VERA VERIFICATION STATEMENT

VERIFICATION OF ENVIRONMENTAL TECHNOLOGIES FOR AGRICULTURAL PRODUCTION

It is hereby stated that

Technology:

Meadow Floor (Slatted floor)

Delivered by: Proflex Betonproducten

has been tested according to the VERA Test Protocol for
Livestock Housing and Management Systems (Version 2, 2011).

The following main results have been documented through the test:

Verified ammonia emission factors:

Ammonia emission of 7.9 kg NH_3/Animal /year when applied by Dairy cows.

Ammonia emission reduction efficiency at 53% NH_3/Animal place/year when calculated according to the Dutch protocol and applied by Dairy cows.

Ammonia emission reduction efficiency at 45% NH_3/Animal place/year when calculated according to the German Standard and applied by Dairy cows.

Verified operational stability:

The tested technology has a satisfactory operational stability when it is operated and maintained as indicated in this verification.

Copenhagen 2021-05-11______________________________________

Thomas Bruun, Managing Director, ETA-Danmark A/S

VERA Verification no 008.

Exemption of liability

The VERA Secretariat does not endorse, certify or approve technologies. VERA verifications are based on an evaluation of the technology performance under specific, predetermined criteria and the appropriate quality assurance procedures.

VERA as a representative for the Danish EPA, the German Federal Ministry of Food and Agriculture, the Dutch Ministry of Infrastructure and Environment and the Flanders ILVO makes no expressed or implied warranties as to the performance of the technology and does not certify that a technology will always operate as verified.

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The VERA Organisation

VERA – Verification of Environmental Technologies for Agricultural Production – is a multinational organisation for testing and verification of environmental technologies for agricultural production. VERA is established as a cooperation between the Danish Environmental Protection Agency, the Dutch Ministry of Infrastructure and Environment, the German Federal Ministry of Food and Agriculture and the Flanders ILVO.

The purpose of VERA is to enhance a well-functioning market for environmental technologies to increase the environmental protection of agricultural production by substantially accelerating the acceptance and use of improved and cost-effective environmental technologies.

VERA verifies the performance of technologies which are tested according to pre-defined test protocols. A VERA Verification Statement secures validated documentation for the environmental efficiency and operational stability of the technology and is an important step in introducing the technology to the market. Based on information from the test reports, the VERA Verification Statement gives a general and short description of the technology, its principle of operation and the main results and conclusions from the VERA test.

Applicant Data

Technology type	Concrete slatted floor elements used in cattle floors
Applied for	Reduction of ammonia emission reduction from the Meadow Floor used in cattle floors
Technology name	Meadow Floor
Company	Proflex Betonproducten
Contact person	Mark Thomassen
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Test institute	Pro Monitoring, Barneveld (currently operating under: TAUW, Deventer)

Technology Description

The Meadow Floor is a system to be mounted on slatted floor elements where rubber mats are attached on top of the slats and synthetic flaps are placed between the slats.

Ridges (‘pedicure profile’) are mounted on the slats of the slatted floor, being approx. 2 cm high, approx. 4,5 cm wide, and approx. 11 cm long. Rubber mats are mounted on the floor, using the ridges to fix (see figure 1). The profile (10 mm wide) in the rubber mats has an inclination of 6% from the middle towards the floor slots. Size tolerance of the rubber mat dimensions is ± 1,5 %. The profile is cleaned using a scraper or robot.

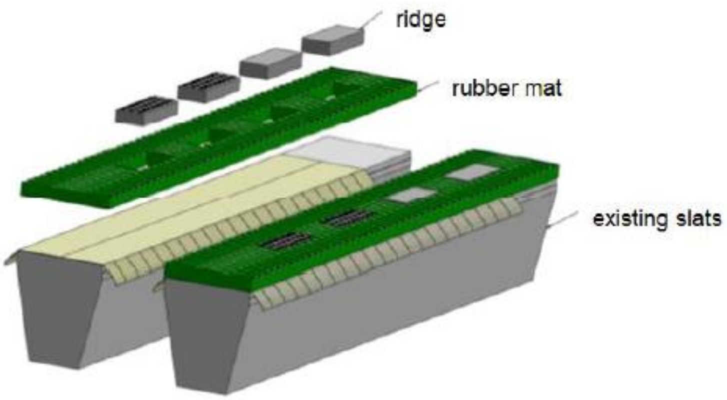

Figure 1. 3D impression of the floor elements with ridges and rubber mats.

The profiled rubber mats of 2 cm thickness are applied on the concrete slatted floor elements in such a way, that the ridges fit the opening in the rubber mat exactly. This generates a closed surface area, which benefits walkability, slip resistance, and cow comfort.

Synthetic flaps are present in the concrete floor slots, with flaps being approx. 3,5 / 4 cm wide (see Figure 2). These flaps assure discharge of faeces and urine, but reduce airflow, and ammonia emission from the slurry pit towards the air inside the barn.

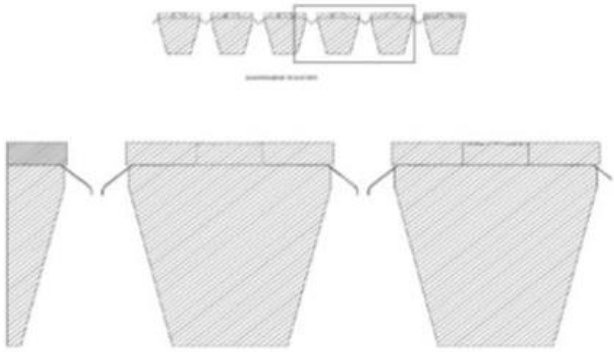

Figure 2. Cross section of the floor

The emission reducing principle of the Meadow Floor is based on three aspects:

- Profiled rubber mats applied on the slats of a slatted floor, with the profile being inclining towards the slots, enhancing the run-off of urine to the slurry pit, thus reducing floor emission;
- Rubber instead of concrete, hence lowering the pH of the urine on the floor;
- Flaps (not completely closed) inserted in the slatted floor slots, to reduce emission from the slurry pit.

Test Design

The technology combination was tested in Netherlands by Pro Monitoring, Barneveld (currently operating under: TAUW, Deventer) in accordance with the VERA test protocol for Housing systems at four cattle farms. The measurements were executed from between January and December 2017.

Test setup

The test was conducted in accordance with the so-called Multi-farm tests setup including one dairy (1) cow barn at each of four (4) farms. All the included barns were equipped with cubicles and Meadow Floor in the aisle areas. The test at each farm included six (6) measurement periods of at least 24 h at each farm. These periods were distributed over the year in accordance with the requirements in the test protocol.

All the included barns were, naturally ventilated, and the method used for determining the ventilation rate was based on the carbon dioxide (CO_2) mass balance. Measurement techniques (devices) for the CO_2 and NH_3 concentration met the requirements in the protocol. The measurement was conducted under agricultural conditions that meet the requirement in the protocol related to e.g. barn occupation rate, milk production data, and diet.

Product configuration

Measurement period	January – December 2017	January – November 2017	January – December 2017	January – November 2017
Barn characteristics	0+3 rows of cubicles with 1 lateralfeeding alley	0+4+0 rows of cubices with 2 lateral feeding alleys	0+4+0 rows of cubices with 2 lateral feeding alleys	2+3 rows of cubicles, with central feeding alley
Number of cubicles	123 cubicles, including 3 separation cubicles and 1 straw area	219 cubicles, including separation and care area behind milking robots and straw area	123 cubicles, 8 separation cubicles and 1 straw area	177 cubicles, including separation area, and 2 straw areas
Milking technology	2 milking robots	3 milking robots	Milking parlour	3 milking robots
Slurry removal	1 scraping robot	1 scraping robot	Chain-pulled scrapers	1 scraping robot
Grazing	Permanent housing	Permanent housing	Grazing	Grazing

Test methods and test conditions

Used methods for carbon dioxide and ammonia concentration measurements are indicated in below:

Measured variable	Measurement method (sampling strategy and measurement technique)
$[CO_2]_{inside}$	Continuous; Non-dispersive Infra Red
$[CO_2]_{outside}$	Continuous; Non-dispersive Infra Red (Sense Air SD800)
$[NH_3]_{inside}$	Accumulation (24 h); Wet-chemical (‚impinger‘)
$[NH_3]_{outside}$	Accumulation (24 h); Wet-chemical (‚impinger‘)

On all locations, temperature and relative humidity (RH) were measured in the barn and in the outside air. Wind direction and wind speed data were obtained from the nearest national weather station (operated by KNMI; Royal Dutch Meteorological Institute).

Agricultural parameters at all farms were investigated to assess whether they met below mentioned requirements:

- Barn in use for at least 2 months (when newly built).
- Cows indoors at night time (typically between afternoon and morning milking) during at least eight (8) weeks prior to each measurement.
- Cows indoors during measurements.
- Occupational rate of cubicles of 90 % or more.
- Dry cows: maximum 25% of the total number of milking cows and dry cows.
- Pregnant heifers: maximum 30% of the total number of milking cows and dry cows over the six (6) measurement periods, and an average of these periods of 25%.
- Milk production: at or above 25 kg per animal per day.
- Urea content of milk: at or above 15 mg per 100 mL.
- Roughage at least 50% of the feed dry matter.
- Crude Protein contents of more than 160 g/kg dry matter.
- Common veterinary care.
- CO2 concentration in the barn: at or below 3,000 ppm.

Test Results

Environmental Efficiency

Ammonia

Measurements and NH_3 emissions per measurement period for barn 1:

Period	1	2	3	4	5	6
Date (start of measurements)	17 January 2017	09 May 2017	06 July 2017	05 September 2017	14 November 2017	04 December 2017
T_{inside} (°C)	4.3	11.7	23.0	20.4	11.3	8.7
RH_{inside} (%)	80.8	52.0	58.6	65.5	84.3	88.7
$T_{outside}$ (°C)	-1.2	13.6	28.8	20.4	8.7	6.6
$[CO_2]_{inside}$ (ppm)	996	588	566	611	727	587
$[CO_2]_{outside}$ (ppm)	435	424	443	443	429	470
V (m^3/h per animal)	567	1,977	2,468	1,908	1,093	2,777
$[NH_3]_{inside}$ (mg/m^3)	0.875	0.506	0.663	0.563	0.558	0.406
$[NH_3]_{outside}$ (mg/m^3)	<0.01	<0.01	0.028	0.028	0.011	0.053
$\Delta[NH_3]$ (mg/m^3)	0.0875	0.506	0.635	0.535	0.551	0.361
NH_3 emission- (kg NH_3 per animal per year	4.7	8.1	13.5[*1)]	7.9	5.0	8.7
average			8.0			
standard deviation			3.2			
median			8.0			
95 % percentile			12.3			

[*1:] internal ventilators were switched on

Measurements and NH_3 emissions per measurement period for barn 2:

Period	1	2	3	4	5	6
Date (start of measurements)	19 January 2017	18 May 2017	29 June 2017	31 August 2017	23 November 2017	30 November 2017
T_{inside} (°C)	6.0	16.9	18.9	17.6	10.9	6.3
RH_{inside} (%)	71.7	77.3	71.5	75.6	84.6	91.2
$T_{outside}$ (°C)	1.9	16.8	20.0	15.6	9.4	1.5
$[CO_2]_{inside}$ (ppm)	1,057	526	617	833	604	830
$[CO_2]_{outside}$ (ppm)	443	423	443	440	444	435
V (m^3/h per animal)	481	3,446	1,723	725	2,100	736
$[NH_3]_{inside}$ (mg/m^3)	0.960	0.534	0.655	0.997	0.603	0.694
$[NH_3]_{outside}$ (mg/m^3)	0.008	0.110	0.029	0.082	0.006	0.028
$\Delta[NH_3]$ (mg/m^3)	0.952	0.424	0.626	0.915	0.597	0.666
NH_3 emission- (kg NH_3 per animal per year	4.0	10.4	8.0	5.4	7.9	3.9
average			6.6			
standard deviation			2.6			
median			6.7			
95 % percentile			9.8			

Measurements and NH_3 emissions per measurement period for barn 3:

Period	1	2	3	4	5	6
Date (start of measurements)	19 January 2017	11 May 2017	15 June 2017	21 September 2017	16 November 2017	07 December 2017
T_{inside} (°C)	5.3	18.0	22.2	16.5	10.6	8.7
RH_{inside} (%)	78.9	67.6	52.4	69.1	93.0	87.0
$T_{outside}$ (°C)	-1.0	19.1	25.2	17.7	7.6	5.0
$[CO_2]_{inside}$ (ppm)	1.122	518	609	654	677	712
$[CO_2]_{outside}$ (ppm)	478	401	414	461	442	427
V (m^3/h per animal)	482	2,815	1,593	1,536	1,240	1,022
$[NH_3]_{inside}$ (mg/m^3)	1.587	0.687	1.248	1.045	0.515	0.810
$[NH_3]_{outside}$ (mg/m^3)	0.053	0.25	0.01	0.008	0.017	<0.001
$\Delta[NH_3]$ (mg/m^3)	1.53	0.44	1.24	1.04	0.50	0.81
NH_3 emission- (kg NH_3 per animal per year	6.5	8.5	15.7	13.2	5.4	7.2
average			9.4			
standard deviation			4.1			
median			7.9			
95 % percentile			15.1			

Measurements and NH_3 emissions per measurement period for barn 4:

Period	1	2	3	4	5	6
Date (start of measurements)	17 January 2017	15 May 2017	12 June 2017	28 August2017	20 November 2017	27 November 2017
T_{inside} (°C)	3.6	21.6	19.1	23.8	12.3	10.2
RH_{inside} (%)	81.4	43.5	62.5	58.8	93.2	90.9
$T_{outside}$ (°C)	-1.0	23.5	17.7	27.2	9.0	6.4
$[CO_2]_{inside}$ (ppm)	962	611	629	806	793	744
$[CO_2]_{outside}$ (ppm)	410	422	412	417	415	411
V (m^3/h per animal)	590	1,682	1,649	828	926	1,073
$[NH_3]_{inside}$ (mg/m^3)	0.950	0.632	1.022	1.230	0.863	0.855
$[NH_3]_{outside}$ (mg/m^3)	<0.001	0.027	0.081	0.028	0.094	0.075
$\Delta[NH_3]$ (mg/m^3)	0.950	0.605	0.941	1.202	0.816	0.814
NH_3 emission- (kg NH_3 per animal per year	5.0	8.4	11.1	8.6	5.8	7.2
average			7.6			
standard deviation			2.2			
median			7.7			
95 % percentile			9.8			

All the mentioned agricultural conditions, except the occupational rate, were met at all farms.

A 90% occupation rate was the target for all measurements at all 4 farms. However, due to phosphate legislation this percentage was not possible for some measurement periods. The observed occupational rate (%) at each the farms at each measuring period were:

Measurement	Barn 1	Barn 2	Barn 3	Barn 4
1th	90	91	83	82
2nd	81	94	77	78
3rd	81	94	75	81
4th	90	91	89	90
5th	90	91	90	90
6th	90	91	90	90
Average	87	92	84	85

It is assessed that the low occupational rate in three of the farms may lead to an insignificant overestimation of the ammonia emission per animal per year, when compared to a situation where the occupational rate at all measuring events were 90 % or more.

Areas of fouled floors surfaces (m^2 animal $place^{-1}$) at each farm were:

Area	Barn 1	Barn 2	Barn 3	Barn 4
Walking alley	3.7	3.8	4.5	4.1
Passages	0.8	0.8	1.1	1.1
Fouled floor in total	4.5	4.6	5.6	5.2

The used scraping equipment and the scraping frequency at each farm where:

	Barn 1	Barn 2	Barn 3	Barn 4
Scraping equipment	scraping robot	scraping robot	chain-pulled scraper*	scraping robot
Scraping frequency, # d^{-1}	20	12	12	12

*Chain-pulled scrapers in walking alley and manually scraping in passages (twice d^{-1})

The calculation of the scrapping frequency at the three farms using scraping robots was based on equal scraping of the total fouled floor surface area. In practice, the first 1 m of the floor behind the feeding fences was scraped less frequently, because floor fouling there is in general less than fouling of the rest of the floor (cows use the floor at the feeding fences mostly to stand while feeding). Effectively, the scaping frequency of the intensely fouled floor surface areas were higher than calculated (up to 20%). Also, the speed of the scraping robot is valid for undisturbed operation. However, the scraping robot also cleans the passages, which are reached by turning at reduced speed. Consequently, the actual speed will be somewhat less than the speed assumed in the calculations. This will result in a reduced scraping frequency. Overall, the actual scraping frequency will be higher than calculated (estimate: + 15%).

Summary of the of NH_3 emissions in kg per animal per year in the 4 barns:

Measurement	Barn 1	Barn 2	Barn 3	Barn 4
1th	4.7	4.0	6.5	5,0
2nd	8.1	10.4	8.5	8.4
3rd	13.5	8.0	15.7	11.1
4th	7.9	5.4	13.2	8.6
5th	5.0	7.9	5.4	5.8
6th	8.7	3.9	7.2	7.2
Average	8.0	6.6	9.4	7.6

The average ammonia emission for the entire test was 7.9 kg per animal per year.

Operational Stability

The operational stability of the floor system relies on that the flaps in slots, the rubber floor and the slurry scraper functions in the intended way.

The used scrapers were able to clean the slats and to avoid that manure clumps clogged the slots, and thereby the floor maintained its ability to let the manure pass to the pit.

The flap system did not seal the pit hermetically. The farmer must ensure that the system is functioning and must continuously reinstall missing flaps and replace mechanically damaged flaps. For example, mechanically damaged flaps can be torn.

In practice, it appears that the valves are (partly) opened. It was established that the valves were also open during the measurements in the test barns. The emission factor for the housing system is determined on this basis.

The inspection criteria can be concluded from above and the below provisions should be included in the maintenance manuals from Proflex.

In general, the slots, the flaps, the ridges, the rubber mats and the scraping equipment (scraping robot or chain-pulled scraper) must be inspected and serviced at least once per year. It is recommended to have a service & inspection agreement with the manufacturer of the scraping equipment, or another expert.

As indicated above there is no need to inspect the degree to which the flaps are opened.

The farmer must regularly check that the flaps allow the manure to pass through to the pit and that the flaps are not mechanically damaged. Also, maintenance is required every year to check that the valves are not mechanically damaged and to replace damaged valves.

Slurry must be removed at a frequency of every 2 hours or more frequently in case a mechanical scraper is operated. A scraping robot must on average remove slurry every 2 hours or more frequently. Surface areas that cannot be scraped must be cleaned by hand at least twice per day. These areas must not constitute more than 20 % of the fouled floor area.

The required running time at each scraping event and the size of the area that can be accepted to be scrapped manually only twice a day shall be specified by Proflex in their maintenance manual.

The measured barns had no water spraying facility. However, it is recommended to operate a water spraying facility when this benefits the floor cleanliness. Such to be decided by the farmer.

For control and registration, there must be a computer for operation of the scraping system with data-logging, with a data storage for the last 3 months, or a sealed counter for operation hours must be present for the registration of the scraping frequency, which contains a log of 1 month; data must be shown upon request, proving the required scraping frequency.

A timer must be present and operated for registration of scraping time; in case of a scraping robot, battery uninterrupted charging time may not exceed 6 hours per day (during night-time).

A log must be kept for registration of inspections and maintenance of the scraping system and the synthetic flaps.

Identified Side Effects

None

Additional Results

None

Additional Information

Animal welfare
The technology effect on animal welfare was not part of the test. However, a purpose of the technology is to generate a closed surface area, which benefits walkability, slip resistance, and cow comfort. A positive animal welfare effect of the MeadowFloor is therefore expected.

Occupational health and safety
The tested technology was not found to have any occupational health and safety effects.

Test Institute

Pro Monitoring, Barneveld (currently operating under: TAUW, Deventer)

Validity and Terms of Use

Validity

This VERA Verification Statement is only valid for the specific verified product / technology and the tested animal category. There is no time limit for the validity of this VERA Verification Statement as long as the product / technology stays unmodified.

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  - Proflex agrees not to use this VERA Verification Statement, the test reports, or to refer to those, for any other technology than the one specified in the statement.
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