



**REPORT ON THE INVENTORY OF SUBSTRATE,  
SALE OF BM AND CIRCULATION OF OUTPUTS**

2017-11-21



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## 1 Introduction

VafabMiljö is a federation (since year 2015) of 12 municipalities and responsible for waste management on behalf of these municipalities. VafabMiljö is located in Västerås, Sweden, and works with the aim of creating conditions for long-term, sustainable, handling of waste. VafabMiljö operates recycling units, waste stations and processing units in the region consisting of the municipalities in the county Västmanland and two municipalities in the county Uppsala.

In 2013 VafabMiljö, together with four other beneficiaries, was granted financial support from the EC regulation 614/2007 called “LIFE+” for the project titled “Maximized biogaspotential from resource innovation in the Biogas Öst region”, also called “Biogas XPOSE.”

Within the project VafabMiljö plan to build a dry fermentation plant in order to utilize a waste based substrate, namely the organic fraction from municipal solid waste, MSW. The dry fermentation technology is considered suitable for utilizing waste-based substrates for biogas production, thus making it possible to increase gas production.

This report contains a characterization of the digestate produced in the dry fermentation process when the organic fraction from MSW is used as substrate. In addition, a market analysis is conducted with a comparison of substrates such as sewage sludge, digestate from existing biogas plants and manure.

This report was written in 2015-01-20 by Ulf Nordberg, JTI Swedish Institute of Agricultural and Environmental Engineering (now a part of Research Institutes of Sweden – RISE) - on assignment of VafabMiljö. Torbjörn Ånger, VafabMiljö, has implemented a slight change in the structure of the report, 2017-11-21 (*photo on front page: Torbjörn Ånger*).

## 2 Characterization of the product

The yearly amount of digestate from dry fermentation of organic fraction from MSW rest waste (dry digestate) is assumed to be about 20 000 ton. The digestate has to go through further treatment, which will reduce the amount to about 6 000 – 15 000 ton. However, the uncertainty in the assumption is very large. The quality, in terms of content of plant nutrients and metals, is unknown and depends on the performance of the equipment in the plant as well as the quality of feed stock. Data from similar plants in Europe concerning plant nutrient and metal content in the digestate has not been found.

To be able to make judgment of the quality of the digestate from dry fermentation at VafabMiljö other data have been used, see **Table 1**.

The quality of dry digestate will most probably not be as good as any of the examples in **Table 1**, below.

Table 1: Metal and nutrient content (mg/kg DW) in compost from Atleverken, Örebro, content according to Schott et al., 2013 for un-avoidable food waste separate collected and un-avoidable food waste in residual waste and average content in Swedish certified co-digestion plants digesting mainly source separated food waste and average content in all certified co-digestion plants in Sweden (2012)- (na = not analyzed).

Substance	Compost from Atleverken,2012 Feedstock: 78 % source separated food waste; 22 % woodchips from garden waste and treas	Unavoidable food waste separate collected, converted to digestate in parenthesis	Unavoidable food waste in residual waste, converted to digestate in parenthesis	Average digestate from food waste <sup>1</sup>	Average digestate from 14 Swedish digestion plants
Cd	0,5	0,11 (0,27)	0,37 (0,90)	0,4	0,3
Cr	30	na	na	14	9
Cu	83	na	na	50	74
Hg	<0,06	na	na	0,1	0,05
Ni	11	na	na	10	8
Pb	21	1,1 (3)	3,3 (8)	7	3
Zn	235	25 (61)	107 (261)	211	250
Tot-N	10120	na	na	137000	134000
NH <sub>4</sub> -N	490	na	na	80000	81000
Tot-P	2400	1641 (4002)	2238 (5459)	13000	15000
mg Cd/kg P	208	67	165	31	20

<sup>1</sup>Values calculated from five Swedish co-digestion plants (yearly average values, 2010-2012) having >71% source separated food waste as feed stock.

## 2.1 Metal and nutrient content

When the feed stock mainly contains of mechanical separated food waste the cadmium content tends to be higher compared to a feed stock mix with more varied origin. From **Table 1** it is also obvious that the phosphorus content will be lower if source separated food waste will be the dominant feed stock. With a higher Cd-content and a lower P-content the Cd/P-ration will increase, see **Table 1**. The average ration for Cd/P in Swedish mineral fertilizers with phosphorus was 4,9 mg Cd/kg P year 2011/12 (SEPA 2013a). The Cd/P-ration for manure is between 8 and 16 mg Cd/kg P. Thus, a fertilizer product having a Cd/P-ration over 100 mg Cd/kg P will differ largely in Sweden and most probably be hard to market in the long run. This especially since the Swedish Government wants to reduce the cadmium contribution to arable land via fertilizers

## 3 Market analysis

### 3.1 Sewage sludge in the region

In the county of Västmanland (the county in which MälärEnergi and VafabMiljö is located) was totally 5 570 ton dry weight sewage sludge produced year 2012 (SCB, 2014) corresponding to between 20 000 and 30 000 ton wet weight. The total amount of sewage sludge in Sweden was 207 460 ton dry weight, corresponding to about 900 000 ton wet weight. The sludge use in the county compared to the whole of Sweden was according to **Figure 1**. Sludge used for unspecified purpose in Västmanland County is, together with sludge used for soil production with high P-content, probably used at landfills.

Thus, the total share used at landfills in Västmanland County will be 40 %. In Sweden as a whole, 57 % was used at landfills. This means that the agricultural use of sewage sludge in the Västmanland County is rather high (44 %) compared to the average in Sweden (23 %) and less is used in landfills, 40 % compared to 57 % for Sweden as an average.

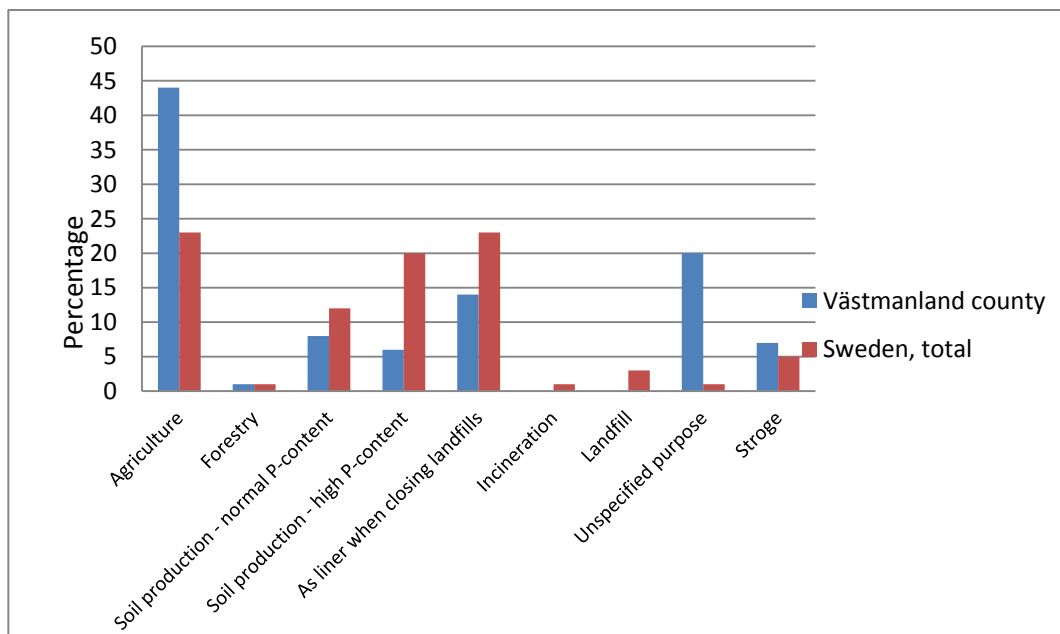


Figure 1. Use of sewage sludge in Västmanland County and Sweden, year 2012 (SCB 2014)

### 3.2 Digestate

There are two biogas plants in the county – one owned and operated by VafabMiljö and one owned and operated by Swedish Biogas International (SBI). VafabMiljö’s plant is co-digesting different types of feed stocks like source separated food waste, organic waste from restaurant and retail shops, silage etc. The annual production was 25 200 ton wet weight year 2013 and all was used in agriculture as fertilizer. SBI’s plant is digesting mainly manure and smaller amounts of vegetable by-products. The plant is newly constructed and operation started during the autumn 2013. The annual digestate production is expected to be up to 80 000 ton wet weight. The whole volume will be used in agriculture.

## 4 Competition between products

### 4.1 Sewage sludge

Today the two major outputs for sewage sludge in the region is agriculture and for closing of old landfills, **Figure 1**. Closing of landfills will soon end. Sewage sludge will thus “return to the market” in short-term perspective. Traditional major outlets for sewage sludge in Sweden are agricultural use as a fertilizer, as a component in soil production, and as landfill liner.

## 4.2 Digestate

Digestate is expected to have a stable market as fertilizer for agricultural use. This applies for both digestion plants (VafabMiljö and SBI).

## 4.3 Manure

In the county of Västmanland the animal density is very low compared to Sweden as a whole. The annual amount of manure is about 460 000 ton wet weight. In the county 21 % of the agricultural area (total agricultural area was 86 800 ha year 2011) is fertilized with manure compared to 38 % as the average for Sweden (SCB, 2012). Thus, there is a demand for organic fertilizers in the county, which also was one of the major driving forces for establishment of VafabMiljö's digestion plant. As SBI's plant is digesting almost only manure there will be no negative competition between agricultural use of digestate from that plant and manure.

## 4.4 Competition

The relatively high demand for organic fertilizers in the county could be one explanation to the rather high figure for agricultural use of sewage sludge (44 %).

Sewage sludge and dry digestate will most probably compete on the same outlets (markets), which is problematic. However, the two products are under different administrative bodies – the sewage sludge is under MälarenEnergi (owned by the municipality of Västerås) and the dry digestate is under VafabMiljö (owned by the municipalities in Västmanland county and the municipalities Heby and Enköping). As the owners to the two companies are not the same it is possible that it could be a true competition between their products and especially if customers are few and not willing to pay. Sewage sludge is also the dominant product both in terms of amount and knowledge among possible customers. In a short term perspective is it thus likely that a larger share of sewage sludge will be used in agriculture when the use at landfills will decrease.

From an agricultural area perspective there is enough of land available for new types of organic fertilizers. This would also be good for the soils as there are areas with low humus content and thus a demand for organic fertilizers. The questions are rather if the quality and customers perception are there?

# 5 Legislation and means of control

Swedish Environmental Protection Agency (SEPA) published a report with suggestion for new limit values when different organic fertilizers are used (SEPA, 2013). The suggestions, together with EU-suggestions for new limit values according to End of Waste for compost as well as for Ecolabel for growing media are presented in *Table 2* and *Table 3*.



Table 2. Limit value in product, mg/kg DW, according to different legislations and suggestions to legislations (SEPA, 2013b).

Substance	Sweden sewage sludge 2014	SEPA suggestion 2015 alt. A (B, C)	SEPA suggestion 2023 alt. A (B, C)	EoW – suggestion to commission	Ecolabel growing media <sup>2</sup> :	Ecolabel growing media – lower limit option – suggestion 2013
Cd	2	0,7 (1)	0,5 (0,9)	1,5	1	0,8
Cr	100	50 (60)	35 (45)	100	100	75
Cu	600	500 (600)	425 (550)	200	100	80
Hg	2,5	0,75 (1)	0,6 (0,8)	1	1	0,75
Ni	50	25 (40)	20 (35)	50	50	50
Pb	100	35 (35)	30 (30)	120	100	75
Zn	800	750 (800)	650 (750)	600	300	250
Ag	-	4 (5)	3 (4)			
PAH <sub>16</sub>	-	-		6	-	

<sup>2</sup>Limit values for products containing material from industrial processes, such as rice hulls, peanut hulls or sludge from the agro-food industry: Mo (2), Se (1,5), As (10), F (200)

Table 3. Limit values for addition of metals to arable land (g(DW)/ha and year) when using the product, according to different legislations and suggestions to legislations (SEPA, 2013b, EC 2014a and b).

Substance	Sweden sewage sludge 2014	SEPA suggestion 2015 alt. A (B, C)	SEPA suggestion 2023 alt. A (B, C)	EoW – suggestion to commission	Ecolabel growing media, new suggestion
Cd	0,75	0,55 (0,55)	0,45 (0,45)	1,5	1
Cr	40	32 (40)	24 (40)	100	75
Cu	300	300 (300)	300 (300)	200	100
Hg	1,5	0,74 (0,8)	0,42 (0,6)	1	0,75
Ni	25	20 (25)	16 (25)	50	30
Pb	25	25 (25)	25 (25)	120	100
Zn	600	590 (600)	510 (550)	600	300
Ag	-	3,46 (3,5)	1,65 (3)	-	-

## 5.1 Implications of legislation on use of digestate from dry fermentation of organic fraction from MSW rest waste

In **Table 4** amounts of metals that will be added to agricultural land are shown if different fractions from **Table 1** will be used as fertilizer. The figures shall be compared to the limit values according to different suggestions in table **Table 3**.

Table 4. Addition of metals to arable land (g/ha and year) if 22 kg tot-P/ha and year are applied from different sources (na = not analyzed).

Substance	Compost Atleverken, Örebro	Unavoidable food waste separate collected	Unavoidable food waste in residual waste	Average digestate from food waste
Cd	5	1,5	3,6	0,7
Cr	280	na	na	23
Cu	760	na	na	85
Hg	<1	na	na	0,1
Ni	100	na	na	17
Pb	195	15	32	11
Zn	2150	335	1052	358

## 6 Conclusions

- Certified digestate has a good acceptance among farmers and the food industry, thus digestate can most probably be used as fertilizer in agriculture also in a long-term perspective. The reason is that the certification system only allows clean and source separated organic waste products from the production chain for food and feed. Dry digestate does not meet these criteria's (not source separated and not only from the food and feed chain).
- It can be assumed that in the dry digestate the content of plant nutrients will be lower and metal content higher compared to other organic fertilizers. Thus the ratio between metals and plant nutrients will be higher. As the legislation stipulates a maximum addition of metals per area when an organic fertilizer is used this means that only a small part of the needed plant nutrients can be supplied by the dry digestate. This will make a low interest for dry digestate as a fertilizer among farmers.
- If the suggested legislation from SEPA will be in force, only about 10 % of the annual plant nutrient need could be added by dry digestate.
- The low content (concentration) of plant nutrients makes the dry digestate more suitable for soil production and use at landfills or similar usage.
- The low plant nutrient concentration in the dry digestate combined with the assumed low acceptance calls for a shift between dry digestate and sewage sludge use at landfills when possible. It is likely more easy to find agricultural users for sewage sludge than for dry digestate. However, this calls for an agreement between VafabMiljö and MälarEnergi.
- Decision on national level regarding long term management of sewage sludge will heavily influence management of the dry digestate. If incineration will be a common option for sewage sludge it will be very difficult to use dry digestate in agriculture. If the situation for sewage sludge will remain as today, it will be difficult to use dry digestate in agriculture according to above. However, in both cases the use of dry digestate for soil production for landfill use or similar soil usage will most probably be an option. As an incineration facility is available in Västerås incineration can always be a back-up option.

## 7 References

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