

New Technology

Applying variable input rates Selecting fields

Whether a farmer uses specialised equipment or not, the most common use of variable rate application is with nitrogen. Its use results in yield increases, providing this technique is applied to suitable fields.



Manual rate variation can be applied in fields with well-defined heterogeneous areas

Fields are not all suited to variable rate applications. In order to best utilise this technique, several conditions must be fulfilled:

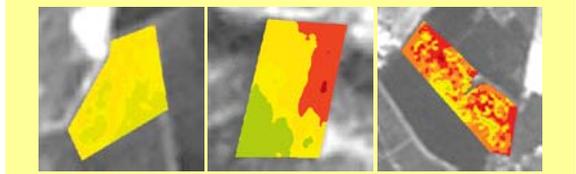
- significant heterogeneity in recommended rates within the field;
- well defined variability, i.e. being able to identify homogeneous areas on the recommendation map;
- size of homogeneous areas is compatible with input variable rate management, i.e. working width.

A study of Farmstar* recommendation maps for late applications on wheat in 2005, 2006 and 2007 shows that 48% of recommendations are considered as homogeneous because the rate variation within the field in question is below 10 units, and there is therefore no benefit from varying the rate. Manual rate variation is possible in some of the other fields (between 13% and 19% depending on the year) with few and well-discernable heterogeneous zones that do not require frequent rate adjustments. The rest of the fields are characterised by less defined variability (between

33% and 40% depending on the year). Rate adjustments are too frequent to be made by the farmer. Rate adjustments must be made automatically (box 2).

85% of nitrogen recommendations for oilseed rape (2006 and 2007) advocate the use of variable rates (40% manually and 45% automatically) (figure 1).

Nitrogen recommendation maps produced by Farmstar: a) advice considered as homogeneous, b) rates adjusted manually, c) rates adjusted automatically (fig. 1)



For late applications on wheat, one recommendation in two advocates the use of variable rates. For oilseed rape, this figure is eight in ten.

* Decision support tool for near real time crop management

How it works (box 1)

Via Farmstar

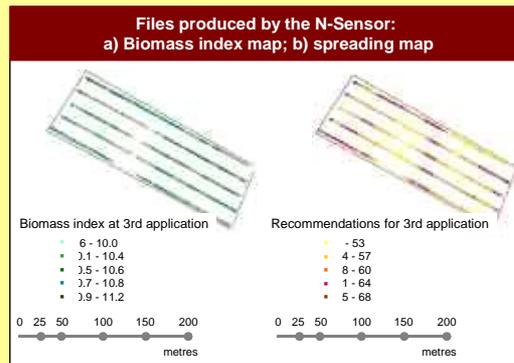
Farmstar advice takes the form of a recommendation map. The farmer receives it via e-mail or through the post. He/she can also receive recommendations for the mid stem elongation phase application to wheat, and the second application to oilseed rape, not as an image this time, but in the form of digital files including geo-referenced data.

The recommended rates are expressed in nitrogen units. They then must be translated into information which can be readily understood by the spreading operator: kg/ha or l/ha (depending on the type of fertiliser used).

Farmstar advice in digital format:
a) tif format; b) txt format

The information is sent in various formats, to ensure compatibility with most machinery or equipment manufacturers. The txt format for instance can be used by John Deere, RDS, Agtronix, etc., via Agriprécis (module of Isagri's Agrimap software). The shp format (dbf and shx) can be used by Satplan's SatPréco. The tif format (and tfw), helps to visualise the geo-referenced recommendation map, but without any rate data.

Via the N-Sensor



as the nitrogen rates that must be spread at each point along the tractor's route.

It can be used with most geo-referenced information systems after going through the free (Yara's) CardWriter software, which transforms it into a csv file (usable in Microsoft Excel).

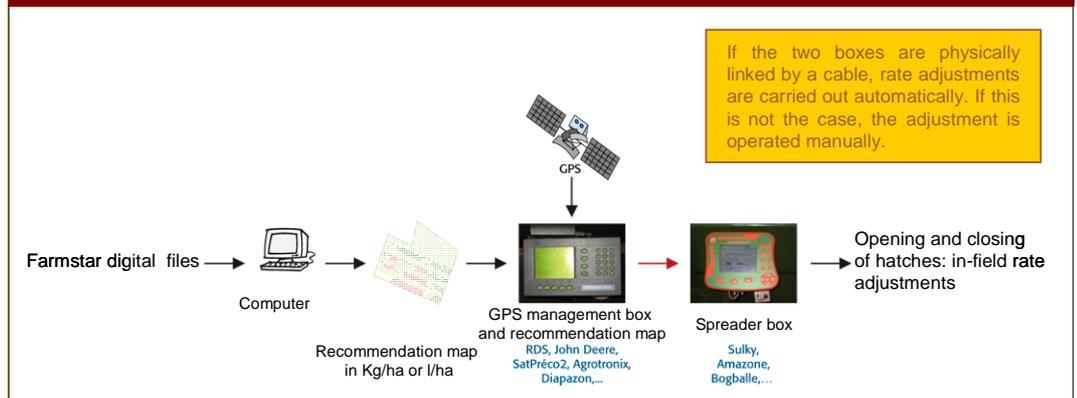
Manual or automatic? (box 2)

To vary the nitrogen rate applied, there are two options:

In manual mode, the farmer adjusts the rates according to visual reference points in the field or a recommendation map. As it is displayed on a pocket PC screen or a machinery or equipment manufacturer's box linked to a GPS, the farmer can see his tractor moving in the field. He/she adjusts the rate on the spreader box. The inaccuracies of this system are due to variations in rates: ± 5 or 10% variation from the reference rate depending on the spreader. The rate applied is therefore approximate. The greatest source of error may come from forgetting to adjust the rate at some point.

The second solution is entirely automatic. Using a GPS, the tractor locates itself on the recommendation map. The rate corresponding to its location is sent by the recommendation map management box (RDS, John Deere, Satplan box, etc.) to the spreader box which opens or closes the hatches according to the rate that should be applied. There may be some compatibility issues between those two boxes. The reading of the recommendation map being automatic, the risk of mistakes is limited, except when there are problems on the recommendation map itself. This solution also has the advantage of making it possible, with most equipment, to check on the application map the rates that were actually applied in the field.

Global operating diagram of nitrogen rate variation





Alternating strips experiment (box 3)

In order to test variable rate application using Farmstar, the experiment alternates two types of strips:

- strips that receive a uniform rate (recommended by Farmstar for the whole field),
- and strips that receive a variable rate (recommended by Farmstar on a point-by-point basis across the field).

The same amount is applied on all the strips, but the spread of the fertiliser varies. Trials are put in place by farmers using their own equipment (spreader, GPS, etc.). Crop harvest is carried out using a full cutter bar width avoiding tramlines and spreader overlap areas. The combine harvester is equipped with a yield and moisture content sensor. Protein content is analysed from ear samples taken the week before harvest. The points are geo-referenced so they can be located on the nitrogen recommendation map.

The trials were not carried out on trial plots but in 20 ha fields which are part of actual farms.



The N-Sensor is calibrated using a traditional diagnostic tool (N-Tester, etc.) on a representative area of the field in question.

Variable rate application via Farmstar

Nine trials were established in wheat fields in 2005 and 2006 in order to measure the impact of Farmstar variable rate nitrogen application recommendations.

In the most heterogeneous and best-defined fields (significant variation of rates: significant typical differences), the increase in wheat yield can reach 250 kg/ha (table 1). This increase results exclusively from a better spread of the fertiliser during its late application, since on average the same amount is spread. The amounts spread are calculated according to the feedback information produced by the spreader, not the recommendation maps. In homogeneous fields, there is logically no difference in yield; the range of rate variation is too small to produce a difference in yield. The yield increase resulting from applying variable rates is measured against a rate calculated with a tool, Farmstar in this instance. If the rate had not been re-evaluated by a regulating tool, the increase in yield may have been greater. In one of the fields, we measured a lower yield from the strips where variable rates had been applied (-200 kg/ha) in spite of the fact that the rates only varied very slightly. Most fields showed no differences in protein content levels.

Yield increase resulting from varying the rate of the 3 rd nitrogen application using Farmstar, in fields belonging to actual farms * (tab. 1)				
Year	Location	Average rate for 3 rd nitrogen application (u/ha)		Yield (kg/ha)
		Uniform	Variable	Variable-uniform
2005	Châteaudun (28)	60	55±6	0
	Châteaudun (28)	60	52±9	100
	Chartres (28)	50	56±17	250
	Epernay (51)	80	76±4	200
	Reims (51)	50	45±10	200
2006	Châteaudun (28)	30	23±4	250
	Chartres (28)	80	80±2	0
	Chartres (28)	80	74±1	0
	Mantes-la-Jolie (78)	30	30±1	-200

* Trials carried out in partnership with Agralys, Cohésis and l'Union Terre de France

The variable rates recommended by Farmstar for the third nitrogen application, compared with an average rate calculated field by field by Farmstar, result in an increase in yield in the most heterogeneous and best-defined fields.

Via the N-Sensor

Nine trials were established using the N-Sensor in 2004 and 2005. In those fields (on actual farms), variable rates were applied for the second and third nitrogen applications (*table 2*). The average rate for the second application is calculated according to the balance method. The average rate of the third application is determined by a regulating tool. Applying variable rates results in an increase in yield of between 0 and 300 kg/ha depending on the level of heterogeneity of the field, compared with "local farmers' practices". Those results concur with those obtained by Yara in Germany from a larger sample of fields.

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Yield increase resulting from varying the rate of the 2nd and 3rd nitrogen applications using the N-Sensor, in fields which are part of actual farms (<i>tab. 2</i>)				
Year	Location	Average rate 2nd + 3rd nitrogen application (u/ha)		Yield (kg/ha)
		Local practice	Variable	Variable-local
2004	Châteauroux (36)	140	130±5	100
	La Ferté Vidamne (28)	140	130±10	100
	St-André-de-l'Eure (27)	155	145±7	0
	Mantes la Jolie (78)	120	120±10	300
	Orléans (45)*	170	160±9	0
2005	Chartres (28)	130	130±5	100
	La Ferté Vidamne	100	110±10	200
	Mantes la Jolie (78)	110	126±6	0
	Mantes-la-Jolie (78)	120	123±5	300

* *Durum wheat*

The application of variable nitrogen rates using the N-Sensor results in a yield increase of 300 kg/ha in the most heterogeneous and best-defined fields, when compared with local practices.