Meer halen uit de biologische kringloop

PRESENTATION OF VLACO AND THE QUALITY ASSURANCE SYSTEM

1. HISTORICAL BACKGROUND AND LEGISLATION OF COMPOSTING AND AD IN FLANDERS

Belgium has three regions: Flanders, Brussels and Wallonia. In Belgium, waste legislation is a competency of the Regions. In the Flemish Region in the last two decades, the Public Waste Agency of Flanders (OVAM) has given very active attention with regards to biowaste treatment, composting and sustainable use of compost. The Flemish waste management policy is built upon the hierarchy of waste management options: prevention > recuperation > waste treatment for recycling > incineration > landfill. Separate collection has been in focus in Flanders from the early nineties. It is nowadays still important, but the focus has shifted towards prevention since the late 1990s. Whereas in the beginning compost was produced from mixed residual waste, with poor market opportunities and severe quality shortfall (chemical, physical, microbiological), gradually the quality of the produced compost has improved, not only due to pre- and post-treatment but rather because of strict acceptation rules. In the beginning, the product standards for compost as described in the VLAREMA (Flemish Regulation on Sustainable Materials Management and Waste) were rarely met. Separate collection initiatives in the Flemish Region have been very successful since then. In the early nineties, the municipalities and inter-municipal waste associations were obliged to implement the separate collection from households for either green waste or vfg-waste (vegetable, fruit and garden waste). In that time, sorting analyses showed that about half of the residual waste consisted of an organic-biological fraction. Together with the setting up of systems for separate collection, the treatment plants were built in the early nineties. Further investments and efforts in separate collection and treatment of biowaste, driven by legislative rather than sheer economical aspects, resulted in new experiences and satisfactory results. Nowadays the composting plants in Flanders produce high quality compost in all cases fit as a soil improver and growing medium in agriculture, horticulture, private households, landscaping, …
A key factor in the Flemish waste legislation is the non-dilution principle: composting plants can not be used as a solution for getting rid of polluted substances: only biowaste that fulfils the end product standards can be accepted as an input material. Furthermore, the treatment of (bio)waste should not divert the problems to other environmental compartments. Closing the cycle for biowaste also implies proper use of the end product and a decent control system.

In the early days of Vlaco (before 2006), the quality assurance was only focused on green compost and vfg-compost, and creating a market for compost by quality guarantee was the main objective. Since 2006, Vlaco has broadened the quality assurance of the biological treatment of biowaste to other end products than compost, e.g. resulting from anaerobic digestion (digestate and related products) and biothermal drying (manure treatment together with biowaste).
Parallel with this, Vlaco started in 2006 to redirect its activities towards a system of independent certification (before, it was mainly quality assurance through sampling and optimising of the end product quality through advice). Meaning we developed a quality handbook (2010) (Vlaco as an independent quality assurance organisation), we implemented a Certification Commission (2009), we developed a document 'General Regulations of the Certification', several checklists (composting and anaerobic digestion) (since 2006) and a control and certification system. This implies regular plant visits (audits, frequency 1/year) and regular sample takings (frequency in function of treatment of the plant). Figure 1 shows the evolution of the policy and the related activities of Vlaco.
In 2011 Vlaco applied for the ECN-QAS Conformity Assessment. After the successful audit in January 2011, Vlaco received the ECN-QAS Conformity Label for Compost. This certification as a Quality

Assurance Organisation according to the rules of ECN-QAS was broadened with the scope of Digestate products in 2014.
Due to a change in the VLAREMA-legislation (Flemish Regulation on Sustainable Materials Management and Waste), in 2014, the General Regulations of the Certification were slightly altered, and the Certification Commission was dissolved.
Currently, anno 2020, the quality assurance of Vlaco includes 118 treatment plants.

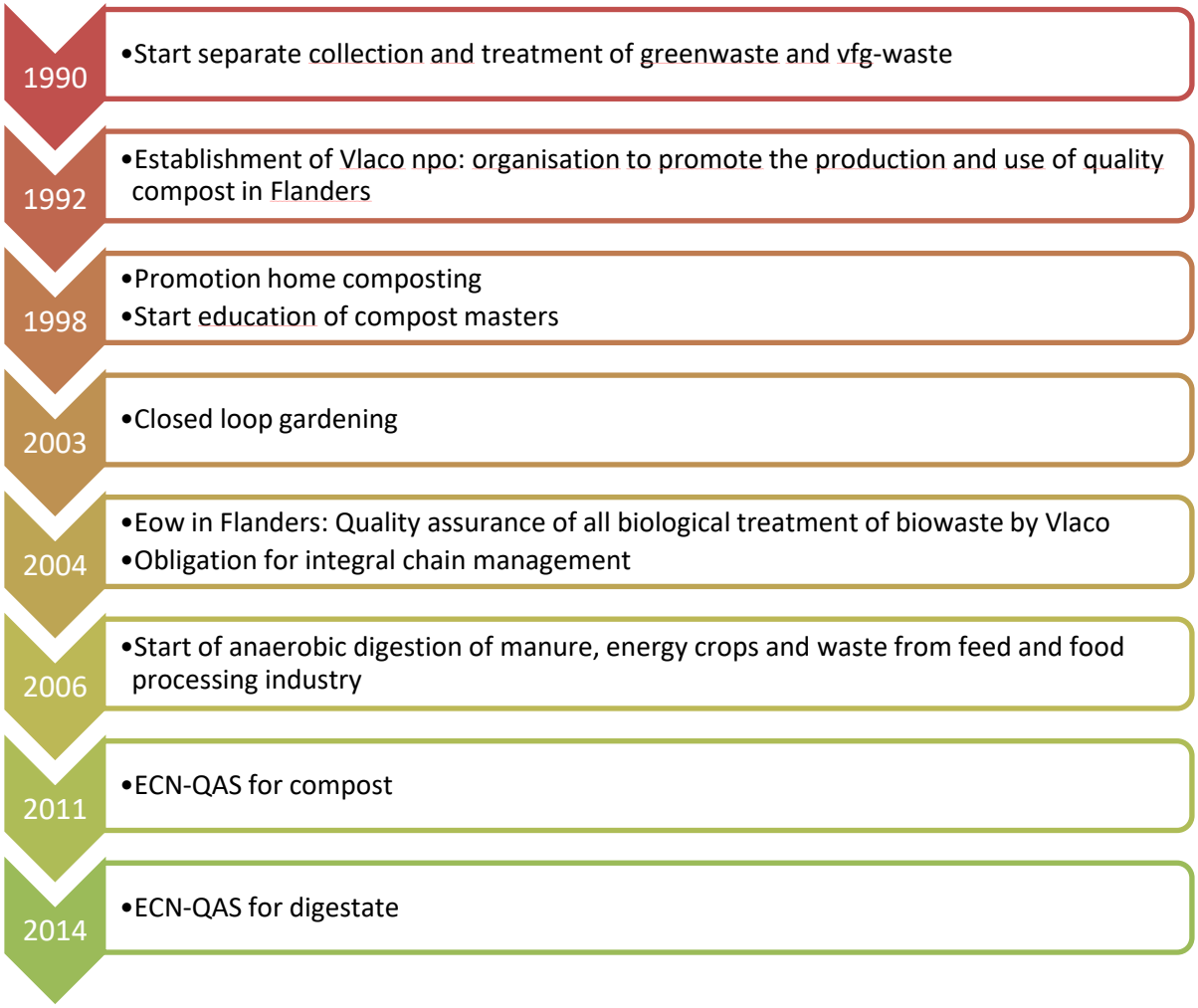

FIGURE 1: Evolution of the policy and related activities of Vlaco

2. QUALITY ASSURANCE OF COMPOST AND DIGESTATE

2.1. Introduction

From the point of view that the production of compost and digestate (resulting from the commitment of separate collection and obligation for treatment) should go hand in hand with the reasoned use of the end product, the Flemish Public Waste Agency (OVAM) supported the initiation of Vlaco, the Flemish Compost Association, an independent non-profit membership organisation bringing together the stakeholders with activities related to prevention, collection and treatment of biowaste (OVAM, compost producers, municipalities and inter-municipalities).
Since its start-up in 1992, Vlaco has considered quality as a key issue. A quality assurance system (QAS) has been put in place, which is obligatory for all professional composting and digestion plants in Flanders. This QAS is based on the principles of integral chain management. The QAS takes into account all aspects of the treatment and production chain, from the acceptance of biowaste, the quality of the treatment process, end product quality up to customer support for a reasoned use. The outcome of the QAS on treatment plant level is one or several product certificates, showing that the compost or digestate is produced according to the criteria set up in the certification scheme and the waste legislation. Without the control certificate, treated biowaste cannot be used as a secondary material. Control of compliance with this certification scheme is done by means of regular audits and product sampling.

2.2. Details of the QAS

The choice for setting up a certification scheme not only based on product analysis but over viewing the whole process from input to output is supported by risk minimising. Infinite sampling and analysis of compost and digestate is practically and economically impossible. Moreover, in a suboptimal treatment process, the product standards (which are rather strict in Flanders) will be met with more difficulty. Therefore, in the QAS monitored by Vlaco, control certificates are granted to treatment plants when the treatment complies with the control points, and the product analyses show that the end product tests are in conformity with the product standards. A parameter that has a direct impact on the product quality is the biowaste fraction being treated. In the Flemish waste regulation, the origin of this biowaste fraction is clearly defined as the separately collected organic fraction of household waste (vfg waste), green waste and organic-biological biowaste from food and feed processing industry. Regular sorting analyses are done by the waste management associations and treatment plants to ensure the intrinsic quality of the input material. There are intensive promotion and information campaigns in Flanders about recycling and separate collection of biowaste, ensuring the basis for a high compost and digestate quality.

The most important aspects of the Vlaco quality assurance system are:

(a) a strict acceptance protocol (input)
(b) process management according to ISO-principles (throughput)
(c) quality monitoring of the end product (output)
(d) reasoned use of the end products

(a) a strict acceptance protocol

Treatment plants must have procedures describing the acceptance of inputs for green waste composting or vfg waste composting. Only separately collected biowaste is allowed to be used as an input for professional composting. Regular sorting analyses must be carried out. Treatment contracts

exists between all professional biowaste treatment plants and the municipalities or inter-municipalities, which guarantees the intrinsic quality of the input material. These contracts also exist for the biowaste that is treated through anaerobic digestion for the production of digestate. Through visual control at the gate and regular sorting tests of the biowaste being presented, treatment plants ensure an input stream of continuous high quality. In case of non-conformity with the acceptance criteria, the biowaste is refused, and the cause of incompliance has to be dealt with. The quality of separately collected biowaste from households, if insufficient, can be adequately improved through sensitizing and information campaigns. The acceptance of industrial biowaste from food industries is only possible when regular analyses on agricultural and environmental parameters are carried out, as well as a risk assessment of the input material (origin, traceability, EWC code, registration, …).

(b) process management according to ISO-principles

Vlaco has set up a QAS for professional treatment plants of biowaste according to the principles of the ISO 9000 certification standard and integral chain management. The whole chain of biowaste treatment, from input quality over the treatment process and quality assessment of the end products is monitored using an integral quality management system, set in place on every treatment plant. Experience showed that a quality assessment only based on end product testing is insufficient. Non-conformities are reported and countered with adequate measures ensuring a progressive improvement of the quality of the production. Registration of the critical process factors (dates, batch numbers, type and quality of input material, process parameters e.g. temperature, management actions e.g. turning, sieving, …) leads to an auto control system that allows tracking and tracing of the products, and guarantees for critical steps in the treatment and production process. During the important step of hygienisation of the biowaste, temperature and management must be over watched very closely. Data has to be registered in the log books. Through regular auditing by Vlaco, the implementation of the quality aspects by the treatment plants are controlled.
Moreover, other legislation on regional, federal (Federal Fertiliser Legislation) or European level (e.g. the Animal By-products Regulation 1069/2009, the intended EPPO-guidelines for treatment of biowaste of plant origin, the Fertilising Products Regulation (EU) 2019/1009) also suggest the importance of a well-founded QAS on treatment plant level together with adequate and sufficient product testing.
The outcome of the system audits together with continued product testing can lead to a control certificate, approving that the products are in accordance with the quality requirements.

(c) quality monitoring of the end product

The VLAREMA-legislation for use of treated biowaste as a secondary material (fertiliser or soil improver) sets up limit values for the most important environmental parameters, both organic (PAH, PCB, other organic compounds, …) and inorganic (e.g. heavy metals). The Vlaco QAS is based on limit values that are even stricter than these values, and carries along parameters indicating the agronomic importance of the end products (nutrients, soil organic matter) as well as the physical and biological quality aspects (impurities, viable seeds, stability). In table 1, the quality standards for green compost are shown, in table 2 the standards for vfg compost and in table 3 the standards and limit values for digestate products. Nutrient composition is tested and to be declared to the user, not regulated.
Since 2015, the quality standards for compost and digestate are officially regulated through application of the General Regulations of the Certification, a document issued by OVAM, for which Vlaco is a recognised certification body. The General Regulations of the Certification is available on the OVAM-website.

TABLE 1: Quality standards for green compost

	QO[1]	Percentile	Standard	Unit
GENERAL PARAMETERS				
Dry matter	>50	20	>45	weight %
Organic matter	>16	20	>14	weight %
pH (water)	-	-	6,5 - 9,5	-
HEAVY METAL CONCENTRATION				
Arsenic	<15	75	<20	mg/kg DM
Cadmium	<1,5	75	<2	mg/kg DM
Chromium	<70	75	<70	mg/kg DM
Copper	<90	75	<150	mg/kg DM
Mercury	<1	75	<1	mg/kg DM
Lead	<120	75	<150	mg/kg DM
Nickel	<20	75	<30	mg/kg DM
Zinc	<300	75	<400	mg/kg DM
IMPURITIES, STONES AND VIABLE SEEDS				
Impurities > 2 mm	<0,5	75	<0,5	weight % DM
Stones >5 mm	<2,0	75	<4	weight %
Viable seeds	<1	90	Max. 1	#/0,5l
STABILITY/MATURITY				
Decomposition degree (temperature)	<30	90	<40	°C
Oxygen Uptake Rate (oxitop)	<10	80	<15	mmol O2/kg VS/h
MICROBIOLOGY				
Salmonella			absent	/25g

Product standards to be judged upon sampling: product appearance. The product must be loose and not compacted.

TABLE 2: Quality standards for vfg-compost

	QO	Percentile	Standard	Unit
GENERAL PARAMETERS				
Dry matter	>50	20	>45	weight %
Organic matter	>16	20	>14	weight %
pH (water)	-	-	6,5 - 9,5	-
HEAVY METAL CONCENTRATION				
Arsenic	<15	75	<20	mg/kg DM
Cadmium	<1,5	75	<2	mg/kg DM
Chromium	<70	75	<70	mg/kg DM
Copper	<90	75	<150	mg/kg DM
Mercury	<1	75	<1	mg/kg DM
Lead	<120	75	<150	mg/kg DM
Nickel	<20	75	<30	mg/kg DM
Zinc	<300	75	<400	mg/kg DM
IMPURITIES, STONES AND VIABLE SEEDS				
Impurities > 2 mm	<0,5	75	<0,5	weight % DM

[1] QO = Quality Objective

Stones >5 mm	<2,0	75	<4	weight %
Viable seeds	<1	90	Max. 1	#/0,5l
STABILITY/MATURITY				
Decomposition degree (temperature)	<40	80	<45	°C
Oxygen Uptake Rate (oxitop)	<10	80	<15	mmol O2/kg VS/h
MICROBIOLOGY				
Salmonella			absent	/25g

Product standards to be judged upon sampling: product appearance. The product must be loose and not compacted.

For digestate and digestate products, the standards and limit values are given in Table3. In Figure 2, the scheme for anaerobic digestion with the different end products is shown.

TABLE 3: Quality standards for digestate products

	VLAREMA	Standard	Unit
GENERAL PARAMETERS			
pH (water)	-	≥ 6	-
HEAVY METAL CONCENTRATION			
Arsenic	<20	<20	mg/kg DM
Cadmium	<6	<2	mg/kg DM
Chromium	<150	<100	mg/kg DM
Copper	<800	<800	mg/kg DM
Mercury	<1	<1	mg/kg DM
Lead	<300	<150	mg/kg DM
Nickel	<100	<50	mg/kg DM
Zinc	<1500	<1500	mg/kg DM
IMPURITIES, STONES AND VIABLE SEEDS			
Impurities > 2 mm	<0,5	<0,5	weight % DM
Stones >5 mm	<2,0	<2,0	weight %
Viable seeds		Max. 1	#/0,5l
STABILITY/MATURITY			
Oxygen Uptake Rate (oxitop)		<50	mmol O2/kg VS/h
MICROBIOLOGY			
Salmonella		absent	/25g

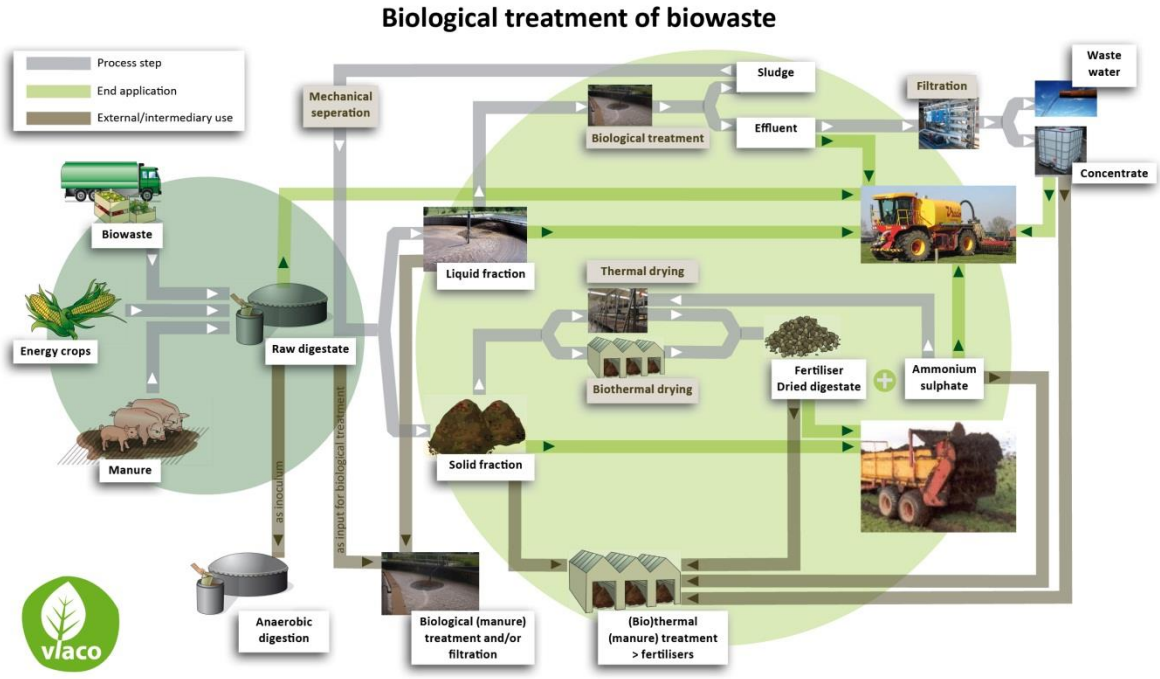

FIGURE 2: Biological treatment of biowaste through anaerobic digestion

As shown in Figure 2, there are different end products of anaerobic digestion and post-treatment of digestate:

- raw digestate
- solid fraction digestate
- liquid fraction digestate
- thermal dried digestate
- effluent and sludge of biological treatment of liquid fraction
- concentrate after filtration

The quality assurance of the final product is carried out on each different product, possibly resulting in several quality certificates on the same production plant.

The necessary samples are taken by Vlaco and offered for analysis in accredited laboratories using recognised methods. The amount of samples necessary per treatment plant is calculated on the basis of biowaste input (as stated in the General Regulations of the Certification). When several product types are produced at the same location, the sampling and analysis protocol is carried out by Vlaco on all product types. The outcome of 1 analysis is always compared with the product standards, but the decision about certification is based on a progressive set of sample results, with quality objectives that are stricter than the product standards. By reviewing several product analysis results on a continuous time scale, the quality assurance organisation (Vlaco) is able to observe temporal product incompliance. This can be related to non-conform process parameters which must be solved in a plan of action. Solitary product analysis reports are insufficient sources of information for assessing a compost production plant. Compost is not only a product, but the result of a controlled and sustainable biological treatment process of separately collected biowaste.
Besides the analyses carried out by Vlaco, the treatment plants are themselves obliged to take product samples for internal quality assurance.

(d) reasoned use of the end products

Not only the composition of the end product is a possible risk from point of view of environmental or public health matters, also the unreasoned use could pose a problem, e.g. excessive application rates with undesired side effects such as phytotoxicity, nutrient overshoot or imbalance, heavy metal application, … Therefore, the Vlaco QAS imposes the professional treatment plants to inform the consumers about the use of the product(s), in all possible applications. This is done by an information leaflet mentioning the composition, usual application rates, application manner, hygienic safety, …

The integration of quality assurance measures all along the production chain of compost and digestate, with strong emphasis on product input, regular product testing and reasoned use of product output, enhances the possibility to assure environmental and public health safety. This is guaranteed through the issuing of certificates for the different products by Vlaco.

2.3. Separate collection in the Flemish Region

In 2019, per inhabitant, 334 kg of household waste was collected separately. The different fractions are shown in Figure 3. Biowaste is considered in 2 different fractions: green waste and vfg-waste, which is the organic fraction of the household waste separately collected from door-to-door. Since January 1st of 2019, catering waste is included in the definition of vfg waste. These 2 fractions (= biowaste) count for 32,2% of the separately collected household waste.

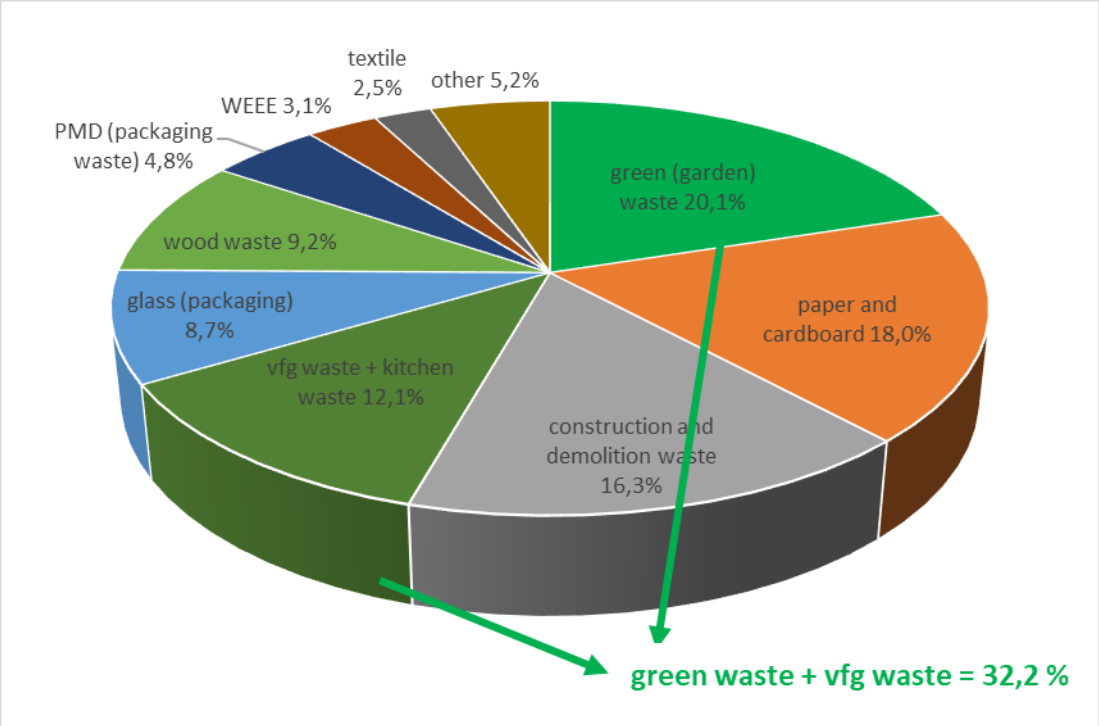

FIGURE 3: Fractions of the household waste separately collected in 2019 (Source: OVAM)

Next to the household waste, there is a large fraction of the industrial biowaste (mainly from food and feed processing industry) which is separately collected and biologically treated. This is mostly done by anaerobic digestion, in both agricultural and industrial AD plants. A small fraction of some

types of biowaste is also co-treated through biothermal drying. This is a manure treatment process (short term composting) to reach the standard treatment parameters described in the Animal By-products Regulation (1h, 70°C, max particle size 12 mm). This treatment is necessary for the export of manure outside the Flemish Region. This co-treatment of biowaste is also under quality assurance of Vlaco.

2.4. Vlaco QAS in figures

The treatment plants (composting plants, AD plants, biothermal drying of manure with biowaste) are all members of Vlaco. Anno 2020, there are 87 treatment plants in the Flemish Region that are a member of Vlaco. These are shown in Figure 4. Together these represent a treatment of 690.000 tonnes of biowaste through green composting + 291.000 tonnes of biowaste through vfg-composting (end products are green compost and vfg compost). This is shown in Figure 4. For anaerobic digestion and biothermal drying, in total 1.593.000 tonnes of biowaste were treated (mainly biowaste from food and feed processing industry and distribution sector), together with manure (790.000 tonnes) and energy crops (232.000 tonnes). The evolution of the separate collection and treatment of organic-biological material is given in Figure 5.

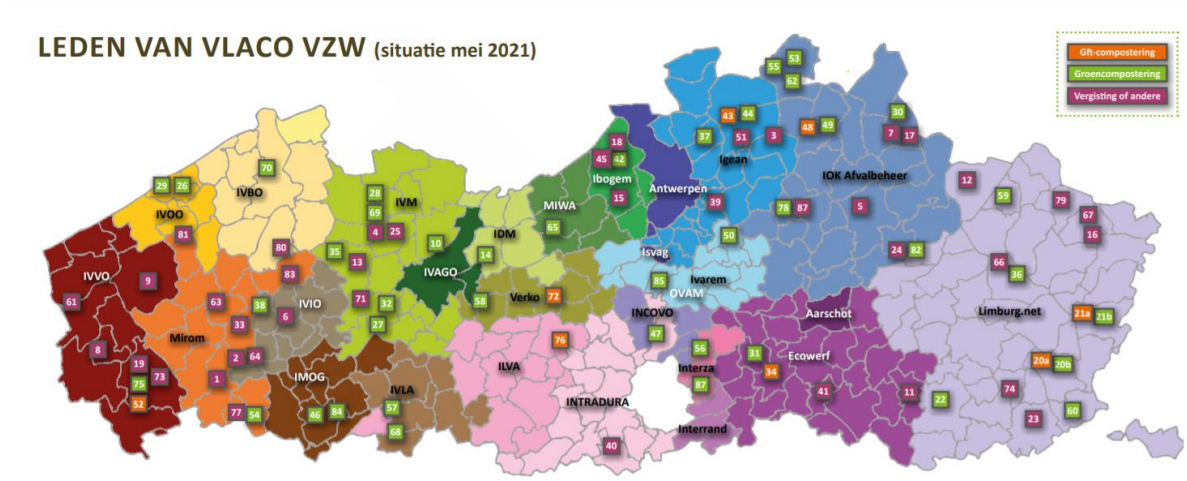

FIGURE 4: Treatment plants of biowaste in Flanders - orange = vfg composting, green = green composting, purple = anaerobic digestion and biothermal drying.

The different colours in the map of Figure 4 indicate the different municipalities and inter-communities (associations of municipalities) in charge of the collection and/or treatment of biowaste.

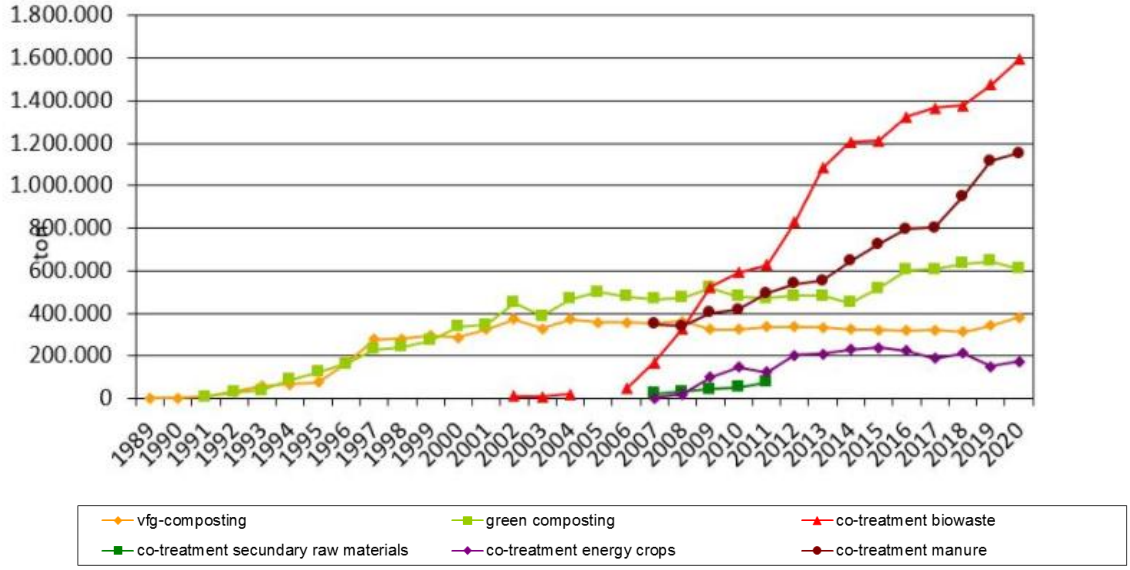

FIGURE 5: Evolution of the treatment of organic-biological material under quality assurance of Vlaco (period 1989 – 2020)

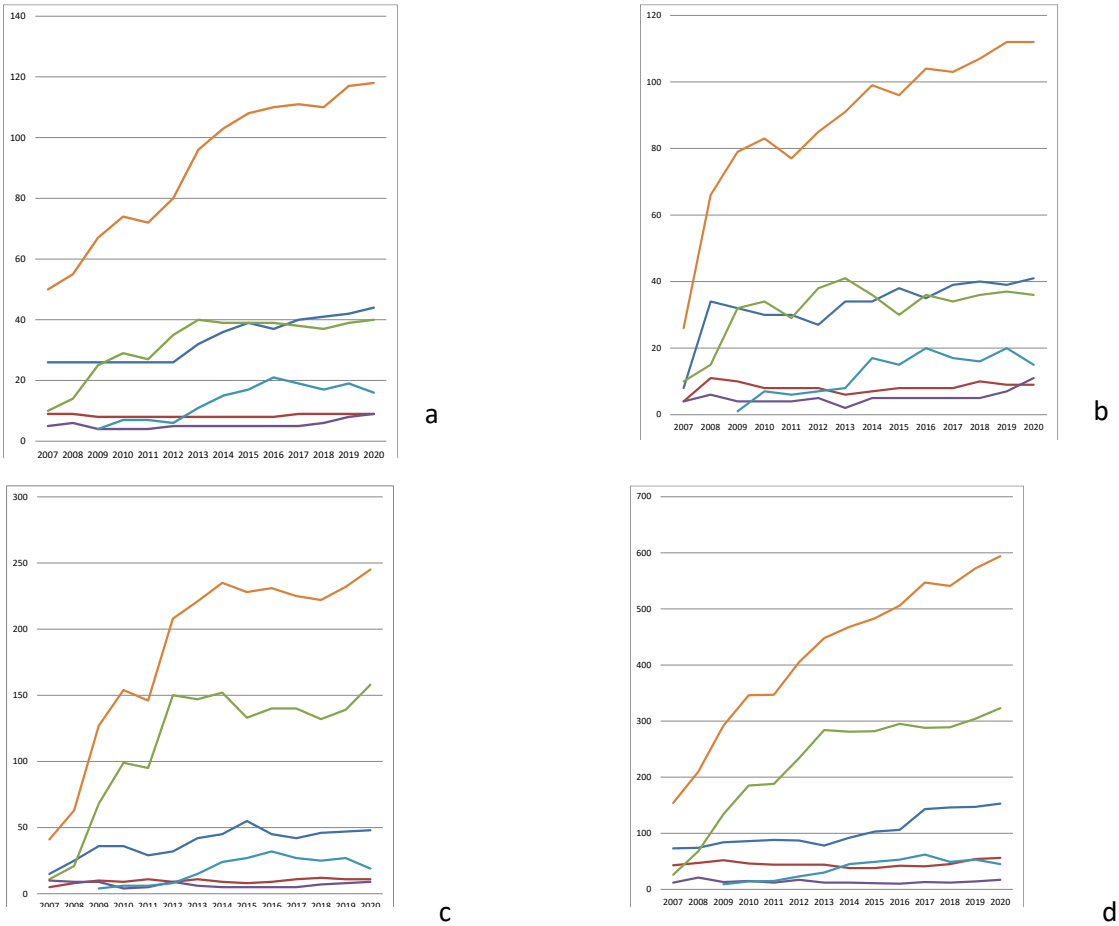

FIGURE 6: Evolution of the Quality Assurance of Vlaco (2007 – 2020) – number of plants (a), number of audits (b), number of certificates (c) and number of samples taken (d).

In 2020, the following data give detailed information on the quality assurance by Vlaco (composting, anaerobic digestion and biothermal drying):
Number of treatment plants: 102
Number of audits carried out: 97
Number of certificates granted: 226
Number of samples taken: 549
The evolution of this data is shown in Figure 6.

In Figure 7, the total number of composting (green and vfg), anaerobic digestion (AD) and biothermal drying plants is given per class of throughput (tonnes/year) for 2020. Input material for composting is green waste and vfg waste respectively, for anaerobic digestion it is manure, biowaste and energy crops, for biothermal drying this is manure and biowaste. Vfg composting plants or vfg anaerobic digestion with after-composting have mainly a capacity between 25.000 tonnes and 50.000 tonnes per year.
Green waste composting plants are found in each class, from small to large scale. The anaerobic digestion plants on agricultural level (on farm) are usually smaller than 50.000 tonnes/year, industrial AD plants treat more than 60.000 tonnes of biowaste. There is a restriction for biowaste of 40% of the input material (over 60% must be agricultural related input material such as manure and energy crops) in agricultural AD plants. Industrial AD plants can treat up to 100% of biowaste as input material.
The treatment plants of biothermal drying (manure in combination with biowaste) are large scale installations, usually treating > 50.000 tonnes/year. They mainly treat solid fraction of manure for export (hygienisation), with co-treatment of a fraction of biowaste or dried digestate.

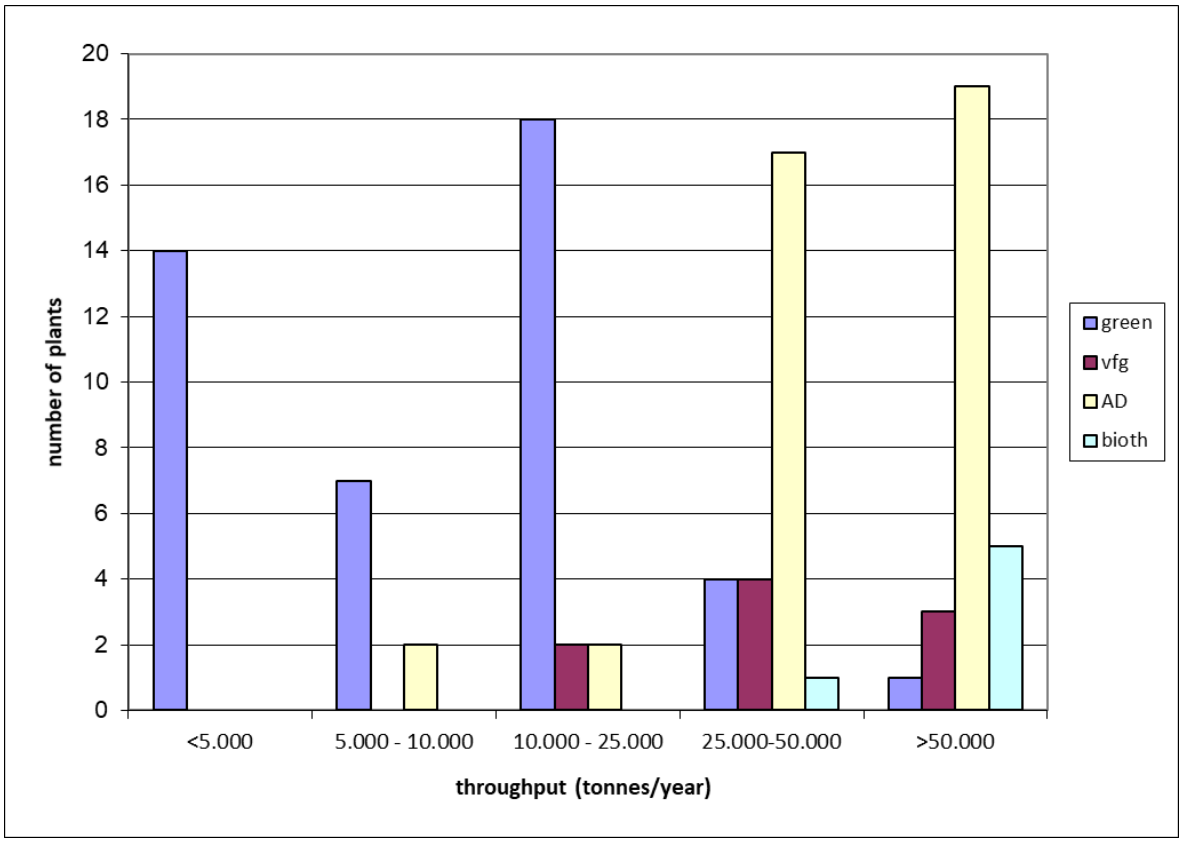

FIGURE 7: Number of plants per class of throughput per year per type of treatment (2020)

Green composting is mainly open windrow composting. 2 green composting plants have composting with membrane cover. In 1 green composting plant the material is composted in tunnels, afterwards maturation in open air. 1 green composting plant is in enclosed windrows.
The vfg composting is carried out in enclosed windrows (tunnel and hall composting). Maturation of vfg-compost is sometimes in open windrows. There are currently 3 vfg-composting plants that have an anaerobic digestion step as a pre-treatment, 2 more are planned.
Anaerobic Digestion is for 2/3 mesophilic, in 1/3 of the cases thermophilic. There are no batch systems, all (semi-)continuous. In some cases, the thermophilic digestion step is validated as an alternative process for pasteurisation (ABPR). The number of AD plants hasn't increased recently, but the amount of input material per plant has. Some plants have a new environmental permit and treat more biowaste.

2.5. End product quality

Vlaco assembles information about the quality of the end product by own sample takings. The treatment plants are visited numerous times per year for sampling and analysis.
The minimum required number of samples taken by the producer is calculated from the fraction of biowaste and secondary materials/energy crops in the input of the treatment plant on an annual basis using the following formula:

$$\text{number of analyses per year} = 1 + \frac{X}{10.000}$$

X = fraction biowaste and secondary materials/energy crops (tonnes)

For a plant treating up to 50.000 tonnes per year this means at least 6 analyses per year. The number is always rounded off upwards. The number of needed analyses is divided through sampling by the quality assurance organisation (minimum half of the samples) and samples ordered by the treatment plants. If the plant personnel has followed the Vlaco-training course for sampling, the own samples can be taken by the plant personnel. If not, they should rely on an acknowledged sample taker/laboratory. Samples are taken using definite methods prescribed by the Compendium of Sampling and Analysis of Waste (CMA).
The analysis packages are considered by the quality assurance organisation on a case by case basis.

If several product types are produced, the formula above is used to calculate the necessary number of analyses, but these can be divided over several end products.
The dates of sampling must be equally divided during the year.

The analyses have to be carried out by acknowledged laboratories, according to a set of standardised methods, legally set in the Compendium of Sampling and Analysis of Waste (CMA). There are regular ring tests for the acknowledgement of laboratories/sample takers. All methods are published on the website of the VITO (Flemish Institute for Technological Research) https://emis.vito.be/nl/erkende-laboratoria/bodem-en-afvalstoffen-ovam/compendium-cma

In normal cases[2], the following parameters are analysed:

Standard package of analysis

parameter	method/description	unity
moisture content	CMA/2/IV/1	%
organic matter	CMA/2/IV/3	%/FM
EC (1/5)	CMA/2/IV/13	µS/cm
pH (H_2O)	CMA/2/IV/13	-
bulk density	CMA/2/IV/24	
chlorides	CMA/2/IV/6 (§5.1) en CMA/2/I/C	mg/L
total nitrogen	CMA/2/IV/4	%/FM
NH_4-N	CMA/2/IV/7	mg/L
NO_3-N	CMA/2/IV/7	mg/L
total P_2O_5	CMA/2/IV/19	%P_2O_5
impurities > 2mm	CMA/2/IV/11	%
stones > 5mm	CMA/2/IV/11	%
viable seeds	CMA/2/IV/10	#/l
maturity level (self heating test)	CMA/2/IV/22	

Package nutrients

parameter	method/description	unity
total K_2O	CMA/2/IV/19	%K_2O
total CaO	CMA/2/IV/19	%CaO
total MgO	CMA/2/IV/19	%MgO
Total SO_3	CMA/2/IV/19	%SO_3

Package heavy metals

parameter	method/description	unity
heavy metals (Cd, Cr, Cu, Pb, Ni, Zn)	CMA/2/IV/19	mg/kg DM

Supplement Hg and As

parameter	method/description	unity
mercury (Hg)	CMA/2/IV/20	mg/kg DM
arsenic (As)	CMA/2/IV/19	mg/kg DM

[2] As function of the type of product to be analysed, the composition of the package of analysis can be different (e.g. compost, liquid fraction digestate, solid fraction digestate, …).

Respiration (oxigen consumption via oxitop® method)

parameter	method/description	unity
respiration (oxitop®)	CMA/2/IV/25	mmolO_2/kg VS/h

Organic and inorganic pollution (VLAREMA Annex 2.3.1.A)

parameter	method/description	unity
heavy metals	CMA/2/IV/19	mg/kg DM
PAH (10)	CMA/3/W	mg/kg DM
mineral oil (GC-FID)	CMA/3/W	mg/kg DM

Microbiological parameters

parameter	methode/omschrijving	eenheid
E. coli	BAM/deel 7/03	KVE/g
Salmonella (present/absent)	BAM/deel 7/05	KVE/25 g

3. ORGANISATIONAL STRUCTURE OF VLACO

The office of Vlaco is located at:
Stationsstraat 110
2800 Mechelen
Belgium
Tel: +32 15 451 370
Fax: +32 15 218 335
Mail: info@vlaco.be
Website: http://www.vlaco.be – http://www.compost.be

Vlaco is a not for profit organisation carrying out several functions. The Quality Assurance is carried out by the division 'Quality and Certification' of Vlaco, and is powered by 6 persons. The organisational structure of Vlaco and the division Q&C is shown in Figure 8.

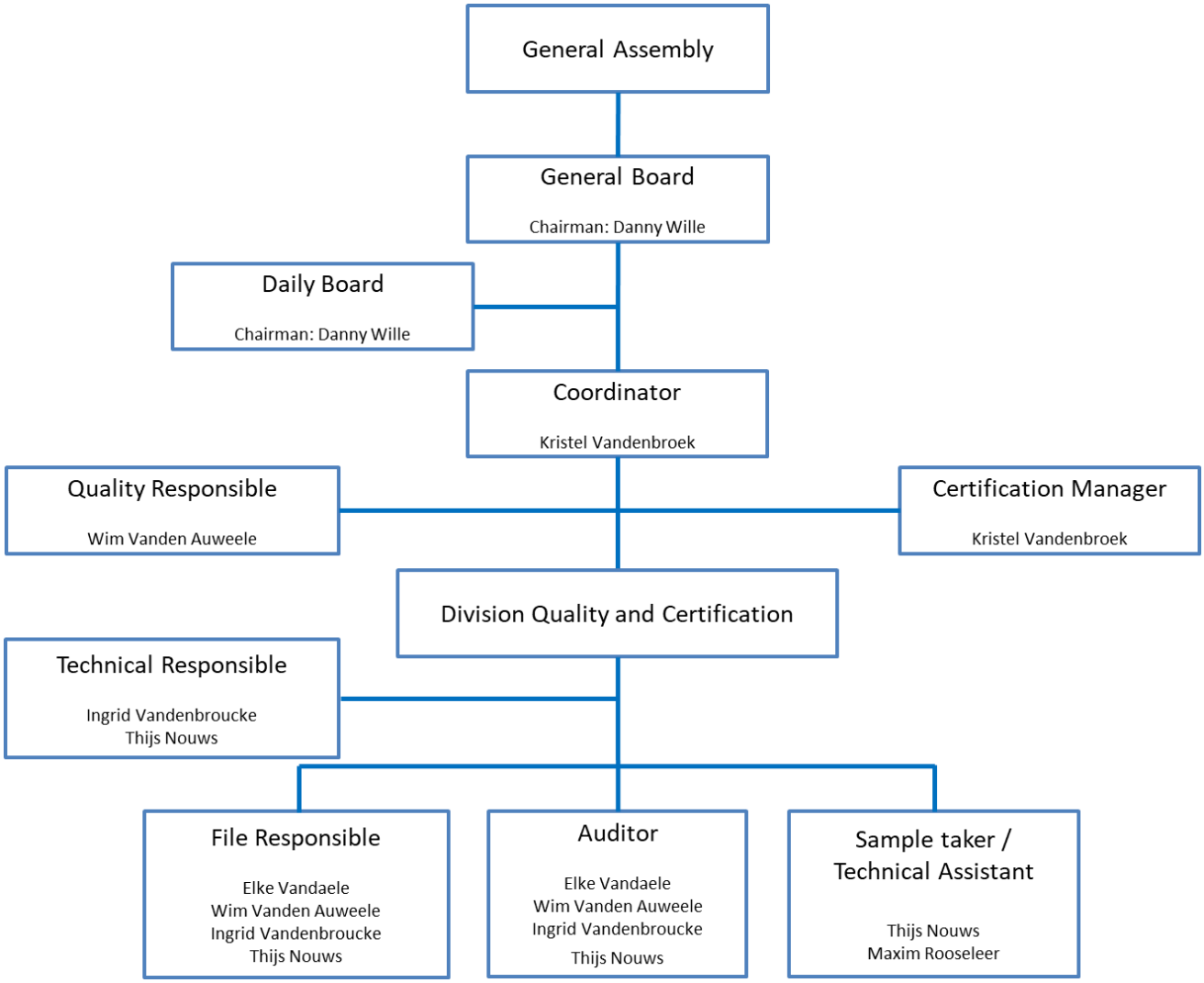

FIGURE 8: Organisation of Vlaco and the division Quality and Certification

4. COURSE OF THE QUALITY ASSURANCE SYSTEM

4.1. Summary

The Quality Assurance System is explained in the 'General Regulations for the Certification', a document which is anchored by law in the VLAREMA legislation. The actual version of the document is available in Dutch on the website of the Certification (as a pdf document) and can be obtained there. The document describes from A to Z all the requirements for the certification.

The General Regulations describe the certification requirements (scope, certification process, requirements of conformity, evaluation, decisions) for the granting of a certificate for the treatment of biowaste to become a secondary raw material (to be used as a fertiliser or soil improver). Vlaco is explicitly assigned by the OVAM to organise, within the framework of the VLAREMA-legislation, the control and certification of treatment plants of biowaste (= producer). Only when a certificate is achieved, the treated biowaste can be considered as a secondary material (and not a waste). Other certification bodies that want to organise equal activities have to prove equivalency.

Within the scope of the certification activities, several different biological treatment processes are complied: (aerobic) composting, anaerobic digestion, biothermal heating, … End products as well as intermediary products can be part of the control and certification activities.

The certification system is based upon the principle of auto control: the treatment plant of biowaste implements an internal quality system, taking into account input and acceptation of biowaste, monitoring of the quality of the treatment process, quality assurance of the end product and reasoned application of the end product as a fertiliser or soil improver. The producer is assessed for the implementation of this internal quality system by a recognised certification body (Vlaco). The instruments used by the certification body for the quality assessment are regular auditing, sampling and analysis and administrative controls.

The decision on granting, maintaining, suspending or withdrawing of a certificate is taken based on the judgement of the audits, administrative controls, corrective measures implied in action plan and several analysis results of the end products and intermediate products.

The certification activities of the quality assurance organisation (Vlaco) are supervised by the OVAM. The General Regulations of Certification is a document published on the website of OVAM (http://www.ovam.be/algemeen-reglement-van-de-certificering). OVAM has also taken over the appeals function of the Certification Commission.

4.2. Flow chart of the QA System

The flow chart of the QA System is given in Figure 9.
In a first phase (for new treatment plants and/or new end products), the necessary controls are carried out by the quality assurance organisation (Vlaco). These are a pre-audit and a first sampling of the end product. The purpose of the pre-audit is to obtain the necessary administrative and technical information (process, license, certification requirements) on the one hand, and to provide the necessary input to the producer on the other hand in order to guarantee optimal start-up of the quality assurance. As an outcome of the pre-audit (together with the first sampling and analysis results), a provisional (quality) certificate is granted for a period of 6 months.

After the period of provisional certification, the production plant enters the procedure of continuous supervision by the quality assurance organisation. During the period of provisional certification, Vlaco takes further samples for analysis, and the initial audit is carried out. The purpose of the initial audit is to assess whether the producer has satisfactory compliance with the required quality assurance criteria (as set in the General Regulations and translated into a check list). As an outcome of this audit, where all criteria are checked initially, together with the continuous sampling and analyses results, the decision is made to grant a full value certificate for all the end product(s) formerly declared to the quality assurance organisation.

In the further course of the quality assurance system, an annual audit is carried out, as well as several sample takings.

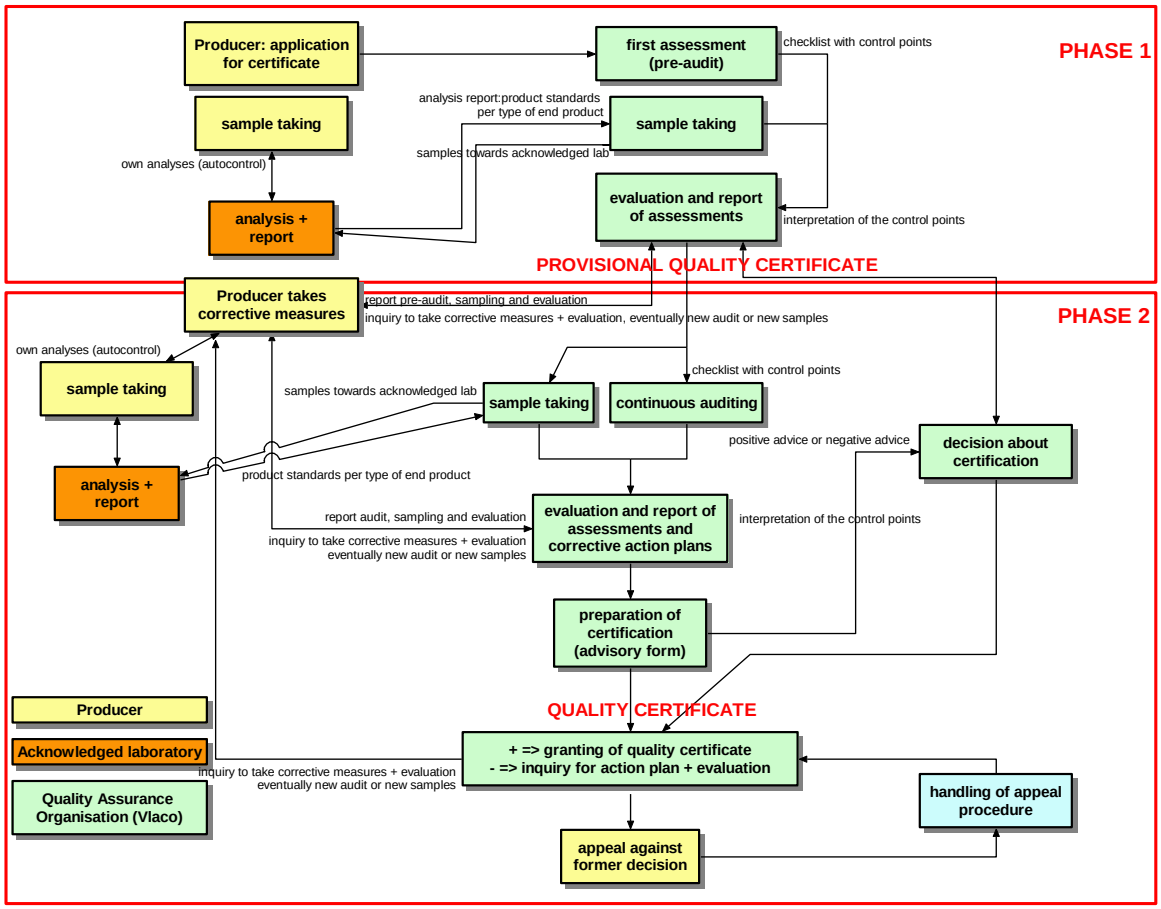

FIGURE 9: Flow chart of the Quality Assurance System

4.3. Certification Requirements

4.3.1. Organisation of internal quality assurance system

The producer develops and implements an internal quality assurance system, taking into account the quality requirements of the end product. To achieve this, he introduces a quality handbook. The different procedures of this quality handbook are available for inspection during audits. Some of the aspects that are assessed by Vlaco are: quality declaration by the management, internal auditing, organisation and responsibilities, alternative treatment of non-complying products, procedure for corrective and preventive measures, complaints procedure, …

4.3.2. Input material and acceptation protocol

This is an essential part in the quality assurance system. The accepted biowaste is subject to strict requirements (physical contamination, chemical or biological contamination), a visual control, registration of type of biowaste, … before being treated. The treatment plant is responsible for the input control on arrival on the treatment plant.
There is no legally defined limitative list of input materials for biological treatment. For green waste compost and vfg-compost, the input material is strictly limited to green waste and vfg-waste (with max 25% of industrial biowaste) respectively. For digestate and other end products not defined as compost, the general criterion for input materials is conformity with the limit values described in the VLAREMA legislation. All treated biowaste that is considered as a possible risk, must demonstrate this conformity by means of regular analyses. For this purpose, three risk classes are set up. Biowaste may not contain other not-regulated contamination in a matter that it implies problems when treated into a fertiliser or soil improver.
For all accepted biowaste, the producer carries out a risk assessment. All analyses need to be carried out by acknowledged laboratories. The input material must be registered. Transport documents need to be stored for a longer period.

4.3.3. Process requirements

All steps in the production process, including eventual after-treatment of the end product, need to be clearly described in the quality handbook. The biological treatment process needs to be carried out in accordance with the best available techniques.
During the biological treatment process, the necessary measurements need to be taken to deal with deviating circumstances. Control of quality through analyses, measurements and monitoring of the process (e.g. in function of the hygienisation of the material) must be described in procedures. The critical process parameters with an impact on end product quality, need to be registered in function of the time. The hygienisation of the end product needs to be guaranteed when this is legally required.
During the entire process, cross-contamination (hygienised material in contact with untreated material) must be avoided (spatial differentiation, use of material, equipment, machines).
There must be a description for the treatment of deviating material when process anomalies occur. The procedure must describe alternative treatment.
During the process, whenever possible, the traceability must be maintained as accurately as possible. This is done for discontinuous processes (e.g. composting) by implementing numbered batches, or for discontinuous processes, registering the time and amount of input feedstock (e.g. pasteurisation unit for anaerobic digestion). In the latter case, a partial traceability remains possible (in a digestion tank, the traceability one-on-one between input and output is eventually lost).

If after-treatment takes place, the process parameters need also to be controlled. The producer should indicate that this after-treatment takes part of the production process because this affects the quality level or application properties of the end product.

4.3.4.End product quality

The producer ensures that the quality of the end product complies with the quality standards and limit values. To achieve this, regular samplings are carried out for product analysis. The necessary analysis results need to be, at any time, proposed to the quality assurance organisation. The quality assurance organisation also takes samples of the end product. Vlaco is acknowledged as a sample taker. The production can't imply other product types than those declared to the quality assurance organisation. The variability of each end product must be kept as low as possible. During the entire process, cross-contamination (hygienised material in contact with untreated material) must be avoided.
All analyses must be carried out by laboratories acknowledged by OVAM, for the matrices of analysis in question and according to the Compendium for Sampling and Analysis for Waste. An electronic version of the Compendium can be found on the web site of Vito (https://emis.vito.be/nl/erkende-laboratoria/bodem-en-afvalstoffen-ovam/compendium-cma). The list of acknowledged laboratories can be found on the web site of OVAM (https://www.ovam.be/laboratoria-voor-monstername-en-analyse) and the quality assurance organisation (https://www.vlaco.be/kenniscentrum/wetgeving/erkende-laboratoria).
The end products must be stored in a manner (location, duration, environment) as to prevent quality loss with an optimal preservation of the traceability.
The producer needs to administer an output register of all end products produced and handled. The records must be kept on site for at least 3 years. The registers must include quantity, product type, quality level, date of delivery, name and ID of the customer.
There must be a procedure in place for dealing with deviating end products, in case the producer fails to be in compliance with the necessary quality objectives of the end products.
The end product standards and quality targets are described in the General Regulations of the Certification.

4.3.5.Reasoned use of end products

The properties of the different end products must be clearly communicated with the customer (agricultural value, proof of hygienisation, application conditions, composition, application rate). The treated biowaste can only be considered as a secondary material when it is used in a reasoned manner in an application fit for the purpose (otherwise, it remains waste). The communication can be delivered through labelling on the packaging or through an accompanying information document for bulk deliveries.
Whenever application restrictions appear because of input, treatment or quality level matters, these must be clearly communicated with the customer.

The detailed description of the certification requirements can also be found in the Vlaco check list.

5. END PRODUCT QUALITY

5.1. Compost

TABLE 3: Product quality of green compost under the Vlaco QAS

Parameter	Unity	Mean	Median	Stdev	25-perctle	75-perctle	95-perctle
Dry matter	w%	55,1	55,6	5,72	51,7	59,1	63,06
Moisture content	w%	44,9	44,4	5,72	40,9	48,3	54,5
OM, fresh	w%	19,6	19,1	4,57	17,3	21,3	24,5
OM, dry	w%	35,1	34,8	5,24	31,6	38,8	43,1
E.C.(1/5)	µS/cm	1105,7	1026,0	404,85	853,0	1286,0	1878,0
pH(water)	-	8,3	8,5	1,32	8,2	8,8	9,1
chlorides	mg/l	909,9	782,0	484,17	550	1110	1710
Ntot, fresh	w%	0,72	0,71	0,16	0,60	0,85	0,96
Ntot, dry	w%	1,31	1,31	0,26	1,17	1,47	1,68
NH_4-N	mg/l	68,0	41,3	62,48	18,2	99	207,2
NO_3-N	mg/l	31,4	10,0	40,38	10	36,5	119,8
C/N		15,3	14,8	3,39	13,2	16,8	22,5
Totaal P_2O_5	w%	0,29	0,29	0,08	0,23	0,32	0,40
Totaal K_2O	w%	0,59	0,58	0,20	0,44	0,74	0,87
Totaal CaO	w%	1,56	1,54	0,37	1,28	1,78	2,26
Totaal MgO	w%	0,30	0,30	0,08	0,24	0,34	0,40
Cd	mg/kg DM	0,78	0,79	0,30	0,55	1,02	1,27
Cr	mg/kg DM	20,0	18,0	10,2	10,8	29,0	35,0
Cu	mg/kg DM	34,8	32,3	8,7	29,0	40,0	47,6
Hg	mg/kg DM	0,20	0,20	0,15	0,14	0,20	0,36
Pb	mg/kg DM	48,5	46,7	21,1	36,8	53,8	68,1
Ni	mg/kg DM	10,1	9,2	4,0	7,1	12,0	15,7
Zn	mg/kg DM	175,1	170,0	36,7	150,0	187,0	245,5
As	mg/kg DM	6,2	5,2	2,81	4,1	10	10
Impurities>2mm	w%	0,11	0,08	0,16	0,04	0,10	0,33
Stones>5mm	w%	0,83	0,67	0,62	0,36	1,07	2,18
Weed seeds	#/l	0,0	0,0	0,2	0,0	0,0	0,0
Self heating		V	V	-	V	V	IV
Temperature	°C	24,9	23,7	5,45	21,7	26,1	32,96
Respiration (Oxitop®)	mmol O2 / kg VS / h	4,5	3,7	3,49	2,5	5,3	9,2

TABLE 4: Product quality of vfg-compost under the Vlaco QAS

Parameter	Unity	Mean	Median	Stdev	25-perctle	75-perctle	95-perctle
Dry matter	w%	68,1	68,6	7,6	63,8	73,0	80,6
Moisture content	w%	31,9	31,5	7,6	27,1	36,2	45,0
OM, fresh	w%	26,1	25,6	4,7	23,1	28,7	33,4
OM, dry	w%	38,4	38,0	5,5	34,3	40,7	49,1
E.C.(1/5)	µS/cm	2599,2	2600,0	593,2	2200,0	2955,0	3575,0
pH(water)	-	8,8	9,0	0,5	8,7	9,1	9,2
chlorides	mg/l	2121,2	2100,0	626,9	1670,0	2450,0	3232,0
Ntot, fresh	w%	1,22	1,22	0,24	1,03	1,40	1,61
Ntot, dry	w%	1,81	1,81	0,45	1,67	1,93	2,18
NH_4-N	mg/l	358,3	345,0	147,8	274,5	440,0	619,8
NO_3-N	mg/l	48,5	10,0	81,1	10,0	43,7	249,8
C/N		11,9	11,5	2,7	10,5	12,7	15,8
Totaal P_2O_5	w%	0,68	0,68	0,17	0,56	0,79	0,92

Totaal K_2O	w%	1,13	1,10	0,34	0,90	1,34	1,57
Totaal CaO	w%	2,61	2,54	0,75	2,14	2,96	3,78
Totaal MgO	w%	0,53	0,51	0,13	0,44	0,60	0,77
Cd	mg/kg DM	0,75	0,75	0,25	0,55	0,96	1,10
Cr	mg/kg DM	28,4	27,0	11,4	20,0	34,0	51,1
Cu	mg/kg DM	53,4	51,0	15,3	44,2	58,8	81,9
Hg	mg/kg DM	0,17	0,17	0,12	0,11	0,20	0,27
Pb	mg/kg DM	63,9	57,0	22,1	47,3	76,3	107,2
Ni	mg/kg DM	13,5	12,7	4,8	10,0	16,0	20,9
Zn	mg/kg DM	245,2	240,0	56,7	206,5	285,6	328,3
As	mg/kg DM	7,0	5,7	3,0	4,8	10,0	12,0
Impurities>2mm	w%	0,17	0,12	0,24	0,06	0,17	0,40
Stones>5mm	w%	1,01	0,94	0,69	0,53	1,35	2,21
Weed seeds	#/l	0,0	0,0	0,1	0,0	0,0	0,0
Self heating		V	V	-	V	V	IV
Temperature	°C	25,8	24,3	6,5	22,1	27,1	40,0
Respiration (Oxitop®)	mmol O2 / kg VS / h	5,5	4,1	5,7	2,5	5,9	16,1

5.2. Digestate

There are many digestate products derived from raw digestate (solid fraction, liquid fraction, dried digestate, mineral concentrates). In the following tables, the composition of the raw digestate is given, distinguished between digestate with animal manure, and digestate without animal manure.

TABLE 5: Product quality of digestate with manure under the Vlaco QAS

Parameter	Unity	mean	median	10-perc	75-perc	90-perc	95-perc
dry matter	weight%	9,0	8,9	5,8	10,6	12,4	14,2
moisture	weight%	91,0	91,1	87,6	92,8	94,2	95,5
Org. matter, fresh	weight%	5,6	5,6	3,4	6,7	7,8	8,7
Org. matter, dry	weight%	62,0	62,6	52,8	66,7	71,3	73,6
E.C.(1/5)	µS/cm	6562,7	6410,0	4260,0	7665,0	9046,0	9482,0
pH(water)	-	8,4	8,4	8,1	8,5	8,6	8,8
chlorid	mg/l	2546,7	2075,0	1157,0	3300,0	4504,0	5129,0
Ntot, fresh	weight%	0,5	0,5	0,2	0,6	0,8	0,8
Ntot, dry	weight%	5,3	5,3	2,6	7,2	8,3	9,6
NH4-N	mg/l	2248,2	2300,0	836,0	2892,5	3534,0	3901,6
NO3-N	mg/l	7,7	5,8	3,1	10,0	10,0	10,0
C/N	-	7,9	6,3	4,0	11,1	13,2	14,3
Total P2O5	weight%	0,41	0,39	0,2	0,50	0,6	0,76
Total K2O	weight%	0,38	0,37	0,2	0,46	0,5	0,68
Total CaO	weight%	0,36	0,30	0,2	0,40	0,6	0,77
Total MgO	weight%	0,12	0,10	0,0	0,15	0,2	0,25
Cadmium (Cd)	mg/kg DM	0,5	0,5	0,4	0,5	0,6	0,8
Chromium (Cr)	mg/kg DM	18,5	17,0	10,0	22,0	29,4	33,4
Copper (Cu)	mg/kg DM	142,1	110,0	55,9	160,0	248,2	299,6
Mercury (Hg)	mg/kg DM	0,1	0,1	0,0	0,1	0,3	0,3
Lead (Pb)	mg/kg DM	11,0	10,0	9,0	10,0	15,0	19,4
Nickel (Ni)	mg/kg DM	13,0	12,0	7,6	15,9	19,7	23,0
Zink (Zn)	mg/kg DM	430,0	380,0	258,0	512,5	641,0	697,1
Impurities>2mm	weight%	0,0	0,0	0,0	0,0	0,0	0,0
Stones>5mm	weight%	0,0	0,0	0,0	0,1	0,1	0,1
Viable weed seeds	#/l	0,0	0,0	0,0	0,0	0,0	0,0

TABLE 6: Product quality of digestate without manure under the Vlaco QAS

Parameter	Unity	mean	median	10-perc	75-perc	90-perc	95-perc
dry matter	weight%	8,8	9,0	3,9	10,8	13,2	13,5
moisture	weight%	91,2	91,0	86,8	93,3	96,1	96,7
Org. matter, fresh	weight%	5,3	5,4	2,5	6,9	7,8	8,5
Org. matter, dry	weight%	60,7	60,8	52,5	65,4	70,0	73,6
E.C.(1/5)	µS/cm	6310,7	6615,0	3870,0	7460,0	8217,0	8831,0
pH(water)	-	8,3	8,3	8,0	8,4	8,7	8,8
chlorid	mg/l	2988,1	2815,0	1023,0	3942,5	5701,9	6477,0
Ntot, fresh	weight%	0,4	0,3	0,2	0,6	0,7	0,8
Ntot, dry	weight%	5,1	4,7	2,3	6,9	8,0	8,9
NH4-N	mg/l	2047,3	2015,0	501,8	2585,0	3463,8	3728,5
NO3-N	mg/l	7,5	10,0	5,0	10,0	10,0	10,0
C/N	-	8,7	7,1	3,7	10,9	13,5	15,2
Total P2O5	weight%	0,33	0,34	0,1	0,45	0,5	0,65
Total K2O	weight%	0,38	0,37	0,3	0,48	0,5	0,59
Total CaO	weight%	0,34	0,31	0,1	0,42	0,6	0,74
Total MgO	weight%	0,08	0,07	0,0	0,10	0,1	0,17
Cadmium (Cd)	mg/kg DM	0,7	0,5	0,5	0,8	1,2	1,4
Chromium (Cr)	mg/kg DM	21,8	18,0	12,0	24,0	34,8	47,2
Copper (Cu)	mg/kg DM	62,4	50,0	35,0	79,0	88,6	109,0
Mercury (Hg)	mg/kg DM	0,1	0,1	0,0	0,2	0,3	0,3
Lead (Pb)	mg/kg DM	14,1	10,0	10,0	11,0	14,0	20,9
Nickel (Ni)	mg/kg DM	14,1	13,0	9,1	16,6	22,9	27,3
Zink (Zn)	mg/kg DM	262,1	255,0	161,0	302,5	359,1	424,5
Impurities>2mm	weight%	0,0	0,0	0,0	0,0	0,0	0,0
Stones>5mm	weight%	0,1	0,0	0,0	0,1	0,1	0,1
Viable weed seeds	#/l	0,0	0,0	0,0	0,0	0,0	0,0