



# 6

## PLANNING NITROGEN USE – CALCULATING $N_{max}$ FOR ARABLE CROPS AND GRASSLAND

Nmax means the total nitrogen applied as manufactured fertilisers **plus** the crop available nitrogen from organic manure applications. Compliance with Nmax will be assessed across the crop type and not at an individual field level. This gives some flexibility at an individual field level.

You must never exceed the Nmax for any crop type on your farm. The following guidance takes you through the stages required to calculate the Nmax for each crop type grown on your farm, including grassland.

The NVZ Action Programme requires you to prepare a nitrogen fertiliser plan in accordance with this guidance. Careful planning will allow you to closely match nitrogen applications with crop need. This booklet guides you through the stages required to complete the Nmax calculation.

## Calculating the Nmax for crops other than Grassland

**Stage 1** The standard nitrogen requirement for each crop in each field is based on the following field information:

- Previous crop.
- Planned crop.
- Soil type.

**Stage 2** The basic field information is then used to derive the standard nitrogen requirement from a simple look-up table. The standard nitrogen requirement for cereal crops and winter oilseed rape is based on standard yields (at 85% dry matter for cereals and 93% dry matter for oilseed rape).

**2.1** The standard figure can then be adjusted to take account of higher than standard yields (for cereals and winter oilseed rape) and marketing requirements for some cereal crops.

**Note:** You must be able to demonstrate higher than standard yields before using the yield adjustment factor. Although some recent crop trials have shown a higher nitrogen requirement for higher yielding crops, this is not always the case and yield related responses are less likely in barley than wheat. Therefore, if you do use the yield adjustment factor, you should carefully monitor future yields.

**2.2** The Nmax for the crop type is calculated by adding up the nitrogen requirement for each field growing that crop type.

**Stage 3** If you apply livestock manure, you must use standard efficiency values to determine the percentage of the total nitrogen content that will become available to the crop. This available nitrogen content contributes to Nmax and must be deducted from the Nmax total to calculate the balance that can be applied as manufactured nitrogen fertiliser. You must follow the same procedure if you use other types of organic manure. (See Appendix 1 of Booklet 9 and pages 7 and 13 of this booklet for further information)



**Stage 4** A further upward adjustment can be made if the actual localised rainfall from 1st October to 1st March exceeds 450mm and the previous crop falls into residue groups 2 to 6 only (the upward adjustment is not available in residue group 1 crops). The permitted adjustments and the N residue groups for previous crops can be found at Booklet 9 “Nmax Standard Reference and Residue Groups”.

## Crops that are not included in the Standard Nitrogen Requirement Tables

If you grow crops that are not included in the standard nitrogen requirement tables you must still undertake an Nmax calculation. In calculating the Nmax for these crops, you must be able to demonstrate how you arrived at the final figure.

The calculation must take account of the previous crop and the soil type. If you apply livestock and other organic manures, these must be accounted for in accordance with Stage 3, above.

### Autumn Nitrogen Application on Winter Oilseed Rape

Autumn applications of manufactured nitrogen fertiliser are only permitted on winter oilseed rape crops (WOSR) and high N demanding leafy brassica crops.

A separate autumn Nmax calculation is therefore required for these crops.

If you grow WOSR **and you wish to apply manufactured nitrogen in the autumn**, you will have to complete the defined procedure at the [Nmax Annex on page 10 of this booklet](#).

You should note that this is in **addition** to the spring Nmax calculation and is treated separately. Full instruction is provided on page 10.

## Calculating the Nmax for Grassland

Grassland production is limited by growing conditions, in particular the quantity of rainfall between April and September. The combined effect of these factors defines the site class. There are potentially five site classes in Scotland, but only classes 1 to 4 are relevant within the NVZs.

Site class 1 is limited by nitrogen not by water supply, since nitrogen is utilised very efficiently and rainfall is above 500mm between April and September.

Site class 5 is severely limited by water supply since rainfall is below 350mm between April and September. The potential yield of grass growing within a Site Class 5 is about half of that growing in a Class 1 site.

Calculating the Nmax for grassland involves the following stages:

**Stage 1:** The site class for each grassland field is derived from a look-up table, based on the soil type and the rainfall for your area.

**Stage 2:** The nitrogen requirement for each field is derived from a simple look-up table and takes account of the site class and the intended management, i.e. the grazing/cutting regime.

**2.1** The Nmax for the whole grassland area is then calculated by adding up the nitrogen requirement for each grassland field.

**Stage 3:** If you apply livestock manure, you must use the efficiency values to determine the percentage of the total nitrogen content that will become available to the crop. This available nitrogen content contributes to Nmax and must be deducted from the Nmax total to calculate the balance that can be applied as manufactured nitrogen fertiliser. You must follow the same procedure if you use other types of organic manure. ([See Appendix 1 of Booklet 9 and pages 7 and 13 of this booklet for further information](#))



**Table 8 Calculating the Nmax for arable crops**

**Harvest year:**

**Crop type:**                      **Standard Yield:**      t/ha      **Average yield for this crop on this farm:**                      t/ha (only if using the yield adjustment factor)

Field	Crop area	Previous crop	Soil type	Standard nitrogen rate	Adjustments		Adjusted Nmax limit		Balance to be applied as manufactured N		Adjust for Excess Winter rainfall only if >450mm From 1st October to 1st March	
					Yield	Market	Nitrogen rate	Total N	Available N from organic manure	Balance to be applied as manufactured N	Adjustment (L)	N to be applied (kg)
					ha	kg N/ha	kg N/ha	kg N/ha	kg	kg		
A	B	C	D	E	F	G	$H = (E+F+G)$	$I = (B \times H)$	J	$K = (I - J)$	See notes	$M = (K + L)$
<b>← Stage 1 →</b>				<b>← Stage 2 →</b>			<b>← Stage 3 →</b>			<b>← Stage 4 →</b>		
TOTAL							(N)			(O)	Adjusted Nmax	(P)

**Stage 1: Field information and cropping**

In columns A to D, provide the field number, utilisable area, previous crop and predominant soil type for the field. These factors will help determine the standard nitrogen rate at Stage 2.

**Stage 2: Identify the standard nitrogen rate for the crop type and adjustments**

In columns E to I, use [Nitrogen Residue Groups \(Booklet 9\)](#) to determine the standard nitrogen requirement of the planned crop, make adjustments to the standard rate for higher yielding fields and the intended market of the crop.

**Stage 3: Calculate nitrogen available to the crop from organic manure applications and the balance that could be applied as manufactured nitrogen (only required where organic manures have been applied to the field)**

In columns J and K use [Appendix 1 \(Booklet 9\)](#) and [Table 9 \(Booklet 8\)](#) to determine the nitrogen available to the crop from organic manure applications. Deduct this from the field nitrogen requirement to determine the maximum manufactured nitrogen that could be applied to the crop.

**Stage 4: Adjust the nitrogen rate for winter rainfall in excess of 450mm (01/10 to 01/03)** In columns L and M use the adjustment factor at the bottom of [Nitrogen Residue Groups 2 to 6 \(Booklet 9\)](#) to increase your maximum field rate for excess rainfall during 01/10 to 01/03 (not available on Appendix 1 crop residue groups).

**Nmax Stop!!**

When you see this **Nmax stop!!** sign in the guidance you have reached a point where Nmax can be completed for a crop type. The **Nmax stop!!** box will provide you with guidance on whether you need to make further calculations based upon your own farm cropping circumstances and management principles.

## Calculating Nmax: all crops other than Grassland

### Stage 1 Field information and cropping

The relevant part of **Table 8** has been copied below for reference

**Table 8 Calculating the Nmax for arable crops** Harvest year: \_\_\_\_\_

Crop type: \_\_\_\_\_

Field	Crop area	Previous crop	Soil type
A	B	C	D
<b>TOTAL</b>			

To complete Stage 1 of the Nmax process you must:

**I** Enter the planned crop type and harvest year in the spaces above the table.

**Column A** Enter the identifier or name of the field growing the crop type.

**Column B** Enter the crop area.

**Column C** Enter the previous crop type grown in each field.

**Column D** Enter the predominant soil type(s) for the field(s) growing the crop type.

### Stage 2 Identify the standard nitrogen rate for the crop type and adjust for higher than standard yield and marketing requirements

The relevant parts of Table 8 and adjustment factors for Residue Groups 1 to 6 are copied below for reference.

**Standard Yield:** \_\_\_\_\_ t/ha **Average yield for this crop on this farm:** \_\_\_\_\_ t/ha (only if using the yield adjustment factor)

Standard nitrogen rate	Adjustments		Adjusted Nmax limit	
	Yield	Market	Nitrogen rate	Total N
kg N/ha	kg N/ha		kg N/ha	kg
<b>E</b>	<b>F</b>	<b>G</b>	<b>H = (E+F+G)</b>	<b>I = (BxH)</b>
				<b>(N)</b>

(Taken from footnotes on Residue Groups 1 to 6 in Booklet 9)

#### Adjustments

- For wheat, an additional 20 kg N/ha is permitted for every tonne that the expected yield exceeds the standard yield.
- For wheat, an additional 40 kg N/ha is permitted to milling wheat varieties.
- For barley and oats, an additional 15 kg N/ha is permitted for every tonne that the expected yield exceeds the standard yield.
- On winter oilseed rape, the spring application can be increased by up to 30 kg N/ha if the expected yield is over 4.0 t/ha.
- On spring barley, an additional 15 kg N/ha is permitted for high N grain distilling varieties.

To complete Stage 2 of the Nmax process you have to refer to **Booklet 9 “Nmax standard reference and Residue Groups” (Residue groups 1 to 6)**. Page 5 of that booklet provides a pictorial guide on how to use the N Residue group look-up tables.

**Column E** Enter the standard nitrogen rate for the planned crop by using the relevant look-up table.

**Column F** Adjust for yield if your average yield is higher than the standard yield for the crop type being grown. You must be able to supply records that demonstrate higher than standard yields if you wish to use the yield adjustment factor. You should use adjustment factors a, c and d where applicable for your cropping situation.

**Note that it is not compulsory to use the yield adjustment factor**

**Column G** Enter any marketing adjustments that apply. The standard nitrogen rate can be adjusted upwards to meet the milling market requirements for wheat and the high N grain market requirements for winter barley. You should use the relevant adjustment factor b or e for the crop type and the intended market.

**Column H** Add up columns E, F and G to calculate the adjusted nitrogen requirement as kg N/ha.

**Column I** Calculate the total nitrogen requirement for the field by multiplying column B (utilisable field area) by column H (the adjusted standard nitrogen rate).

**Nmax Stop!!**

If you do not apply organic manures or require adjustments for excess winter rainfall you are not required to do any further calculations for this crop type. The total of column I entered at box N is the Nmax figure for this crop type.

**Stage 3: Calculate the nitrogen available from organic manure applications**

The relevant part of **Table 8** has been copied below for your reference.

Available N from organic manure
kg
J

You must take account of the nitrogen available from organic manure applications. **You will need to refer to the look-up tables at Appendix 1 (Booklet 9) and Table 9 Booklet 8 (Blank Tables).**

Follow through the steps on Table 9 as described below to determine the available nitrogen from organic manure applications and arrive at the column J figure for the crop type.

**Column J** Complete the required steps on **Table 9** for an organic manure application. This will give you the nitrogen (kg N/ha) that will become available to the following crop (at column 10 below). You must transfer that figure to column J to allow the available nitrogen to be deducted from the standard nitrogen rate for the field. This will allow you to calculate the adjusted amount of nitrogen that can be applied to the crop type as manufactured fertiliser.

You may find it easier to complete one copy of **Table 9** for each crop type that receives organic manures. An extract from Table 9 has been copied below for reference.

Field	Soil type	Manure Ref. no.	Total N (kg/t)	Season applied	% N available to next crop	Area spread (ha)	Amount applied (t/m <sup>3</sup> )	Rate applied (t/m <sup>3</sup> /ha)	Available N rate for next crop (kg/ha)	Total N available to next crop (kg)
1	2	3	4	5	6	7	8	9 = (cols 8 ÷ 7)	10 = (cols 4 x 6 x 9) ÷ 100	11 = (col 10 x 7)

- Column 1** Enter each field name/number growing the crop type, which will receive an application of livestock manure.
- Column 2** Enter the soil type.
- Column 3** Enter the appropriate Manure Ref. No. for the manure type being applied see Appendix 1 (**Booklet 9**). **Note that there are separate look-up tables for FYM, Poultry Manure and Slurry.**
- Column 4** Enter the nitrogen content of the manure (kg/t). You may use either the typical standard values for the manure type (Appendix 1 in Booklet 9) or your own values based on analysis of the manure. If you use your own analysis, you must follow the [Protocol for Sampling Slurry and Solid Manure for Analysis \(Page 16, Booklet 9\)](#).
- Column 5** Enter the Season of Application.
- Column 6** Enter the % N available to the next crop (efficiency % of the manure). **This is provided in the tables at Appendix 1 of Booklet 9 and is dependent on manure type, method and season of application.**
- Column 7** Enter the area spread (ha).
- Column 8** Enter the total amount of manure applied to the field (t/m<sup>3</sup>).
- Column 9** Calculate the application rate (t/m<sup>3</sup>/ha): (column 8) ÷ (column 7).
- Column 10** You can now calculate the quantity of nitrogen that will become available to the next crop (kg N/ha): (column 4 x column 6 x column 9) ÷ 100.
- Column 11** The total nitrogen available to the next crop is calculated by multiplying column 10 x column 7.

### Calculate the balance that could be applied as manufactured nitrogen

The relevant part of **Table 8** has been copied below for your reference.

Balance to be applied as manufactured N
kg
K = (I - J)
(0)

### Column K

Using figures that you have already calculated at columns I and J, simply subtract the column J figure (available nitrogen from organic manures) from the column I figure (total nitrogen rate for the field). If no organic manure has been applied to some fields you should carry the column I figure forward to column k. Add up column K in box O to calculate the maximum amount of manufactured nitrogen that can be applied to the crop type.

## Nmax Stop!!

You have now calculated the balance that can be applied as manufactured nitrogen fertiliser. You can make a further upward adjustment for some fields if the actual localised winter rainfall (for the period 1st October to 1st March) exceeds 450mm, but this is not compulsory. If your actual localised winter rainfall exceeds 450mm and you wish to update your Nmax calculations, proceed to [Stage 4](#).

## Stage 4: Adjust the nitrogen rate for winter rainfall in excess of 450mm (1st October to 1st March) **Only applicable to Residue Group 2 to 6 Crops**

The relevant part of **Table 8** has been copied below for your reference.

Adjust for excess winter rainfall only if >450mm from 1st October to 1st March	
Adjustment (L)	N to be applied (kg)
See notes	$M = (K + L)$
Adjusted Nmax	(P)

Upward adjustments can be made where the rainfall from 1st October to 1st March exceeds 450mm. Note that this only applies if the previous crop was in N residue groups 2 to 6.

**It is not compulsory to use the excess winter rainfall adjustment.**

If you wish to use the adjustment refer to the note at the bottom of [Residue Groups 2 to 6](#) for the upward adjustment figures.

**Column L** Enter the adjustment amount (kg/ha).

**Column M** Add the adjustment to the figure from column K. The total of column M will be the final adjusted Nmax figure for the crop type. **Enter this figure at box P.**

### **Nmax Stop!!**

This is the final adjustment that can be made to Nmax. The figure you have arrived at **box P** is the Nmax for the crop type.

## Nmax Annex – Autumn Nitrogen Application on Winter Oilseed Rape

Autumn applications of manufactured nitrogen fertiliser are only permitted on winter oilseed rape crops (WOSR) and high N demanding leafy brassica crops. A separate autumn Nmax calculation is therefore required for these crops. You should note that this is in addition to the spring Nmax calculation and is treated separately.

Any organic manures applied in the autumn do not count towards the autumn Nmax and should be accounted for in the spring Nmax calculation for WOSR and high N demanding leafy brassica crops.

### Calculating Autumn Nmax for WOSR

The standard autumn nitrogen rate for WOSR crops is included in the Nmax standard reference and residue group tables (Booklet 9) under the planned crop heading of “Winter Oilseed Rape (autumn)”.

In the table below insert

**Column A** The field identifier or name

**Column B** The utilisable or crop area of the field

**Column C** The previous crop (this determines the N residue group)

**Column D** The standard (autumn) Nitrogen requirement for the crop.

**Column E** The total N requirement for the crop area in each field (B x D)

**Table 16**

A	B	C	D	E	
Field identifier	Utilisable / Cropped Area (ha)	Previous crop	Standard nitrogen requirement (kg N/ha)	Total N (kg) (B x D)	
Total	(ha)	Total	(kg N/ha)	Nmax	(f) kg

Multiply the utilisable or cropped area by the standard nitrogen requirement as determined by the previous crop residue group for each field in table 16. Enter this figure for each field in column E. Total the figures in column E to calculate the autumn Nmax for WOSR. Enter this figure at Box F.

As with all Nmax calculations by completing this process you have determined the maximum amount of autumn nitrogen that could be applied to your WOSR fields as a crop type. You must record the individual applications of Nitrogen fertiliser to the individual fields using Table 11 of Booklet 8. You must continue to monitor applications and amounts applied to ensure that you remain compliant with the Nmax limit and the Regulations.

A blank copy of this table has been provided at Table 16 in Booklet 8 for use or photocopying.

**Table 10 – Calculating the Nmax for grassland**

Field number	Grass area	Site class	Intended use	Standard N requirement	Total nitrogen	Balance to be applied as manufactured N	
	ha	1,2,3 or 4	i,ii,iii,iv or v	kg/ha	kg	Crop available N from organic manure	Balance to be applied as manufactured N
a	b	c	d	e	$f = b \times e$	g	$h = (f - g)$
	<b>Stage 1</b>		<b>Stage 2</b>		<b>Stage 3</b>		
Total				Nmax =	(j)		(k)

**Stage 1: Field and management information and identify the site class for your farm**

In columns a and b, provide the field number and utilisable area of the field. Use look-up Table 14 in Booklet 9 to determine your site class. Site class is derived from your locality and soil type. Insert the appropriate site class reference in column c.

**Stage 2: Identify total nitrogen requirement from site class and intended use**

Enter the crop use indicator i to v from Table 15 in Booklet 9 to indicate your grass management for the field, enter this at column d. Using your determined site class and the intended use for the grass crop, use look-up Table 15 of Booklet 9 to determine the standard nitrogen requirement, enter this figure at column e.

Use column f to determine the total nitrogen that could be applied to the field by multiplying the fields utilisable area with the standard nitrogen requirement derived at column e.

**Stage 3: Calculate nitrogen delivered to the field from organic manure applications and thus the balance that could be applied as manufactured nitrogen**

*(only required where organic manures have been applied to the field)*

In columns g and h use [Appendix 1 \(Booklet 9\)](#) and [Table 9 \(Booklet 8\)](#) to determine the nitrogen available to the crop from organic manure applications. Deduct this from the field nitrogen requirement to determine the maximum manufactured nitrogen that could be applied to the field.

**Nmax Stop!!**

**When you see this Nmax stop!! Sign in the guidance you have reached a point where Nmax can be completed for a crop type. The Nmax stop!! Box will provide you with guidance on whether you need to make further calculations based upon your own farm grassland management principles.**

## Calculating Nmax: Grassland

The following guidance takes you through the stages required to calculate the Nmax for grassland on your farm. The Grassland Nmax represents the maximum quantity of nitrogen that can be applied to the grassland area of the farm. Setting the Grassland Nmax against the whole of the grassland area allows for flexibility at an individual field level.

### Stage 1: Field and management information and Identifying the site class for your farm

The relevant part of Table 10 has been copied below for reference.

Field number	Grassarea
	ha
a	b

To complete Stage 1 of the Nmax process you must:

- Column a** Enter the identifier or name of the field
- Column b** Enter the utilisable area of the field

#### 1.1 Identify the site class for your farm

The relevant part of Table 10 has been copied below for your reference.

Site class
1,2,3 or 4
c

To complete Stage 1: use Table 14 (Booklet 9) to determine your site class. Depending on your locality and soil type your site class will fall into one of two categories.

- Column c** Enter the derived site class for the field into column c for use in determining the standard nitrogen rate at Stage 2.

### Stage 2: Identify total nitrogen requirement from site class and intended use

The relevant part of Table 10 has been copied below for your reference.

Intended use	Standard N requirement	Total nitrogen
i,ii,iii,iv or v	kg/ha	kg
d	e	f = b x e
Nmax =N		(j)

**Column d** Use look up Table 15 (Booklet 9) to determine the standard nitrogen requirement for the field (using your intended grassland management for the field and the site class from Stage 1.1).

**Column e** Enter the derived maximum nitrogen rate from Table 15.

**Column f** Calculate the nitrogen requirement for the field by multiplying **b** by **e**.

**2.1** Add up all of the column 'f' values to calculate the grassland Nmax in **box j**.

#### Nmax Stop!!

If you do not apply organic manures, you are not required to do any further calculations. The total of column f entered at box j is the Nmax figure for grassland.

### Stage 3: Calculate nitrogen available from organic manure applications and the balance that can be applied as manufactured nitrogen

The relevant part of **Table 10** has been copied below for your reference.

Crop available N from organic manure
g

You must take account of the nitrogen available from organic manure applications. You will need to refer to **Appendix 1 (Booklet 9) and Table 9 (Booklet 8)**.

Follow through the steps on **Table 9** as described below to determine the available nitrogen from organic manure applications and arrive at the column g figure for each field that receives an application of organic manure.

**Column g** When you have completed the required steps on Table 9 for an organic manure application, you will have calculated the nitrogen (kg N/ha) that will become available to the grassland field (at column 10). You must transfer that figure to column g to allow the available nitrogen to be deducted from the standard nitrogen rate for the field. This will allow you to calculate the adjusted amount of nitrogen that can be applied to the crop type as manufactured fertiliser.

**Column h** An extract from Table 9 been copied below for reference

Field	Soil type	Manure Ref. no.	Total N (kg/t)	Season applied	% N available to next crop	Area spread (ha)	Amount applied (t/m <sup>3</sup> )	Rate applied (t/m <sup>3</sup> /ha)	Available N rate for next crop (kg/ha)	Total N available to next crop (kg)
1	2	3	4	5	6	7	8	9 = (cols 8 ÷ 7)	10 = (cols 4 x 6 x 9) ÷ 100	11 = (col 10 x 7)

- Column 1** Enter each field name/number growing the crop type, which will receive an application of livestock manure.
- Column 2** Enter the soil type.
- Column 3** Enter the appropriate Manure Ref. no. for the manure type being applied (**see Appendix 1 of Booklet 9**). **Note that there are separate look-up tables for FYM, poultry manure and slurry.**
- Column 4** Enter the nitrogen content of the manure (kg/t). You may use either the typical standard values for the manure type or your own values based on analysis of the manure. If you use your own analysis, you must follow the **Protocol for Sampling Slurry and Solid Manure for Analysis (Page 16, Booklet 9)**.
- Column 5** Enter the Season of Application.
- Column 6** Enter the % N available to the next crop (efficiency % of the manure). **This is provided in the tables at Appendix 1 of Booklet 9 and is dependent on manure type, method and season of application.**
- Column 7** Enter the area spread (ha).
- Column 8** Enter the total amount of manure applied to the field (t/m<sup>3</sup>).
- Column 9** Calculate the application rate (t/m<sup>3</sup>/ha): (column 8) ÷ (column 7).
- Column 10** You can now calculate the quantity of nitrogen that will become available to the next crop (kg N/ha): (column 4 x column 6 x column 9) ÷ 100.
- Column 11** The total nitrogen available to the next crop is calculated by multiplying column 10 x column 7

### 3.1 Calculate the balance that could be applied as manufactured nitrogen

The relevant part of **Table 10** has been copied below for your reference.

Balance to be applied as manufactured N
$h = (f - g)$
(k)

#### Column h

Using figures that you have already calculated at columns f and g. Simply subtract the column g figure (available nitrogen from organic manures) from the column f figure (total nitrogen rate for the field). If you do not apply organic manure to some of your fields carry the column f figures forward to column h. Total column h in box k to calculate the total amount of manufactured nitrogen that can be applied to the grassland area of the farm.

#### **Nmax Stop!!**

This is the final adjustment that can be made to Nmax. The figure you have arrived at box k is the Nmax for grassland.

## Notes

**Notes**