

Technical file

Optimal use of farm manure

**Increase the value of your stock farming
waste where the plant needs it the most!**



WHY? - WHEN? - HOW? - HOW MUCH? - AT WHICH PRICE?

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Optimal use of farm manure

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Optimal use of farm manure

A. INTRODUCTION

FARM MANURE, A REAL OPPORTUNITY FOR MODERN AGRICULTURE!

“For all modern farmers, it is more and more important to:

- know, master and lower the production cost (the price of mineral fertilizers keeps increasing, following the fuel and energy prices);
- manage and use the stock farming waste, but also a range of dead organic matter;
- maintain the soil fertility and humus rate. If quality manure is spread every year, it is possible to get a 1 % increase in organic matter in 20 years. On the contrary, 10 years without spreading manure are enough to lose it.”

Source: Le Sillon belge, 12/10/04, p. 13

“Several elements have to be taken into account when intending to use organic matter, especially farm manure:

- the spreading time, often depending on the nitrogen effect;
- the nature of this fertilizing matter and its own properties (composition, agronomic and financial value...);
- the bioavailability or the efficiency of the supplied mineral elements.

There are two categories of farm manure:

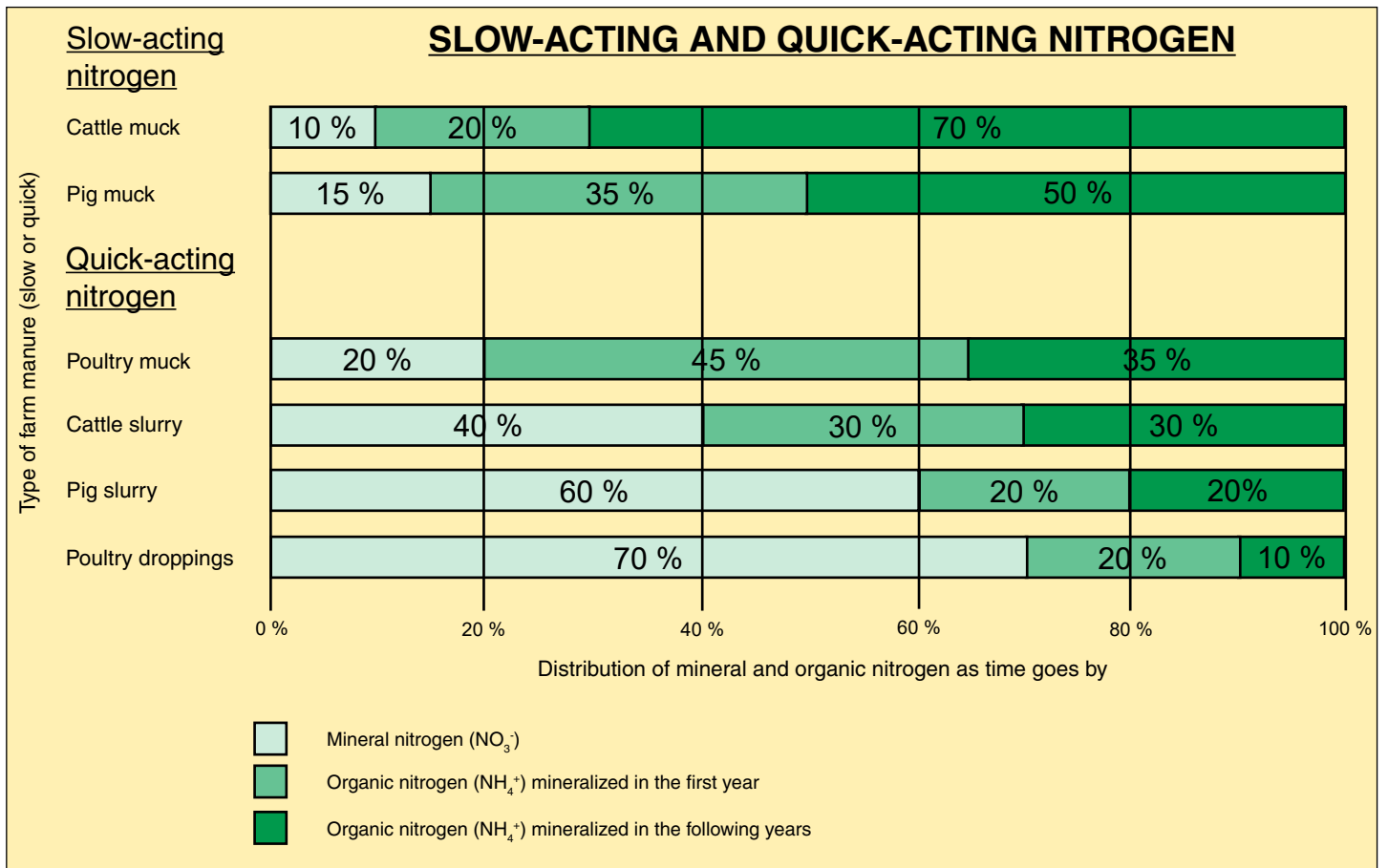
- slow-acting manure (mainly the different types of muck, except poultry muck), which should rather be spread in summer (just before planting a nitrate trap crop) or in autumn;
- quick-acting manure (mainly the different types of slurry and the poultry droppings), which should rather be spread in spring (just before ploughing or when doing it again in the next year).“

Source: Le Sillon belge, 12/10/04, p. 13

The graph 1 clarifies the notion of slow-acting and quick-acting nitrogen by indicating the distribution of mineral and organic nitrogen as time goes by.

Graph 1: Distribution of mineral and organic nitrogen contained in different types of farm manure and illustration of the notion of slow-acting and quick-acting nitrogen

Source: *Le Sillon belge*, 12/10/04, p. 14



“There are two categories of farm manure:

- *slow-acting manure (mainly the different types of muck, except poultry muck), which should rather be spread in summer (just before planting a nitrate trap crop) or in autumn;*
- *quick-acting manure (mainly the different types of slurry and the poultry droppings), which should rather be spread in spring (just before ploughing or when doing it again in the next year).”*

Source: Le Sillon belge, 12/10/04, p. 13

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B. AGRONOMICAL REASONS WHY USING FARM MANURE

FARM MANURE IS A SOIL CONDITIONER AND A COMPLETE FERTILIZER:

- The basic and mainly organic SOIL CONDITIONING VALUES of farm manure, which have been neglected for long, must absolutely be taken into account in order to maintain the soil fertility and limit the pollution risks. Indeed, spreading muck of muck compost regularly can significantly modify the soil content of organic matter in ten years.
- As far as most nutrients are concerned (P - K - Ca - Mg and trace elements), the FERTILIZING VALUE of farm manure is the same as for mineral fertilizers.

On the contrary, as far as NITROGEN is concerned, the directly usable fraction (comparable to ammonium nitrate) may vary from 10 % for cattle muck to 70 % for pig and poultry slurry (the remaining part seems to reach the soil organic matter reserve with a much lower mineralizing rhythm).

This is the reason why it is important to manage the fertilizing process with very different “time steps” according to the considered type of farm manure.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.29; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC



1. FARM MANURE, UNDENIABLE ORGANIC SOIL CONDITIONER

“The organic soil conditioners include the “fertilizing matter mainly made up of fermented or fermentable carbonaceous compounds of vegetal origin, which aim at maintaining or rebuilding the soil organic matter reserve”.

They allow to:

- increase the number of days available to carry out the soil working and seeding operations in good conditions,
- improve the growth quality, namely in silty soil,
- increase the water and mineral cation retention of the soil, e.g. in sandy soil,
- create soil conditions that are favourable to the competing or even antagonist micro-organisms of the parasitic fungus on crop roots.

According to their composition, the various types of farm manure act or not as organic soil conditioners.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.6; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

“Given their content of organic matter, the nature of these organic elements and the spread quantities, some types of farm manure are to be considered as real organic soil conditioners. This mainly concerns cattle, caprine, horse, sheep and pig muck, as well as the corresponding composts.

Besides, do not forget that farm manure, acting as an organic soil conditioner, improves the physical state of the seed bed quicker because it can be left on the surface or simply mixed with the seed bed. In this respect, muck composts are more interesting than muck. Indeed, they do not prevent the seeding or seed bed preparing tools from working properly and they do not hinder the seedling growth, as they prevent nitrogen deficiency and hollow soil.

In ruminant stock breeding, i.e. with annual areas of forage crops, long-duration pastures and fertilizing systems based on muck-like slurry or compost-like muck, it is possible to significantly increase the soil content of organic matter in ten years.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.32; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

2. FARM MANURE, UNDENIABLE MINERAL SOIL CONDITIONER

2.1. NITROGEN

“Farm manure brings two types of nitrogen: MINERAL and ORGANIC.

The farm manure mineral nitrogen has the same effect as the mineral fertilizers.

The organic nitrogen comes from the living or dead micro-organisms of the intestinal tract, the non-digestible proteins and the litters.

Actually, both compartments are permanently mixed up. In favourable conditions, part of the organic nitrogen is mineralized in the 3 to 5 weeks after spreading. This mineralizing time may last several months when spreading muck at the beginning of winter. Another part reaches the pool of humidified organic matter in the soil.

The first two parts (mineral and easily mineralized organic fractions) are very quickly available for the cultivated vegetation covers. They correspond to the direct nitrogen effect of farm manure. The last organic fraction is mineralized very slowly, from the second year on, simultaneously with the stable organic matter in the soil. It corresponds to the after-effect of farm manure.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.36; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

“The development of the different nitrogenous fractions in farm manure

The nitrogen may be gaseous, solid or dissolved in ground water. Its development is a cycle to which farm manure contributes. The development of the different nitrogenous fractions in farm manure is presented in Diagram 1.

The nitrogen is an essential gas to produce proteins, without which one cannot live. On the other hand, only the mineral nitrogen (NO_3^-), which is soluble in water, can be directly absorbed by the plants. Indeed, this is not the case for gaseous nitrogen (N_2) and organic nitrogen (NH_4^+), which must be mineralized beforehand.

Actually, the nitrogenous fraction that can be absorbed by the plants is the result of simultaneous phenomena:

- VOLATILIZATION: gaseous losses, as ammonia (NH_3),
- NITRIFICATION: NH_4^+ ions turned into NO_3^- ions, which are absorbed by the cultivated plants (feeding) or lixiviated by drainage water (leaching) when they are not absorbed by the roots,
- IMMOBILIZATION: nitrogen organization in soil organic matter,
- MINERALIZATION of easily mineralized organic nitrogen coming from spread slurry or muck,
- DENITRIFICATION: NO_2^- ions coming from NH_4^+ oxidation or NO_3^- reduction can be lost as gas, i.e. oxide of nitrogen (N_2O , NO ,...) or gaseous nitrogen (N_2).”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.40; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

“The mineralization of easily mineralized organic nitrogen

When the soil temperature and humidity are favourable, the first mineralization process of farm manure organic nitrogen takes place within the first days or weeks after spreading. It goes along with a sudden increase in the microbial biomass, which consists of agents specialized in the degradation of easily degraded organic molecules: soluble sugar, starch, cellulose and proteins.

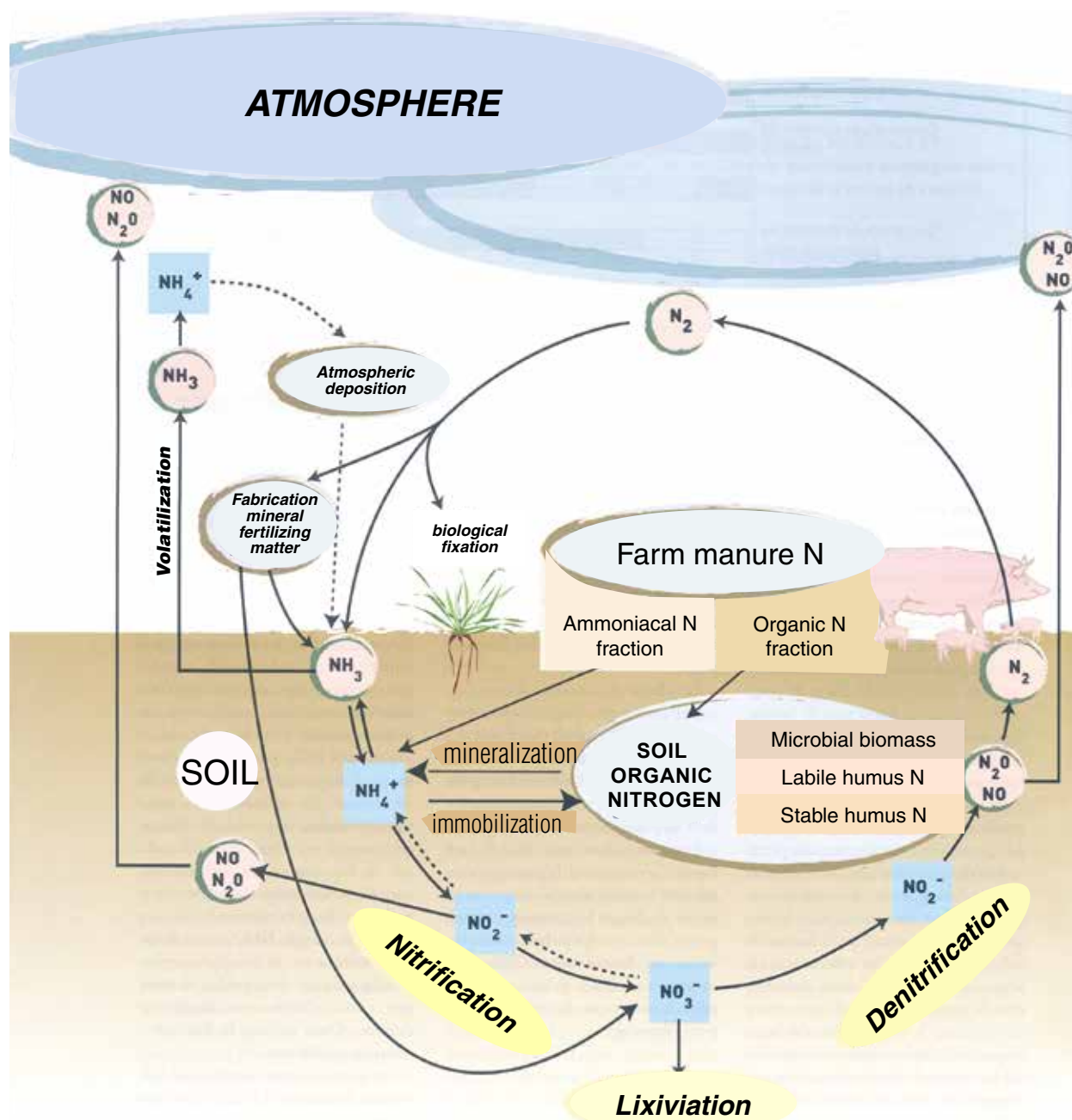
When the quantity of easily degraded organic matter is not sufficient any more to ensure the growth of the microbial biomass, part of it dies. It is mineralized by releasing NH_4^+ ions that go and reach the soil organic nitrogen reserve.

As a result, half of the organic nitrogen found in pig slurry (i.e. 20 % of total N) and cattle slurry (i.e. 30 % of total N) is turned into ammoniacal nitrogen in a few weeks after spreading.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.40; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

Diagram 1: Nitrogen cycle

Source: *Fertiliser avec les engrais de ferme*, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p. 29; *Chambres d'agriculture de Picardie (2001)*; Vlaco vzw; Agra Ost; BPC



In the air

The biggest nitrogen reserve necessary to life is the air, which is indeed made up of 80 % nitrogen and 20 % oxygen.

Unfortunately, the gaseous nitrogen (N_2) cannot be directly absorbed by living organisms. It must first be mineralized.

This mineralizing process is executed:

- by electrochemical (lightning,...) or photochemical (U.V.) fixation, the oxidation capacity of which allows nitrogen to become oxidized (by the oxygen in rain water H_2O) and to create NO_3^- ;
- by special nitrogen fixing and nitrate (NO_3^-) producing bacteria.

Thanks to this mineralization, nitrogen is brought to the plant roots after being turned into nitrate (NO_3^-). These nitrate anionic ions are soluble in water and they can consequently be absorbed by the plants.

In the soil

There is a second big reserve of nitrogen necessary to life: the nitrogen of organic origin (dead organisms, leaves,...). The animal effluents (slurry, muck, droppings...), i.e. urea, are also part of this category.

Just as the gaseous nitrogen (N_2), the organic nitrogen cannot be directly absorbed by living organisms. It must first be mineralized. The organic matter is decomposed by bacteria and fungus. The organic nitrogen (NH_4^+), which comes from decomposing dead organisms, undergoes several chemical transformations (nitrification) in order to create mineral nitrogen that can be directly absorbed by the plants (NO_3^-).

The urea is turned into ammonia (NH_3) before undergoing the same nitrification process as the other kinds of organic matter.

Thanks to this mineralization, nitrogen is brought to the plant roots after being turned into nitrate (NO_3^-). These nitrate anionic ions are soluble in water and they can consequently be absorbed by the plants.

3. FARM MANURE DOES NOT ACIDIFY THE SOIL

“The basic soil conditioner mainly aims at maintaining or increasing the soil pH when the soil shows acidification risks. Its aim is to:

- favour the activity of some micro-organisms meddled in the nitrogen cycle,
- prevent manganic and mainly aluminic phytotoxicity risks on crops,
- improve the molybdenum availability, this trace element being essential to rapeseed and some legumes (lucerne, soya and clover).

As opposed to what people may think, spreading farm manure means reducing the soil acidity. It can even help to limit the mineral fertilizer supply.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.33; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC



“Many tests show that partly or completely replacing the ammonium nitrate nitrogen by cattle slurry or cattle muck allows to significantly reduce the basic mineral maintenance and to end up with a maintained or even increased soil pH.”

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001, p.32; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

4. BIOAVAILABILITY AND EFFICIENCY OF FARM MANURE!

“The different types of farm manure are an interesting source of major (N-P-K-Mg, but also sulphur and calcium) and minor (zinc, copper, boron...) organic elements. Some of these have exactly the same availability on arable grounds than those supplied by mineral fertilizers. Other organic elements are only partially available, while the bioavailability of some others may increase from year to year.

The potash and the magnesia are characterized by a good bioavailability. The potassium and magnesium - which are soluble (carbonate, sulfate, chloride...) - and most of the trace elements coming from organic manure have (almost) the same bioavailability (90 % for potash) than those coming from synthetic mineral fertilizers.

The nitrogen, the sulphur and (to a lesser extent) the phosphorus are less efficient:

- organic manure nitrogen is always less efficient than synthetic fertilizer nitrogen (e.g. the ammonium nitrate). A great deal of the nitrogen is temporarily stuck in the soil and its organic character prevents it from being used directly.

As a result, only the nitrogen coming from the organic nitrogen mineralization (which takes place between the emergence and the haulm stripping) can be directly taken by the crop. This largely explains why the organic products are less efficient when they are supplied in autumn instead of end winter - begin spring. When spreading in autumn, part of the nitrogen coming from the farm manure spread in late autumn will be leached and lost;

- the phosphorus of cattle muck or slurry is as efficient as that of soluble phosphatic fertilizers.

In some cases, the phosphorus coming from pig and mainly poultry breeding facilities ends up in slurry and poultry droppings as organic elements resisting to mineralization. Its bioavailability may consequently be limited. In Belgian soils, we generally work on the principle that the coefficient of equivalence of P_2O_5 is 1.

As a result, it is absolutely necessary to be able to assess the availability of the different mineral elements as precisely as possible, according to their origin (type of manure) and their spreading time in the year.”

Source: Le Sillon belge, 12/10/04, p. 14

“Tests have been made with farm manure in order to compare mineral, organic or mixed types of fertilizing matter, leading to the following observations:

- the injection of slurry (at the beginning of the year and in good soil conditions) allows to meet a great deal of the plant needs in fertilizing elements;
- the actual composition of slurry is often quite different from the average composition, so that it is important to make analyses beforehand;
- the quality and output results (when using slurry) are similar to those of completely mineral types of fertilizers (with mineral complement at the beginning or in the course of the season).

Moreover, all the needs in nitrogen can be met by cattle or pig slurry if the soil is clayey. Besides, spreading slurry (without adding synthetic nitrogenous fertilizers) is at least as profitable as using mineral nitrogen supply.”

Source: Le Sillon belge, 12/10/04, p. 15

“The agronomical reasons why using organic matter can be summed up as follows:

- *maintaining or even improving the physical (soil structure) and physicochemical (humus role) condition, as well as the content of organic matter;*
- *directly providing the soil with major and minor nutrients;*
- *stimulating the soil microbial life.”*

Source: Le Sillon belge, 12/10/04, p. 13

5. AVERAGE COMPOSITION OF FARM MANURE

“The soil organic matter is a nitrogen reserve that is never completely dried up but seldom contains a sufficient quantity of this element.

This reserve does not only include nitrogen but also all the other elements (phosphorus, potash, magnesium, as well as minor elements and trace elements). It is therefore important to supply organic matter regularly and to know, as precisely as possible, the value, availability and efficiency of the different types of farm manure. In this way, it is indeed possible to complete this organic manure with mineral fertilizers (if need be).

The table 1 indicates the average supply of the different types of farm manure. Do not forget that a previous analysis of the product is essential to spread manure in a sensible way.”

Source: Le Sillon belge, 10/12/2004, p.13

**Table 1: Quantities of organic matter and mineral elements
in several types of farm manure (kg/t)**

Source: Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP 2001; Chambres d'agriculture de Picardie (2001); Vlaco vzw; Agra Ost; BPC

	Dry matter	Organic matter	Total nitrogen Total N	Phosphorus Units of P ₂ O ₅	Potash Units of K ₂ O	Magnesium Units of MgO	Sulphur Units of SO ₃	Lime Units of CaO
<i>Compact to very compact cattle muck</i>	180 to 220	150 to 180	5 to 6	1.05 to 2.5	7 to 9.6	2 to 2.5	1.8	2.5
<i>Compost of very compact cattle muck</i>	330	210	8	5	1.4	2.5	3.8	4
<i>Muck of table breed poultry</i>	650 to 750	400 to 530	20 to 32	18 to 27	15 to 20	4.7	8.3	
<i>Humid or pre-dried poultry droppings</i>	200 to 400	120 to 240	15 to 22	14 to 20	12	2.9		60
<i>Cattle slurry</i>	50 to 110	40 to 90	1.5 to 5	1 to 3.3	2.5 to 4	1	0.4 to 1.1	2
<i>Pig slurry</i>	50 to 90	30 to 60	4 to 9.6	3.5 to 5	2.5 to 6.4	1.3	0.5 to 0.9	3

6. FERTILIZING VALUE OF FARM MANURE

Source: Eau-Nitrate, Bonnes pratiques agricoles, NITRAWAL, 07/2004

6.1. Cattle muck

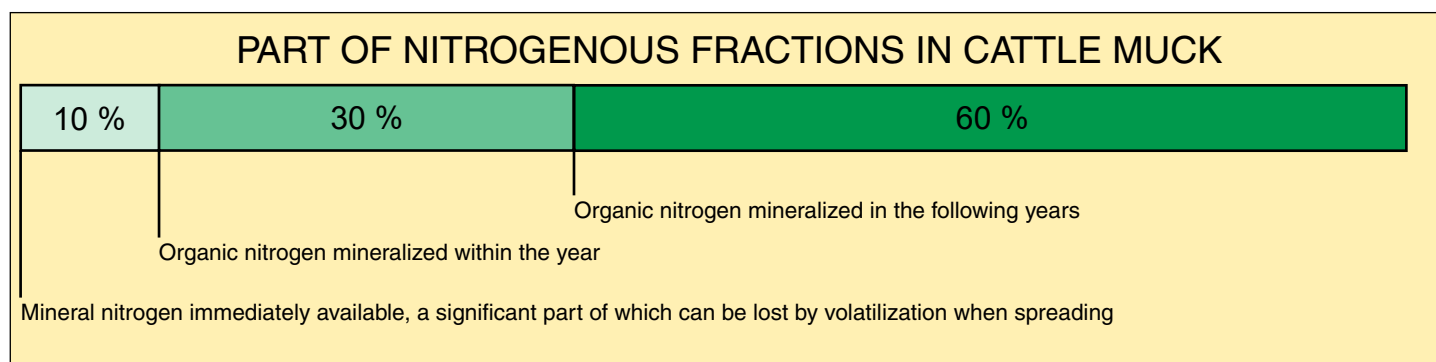
6.1.1. Average content of fertilizing elements in cattle muck

These are average contents. The composition may vary from one type of muck to the other, according to the feeding and stocking conditions.

It is always advisable to make an analysis in a laboratory.

Cattle muck	kg straw/animal/day	% dry matter	Total N (kg/ton effluents)	P ₂ O ₅ (kg/ton effluents)	K ₂ O (kg/ton effluents)
<i>Very compact from piled up litter</i>	>5	22.3	5.8	2.9	9.6
<i>Compact from straw slope</i>	4.5	18.2	4.9	2.3	9
<i>Compact from stanchion stable</i>	3.5	18.5	5.3	1.7	7.1
<i>Laying box effluents</i>	2.5	19	5.1	2.3	6.2

Unlike in the case of mineral fertilizers, these quantities are not completely available for the plant. They vary according to the crop, the spreading date and frequency, especially as far as the nitrogen contents are concerned.



6.1.2. Coefficient of mineral equivalence of cattle muck

The coefficient of equivalence makes it possible to compare farm manure to mineral fertilizers. This coefficient varies in relation to the type of farm manure, the crop, the spreading time and the supply frequency.

Coefficient of equivalence for nitrogen	Cereals		Maize/Beets (and other spring crops)		Meadows	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
<i>Every year</i>	0.50	0.50	0.70	0.80	0.80	0.83
<i>Every 2 years</i>	0.33	0.33	0.45	0.55	0.50	0.53
<i>Every 3 years</i>	0.27	0.27	0.37	0.47	0.40	0.43
<i>Occasionally</i>	0.15	0.15	0.20	0.30	0.20	0.23

The coefficients of equivalence for potassium and phosphorus are unchanged.

6.1.3. Quantity of fertilizing elements supplied by cattle muck

Make the following operation in order to assess the supplied quantity C of fertilizing elements:

$$\mathbf{A \times B \times \text{spread quantity} = C}$$

A: Average content of fertilizing elements in cattle muck

B: Coefficient of mineral equivalence of cattle muck

C: Quantity of fertilizing elements supplied by the organic manure, to be subtracted from the needed quantity of mineral fertilizers

6.2. Cattle slurry

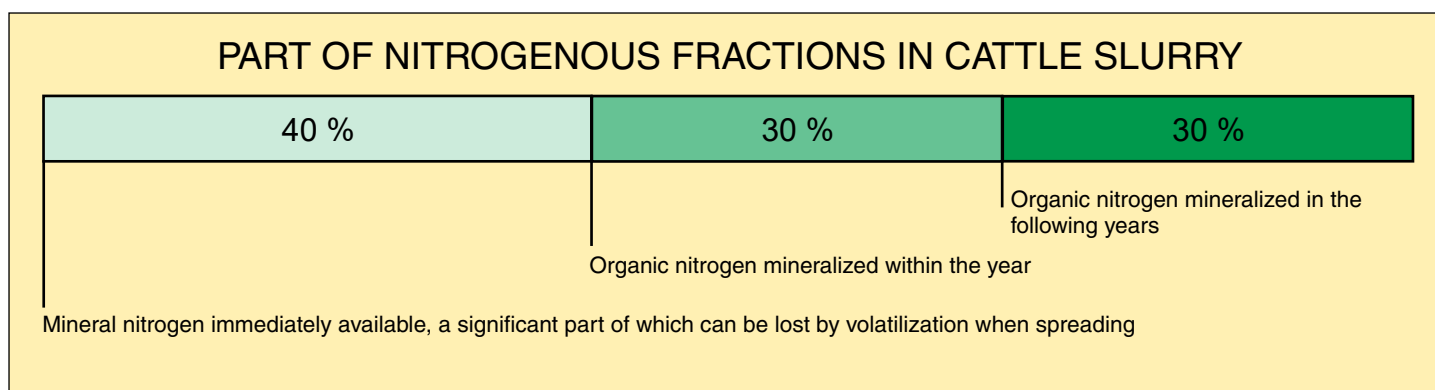
6.2.1. Average content of fertilizing elements in cattle slurry

These are average contents. The composition may vary from one type of slurry to the other, according to the feeding and stocking conditions.

It is always advisable to make an analysis in a laboratory.

Cattle slurry		% dry matter	Total N (kg/ton effluents)	P ₂ O ₅ (kg/ton effluents)	K ₂ O (kg/ton effluents)
<i>In covered system</i>	<i>Almost hard</i>	11.1	4	2	5
	<i>Diluted</i>	8	2.7	1.1	3.3
<i>In non covered system</i>	<i>Very diluted</i>	5.1	1.6	0.8	2.4

Unlike in the case of mineral fertilizers, these quantities are not completely available for the plant. They vary according to the crop, the spreading date and frequency, especially as far as the nitrogen contents are concerned.



6.2.2. Coefficient of mineral equivalence of cattle slurry

The coefficient of equivalence makes it possible to compare farm manure to mineral fertilizers. This coefficient varies in relation to the type of farm manure, the crop, the spreading time and the supply frequency.

Coefficient of equivalence for nitrogen	Cereals		Maize/Beets (and other spring crops)		Meadows	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
<i>Every year</i>	0.40	0.50	0.62	0.77	0.75	0.80
<i>Every 2 years</i>	0.30	0.40	0.46	0.61	0.55	0.60
<i>Every 3 years</i>	0.27	0.37	0.41	0.56	0.48	0.53
<i>Occasionally</i>	0.20	0.30	0.30	0.45	0.35	0.40

The coefficients of equivalence for potassium and phosphorus are unchanged.

6.2.3. Quantity of fertilizing elements supplied by cattle slurry

Make the following operation in order to assess the supplied quantity C of fertilizing elements:

$$\mathbf{A \times B \times \text{spread quantity} = C}$$

A: Average content of fertilizing elements in cattle slurry

B: Coefficient of mineral equivalence of cattle slurry

C: Quantity of fertilizing elements supplied by the organic manure, to be subtracted from the needed quantity of mineral fertilizers

6.3. Pig slurry

6.3.1. Average content of fertilizing elements in pig slurry

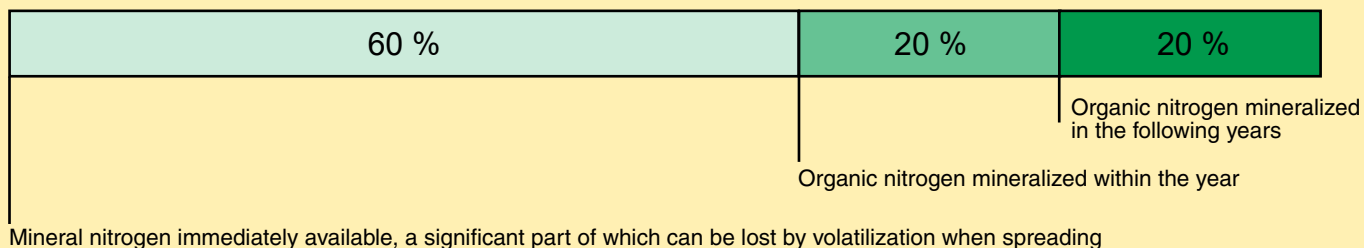
These are average contents. The composition may vary from one type of slurry to the other, according to the feeding and stocking conditions.

It is always advisable to make an analysis in a laboratory.

Pig slurry	% dry matter	Total N (kg/ton effluents)	P ₂ O ₅ (kg/ton effluents)	K ₂ O (kg/ton effluents)
<i>Pregnant sows</i>	1.6	2.8	0.9	2.5
<i>Nursing sows</i>	3.7	3.5	2.7	2.3
<i>Post-weaning piglet</i>	6.5	5.7	4.8	4.1
<i>Finishing pigs</i>	8.2	8	5.7	4.4
<i>In non covered system</i>	8.2	7.9	7.8	5.8

Unlike in the case of mineral fertilizers, these quantities are not completely available for the plant. They vary according to the crop, the spreading date and frequency, especially as far as the nitrogen contents are concerned.

PART OF NITROGENOUS FRACTIONS IN PIG SLURRY



6.3.2. Coefficient of mineral equivalence of pig slurry

The coefficient of equivalence makes it possible to compare farm manure to mineral fertilizers. This coefficient varies in relation to the type of farm manure, the crop, the spreading time and the supply frequency.

Coefficient of equivalence for nitrogen	Cereals		Maize/Beets (and other spring crops)		Meadows	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
<i>Every year</i>	0.33	0.53	0.50	0.80	0.60	0.70
<i>Every 2 years</i>	0.27	0.47	0.40	0.70	0.48	0.58
<i>Every 3 years</i>	0.24	0.44	0.37	0.67	0.43	0.53
<i>Occasionally</i>	0.20	0.40	0.30	0.60	0.35	0.45

The coefficients of equivalence for potassium and phosphorus are unchanged.

6.3.3. Quantity of fertilizing elements supplied by pig slurry

Make the following operation in order to assess the supplied quantity C of fertilizing elements:

$$\mathbf{A \times B \times \text{spread quantity} = C}$$

A: Average content of fertilizing elements in pig slurry

B: Coefficient of mineral equivalence of pig slurry

C: Quantity of fertilizing elements supplied by the organic manure, to be subtracted from the needed quantity of mineral fertilizers

6.4. Poultry effluents

6.4.1. Average content of fertilizing elements in poultry effluents

These are average contents. The composition may vary from one type of effluent to the other, according to the feeding and stocking conditions.

It is always advisable to make an analysis in a laboratory.

Poultry effluents		% dry matter	Total N (kg/ton effluents)	P ₂ O ₅ (kg/ton effluents)	K ₂ O (kg/ton effluents)
Muck	Table breed	75	29	25	20
	Label breed	70	20	18	15
Droppings	Humid droppings	25	15	14	12
	Pre-dried droppings (on floor)	40	22	20	12
	Dried droppings (in shed)	80	35	40	28

Unlike in the case of mineral fertilizers, these quantities are not completely available for the plant. They vary according to the crop, the spreading date and frequency, especially as far as the nitrogen contents are concerned.

PART OF NITROGENOUS FRACTIONS IN POULTRY EFFLUENTS

70 %	20 %	10 %
Mineral nitrogen immediately available, a significant part of which can be lost by volatilization when spreading	Organic nitrogen mineralized within the year	Organic nitrogen mineralized in the following years

6.4.2. Coefficient of mineral equivalence of poultry effluents

The coefficient of equivalence makes it possible to compare farm manure to mineral fertilizers. This coefficient varies in relation to the type of farm manure, the crop, the spreading time and the supply frequency.

Coefficient of equivalence for nitrogen		Cereals		Maize/Beets (and other spring crops)		Meadows	
		Autumn	Spring	Autumn	Spring	Autumn	Spring
<i>Muck</i>	<i>Every year</i>	0.40	0.50	0.62	0.77	0.75	0.80
	<i>Every 2 years</i>	0.30	0.40	0.46	0.61	0.55	0.60
	<i>Every 3 years</i>	0.27	0.37	0.41	0.56	0.48	0.53
	<i>Occasionally</i>	0.20	0.30	0.30	0.45	0.35	0.40
<i>Droppings</i>	<i>Every year</i>	0.33	0.53	0.50	0.80	0.60	0.70
	<i>Every 2 years</i>	0.27	0.47	0.40	0.70	0.48	0.58
	<i>Every 3 years</i>	0.24	0.44	0.37	0.67	0.43	0.53
	<i>Occasionally</i>	0.20	0.40	0.30	0.60	0.35	0.45

The coefficients of equivalence for potassium and phosphorus are unchanged.

6.4.3. Quantity of fertilizing elements supplied by poultry effluents

Make the following operation in order to assess the supplied quantity C of fertilizing elements:

$$\mathbf{A \times B \times \text{spread quantity} = C}$$

A: Average content of fertilizing elements in poultry muck and droppings

B: Coefficient of mineral equivalence of poultry effluents

C: Quantity of fertilizing elements supplied by the organic manure, to be subtracted from the needed quantity of mineral fertilizers

Optimal use of farm manure

C. LIMITING THE AMMONIA LOSSES BY VOLATILIZATION

Source: Interaction entre les modes d'épandage et les odeurs, Agra-Ost

1. FACTORS INFLUENCING THE AMMONIACAL NITROGEN LOSSES BY VOLATILIZATION

The ammoniacal nitrogen (NH_3) comes from urine and uric acids. As it is soluble in water, the following balance arises:



The ammoniacal nitrogen losses by volatilization increase as the balance moves to the left, i.e. when there is more and more NH_3 than NH_4^+ .

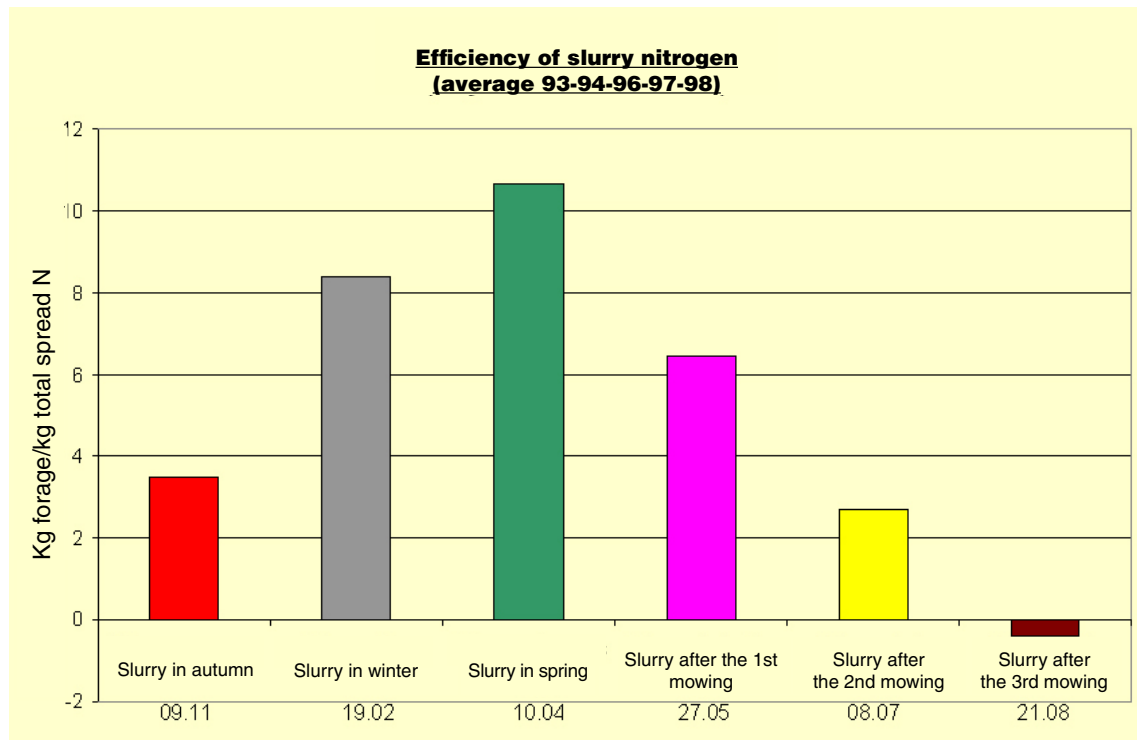
In this way, the nitrogen losses can amount to 15 % when spreading ammonia fertilizers in difficult conditions.

As far as muck and slurry are concerned, these losses can vary from 10 to 90 % in difficult spreading conditions.

The factors making the balance move to the left are the following ones:

- Type and composition of farm manure:
 - Muck/slurry
 - pH of muck/slurry:
When the pH is > 8 , the ammoniacal nitrogen volatilization becomes highly significant.
 - Dry matter content of muck/slurry:
The ammoniacal nitrogen volatilization increases in direct proportion to the dry matter content of muck/slurry.
 - Ammoniacal nitrogen content of slurry:
The ammoniacal nitrogen volatilization increases in direct proportion to the ammoniacal nitrogen content of slurry.
- Soil:
 - Soil type (content of clay and organic matter):
CEC = Cation Exchange Capacity
The Cation Exchange Capacity indicates the binding capacity of the NH_4^+ ions to clayey minerals and humus. The higher this capacity, the lower the concentration in NH_4^+ ions. As a result, the balance moves to the right, which means that ammonia (NH_3) is turned into ammonium (NH_4^+).
The volatilization is therefore limited for soils with a very high CEC.
 - Soil structure/state
Impermeable soil (waterlogged, compacted or frozen) favours ammoniacal losses.
 - Soil vegetation cover
A dense and rich cover prevents slurry from seeping into the soil and is a great emission surface.
 - Soil humidity (water content)
- Weather conditions:
 - Temperature: The ammoniacal nitrogen volatilization increases exponentially with the temperature.
 - Relative air humidity
 - Wind speed
 - Precipitations

- Spreading time:
 - Hour
 - Season



Source: Interaction entre les modes d'épandage et les odeurs, Agra-Ost

Graph 2: Efficiency of slurry nitrogen according to the spreading time (average 93-94-96-97-98)

- Slurry spreading mode:
 - On the surface
 - Injection

Whatever the slurry spreading mode may be, it is always advisable to distribute slurry homogeneously. We will also tend to limit the air/slurry contact and to prevent slurry from sticking to leaves (e.g. in meadows). In this respect, it is essential to spread fluid and homogeneous slurry, to use appropriate material and to work in cloudiness.

Table 2: Nitrogen emissions linked to the different spreading systems

Spreading mode	Spreading tools	Ammonia losses in relation to the total spread quantity of NH_4^+ (%)
Thrown, high and far away, as small drops	- Exact scatterer, - Twinjet spreading boom, - Multitwist multi-nozzle spreading boom.	20 - 100
Close to the ground	- Pendentist line spreading boom, - Multi-Action meadow injector, - Wide-Action meadow injector.	10 - 50
In the soil	- Solodisc meadow injector, - Terraflex arable injector, - Terrasoc arable injector.	0 - 15

Source: Interaction entre les modes d'épandage et les odeurs, Agra-Ost

Whatever the slurry spreading mode may be, it is always advisable to distribute slurry homogeneously. We will also tend to limit the air/slurry contact and to prevent slurry from sticking to leaves (e.g. in meadows). In this respect, it is essential to spread fluid and homogeneous slurry, to use appropriate material and to work in cloudiness.

Presentation of the JOSKIN “spreading tools” range

In the modern agricultural world, it becomes more and more important to know, master and lower your production costs. At the same time, it is therefore more and more important to manage and increase the value of your farm manure in the best possible way, in order to maintain the soil fertility and the humus rate in the ground.

Besides, the national legislations tend to make the injection of slurry compulsory in the near future, even if this is not the case yet.

In short, no stone is left unturned in order to use your farm manure in a sensible and environmentally beneficial way. The sustainable management of nitrogen is already one of the daily concerns of modern agriculture.

In this XXIst century, the agricultural world will have to face an important challenge: how to increase the value of farm manure where the plants draw the nutrients they need to grow: in the ground, near the roots!

The legislation of several countries of the E.U. increasingly tends to make the injection of all kinds of slurry compulsory (in the short or middle term).

In the same way, the various troubles linked to slurry smells are more and more subjected to restrictive norms and regulations.

Facing these new obligations, JOSKIN offers several solutions that are suited to the needs of each farmer and meet the requirements of the professional and modern farmers.

Today, JOSKIN presents a “spreading tools” programme that is both extensive...

- spreading booms,
- meadow injectors,
- arable injectors,

... and in the forefront of technology, leading to:

- efficient and profitable injection,
- improved ground output,
- limited ammoniacal nitrogen losses by volatilization (according to weather conditions): 20 to 100 % losses when using an exact scatterer (traditional spreading) and never more than 15 % losses when using an injector,
- less smells,
- less chemical fertilizers to buy.



Arable injectors

1: Terrasoc

- 2 rows of fixed tines
- 24 cm wide duckfoot shares
- Working depth: 10 to 12 cm

2: Terraflex/2

- 2 rows of flexible tines
- 6,5 cm wide reversible straight shares
- Working depth: 12 to 15 cm

2: Terraflex/3

- 3 rows of flexible tines
- 6,5 cm wide reversible straight shares
- Working depth: 12 to 15 cm

Meadow injectors

3: Multi-Action

- Multifunctional injector
- Works thanks to its own weight
- Working depth: 0 to 3 cm

4: Solodisc

- Disc injector
- Hydraulic system regulating the working depth
- Discs: Ø 406 mm
- Working depth: 1 to 6 cm

5: Wide-Action

- Injector with discs and skids
- Hydraulic system keeping a constant pressure on the linkage
- Discs: Ø 250 mm
- Working depth: 0 to 4 cm

Spreading booms

6: Peditwist

- Line spreading
- Slurry laid down at the foot of the plant
- Multiple applications
- Anti-drip linkage to prevent any slurry loss during transport

7: Multitwist

- Several umbrella-jets
- Low wind resistance and good distribution
- Anti-drip linkage to prevent any slurry loss during transport

8: Twinjet

- 2 swinging scatterers
- Traditional (air) spreading with large working width
- Direct feeding

Optimal use of farm manure

D. USING FARM MANURE IN A SENSIBLE WAY

“Using organic manure in a non sensible way has various negative effects. Which are these risks?”

- nitrogen overfertilization, leading to possible problems during the cultivation;
- nitrogen leaching and possible ground water pollution, e.g. when spreading manure at the wrong time or in too large quantities;
- soil compaction when spreading manure on grounds that have not been dried enough or using inappropriate material. The resulting compaction may have several negative consequences (clod formation, damage to the soil structure...).

The way the farmer will use his farm manure has to be thought out in several stages:

- 1) Choosing the appropriate time in order to limit the agronomic risks as much as possible (compaction of and damage to the soil structure, nitrogen supply at the wrong time or in too large quantities, blown soil), as well as environmental risks (leaching and ground water pollution);
- 2) Assessing the organic matter to be spread as precisely as possible or analyzing it in order to know its composition;
- 3) Taking the bioavailability and the coefficient of efficiency/equivalence of the supplied mineral elements into account;
- 4) Homogenizing the farm manure when collecting it in the barn and loading it into a muck spreader or a slurry tanker, while making sure the spreading operation is properly carried out (performing and correctly set up material). This is essential to distribute the mineral elements in the best possible way.”

Source: Le Sillon belge, 12/10/04, p. 14



Optimal use of farm manure

E. FINANCIAL REASONS WHY USING FARM MANURE

1. PRACTICAL EXAMPLES

1.1. Example 1

The first example concerns a milk producer who owns 60 ha pastures and 10 ha silage maize. His livestock is made up of:

- 120 dairy cows,
- 20 heifers from 0 to 1 year,
- 20 heifers from 1 to 2 years.

We work on the principle that 30 % of the farm manure is used on maize crops and the remaining 70 % on pastures, the animals staying in the barn in the winter period (6 months/year) and 6 hours/day in the summer period (milking).

Considering that:

- each dairy cow produces 12.5 m³ slurry/year,
- each heifer from 0 to 1 year produces 3.7 m³ slurry/year,
- each heifer from 1 to 2 years produces 5.6 m³ slurry/year,

Source: Arrêté du Gouvernement wallon relatif à la gestion durable de l'azote en agriculture, October 10, 2002

The quantity of valuable slurry per year on all the grounds of this farming concern amounts to:

$$120 * 12.5 + 20 * 3.7 + 20 * 5.6 = 1.686 \text{ m}^3$$

The cattle slurry contains 4 kg nitrogen per ton of stock farming waste (on average). About 40 % of this nitrogen is mineral and can be directly absorbed by the plant while the remaining nitrogen (60 %) is organic and will be mineralized in the 2nd and 3rd year after spreading. As a result, the farmer can count on an annual mineral nitrogen supply from his stock farming waste that amounts to:

- immediately (within the year): $1686 * 4 * 40 \% = 2.698 \text{ kg mineral nitrogen}$
- in the second year: $2698 + (1686 * 4 * 30 \%) = 4.721 \text{ kg mineral nitrogen}$
- in the third year: $4721 + (1686 * 4 * 30 \%) = 6.744 \text{ kg mineral nitrogen}$

When relating these weights to the mineral nitrogen of chemical origin and taking the coefficient of equivalence into account (for pastures and maize crops, slurry being spread each year in spring), we get the following quantities:

- in the first year: $(2698 * 70 \% * 0.8) + (2698 * 30 \% * 0.77) = 2.134 \text{ kg mineral nitrogen}$
- in the second year: $(4721 * 70 \% * 0.8) + (4721 * 30 \% * 0.77) = 3.735 \text{ kg mineral nitrogen}$
- in the third year: $(6744 * 70 \% * 0.8) + (6744 * 30 \% * 0.77) = 5.335 \text{ kg mineral nitrogen}$

Considering that the factory price of chemical fertilizers (15, 15, 15 ; i.e. 15 % N, 15 % P, 15 % K) is 204 € VAT excl./ton (*Source: S.C.A.R. price list, 01/03/2006*), the total saving per year amounts to:

- in the first year: $(2134/150) * 204 = 2.902 \text{ €}$
- in the second year: $(3735/150) * 204 = 5.080 \text{ €}$
- from the third year on: $(5335/150) * 204 = 7.256 \text{ €}$

Of course, we do not take the spreading costs into account. As a rule, the farm manure spreading costs are indeed higher than the chemical fertilizer spreading costs. Nevertheless, the money saving remains significant.

1.2. Example 2

The second example concerns a pig breeder who owns 500 ha cereals. His livestock is made up of:

- 150 pregnant sows,
- 150 sows with piglets,
- 2500 feeding pigs,
- 10 boars.

We work on the principle that the animals stay in the barn the whole year through.

Considering that:

- each pregnant sow produces 5 m³ slurry/year,
- each sow with piglets produces 6 m³ slurry/year,
- each feeding pig produces 2 m³ slurry/year,
- each boar produces 5 m³ slurry/year,

Source: Arrêté du Gouvernement wallon relatif à la gestion durable de l'azote en agriculture, October 10, 2002

The quantity of valuable slurry per year on all the grounds of this farming concern amounts to:

$$150 * 5 + 150 * 6 + 2500 * 2 + 10 * 5 = 6.700 \text{ m}^3$$

The pig slurry contains 6 kg nitrogen per ton of stock farming waste (on average). About 60 % of this nitrogen is mineral and can be directly absorbed by the plant while the remaining nitrogen (40 %) is organic and will be mineralized in the 2nd and 3rd year after spreading. As a result, the farmer can count on an annual mineral nitrogen supply from his stock farming waste that amounts to:

- immediately (within the year): $6700 * 6 * 60 \% = 24.120 \text{ kg mineral nitrogen}$
- in the second year: $24120 + (6700 * 6 * 20 \%) = 32.160 \text{ kg mineral nitrogen}$
- in the third year: $32160 + (6700 * 6 * 20 \%) = 40.200 \text{ kg mineral nitrogen}$

When relating these weights to the mineral nitrogen of chemical origin and taking the coefficient of equivalence into account (for cereals, slurry being spread each year in spring), we get the following quantities:

- in the first year: $24120 * 0.53 = 12.784 \text{ kg mineral nitrogen}$
- in the second year: $32160 * 0.53 = 17.045 \text{ kg mineral nitrogen}$
- in the third year: $40200 * 0.53 = 21.306 \text{ kg mineral nitrogen}$

Considering that the factory price of chemical fertilizers (15, 15, 15; i.e. 15 % N, 15 % P, 15 % K) is 204 € VAT excl./ton (*Source: S.C.A.R. price list, 01/03/2006*), the total saving per year amounts to:

- in the first year: $(12784/150) * 204 = 17.386 \text{ €}$
- in the second year: $(17045/150) * 204 = 23.181 \text{ €}$
- from the third year on: $(21306/150) * 204 = 28.976 \text{ €}$

Of course, we do not take the spreading costs into account. As a rule, the farm manure spreading costs are indeed higher than the chemical fertilizer spreading costs. Nevertheless, the money saving remains significant.

Optimal use of farm manure

F. CONCLUSIONS

Source: Les bonnes pratiques agricoles en matière de gestion des engrais de ferme, 28/10/2004, Agra-Ost

OPTIMAL USE OF FARM MANURE: SOME USEFUL NOTES!

- **Knowing the value of farm manure**

A quick analysis in a laboratory is the best way to know the value of farm manure, e.g. the concentration of NH₄⁺ in slurry, manure effluent, muck, etc.

Even though the analysis may seem expensive for the farmer, it is quite cheap with regard to the richness of farm manure (in nitrogen, phosphorus, potassium, sulphur and magnesia) and the savings on mineral fertilizers. Moreover, the analyses also have an educational value because they prove that farm manure is valuable and that practices have to be changed.

- **Slurry homogeneity**

Spreading homogeneous slurry will lead to limited ammoniacal nitrogen losses. Regularly mixing slurry and composting muck (in order to prevent over-fertilization and the disadvantages of fresh muck) will lead to a sufficient homogenization of your stock farming waste.

- **Treatment**

Diluting slurry with 6-7 % of dry matter will also enable you to limit the ammoniacal nitrogen losses by volatilization.

- **Exact distribution**

Exactly and homogeneously distributing slurry will significantly limit the ammoniacal nitrogen losses.

- **Optimal weather conditions**

Farmers will tend to spread slurry on a rainy day (cloudiness) in order to avoid the ammoniacal nitrogen losses by volatilization as much as possible. Besides, the temperature should rather be relatively low and there should be no wind.

- **The optimal spreading time**

Slurry should rather be spread at the end of winter and during the growing period on permanent meadows.

- As far as arable grounds are concerned, slurry should rather be spread directly before seeding.
- Muck is also to be spread in winter.

- **The quantities**

The spread quantities will directly depend on the results of the laboratory analysis and the regulations in force in the country concerned.

- **The spreading mode**

Slurry will preferably be directly injected in the soil in order to limit the ammoniacal nitrogen losses by volatilization as much as possible. As a result, the injected slurry will be immediately and optimally available for the plant.

*The organic manure is the basis of fertilization!
The mineral fertilizers can possibly be used as a complement!*

Optimal use of farm manure

G. APPENDIXES

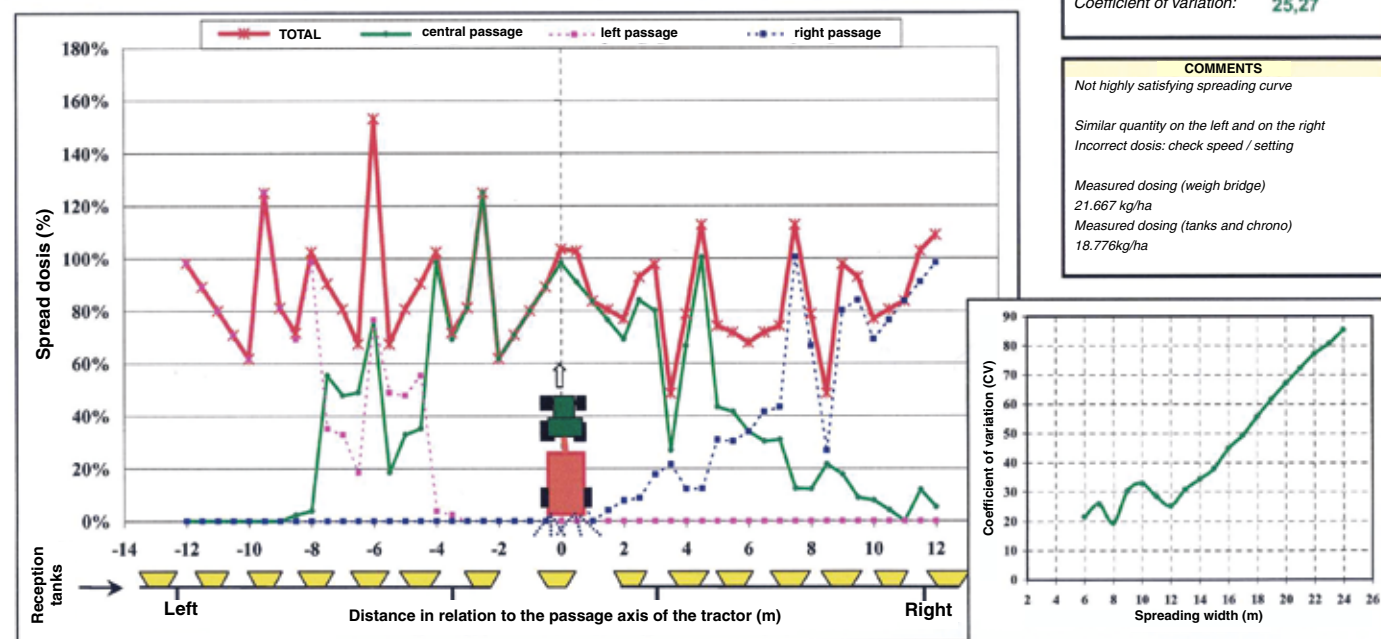
For information, the table below gives the results of the spreading test (normal muck) carried out with the JOSKIN Tornado2 muck spreader.

For a given spreading width, these tests work on the principle that the quantity (kg/ha) and the distribution can be considered as outstanding - the coefficient of variation remaining below 30.

The JOSKIN Tornado2 has managed to keep a coefficient of variation lower than 30 for a given spreading width of 12 m, which makes JOSKIN one of the few manufacturers who succeeded in doing so!

Organic matter spreading test report - Field spreading back and forth

TEST	MATTER	MACHINE	RESULT
Date: 20/03/2006 Place: Chantemelle Measured dosis: 21667 kg/ha Set-up width: 12 m Theoretical speed: 4,39 km/h Actual speed: 4,39 km/h Nr of passages: 1 Wind speed: Low - null Wind direction:	Type: 'normal' muck	Owner: Joskin Brand: Joskin Model: Tornado 2 Set-up flow: Set-up width: P.T.O. rpm: Others: 2 vertical beaters	Average dosing: 86,7% Maximum drift: 66,57% Maximum dosis: 153,2% Minimum dosis: 48,6% Left distribution: 51,5% Right distribution: 48,5% Coefficient of variation: 25,27



COMMENTS
Not highly satisfying spreading curve

Similar quantity on the left and on the right
Incorrect dosis: check speed / setting

Measured dosing (weigh bridge)
21.667 kg/ha
Measured dosing (tanks and chrono)
18.776kg/ha

test chantemelle joskin

Département Génie rural - CRAW

Contact O. Miserque 081/627155 J. Bruart 081/627166

NOTES

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NOTES

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Optimal use of farm manure

H. SOURCES

- Fertiliser avec les engrais de ferme, Institut de l'élevage, ITAVI, ITCF, ITP (2001); Chambres de l'agriculture de Picardie (2001); VLACO vzw; Agra OST; BPC
- Le Sillon belge, 10/12/2004, p. 13, 14, 15
- Arrêté du Gouvernement wallon relatif à la gestion durable de l'azote en agriculture, 10/10/2002)
- Interaction entre les modes d'épandage et les odeurs, Agra-Ost
- Tarif S.C.A.R., 01/03/2006
- Les bonnes pratiques agricoles en matière de gestion des engrais de ferme, 28/10/2004, Agra-Ost
- Eau-Nitrate: Bonnes pratiques agricoles, NITRAWAL, 07/2004
- <http://users.skynet.be/the.fly/>
- <http://www.nitrawal.be>
- <http://agraost.be>
- <http://wallex.wallonie.be>

JOSKIN

Selecting adequate and appropriate spreading material means using your farm manure optimally!



The ammonia losses linked to mineral fertilizer spreading (chemicals) vary from 0 to 15 %.

The meadow or arable injectors as well as the line spreading booms allow to limit the ammonia losses up to a similar level.

Tomorrow, you can increase the value of your stock farming waste as much as possible, as it is now transported from the farm to the fields at quite a high cost and is hardly profitable for your meadows and arable grounds!

rue de Wergifosse, 39
B-4630 Soumagne - BELGIUM
Exit 37 Herve - Soumagne

Tel.: +32 (0) 43 77 35 45
Fax: +32 (0) 43 77 10 15
E-mail: info@joskin.com

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