NUTRIENT-BALANCED FERTILIZATION CALCULATIONS – AN IMPORTANT TOOL TO SAVE NUTRIENT RESOURCES AT SOURCE AND TO BUILD BENEFICIAL FARMING
Nutrient balances provide information about environmental pressures. A nutrient deficit (negative value) indicates declining soil fertility, if the soil nutrient content is very low.

A nutrient surplus (positive data) indicates a risk of polluting soil, water and air. The nutrient balance is defined as the difference between the nutrient inputs entering a farming system (mainly livestock manure and fertilizers) and the nutrient outputs leaving the system (the uptake of nutrients for crop and pasture production). Inputs of nutrients are necessary in farming systems as they are critical in maintaining and raising crop and forage productivity. However, a build up of surplus nutrients in excess of immediate crop and forage needs can lead to nutrient losses, representing not only a possible cause of economic inefficiency in nutrient use by farmers, but also a source of potential harm to the environment, through water pollution or air pollution, notably ammonia or greenhouse gas emissions.

OECD data – 2013
This indicator is presented for the two main nutrients, nitrogen and phosphorus, and is measured in kilograms of nutrient per hectare of agricultural land (2013).

Agriculture is responsible for a large share of the leaching of nutrients to watercourses (including groundwater), lakes and finally the sea. The result of plant nutrient studies show that the specialization of farms is one main reason for the high losses of nutrients to the environment. One type of farm specializes in crop production base on the use of artificial fertilizers, another in animal production with high input s of purchased fodder and a surplus of nutrients in the form of ineffectively utilized manure from the animals.

To understand and partly solve problem of nutrient surplus the nutrient balance was introduced.
Nutrient balance is a calculation tool to keep track of the nutrient flows on the farm, and the key for improved nutrient use efficiency and reduced risk of nutrient losses on the farm. The preparation of nutrient balances is beneficial for long-term planning of nutrient (organic and inorganic fertilizers) use.

Nutrient balances inform farmers about their degree of nutrient utilization and help to identify the risk of nutrient leaching and other losses from the field and the whole farm. The work with nutrient balances provides important information for improved fertilizer planning and improved farm finances.

The balances are usually calculated for nitrogen (N), phosphorus (P) and potassium (K) and at the beginning the quantitative analysis help farmer to understand how much these components he need.

Field balance:

<table>
<thead>
<tr>
<th>Nutrient inputs to the field</th>
<th>Nutrient uptake of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of fertiliser (kg) x N-P-K per kg (or % elemental N-P-K)</td>
<td>Harvested products (kg) x N-P-K per kg (or % elemental N-P-K)</td>
</tr>
<tr>
<td>Seeds (kg) x N-P-K per kg (or % elemental N-P-K)</td>
<td></td>
</tr>
<tr>
<td>N2-fixation</td>
<td></td>
</tr>
<tr>
<td>Atmospheric deposition</td>
<td></td>
</tr>
</tbody>
</table>

Farm balance:

<table>
<thead>
<tr>
<th>Nutrient inputs to the farm</th>
<th>Nutrient uptake with product</th>
</tr>
</thead>
<tbody>
<tr>
<td>fertilizers</td>
<td>milk, meat, eggs</td>
</tr>
<tr>
<td>seeds</td>
<td>grain</td>
</tr>
<tr>
<td>seedlings</td>
<td>manure (if given to another farm)</td>
</tr>
<tr>
<td>feed</td>
<td>sold animals</td>
</tr>
<tr>
<td>new animals</td>
<td></td>
</tr>
</tbody>
</table>

On farms with only crop production, the farm balance equals the sum of field balances.

**CONVENTIONAL FARMING**

In conventional agriculture where the losses are bigger and practically the effectiveness is about 50%. Raising this value to 70%, as a result of the optimization of fertilization, regulate soil pH and good agricultural practices would enable savings of 20 kg N/ha per year.

This relationship is shown in the diagram below, taking into account the prices of ammonium nitrate 34% N from 2016 (price in Poland).
Organic agriculture depended on two main sources of nitrogen for crop production:
- Nitrogen fixation through leguminous plants in the crop rotation.
- Ruminant animals that could contribute to produce food and manure, so that the major part of nutrients could be recycled to the soil.

In balance should be considered potential availability of N and P and its contents in manure every year. Biogens supplied to the soil are in organic compounds, so it takes time to mineralize and depend of temperature, rain and operated sun. Therefore, the values given in the boxes are approximate values.
### Box 1. Potential availability of N and P from farmyard manure

<table>
<thead>
<tr>
<th>Spreading of 30 t/ha/year =</th>
<th>Availability in the first year</th>
<th>Availability amount/ha in the first year</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 kg N</td>
<td>20%</td>
<td>30 kg</td>
</tr>
<tr>
<td>36 kg P</td>
<td>50%</td>
<td>18 kg</td>
</tr>
</tbody>
</table>

Source: Ecological Recycling Agriculture; Guidelines for farmers and advisors.

In general, most farms do not need P because of the high P levels, that remain in the soil. P is introduced and recycled via crop residues, and farmyard manure. Up to 40% of the P can be taken from subsoil. Active nutrient mobilisation is accomplished for example by legumes which lower the pH in their root zones.

Finally the balanced saldo (plus/minus 20 Nkg/ha) indicates good status. Negative saldo indicates losses to environment and deficit needs to compensated. In case phosphorus, a deficit of up to 2 kg P/ha is possible.

The deficit of P is recognised by characteristic symptoms on the plants: the dark green older leaves turning red and violet and even stalks turning red in colour.

Plants without phosphorus.
The second significant source of nitrogen in organic agriculture are legumes, which fix nitrogen from air with the aid of nodule bacteria living symbiotically at legume roots. They have also ability to mobilize phosphorus from the soil through the secretion of organic acid in the rhizosphere. The average N fixation of forage legumes is roughly 200 kg N/ha/year, which is around twice the amount from grain legumes. Near 80% of N is removed with yields, the rest left in the soil.

The practical solution of nutrient balance is farm base on principles Ecological Recycling Agriculture (ERA). ERA farms have a good balance between crop and animal production with an animal density on each farm adapted to the farm’s own fodder production. Only 20% of fodder can be imported from other farms. ERA is based on the recycling principle of ecological agriculture combined with diverse crop rotation with high share symbiotic nitrogen-fixing legumes like clover grass leys. The animals – ruminants play crucial role, because its manure is returned to the soil and contributes to the soil fertility.
Our mission is: Supporting sustainable development, saving and improving the environment, protection of nature and life, as well as human health.

We are all responsible for the quality of our environment – you are too! You can make a real difference for the world we live in. Start acting!

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