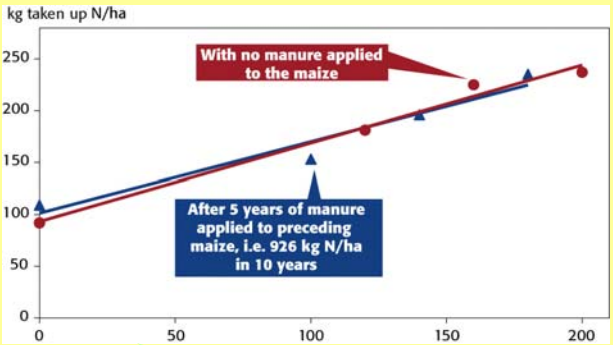
Long-term impact

Taking mineralization from organic materials into account

In the long run, organic products inputs add nitrogen to the stable organic materials present in the soil. Those quantities of mineralisable nitrogen must be taken into account through soil analysis, in order to estimate the amount of nitrogen available to the plants.

Two years after the manure has been spread, the nitrogen which has not been taken up by plants or lost is hardly available for the crops because it is incorporated in the soil organic matter and undergoes its low mineralization rate

Bignan (Brittany): quantities of nitrogen taken up by the wheat in 1996, in fields having/not having received manure in the pre vious 10 years *(fig. 1)*



With or without manure applications, the crop absorbed the same amount of nitrogen

Long-term experiments have been carried out in France since 1980, in order to study the contribution made by repeated organic matter inputs to the nitrogen nutrition of crops. Those studies have shown that the organic nitrogen they content is mineralised following a kinetic pattern particular to each kind of material, for a period rarely exceeding a year in a temperate climate. It seems that beyond this first specific mineralization phase, the residual organic nitrogen is incorporated into soil humus, and then evolves in the same way as the latter.

The following examples are a good illustration of this phenomenon, observed in most of the long-term experiments.

In one experiment carried out on silty soil in Bignan (Brittany), cattle manure was applied every two years before maize succeeding to a wheat crop which never received any organic supply. In 1996, the tenth year of the study, after five cattle manure applications totalling 926 kg N/ha, In 1996, the wheat took up the same nitrogen amount whether it received manure or not (figure 1).

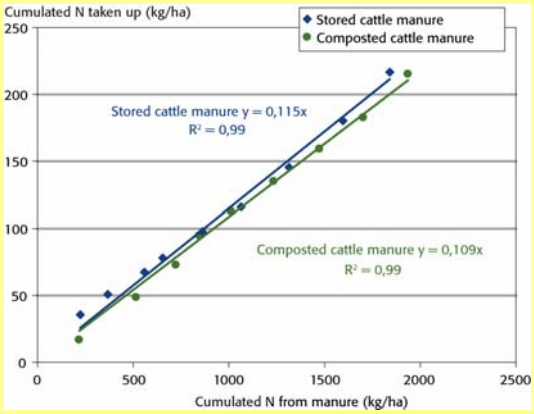
In another experiment also conducted in silty soil, at La Jaillière (western France), manure and compost were supplied on a perennial ryegrass meadow every year in autumn for nine years. The relationship between the cumulated nitrogen taken up by the grass and the cumulated organic nitrogen added between 1996 and 2004, is described very clearly by a linear function (figure 2).

The nature of this relationship shows a steady recovery of the applied nitrogen by the grass of over time of around 11% over time. This means that there are no noticeable long term effects in terms of plant nutrition, from the 89% of unused nitrogen each year.

Work carried out abroad led to the same conclusion. One of the most significant work, carried out in Denmark, helped to study the evolution of ^{15}N labelled nitrogen isotope from the different parts of sheep manure (straw, urine, faeces) and from an inorganic fertiliser. The ^{15}N recovery by crops from different sources differed dramatically the first year after application (figure 3). Later on, recovery of the applied nitrogen was nearly the same for the inorganic source and the manure components. This shows that after a while, the nitrogen present in the soil, that has not been taken up by the plants or lost through leaching or gaseous pathway, is transformed and has the same future, regardless of its nature.

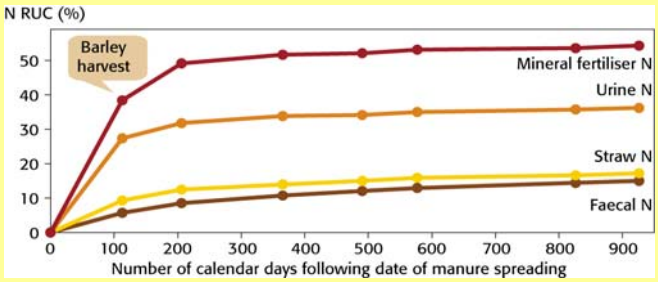
This set of observations leads to the conclusion that the long-term effect of nitrogen from organic material on the plant nutrition depends on the variation in the amount of organic nitrogen present in the soil resulting mainly from the frequency and the amount of inputs.

Relationship between the cumulated amounts of nitrogen taken up by the grass and the cumulated amounts of nitrogen applied with cattle manure, between 1996 and 2004 as part of experiment carried out at La Jaillière (western France) *(fig.2)*



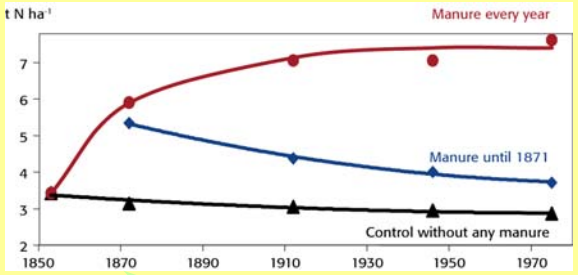
The relationship between the nitrogen applied and the nitrogen taken up by the grass shows a steady recovery over time (around 11%)

^{15}N recovery of sheep manure components and inorganic fertiliser by spring barley and perennial ryegrass undersown with the barley, during the first 6 cuts (Jensen et al 1999, Soil Science Society of America Journal 63 : 416-423) (fig.3)



The ^{15}N recovery by crops from different sources differed dramatically the first year after application. Later on, the recovery of the nitrogen applied was nearly the same for the inorganic fertiliser and the manure components.

Impact of the cattle manure input regime on the evolution of organic nitrogen amounts in the soil for theRothamsted trials (Addiscott 1991) (fig.4)



Annual manure input over many years helps enrich the soil in organic nitrogen

Periodical assessment of the amount of nitrogen supplied by the mineralization of humus

Changes in the amount of organic nitrogen contained in soil humus depend on the original content level, as well as on the quantity applied and frequency of organic material applications.
The observations made through very long-term experiments, such as the Rothamsted experiment in England, have shown that the soil organic nitrogen amount present in the soil changes relatively slowly in usual farming conditions. *(figure 4)*.
In that trial, it took twenty years of annual cattle manure spreading, at a rate of 30 t/ha/year, to double the initial, rather low, total nitrogen stock in the soil.
After 60 years of yearly applications, the amount of nitrogen in the soil was kept stable at a level equal to twice the initial stock by the subsequent applications. Conversely, withholding manure inputs after a twenty-year trial resulted in an immediate slow but steady decrease of the stock which had been built up.

Given that for each soil type, the amount of organic nitrogen which is mineralised proportional to the stock level, the latter must be periodically assessed, notably when the cropping system and organic applications change.
Estimating the nitrogen amount that will be mineralised in relation to the organic nitrogen in stock in the soil as well as other soil characteristics, is the purpose of a work undertaken in France by INRA, ARVALIS - Institut du végétal and CETIOM (French technical institute for oilseed crops).

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