REVIEWING fertilisation strategies

The chemical composition of digestates varies a lot depending on their type and the proportion of organic matter used to feed the digester.

The Vadimethan research project is providing new information on the fertiliser value of digestates. Several parameters must be considered before spreading this type of product, including its composition, the assessed availability of each nutrient and the ongoing impact on the soil's organic matter content.

The recent development of collective or on-farm anaerobic digesters raises the issue of what happens to the digestates. The preferred utilisation of those products is currently to spread them on fields, but their extremely variable contents in fertilising elements can complicate fertilisation management. The chemical composition of digestates varies a lot depending on their type and the proportion of organic matter used to feed the digesters (manure, slurry, crop residue, cover crops, agro-industrial effluent, food industry waste, etc.). The anaerobic digestion process takes their most easily degraded fraction to produce methane (CH_4), but does not alter their nitrogen and mineral (P, K, Ca, Mg…) content. Before it is applied to fields, this product must therefore be analysed. Ideally, this analysis should be carried out at a date close to the spreading period, as the digestate keeps changing during storage, and may undergo transformations through phase separation. Mineral elements may end up either in the digestate's liquid phase (such as very soluble potassium), or may be fixed in the solid phase (phosphorus which is not very soluble) which may then be composted with by-products (often green waste). Those processes will result in products with very different mineral and dry matter contents.

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Readily available nitrogen

As mineral nitrogen mainly contains ammonia (NH_4 +), it will tend to be found in the liquid phase, whereas organic nitrogen essentially remains in the solid phase. This ammonia results from the mineralisation of organic nitrogen compounds during anaerobic digestion as they cannot become oxidised in the digester. The risk of nitrogen loss through ammonia volatilisation during spreading and in the hours that follow, is high, both for liquid digestates and those resulting from dry anaerobic digestion. Optimal spreading conditions should therefore be a priority (no wind and possibly rain forecast within the following 24 hours). The most effective methods for reducing post-spreading losses are either the immediate incorporation of the digestate down to 8 to 10 cm with a stubble plough or using a spreader-incorporator on bare ground before sowing. Practising phase separation and spreading the liquid phase in order to encourage rapid infiltration into the ground, as well as co-composting the solid phase are also recommended. Those practices help to optimise the nitrogen provided by the digestate, which can have a similar composition to pig slurry *(1)*. Those products are spread at a date close to the receiving crop's peak uptake phase, i.e. at the beginning or during the spring. Late summer or early autumn spreading is possible in some regions, for establishing oilseed rape or cover crops, with rates under 100 kg nitrogen per ha *(2)*. The nitrogen equivalent coefficient (KeqN) is however hugely variable depending on the digestate and must be adjusted according to the type of product. A trial network established as part of the Vadimethan project *(insert),* under the direction of the Chambre régionale d'Agriculture des Pays-de-Loire, has highlighted the extremely variable impact of nitrogen from three different digestates spread on wheat at the end of winter. Those digestates result from the anaerobic digestion of mainly slurry, manure or food industry waste. However, additional trials will be needed to confirm those results and to define more precisely the different types of digestates (input products, length of anaerobic digestion, length of storage, etc.) resulting in different KeqN.

One of the most effective methods for reducing post-spreading ammonia losses is the immediate incorporation of the digestate down to 8 to 10 cm with a stubble plough.

A level of organic enrichment similar to that of manure

The potassium contained in digestate is generally totally available for the receiving crop. There is still insufficient data for phosphorus to give a reliable KeqP value, but this nutrient should be considered as available over the medium term. In any case, the part that is not assimilated will increase the P2O5 stocks in the soil, which in turn will feed subsequent crops. As for organic matter, liquid digestate supplies relatively little of it. Products resulting from dry anaerobic digestion contain more. This organic matter mainly comprises carbon chains that the microorganisms present in the digester find difficult to decompose. It is highly stable and therefore has a very positive impact on the parcel's humus balance. The study carried out as part of the Vadimethan project actually highlighted the fact that spreading digestate instead of slurry or manure did not modify the soil's organic matter content over the medium-term (20 years) on the farms involved. This research work also showed that the introduction of a digester affected the distribution of organic

matter back into the soil to varying degrees from one farm to another. It also affects the cropping system, with the introduction of cover crops harvested to secure enough materials to feed the digester. The digestate is distributed between the crops and parcels differently from livestock effluent used previously, because its fertilising effect, especially as far as the nitrogen is concerned, is different. This type of organic fertiliser opens up new spreading opportunities, for instance at the end of winter on established crops or on pasture on certain farms. Those changes result in a reduction of carbon inputs on some parcels and their increase on others, with, in the end, an overall neutral carbon balance put back into the soil at farm level.

(1) See the COMIFER method's nitrogen equivalent coefficients (KeqN): www.comifer.asso.fr.
(2) In any case, refer to local regulations.

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VADIMETHAN: a project designed to provide greater understanding of the nature of digestates

This project, which ran from 2013 to 2015, was directed by the regional Chambre d'Agriculture of the Pays-de-Loire and involved seven partners: the Chambres d'Agriculture of the Maine-et-Loire, Loire-Atlantique and Sarthe *départements*, ARVALIS, TERRENA, AILE and ADEME. Its aim was to provide reference data on the nitrogen fertilisation value of the digestates produced at regional level, and to quantify their long-term impact on the soils' organic matter content, where they replaced slurry. Three different digestates were selected and spread on wheat at the end of winter in three experimental sites. In order to verify the reason for the differences in KeqN noted, the three digestates were compared on all three sites in the third year of the trial. Their subsequent characterisation in a lab environment helped to study their impact on the changes in organic matter content occurring in the soils of the farms involved.