

EU4GREEN

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

September 2025



Funded by
the European Union



With funding from

Austrian
Development
Cooperation

umweltbundesamt^U
ENVIRONMENT AGENCY AUSTRIA

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Imprint:

Owner and Editor:
Umweltbundesamt GmbH
Spittelauer Lände 5, 1090 Vienna, Austria

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September 2025

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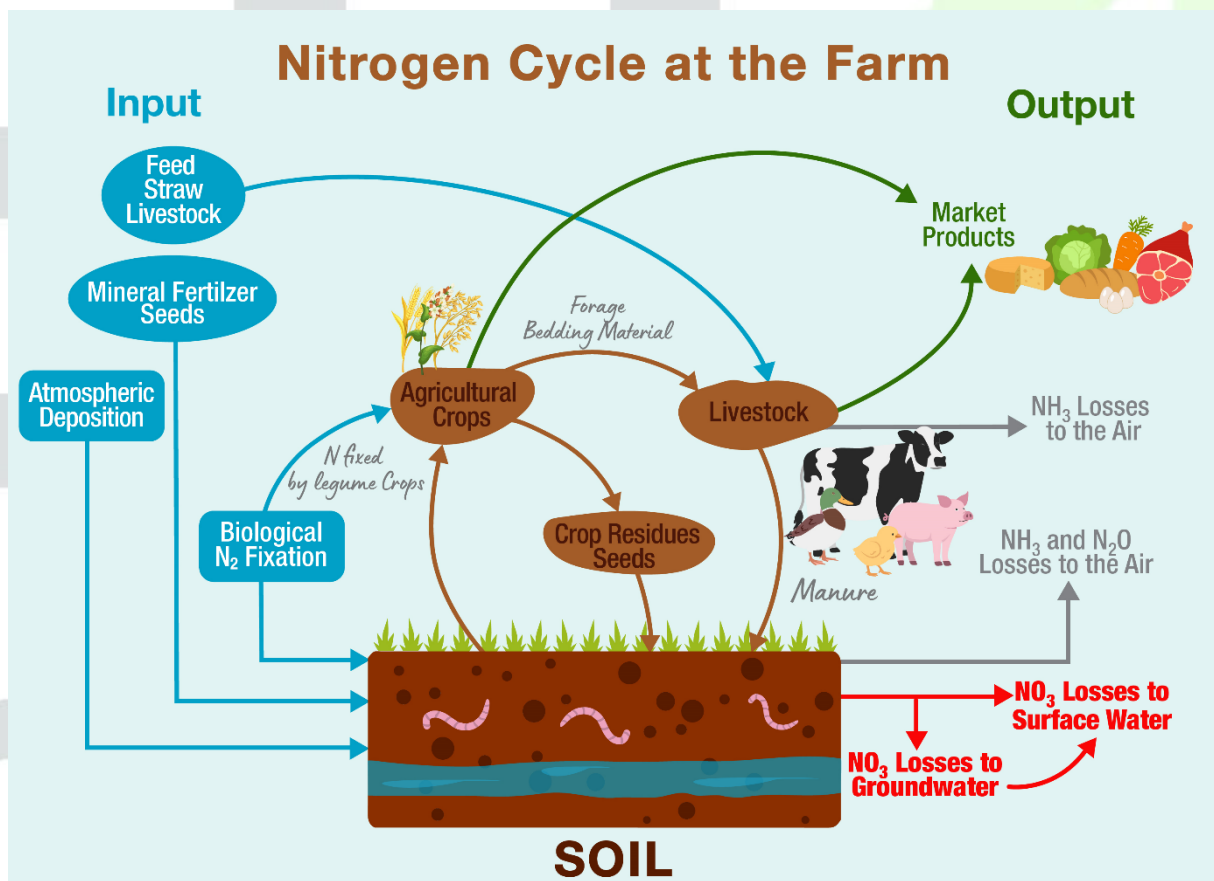
1. OBJECTIVES AND HOW TO USE THIS BROCHURE

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 Serbia 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 nitrogen excreted amounts per livestock category and volumes of manure storage capacities.

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.

Loss of nutrients



Costs of artificial fertilizers



Crop yields



Farmer's income



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.

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

INFLUENCING FACTORS TO DEFINE THE PERIOD:

What does this mean for my farm?

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

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

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.

In **Serbia** manure shall not be applied on steep slopes where runoff risk is high. Plowing in applied slurry within 6 hours and solid manure within 24 hours is recommended, except in bad weather or equipment failure.

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



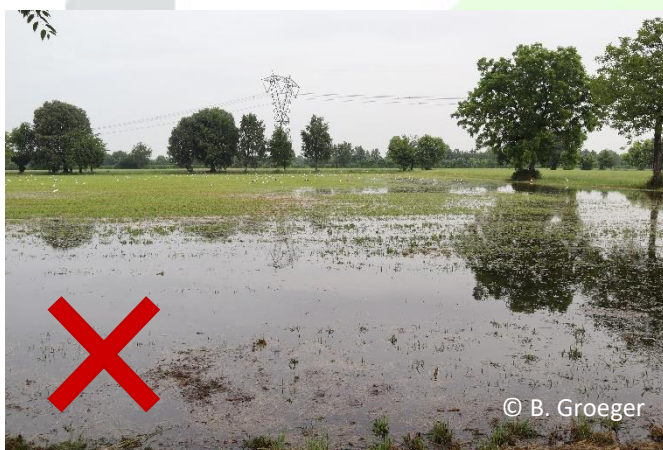
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Sloping agricultural fields where applied fertilizers can be washed away

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 Serbia fertilizers shall not be applied during heavy rains when there is a significant risk of runoff or leaching. Furthermore, they shall not be applied on waterlogged, flooded, frozen, or snow-covered land, or when heavy rain is forecast within 48 hours. Here are a few indicators of unfavorable conditions for fertilization:

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.

Official Gazette of RS, No. 23/2023

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:

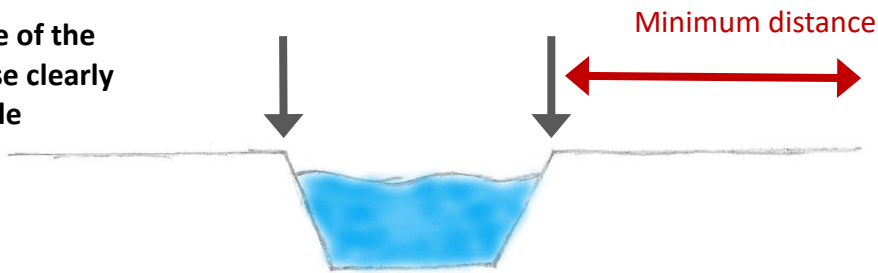
Establish a permanent vegetation cover within approximately 3 m from the edge of the watercourse. This should not be plowed and should only be renewed every 5 years at most. This measure helps to prevent the loss of valuable fertilizer into the water.

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

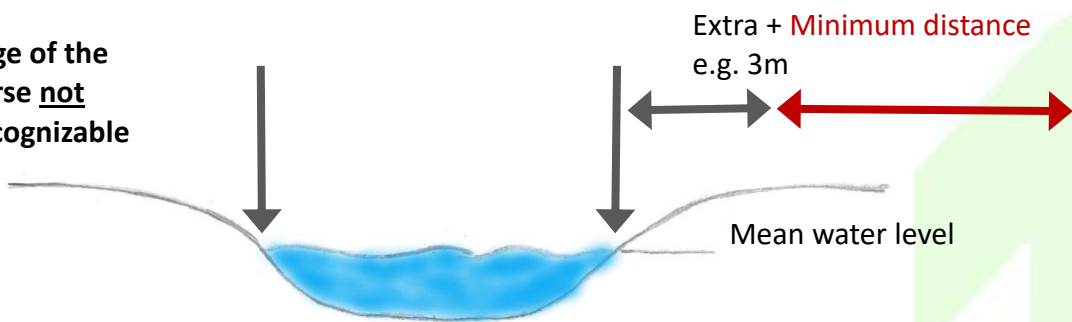


Reference points for minimum distances from watercourses

Upper edge of the watercourse clearly recognizable



Upper edge of the watercourse not clearly recognizable



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In **Serbia**, the following distances are recommended to protect watercourses and wells:

- minimum distance of 5 meters from flowing water bodies
- minimum distance of 10 meters from standing waters,
- minimum distance of 50 meters from wells or boreholes up to 20 meters deep used for drinking water or milk processing.

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.



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



Manure accumulation amounts for each livestock category are included in the Annex

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



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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

What does this mean for my farm?

Formulas and units for calculations:

- ⇒ Slurry: 1t = 1 m³
- ⇒ Solid Manure: Cattle: 0.83 t = 1 m³. Pigs: 0.91 t = 1 m³, Poultry: 0.5 t = 1 m³, Sheep/Goats: 0.7 t = 1 m³

Calculate the area of a manure pad:

$$\frac{\text{Total solid manure (m}^3\text{) for 6 months period}}{2} = \text{area of manure pad (m}^2\text{)}$$

Manure Storage in Serbia (Action Program 2018)

The **manure storage capacity** should cover at least **6 months**, but it is recommended to build larger storage capacities to ensure maximum flexibility.

Solid manure: stored on a concrete waterproof platform. Should have a collection channel to prevent seepage into ground and surface water.

Slurry and liquid manure: collected and stored in a watertight slurry tank/reservoir. Should preferably be covered.

Manure storage facilities should be built at least at:

- **3 m** distance from the outer edge of the watercourse with a bed width of 5 m or more
- **10 m** distance from the outer edge of the watercourse bed, on sloping terrains along watercourses with a slope greater than 10%
- **20 m** distance from the outer edge of the lake bed or other standing water

"Official Gazette of the RS", no. 81/06

To support proper manure management, **investments** in manure storage and handling are subsidized by the Rural Development Program 2021-2027 (IPARD III-Program of the Instrument for Pre-Accession Assistance for Rural Development).

For more information see:
<https://ipard.gov.rs/>

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**

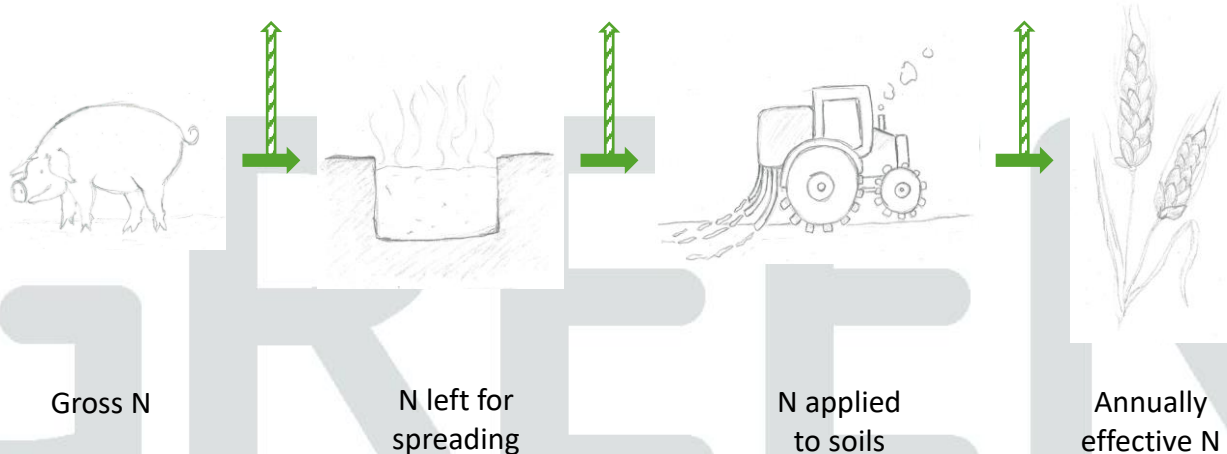
WHAT SHOULD BE TAKEN INTO ACCOUNT?

- 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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Procedures for Fertilization in Serbia (Draft Action Program 2018)

Foreseen permitted quantities of nitrogen for fertilization:

- **210 kg/ha per year**, in a period of 4 years after the entry of Serbia in the EU
- **170 kg/ha per year**, after the expiration of 4 years after the entry of Serbia in the EU

When applying manure, the evaporation of nitrogen into the air should be reduced as much as possible during loading, transport and spreading on fields.

Furthermore the following measures should be applied:

- Control fertilizer application in nitrate-sensitive areas based on crop needs, existing soil nitrogen and phosphorus levels and lab-tested manure nutrient content.
- Keeping records of all fertilizer applications, including annual purchased quantities, type, nutrient content, application dates and amounts, and location and size of the plot is also part of the Code of Good Agricultural Practice.
- Nitrogen fertilizers shall not be applied on land intended for catch crops or nitrogen-fixing crops.

Official Gazette of RS, No. 23/2023

3. LITERATURE

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Regulations on veterinary-sanitary conditions for facilities for breeding and keeping ungulates, ungulates, poultry and rabbits. "Official Gazette of the RS", no. 81/06.

4. ANNEX: NITROGEN EXCRETION AND MANURE PRODUCTION IN LIVESTOCK

Nitrogen excretion coefficients and manure production quantities for livestock categories in Serbia. Data source: Nitrogen excretion coefficients: Montenegrin Regulation on the principles of good agricultural practice for the application of fertilizers ("Official Gazette of Montenegro", No. 29/2014); Daily manure production/animal: Faculty of Agriculture, University of Belgrade, Beograd, 2004 (Codes of Good Agricultural Practice Serbia 2016). Note: At the time of writing, no specific values for manure production for sheep and goats for Serbia were available. For this reason, values from Montenegro are included in the table (Daily manure production/animal: 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 ³) per month SLURRY
Cattle		
Cattle less than 1 year (calf)	28.0	0.2
Young Male Cattle	70.0	0.7
Young Female Cattle	56.0	0.8
Dairy Cows	70.0	1.7
Swine		
Piglets (less than 20kg)	1.6	0.07
Breeding boars	32.0	0.33
Breeding sows	24.0	0.46
Fattening pigs	12.0	0.15
Sheep and Goats		
Sheep	7.0	0.2
Goats	3.5	0.2
Poultry		
Broilers	0.2	0.002
Layers	0.3	0.005
Turkeys	1.7	0.009

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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