VERA VERIFICATION STATEMENT

VERIFICATION OF ENVIRONMENTAL TECHNOLOGIES FOR AGRICULTURAL PRODUCTION

It is hereby stated that

Technology:

Easyfix SDR slatted rubber mats (Slatted floor)

Delivered by: EASYFIX

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 9.5 kg NH_3/Animal /year when applied by Dairy cows.

Corresponds to 8,8 kg per animal place per year and 8,0 kg per animal place per year (standardized according to Dutch requirements) – see page 12.

Verified operational stability:

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

Copenhagen 2021-10-12

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

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 Easyfix SDR slatted rubber mats used in cattle floors
Technology name	Easyfix SDR slatted rubber mats (Slatted floor)
Company	EASYFIX
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Test institute	Pro Monitoring, Barneveld (currently operating under: TAUW, Deventer)

Technology Description

The Easyfix SDR rubber mats are slatted rubber mats to be installed on slatted concrete floors in cattle houses..

EasyFix SDR are installed in double 'strips'. These are fixed in the lattice gaps. Each mat has a width of approx. 300 mm, with openings in the middle (connected to the grid slits) of 35 mm wide. The width of each of the tracks is exactly the same as the width of a grid beam, i.e. 135 mm.

Each mat covers two bars of the concrete slat – the curved profile slopes from the centre of each mat towards the opening in the slat to the manure collection tank underneath.

The rubber mats have a sloped surface profile of approximately 8.5% - (1% is 1 mm slope over a length 100 mm); on the sides this is more than 6%. On average, the rubber mats have a slope of about 7%.

The urine is drained through the openings to the underlying manure cellar. This can be supported by the regular (minimum once every 2 hours) cleaning of the surface with manure robot, a scraper (pulled by chain, rope or cable) or a LELY collector.
The surface of the walkways and the crossings are continuous cleaned twice a day. It is important that the rubber mats are not damaged by the cleaning. Normal movement of animals on the rubber will also contribute to the cleaning of the rubber surface.

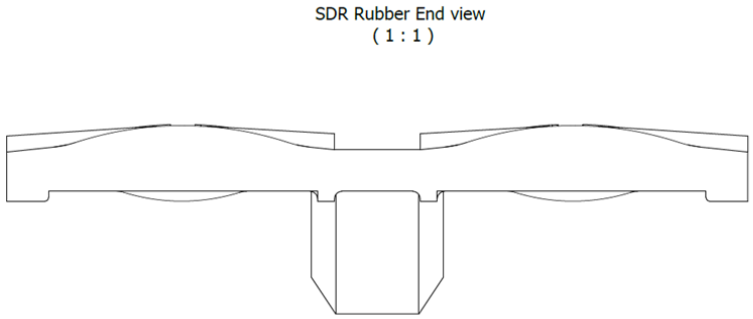

Figure 1. End View showing Surface Profile.

The profiled rubber mats are applied on the concrete slatted floor elements in such a way, that the ridges fit the opening in the rubber mat exactly. The mats are fixed to the slats with the wedges underneath the mats.

The emission reducing principle of the Easyfix SDR 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;

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 October 2017 and September 2018.

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	November 2017 – september 2018	November 2017 – september 2018	November 2017 – september 2018	November 2017 – september 2018
Barn characteristics	0+3 rows of cubicles	3+3 rows of cubices	0+6+0 rows of cubices	4+3+1 rows of cubices,
Number of cubicles	118 cubicles,	141 cubicles	202 cubicles	185 cubicles,
Milking technology	2 milking robots	2 milking robots	3 milking robots	milking parlor
Slurry removal	1 scraping robot	1 scraping robot	1 scraping robot	1 scraping robot
Grazing	Grazing	Permanent housing	Permanent housing	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; Photoacoustic (innova)
$[CO_2]_{outside}$	a 24-hour sampling in gasbags after which the gas is offered to the Innova monitor/addionally with Extech sensors
$[NH_3]_{inside}$	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
- Occupation rate of the cubicles: 90%
- 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%
- Common veterinary care
- Milk production: at or above 25 kg per animal per day
- Urea content of milk: at or above 15 mg per 100 mL
- CO2 concentration in the barn: at or below 3,000 ppm
- Permanent housing (no grazing)
- Dry matter intake
- Composition of the diet (in % of DM, grass/maize-silage ratio, fresh grass)

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)	01-11-2017	9-1-2018	26-3-2018	23-5-2018	12-7-2018	18-9-2018
T_{inside} (°C)	10,9	7,5	7,7	20,1	20,7	21,3
RH_{inside} (%)	79	84	79	59	68	67
$T_{outside}$ (°C)	11,0	6,0	7,8	21,0	22,3	23,3
$[CO_2]_{inside}$ (ppm)	562	580	578	485	543	553
$[CO_2]_{outside}$ (ppm)	483	433	453	406	426	423
Wind velocity (m/s)	3,4	3,0	3,0	3,4	2,6	4,7
Heat production per animal (HPU)	1,6	1,6	1,4	1,4	1,5	1,3
V (m^3/h per animal)	3911	2118	2302	3602	2493	2005
$[NH_3]_{inside}$ (mg/m^3)	0,26	0,43	0,47	0,27	0,62	0,29
$[NH_3]_{outside}$ (mg/m^3)	< 0,001	0,06	0,024	0,016	0,008	0,021
$\Delta[NH_3]$ (mg/m^3)	0,26	0,38	0,45	0,26	0,61	0,27
NH_3 emission- (kg NH_3 per animal place per year (Germany)	8,3	6,3	8,2	7,4	12,3	4,3
NH_3 emission- (kg NH_3 per animal place per year standardized (the Netherlands)	7,8	6,1	8,2	5,7	7,9	3,5
NH_3 emission- (kg NH_3 per animal per year	9,1	7,0	9,0	8,1	13,4	4,7
Average - (kg NH_3 per animal per year			8,5			
standard deviation			2,9			
Median - (kg NH_3 per animal per year			8,5			
95 % percentile			12,3			

Measurements and NH_3 emissions per measurement period for barn 2:

Period	1	2	3	4	5	6
Date (start of measurements)	7-11-2017	16-1-2018	20-3-2018	28-5-2018	17-7-2018	11-9-2018
T_{inside} (°C)	8,7	6,3	8,5	24,1	21,3	19,1
RH_{inside} (%)	82	83	68	69	66	83
$T_{outside}$ (°C)	8,6	3,4	3,9	22,7	25,0	17,3
$[CO_2]_{inside}$ (ppm)	709	632	939	591	546	737
$[CO_2]_{outside}$ (ppm)	476	410	445	394	422	427
Wind velocity (m/s)	2,5	7,4	5,1	4,2	3,3	4,2
Heat production per animal (HPU)	1,4	1,5	1,5	1,4	1,4	1,4
V (m^3/h per animal)	1229	1334	603	1424	2331	890
$[NH_3]_{inside}$ (mg/m^3)	1,09	1,16	0,69	0,65	0,44	1,34*
$[NH_3]_{outside}$ (mg/m^3)	0,01	0,07	0,01	0,03	0,012	0,04
$\Delta[NH_3]$ (mg/m^3)	1,08	1,09	0,67	0,62	0,43	1,30
NH_3 emission- (kg NH_3 per animal place per year (Germany)	10,7	11,6	3,2	7,1	7,9	9,1
NH_3 emission- (kg NH_3 per animal place per year standardized (the Netherlands)	10,8	12,4	3,8	5,4	6,6	8,4
NH_3 emission- (kg NH_3 per animal per year	11,7	12,7	3,6	7,8	8,7	10,2
average- (kg NH_3 per animal per year			9,1			
standard deviation			3,3			
median- (kg NH_3 per animal per year			9,4			
95 % percentile			12,4			

Measurements and NH_3 emissions per measurement period for barn 3:

Period	1	2	3	4	5	6
Date (start of measurements)	31-10-2017	24-1-2018	29-3-2018	15-5-2018	26-6-2018	10-7-2018
T_{inside} (°C)	12,3	11,8	7,8	20,5	19,9	17,6
RH_{inside} (%)	83	80	76	55	66	69
$T_{outside}$ (°C)	10,7	10,2	9,0	22,8	23,9	20,9
$[CO_2]_{inside}$ (ppm)	593	561	585	615	828	685
$[CO_2]_{outside}$ (ppm)	420	455	472	419	472	434
Wind velocity (m/s)	2,8	4,7	4,1	6,5	2,8	4,0
Heat production per animal (HPU)	1,5	1,4	1,5	1,4	1,4	1,5
V (m^3/h per animal)	1704	2730	2593	1464	809	1191
$[NH_3]_{inside}$ (mg/m^3)	0,72	0,44	0,51	1,20	1,47	0,82
$[NH_3]_{outside}$ (mg/m^3)	0,01	0,04	0,01	0,03	0,01	0,01
$\Delta[NH_3]$ (mg/m^3)	0,72	0,40	0,50	1,17	1,46	0,81
NH_3 emission- (kg NH_3 per animal place per year (Germany)	10,6	9,3	10,9	14,5	10,0	8,1
NH_3 emission- (kg NH_3 per animal place per year standardized (the Netherlands)	10,4	9,1	10,4	11,5	7,7	6,3
NH_3 emission- (kg NH_3 per animal per year	10,7	9,7	11,3	15,0	10,3	8,5
average- (kg NH_3 per animal per year			10,9			
standard deviation			2,2			
median- (kg NH_3 per animal per year			10,5			
95 % percentile			14,1			

Measurements and NH_3 emissions per measurement period for barn 4:

Period	1	2	3	4	5	6
Date (start of measurements)	7-11-2017	16-1-2018	3-4-2018	28-5-2018	28-8-2018	11-9-2018
T_{inside} (°C)	10,0	6,2	12,6	23,0	18,4	16,7
RH_{inside} (%)	84	83	83	71	75	88
$T_{outside}$ (°C)	6,0	3,3	12,7	24,5	20,6	16,0
$[CO_2]_{inside}$ (ppm)	1001	871	603	498	627	517
$[CO_2]_{outside}$ (ppm)	424	411	451	405	401	413
Wind velocity (m/s)	3,0	8,2	4,8	7,0	4,4	6,2
Heat production per animal (HPU)	1,4	1,4	1,4	1,4	1,4	1,4
V (m^3/h per animal)	477	620	1862	2951	1201	2607
$[NH_3]_{inside}$ (mg/m^3)	1,74	1,55	0,78	0,34	1,07	0,46
$[NH_3]_{outside}$ (mg/m^3)	0,005	< 0,01	0,034	0,023	0,010	0,008
$\Delta[NH_3]$ (mg/m^3)	1,73	1,55	0,74	0,32	1,06	0,45
NH_3 emission- (kg NH_3 per animal place per year (Germany)	7,7	7,6	11,0	7,4	9,5	8,6
NH_3 emission- (kg NH_3 per animal place per year standardized (the Netherlands)	8,7	7,8	10,9	6,3	8,7	8,2
NH_3 emission- (kg NH_3 per animal per year	7,2	8,4	12,1	8,2	11,1	10,3
average- (kg NH_3 per animal per year			9,6			
standard deviation			1,9			
median- (kg NH_3 per animal per year			9,4			
95 % percentile			11,9			

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	92	92	99	106
2nd	91	92	96	91
3rd	91	91	96	91
4th	92	91	97	90
5th	95	91	97	85
6th	91	90	96	83
Average	92	91	97	91

It can be concluded that 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	3.69	3.78	3.99	X
Passages	0.72	0.74	1.03	x
Fouled floor in total	4.41	4.53	5.02	4.58

The used scraping equipment was at all farms scraping robot (Lely Discovery, with water spray facility off on measuring days). and the scraping frequency at each farm where:

	Barn 1	Barn 2	Barn 3	Barn 4
Scraping frequency, # d^{-1}	19	14	10	12

The calculation of the scrapping frequency was based on equal scraping of the total fouled floor surface area.

Summary of the of NH_3 emissions in kg per animal per year in the 4 barns. Average values from 6 measurements:

Measurement	kg per animal per year	kg per animal place per year	kg per animal place per year, standardized*
		Germany	Netherlands
Barn 1	8,5 (std. 2,9)	7,8	6,5
Barn 2	9,1 (std. 3,3)	8,3	7,9
Barn 3	10,9 (std. 2,2)	10,6	9,2
Barn 4	9,6 (std. 1,9)	8,6	8,4
Overall average	9,5	8,8	8,0

* The Dutch Ministry of Environment applies different requirements on minimal animal occupancy from 90% to 70% for a restricted period of time. This period overlapped a part of the measurement period for the test barns under consideration

The overall average ammonia emission for the entire test was 9.5 kg per animal per year; 8,8 kg per animal place per year and 8,0 kg per animal place per year (standardized).

Operational Stability

The operational stability of the floor system relies on that the wedges in the slats, 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.

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 Easyfix.

In general, the slots, the wedges, 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.

The farmer must regularly check that the wegdes allow the manure to pass through to the pit and that the wegdes 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 Easyfix 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 Easyfix SDR slatted rubber mats 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.

The International VERA Secretariat can, however, at any time invalidate the VERA Verification Statement if it is found to be misused or if significant modifications have been made to the product / technology that are estimated to have a negative effect on the environmental efficiency or operational stability. In regard to the latter the International VERA Secretariat can require that a new VERA test should be performed.

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- Eastfix must inform the International VERA Secretariat if any modifications are applied to the technology that can significantly influence the environmental efficiency and / or the operational stability.
- This verification cannot be considered as an endorsement, approval, authorization or warranty of any kind, and the performance parameters provided cannot be extended to other applications or to other technologies.
    - Easyfix 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.
- The VERA Verification Statement will be made available for public access at the VERA website: www.vera-verification.eu .
- All other information obtained or produced during the verification process is considered confidential and will not be made available for others than the part owning the intellectual property rights.

Contact Information

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