THE CURRENT STATE OF NITROGEN APPROACHES WITHIN THE CZECH REPUBLIC

Dr. Pavel Čermák
Crop Research Institute, Prague

Martin Dědina, Ph.D.
Research Institute of Agricultural Engineering

Dr. Michaela Budňáková
Ministry of Agriculture of the Czech Republic
From the point of view of soil and climatic conditions the Czech Republic is a Gordian knot of Europe, so country is divided into four growing areas:

Maize growing area (MGA) & Sugar-beet growing area (SBGA):
- higher soil fertility, more conducive climatic conditions (higher temperatures)

Potato growing area (PGA) & Mountain growing area (MtGA):
- lower soil fertility, less conducive climatic conditions (lower temperatures)
These different areas have different demands on farming (different crop varieties, different plant protection, different application doses of fertilisers, especially nitrogen ...).
Consumption of mineral nutrients and limy materials in kg.ha\(^{-1}\) of agricultural land

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>P(_2)O(_5)</th>
<th>K(_2)O</th>
<th>(\Sigma) of nutrients</th>
<th>Limy materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\sigma) 1981–85</td>
<td>102</td>
<td>75,9</td>
<td>82,8</td>
<td>260,7</td>
<td>2 316 000</td>
</tr>
<tr>
<td>(\sigma) 1986–90</td>
<td>95</td>
<td>65,06</td>
<td>63,76</td>
<td>223,8</td>
<td>2 274 000</td>
</tr>
<tr>
<td>(\sigma) 1991–95</td>
<td>49,44</td>
<td>11,86</td>
<td>10,28</td>
<td>71,6</td>
<td>352 000</td>
</tr>
<tr>
<td>(\sigma) 1996–2000</td>
<td>55,94</td>
<td>11,1</td>
<td>7,5</td>
<td>74,5</td>
<td>258 200</td>
</tr>
<tr>
<td>(\sigma) 2001–2005</td>
<td>70,9</td>
<td>12,34</td>
<td>7,98</td>
<td>91,2</td>
<td>163 620</td>
</tr>
<tr>
<td>(\sigma) 2006–2010</td>
<td>77,34</td>
<td>10,8</td>
<td>7,7</td>
<td>95,9</td>
<td>135 221</td>
</tr>
<tr>
<td>2011</td>
<td>100,7</td>
<td>11,3</td>
<td>6,5</td>
<td>118,5</td>
<td>173 000</td>
</tr>
<tr>
<td>2012</td>
<td>98,98</td>
<td>12,15</td>
<td>6,46</td>
<td>117,59</td>
<td>201 000</td>
</tr>
<tr>
<td>2013</td>
<td>94,18</td>
<td>11,83</td>
<td>7,03</td>
<td>113,04</td>
<td>398 072</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture of the Czech Republic, 2014; relative to 3 525 889 hectares of used agricultural land
Consumption of mineral nutrients and limy materials in kg.ha$^{-1}$ of agricultural land

Source: CISTA & Ministry of Agriculture of the Czech Republic, 2014
!!!! BIG PROBLEM !!!!
to keep

Optimal ratio of nutrients

\[
\begin{align*}
N : P : K \\
1,0 : 0,5 : 0,8 - 1,0
\end{align*}
\]
Nutrients ratio in mineral fertilisers in member states of EU

- Itálie
- Španělsko
- Portugalsko
- Rakousko
- Francie
- Belgie
- Finsko
- EU 15
- Irsko
- Velká Británie
- Dánsko
- Německo
- Švédsko
- Nizozemí
- ČR

Nutrient ratios include:
- K₂O
- P₂O₅
- N
Livestock density and the livestock composition expressed in livestock units
(as at 1st April 2012)

<table>
<thead>
<tr>
<th>Year</th>
<th>Livestock units per 1 ha of agricul. land</th>
<th>Share in total number of livestock units in %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cattle</td>
</tr>
<tr>
<td>2005</td>
<td>0.526</td>
<td>61.1</td>
</tr>
<tr>
<td>2007</td>
<td>0.514</td>
<td>63.9</td>
</tr>
<tr>
<td>2008</td>
<td>0.482</td>
<td>66.9</td>
</tr>
<tr>
<td>2009</td>
<td>0.476</td>
<td>67.2</td>
</tr>
<tr>
<td>2010</td>
<td>0.466</td>
<td>69.0</td>
</tr>
<tr>
<td>2011</td>
<td>0.461</td>
<td>70.6</td>
</tr>
</tbody>
</table>

Source: CSO, 2013

Inputs of organic matter and next nutrients in organic form into the soil (according to the Czech Statistical Office it was 0.81 livestock unit. ha\(^{-1}\) (LU. ha\(^{-1}\)) in 1989, while in 2011 only 0.46 LU. ha\(^{-1}\)).
All these factors:

1) low inputs of mineral nutrients in form of mineral fertilisers and limy materials
2) unbalanced ratio of nutrients
3) low inputs of organic matter and nutrients in organic form

have a negative effect on soil fertility.
Specifics of the Czech agriculture

- Large size of CZ farms
- High proportion of rented land (~ 80 %) – problems with planning and constructing of dung-yards on the fields
- Problems with planning and constructing of dung-yards in urban area
- Very often the already built dung-yards in villages or near their area can not be used (population protests)
## Structure of agriculture farms in CZ

*(to the end 2009)*

Source: CSO, 2009

<table>
<thead>
<tr>
<th>Area of farm (ha)</th>
<th>Distribution of farms in CZ (%)</th>
<th>Portion on total agr. area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 0 &lt; 5</td>
<td>52,3</td>
<td>1,1</td>
</tr>
<tr>
<td>5 – 10</td>
<td>12,2</td>
<td>1,1</td>
</tr>
<tr>
<td>10 – 50</td>
<td>20,9</td>
<td>6,1</td>
</tr>
<tr>
<td>50 – 100</td>
<td>5,1</td>
<td>4,6</td>
</tr>
<tr>
<td>100 – 500</td>
<td>5,6</td>
<td>16,0</td>
</tr>
<tr>
<td>500 – 1000</td>
<td>1,7</td>
<td>16,3</td>
</tr>
<tr>
<td>1000 – 2000</td>
<td>1,4</td>
<td>26,4</td>
</tr>
<tr>
<td>&gt; 2000</td>
<td>0,7</td>
<td>28,4</td>
</tr>
</tbody>
</table>

85 % farms (small) ~ 8 % of agr. land

4 % farms (large) ~ 75 % of agr. land
Designation and revision of Vulnerable Zones in the Czech Republic

50 % of the agricultural land of the Czech Republic
In 1999, the Ministry of Agriculture of Czech Republic decided to build an agricultural parcel identification system (LPIS). The blocks of used land were plotted using aerial photos and verified with farmers. Land block boundaries were digitally plotted off-line on the contractor’s site.
The Land Parcel Information System (LPIS) registers agricultural land that is eligible for area-based subsidies. It is part of the Integrated Administrative and Control System (IACS).

In the Czech Republic, the Land Parcel Information System registers physical blocks, which may be divided into farmer blocks. A physical block is a continuous area of agricultural land delimited by distinct terrain barriers (forest edge, trees growing along a river, road, etc).

The LPIS is a geographic database, which means that the electronic file stores, for each block, attributes (e.g. land use and farmer) as well as information regarding the location and shape of the block.

In the database, each physical block (or a farmer block) is identified by a unique code. In order to identify physical block, a nine-character code is used that is based on the position of the block’s centroid in the S-JTSK national coordinate system.

Each physical/farmer block in the LPIS covers a specific area in hectares.

Further, there are other data: i.e. land use, farmer, organic farming, location in a less favoured area.
Application zones
Soil erosion
Water bodies
Skladování tuhých statků a org. hnojiv
Storage of the manure
LPIS: Mapping of manure heap (on the field)

Good tool for farmers and simultaneously for inspection bodies
### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Data</th>
<th>Characteristics</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map, parcel code</td>
<td>(640-1170)-1905/1 - vedle</td>
<td>Floodplain</td>
<td>No</td>
</tr>
<tr>
<td>Cadastral area</td>
<td>Stupečice</td>
<td>NVZ</td>
<td>Yes</td>
</tr>
<tr>
<td>Name</td>
<td>Place for manure deposition No. 3</td>
<td>Overlap of drainage (m²)</td>
<td>0</td>
</tr>
<tr>
<td>Type</td>
<td>Place for manure deposition</td>
<td>Threatened by soil erosion (m²)</td>
<td>0</td>
</tr>
<tr>
<td>Capacity (t)</td>
<td>600</td>
<td>Water saturated soil (m²)</td>
<td>0</td>
</tr>
<tr>
<td>Area (m²)</td>
<td>2 000</td>
<td>Near water course (50 m)</td>
<td>No</td>
</tr>
<tr>
<td>Manure type</td>
<td>Cattle FYM, deep litter</td>
<td>Distance from water course (m)</td>
<td>532</td>
</tr>
<tr>
<td>Water source protection zone</td>
<td>No</td>
<td>Slope (°)</td>
<td>0,4</td>
</tr>
<tr>
<td>GPS</td>
<td>N 48°59'7.59&quot; - E 16°3'23.15&quot;</td>
<td>Suitability of the location</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Practical procedure (Example - farm XY)

a. selection of suitable places for manure deposition (LPIS maps)

b. drawing of proposal places to the emergency plan, filling in the table with characteristics for each place
Monitoring of the Action programme

- Evaluation of the effectiveness of the Nitrates Directive Action Programme in the Czech Republic is provided under the monitoring of the Action Programme

- Monitoring of the Programme includes:
  - verification survey of meeting the requirements of the Action Programme on farms in NVZ (about 30 to 40 pilot enterprises)
  - evaluation of the development of soil nitrogen content in terms of crops, and agricultural technologies used during weathering,
  - field survey on farms in NVZ (about 250 farms)
  - monitoring of the impact of farming management in accordance with the action program on water quality in the pilot area in NVZ,
  - evaluation of the impact of farming, soil-climatic conditions and weather during the water quality in 360 sub-basins of the Czech Republic,
  - measuring the flows of nitrogen in NVZ, and modeling the movement of nitrogen in soil and water for the prediction of the future development of water quality
  - monitoring of the development of farming in NVZ based on data from the Czech Statistical Office, Evidence of soil by user relations and Evidence of livestock
Deposition of manure on fields

Manure heaps monitoring 2013

- About 80 manure heaps in 2013
  (100 heaps in 2010, 2011, 2012)

- Focused on:
  - manure quality,
  - Nmin content in the soil
  - quality of water
The diagram shows the N\textsubscript{min} content near manure heap with different bedding.

**FYM from insufficient bedding**

**FYM from sufficient bedding**

**FYM from deep litter**

The graphs compare the mg N/kg of soil layers at varying distances from the heap, including near heap, 10 m from heap, 30 m from heap, and 50 m from heap.
Content of Nmin in the soil under manure heap - space (soil profile) scaling

Average amount of Nmin under cattle manure heap

kg N/heap (750 m²)

0 - 30
30 - 60
60 - 90
90 - 120
Whole soil profile (0-120 cm)

- after removing
- 1st year after
- 2nd year after
- 3rd year after
Content of Nmin in the soil under manure heap - time scaling

Average amount of Nmin under cattle manure heap

<table>
<thead>
<tr>
<th>After removing</th>
<th>1st year after</th>
<th>2nd year after</th>
<th>3rd year after</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-NH4</td>
<td>18.5</td>
<td>36.8</td>
<td>21.3</td>
</tr>
<tr>
<td>N-NO3</td>
<td>62.2</td>
<td>22.1</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Average amount of Nmin (kg N/heap) in the soil under manure heap (750 m²)
Content of Nmin in the soil under manure heap - type aspect

Average amount of Nmin under manure heaps

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Area (m²)</th>
<th>Soil Layer (kg N/heap)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>750</td>
<td>0-30: 60, 30-60: 10, 60-90: 5, 90-120: 2</td>
</tr>
<tr>
<td>Horses</td>
<td>194</td>
<td>0-30: 5, 30-60: 1, 60-90: 1, 90-120: 0</td>
</tr>
<tr>
<td>Sheep, Goats</td>
<td>128</td>
<td>0-30: 10, 30-60: 5, 60-90: 2, 90-120: 1</td>
</tr>
<tr>
<td>Poultry</td>
<td>554</td>
<td>0-30: 70, 30-60: 20, 60-90: 5, 90-120: 1</td>
</tr>
<tr>
<td>Composts</td>
<td>655</td>
<td>0-30: 50, 30-60: 10, 60-90: 5, 90-120: 2</td>
</tr>
</tbody>
</table>
Water quality


![Bar chart showing average NO3 concentration mg/L for % ≥ 25 mg/L and % ≥ 50 mg/L for 2004-2007 and 2008-2011.]

![Pie chart for 2008-2011 showing percentage of decreasing, stable, and increasing concentrations.]

- % decreasing: 30%
- % stable: 43%
- % increasing: 26%
Water quality

Monitoring of surface water - a comparison between the periods 2004-2007 and 2008-2011

[Bar chart and pie chart showing comparison between two periods]
New legislative requirements since 2014
(this provision shall enter into effect on 1. 1. 2014)

Storage of manure on farmland (under legislation requirements):

- Manure storage capacities (FYM, slurry) for 6 months
- Solid manure can be deposited on agricultural land after 3 month period of storage (after dewatering) or after uniphase dispatch from the stable with deep litter
- FYM can be deposited only in places approved in the emergency plan
- Storage max. for 12 months (in vulnerable zones) & 24 months out of vulnerable zones
New legislative requirements since 2014
*(this provision shall enter into effect on 1. 1. 2014)*

**Limitation of fertilization by nitrogen compounds:**
- Limit 170 kg of nitrogen (in organic form) per hectare
- New limits of crop fertilization by nitrogen (totaly)
- Fertilizing with nitrogen compounds is determined by the needs of individual crops on particular sites

**Fertilization near by watercourses:**
- No fertilizers in a strip next to the watercourses and other waters formations
- No liquid fertilizers with rapidly releasable N in strip near by the watercourses
It’s time to finish !!!!!

A lot of thanks to my co-authors and colleagues

Thank you for your attention