# An estimate of the value of biofertiliser

## Technical Article: TA10

***Biofertiliser, the liquid product obtained from anaerobic digestion, contains nutrients that can be used in place of chemical fertilisers to fertilise soil and as such have a monetary value. This Technical Article details the calculations and assumptions made by SOWTech to calculate the main plant nutrients which can be potentially found in the biofertiliser produced by a Flexigester V10 and the monetary worth of those nutrients if they were applied as chemical fertilisers.***

## Introduction

Biofertiliser is made from the anaerobic digestion (AD) of organic material. This can be animal, vegetable or human waste. The breakdown of the organic material produces biogas (methane and carbon dioxide) and biofertiliser. During the AD process large molecular weight molecules, including proteins and carbohydrates, are broken down into smaller molecules which dissociate into ions in the liquor (Ref 1). These ions are then absorbed through the roots of plants as nutrients (Ref 2). These nutrients which include nitrogen, phosphates and potassium as well as other trace minerals are essential for plant growth. Anaerobic digestion cannot create nutrients; it can only capture the nutrients present in the organic material and make them more readily available to plants.

The calculations presented here are for the three primary nutrients required by plants. It is acknowledged that these nutrients alone are not sufficient for healthy plant growth and that there are many other factors which affect plant growth and the health of the crop including water availability, seed variety, pests and disease. Plants also require other secondary nutrients (sulphur, magnesium and calcium) and a number of other micro-nutrients as well as carbon, hydrogen and oxygen for growth. Biofertiliser can contain these secondary and micro-nutrients but they are not considered here as there is limited published quantifiable data of their prevalence in biofertiliser.

This Technical Article deals only with the value of the nutrients in the biofertiliser. There are numerous other benefits to using biofertiliser compared to using manure alone. The manure also contains the nutrients required for plant growth and, like biofertiliser, adds organic matter to the soil unlike chemical fertilisers, however, these nutrients are not available for plant uptake until the manure rots down and releases the ions. A variety of organic materials can be treated by an anaerobic digester which means that the biofertiliser output will contain a blend of the nutrients from all the material. This will reduce the possibility of the biofertiliser lacking, or being low in any one nutrient which could be possible if a single source manure is applied to the land.

There is often a concern about the spread of disease when waste organic matter is applied to land (Ref 3). Wastes, including manure can harbour pathogens which can cause disease in humans. The use of thermal treatment is often used to deactivate these pathogens. It has been shown that anaerobic digestion can also reduce pathogen count in manure by up to 95% when there is a retention time of more than 20 days(Ref 4).

Anaerobic digestion of wastes to produce biofertiliser can therefore confer many additional benefits compared to applying manure direct or chemical fertilisers. This Technical Article does not attempt to quantify these benefits but it should be borne in mind that these give additional value to the biofertiliser.



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## Objective

The purpose of this paper is to demonstrate how SOWTech have calculated an indicative potential monetary value of the biofertiliser output of a Flexigester V10 and to detail the assumptions made in those calculations.

## Method

The calculations given below were performed to be able to demonstrate the potential value of the biofertiliser output of the Flexigester V10.

1. Calculations were performed to establish the volume of material held in the digester at any given time. The digester is built cylindrical in shape. However, as the digester is not rigid, it does not maintain a regular cylindrical shape when filled with waste materials. The actual volume has therefore been extracted from the CAD drawing used in the design of the Flexigester V10. See Table 1.

2. The amount of material per year was then calculated. The material throughput of the digester is not only dependent on the volume but also on the length of time the material is held within the Flexigester. The longer material is held the less material can be treated per year. Two different retention times have been used for illustrative purposes. The 30 day retention time is the shortest recommended retention time. As the amount of material put into a Flexigester equals the amount taken out, the total potential input of material per year was calculated which therefore equated to the amount of biofertiliser that could be produced. See Table 2.

3. Cattle manure was chosen as the example feedstock of the digester. It is difficult to obtain reliable data for mixed feedstocks for anaerobic digestion as the composition of such feedstock in often not known. A single feedstock of cattle manure was therefore chosen. A literature search established the indicative nutrient value of cattle manure post digestion. The values used in these calculations were taken from the study by Scottish Agricultural Collage and ADAS on the Nutrient Value of Digestate-Scotland (Ref 5). This gave nutrient values for cattle slurry from over 200 farms in Europe and the USA. These were combined to give average nutrient values. See Table 3.

4. Using the values in Table 3 and the annual throughput from Table 2 the potential amount of nutrients that can be obtained from the Flexigester V10 were calculated. See Table 4.

5. To calculate the potential monetary value of the digestate the value of nutrients in commercial fertiliser in the UK was obtained from the WRAP Compost Calculator (Ref 6). These values can only be indicative as the value of nutrients in fertiliser fluctuates over time. See Tables 5 and 7.

6. The cost of buying fertiliser in African countries can be up to six times higher than the cost of the same fertiliser on the global markets (Ref 7). The cost of fertiliser is influenced by a number of factors including transportation, taxes, agents fees and lack of economies of scale. An factor of five has been used in these calculations as a typical increase in price over that paid in the UK. See Table 7.

## Calculations

| **Digester dimensions** | | |
|---|---|---|
| Circumference of Flexigester | 4.18 | m |
| Diameter of Flexigester | 1.33 | m |
| Cross sec area | 1.39 | $m^2$ |
| Volume per linear m | 1.39 | $m^3$ |
| Length of Flexigester | 12 | m |
| Volume from CAD drawing taking into account distortion of shape | 10 | $m^3$ |

*Table 1: Digester dimensions with volume taken from CAD drawing*




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| | | | | |
|---|---|---|---|---|
| Amount of material in Flexigester V10 | 10 | $m^3$ | | |
| Retention time in digester | 30 | days | 60 | days |
| Therefore daily input volume is | 333 | l/d | 167 | l/d |
| The biofertiliser produced will be | 333 | l/d | 167 | l/d |
| This equates to a yearly output of | 122 | $m^3$ | 61 | $m^3$ |

*Table 2: Annual biofertiliser produced by Flexigester V10 as a function of volume and retention time in digester*

| **Cow slurry nutrients** | | |
|---|---|---|
| Total N | 3.87 | $kg/m^3$ |
| Ammonical N | 1.72 | $kg/m^3$ |
| Phosphate | 1.44 | $kg/m^3$ |
| Potassium | 4.25 | $kg/m^3$ |

*Table 3: Amount of primary nutrients per $m^3$ of post digestion cow slurry. Taken from "Nutrient value of digestate Scotland" (Ref 5).*

| **Nutrients per year** | **30** | **day retention** | **60** | **Day retention** |
|---|---|---|---|---|
| Total N | 470 | kg | 235 | kg |
| Ammonical N | 210 | kg | 105 | kg |
| Phosphate | 175 | kg | 88 | kg |
| Potassium | 517 | kg | 258 | kg |

*Table 4: Potential nutrients in biofertiliser from Flexigester V10. Calculated from the yearly output figures in Table 2 and the nutrients per $m^3$ in Table 3.*

| **July 2014** | **£/kg** |
|---|---|
| Total N | £0.87 |
| Phosphate ($P_2O_5$) | £0.62 |
| Potassium ($K_2O$) | £0.43 |

*Table 5: UK fertiliser prices July 2014 obtained from the WRAP Compost Calculator (Ref 6) which uses the fertiliser prices supplied by FARM BRIEF.*

| **UK value per year** | **30** | **day retention** | **60** | **Day retention** |
|---|---|---|---|---|
| Total N | £409 | £/yr | £205 | £/yr |
| Phosphate | £109 | £/yr | £54 | £/yr |
| Potassium | £222 | £/yr | £111 | £/yr |
| **Total biofertiliser** | **£740** | **£/yr** | **£370** | **£/yr** |

*Table 6: Calculated monetary worth of biofertiliser in UK using the Flexigester V10 potential annual nutrients from Table 4 and the July 2014 UK fertiliser prices in Table 5.*

| **Potential worth of fertiliser in Africa** | | | | |
|---|---|---|---|---|
| | 30 | Day retention | 60 | Day retention |
| Total N | £2,046 | £/yr | £1,023 | £/yr |
| Phosphate | £543 | £/yr | £271 | £/yr |
| Potassium | £1,111 | £/yr | £555 | £/yr |
| **Total biofertiliser** | **£3,699** | **£/yr** | **£1,850** | **£/yr** |

*Table 7: Calculated potential worth of fertiliser in Africa using the assumption that it is 5 times the cost of fertiliser in UK.*



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## Discussion

The numbers presented in this Technical Article have been calculated to give an indication of the value, in UK terms, of the biofertiliser produced by a Flexigester V10 to show that the treatment of waste products have a worth in monetary terms.

It is difficult to obtain reliable information on the nutrients in feedstocks and outputs from anaerobic digestion as the inputs are normally waste products and are usually from mixed sources. This makes the inputs heterogeneous and they can be variable day to day. For this reason data from a single feedstock type, cow slurry, has been used. The data was a composite of data obtained by Scottish Agricultural College and ADAS from over 200 anaerobic digestion facilities (Ref 5). Using this composite data it was felt that the figures used in the calculations were sufficiently reliable to give indicative values. Although the nutrient values used were obtained from cattle manure from Europe and USA it has been assumed that the nutrients in cattle manure from other parts of the world will be similar. There is a lack of available data on cattle manure nutrients in Third World Countries.

The monetary figures attributed to the nutrients give an indication of the scale of the value of biofertiliser. Global fertiliser prices fluctuate over time. The actual cost of the fertilisers in low-income countries vary from place to place with the largest additional costs being dependant upon the transportation distance both from the country of manufacture to the seaport in Africa and also the overland transportation from the seaport to the local fertiliser dealer. The cost also increase with in country taxes and customs duties. Although figures for the value of the nutrients in the biofertiliser have been calculated it is not the purpose of this article to imply that the biofertiliser could be sold for this amount but to show that the biofertiliser has a worth to the formers.

## Conclusion

The calculations for the potential biofertiliser produced by the Flexigester V10 have shown that the biofertiliser has a significant nutrient value. If this is used to fertilise arable land it can contribute to increased crop yields which will improve food security and may lead to excess produce which could be sold at market.

## References

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