Manure Standards

# Guidelines for manure sampling and analysis (WP2)

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Interreg Baltic Sea Region
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EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

# Main activities in WP2

- Finding suitable **pilot farms,** planning and carrying out **manure sampling.**
- Writing ***Instructions for manure sampling***
- Writing **Instructions for *manure analysis***
- Making ***Templates for collecting of manure and farm data***
- Putting up a ***Data base with analysis results***
- Putting up a ***Data base with farm data***
- Creating an ***Instruction film*** on manure sampling
- Synthesizing above into a ***Short guideline for manure sampling and analysing***, including templates for manure and farm data.
- ***Water flow measurements*** at 5 Swedish pilot farms.

Solid manure sampling in Latvia

# ➢ PILOT FARMS

- Main criteria was that chosen farms should represent the country production and have simple nutrient flows which could easily be followed from animal to storage.

| Country | No of farms |
|---|---|
| Denmark | 11 |
| Estonia | 6 |
| Finland | 7 |
| Germany | 5 |
| Latvia | 26 |
| Lithuania | 6 |
| Poland | 5 |
| Russia | 11 |
| Sweden | 5 |
| **Sum** | **82** |

| Antal av Manure type / Radetiketter | Kolumnetikett: Deep litter | Dung + urine | Semi-Solid manure | Slurry | solid manure | Totalsumma |
|---|---|---|---|---|---|---|
| **Denmark** | | | | **10** | **1** | **11** |
| Broilers | | | | | 1 | 1 |
| Dairy Cattle | | | | 1 | | 1 |
| Fattening pigs | | | | 7 | | 7 |
| Fur animals | | | | 1 | | 1 |
| Pigs Integrated | | | | 1 | | 1 |
| **Estonia** | | | | **2** | **4** | **6** |
| Beef cattle | | | | | 2 | 2 |
| Broilers | | | | | 1 | 1 |
| Dairy Cattle | | | | 2 | | 2 |
| Laying hens | | | | | 1 | 1 |
| **Finland** | **2** | **1** | | **3** | **1** | **7** |
| Beef cattle | 1 | | | 1 | | 2 |
| Broilers | 1 | | | | | 1 |
| Dairy Cattle | | 1 | | 1 | | 2 |
| Fattening pigs | | | | 1 | | 1 |
| Fur animals | | | | | 1 | 1 |
| **Germany** | | | **1** | **8** | **2** | **11** |
| Beef cattle | | | | 1 | | 1 |
| Dairy Cattle | | | | 5 | 1 | 6 |
| Fattening pigs | | | | 2 | 1 | 3 |
| Laying hens | | | 1 | | | 1 |
| **Latvia** | | | | **23** | **20** | **43** |
| Beef cattle | | | | 2 | 10 | 12 |
| Dairy Cattle | | | | 15 | 8 | 23 |
| Fattening pigs | | | | 3 | | 3 |
| Pigs Integrated | | | | 3 | | 3 |
| Sheep | | | | | 2 | 2 |
| **Lithuania** | **3** | **2** | | **1** | | **6** |
| Beef cattle | 1 | | | | | 1 |
| Broilers | 1 | | | | | 1 |
| Dairy Cattle | | 1 | | 1 | | 2 |
| Horse | | 1 | | | | 1 |
| Sheep | 1 | | | | | 1 |
| **Poland** | **2** | | **1** | **2** | | **5** |
| Beef cattle | 1 | | | | | 1 |
| Broilers | | | 1 | | | 1 |
| Dairy Cattle | | | | 1 | | 1 |
| Fattening pigs | | | | 1 | | 1 |
| Sheep | 1 | | | | | 1 |
| **Russia** | **1** | | **2** | **7** | **1** | **11** |
| Dairy Cattle | 1 | | 2 | 6 | | 9 |
| Fattening pigs | | | | 1 | | 1 |
| Laying hens | | | | | 1 | 1 |
| **Sweden** | **2** | | | **3** | | **5** |
| Broilers | 1 | | | | | 1 |
| Dairy Cattle | | | | 2 | | 2 |
| Fattening pigs | | | | 1 | | 1 |
| Pigs Integrated | 1 | | | | | 1 |
| **Totalsumma** | **10** | **3** | **4** | **59** | **29** | **105** |

# Manure Standards

Deep litter
Solid manure

Number of farms: 82
Number of manure lines: 96
Total number of samples: 890

Slurry

| Country | (Alla) | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Antal av Manure type** | **Kolumnetiketter** | | | | | |
| **Radetiketter** | **Deep litter** | **Dung + urine** | **Semi-Solid manure** | **Slurry** | **solid manure** | **Totalsumma** |
| Beef cattle | 6 | | | 3 | 5 | 14 |
| Broilers | 4 | | 1 | | 1 | 6 |
| Dairy Cattle | 2 | 2 | 2 | 32 | 10 | 48 |
| Fattening pigs | | | | 14 | 1 | 15 |
| Fur animals | | | | 1 | 1 | 2 |
| Horse | | 1 | | | | 1 |
| Laying hens | | | 1 | | 2 | 3 |
| Pigs Integrated | 1 | | | 1 | | 2 |
| Sheep | 3 | | | 1 | | 4 |
| Sows | | | | 1 | | 1 |
| **Totalsumma** | **16** | **3** | **4** | **53** | **20** | **96** |

# SAMPLING INSTRUCTIONS

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Produced to be used at the pilot farms –a lot of discussions on how careful the instructions should be (number of sub samples)

Table of contents

# Sampling - Challenges

- Sampling  mostly went well.
- Getting representative samples can be very laborious, especially from solid manure storages.
- Accuracy against practical feasibility. It was concluded instructions are too laborious for being practiced by farmers.
- Slurry tanks are seldom enough mixed.
- Farmers are often stressed at this time of the year.
- Farmers are reluctant to mix the slurry at other times than before spreading – the time window is only a couple of hours.

Sampling device

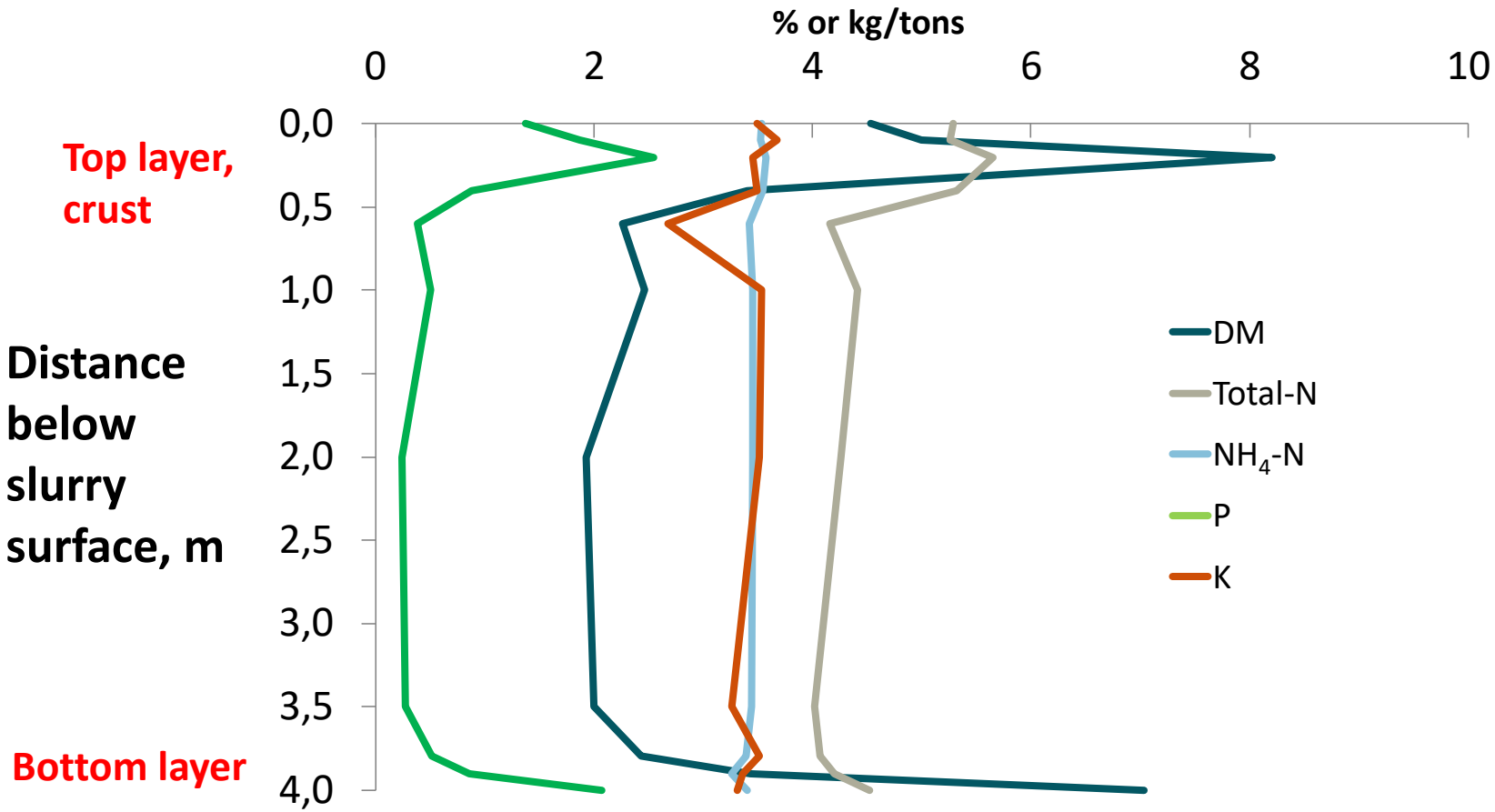
# Reflections

**All slurry tanks are different – but taking a representative manure sample is always challenging – and sometimes impossible.**




SEGES

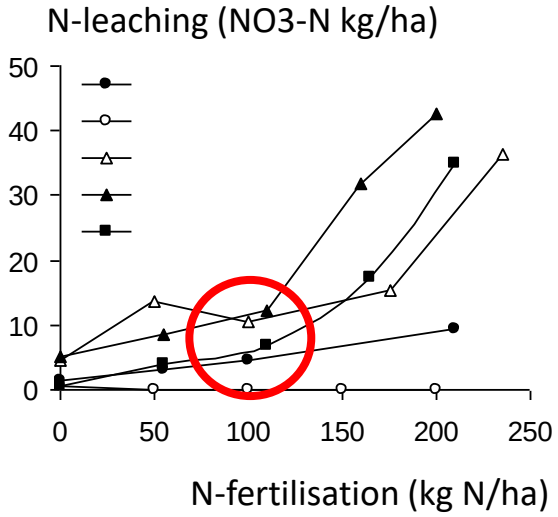
# Concentrations of nutrients in a un-mixed slurry tank

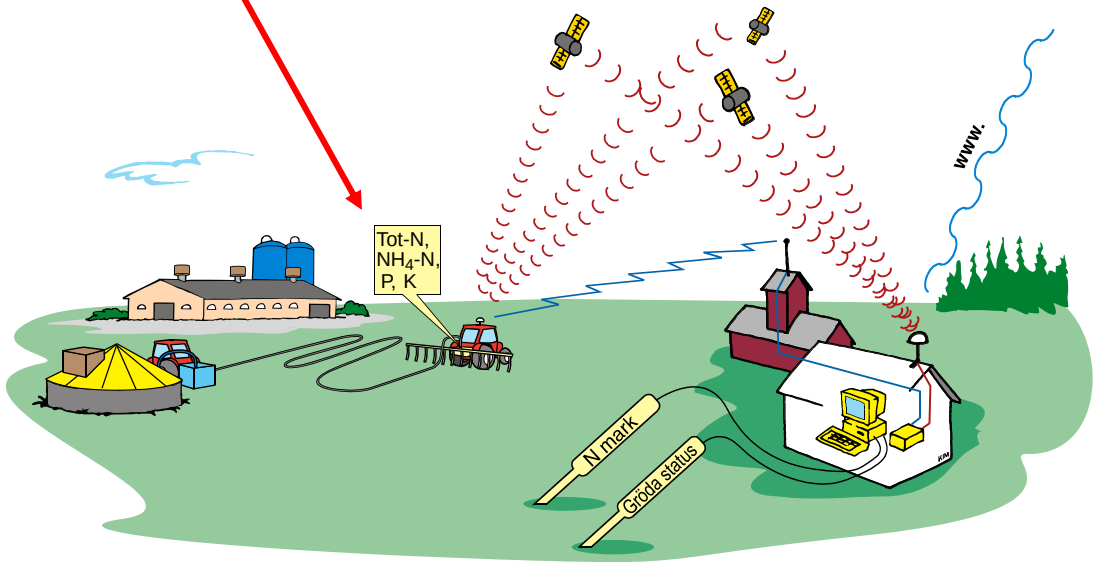



SEGES

# Reduced losses of nutrients require precision agriculture

## Important to know the nutrient content




**Importance of adjusting fertilization rates to the crop need**

Considering plant uptake and soil delivery

However precision fertilisation requires also enough land and storage capacity!

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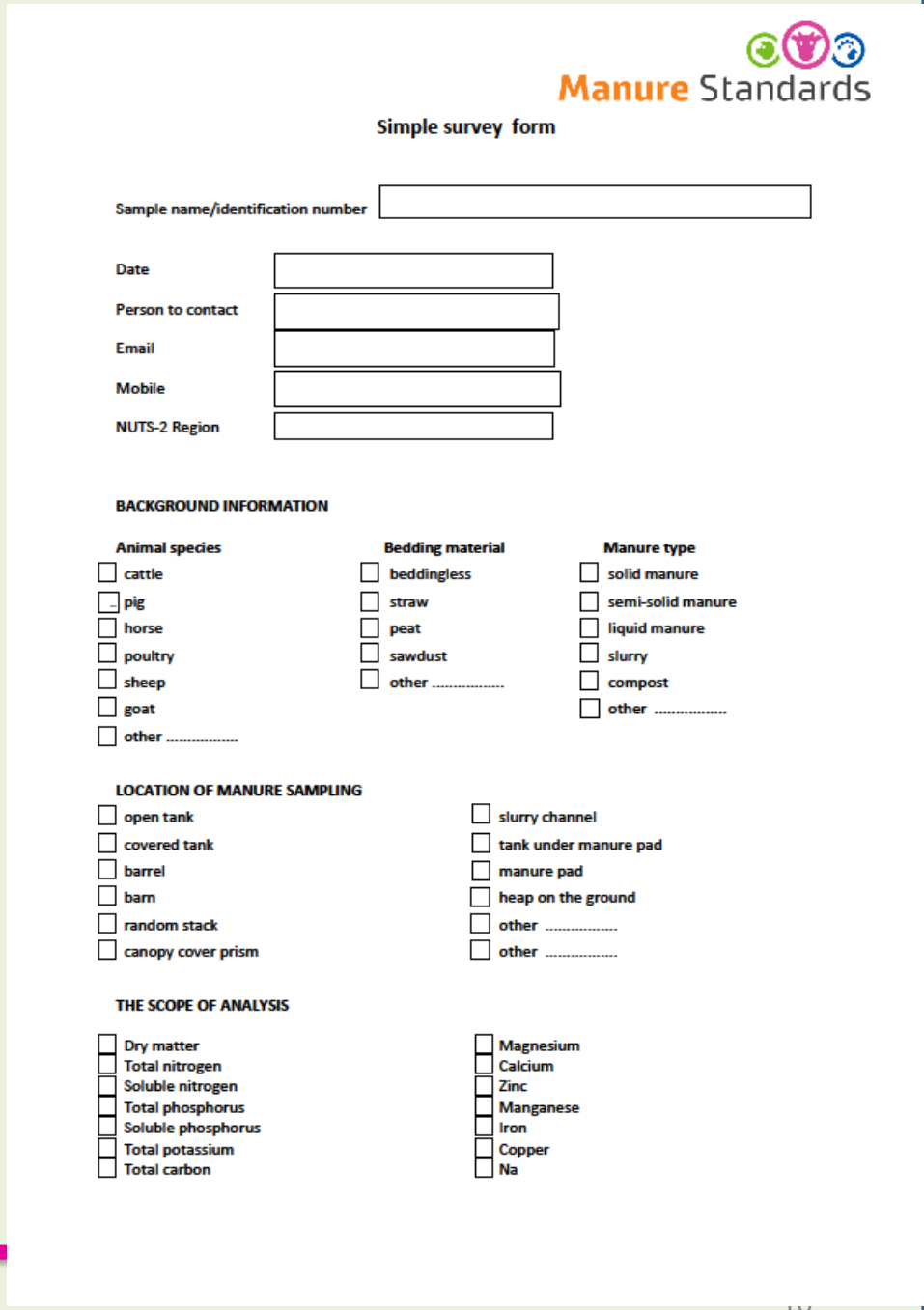
# ➢ TEMPLATES –Simple survey form

to be filled in at sampling and sent to the laboratory together with the sample

Data on:

- Animal species
- Manure type
- Location of manure sampling
- The scope of analysis

This work had a step stone in existing templates from e.g. Estonia, Sweden and the Netherlands.



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**Simple survey form**

Sample name/identification number

Date

Person to contact

Email

Mobile

NUTS-2 Region

**BACKGROUND INFORMATION**

| Animal species | Bedding material | Manure type |
|---|---|---|
| ☐ cattle | ☐ beddingless | ☐ solid manure |
| ☐ pig | ☐ straw | ☐ semi-solid manure |
| ☐ horse | ☐ peat | ☐ liquid manure |
| ☐ poultry | ☐ sawdust | ☐ slurry |
| ☐ sheep | ☐ other ..... | ☐ compost |
| ☐ goat | | ☐ other ..... |
| ☐ other ..... | | |

**LOCATION OF MANURE SAMPLING**

| | |
|---|---|
| ☐ open tank | ☐ slurry channel |
| ☐ covered tank | ☐ tank under manure pad |
| ☐ barrel | ☐ manure pad |
| ☐ barn | ☐ heap on the ground |
| ☐ random stack | ☐ other ..... |
| ☐ canopy cover prism | ☐ other ..... |

**THE SCOPE OF ANALYSIS**

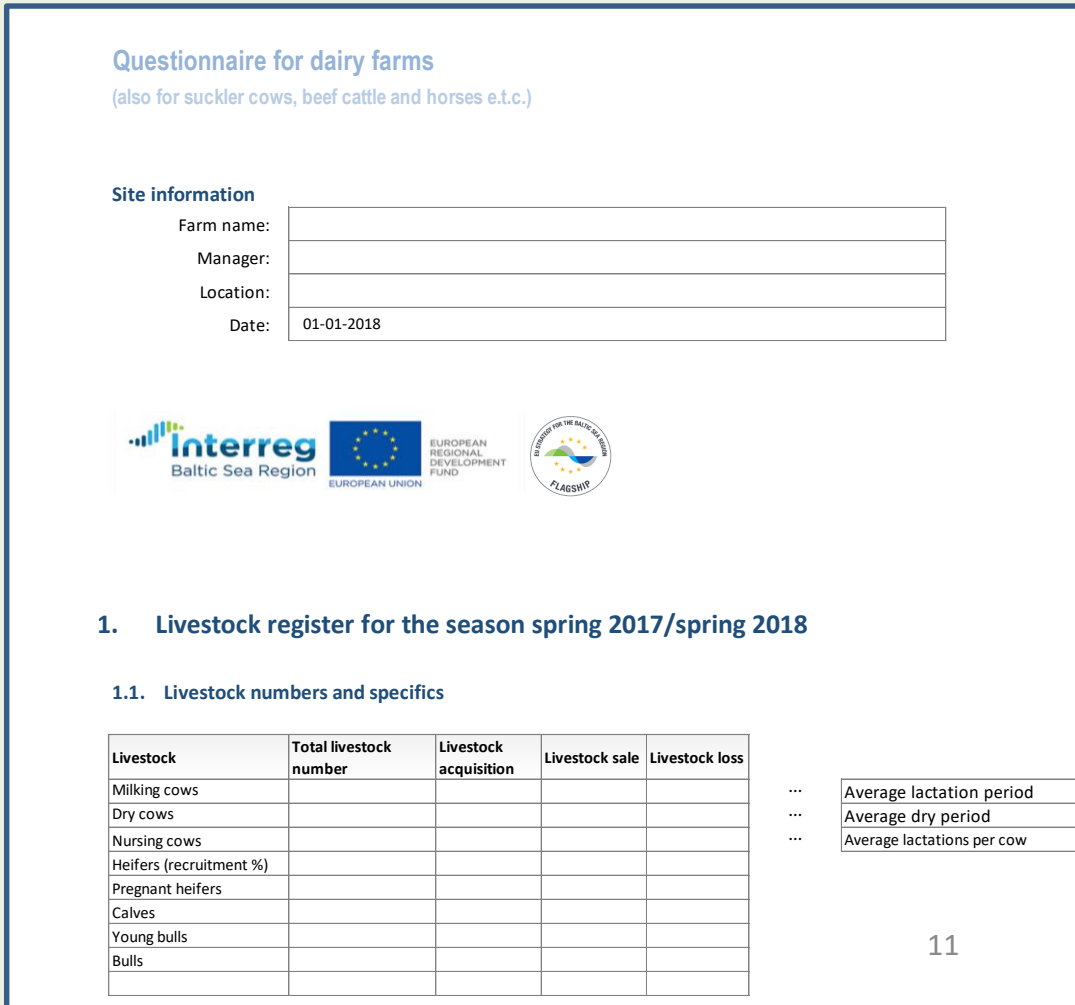
| | |
|---|---|
| ☐ Dry matter | ☐ Magnesium |
| ☐ Total nitrogen | ☐ Calcium |
| ☐ Soluble nitrogen | ☐ Zinc |
| ☐ Total phosphorus | ☐ Manganese |
| ☐ Soluble phosphorus | ☐ Iron |
| ☐ Total potassium | ☐ Copper |
| ☐ Total carbon | ☐ Na |

# TEMPLATES –Extended survey form

## Indata to the modelling in WP3 and WP4

- Three templates:
  1. Dairy farms (also for suckler cows, beef cattle, horses etc.)
  2. Swine
  3. Poultry

- Developed hand in hand with the calculation tool to cover data needs



Questionnaire for dairy farms

(also for suckler cows, beef cattle and horses e.t.c.)

**Site information**

| | |
|---|---|
| Farm name: | |
| Manager: | |
| Location: | |
| Date: | 01-01-2018 |

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**1. Livestock register for the season spring 2017/spring 2018**

**1.1. Livestock numbers and specifics**

| Livestock | Total livestock number | Livestock acquisition | Livestock sale | Livestock loss |
|---|---|---|---|---|
| Milking cows | | | | |
| Dry cows | | | | |
| Nursing cows | | | | |
| Heifers (recruitment %) | | | | |
| Pregnant heifers | | | | |
| Calves | | | | |
| Young bulls | | | | |
| Bulls | | | | |
| | | | | |

… Average lactation period
… Average dry period
… Average lactations per cow

# Templates - Challenges

- Difficult to make a template that suits all farms. Amount of and the form of data available differs very much between countries and farms.
- Farmers might not understand the questions.
- Units commonly used differs between countries. Recalculation is often needed.
- Free units desirable. The modeler, not the farmer should carry out the recalculations.
- We are behind time table within the project.

# CURRENT ANALYSIS METHODS

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- Current methods in country laboratories were collected.
- Methods and standards differ a lot between laboratories, also within the same country.
- Chemists at LUKE (FI) will help out with how to proceed.
- Laboratories in some countries are very slow, might take months, which is not acceptable. The objective must be a week.

| Country | Laboratory | | Ntot | NH4-N | Nsol | Ptot | Psol | Ktot | Dry matter | Volume weight | Microelements | Carbon | pH | Sample volume | Storage[1] | Quality control | No.of analyses for nitro | Preparation for analysis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latvia | 1 | SPPS, Agrochemical Laboratory | LVS EN 13654-1:2003 Digestion: 1 g of sample is digested with mixture of salicylic acid, sulfuric acid and potassium sulfate in prexence of copper sulfate catalyst Determination: Kjeldahl Results expressed to dry or raw sample | LVS EN 13652:2003 Extraction: 1 g of sample is extracted with water at 1:5 volume ratio Determination: Kjeldahl Results expressed to raw or dry sample | - | LVS EN 13650:2003 Digestion: 1 g of sample is digested with aqua regia Determination: spectrophotometry Results expressed to dry or raw sample as P2O5 | - | LVS EN 13650:2003 Digestion: 1 g of sample is digested with aqua regia Determination: flame emission spectrometry Results expressed to dry or raw sample as K2O | LVS EN 13040:2008 Sample is dried at 103±2 °C Results expressed as water content or dry matter content | - | - | LVS EN 13039:2012 Sample is dry ashed at 450±25 °C Results are organic matter expressed to dry or raw sample | LVS 13037:2012 Extraction: sample is extracted with water at 1:5 volume ratio at 22±3 °C Detreminatio n: pH meter | At least 2 L | 1-5 °C for up to 2 weeks | Every anlysis for every sample is replicated at least 2 times | Every anlysis for every sample is replicated at least 2 times | LVS EN 13040:2008 Samples are milled to 2 mm, pH and NH4 are determined before drying, samples are dried at 103±2 °C |
| Latvia | 1 | SPPS, Agrochemical Laboratory | - | - | - | Digestion: 1 g of sample is digested with mixture of salicylic acid and sulfuric acid Determination: spectrophotometry Results expressed to dry or raw sample as P2O5 | - | Digestion: 1 g of sample is digested with mixture of salicylic acid and sulfuric acid Determination: flame emission spectrometry Results expressed to dry or raw sample as K2O | - | - | - | - | - | - | - | - | - | - |
| Lithuania | 1 | Agrolab | Kjeldahl | - | | Mineralization with sulphuric acid and subsequent colorimetric determination. | - | Mineralization with sulphuric acid and subsequent flame photometry. | 105 C | 1 litre, EN 13040 | | LST EN 13137+ 2002 | potentiometric | ? | | | | manual mixing, dried samples milled |
| Lithuania | 2 | | | | | | | | | | | | | | | | | |

# Example of differences between laboratories

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**Total-N:**

Most laboratories use Kjeldahl titration for Tot-N.
However, one laboratory in Sweden (slurry and solid manure) and two in Germany (slurry) use dry combustion. Measuring on dry samples with Dumas method (Leco). Total N is then calculated as: $NH_4$-N + N measured with Dumas method

| | |
|---|---|
| + Dumas method | Easier getting a representative sample |
| - Dumas method | N might be overestimated in case not all $NH_4$ disappear during combustion. |

**Plant available N:**

Generally laboratories analyse for ammonia ($NH_4$)
However, all Finnish laboratories analyse for soluble N
Russia do not analyse for plant available N

| | |
|---|---|
| + Soulable N | Plants may to some extent take up also organically bound N. |
| - Soulable N | Result strongly dependent on mesh size used and extraction solvent. Probably difficult to standardize. |

**Analysis methods will be further discussed during reporting period 3 and recommendations will be presented in the final project output.**

# ANALYSIS RESULT DATABASE

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- Sorting functions for grouping of data.
- Results are still coming in – a lot of data processing remains.

Manure Standards

**Analysis Results**

Report the results on wet (fresh) basis - conversion formula (if needed) in "FILL IN INSTRUCTIONS"-sheet.

Additional parameters - Please add columns (to the right) for parameters which are missing.

Column F-J is filled in by selecting the best suitable option from the in-cell dropdown menu.

Manure types marked * - only to be used for farms with manure processing.

Sorting function - is locked at this sheet but can be used in the "SORTING OPTIONS"-sheet or by copying data to new sheet.

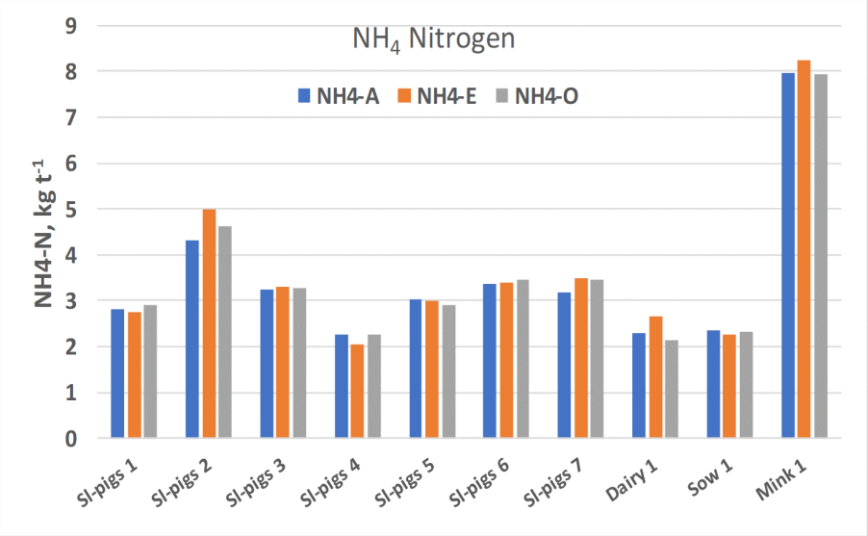
More instructions on how to fill in results you find in the "FILL IN INSTRUCTIONS"-sheet below.

Background information

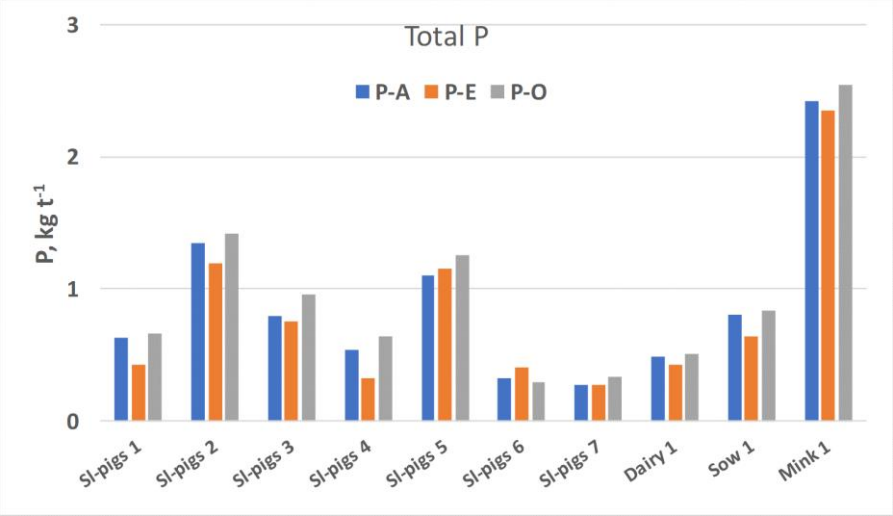
| Result No | Country | Country Farm number | Manure line ID | Sampling Date (dd.mm.yyyy) | Animal group | Manure type | Sampling time | Sampling spot | Sampler | Country laboratory number |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sweden | 4 | 4deeplitter | 25.4.2018 | pigs integrated | deep litter | spring | ex storage | professional | 1 |
| 2 | Sweden | 4 | 4slurry | 22.4.2018 | pigs integrated | slurry | spring | ex storage | professional | 1 |
| 3 | Sweden | 4 | 4deeplitter | 25.4.2018 | pigs integrated | deep litter | spring | ex storage | professional | 2 |
| 4 | Germany | 1 | 1slurryc | 07.05.2018 | dairy cows | slurry | spring | ex housing | professional | 3 |
| 5 | Germany | 1 | 1solidp | 07.05.2018 | fattening pigs | solid | spring | ex storage | professional | 3 |
| 6 | Germany | 1 | 1solidc | 07.05.2018 | dairy cows | solid | spring | ex housing | professional | 3 |
| 7 | Germany | 1 | 1solidh | 07.05.2018 | laying hens | solid | spring | ex storage | professional | 3 |
| 8 | Germany | 2 | 2slurrycn | 07.05.2018 | dairy cows | slurry | spring | ex housing | farmer | 3 |

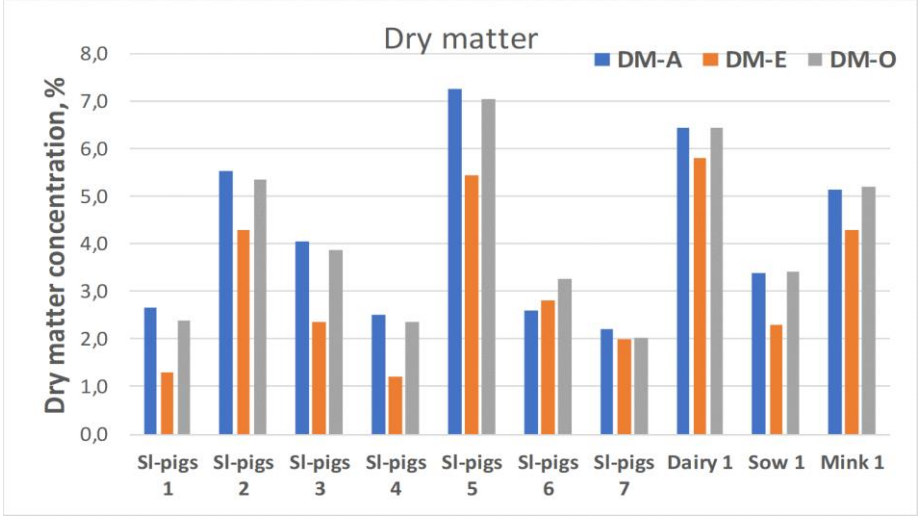
Analysis results

| Dry matter/Total so (%) | Tot-N (kg/ton) | NH4-N (kg/ton) | Tot-P (kg/ton) | K (kg/ton) | Tot-C (kg/ton) | pH | C/N | Ashes (%) | S (kg/ton) | Mg (kg/ton) | Na (kg/ton) | Ca (kg/ton) | Cu (g/ton) | Mn (g/ton) | Zn (g/ton) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21,3 | 7,01 | 1,3 | 3,2 | 8,5 | | 8,51 | 11 | 5,4 | 1,5 | 2,1 | 0,92 | | | | |
| 5,3 | 5,23 | 3,7 | 0,76 | 2,1 | | 6,71 | 4,1 | 1 | 0,51 | 0,63 | 0,78 | | | | |
| 21,6 | 6,3 | 0,4 | 2,16 | 4,33 | 87,4 | 7,2 | 13,9 | | 1,3 | 1,33 | 0,91 | 4,33 | | | |
| 9,94 | 3,66 | 0,78 | 0,84 | 4,74 | 40,95 | 7,2 | 11,19 | | 0,61 | 0,49 | | 1,29 | | | |
| 22,08 | 5,95 | 0,93 | 3,61 | 3,47 | 88,24 | 8,2 | 14,83 | 2,65 | 1,11 | 3,05 | | 5,32 | | | |
| 27,11 | 6,23 | 0,14 | 1,27 | 10,37 | 108,52 | 9,3 | 17,42 | 3,94 | 1,34 | 0,87 | | 2,72 | | | |
| 32,41 | 23,6 | 8,02 | 4,54 | 7,49 | 117 | 7,9 | 4,96 | 4,7 | 1,42 | 1,69 | | 19,3 | | | |
| 8,06 | 4,16 | 1,34 | 0,7 | 3,59 | 31,5 | 7 | 7,57 | | 0,44 | 0,6 | | 2,1 | | | |

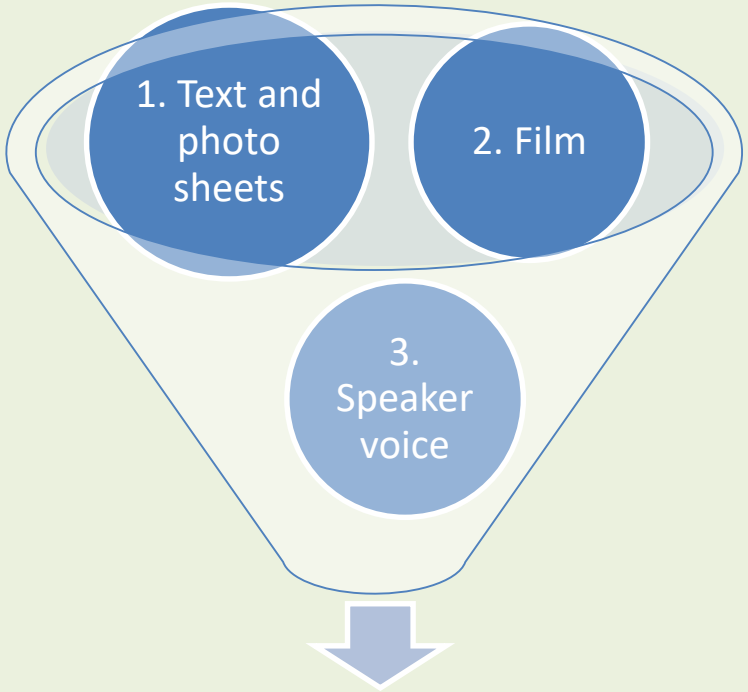



Results from Danish pilot farms show that accredited and experienced laboratories find similar results - especially regarding the water-soluble nutrients $NH_4$ and K. Some variations are found for P and dry matter content (figures by SEGES).



# INSTRUCTION FILM – Components for film making




- Filming was made during sampling season.
- Work proceeds with editing, adding text and voice.
- Low budget – no professional camera man and we filmed some sequences ourselves.
- Latvia is producing a national film on the theme.

Manure, the Movie (max 10 minutes)

# WATER FLOW MEASUREMENTS

In Baltic Manure, it was noticed that the manure quantity and quality changed a lot through dilution from identified and diffuse water sources. Therefore, special attention is given to collection of this data.

- 5 farms
- Drinking (indoor, outdoor)
- Milkroom (dishing etc)
- Washing (stable, field equipment)
- Feeding
- Staff areas
- Total consumption

# Output

- Currently the sampling instruction and the templates are being finalized, after being tested and discussed among partners.  Analysis results are being processed.
- The work with the final output is taking on
  - An **easy-to-read, clear guideline for sampling and analyzing** manure on typical BSR animal farms with different animal species and manure types, including templates for collection of farm data.
  - An **Instruction film**, showing shortly the sampling process. In addition, Latvia is producing a national film.

# Manure analysis - advantages and drawbacks



**(-) Manure data – not in time!!**

Sampling at spreading will not provide data in time for being used at the current occasion. *Solid* manure sampling can easily be done in advance. Slurry however, is generally sampled after mixing, before filling the spreading tankers, and farmers generally do not want/have time to mix one extra time. *On line measurements* is desirable. The technique is however still too unprecise.

**(-) Difficulties getting representative values!**

Slurry tanks and especially lagoons are often not enough mixed to facilitate a representative manure sampling. Solid manure piles are inhomogeneous.

**(+) Complex nutrient flows!**

Striving against a "circular economy" creates *complex nutrient flows* on farms, making *mass balance calculations* more difficult. Farmers often collaborate with surrounding society for example by sending manure for *digestion or combustion*, getting rest products back into manure storage. Or by receiving other rest products as ammonium sulphate from steel industry or whey from cheese production.


Manure Standards
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