

# EU4GREEN

WP 1-6: CODES OF GOOD  
AGRICULTURAL PRACTICE –  
KEY ELEMENTS TOWARDS  
NITROGEN USE EFFICIENCY

September 2025



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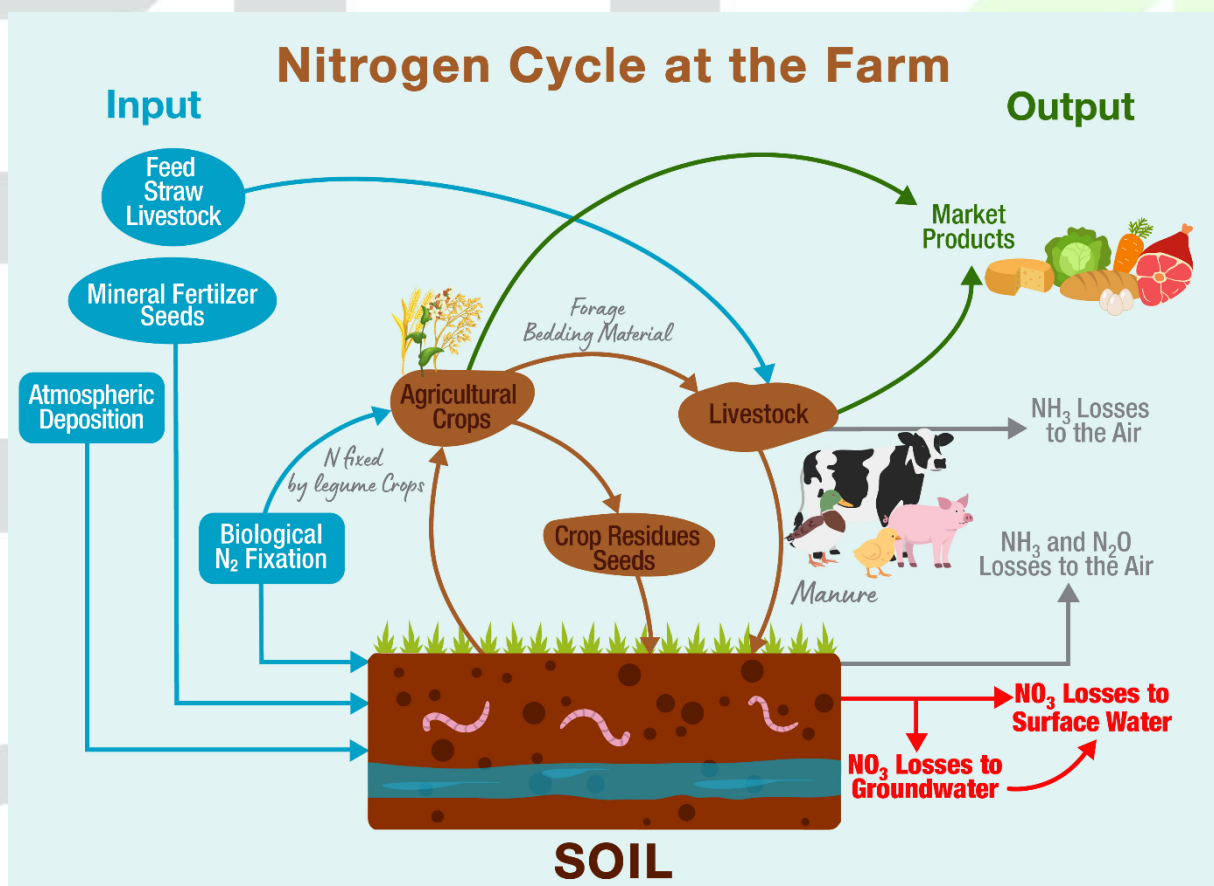
## 1. OBJECTIVES AND HOW TO USE THIS BROCHURE

### 1.1 Nitrogen management required by the EU Nitrates Directive (91/676/EEC)

The Nitrates Directive aims to protect water quality across Europe by preventing nitrates from agricultural sources from polluting ground and surface waters and by promoting the use of codes of good agricultural practices to manage nitrogen use efficiently.

The Directive aims to reduce water pollution from nitrates used in agriculture by

- monitoring nitrate concentrations of water bodies,
- designating nitrate vulnerable zones and
- establishing codes of good agricultural practices and measures to prevent and reduce water pollution from nitrates.



**Reducing nutrient losses to ground and surface water** means more nutrients are available to the farmers, reducing the need for expensive mineral fertilizer inputs. The aim is to increase nitrogen efficiency at farm level and to close the farm nitrogen cycle as far as possible.

Nitrogen is essential for agricultural crop production and can be applied in the form of commercially produced mineral fertilizers, as well as through organic fertilizers such as animal manure, compost or sewage sludge. Another important source of nitrogen in agro-ecosystems

is biological nitrogen fixation by leguminous crops, such as alfalfa, clover, clover-grass-mixtures, soy, peas and field beans.

However, when used excessively or under poor conditions nitrogen can be a major source of water and air pollution, with negative impacts on both biodiversity and the climate.

Water pollution means nitrates losses to ground- and surface water. Nitrates can be leached from the soil into groundwater. Surface water run-off and soil erosion can lead to nitrate losses to surface water. Air pollution is caused by gaseous nitrogen losses in the form of ammonia, mainly from manure and mineral fertilizers – especially urea - and to a lesser extent from the soil. In addition, gaseous nitrogen losses from the soil can occur as climate-relevant nitrous oxide, mainly after fertilization in wet and compacted soils with anaerobic conditions (incomplete denitrification).

## 1.2 Definitions

**Liquid manure** refers to the liquid component of livestock excrement (urine) when collected separately from the solid components.

**Solid manure** refers to the solid component of livestock excrement (manure). This is often mixed with materials used as bedding for animals in the barn, such as straw.

**Slurry** refers to a mixture of solid and liquid components of livestock excrements (total urine + manure). Sometimes this mixture is diluted with water so that it can be spread more evenly on the field as fertilizer.

## 1.3 How this brochure can help...

The aim of this brochure is to support farmers in Montenegro in increasing their nitrogen efficiency by closing nitrogen cycles on the farm and preventing nitrogen losses to the environment.

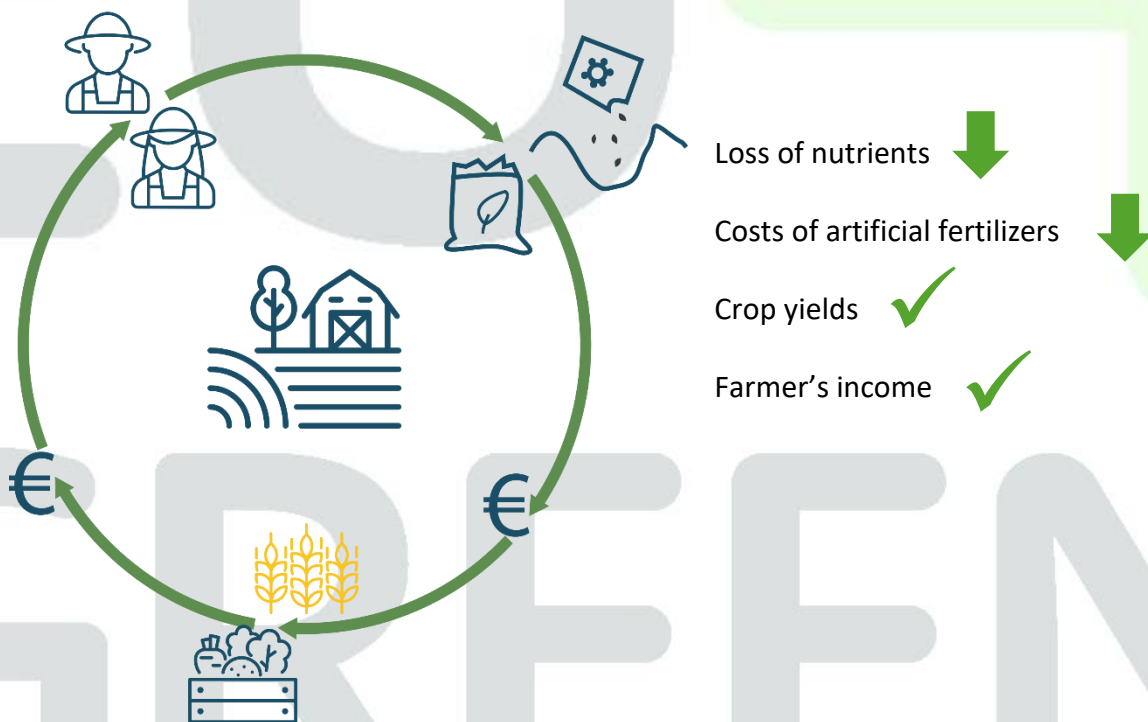
The six key elements according to the EU Nitrates Directive show how to save nitrogen for the farm and for the cultivated plants (food and feed), and thus reduce nitrogen losses to the air or to the water. The brochure lists the six elements of the Codes for Good Agricultural Practice under the Nitrates Directive:

1. Periods when the application of fertilizer is inappropriate
2. Application of fertilizer to steeply sloping ground
3. Application of fertilizer to water-saturated, flooded, frozen or snow-covered ground
4. Conditions for application of fertilizer near watercourses
5. Capacity and construction of storage vessels for livestock manures
6. Procedures for Fertilizer application, including rate and uniformity of spreading

Furthermore, this brochure includes tables with mean nitrogen values to enable nutrient and manure calculations at farm level, like average nitrogen contents of manure, average excreted nitrogen amounts per livestock category and volumes of manure storage capacities. The contents are mainly based on the Official Gazette of Montenegro, No. 29/2014. The target group for this brochure are farmers and agricultural advisors interested in improving the nutrient management of the farms.

## 1.4 Why is Nitrogen Management important and how do farmers benefit?

Pollution of soil, water and air by leaching and fertilizer run-off not only affects the environment but also human health of present and future generations. Responsible agricultural practices ensure clean drinking water and fertile soils for a secure food supply. A particularly important consideration for farmers is the financial aspect. Nutrient losses due to inappropriate fertilizer application lead to a waste of valuable farm resources. Efficient use of fertilizers saves additional costs for mineral fertilizers and ensures stable crop yields. This can lead to higher incomes for farmers and a more secure financial situation for family farms. Manure is a low-cost, valuable source of nitrogen on livestock farms.



## 2. THE 6 KEY ELEMENTS OF THE CODE OF GOOD AGRICULTURAL PRACTICE ACCORDING TO EU NITRATES DIRECTIVE (91/676/EEC)

### 2.1 Periods when fertilizer application is inappropriate

#### What is it about?

Apply nutrients only during the growing season in suitable climatic conditions.

- ⇒ Target fertilizer application to periods when crops need nitrogen. This prevents nutrient losses to water (e.g. no fertilizer application in winter or during drought in summer)
- ⇒ There is no exact blueprint for determining these periods, as each region has specific requirements. It depends on agricultural practices, climate and soil conditions, when nutrient losses are most likely.



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#### What does this mean for my farm?

- ⇒ Define necessary storage capacity for manure storage to avoid manure application in these periods (Element 5).

#### INFLUENCING FACTORS TO DEFINE THE PERIOD:

1. Periods with low water infiltration rate: slaking, crust formation and water saturation of the soil.
2. Periods, when crop growth is just established or inhibited by cold, or when soils are left fallow.
3. Periods, when precipitation (including thawing) exceeds the water infiltration rate to the soil, depending on:
  - average monthly precipitation surpluses
  - temporal uptake patterns and uptake capacity of specific crop types
  - the presence or absence of cover crops and vegetated buffers
  - the use of irrigation.

## Periods when the application of fertilizer is inappropriate as defined for Montenegro (Gazette No. 29/2014):

Liquid manure and slurry	1. December - 1. March
	1. July - 1. August (without incorporation)
Solid manure	1. June – 1. September
Mineral Fertilizer	1. November – 1. February

The Codes of Good Agricultural Practice (CGAP) for Montenegro define two periods in which fertilizer application is inappropriate:

- The common period in the winter months, when crop growth is reduced or inhibited by cold,
- a second period in summer: July and August for liquid manure and slurry. From 1. June to 1. September for solid manure. This accounts for the low precipitation and high temperatures during this time, in which the nutrient uptake of plants is reduced and nitrogen losses are high.

MIDAS-Project, Goss (2012)

## 2.2 Fertilizer application to steeply sloping ground

### What is it about?

After fertilizer is applied to hilly or sloping land (slopes of 15% or more), rain or soil erosion can cause nutrient run-off (nitrogen and phosphorus). This results in the loss of important nutrients intended for plant growth. In addition, the washed-off fertilizers are carried into nearby water bodies and pollute them.

Slurry and liquid manure are not spread

- in general on sloping ground, where it runs off the surface and
- on sloping terrain along watercourses with a gradient of more than 10 % at a distance of less than 10 m from the watercourse

Official Gazette of Montenegro, No. 29/2014

### WHAT TO DO TO REDUCE THE RISK OF NUTRIENT SURFACE RUN-OFF:

- Establish areas with vegetation throughout the year (e.g. pastures instead of fields)
- Incorporate fertilizer quickly after application (especially for liquid manure, biogas manure, fermentation residues, non-stabilized urea fertilizers and non-dewatered sewage sludge)
  - Splitting of fertilizer amounts (partial applications over time)
- Special protective measures for crops with particularly late spring development (e.g. beet, maize, broad beans, soybean):
  - Cultivation across the slope or with other cultivation methods that prevent run-off (e.g. mulch and no-till), cross-ditches with plant cover

- Moderately steep slopes: slope of 10 to 20%
  - Steep slopes: more than 20% (MIDAS, 2012)



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*Sloping agricultural fields where applied fertilizers can be washed away*

## 2.3 Fertilizer application to water-saturated, flooded, frozen or snow-covered ground

### What is it about?

Frozen soil and snow cover limit nutrient movement into the soil and greatly increase the risk of nutrients being carried into surface waters by runoff. The same is true for water-saturated soil. This often occurs after the land has been flooded due to unusually heavy rainfall or when rivers and streams overflow. Therefore, no fertilization should take place in such conditions. This applies equally to arable land and grassland. Furthermore, the use of heavy machinery in very wet conditions can lead to severe compaction of the soil.



In Montenegro manure should not be spread (Official Gazette of Montenegro, No. 29/2014):

- on soil saturated with water;
- on areas that are covered with snow;
- on frozen land;
- on flooded soil: only after the end of the flood risk period, excluding the possibility of flooding.

**Water saturated soil:** the soil is so wet that it cannot absorb any more water, for example after heavy rainfall. It is recommended to check the weather forecast for the next 48 hours before applying fertilizer. This can prevent the loss of valuable fertilizer through run-off.

**Flooded soil:** the ground is flooded due to overflowing watercourses and cannot absorb any more water. Fertilizer application in regularly flooded areas should be limited to the growing season when the crop uptake is high.

**Snow-covered soil:** if less than half of the soil in the field is free of snow.

**Frozen soil:** if the soil does not thaw during the day.

## 2.4 Fertilizer application near water courses

### What is it about?

Buffer zones protect water bodies from fertilizer run-off. Therefore, avoid the direct entry of nutrients into surface waters by keeping a certain distance between fertilized area and surface water.

### Recommendation:

Establish a permanent vegetation cover within approximately 3 metres from the edge of the watercourse. This zone should not be plowed and should only be renewed every 5 years at most. This measure helps to prevent the loss of valuable fertilizer into the water.

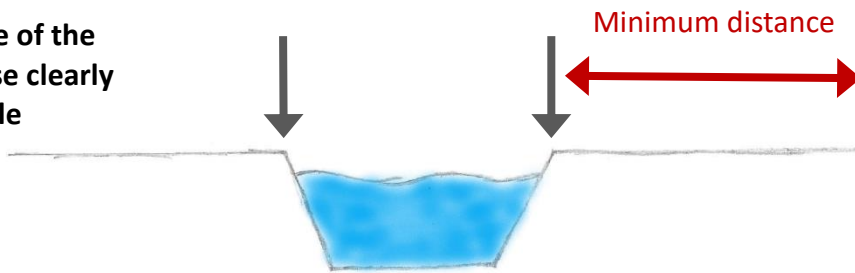
Example: Buffer zone widths in Austria	Slope in %	Distance to standing water bodies	Distance to running water bodies
Arable field	< 10 %	20 m	10 m
	< 10 %	10 m (covered with living plants all year)	3 m (covered with living plants all year)
	> 10 %	20 m	5 m (covered with living plants all year)
Grassland	< 10 %	10 m	3 m
	> 10 %	20 m	5 m



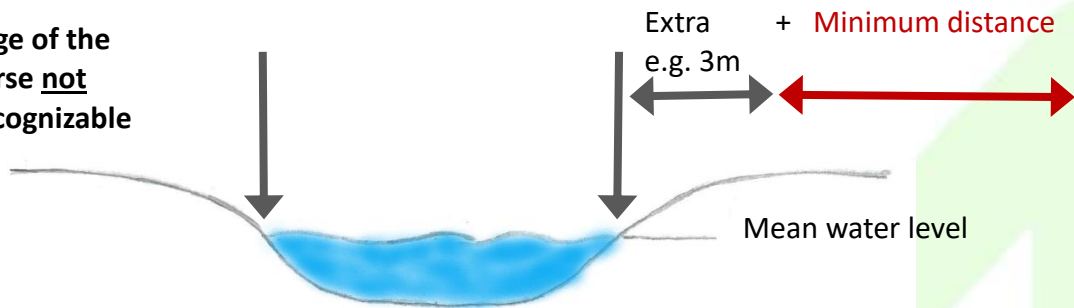
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## Reference points for minimum distances from watercourses

Upper edge of the watercourse clearly recognizable



Upper edge of the watercourse not clearly recognizable



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In Montenegro slurry and liquid manure should **not** be applied:

- at a distance of 50 m from a well,
- at a distance of 20 m from a lake,
- at a distance of 5 m from other watercourses.

Official Gazette of Montenegro, No. 29/2014

## 2.5 Capacity and construction of storage vessels for livestock manures

### What is it about?

Safe and secure manure storage to prevent water pollution from run-off and leaching into ground and surface water.

- ⇒ Condition of storage containers or pads: liquid-tight containers, concrete waterproof areas, controlled leachate discharge into a liquid-tight collection pit
- ⇒ Sufficient storage capacity prevents manure application at inappropriate times.



### Calculation of Storage Capacity

- Storage capacity should be adapted to the longest period during which fertilizer application is not appropriate → Key element 1
- The recommended minimum storage capacity for manure on a livestock farm is 6 months
- Do not forget to include the amount of precipitation and water from cleaning processes

### Tip: HOW TO CALCULATE THE CAPACITY OF THE MANURE STORAGE TANK



Manure accumulation amounts for each livestock category are included in the Annex (attention: use the manure production amounts according to the manure system on your farm, e.g. slurry or solid and liquid manure)

$$\begin{aligned} & \text{Manure production per animal per month} \times \\ & \text{number of animals} \times 6 \text{ months} \\ & = \text{Minimum storage capacity for 6 months (m}^3\text{)} \end{aligned}$$



## 2.6 Procedures for fertilizer application, including rate and uniformity of spreading

### What is it about?

Procedures for fertilizer application, including rate and uniformity of spreading, of both chemical fertilizer and livestock manure, which will maintain nutrient losses to water at an acceptable level.

- ⇒ The Nitrates Directive sets a maximum limit for the nitrogen amount applied from livestock manure: 170 kg N per hectare per year.

**Tip: HOW TO CALCULATE THE TOTAL NITROGEN AMOUNTS OF LIVESTOCK MANURE AVAILABLE AT THE FARM PER YEAR**



Nitrogen amounts per livestock category and year are included in the Annex

**Nitrogen excretion per animal × number of animals  
= total Nitrogen (kg) in manure in one year**

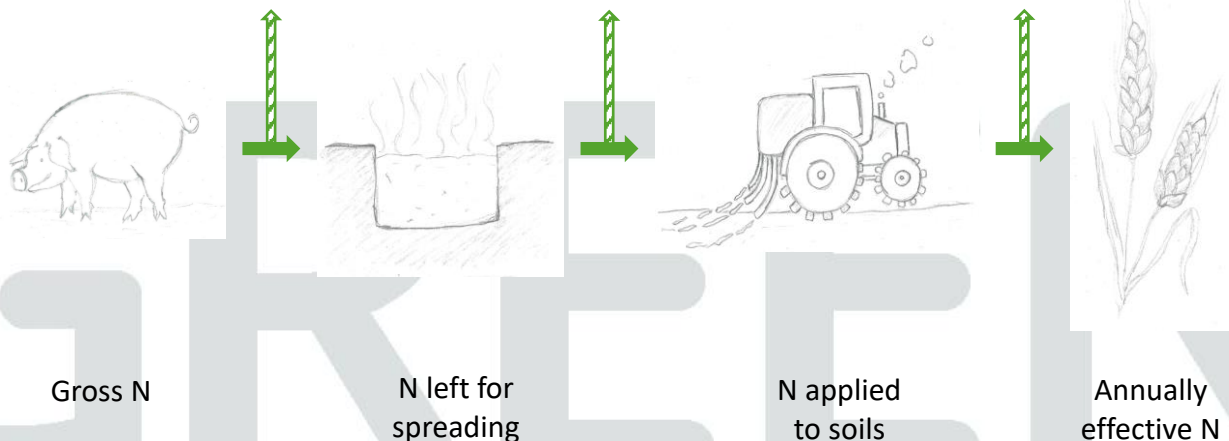
What should be taken into account?

- Nitrogen excretion coefficients per animal category to calculate the nitrogen amounts available in manure
- Splitting of fertilizers
- Accuracy of fertilizer distribution: equipment must be adequate to portion and distribute fertilizers properly
- Incorporation of fertilizers
- Weather and wind conditions

Stable and storage losses

Losses during spreading

Delayed effectiveness of organically bound N



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## Planned Nitrogen limit for Mineral fertilizers in Montenegro:

From harvest to the beginning of the time periods of → **Key element 1:**

max. amount of nitrogen:

- on light (sandy) soils: 40 kg/ha;
- on heavy (clayey) soils: 80 kg/ha.

Official Gazette of Montenegro, No. 29/2014

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## LITERATURE

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## ANNEX: NITROGEN EXCRETION AND MANURE PRODUCTION BY LIVESTOCK

*Nitrogen excretion coefficients and manure production for livestock categories in Montenegro. Data source: Regulation on the principles of good agricultural practice for the application of fertilizers ("Official Gazette of Montenegro", No. 29/2014)*

Livestock category	Nitrogen excretion in kg N per year per animal	Manure production per animal (m <sup>3</sup> ) per month SOLID MANURE	Manure production per animal (m <sup>3</sup> ) per month LIQUID MANURE	Manure production per animal (m <sup>3</sup> ) per month SLURRY
<b>Cattle</b>				
Cattle less than 1 year	28.0	0.5	0.1	0.9
Cattle 1-2 years	49.0	0.9	0.2	1.2
Male Cattle over 2 years	70.0	1.3	0.3	1.7
Female Cattle over 2 years	56.0	1.1	0.3	1.3
Dairy Cows	70.0	1.3	0.3	1.7
Breeding bulls	98.0	1.9	0.5	2.3
<b>Swine</b>				
Piglets (less than 20kg)	1.6	0.03	0.01	0.03
Breeding boars	32.0	0.5	0.1	0.7
Breeding sows	24.0	0.4	0.1	0.5
Fattening pigs	12.0	0.2	0.1	0.25
<b>Sheep and Goats</b>				
Sheep	7.0	0.1	0.03	0.2
Goats	3.5	0.1	0.03	0.2
<b>Poultry</b>				
Broilers	0.2	0.003	0.001	0.004
Layers	0.3	0.01	0.001	0.01
Turkeys	1.7	0.03	0.01	0.03
Rabbits and Game birds	0.2	0.003	0.001	0.003
<b>Horses</b>				
Foal < 1 year	30.0	0.7	0.2	0.8
Horses	72.0	1.6	0.4	2.0

A free **Livestock Manure Calculator** (Microsoft Excel spreadsheet) is available under the following QR code to help you calculate the **manure storage capacity** and the **nitrogen amount in manure**:



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