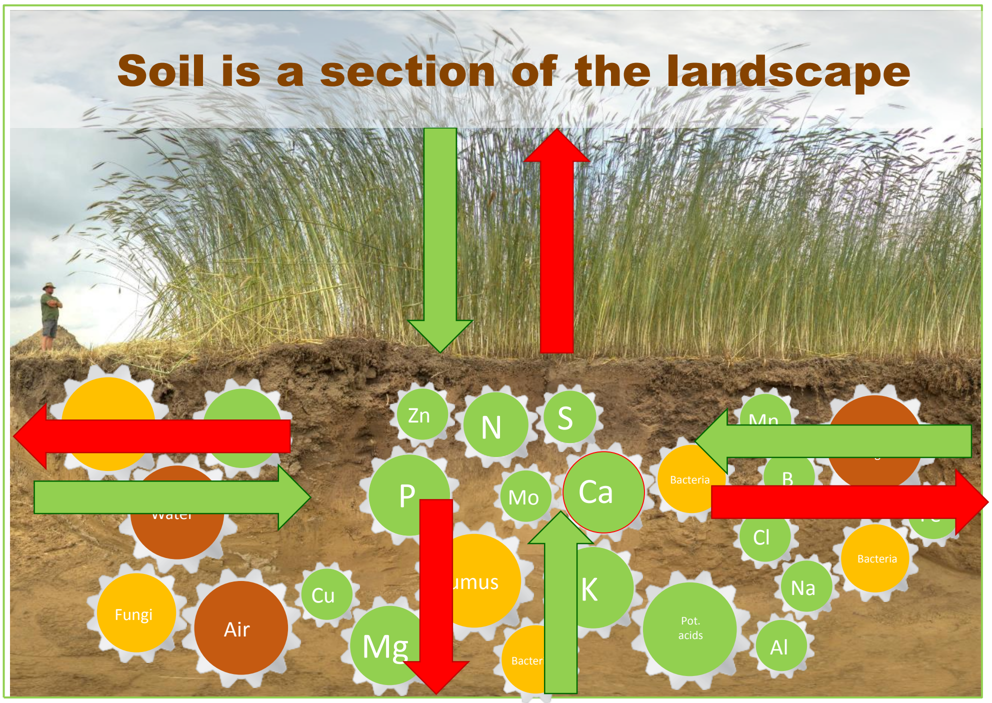


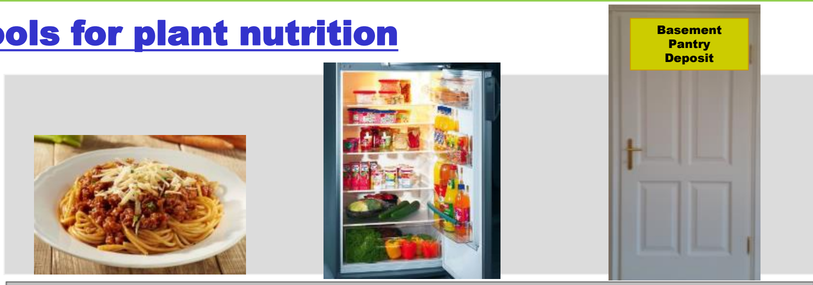
Figure 2: Soil biology, soil chemistry and soil physics form the "gears" of soil fertility

Soils are bound above by atmospheric air and below by rock, sediments or the **groundwater body**. For both **air** and **groundwater**, there are national and international guidelines and threshold values to ensure quality. The **soil**, which has developed as a "**buffer**" between these different ecosystems, unfortunately **does not have an influential lobby**! Whether agriculture can be carried out successfully in the future depends on **water management** and measures to maintain **soil fertility**! Measures are necessary to ensure that **precipitation water** can **infiltrate as completely as possible** into the soil at any time, and **stored** in a way that is available to plants. **For this purpose, a soil must be biologically active**. **Earthworm tunnels, root tubes** of intercrops and green manure mixtures quickly transport water from the topsoil to deeper soil layers. Above-ground **vegetation** absorbs the **energy** of raindrops and thus **prevents erosion** or **crusting processes**. Current studies prove once again that the full implementation of the ***AKRA DGC*** recommendation from the ***fractionated analysis*** can extend the water supply of light soils by **several days** and of medium-heavy soils by **2 weeks**. The **Ca and Mg** compounds from the ***AKRA DGC*** stabilize soil aggregates and also promote the tolerance towards heavy precipitation. Another contribution to increasing water storage capacity is provided by ***AKRA Kombi***, a zeolite-based product that can store 20 times its own weight of **water** in plant-available form.

Efficient use of nutrients/fractionated analysis

Which nutrients are present in the soil and in what quantity? Can the plants use these nutrients? Fractionated analysis provides answers to precisely this question!

Pools for plant nutrition



FRACTIONS: water-soluble, exchangeable, reserve					
Soil solution [mg/l]		**Exchangeable [kg/ha]**		**Reserve [kg/ha]**	
Calcium (Ca)	63,9	Calcium (Ca)	5130	Calcium (Ca)	127100
Magnesium (Mg)	4	Magnesium (Mg)	274	Magnesium (Mg)	27400
Potassium (K)	1,5	Potassium (K)	104	Potassium (K)	3000
Sodium (Na)	3,31	Sodium (Na)	18	Sodium (Na)	200
Ammonium nitrogen (NH4-N)	0,06	Ammonium nitrogen (NH4-N)	0	Nitrogen total (N tot)	7473
Nitrate nirogen (NO3-N)	9,84				
Phosphorus (P)	0,11	Phosphorus (P)	5	Phosphorus min. (P mi	1650
				Phosphorus total (P tot	4657
Sulphate (SO4)	10,59			Sulphur total (S tot)	1798
Chloride (Cl)	7,68				
Aluminium (Al)	0,00	Aluminium (Al)	0,00	Aluminium (Al)	19900
Iron (Fe)	0,08	Iron (Fe)	0,00	Iron (Fe)	11000
Manganese (Mn)	0,00	Manganese (Mn)	0,00	Manganese (Mn)	1970
Born (B)	0,08	Boron (B)	0,38	Boron (B)	15
Zinc (Zn)	0,00	Zinc (Zn)	0,00	Zinc (Zn)	70
Copper (Cu)	0,01	Copper (Cu)	0,00	Copper (Cu)	35
Molybdenum (Mo)	0,00	Molybdän (Mo)	0,00	Molybdenum (Mo)	0

Figure 3: Nutrient pools as shown in the fractionated analysis

The nutrient pools in the soil are comparable to the human diet. What is on the **plate** (immediately available), what is in the **fridge** (short-term resupply) and what is in the **pantry** (long-term resupply)? The "**dish on the plate**" must be balanced and correspond to the **stage of development** (**water-soluble substances**)! In what may be compared to the "**fridge**" the entire storage potential should be used (**exchange capacity),** whereby also here attention should be paid particularly to the fact that the nutrients occur in certain ratios. What is hidden in the shelves behind the door to the "pantry" is important for the derivation of measures for **mobilization** (**reserve pools** of e.g. phosphorus).

Whether the nutrient pools can be used depends on the **milieu conditions** such as the **pH value**, the **salt concentration** and the **redox potential** (also derivable from the fractionated analysis). By implementing the ***AKRA Fertilization System***, the milieu conditions are improved or maintained at a favorable level. **This ensures that the subsequent delivery of the food from the fridge to the plate, from the pantry to the fridge/plate works!**

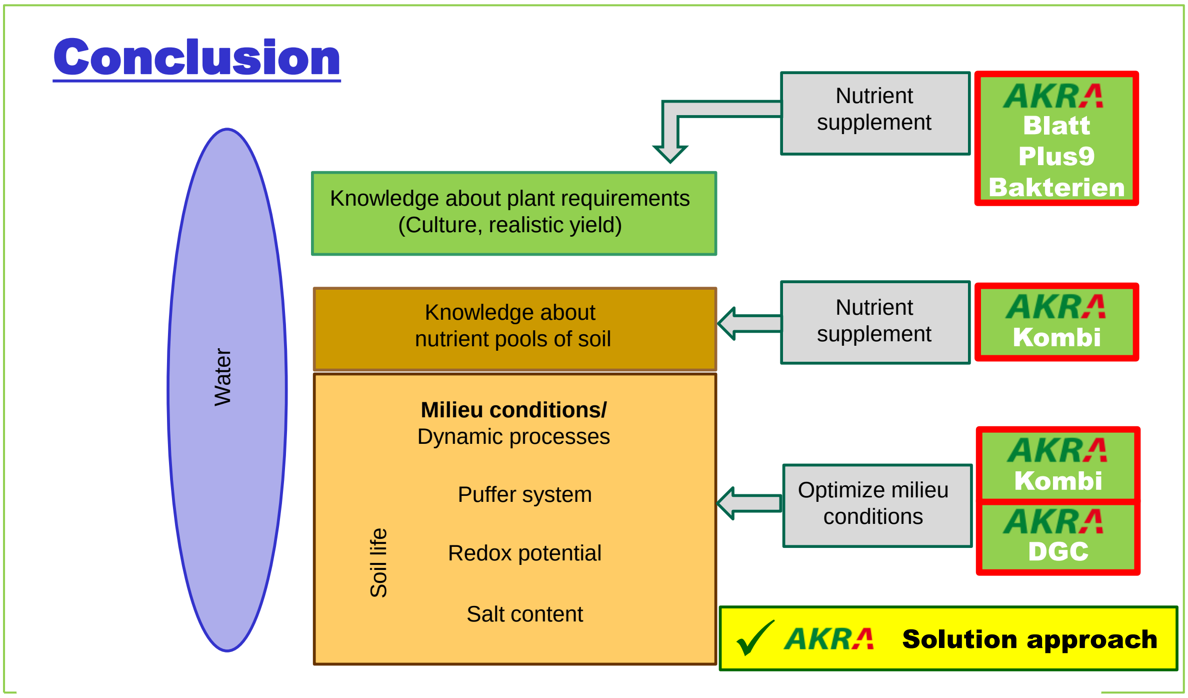


Figure 4: AKRA fertilizer system improves environmental conditions, nutrients are used efficiently

Sulfur: Soil / Plant / Fertilization

Sulfur is an **essential** nutrient and is present in about **0.1 to 0.5%** of plant dry matter. Atmospheric **sulfur input** has decreased from 60 to 80 kg/ha per year since 1990 to about **5 to 8 kg/ha** per year. At the same time, annual **leaching** is **30 to 50 kg/ha**.
The **sulfur reserves** in the soil are mainly **organically** bound (**C/S ratio important**! Cf. fractional analysis!). **Mobilization** takes place through various **microorganisms**. Their activity in turn depends on the weather conditions.

- for winter crops the resupply from the soil is often too late
- sufficient for crops grown later (e.g. corn)

Sulfur in plants:

- component of **amino acids** (protein)
- component of aroma, odor and flavor substances (**leek and mustard oils)**
- component of **glutathione** for detoxification of potentially toxic substances
- component of compounds for **defense** against **harmful** fungal and animal **organisms**
- important role in **microbial N fixation**
- important role in **nitrate utilization**

Through the implementation of the ***AKRA Fertilization System***, the **sulfur supply** of many agricultural crops is **secured**.
In addition, due to its **specific chemical formulation**, the sulfur from ***AKRA foliar fertilization*** reaches the plant organs directly, where the important compounds for **defense against fungal and animal harmful organisms** are formed.
ATTENTION: Pure elemental sulfur or elemental sulfur mixed with oil exhibit this effect only to a very limited extent!

Nitrogen – Fertilizer Directive – Slurry application

The **red areas** in Germany are designated by the implementation of the **Nitrate Directive** and correspond to those areas where the nitrate concentration in the groundwater exceeds **50 mg/l**.
Although it may seem to be provocative, it can be said that the **problems** are largely **self-made**. Political, economic, and consulting interests have created regions of intensive livestock farming, and the recommendation for mineral N fertilizers has been based predominantly on the nitrate-containing fertilizer calcium ammonium nitrate (**KAS**), also called nitramoncal (**NAC**), with 27%N. 45% of the mineral N fertilizer in **Germany** is KAS. This is **unique** in the **world**! In many other regions, **urea** (46%N) is the N fertilizer with the widest distribution.

The balance of the total agricultural N balance is still at an incredible ~ 100kg/ha annual surplus!

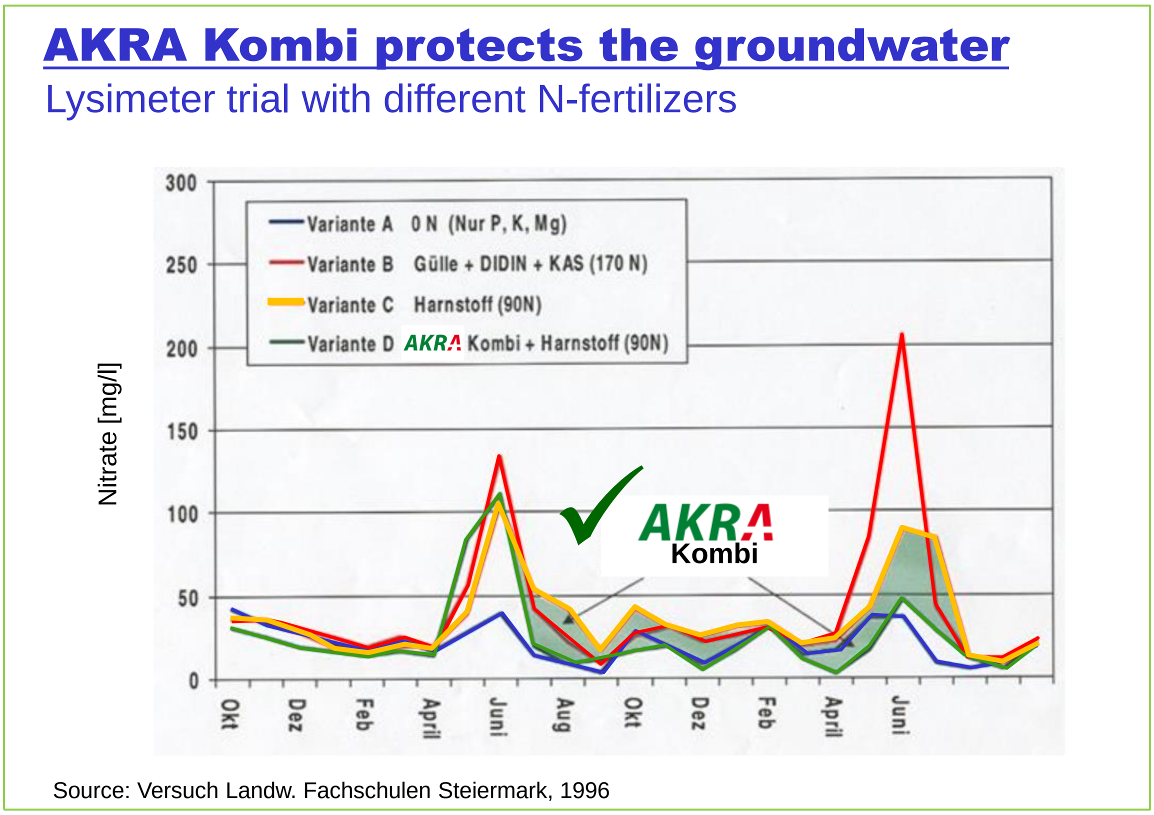


Figure 5: *AKRA Kombi* binds nitrate and protects groundwater

The experiment presented in Figure 5 shows that nitrification inhibitors do not necessarily reduce nitrate concentrations. The nanoporous aluminosilicate ***AKRA Kombi***, on the other hand, can **prevent nitrate** from **leaching into groundwater**.

The Haber-Bosch process and its consequences

The Haber-Bosch process succeeded ~ 70 years ago in converting **molecular atmospheric nitrogen** (the air is composed of ~ 78% N_2) **to ammonia** and further to various **N fertilizers**. At the time, this was a huge, almost **revolutionary step** for agricultural production. The increased yields made it possible to keep more animals, which in turn produced more manure. Above all, however, the purchase of protein (e.g. soy from Brazil, concentrated feed, etc.) interrupted the nutrient and energy cycles of the farms. It can be said succinctly that nitrogen and other nutrients are **imported from Brazil and other countries to Germany/Austria** and remain here as **organic excreta product**!

Idel (2019)* describes in the book "Die Kuh ist kein Klimakiller" the consequences of industrial N bonding for climate change. Due to the enormous energy consumption and the conversion of different N forms into nitrous oxide (N_2O), the "**synthetic nitrogen fertilizer has become the most important agricultural component responsible for climate change.**".

Mikrobial N fixation

In contrast to the Haber-Bosch process, the binding of atmospheric nitrogen by symbiotic, free-living or associative **microorganisms** is completely **irrelevant to climate change**!
Through the ***AKRA Seed Treatment*** and the ***AKRA Azo+***, the microbial N fixation in the soil and the above-ground plant organs is specifically promoted.

Nitrogen turnover in higher plants

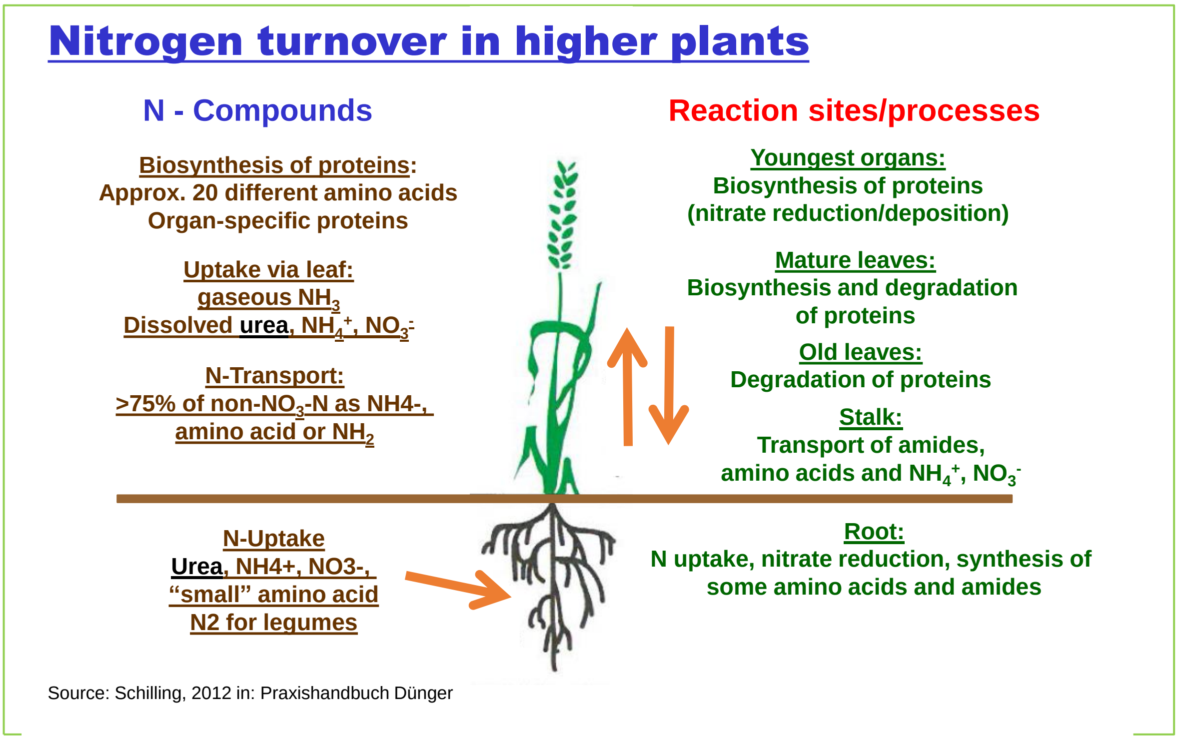


Figure 6: Nitrogen turnover in higher plants

Plants take up nitrogen via the **roots** as **urea, ammonium, nitrate** and low-molecular **amino acids**. The uptake in the form of **urea** can also take place **passively** and is thus the absorption process with the **lowest energy input**. In legumes, symbiotic atmospheric nitrogen fixation results in the transfer of ammonium to the roots. **Above-ground** plant organs can take up N in gaseous form as **ammonia** and in liquid form as **urea, ammonium** and **nitrate**.
Amino acids can be formed in the roots, but the majority of amino acid formation occurs in the leaves. **Protein** is formed exclusively in **leaves**.

Utilization of different forms of N

Nitrate is considered a **cell poison** and cannot be directly utilized by the plants. Only through **extremely energy-consuming** processes **(~ 25%** of the total **energy requirement**!) and in the presence of sufficient **sulfur, molybdenum** and **iron**, nitrate can be converted via enzymatic **reduction** to **ammonium** and thus made usable for the plant.

*Idel Anita (2019): Die Kuh ist kein Klimakiller! Wie die Agrarindustrie die Erde verwüstet und was wir dagegen tun können. Hsg. Schweinsfurth-Stiftung. Metropolis Verlag.

Nitrate can hinder the production of the ripening hormone **auxin**. An addition of N in the form of nitrate for quality fertilization does not lead to higher protein contents, quite the opposite! Nutrients and energy are drawn from the generative organs to form **new tillers**.
Urea, ammonium and **low-molecular amino acids** can be **directly incorporated** into glutamine, the base substance for all other N-containing compounds.

<u>Nitrogen and liquid manure</u>
The **greatest N losses** occur in the **barn** and during **storage**. Between **15** and **40 (!) %** are quoted. **Measures must be taken** to reduce N losses ad hoc (covering the slurry store, feeding below the floating cover, ...).

Current publications of the Bavarian State Institute show that the **application losses** are often much **lower** than the stable and storage losses (exception: cattle slurry).

So which **method of application** holds the **most greenhouse gas potential**? Is it the baffle plate? The drag hose? Or perhaps even the slit drill method?

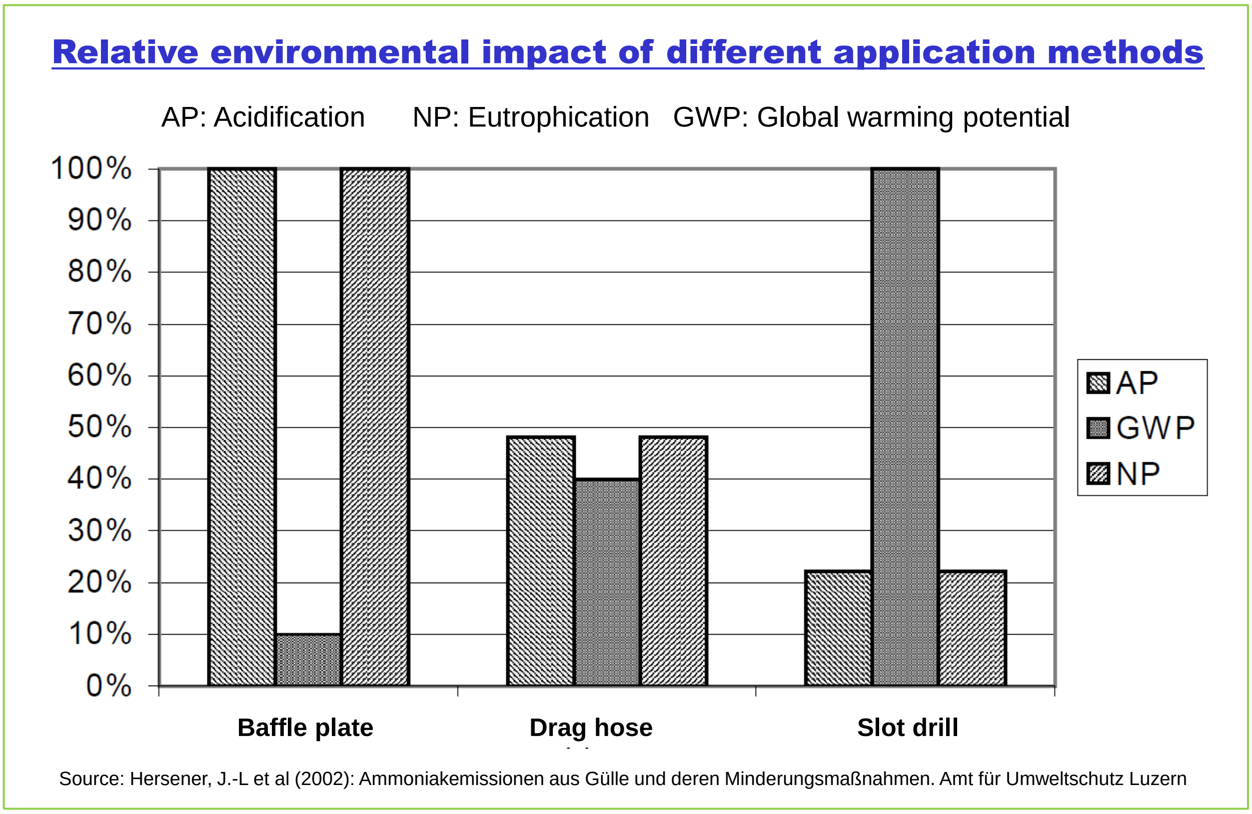


Figure 7: Environmental impact of different slurry application methods

It is clearly visible that the application with the **baffle plate** contributes to **acidification** and **eutrophication** of the surrounding vegetation and water bodies. However, the impact on climate change is less than with the other processes!
The **slot drill** method has the greatest potential **for outgassing nitrous oxide** and thus is responsible for a **massive increase** in **climate-relevant gases**!

Does it make sense to rely purely on technology and to oblige every farm to slit the slurry as a "concentrated band"?

(**The economy must be boosted - but at whose expense?)**

Or could it make sense to strongly reduce the negative effects of the baffle plate (ammonia losses) with the simplest measures and to continue to use the baffle plate especially in small structured, often impassable terrain?

Based on this question, ***Karner Fertilizer Production*** has formulated a **research project** to confirm what has already been affirmed thousands of times in **practice**:

Adding **fresh water** to the slurry (1%) immediately before the application significantly reduces odor nuisance and ammonia outgassing. If ***AKRA WD*** is also added, the ammonia outgassing decreases even more!

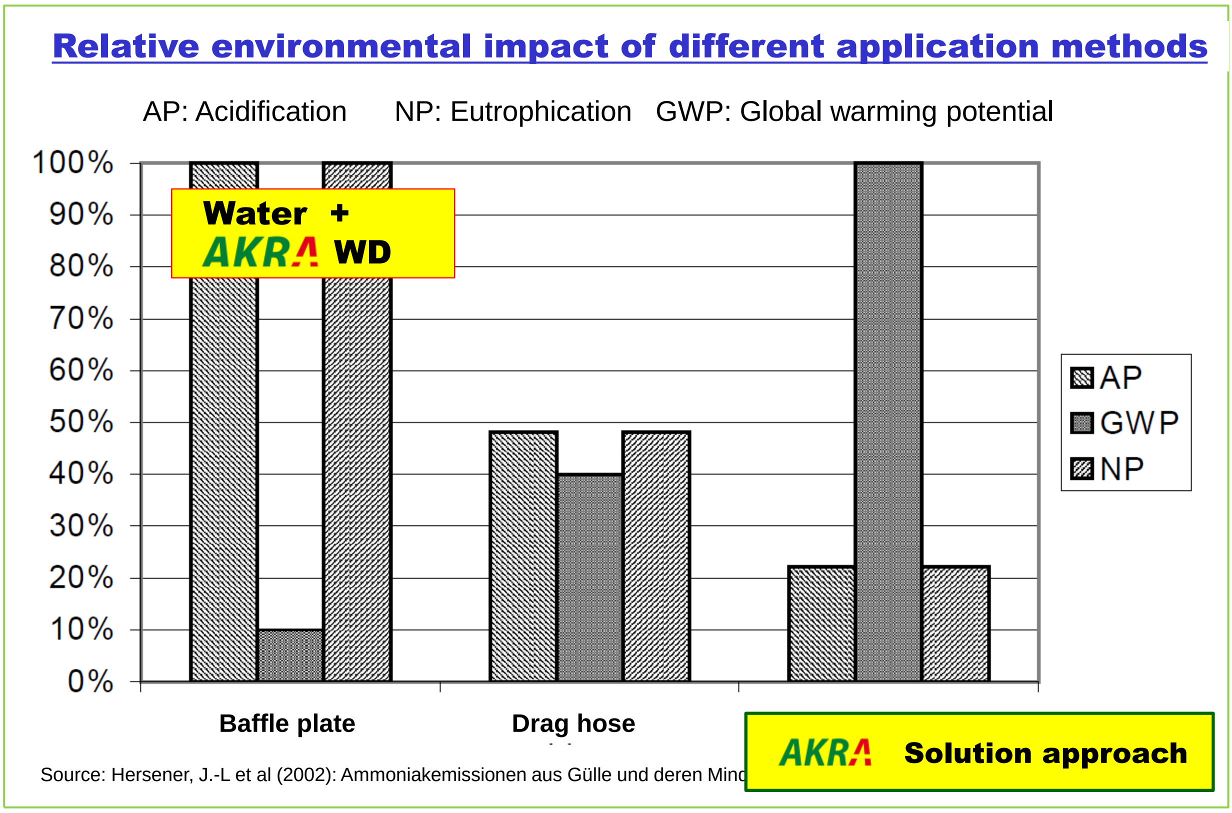


Figure 8: First laboratory results show the reduction of ammonia outgassing when applying slurry with the baffle plate by adding water and *AKRA WD*.

The philosophy of *Karner Fertilizer Production* and *TB Unterfrauner* is also demonstrated in this practical example:

Show solutions and offer a concrete approach to solving current problems in practical agriculture! With knowledge of the basics of the interrelationships of biology, physics, and chemistry, a practical approach can immediately be developed without several years of laboratory research. The results in the practical implementation and of course the parallel running research very often confirm the first approach and usually only lead to a refinement of the practical recommendation.

Fractionated analysis + AKRA (fertilizer) system = Soil fertility