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Baltic Slurry Acidification

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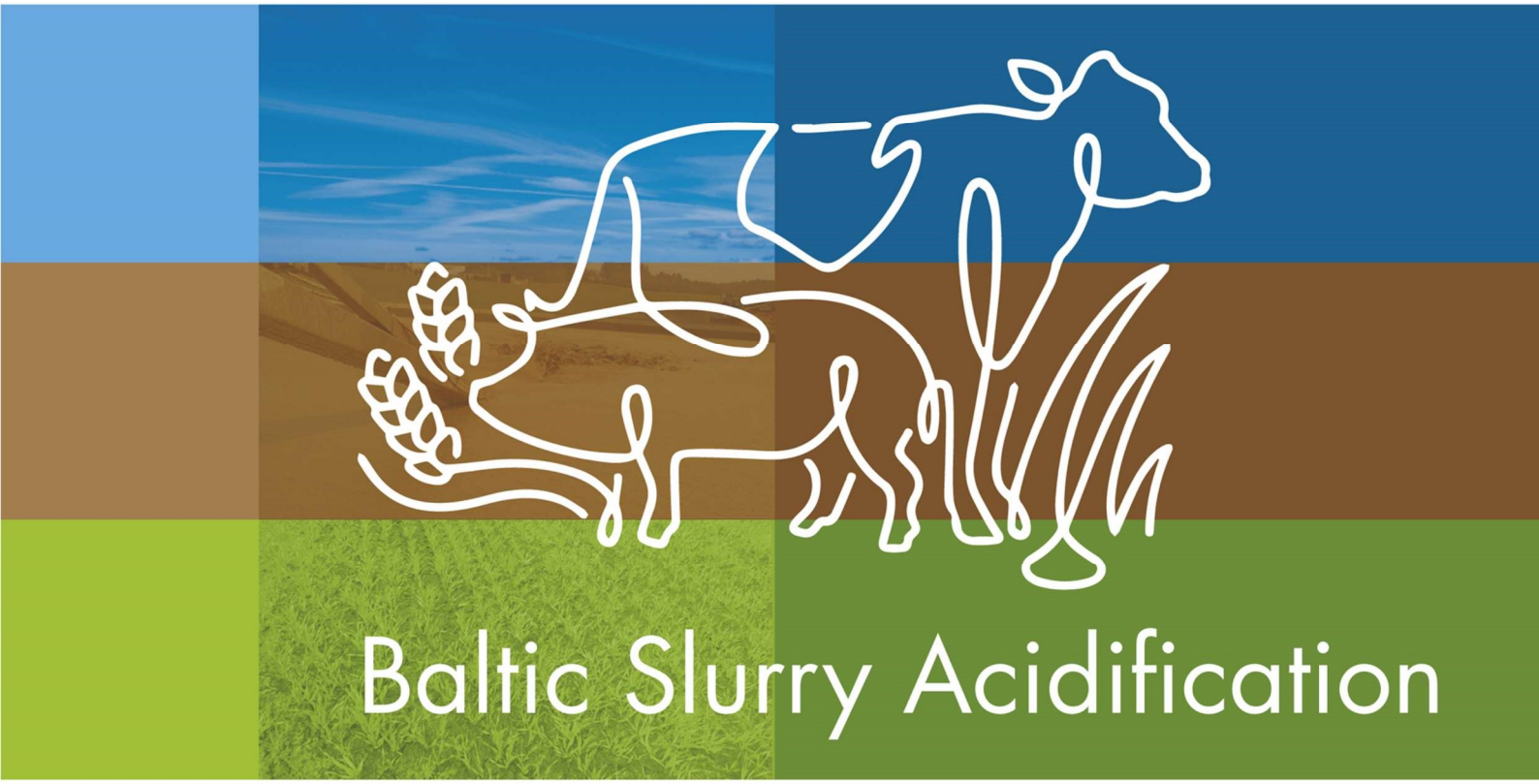

Feasibility studies for pilot installations

Edited by Henning Lyngsø FOGED, Organe Institute Aps

August 2017

Organe
Institute Aps

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August 2017

Preface

This report is prepared in the frames of the Baltic Slurry Acidification project, co-financed by Interreg Baltic and implemented by 17 partners from Baltic Sea Region (BSR) countries in the period from March 2016 to February 2019.

The report is a deliverable of work package 3 (WP3) concerning Pilot installations and demonstrations.

The report contains descriptions, plans and estimates for each of the slurry acidification pilot installations to be established in the project. This includes needed capacity, location, necessary preparations (technical drawings, etc.), as well as estimates of the environmental and economic implications of the technology at the specified premises, such as expected consumption of sulfuric acid, etc. and the costs for that, and any possible benefits, for instance in the form of saved sulphur and nitrogen fertiliser.

In each case, the choice of the specific slurry acidification technology was due to the feasibility considerations reconsidered within available budget limitations.

The report is compiled by the assisting WP3 leader on basis of information and data provided by the pilot installation hosts.

WP3 leader, Janis Kazotnieks, Latvian Rural Advisory and Training Centre has carried out review of the report.

Skødstrup, Denmark

August 2017

Henning Lyngsø FOGED

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Summary

Feasibility studies for seven pilot installations of slurry acidification technology has confirmed either the commercial viability or the scientific relevance of the planned investments.

Feasibility studies confirmed the selection of SAT type for the seven pilot installations, and established estimates of the economic and environmental performance of the installations, as well as plans for their technical configuration etc. One investor in Latvia, Vecsiljani was replaced with Lauku Agro during the process due to incompliance with their maize silage based biogas production on the farm. Another investor, Dotnuva Experimental Farm, decided to change their original plans of investing in in-house acidification, and will instead invest in in-storage acidification.

Compared to experiences from Denmark, the indicative titration results show in general a relatively high sulphuric acid consumption. This situation will be further explored during use of the slurry acidification technologies.

The seven investment projects have a total budget of M€ 1.3 and is expected to save the environment for about 100 tons nitrogen annually via avoided ammonia evaporation, and the subsequent reduced use of nitrogen mineral fertiliser. The consumed use of sulphuric acid will in all cases replace and save the costs for purchase of sulphur mineral fertiliser.

Investments will be made on a pure commercial basis in four cases, by Blunk GmbH in Germany and Br. Göransson Ab in Sweden, which both are contractors, and by Lauku Agro in Latvia and Dotnuvas Experimental Farm in Lithuania, that are farm businesses. Two investors, Institute of Technology and Life Sciences in Poland, and Animal Science Institute of Lithuanian University of Health Sciences in Lithuania has scientific aims for the investments, but will also use the equipment for their own livestock farms. Estonian Crop Research Institute will use their slurry acidification equipment exclusively for scientific purposes.

No legal bottlenecks were identified for the use of slurry acidification equipment. It is needed to wear appropriate protection gear when working with sulphuric acid, and ensure that safety signs are in place. In some countries, special measure must be taken, such as training of staff or the development of a work safety plan.

The feasibility studies are followed by a procurement process, starting with tendering, that in some case already began. More of the investing organisations found it a challenge and reason for major delay to organise needed documentation to comply with national and EU tender regulations in combination with the strict procurement requirements of Interreg Baltic.

A registration program will seek to document and verify the feasibility estimates of economic and environmental performances of the slurry acidification technologies after installation and commissioning of the equipment has happened.

1: Background

It is in case of investment in slurry acidification technologies (SATs) relevant to consider planning issues, such as needed capacity, placement, necessary preparations (soil works, water supply, electricity connections, etc.). Also, the investor would need more precise estimates of the environmental and economic implications of the technology at their premises, such as expected consumption of electricity, sulfuric acid, labour, etc. and the costs for that, as well as any possible benefits, for instance in the form of possible saved sulphur and nitrogen fertiliser.

There are three types of SATs:

1) "In-house" acidification (In-house acidification of liquid livestock manures) of slurry, was developed more than 15 years ago. Slurry is mixed with sulfuric acid in a tank outside the stable. Part of the acidified slurry is pumped back to the stables to ensure all slurry in the stables also is acidified, and the rest of the slurry is pumped to storage tanks. The system is comprised of pumps, pH meters, mixers, computer controllers and regulators, and a sealed acid tank mounted onto a concrete foundation. This system reduces ammonia emission in the stables, in the storage tank and during field spreading. Reducing ammonia emission in the stables also greatly improves animal welfare.

   In a modified version of in-house acidification, the acidified slurry is not circulated in the stable, but the acidification is done in a continuous, automated and closed process in a mixer tank outside the stables, from where the slurry is pumped to the storage tanks. This modified in-house acidification thus secures that slurry in the storage tanks is acidified, and has effect on ammonia emissions from stores and fields.

2) "In-storage" acidification (Acidification of slurry in storage tanks) of slurry in storage tanks was developed to provide a simpler way to acidify slurry. The system consists of a slurry mixer and an acid pump and it mixes the sulfuric acid directly into the slurry of the storage tanks before spreading. Due to the batch processing, which typically is done a few hours before field spreading, the acidification is alone having effect on ammonia emissions in the field. However, it is possible to use tank-acidification equipment for keeping a sufficient low pH of the slurry during storage, thus to reduce ammonia emissions from the tanks as well. The acidification process must in that case be repeated along with adding fresh slurry to the tank, and because the pH of acidified slurry is unstable and has a tendency to raise after some time.

3) "In-field" acidification (Slurry acidification during field spreading) of slurry during field spreading is an add-on technology to slurry tankers, typically

equipped with band laying system (also called trailing hoses). The system is comprised of 4 parts: 1) tank with sulfuric acid, typically placed in front of the tractor, 2) a steering system that automatically regulates the dosing of sulfuric acid, 3) a pH meter for real-time monitoring of the pH of the acidified slurry, and 4) a unit for adding sulfuric acid to the slurry just before it is pumped out into the trailing hoses. The system is connected to GPS and GIS technology, and can thus be used for documentation of the performed field spreading of acidified slurry. In-field acidification has ammonia emission reduction effect in the field, and the sulphuric acid consumption is lower than for the other SAT types, due to the instant effect. A commercial in-field acidification also exists in a simpler and completely manual system that uses 50% sulphuric acid.

More information about the three different SAT types can be obtained from http://www.agro-technology-atlas.eu).

Acidification in the slurry storage is done in an agitation process, just before field application. Photo provided by HARSØ.

In-storage and In-field SATs are essentially equipment deliveries that are relatively easy to install, although typically requiring concrete platforms for storage of sulphuric acid tanks and safety arrangements, such as a shower, unless this is part of the equipment. In-house acidification is different and requires some construction works and careful planning for proper integration with the existing manure handling

infrastructure on the farm. Local legislation and building codes will need to be considered. Usually the planning would have to comply with local municipality's building regulations, and it is necessary to consult the respective authorities and to obtain required permissions as part of the preparation process.

There are five commercial solutions of the three SAT types.

Planning of relevant education should be considered seriously too, since the handling of sulfuric acid potentially is hazardous.

The following gives a presentation of the considerations of the Baltic Slurry Acidification-project partners with investment budgets prior to the realisation of their investments.

2: Method and organisation

Planning of the SAT investments was structured in the following way:

1. Project preparation before project start: The individual investment partner made an indicative decision about the preferred SAT, and included indicative budgets for the needed investments in the entire project budget.
2. WP3 meeting in Lithuania in late April 2016 to discuss WP3 planning in general: Two of the suppliers were present, BioCover and JH Agro, and gave information about their commercial solutions and slurry acidification technologies in general.
3. A study tour to Denmark: The participants visited suppliers and saw their equipment and installations in use at farms.
4. Detailed planning: Feasibility issues, where the individual investment partner estimates the economic, financial, logistical, environmental and other relevant issues.
5. Conclusion: Final decision about the preferred SAT for the individual investment partner was taken and the feasibility study planning used for preparation of tender material, and will be followed by a registration program to verify feasibility study expectations to the economic and environmental performance of the installations.

The main methods and ways to organise the mentioned activities are presented in the following.

2.1: Project preparation before project start

Seven project partners had on basis of general information and considerations about slurry acidification technologies taken an indicative decision to invest in one of the three main SAT's in connection to the drafting of the project document and development of partner budgets. The plans were indicatively as shown in table 1.

Table 1: Original plans for organising of pilot SAT installations.

Country	Partner No.	Partner name	Preferred SAT	Foreseen use besides field trials
Denmark	Not relevant to establish a pilot investment considering that about 300 systems already exist.			
Estonia	3	Estonian Crop Research Institute	In-field	-

Country	Partner No.	Partner name	Preferred SAT	Foreseen use besides field trials
Finland	Finnish investments were not planned.[1]			
Germany	10	BLUNK	In-field	Service farmers with in-field acidification
Latvia	19	Vecsiljani	Modified in-house*	Acidification of digestate during storage to conserve its nitrogen content
Lithuania	1: 14 2: 18	1: Dotnuva Experimental Farm 2: Animal Science Institute of Lithuanian University of Health Sciences	1: In-house 2: In-field	1: Own use of in-house acidification 2: Service own and other farms with in-field acidification
Poland	7	Institute of Technology and Life Sciences	In-tank	Service own farm with in-tank acidification
Sweden	17	Br. Göransson	In-field	Service farmers with slurry acidification

* Modified in the way that the acidified slurry is not circulated in the stables, but first after anaerobic digestion and a further solid-liquid separation.

Summing up, the original plans were to establish seven pilot SAT installations in six countries, whereof four in-field systems, one in-house system, one modified in-house system and one in-storage system.

2.2: WP3 meeting in Lithuania

A WP3 meeting was held at the headquarters of The Lithuanian Agricultural Advisory Services in Akademija on 29 April 2016. The meeting was used for detailed planning of WP3 activities, and it was decided to organise a study tour to Denmark to see SAT technology in practical use. Danish SAT providers were invited to be present at the

[1] An in-field SAT system was present in Finland upon project preparation, owned by a contractor and used for a test. On that background, Finnish project partners reserved a limited budget for renting of that equipment to be able to organise field trials and demonstrations with acidified slurry. However, the equipment was disassembled from the slurry tanker and has since been un-utilised, and field trials are carried out with manually acidified slurry.

meeting and present their technologies, and two of them, BioCover and JH Agro had accepted the invitation. The meeting also included visits to the project partners to organise the pilot SAT investments, Dotnuva Experimental Farm and Animal Science Institute of Lithuanian University of Health Sciences.

Newly build slurry tank at Dotnuva Experimental Farm, April 2016.

2.3: Study tour to Denmark

A study tour to Denmark was organised in May 2016 by Organe Institute Aps, to make project partners and especially those with an investment budget more familiar with the different slurry acidification technologies, and in specific:

- Give investment partners a better basis for deciding the SAT type to invest in, and to collect information to improve the quality of initial feasibility studies, especially about the potential economic impacts of various SATs;
- Make other project partners more familiar with SAT, and in this way enhance the quality of tests and demonstration plans in the project, such as plans for field trials.

The entire study tour programme is seen in Annex A.1 as well as the list of participants. Annex A.2 presents the approximated investment costs of the SAT equipment.

HARSØ equipment for in-tank acidification is being demonstrated to the tour participants.

BioCover had organised farm visits to see the in-field SyreN equipment in action during the study tour. Photo: Morten Toft.

2.4: Feasibility issues

The preparation of the feasibility studies started with the collection of structured and comparable data via elaborated checklists, see Annex B, which each of the investment partners has filled in, and which constituted the foundation for the feasibility studies

drawn up in Annex C – I. The individual feasibility studies also include a narrative description of the investment partner, the foreseen use of the SAT equipment, and the relevant context for the investment. The conclusions aim at estimating economic and environmental performances of the investments.

The development of the feasibility study and the preparation of the checklist information, as well as the related considerations gave reason for changes of the original investment plans:

- It became clear for the Latvian farm Vecsiljani, that slurry acidification would turn out to be unprofitable in their situation. The reason being that preliminary analyses of manures and digestates from the farm, as well as test-titration of that with sulphuric acid, showed the farm would have annual costs for sulphuric acid of about € 90,000, whereas the savings in sulphur fertiliser would be limited to only about € 12,000. The situation is caused by the fact that the large cattle farm has its own biogas plant, which as influent uses about one third cattle slurry and two thirds maize silage on dry matter basis. While digestate on beforehand is costlier to acidify due to a pH that is higher than that of raw slurry, the sulphur consumption is even higher in case the dry matter originates from maize. Furthermore, the input of the huge amount of maize silage into the nutrient cycle on the farm creates a situation with sufficient nutrients in the cycle for fertilising of the crops. The situation is rather unlucky as acidification would have been able to effectively conserve the highly volatile nitrogen content that is found in digestate. However, the Vecsiljani case is just another confirmation of the environmental damage that biogas production on basis of maize silage creates.
- Realising the un-prospective participation in the project, Vecsiljani withdrew as partner and Lauku Agro replaced them. Lauku Agro had initially the intention to invest in in-field acidification equipment using 50% sulphuric acid, but changed their mind after titration of the slurry to acidify. Current market prices for 50% sulphuric acid, in combination with the needed acid amounts gave a clear advantage to the use of concentrated sulphuric acid.
- In Germany, it was realised that although the current design of in-field acidification systems may be approved in relation to traffic regulations, a successful dissemination of the SAT would require a redesign of the system to avoid the front tank to cause concerns and to be able to carry more acid and replace acid tanks fewer times during a working day. Therefore, the German partners, including the organiser of the investment, Blunk GmbH, initiated in cooperation with slurry tanker suppliers the development of a re-design, where the acid is carried in tanks standing on a platform in front of the slurry tanker, behind the tractor.

2.5: Final conclusions

Final conclusions appear from the next section.

3: Main characteristics of feasibility studies for seven pilot installations

A summary of the main SAT investment feasibility study conclusions is shown in the following table:

Table 2: Summary of the main SAT investment feasibility study conclusions.

Country	Organisation	Preferred SAT	Expected investment cost, €	Expected time of procurement	Expected annual reduction of N-loss, kg
EE	Estonian Crop Research Institute	In-field	192,000	Quarter 4/2017.	Minimal
DE	Blunk GmbH	In-field	233,333	Autumn 2017	25,300
LV	Lauku Agro	In-field	160,000	Second half of 2017	12,500
LT	1: Dotnuva Experimental Farm 2: Animal Science Institute of Lithuanian University of Health Sciences	1: In-tank 2: In-field	1: 190,000 2: 180,000	1: Autumn 2017 2: Autumn 2017	1: 33,544 2: 10,240
PL	Institute of Technology and Life Sciences	In-tank	39,000	Second half of 2017	8,740
SE	Br. Göransson	In-field	315,000	Feb. 2017	10,200
IN TOTAL	7 pilot installations		1,309,333		100,524

The following table summarises the chemical analyses of the material that will be acidified with the various pilot installations, as well as their titration properties.

Table 3: Summary of chemical analyses and titration results. Ca – cattle slurry, Pi - pig slurry, Di – digestate, SC – separation liquids, cattle, SP – separation liquids, pigs.

Country	Type	Chemical analyses							Titration results		
		DM	N_{total}	NH4-N	P	K	S	pH			
		%	kg/ton						6.4	6.0	5.5
EE	Ca	8.0	3.8	2.3	0.59	2.2	0.29	7.9	3.82	5,15	6,73
DE	Di	7.9	4.8	2.29	2.1	6.0		7.8	3.88	4.48	4.84
LV	SP	3.1	4.2	3.3	2.4	3.2		8.0	3.6	4.2	5.4
LT1	Ca	9.77	2.3	1.66	0.08	2.45	0.09	6.44	0.95	1.4	1.85
LT2	Ca	6.31	3.79	2.39	0.39	2.61	0.11	6.83	0.80	1.59	2.36
PL	Ca	8.00	2.19	2.09	0.99	3.29	0.47	7.09	0.8	1.6	3.1
SE	Di	1.7	3.5	2.9	0.16	0.29	0.14	8.3	1.9	3	4.2

Compared to experiences from Denmark, the indicative titration results show in general a relatively high sulphuric acid consumption. This situation will be further explored during use of the slurry acidification technology.

Some main characteristics of the seven feasibility studies in annexes C – I are presented here:

Estonia

ECRI plans to invest in an in-field acidification system for research purposes. SEGES in Denmark has been consulted about the technical set-up up of their SAT system used for field trials with acidified slurry, as ECRI plans to use their system in a comparable way.

The investment costs are planned to follow the project budget of € 192,000. A national tender in three lots will be undertaken during the autumn of 2017, and procurement will happen before end of 2017. Field trials has been established in 2017 by use of manually mixed acidified slurry as a temporary solution that compromises labour safety, unsuited for demonstration and for upscaling to practical use.

There exist some legal requirements for work safety when dealing with sulphuric acid. Tender regulations apply and is dealt with. No specific training of persons working with sulphuric acid is required by law in case the company has less than 100 tons of sulphuric acid. Driving on the road with a tractor carrying the sulphuric acid is legal under ADR provisions.

The direct operational costs and savings, as well as the captured amount of N is negligible as the equipment will be used for scientific field trials in small plots.

Germany

Blunk GmbH will procure an in-field SAT system, and has decided to re-design it so that 2,000 litres of sulphuric acid can be carried by the system, and so that the IBC tanks with sulphuric acid is placed in front of the slurry tanker rather than in front of the tractor. The tender process has begun in June 2017 with half a year delay due to the lengthy process of preparing the tender documents. However, a SyreN in-field acidification system from BioCover was rented in the meantime to be able to produce acidified slurry for field trials in spring 2017.

The investment budget is € 233,333.

There exist legal requirements for work safety when dealing with sulphuric acid. In case of the SyreN system, the relevant labour safety regulations prescribe use of glovers and safety goggles when changing the IBC tanks, and appropriate warning signs have to be used. Tender regulations apply and is dealt with. No specific training of staff that carry out the slurry acidification is required by legislation. Driving on the road with a tractor carrying the sulphuric acid is legal under ADR provisions.

The feasibility study shows that farmers will have to pay € 1.3 extra for services to spread acidified slurry or digestate, compared to the spreading cost for raw slurry or digestate. It is anticipated that this additional cost would be balanced by savings on app. 0.5 – 1 kg N and 1 kg S fertiliser per ton slurry, and that farmers in addition would be interested in the technology as a way to meet the high demands for N nutrient use efficiency according the new fertiliser law that came into force by June 2017.

The planned coverage of about 750 ha with 25,000 tons acidified slurry annually will thus save the nature for 25,300 kg N, and further reduce farmers need for S-fertiliser with about 7,600 kg per year.

Latvia

Lauku Agro will invest in in-field acidification and use it for spreading acidified separation liquids from pig slurry at about 1,200 ha, one third of the total cultivated area of the farm.

Lauku Agro plans to procure an in-field acidification system using concentrated sulphuric acid mounted on a slurry tanker with a 24-meter drip-hose boom, and an investment budget of € 160,000 is reserved for that.

There are no legal requirements for permits to deal with sulphuric acid working in small quantities up to 10m3. If to deal with larger amounts, it is obligatory to have specially equipped storage place as well as a registration of quantities stored. Tender regulations apply and are dealt with. No specific training of staff that carries out the slurry acidification is required by legislation. There are just general requirements working with dangerous substances. Driving on the road with a tractor carrying the sulphuric acid is legal without any special permits, because it has not been defined as a transport activity.

The estimated environmental impact is a reduced outlet of 12,500 kg N, and that the farm also will save the purchase of 33,750 kg S per year.

The tender will be organised in autumn 2017 and procurement happen before end of 2017.

Lithuania -1

Dotnuva Experimental Farm has changed its original plans from in-house acidification to in-storage acidification.

A tender procedure would need to await a new board for the farm to be established, as they would have to confirm the investment plans, indicatively in second half of 2017. The investment plans are about a half year delayed due to that.

The plan is to invest in a slurry tanker and an in-storage SAT system according the budget of € 190,000.

According the legislation, the dealing with sulphuric acid require the establishment of a work safety plan by an external expert, training of involved staff, and a special dedicated and adapted storage place for acid. Tender regulations apply and is dealt with. No specific training of staff that carry out the slurry acidification is required by legislation. Driving on the road with a tractor carrying the sulphuric acid is legal under ADR provisions, provided the driver has obtained a special training and licence.

Annual operational cost covers would include purchase of sulfuric acid, amounting to € 8,094. Annual savings will be purchase of 33,544 kg N in mineral fertiliser, equal to a value of € 26,835. In addition, the saving of 21,663 kg S in mineral fertiliser, equal to a value of € 6,066. The total savings in purchase of mineral fertilisers are thus in the level of € 32,900.

Lithuania -2

The Animal Institute in Baisolgala sticks to their original plans of procuring in-field acidification equipment mounted at a slurry tanker within their budget of € 180,000.

According the legislation, the dealing with sulphuric acid require the establishment of a work safety plan by an external expert, training of involved staff, and a special dedicated and adapted storage place for acid. Tender regulations apply and is dealt with. No specific training of staff that carry out the slurry acidification is required by legislation. Driving on the road with a tractor carrying the sulphuric acid is legal under ADR provisions, provided the driver has obtained a special training and licence.

Use of the in-field SAT equipment is planned for 600 ha of crops and meadows, which will be given 12,000 m3 acidified slurry. This would save the environment for 20,240 kg N and 6,080 kg S every year, which the purchase of N and S in mineral fertiliser can be reduced with.

Purchase was completed by August 2nd 2017 and equipment will be delivered until the end of October 2017. They will be able to use it till November 15th. Due to unfavourable weather conditions (rain), it is not clear if it will be possible to go into the fields till November 15th. Sometimes, due to weather conditions, it is allowed to water slurry manure until December 1st.

After equipment delivery, if the weather will be fine, they will start using it on grasslands. Next year they will spread slurry on winter and summer crops from April 1st to November 1st as allowed by the regulations.

Poland

The plan is to establish in-storage acidification at a research farm belonging to ITP in the north-eastern Poland.

There are not identified any legal requirements for permits to deal with sulphuric acid. The special hazard when working with in-storage acidification require appropriate warning signs to be placed at the site, and that persons working with the in-storage acidification wears protection gear, including full-face masks, gloves, suit and boots, and have to attend a special training course to be able to carry out the acidification. Driving on the road with a tractor carrying the sulphuric acid is legal under ADR provisions, provided a maximal amount of 333 litres is carried on the vehicle.

Annual savings will be purchase of 8,740 kg N in mineral fertiliser, equal to a value of € 8,128.20. In addition, the saving of 6,936 kg S in mineral fertiliser, equal to a value of € 2,011. The total savings in purchase of mineral fertilisers are thus in the level of € 10,139. Compared to that, the annual costs for purchase of sulphuric acid would amount to about € 2,592 per year.

The procurement process will be initiated during the summer 2017, and the SAT installation be in place for producing acidified slurry in the autumn 2017.

Sweden

Br. Göransson is an agricultural contractor providing, among other things, slurry spreading services to farms in their vicinity. They spread approximately 100,000 m3 of slurry per year, half of which is digestate and the other half a combination of pig and cattle slurry. Their plan was to procure an in-field SAT system in order to sell slurry acidification services to their customers when spreading the slurry.

The total investment budget was estimated to be € 315,000 including an in-field SAT, a 28 m3 slurry tanker with 24 m trailing hose boom, and an acid storage area. However, only € 200,000 was eligible for the investment within the project and the remaining € 115,000 will be paid by Br. Göransson.

As it turns out, no specific training of staff was needed for Br. Göransson to work with sulfuric acid. Furthermore, moving the acid with a tractor on public roads in Sweden is exempt from the ADR regulations as long as the acid is in an approved container (i.e.

and IBC tank). None the less, to ensure highest possible safety standards, the two Br. Göranssons employees who would be working with the acidification system attended an ADR training and are now certified for ADR transport of dangerous goods.

The business plan for selling acidification services were based on fixed investment costs plus variable costs of acid use. Br. Göransson decided to follow the Danish contractor's model for acidification costs which includes charging a fixed fee per m3 of slurry treated to cover the fixed investment and a variable fee to cover the cost of the acid. Charging a fixed cost per m3 treated will depend on how much slurry they can treat annually. Since acid cost must also include the cost of IBC containers that have a limited life span, the variable acid cost also depends on how much slurry is treated annually.

Calculating costs based on treating 20% of the slurry they currently spread, about 18,000 m3 per year, the fixed costs would be about 5.25 SEK per m3 of slurry and the variable costs for acid would be SEK 2.85 per litre. It is anticipated that this additional cost for farmers will be balanced by increased yields from reduced N loss and saving S fertilizer costs. This will correspond to saving about 10,000 tons of N-loss to the environment. If all of the slurry they spread was acidified, approximately 50,000 tons of N-loss to the environment would be saved.

Achieving 20% treatment rates is the long-term goal of Br. Göransson, however, the costs will be considerably greater during initial years of implementation when less slurry is treated. This actual cost during initial years must be covered by Br Göransson in order to establish an interest among farmers to use acidification treatment, because if the cost for farmers to acidify slurry are more than the yield increase and fertilizer savings, no one will use it.

The tendering and procurement was completed in March 2017, the installation of the in-field SAT was complete in April 2017, testing began in May, the inauguration was held at the Borgeby Agricultural Fair in June 2017 and 4 demonstrations were held in July.

Annex A.1: Programme and participant list for study tour to Denmark

Dates	18-20 May 2016
Purpose	The Interreg Baltic co-financed "Baltic Slurry Acidification"-project has the objective to verify results and official tests of slurry acidification technologies (SAT) use in Denmark through demonstrations and tests in the countries of the Baltic Sea Region. The project will establish seven installations in six of the countries, and tests happen in all the countries except Denmark. Tests will focus on environmental and agricultural effects, such as the impact on crop production. Of the 17 partners, seven are "investment partners" with a budget for investing in a selected SAT. The seven partners have indicated their priorities, and will during 2016 take the final decision about the most relevant SAT (in-house, in-store or in-field) for them, and thereafter procure the technology according EU and national procurement rules. At this stage, the project partners has a high need for clarification of issues related with slurry acidification technologies. On this background, the purpose of the study tour is to make the participants familiar with in-house, in-store and in-field SAT to: • Give investment partners a better basis for the decision about the SAT they will invest in, and to collect information to improve the

quality of initial feasibility studies, especially about the potential economic impacts of various SAT in their situation;

- Make other project partners more familiar with SAT, and in this way enhance the quality of tests and demonstration plans in the project, such as plans for field trials.

Organiser Organe Institute Aps, leader of work package 6 concerning policies and market analyses.

Programme

Wednesday 18 May 2016

13:20:	Tour start at arrival hall of Billund Airport by arrival of Latvian participants with Air Baltic from Riga. Latest arrival of participants from Poland at 13:45. JTI people will pick-up rented cars after arrival, so we have 3 cars = 19 seats until noon 19 May and thereafter 14 seats.
15:00 – ~17:	Programme organised by HARSØ (www.harso.dk). The use of their equipment has finished for the spring season, so we will visit the factory, see the equipment and hear about in-storage acidification.
18:30:	Arrival to Hovborg Kro (www.hovborg-kro.dk), accommodation and dinner In-tank acidification system offered by Ørum Smeden (http://www.oerum-smeden.dk/), after agreement with Frede Ørum presented by Henning L. Foged.

Thursday 19 May 2016

7:30 – 14:00:	Program organised by JH Agro (www.jh-agro.com/) – see below.
14:00 – 17:30:	Program organised by Kyndestoft (www.kyndestoft.eu/)
19:00:	Arrival to Hovborg Kro (www.hovborg-kro.dk), accommodation and dinner. Most probably, Morten Toft and Christian Toft of BioCover will join our dinner and introduce us to Friday's program.

Friday 20 May 2016

7:00 – 12:45:	Program organised by BioCover (www.biocover.dk) – see below.

13:40 (latest): Arrival to Billund Airport

14:40: Departure of AirBaltic to Riga

JH AGRO A/S
A HYLDGAARD GROUP COMPANY

Lundholmvej 41
7500 Holstebro
Bank: 5079 0001399285
SWIFT/BIC: JYBADKKK

Tlf.: +45 96 32 68 00
info@JH-agro.com
CVR/VAT: DK27672671
IBAN: DK1150790001399285

PROGRAM FOR INTERREG BALTIC SEA REGION
THURSDAY MAY 19, 2016

07.30	Departure from Hovborg Kro
08.20	Albæk I/S Albækvej 1 6900 Skjern Infarm NH4+ system pig farm
08.50	Departure from Albæk I/S
09.05	Moselund I/S Bøllingvej 9 6900 Skjern JH NH4+ system pig farm (test plant), presentation by Lars Smed Pedersen, R&D engineer, JH AGRO A/S
09.40	Departure from Moselund I/S
10.00	Henning Bjerregård Stauningvej 7 6900 Skjern JH NH4+ system cow farm
10.30	Departure from Henning Bjerregård
11.15	Kurt T. Hansen Thusholtvej 1 7550 Sørvad Infarm NH4+ system cow farm
11.45	Departure from Kurt T. Hansen
12.00	JH Agro A/S Lundholmvej 41 7500 Holstebro
12.00	Company tour and lunch
12.30	*Presentation of the chemical process in a JH NH4+ acidification system,* by Kamilla Klausen, M.Sc., JH AGRO A/S
13.00	*Presentation of JH NH4+ acidification systems for cow and pig stables,* by Mogens Christiansen, Executive Chairman, JH AGRO A/S
13.30	*Advantages and financial benefits of JH NH4+ acidification systems,* by Tina Sørensen, Export & Marketing, JH AGRO A/S
14.00	Questions and final remarks

Contact:
Kurt West
+4530635857

BioCover Program Baltic slurry acidification Friday 20.05.2016

7.00 Departure Hovborg Kro

7.15

Hulvadgaard is a swinefarm. They own / manage 540 Ha and have their own slurry tanker and SyreN. They have used SyreN acidification since 2012. We stop for ½ hour to talk to Jens Peter and listen to his experiences

8.15

Rostgaard is a large farm and contractor. They own / manage 750 Ha and run 5 slurry tankers – 3 with SyreN system since 2012. We stop for 15 minutes and listen to their experiences.

9.15

Rønhauge is one of the largest private breeding centers for pigs in Denmark. Rønhauge started with SyreN+ this year and have finished slurry application, but they have saved a small field for us where we can do slurryacidification (weather permitting) and those who wish can drive with the tractor. The pilot speaks good English.

The system at Rønhauge is a SyreN+, so we will start with a small presentation of acidification and addition of anhydrous ammonia to slurry and then we will see the system in the field.

12.00

MI – Maskinhandlens indkøbscenter – is the distributer of SyreN system and also contact point for purchase of SyreN system. We stop for 1 hour and get a sandwich and a short presentation of MI

13.00

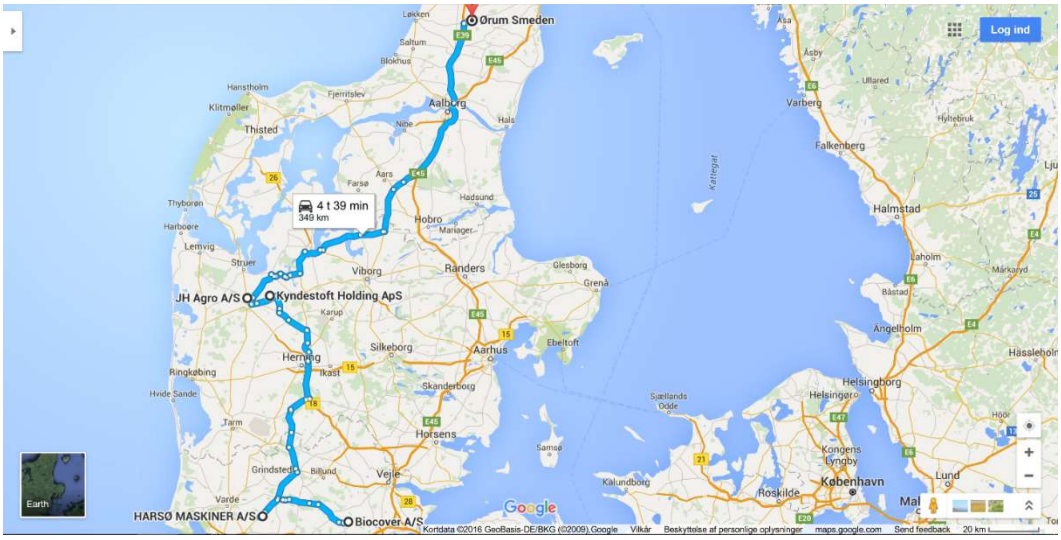
Departure for Billund airport with arrival at 13.40

Participants

1. Erik Sindhøj (project/WP1 leader), Swedish Institute of Agricultural and Environmental Engineering (JTI)
2. Lena Rodhe (deputy project/WP1 leader, Swedish Institute of Agricultural and Environmental Engineering (JTI) – till around noon on 19 May
3. Marianne Tersmeden, Swedish Institute of Agricultural and Environmental Engineering (JTI)
4. Juris Sprukulis, Vecsiljani, Latvia
5. Guntis, Vesciljani, Latvia
6. Janis Kazotnieks (WP3 leader), Latvian Rural Advisory and Training Centre
7. Kamila Mazur (WP2 leader), Polish Institute of Technology and Life Sciences
8. Tomasz Walczuk, Polish Institute of Technology and Life Sciences
9. Artūras Šiukščius, Animal Science Institute of Lithuanian University of Health Sciences
10. Rimgaudas Praninskas, Dotnuvas Experimental Farm, Lithuania
11. Justyna Fila, Agricultural Advisory Center in Brwinow Branch office in Radom
12. Andrzej Szymański, Agricultural Advisory Center in Brwinow Branch office in Radom
13. Kaisa Riiko, Baltic Sea Action Group, Finland
14. Henning Lyngsø Foged (WP6 leader), Organe Institute Aps

Hovborg Kro

Location of Danish SAT providers



Danish SAT providers:

#	Technology	Company	Address	Homepage	Primary contact
1	Stable	JH Agro A/S*	Lundholmvej 41, DK-7500 Holstebro	http://www.jh-agro.com	Kurt West kw@jhstaldservice.dk +45 3063 5857
2	Storage	Ørum Smeden	Vrejlevklostervej 310, DK-9830 Tårs	http://www.oerum-smeden.dk/	Frede Ørum info@oerum-smeden.dk +45 2046 8232
3	Storage	Harsø	Fåborgvej 5, DK-6818 Årre	http://www.harso.dk	Harry Højvang Sørensen harso@harso.dk +45 7519 5333
4	Field	BioCover	Veerst Skovvej 6, DK-6600 Vejen	http://www.biocover.dk/	Morten Toft mt@biocover.dk +45 2963 4936
5	Field	Kyndestoft	Vesterled 38 A, DK-7830 Vinderup	http://www.kyndestoft.eu/	Albert Hedegaard Info@kyndestoft.dk +45 9613 3000 / +45 2371 8065

* has taken over Infarm, which does not exist anymore

Annex A.2: Price information obtained during the study tour to Denmark

During the study visit, the following prices was obtained for the supplier equipment:

- HARSØ (in-tank acidification): € 75,000, including € 10,000 for the acidification equipment and € 65,000 for the slurry pump
- Ørum Smeden (in-tank acidification): € 14,000 for the acidification equipment + € 25,000 for the GDM7500 slurry mixer OR € 38,000 for the GDM85 slurry mixer
- JH Agro (in-house acidification): Indicatively € 90,000 for the system, ex local soil and concrete works for an adapted in-house system for cattle, meaning without re-circulation in the stable, and a price that may vary with the final design of the system.
- Kyndestoft (in-field acidification): € 40,000
- BioCovers SyreN system (in-field acidification): € 54,000, ex mounting and delivery (to be bought at MI)

Annex B – Check lists template

Annex B.1: Description of the planned installation

Type of material to be treated:		
Cow slurry		
Pig slurry		
Digestate		
Other		
Separated or not		
SAT type chosen:		
In house		
In storage		
In field		
Building requirements:		
None		
Basement for mixing tank		
Basement for acid tank		
Place for storage containers of acid		
Modification of the existing barn		
Electricity supply		
Water supply		
Other (please specify)		
Purchase requirements:		
Whole in house SAT		
Whole in storage SAT		
Whole in field SAT		
Tanker		m^3
Machinery availability to operate the SAT:		

Annex B.2: Legal implications

Legislation which limits handling of the acid (title, number, date and text of the specific article):							
Legislation which limits the procurement (title, number, date and text of the specific article):							
Legislation which limits the training of operators (title, number, date and text of the specific article):							
Legislation which limits the transportation of acid (title, number, date and text of the specific article):							

Annex B.3: Economic and environmental performance

Quality of the material to be treated:	Values		
Content of ammonium (NH_4^+-N)		kg/ton	According recent, representative, chemical analysis
Content of total N (N_{tot})		kg/ton	
Content of dry matter (DM)		%	
Content of P (optional)		kg/ton	
Content of K (optional)		kg/ton	
Content of S (optional)		kg/ton	
pH			
Buffer capacity of material to be treated:			
pH after adding 15 ppm (1.5 litres per ton) of 98% pure sulfuric acid			According titration of the above analysed material. 1.5 litre per ton is a typical commercial treatment of slurry. pH 6.4 is sufficient for SyreN, pH 6.0 for in-tank acidification at time of spreading, and pH 5.5 needed for in-tank and in-house adcidification at processing.
ppm of 98% pure sulfuric acid needed for pH 6.4			
ppm of 98% pure sulfuric acid needed for pH 6.0			
ppm of 98% pure sulfuric acid needed for pH 5.5			
Prices of:			
N as mineral fertiliser with delivery to farm		EUR/kg	Calculated as the price for the pure nutrient, based on a variety of commercial qualities of mienral fertilisers that contain N and S.
S as mineral fertiliser with delivery to farm		EUR/kg	
98% sulfuric acid with delivery to farm		EUR/1000 litres	
Electricity		EUR/kWh	
Diesel		EUR/l	
Labour (gross)		EUR/h	
Amount of material to be treated:		m^3/annually	
Area for spreading, normal dose:	ha/year	Dose, ton/ha	
Winter wheat			
Winter rape			
Rye			
Spring wheat			
Spring barley			
Spring rape			
Oats			
Maize			
Grassland			
Other (please specify)			
Fertiliser norms of N and S:	**N**	**S**	
Winter wheat			kg/ha
Winter rape			kg/ha
Rye			kg/ha
Spring wheat			kg/ha
Spring barley			kg/ha
Spring rape			kg/ha
Oats			kg/ha
Maize			kg/ha
Grassland			kg/ha
Other (please specify)			kg/ha
Other expected costs or savings compared to existing situation:		**EUR/annually**	Please describe:
Other expected advantages or disadvantages compared to existing situation:	Please describe:		

Annex C – Feasibility study for Estonian installation

Annex C.1: Description of the planned installation

Estonian Crop Research Institute is a state research and development institute that support the governance of Estonian Ministry of Rural Affairs. The Institute is based on a reorganisation and merger of the Estonian Research Institute of Agriculture and the Jõgeva Plant Breeding Institute on 1 July 2013. Research and development activities of the Institute support increased efficiency and competitiveness of the agricultural production, mitigates negative impacts of agricultural production on the environment and helps in the maintenance of agrobiodiversity. Applied and basic studies are carried out in following areas: Development and upgrade of efficient and environmentally friendly agro-technologies, dependence of yield and quality formation from used varieties and agro-technologies, plant protection, plant health, agro-chemistry, fertilisation, and agro-meteorology. For maintenance of agrobiodiversity, the main activities are: Breeding new varieties of agricultural crops, ensuring maintenance breeding of registered varieties, preserving plant genetic resources as well as production and distribution of certified seeds of various agricultural crops. Active national and international cooperation with research and development institutes and universities is directed towards increase of efficiency and scientific level of research.

ECRI workers establishes field trials with manually prepared acidified slurry, spring 2017.

The Institute provides scientific expertise for farm advisory, state officials and development of legislation. Close collaboration with farmers and industry is a

prerequisite for implementation of research results into practice. ECRI has know-how about 1) building of algorithms for economic estimations, 2) estimation of technological costs of slurry handling, 3) technologies and environmental aspects of slurry handling. ECRI has facilities for scientific field trials and for demo trials ar farms.

ECRI has currently no slurry spreading equipment. It is planned to invest in a 6 m^3 slurry tank, a 3-m wide grass injector and an in-field acidification system. ECRI has several 100 kW tractors to work with slurry spreading equipment. The grass injector can be used also as trail hose spreader, if the cutting discs are kept above soil surface during spreading. The slurry spreading system is planned to be used in field trials and demonstration trials. The system allows to demonstrate and compare different slurry application technologies: acidified slurry spread with trail hoses, non-acidified slurry spread with trail hoses, and non-acidified slurry spread with disc-injector.

ECRI itself has no animals nor slurry. However, the institute has good relationships with farmers with cattle and pig slurry. There are several cattle farms within 20 km radius from ECRI's largest field trial location. It is possible to transport the SAT equipment by trailer to some other location in Estonia for field trial or demonstration purposes. If to calculate by NPK content, then the average cattle slurry costs about 4,5 EUR/m^{-3}. The slurry transportation service costs 1,8 EUR/m^{-3} if distance is less than 7 km. Starting from 7 km every km increases the cost by 0,1 EUR/m^{-3}. Thus for 13 km (this distance is realistic for ECRI) it makes 2,5 EUR/m^{-3} and total cost would be 4,5+2,5=7 EUR/m^{-3}, which is far too much. ECRI will have to pay at least for transportation.

Due to the plans for use of the SAT system for field trials and demonstration, the planned slurry amounts to process are relatively small, and the need is alone a small acid tank. A 25 litre acid canister would with a consumption of 2 litres of acid per m^3 slurry be sufficient for spreading of 12.5 m^3 acidified slurry. The average dose of acidified slurry in a field trials is 30 m^3 per ha, thus the fertilised area can be more than 4,000 m^2, wherefore a 25-litre acid canister is sufficient for field trial purposes.

The current acid price is € 0.75 per litre when bought in 25 litres canisters.

The Danish Agriculture Advisory Centre, SEGES, also uses an in–field SAT system for field trial purposes. ECRI therefore asked SEGES for clarification of some technical issues:

Answers provided by Henrik Junker-Hansen, SEGES:

1: Which tractor model are you using?

Claas Arion 650 C-matic (variable transmission). It is not necessary with such a big tractor, but we have the need of its horsepower's when we are doing maize silage.

2: What is the slurry tank model you use?

Currently a JOS, which is an old, Danish slurry tanker. We are waiting for our new slurry tanker to be delivered. It also made from a Danish company called GØMA.

Hopefully it's delivered within a short period of time. This tanker is also fitted with different pumps to be used when different additives is needed in different plots.

3: What is the tank size?

6 t, the new one likewise

4: How is the tank filled with slurry?

It has its own pump tower

5: What kind of pump you are using during slurry spreading? What is the pump capacity?

Both the new an old slurry tanker is fitted with a Vogelsang 120 pump. 1,500 l/min = 90 m^3/hour (https://www.kramp.com/do/action/ProductDisplay?catalogId=20000&categoryId=57961&langId=-3&productId=1609892&storeId=55&krypto=7FCMd1FoZSwhcdcmcC7xF9vHVokuR%2BJe2iCEkbSVBp%2FJ51mZ1slv3FS09kEzFPmS2QnuCInGwY9NzgU5SaSm2kvgSn3neVyF3tthoyL%2FbPuXCh2IK30NhU4ORdRqP9CpxlQWAXszQ6GUxwOjswSdIXp8HF3k1U%2FP1h%2BvOaUWzJ%2B6644RUY9%2FOD12AF1%2BOMEHvBnHJM9nJaZ%2Fxvx%2BDmhLfQ%3D%3D&ddkey=http%3Ashop-ch%2Fde%2F57961%2F640800%2F1609892%2FDrehkolbenpumpe+R116-120S)

6: What type of slurry spreader are you using? What is the spreader model? Spreader width?

We have three types, all made by Samson. They are all 3 meters wide. We use the incorporators named TD and CMX series (http://www.samson-agro.com/products/incorporators-injectors/). The last model is a customized incorporator to be used in maize at BBCH 15. All types of incorporators are also fitted with drip hose booms, also in 3 meters width. This was custom made for us, enabling us to compare incorporation vs. drip hose booms, and likewise acidification vs. incorporation.

7: What is the in-field acidification system model you are using on the spreader?

We use the system from Morten Toft/ BioCover, though with a smaller pump.

8: How big acid tank are you using on the spreader?

1,000 litres pallet tank. But only filled with 3-400 litres from the start.

Additional comments by Morten Toft (BioCover): Yes, there are limits for the lower application. The RPM on the pump is unreliable at about 5 litres pr. min., so the lower limit is a volume of app. 6 m^3 pr. min.

We have a system as plot system with our farm advisory service organisation – SEGES. They have a different pump (same manufacturer) with a higher precision at the low dose rate. It is a little more expensive - + € 1,000 and fitting charge. The software is already adapted, so it is a pure mechanical process to install it.

I order to control the dose rate to an exact amount, they do not use the automatic system on SyreN, but instead the pump is connected direct to the tractor hydraulics and then they control the amount of acid through the oil litre pr. minute. That allows them to start / stop with the accuracy that is needed for plot trials.

ECRI plan to establish a technical solution for in-field acidification that is alike the system SEGES uses. ECRI wish to follow its original plans according the project budget, namely to invest in a 6 m^3 slurry tanker, a 3 metre disc injector and an in-field acidification system. According Estonian regulations, national tenders must be organised for procurements of values above € 40,000, and international tenders for values above € 130,000. All three items to procure have values below the threshold for international tenders, provided they are purchased separately.

Procurement for slurry tank and spreading device failed, because there was only one valuable offer and the price for tank and spreader (without acidification system) was too high - 165 790 EUR plus VAT, instead of 175 000 EUR for whole system (tank, spreader, acidification system). There will be another procurement process for tanker and spreading device completed within 2017. The procurement for slurry acidification system will be completed by the end of October, 2017.

Checklist information:

Type of material to be treated:	
Cow slurry	X
Pig slurry	
Digestate	
Other	
Separated or not	
SAT type chosen:	
In house	
In storage	
In field	X
Building requirements:	
None	X
Basement for mixing tank	
Basement for acid tank	
Place for storage containers of acid	
Modification of the existing barn	
Electricity supply	
Water supply	
Other (please specify)	

Purchase requirements:	
Whole in house SAT	
Whole in storage SAT	
Whole in field SAT	X
Tanker	6 m^3 with grass injector, 3m
Machinery availability to operate the SAT:	Tractors 100 kW

Annex C.2: Legal implications

Checklist information:

Legislation which limits handling of the acid (title, number, date and text of the specific article):

There are requirements by regulation „Occupational health and safety requirements for the use of hazardous chemicals and materials containing hazardous chemicals" - https://www.riigiteataja.ee/en/eli/518112015002/consolide.

Occupational Health and Safety Act (Töötervishoiu ja tööohutuse seadus) has regulation about "The maximum limit of parameters of chemical hazards" (Töökeskkonna keemiliste ohutegurite piirnormid).

By this regulation is the maximum limit for sulphur acid fog 0,05 mg m^3.

https://www.riigiteataja.ee/en/eli/505052017007/consolide

https://www.riigiteataja.ee/aktilisa/1301/1201/1011/VVm_293_lisa_uus.pdf#

Legislation which limits the procurement (title, number, date and text of the specific article):

Public Procurement Act1. National procurement starts from € 40,000 and international from € 130,000:

https://www.riigiteataja.ee/en/eli/501112016003/consolide

Procurement regulation in ECRI:
http://www.etki.ee/images/pdf/Riigihange/Riigihank_eeskiri_2014_06_27.pdf

Legislation which limits the training of operators (title, number, date and text of the specific article):

ADR training for drivers driving tank trucks to transport hazard substance.

If there is over 100 t of sulfuric acid in the farm in one time moment then the farm is classified as high-risk enterprise and should have safety advisor.

There is no information about any other special training required for operators working with sulfuric acid.

By the regulation „Occupational health and safety requirements for the use of hazardous chemicals and materials containing hazardous chemicals", paragraph 9:

(1) The employer must ensure that workers are aware of the following factors concerning the hazardous chemicals and materials containing hazardous chemicals used at work:

1) their possible health effects;

2) the appropriate personal protective equipment to be used to reduce their effects;

3) the result of the risk assessment;

4) all the safety information provided by the supplier about the hazardous chemical on the safety data sheet in accordance with Article 31 of the REACH Regulation [RT I, 26.03.2015, 5 — entry into force 1 June 2015];

5) the results of the measurement of concentrations in the air in the working environment, and the limit values;

6) the legal acts regulating work with those chemicals and materials.

(2) The employer must provide workers with training on the use of practices that ensure safety.

Legislation which limits the transportation of acid (title, number, date and text of the specific article):

ADR training for drivers driving tank trucks to transport hazard substances.

Road Transport Act. (Autoveoseadus)

Rules for the carriage of dangerous goods (Ohtlike veoste autoveo eeskiri) says that sulphuric acid over 51% is dangerous good. The transporter has sign of danger 8.

Prohibited to drive in E-category tunnels.

https://www.riigiteataja.ee/en/eli/505022016005/consolide

https://www.riigiteataja.ee/akt/110062011019?leiaKehtiv

Transportation information is also described on safety data sheet (Roth)

In English: https://www.carlroth.com/downloads/sdb/en/4/SDB_4623_GB_EN.pdf

In Estonian: https://www.carlroth.com/downloads/sdb/et/4/SDB_4623_EE_ET.pdf

Annex C.3: Economic and environmental performance

Checklist information:

Quality of the material to be treated[2]:	Values	
Content of ammonium (NH_4^+-N)	2.3	kg/ton
Content of total N (N_{tot})	3.8	kg/ton
Content of dry matter (DM)	8	%
Content of P (optional)	0.59	kg/ton
Content of K (optional)	2.2	kg/ton
Content of S (optional)	0.29	kg/ton
pH	7.9	
Buffer capacity of material to be treated[3]:		
pH after adding 15 ml/litre (1.5 litres per ton) of 98% pure sulfuric acid	6.7	
ml/litre of 98% pure sulfuric acid needed for pH 6.4	3.82	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	5.15	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	6.73	
Prices of[4]:		
N as mineral fertiliser with delivery to farm	0.73	€/kg
S as mineral fertiliser with delivery to farm	0.4	€/kg
98% sulfuric acid with delivery to farm	750	€/1,000 litres
Electricity	0.16	€/kWh
Diesel	0.485	€/l
Labour (gross)	8.59	€/h
Amount of material to be treated:	150	m^3/annually
Area for spreading, normal dose:	ha/year	Dose, ton/ha
Winter wheat	2	30
Winter rape	1	20
Rye		
Spring wheat		

[2] According recent, representative, chemical analysis

[3] According titration of the above analysed material. 1.5 litre per ton is a typical commercial treatment of slurry. pH 6.4 is sufficient for SyreN, pH 6.0 for in-tank acidification at time of spreading, and pH 5.5 needed for in-tank and in-house acidification at processing.

[4] Calculated as the price for the pure nutrient, based on a variety of commercial qualities of mineral fertilisers that contain N and S.

Spring barley		
Spring rape		
Oats		
Maize	1	30
Grassland	2	20
Other (please specify)		
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	150	20-(25)
Winter rape	160	50-(60)
Rye	110	10
Spring wheat	130	15
Spring barley	110	10
Spring rape	140	40
Oats	100	10
Maize	200	20-25
Grassland	200	10-15
Other (please specify)	120	10

Annex C.4: Conclusions

C.4.1: Summary of advantages and disadvantages of the investment

Advantage: ECRI has possibilities to make research and demonstration trials with acidified and non-acidified slurry with less manpower on bigger areas and on higher work safety level than today.

C.4.2: Investment costs

The investment budget is € 175,000, including € 95,000 for tanker and spreading boom and € 80,000 for acidification system.

C.4.3: Annual operational costs

€ 1/m^3 slurry plus € 1.2/m^3 for sulphuric acid.

If to calculate by NPK content, then the average cattle slurry costs about € 4.5 per m3. The slurry transportation service costs € 1.8 per m3 if distance is less than 7 km. Starting from 7 km every km increases the cost by € 0.1 per m3. Thus for 13 km (this distance is realistic for ECRI) it makes € 2.5 per m3 and total costs would be € 4.5 + 2.5 = € 7 per m3.

C.4.4: Annual savings and benefits, including fertiliser savings

ECRI has possibilities to make research and demonstration trials with acidified and non-acidified slurry with less manpower on bigger areas and on higher work safety level than today.

C.5.5: Time plans for tender / procurement and installation

Procurement is planned to be organised as a national tender in three lots during the autumn of 2017, and procurement is planned to happen before end of 2017. The situation by end of October 2017 is as follows:

- Our first attempt for procuring a slurry tanker and spreading boom failed as there was only one tenderer and the price for tanker and spreading boom (without acidification system) was € 165,790 excl. VAT. We planned to spend for the whole system (tanker, spreading boom and acidification system) € 175,000. The problem is that we set our requirements too high.
- We discussed thereafter with different slurry device sellers to define realistic requirements.
- A new tender has been organised with deadline for reply till end of October 2017.

C.5.6: Any deviations from initial plans

None.

Annex D – Feasibility study for German installation

Annex D.1: Description of the planned installation

The pilot SAT installation in Germany will be organised by Blunk GmbH, which is a large contractor with more than 200 employees, headquarters in Rendswühren in Schleswig-Holstein and several affiliates in the north-eastern regions of Germany. Field-spreading of slurry is among the most important services Blunk GmbH provides to farmers.

Blunk GmbH is planning to procure an in-field acidification system for producing acidified slurry for field trials at client farms. The trials will be conducted by the University of Kiel with the aim to explore the feasibility of slurry acidification under German circumstances.

BLUNK organises field trials in large plots based on a temporary agreement with BioCover about renting a SyreN system in 2017 until procurement of their own system is done.

Germany has a vast number of agricultural biogas plants. The digestate of the biogas plants has a higher pH level than raw slurry. The average pH for digestate is about 7.8, whereas raw slurry has normal pH levels about 6.8. Digestate require therefore about the double amount of sulphuric acid to reach an envisaged pH level of 6.4, meaning a sulphuric acid consumption of 3.8-6 l/m^3 of digestate. So, we must use and handle a bigger amount of acid per day, compared to the typical situation in Denmark, and this is an economic and logistic challenge.

Overall, the object is to have a slurry tanker that can transport 2,000 litres of acid in two IBC containers in an easy and legal way, and to apply the acidified slurry with trailing hoses in a working width up to 36 metres. A decision was therefore taken to re-design an in-field acidification system for use of concentrated sulphuric acid, and to

do this in a way that also aims at the highest possible labour safety regarding the acid handling.

It is also planned to build a small storage for the IBC tanks, to store and to handle the containers safely.

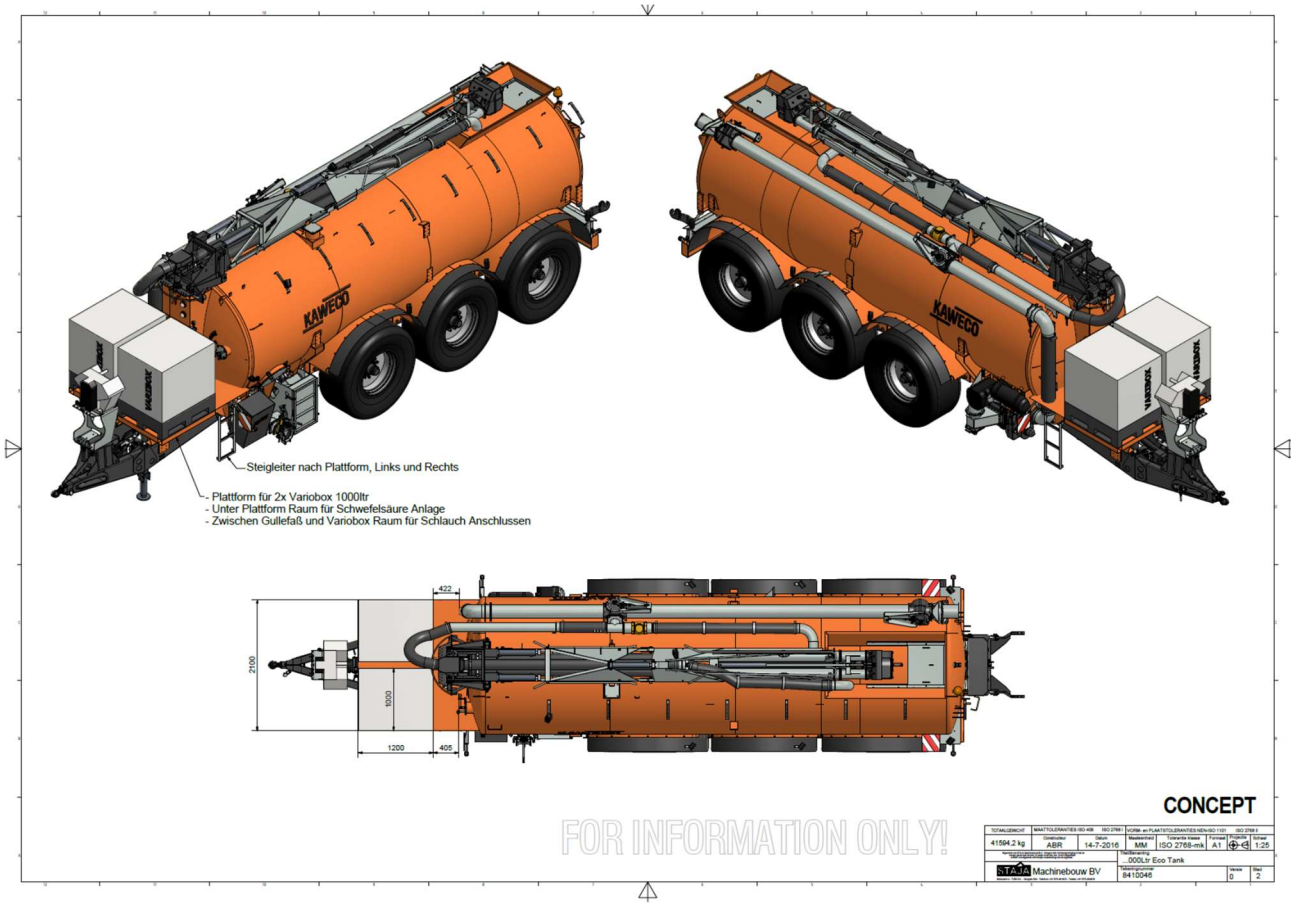
Checklist information:

Type of material to be treated:	
Cow slurry	X
Pig slurry	In the future
Digestate	X
Other	
Separated or not	
SAT type chosen:	
In house	
In storage	
In field	X
Building requirements:	
None	
Basement for mixing tank	
Basement for acid tank	
Place for storage containers of acid	X
Modification of the existing barn	
Electricity supply	
Water supply	X
Other (please specify)	
Purchase requirements:	
Whole in house SAT	
Whole in storage SAT	
Whole in field SAT	X
Tanker	28 m^3
Machinery availability to operate the SAT:	X

Explanation of the re-designed system and why:

Germany differ from other countries of the Baltic Sea Region by having a vast number of agricultural biogas plants, and hence a high amount of digestate with a higher pH level (cow slurry → pH of 6.8, digestate → pH of 7.8). The higher pH means that

approximately the double amount of sulphuric acid is needed to reach an optimal pH in the acidified, compared to raw slurry. A slurry tanker would during a normal working day apply app. 1,000 m^3 of slurry, which require 4,000 – 6,000 litres of sulphuric acid per day, which must be handled and transported. An initial re-design, shown on the following drawing, would enable an economic working process. By transporting 2,000 litres of acid on the tanker it would alone be needed with replacement of the IBC tanks 2 – 3 times per day:



Annex D.2: Legal implications

Checklist information:

Legislation which limits handling of the acid (title, number, date and text of the specific article):

Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße, mit Eisenbahnen und auf Binnengewässern (Gefahrgutverordnung Straße, Eisenbahn und Binnenschifffahrt – GGVSEB) vom 17. Juni 2009)

In English: Regulation on the national and international transport of dangerous goods by road, railways and inland waterways (Dangerous Goods Regulation Road, Rail and Inland Waterway - GGVSEB) of 17 June 2009.

Link: https://www.gesetze-im-internet.de/ggvseb/BJNR138900009.html

GESTIS Substance Database

Institute for Occupational Safety and Health of the German Social Accident Insurance

IDENTIFICATION

Sulfuric acid

ZVG No: 1160

CAS No: 7664-93-9

EC No: 231-639-5

INDEX No: 016-020-00-8

Safe Handling

TECHNICAL MEASURES - HANDLING

Workplace:

- Provision of good ventilation in the working area.
- The floor must be acid resistant.
- Washing facility at the workplace required.
- When handling excessive amounts of the substance an emergency shower is required.
- Eye bath required. These locations must be signposted clearly.

Equipment:

- Use closed apparatus if possible.
- If release of the substance cannot be prevented, then it should be suctioned off at the point of exit.
- Label containers and pipelines clearly.

Suitable materials:

generally resistant:

Glass

Enamel

At lower temperatures:

Polyethylene PE

Polyvinyl chloride

Polypropylene PP

In different concentration- and temperature ranges, the resistance of metals may vary enormously.

Before choosing construction materials, search for distinct information.

Unsuitable materials:

- non-noble metals

Advice on safer handling:

- Take care to keep workplace clean and dry.
- The substance must not be present at workplaces in quantities above that required for work to be progressed.
- When mixing with water or organic liquids add concentrated sulphuric acid slowly under stirring and cooling if necessary.
- Do not leave container open.
- Use leak-proof equipment with exhaust for refilling or transfer.
- Avoid splashing.
- Fill only into labelled container.
- Use acid resistant utensils.
- Avoid any contact when handling the substance.
- Use an appropriate exterior vessel when transporting in fragile containers.
- Cleaning and maintenance:
- Use protective equipment while cleaning if necessary.
- Only conduct maintenance and other work on or in the vessel or closed spaces after obtaining written permission.

<u>PERSONAL PROTECTION</u>

Body protection:

- Depending on the risk, wear a tight, long apron and boots or suitable chemical protection suit.
- The protection clothing should be acid resistant.

Respiratory protection:

- In an emergency (e.g.: unintentional release of the substance, exceeding the occupational exposure limit value) respiratory protection must be worn. Consider the maximum period for wear.

- Respiratory protection: Particle filter P2, colour code white.
- Use insulating device for concentrations above the usage limits for filter devices, for oxygen concentrations below 17% volume, or in circumstances which are unclear.

Eye protection:

- Sufficient eye protection must be worn.
- Wear chemical safety goggles.
- If the face is at risk a protective shield must also be worn.
- If vapours or aerosols that may injure the eyes arise, then safety of the eyes can best be guaranteed by wearing a full mask.

Hand protection:

- Use protective gloves. The glove material must be sufficiently impermeable and resistant to the substance. Check the tightness before wear. Gloves should be well cleaned before being removed, then stored in a well ventilated location. Pay attention to skin care.
- Skin protection cremes do not protect sufficiently against the substance.
- Textile or leather gloves are completely unsuitable.
- The following information refers to 10% w/v and 25% w/v sulphuric acid:

The following materials are suitable for protective gloves (Permeation time >= 8 hours):

- Natural rubber/Natural latex - NR (0,5 mm) (use non-powdered and allergen free products)
- Polychloroprene - CR (0,5 mm)
- Nitrile rubber/Nitrile latex - NBR (0,35 mm)
- Butyl rubber - Butyl (0,5 mm)
- Fluoro carbon rubber - FKM (0,4 mm)
- Polyvinyl chloride - PVC (0,5 mm)

The following information refers to 50% w/v sulphuric acid:

The following materials are suitable for protective gloves (Permeation time >= 8 hours):

- Polychloroprene - CR (0,5 mm)
- Nitrile rubber/Nitrile latex - NBR (0,35 mm)
- Butyl rubber - Butyl (0,5 mm)
- Fluoro carbon rubber - FKM (0,4 mm)

- Polyvinyl chloride - PVC (0,5 mm)
- Following materials are unsuitable for protective gloves because of degradation, severe swelling or low permeation time:
- Natural rubber/Natural latex - NR

The following information refers to 96% w/v sulphuric acid:

The following materials are suitable for protective gloves (Permeation time >= 8 hours):

- Fluoro carbon rubber - FKM (0,4 mm)
- Protective gloves of the following materials should not be worn longer than 2 hours continually (Permeation time >= 2 hours):
- Butyl rubber - Butyl (0,5 mm)
- Following materials are unsuitable for protective gloves because of degradation, severe swelling or low permeation time:
- Natural rubber/Natural latex - NR
- Polychloroprene - CR
- Nitrile rubber/Nitrile latex - NBR
- Polyvinyl chloride - PVC

The times listed are suggested by measurements taken at 22 °C and constant contact.

Temperatures raised by warmed substances, body heat, etc. and a weakening of the effective layer thickness caused by expansion can lead to a significantly shorter breakthrough time. In case of doubt contact the gloves' manufacturer. A 1.5-times increase / decrease in the layer thickness doubles / halves the breakthrough time. This data only applies to the pure substance. Transferred to mixtures of substances, these figures should only be taken as an aid to orientation.

Occupational hygiene:

- Foods, beverages and other articles of consumption must not be consumed at the work areas. Suitable areas are to be designated for these purposes.
- Avoid contact with skin. In case of contact wash skin.
- Avoid contact with eyes. In case of contact rinse the affected eye(s).
- Avoid inhalation of vapour or mist.
- Avoid contact with clothing. Contaminated clothes must be exchanged and cleaned carefully.
- Provide washrooms with showers and if possible rooms with separate storage for street clothing and work clothing.

- The skin must be washed with soap and water before breaks and at the end of work.
- Apply fatty skin-care products after washing.

REGULATIONS

Classification:

Corrosive to metals, Category 1; H290

Skin corrosion, Category 1A; H314

Signal Word: "Danger"

Hazard Statement - H-phrases:

- H290: May be corrosive to metals.
- H314: Causes severe skin burns and eye damage.
- Precautionary Statement - P-phrases:
- P280: Wear protective gloves/protective clothing/eye protection/face protection.
- P301+P330+P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
- P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes.
- Remove contact lenses, if present and easy to do. Continue rinsing.
- P308+P310: IF exposed or concerned: Immediately call a POISON CENTER or doctor.

Manufacturer's specification by Merck

Reference:01211

State: 2015

Checked:2016

The substance is listed in appendix VI, table 3.1 of CLP regulation.

The given classification can deviate from the listed classification, since this classification is to be complemented concerning missing or divergent danger classes and categories for the respective substance.

Reference:99999

GHS-CLASSIFICATION OF MIXTURES

Specific Concentration Limits:

- Skin Corr. 1A; H314: C >= 15 %
- Skin Irrit. H315: 5 % <= C < 15 %
- Eye Irrit. 2; H319: 5 % <= C < 15 %

The general concentration limits from Annex 1 of the Regulation (EU) 1272/2008 are to be used for possibly unspecified concentration ranges or further available substance classifications.

Reference:07500

WORKPLACE LABELLING ACCORDING TO GERMAN ASR A1.3

Warning label:


Caution - corrosive material

Precept label:


Use safety goggles


Wear safety gloves

GERMAN WATER HAZARD CLASS

Substance No: 182

WGK 1 - low hazard to waters

Classification according to the Administrative Regulation of Substances Hazardous to Water (VwVwS)

Legislation which limits the procurement (title, number, date and text of the specific article):

RICHTLINIE 2014/24/EU DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 26. Februar 2014 über die öffentliche Auftragsvergabe und zur Aufhebung der Richtlinie 2004/18/EG

In English: Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC.

Link: https://www.bmwi.de/Redaktion/DE/Downloads/P-R/richtlinie-vergabe-oeffentlicher-auftraege.pdf?__blob=publicationFile&v=1

Legislation which limits the training of operators (title, number, date and text of the specific article):

Gesetz über die Beförderung gefährlicher Güter (Gefahrgutbeförderungsgesetz - GGBefG)

In English: Act on the Transport of Dangerous Goods (Gefahrgutbeförderungsgesetz - GGBefG).

Link: https://www.gesetze-im-internet.de/gefahrgutg/BJNR021210975.html

In der Fassung der Bekanntmachung vom 7. Juli 2009 (BGBl. I S. 1774, 3975)

Zuletzt geändert durch Artikel 5 des Gesetzes vom 26. Juli 2016 (BGBl. I S. 1843)

Legislation which limits the transportation of acid (title, number, date and text of the specific article):

Richtlinie 2008/68/EG vom 17.06.2015

In English: Directive 2008/68 / EC of 17 June 2015

Link: http://www.bfe.bund.de/SharedDocs/Downloads/BfE/DE/rsh/1f-recht-eu/1F-3-10-2016.pdf?__blob=publicationFile&v=1

TRANSPORT REGULATIONS

UN Number: 1830

Shipping name: Sulphuric acid, with not less than 51 % pure acid

Hazard Identification Number: 80

Class: 8 (Corrosive Substances)

Packing Group: II (medium danger)

Danger Label: 8

Tunnel restrictions: Passage forbidden through tunnels of category E.

UN Number: 2796

Shipping name: Battery fluid, acid or Sulphuric acid with not more than 51 % pure acid

Hazard Identification Number: 80

Class: 8 (Corrosive Substances)

Packing Group: II (medium danger)

Danger Label: 8

Tunnel restrictions: Passage forbidden through tunnels of category E.

Annex D.3: Economic and environmental performance

Checklist information:

Quality of the material to be treated:	Values	
Content of ammonium (NH_4^+-N)	2.29	kg/ton
Content of total N (N_{tot})	4.8	kg/ton
Content of dry matter (DM)	7.9	%
Content of P (optional)	2.1	kg/ton
Content of K (optional)	6.0	kg/ton
Content of S (optional)		kg/ton
pH	7.8	
Buffer capacity of material to be treated:		
pH after adding 15 ml/litre (1.5 litres per ton) of 98% pure sulfuric acid		
ml/litre of 98% pure sulfuric acid needed for pH 6.4	3.88	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	4.48	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	4.84	
Prices of:		
N as mineral fertiliser with delivery to farm	0.5	€/kg
S as mineral fertiliser with delivery to farm	0.15	€/kg
98% sulfuric acid with delivery to farm	66	€/1000 litres
Electricity	0.29	€/kWh
Diesel	0.89	€/l
Labour (gross)	21	€/h
Amount of material to be treated:	25,000	m^3/year
Area for spreading, normal dose:	ha/year	Dose, ton/ha
Winter wheat	100	20
Winter rape	100	20
Rye	100	20
Spring wheat		
Spring barley		
Spring rape		
Oats		

Maize	200	40
Grassland	200	40
Other (please specify)	50	20
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	220	35
Winter rape	230	22.5
Rye	160	21
Spring wheat		
Spring barley		
Spring rape		
Oats		
Maize	170	22.5
Grassland	220	30
Other (please specify)		

Annex D.4: Conclusions

D.4.1: Summary of advantages and disadvantages of the investment

Presently, German farmers are not required to use slurry acidification. Use of slurry injection is increasing in Germany, not because of a better nitrogen use efficiency, but due to the fact that this operation both spreads slurry and harrow the field. However, the future situation might be that a higher share of the slurry would have to be spread in the spring on growing crops in order to obtain a higher nitrogen use efficiency as required by the new fertiliser law from 2017. For application in growing crops with a big working width (the farmers have up to 36 m) and a good efficiency, slurry acidification would be an interesting and very important technology for the future. Within the frames of the project, we have the unique opportunity to show the farmers in a price neutral way that the slurry acidification system is working and that they have a much better nitrogen use efficiency. In addition, we have the option to show that this technology can work under German national conditions. In the future, and with the view of new laws and new tasks influenced by the EU (NEC Directive) the farmers must pay additionally € 1.30 per m^3 of acidified slurry. Loss of nitrogen during field spreading is not a realised cost for German farmers now, but it will be in the future, and this would increase the relevance of slurry acidification.

The primary advantage is the better efficiency of nitrogen, and German farmers have due to new legal requirements to apply more slurry in early spring in growing cultures like wheat, barley and canola. This is possible with an application technique, which can be used in growing cultures using the field tracks up to a working width of 36 m with trailing hoses. The normal techniques are not efficient enough, but with the acidification we have a system with an N-efficiency comparable to injection, which is

the main advantage. A disadvantage is the handling of the acid, but which we will be able to deal with. Also, the high share of digestate is a challenge as it gives a higher acid consumption.

D.4.2: Investment costs

The planned investment for the equipment is € 223,333 for the slurry tanker, the in-field SAT system and the spreading boom. However, the re-designed SAT system makes it impossible to predict the final price. € 10,000 is reserved for the construction of a storage place for acid tanks.

D.4.3: Annual operational costs

The expected annual operational costs are € 0.30 per m^3 for the acidification technique and approximately € 1 (0.25 EUR/l x 4 litres) per m^3 for the acid and the acid handling, 1,3 EUR per m^3 in total. These are the additional costs the farmers have to pay in future.

The first trials with digestate indicated that the high pH level of the digestate and the high amount of needed acid (4-6 l/m^3) reduced the application capacity of the tanker with 30-40%. Probably, this is due to the heavy chemical reaction and the increase of the volume of the acidified digestate. A reduced application capacity would lead to a similar increase in the price for the farmers, which would have deteriorating effect on the interest for the technique.

D.4.4: Annual savings and benefits, including fertiliser savings

The main benefit is the improved N efficiency. With the new German fertiliser law that came into force from June 2017, nitrogen is a limiting factor in crop production. Slurry acidification gives the possibility to reduce the amount of mineral fertiliser in case of an increased N efficiency of the organic fertiliser.

With the foreseen use of the slurry acidification equipment, we would be able to save 25,300 kg of N and 7,600 kg of S, having a value of € 14,550.

D.5.5: Time plans for tender / procurement and installation

We started the public procurement process in June 2017 and it will end in October 2017 so we have the tanker in February 2018. The installation of the storage for the IBC container is planned for the first half of 2018.

D.5.6: Any deviations from initial plans

Due to a slow process of preparing the procurement tender documents, we became half a year behind our planned investment schedule. However, we rented a SyreN system from BioCover so we could start with the field trials as planned in spring 2017.

Annex E – Feasibility study for Latvian installation

Annex E.1: Description of the planned installation

The Latvian SAT pilot installation will be organised by Lauku Agro.

Lauku Agro manages more than 3,600 ha of land in south-western part of Latvia, and employs around 30 staff. Fields are cultivated with wheat, rape, barley, rye, peas and maize. Lauku Agro fertilise with pig slurry and digestate from a sister company.

Headquarters of Lauku Agro is the hub for field machinery. The place also includes a biogas plant and some pig production, belonging to a sister company. Acidification will be done of separation liquids of pig slurry from another site without biogas production.

Lauku Agro will procure an in-field SAT system based on use of concentrated sulphuric acid, mounted at a slurry tanker, and will be using an existing Fendt 930 tractor.

The plan is to start using acidified slurry after harvest, meaning in August and September before ploughing.

Checklist information:

Type of material to be treated:	
Cow slurry	
Pig slurry	x
Digestate	Available, but not planned
Other	
Separated or not	Separated
SAT type chosen:	

In house	
In storage	
In field	x
Building requirements:	
None	x
Basement for mixing tank	
Basement for acid tank	Basement for acid containers not needed for in-field SAT.
Place for storage containers of acid	IBC containers of acid will be stored in fenced area, with water supply if needed. We may start with app. 25 IBC containers of acid, which will be enough for acidifying app. 7,000 - 8,000 m^3 of slurry.
Modification of the existing barn	
Electricity supply	
Water supply	
Other (please specify)	
Purchase requirements:	
Whole in house SAT	
Whole in storage SAT	
Whole in field SAT	x
Tanker	25 m^3
Machinery availability to operate the SAT:	Fendt 930

Annex E.2: Legal implications

Checklist information:

Legislation which limits handling of the acid (title, number, date and text of the specific article):

Ķīmisko vielu likums, Chemical Substances Law, 29 October 2009, https://likumi.lv/doc.php?id=47839. English version available.

Darba aizsardzības likums, Labour Protection Law, 20 June 2001, https://likumi.lv/doc.php?id=26020. English version available.

If more than 10t of acid is stored, LR MK noteikumi Nr.1082, Rīgā 2010. gada 30. novembrī (prot. Nr.69 10.§) Kārtība, kādā piesakāmas A, B un C kategorijas piesārņojošas darbības un izsniedzamas atļaujas A un B kategorijas piesārņojošo darbību veikšanai, Cabinet Regulation No.1082 (30 November 2010) Procedure by

Which Polluting Activities of Category A, B and C Shall Be Declared and Permits for the Performance of Category A and B Polluting Activities Shall Be Issued, https://likumi.lv/doc.php?id=222147. English version available.

LR MK noteikumi Nr. 325, Rīgā 2007. gada 15. maijā (prot. Nr. 29 29.§) Darba aizsardzības prasības saskarē ar ķīmiskajām vielām darba vietās, Cabinet Regulation No.325 (15 May 2007) Labour Protection Requirements when Coming in Contact with Chemical Substances at Workplaces, https://likumi.lv/doc.php?id=157382. English version available.

Legislation which limits the procurement (title, number, date and text of the specific article):

Publisko iepirkumu likums, Public Procurement Law, 15 December 2016, https://likumi.lv/doc.php?id=287760 English version not available.

Legislation which limits the training of operators (title, number, date and text of the specific article):

Darba aizsardzības likums, Labour Protection Law, 20 June 2001, https://likumi.lv/doc.php?id=26020 English version available.

LR MK noteikumi Nr.749, Rīga 2010. gada 10. augustā (prot. Nr. 41 28.§) Apmācības kārtība darba aizsardzības jautājumos, Cabinet regulation No.749 Regulations Regarding Training in Labour Protection Matters, https://likumi.lv/doc.php?id=214922 English version available.

Legislation which limits the transportation of acid (title, number, date and text of the specific article):

It is not defined as transport if acid is moved from farm to field. So, there are no regulations specified for transport on farm level.

Annex E.3: Economic and environmental performance

Checklist information:

Quality of the material to be treated:	Values	
Content of ammonium (NH_4^+-N)	3.3	kg/ton
Content of total N (N_{tot})	4.2	kg/ton
Content of dry matter (DM)	3.1	%
Content of P (optional)	2.4	kg/ton
Content of K (optional)	3.2	kg/ton
Content of S (optional)	-	kg/ton
pH	8.0	
Buffer capacity of material to be treated:		

pH after adding 15 ml/liter (1.5 litres per ton) of 98% pure sulfuric acid		
ml/litre of 98% pure sulfuric acid needed for pH 6.4	3.6	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	4.2	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	5.4	
Prices of:		
N as mineral fertiliser with delivery to farm	0.6	€/kg
S as mineral fertiliser with delivery to farm	0.6	€/kg
98% sulfuric acid with delivery to farm	237	€/1000 litres
Electricity	0.11	€/kWh
Diesel	0.63	€/l
Labour (gross)	5.00	€/h
Amount of material to be treated:	25,000	m^3/year
Area for spreading, normal dose:	ha/year	Dose, ton/ha
Winter wheat	550	20
Winter rape	350	20
Rye	200	20
Spring wheat	-	-
Spring barley	-	-
Spring rape	-	-
Oats	-	-
Maize	100	30
Grassland	-	-
Other (please specify)	-	-
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	220	20
Winter rape	190	45
Rye	160	25
Spring wheat	200	20
Spring barley	170	20
Spring rape	-	-
Oats	-	-
Maize	160	20
Grassland	-	-
Other (please specify)	-	-

Annex E.4: Conclusions

E.4.1: Summary of advantages and disadvantages of the investment

By acidifying slurry, less nitrogen would go up in the air and more be available for fertilising the crops. Also, the higher S-content of acidified slurry would reduce the need to spread sulphur fertiliser on the fields. Reducing smell is another good thing

which is very actual when working with raw slurry. The negative side includes concerns for the acid with respect to labour safety and corrosion of machinery and concrete. The size of the slurry tanker will maximally be 25 m^3, as we fear soil compaction.

E.4.2: Investment costs

An investment budget of € 160,000 is reserved for a new or used SAT system, fully working and assembled with a slurry tanker with 24 metre drip hose booms.

E.4.3: Annual operational costs

a) € 1,000 service for acid system and slurry tanker;

b) Buying sulphuric acid for about € 13,000 (for 25,000 m^3 of slurry and an average consumption of 2.2 litres of acid per m^3 slurry.

c) Costs like diesel and labour are not expected to be affected by acidification.

E.4.4: Annual savings and benefits, including fertiliser savings

By using sulphuric acid in an amount equal to our S need for fertilising, meaning app. 2.2 litre per m^3 slurry, we anticipate that we can

- save the purchase of 33,750 kg S in fertilisers of a value of € 22,000; and
- conserve 0.5 kg N per m^3 slurry and digestate, equal to 12,500 kg N of a value of € 8,000 by improving the nitrogen use efficiency from 50 to about 62%.

The total savings are thus about € 30,000. Taking away expenses for acid we still have about € 27,000 savings!

The environment is saved for about 12,500 kg N.

E.5.5: Time plans for tender / procurement and installation

Tender announcements are planned for the first week of July 2017, and contracting by end of July. Thus, we would be able to test the SAT system by end of August or first week of September, just before ploughing.

E.5.6: Any deviations from initial plans

A deviation was hesitation between two in-field acidification system manufacturers. We were concerned about the labour safety connected to concentrated acid, which potentially is more harmful than 50% concentrated sulphuric acid. However, economic calculations were most favourable for concentrated sulphuric acid.

Annex F – Feasibility study for Lithuanian installation (1)

Annex F.1: Description of the planned installation

This pilot SAT installation in Lithuania will be organised by Dotnuva Experimental Farm (DEF), which is a modern demonstration farms with dairy and beef cattle production. DEF is run as a commercial farm besides being used for scientific research and implementation of new technology. The most important economic activities are dairy and meat production. DEF's dairy cows has a high yield and DEF sells breeding material for use in Lithuania and internationally. DEF also has a long experience with beef cattle breeding.

View of the modern dairy cow stable at Dotnuva Experimental Farm.

Dotnuva Experimental Farm is planning to invest in in-storage acidification. This system consists of a slurry mixer with acid pump, and it mixes the sulphuric acid directly into the slurry before spreading. It will be needed to establish a platform for storage of sulphuric acid, including safety arrangements, such as a shower. The platform for storage of sulphuric acid will be fenced and have a locked gate. The plans also include investing in a slurry tanker.

Checklist information:

Type of material to be treated:	
Cow slurry	X
Pig slurry	
Digestate	
Other	
Separated or not	
SAT type chosen:	
In house	
In storage	X
In field	
Building requirements:	
None	
Basement for mixing tank	-
Basement for acid tank	-
Place for storage containers of acid	Planned sulphuric acid container (1000 l plastic) to keep the high fenced area at a time will be from 20 to 25 containers
Modification of the existing barn	-
Electricity supply	-
Water supply	-
Other (please specify)	X
Purchase requirements:	
Whole in house SAT	-
Whole in storage SAT	X
Whole in field SAT	
Tanker	New slurry tanker, 26 - 30 cubic meters
Machinery availability to operate the SAT:	CASE PUMA 210 or similar

Annex F.2: Legal implications

Carrying out the project 'Baltic Slurry Acidification' in Lithuania, we are planning to use concentrated sulfuric acid (98%) which must be handled per dangerous chemical materials safety data sheet. Sulphur acid is classified per regulation (EB) No. 1272/2008 GHS05 corrosion Met. Corr.1 H290, which shows that sulphur acid can erode metals. The classification Skin Corr. 1A H314 shows that it can strongly burns skin and damages the eyes. Sulphur acid is also classified by council directive 67/548/EEB or directive 1999/45/EB C. Product (sulfuric acid (98%) is classifying and marking by directive (EB) No. 1272/2008.

Working with concentrated sulphuric acid (98%) is dangerous and, therefore, only persons over 18 years of age having doctor's permission (medical certificate) are allowed to work with it. Moreover, prior to working, a person must be acquainted with

the safety requirements regarding work with sulphuric acid and his knowledge should be appraised by the Commission set up by the head of the institution. A certified labour safety specialist should be a member of the Commission. Following the person's knowledge appraisal, he must sign in the labour safety journal.

The concept "transport" by ADR and national law includes preparation of the dangerous consignment (identification, classification, packaging, and documentation), all loading operations, transportation and temporary storage. Therefore, all the transport partners (shipper, loader, driver, recipient, etc.) should be familiar with ADR requirements.

Checklist information:

Legislation which limits handling of the acid (title, number, date and text of the specific article):

There are a lot of legislation that are specific for each procedure with acid: the product delivery to the farm (the question is not actual in this case as acid will be bought from a commercial firm), acid storage in a farm, work safety when it is operating with acid, driving the agricultural machinery with the acid on local ways, etc. After the consultations with the Ministry of Labour of the Republic of Lithuania we can state that there are a lot of obligations for employers regarding dangerous chemical materials. It would be very complicate to translate all articles so we could expose you only the names of them:

- Occupational Safety and Health Law of the Republic of Lithuania, 1 of July 2003, No. IX-1672, Vilnius;
- Order of Social Security and Labour Minister and Health Minister of Lithuanian Republic
- "Approved provisions and protection of workers from chemical agents at work place and protection of workers from carcinogens and mutagens at work place", 24 of July 2001, No. 97/406, Vilnius;
- Order of Social Security and Labour Minister "Approved framework for equipment using in working place", 22 of December 1999, No. 102, Vilnius.
- Order of Social Security and Labour Minister "Approved provisions about personal protection equipment for workers", 26 of November 2007, No. A1-331, Vilnius.

In summary, the mentioned documents require;

- To find work safety experts to develop work safety plan in the farms (this service must be paid by farms);
- To organize training of workers for work with sulfuric acid (this activity will cost also);

- To implement requirement for acid tankage storage (this information will be taken from acid suppliers).

Legislation which limits the procurement (title, number, date and text of the specific article):

There is no specific legislation that limits the acid procurement and the specific technic of SAT for each partner. EU-wide-tender method will be used for the equipment and open national tender for other needs.

Legislation which limits the training of operators (title, number, date and text of the specific article):

We see the situation in two aspects:

- We expect the training courses from the suppliers of the equipment. It is very important to know specifics of such technic use and to be capable to solve the problems if suddenly such will appear during the using of the technic.
- Staff must be prepared to work with the acid in the farm over a special training courses.

Legislation which limits the transportation of acid (title, number, date and text of the specific article):

Pure sulfuric acid is classified as a high-risk dangerous substance. So, in all EU countries there are obligation to follow ADR requirements if there is a need to use regional, national or international roadways to reach the place where the acidification process will be held. Such slurry acidification technic driver (in both cases: in field and in storage) must have a special license on basis of a special training course. In Lithuania, the course is on-line (internet page you check the content of the course - https://www.vkti.gov.lt/index.php?1104541375) and organised by some institutions (there is a list of such institutions - https://www.vkti.gov.lt/index.php?618170454). After the successful pass of an exam the driver of a technic would fill in the special document (adding some documents, photo, etc.) with asking to get the special driver license. The license is valid for five years. A state fee and other conditions for ADR - https://www.vkti.gov.lt/index.php?92077086.

Annex F.3: Economic and environmental performance

Checklist information:

Quality of the material to be treated:	Values	
Content of ammonium (NH_4^+-N)	1.66	kg/ton
Content of total N (N_{tot})	2.3	kg/ton
Content of dry matter (DM)	9.77	%
Content of P (optional)	0.08	kg/ton
Content of K (optional)	2.45	kg/ton
Content of S (optional)	0.09	kg/ton
pH	6.44	
Buffer capacity of material to be treated:		
pH after adding 15 ml/litre (1.5 litres per ton) of 98% pure sulfuric acid	5,02	
ml/litre of 98% pure sulfuric acid needed for pH 6.4	0,95	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	1,4	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	1,85	
Prices of:		
N as mineral fertiliser with delivery to farm	0.8	€/kg
S as mineral fertiliser with delivery to farm	0.28	€/kg
98% sulfuric acid with delivery to farm	220	€/1000 litres
Electricity	0.1254	€/kWh
Diesel	0.434	€/l
Labour (gross)	3.5	€/h
Amount of material to be treated:	19,888	m^3/year
Area for spreading, normal dose:	ha/year	Dose, ton/ha
Winter wheat	252	23
Winter rape		
Rye		
Spring wheat	149	23
Spring barley	87	20
Spring rape		
Oats		
Maize	158	25
Grassland	167	25
Other (please specify)	32	25
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	140	18,4
Winter rape		
Rye		
Spring wheat	140	18,4

Spring barley	110	16
Spring rape		
Oats		
Maize	130	20
Grassland	68,8	17
Other (please specify)	130	20

We will store 15 m^3 of acid. We are planning to acidify in spring and in autumn as well.

We plan to carry out all that are required when working with acidification, e.g. to build some shower - like cleaning sites for personnel close to the acidification place.

Annex F.4: Conclusions

F.4.1: Summary of advantages and disadvantages of the investment

The advantages include new slurry acidification technology, which is applied in the farm and giving savings for mineral fertiliser, by-products (slurry) using for agricultural needs, cooperation with scientists and agricultural advisors.

We see the advantages of the project that it will give us possibility to demonstrate an innovative technology, it will give savings on purchase of mineral fertiliser, and we will increase the cooperation with scientists and agricultural advisors.

F.4.2: Investment costs

Investment costs will be as planned, namely € 190,000 for equipment, whereof € 100,000 for slurry tanker with band laying system and € 90,000 for other specific equipment.

F.4.3: Annual operational costs

Annual operational cost covers would include purchase of sulfuric acid, amounting to 1.85 litre x 19,888 m3 slurry x € 0.22/litre = € 8,094.

H.4.4: Annual savings and benefits, including fertiliser savings

Annual savings will be purchase of 33,544 kg N in mineral fertiliser, equal to a value of € 26,835, based on the above market price for nitrogen fertiliser. In addition, the saving of 1.84 kg/litre sulphuric acid x 1.85 litre/m3 x 19,888 m3 x 0.32 kg S/kg sulphuric acid = 21,663 kg S in mineral fertiliser, equal to a value of € 6,066 on basis of the abovementioned market price of S fertiliser.

The total savings in purchase of mineral fertilisers are thus in the level of € 32,900.

F.5.5: Time plans for tender / procurement and installation

We must combine all our plans and decisions to the Board and get their approval. At the moment, our previous Board has completed its term of office and the new Board is not confirmed yet. We could start the procurement procedures (bid-off three type) this autumn, provided approval from the new Board.

F.5.6: Any deviations from initial plans

During the project preparation process, modified in-house slurry acidification seemed the most appropriate for the existing infrastructure of DEF. However, the study-visit to Denmark made us realise that in-storage acidification would be better and easier to apply in our farm. Also, it is easier to present this technology to other farms and spread knowledge about it. Dotnuva Experimental Farm also have other complexes. In the future, after modernisation of these complexes, we could also apply this technology there, which would not be possible with a stationary system.

The board members of DEF will be changed during the summer 2017, and the investment plans must be confirmed by the new board.

Annex G – Feasibility study for Lithuanian installation (2)

Annex G.1: Description of the planned installation

This Lithuanian pilot SAT installation will be organised by Animal Science Institute of Lithuanian University of Health Sciences. The Institute (LUHS) has a staff totalling 84 persons, of which 21 are scientific staff. The main research activities of the Institute are the studies of animal breeding, biology of reproduction and genetic resources; the studies of animal nutrition and production quality; the studies of animal welfare and environmental issues related with animal production. The institute has department of farm management. The objectives of the Department are to provide the basis for the research activities and trials of the Institute, to test new technologies and efficiency of the proposed recommendations and to develop production on a profitable basis. The total farming land is 742.49 ha with fodder, grain and corn. The experimental farm specialises in milk and meat cattle production and has 502 cattle including 228 dairy cows and 41 beef cattle. Also, the Institute has 228 sows, 51 horses, 105 ewes and 156 geese for the preservation of indigenous Lithuanian breeds.

Animal Science Institute in Baisogala will invest in in-field acidification and use it for spreading own slurry as well as to provide slurry field spreading services to other farms.

Lithuanian University of Health Sciences is planning to procure in-field slurry acidification technology, mounted on a slurry tanker with a capacity of 20 m^3 and with a 12 metres wide trailing hose boom. It is intended to buy an in-field SAT system using concentrate sulphuric acid. This system requires a yard for storage of the IBC tanks with concentrated acid. During a year, it is planned to buy up to 10 tanks from a supplier, according the needs. During the slurry spreading, the containers with sulphuric acid will be attached to the tractor's front and carried to the fields together with the slurry. The distance from slurry loading to its spreading will be 3-8 km.

Containers for storage of slurry acid will be stored at a 50 square metres concrete platform with a 1.8 m high fence and a locked gate. The IBC tanks will further be kept under roof.

Acidified separation liquids from cattle slurry will be used for field trials. It will be spread on winter and summer crops as well as on grassland and pastures after cutting.

After equipment will be delivered the plan is to spread 6,000 m^3 separated cattle slurry (from their own farm). They do also plan to contract the neighbouring pig farm with 3,500 pigs and not less than 6,000 m^3 of slurry per year. The total production is about 25,000 m^3 slurry per year. This farm is only 3 to 5 km away from LUHS fields and they are named joint-stock company „Kiaulių veislininkystė" (Pig Breeding). LUHS have the area to spread up to 30,000 m^3 slurry per year on their fields.

Checklist information:

Type of material to be treated:	
Cow slurry	X
Pig slurry	In the future about 6000 m3/annually – not separated
Digestate	-
Other	-
Separated or not	Separated
SAT type chosen:	
In house	-
In storage	
In field	X
Building requirements:	
None	X
Basement for mixing tank	-
Basement for acid tank	-
Place for storage containers of acid	Concrete fenced and roofed platform for IBC tanks
Modification of the existing barn	-
Electricity supply	-
Water supply	-

Other (please specify)	-
Purchase requirements:	
Whole in house SAT	-
Whole in storage SAT	
Whole in field SAT	X
Tanker	New slurry tanker, 20 cubic meters
Machinery availability to operate the SAT:	FENDT 936 PROFI or similar

Annex G.2: Legal implications

Like Annex F.2.

Annex G.3: Economic and environmental performance

Checklist information:

Quality of the material to be treated:	Values	
Content of ammonium (NH_4^+-N)	2.39	kg/ton
Content of total N (N_{tot})	3.79	kg/ton
Content of dry matter (DM)	6.31	%
Content of P (optional)	0.39	kg/ton
Content of K (optional)	2.61	kg/ton
Content of S (optional)	0.11	kg/ton
pH	6.83	
Buffer capacity of material to be treated:		
pH after adding 15 ml/litre (1.5 litres per ton) of 98% pure sulfuric acid	6.06	
ml/litre of 98% pure sulfuric acid needed for pH 6.4	0.80	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	1.59	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	2.36	
Prices of:		
N as mineral fertiliser with delivery to farm	0.65	€/kg
S as mineral fertiliser with delivery to farm	0.3	€/kg
98% sulfuric acid with delivery to farm	220	€/1000 litres
Electricity	0.1254	€/kWh
Diesel	0.434	€/l
Labour (gross)	3.5	€/h
Amount of material to be treated:	12,000	m^3/year

	In the future about 6,000 not separated pig slurry	
Area for spreading, normal dose:	ha/year	Dose, ton/ha
Winter wheat	130	20
Winter rape		
Rye		
Spring wheat		
Spring barley	70	20
Spring rape		
Oats	45	20
Maize	80	20
Grassland	260	20
Other (please specify)	145	0
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	140	20
Winter rape		
Rye		
Spring wheat		
Spring barley	110	10
Spring rape		
Oats	130	10
Maize	170	20
Grassland	100	15
Other (please specify)	100	20

Annex G.4: Conclusions

G.4.1: Summary of advantages and disadvantages of the investment

In-field SAT technology will be tested on winter and spring crops and on the meadows after grass cutting. Conservation of the nitrogen content in the slurry via reduction of ammonia emissions gives the plants a lower demand for nitrogen through mineral fertilisers. Also, slurry acidification results in less unpleasant odour during spreading and the slurry can be field-spread in warmer weather.

The investment will allow demonstrating the efficiency of slurry acidification at growing crops, meadows and grasslands to farmers, farm advisers and agricultural enterprises, including the effects on odours.

Slurry acidification will give savings on purchase of mineral fertilisers and in addition solve slurry handling and environmental problems. However, the technology requires a large initial investment and will also have operational costs for its maintenance and the purchase of sulphuric acid. However, we expect a positive return of the investment.

G.4.2: Investment costs

The investment budget is € 180,000 for an in-field slurry acidification system mounted on a slurry tanker with 20 cubic metre of capacity and a 12 metres wide trailing hose boom.

G.4.3: Annual operational costs

The cost of slurry acidification system will make up € 1,500 for system maintenance (acidification system and tractor maintenance, sulphuric acid storage costs), 28,000 litres of sulphuric acid will cost € 6,160 and additional works € 1,000. Annual cost for system maintenance will be approximately € 8,660.

G.4.4: Annual savings and benefits, including fertiliser savings

Fertilisation of grasslands and pastures, winter and spring crops with acidified slurry will allow to save 100 tonnes of mineral fertilisers, the cost of which currently amounts to € 22,000. If from this sum we subtract the costs required for slurry acidification equipment maintenance, € 6,160, we can save € 15,840 per year.

Also, using acidified slurry saves additionally 20,240 kg of N and 6,080 kg of S, equal to € 14,980. Altogether, with a use for 12,000 m3 acidified slurry we could save € 30,820.

G.5.5: Time plans for tender / procurement and installation

Institute of Animal Science of LUHS is planning to purchase in-field slurry acidification equipment mounted at a 20 m^3 slurry tanker. The procurement has been delayed due to strict requirements to the tender documentation.

Finally, purchase was completed in August 2017 and the equipment will be delivered until the end of October 2017. Due to unfavourable weather conditions (rain), it is not clear if it will be possible to go into the fields till November 15th. Sometimes, due to weather conditions, it is allowed to spread manure until December 1st.

Spreading acidified slurry is planned in the autumn 2017. Equipment is planned to use for field trials with winter and summer cereals, field pastures and grassland fertilising in spring and repetition after cutting during following years.

G.5.6: Any deviations from initial plans

Institute of Animal Science of LUHS was planning to purchase slurry acidification equipment mounted on a 25 m^3 tanker. The tender process was delayed due to strict requirements to the tender documents. In addition, it was clarified during the process that the 25 m^3 slurry tanker would be too expensive for the available budget, wherefore we lowered the size to 20 m^3.

Annex H – Feasibility study for Polish installation

Annex H.1: Description of the planned installations

The pilot SAT installation will be organised by Institute of Technology and Life Sciences (ITP). The Institute conducts research and development in the following areas:

- Protection, use, landscaping and infrastructure in rural areas, water resources, agro-ecosystems, permanent grassland, the environment and nature conservation of lowlands and mountainous areas;
- Innovative, complex technologies in production of crop, livestock, including fish, and food processing, technical infrastructure in villages and obtaining energy from renewable sources; and
- Safety of the implemented technologies as well as usage of machinery and equipment.

ITP will organise the pilot SAT installation at its experimental farm placed in Biebrza in the north-east of Poland, about 200 km from Warsaw. The farm has 766 hectares of land, with 435 hectares of pastures in these areas. A part of the farms is Natura2000 area, and must accordingly comply with special regulations for protection of soil and air of that area.

The farm has 330 milking cows with an average milk yield of about 8,600 kg/cow, 120 pregnant heifers, 30 heifers of 0,5-1,0 year old, 40 young calf. Slurry is produced from about 180 of the milking cows that are kept in a cubicle stable, whereas the rest of the animals are kept in stables with deep litter.

ITP has established field trials in spring 2017, among other with maize. The photos illustrate the personal protection needed when acidifying slurry manually.

IPT plans to install an "in-storage" slurry acidification system. The system should be simple in construction and easy to install on a tractor. Acid should be delivered directly from the acid supplier tanker or from 1,000 l containers to a nozzle distributor at a slurry agitator.

Apart from the experimental farm in Biebrza, ITP plan to demonstrate and promote the system as well at other, modern farms in that area. Demonstration and promotion activities will be organised in cooperation with Radom Agriculture Advisory Centrum to optimise the impacts.

Checklist information:

Type of material to be treated:	
Cow slurry	X
Pig slurry	
Digestate	
Other	
Separated or not	both
SAT type chosen:	
In house	
In storage	x
In field	
Building requirements:	
None	
Basement for mixing tank	
Basement for acid tank	
Place for storage containers of acid	
Modification of the existing barn	
Electricity supply	
Water supply	
Other (please specify)	
Purchase requirements:	
Whole in house SAT	
Whole in storage SAT	x
Whole in field SAT	
Tanker	
Trailing hoses	x
Machinery availability to operate the SAT:	Tractor 120 kW Tanker 10 m^3

Figures H.1, H.2 and H.3 shows a scheme of the planned in-storage slurry acidification system for Biebrza experimental farm. The cattle are distributed in several stables that

are located with some distance to each other. There are two slurry tanks with capacities of 600 and 1,000 m^3, respectively, connected to each other.

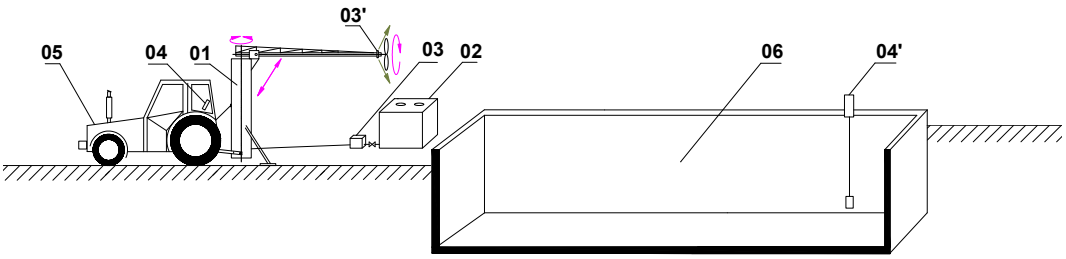


Fig. H.1: Scheme of acidification process using: slurry mixer, acid injection system, acid nozzles and slurry pH controller, all powered by a tractor and installed on ITP Experimental farm in Biebrza about 200 km north-east from Warsaw. 01 – slurry and acid mixer, 02 – acid tank, 03 – acid injection system, 03' – acid nozzles, 04 – pH meter, 04' – pH probe, 05 – tractor, 06 – slurry tank.

Slurry which is in tank 06 is mixed using acidification system 01, equipped in nozzles 03' located nearby the propeller.

Acid will be delivered by professional contractors.

Acidified slurry will be spread on the fields using tanker equipped in trailing hoses. Fig. H.2. present cross section view of slurry tank in Biebrza.

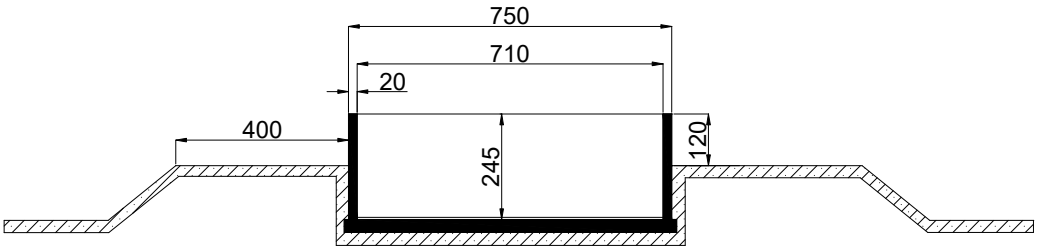


Fig. H.2. Cross section view of slurry tank in Biebrza (tank size: length x width x depth 6,300 x 750 x 245 - dimensions in cm).

Figure H.3 shows side and top view of the area of work the acidification system.

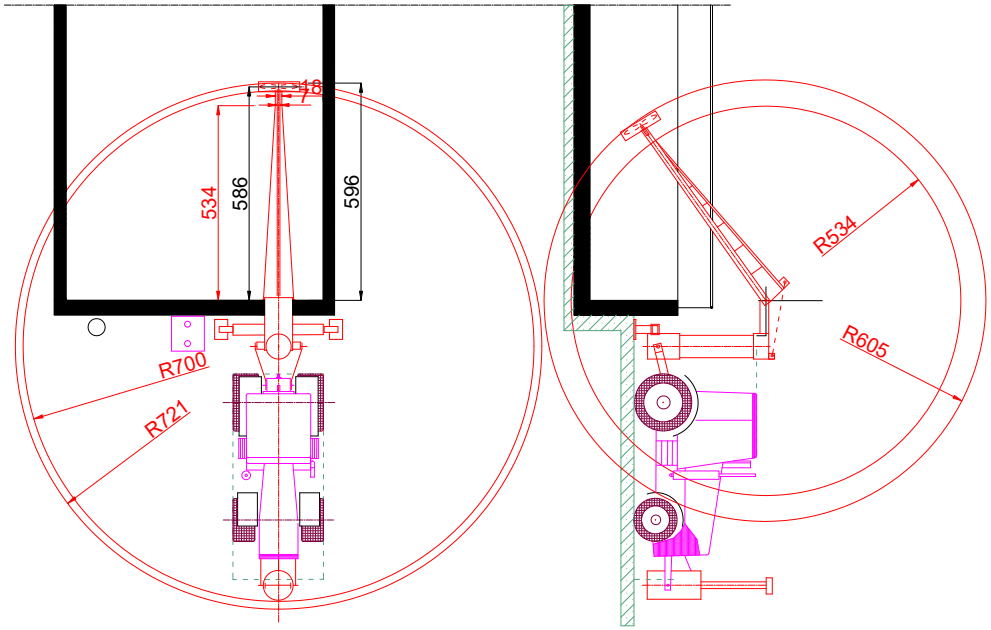


Fig. H.3: Side and top view of planned in-storage acidification at Biebrza.

Demonstrations for farmers, agriculture press, TV etc. will be provided together with Radom Advisory Centrum. Besides that, demonstrations will be also provided in other well-equipped farms, where it will be possible to show advantages of slurry acidification system.

Annex G.2: Legal implications

Legislation which limits handling of the acid (title, number, date and text of the specific article):

Regulation (EC) No 1907/2006 of The European Parliament and Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

The Act of 25 February 2011 on chemical substances and mixtures (Official Act 2011 No. 63, item. 322).

The Directive requires to establish of national central body for technical, scientific and administrative control of all kinds of chemicals and chemical substances. In Poland, this role fulfill The Office for Chemical Substances (This Central Office supports Inspector for Chemical Substances), https: //www.chemikalia.gov.pl

Regulation of Health Minister concerning packing of hazardous substances from 5 0f March 2009 (Dz.U. 09.53.439).

Legislation which limits the procurement (title, number, date and text of the specific article):

There is no specific legislation that limits the procurement. Bid-at-three will be used in all types of purchase per investment plan.

Legislation which limits the training of operators (title, number, date and text of the specific article):

LABELING OF CHEMICAL GOODS

Regulation of the Health Minister – of 20 April 2012 on labelling of chemical dangerous substances and mixtures (2012 item 445).

Labels:

Danger - According to Commission Regulation (EU) No 1272/2008

Harmful products - according to EEC Directive 67/548

PERSONAL PROTECTION

Regulation of the Minister of Economy, Labour and Social Policy of 21 December 2005 on the basic requirements for personal protective equipment (2005 No. 259 item 2173):

Class of resistance of protective clothing PN-EN 6529: 2005

Goggle and the gas mask with the filter of PN-EN-141

Coveralls resistant to acids

Resistant gloves

Acid-resistant and easy to clean shoes

Goggle and the gas mask with the filter of PN-EN-141

Coveralls resistant to acids

Resistant gloves

ACID STORAGE

Sulphur acid should be stored in a dry, cool and well-ventilated place in the original packaging, away from direct sunlight and away from alkali, food and drink.

The container of acid should be tightly closed until ready for use.

Containers that have been opened must be carefully resealed and kept upright.

Do not store acid in un labelled containers.

WASTES HANDLING

The Act of 14 December 2012 on wastes (2013 item 21).

The Act of 13 June 2013 on packaging wastes (2013 item 888).

Regulation of the Minister of the Environment of 9 December 2014 on the waste catalogue (2014, item 1923).

Waste treatment methods:

Used containers must be submitted to specialized companies with appropriate permissions for waste management.

Sulphur acid has a waste code 060101.

Managing person should inform the appropriate authorities and service, in case of leakage and contact with soil, what has caused environmental pollution.

All staff from ITP involved in SAT project attended special acidification safety course and got special certificate.

Besides that, company selling acidification equipment should organize demonstration and training course concerning safety at work.

Legislation which limits the transportation of acid (title, number, date and text of the specific article):

Transportation of sulfuric acid can be provided by road, rail or water, and can be a significant risk of accidents. Therefore, in order to ensure the best security conditions, various types of actions are taken by state authorities in both national and EU legislation.

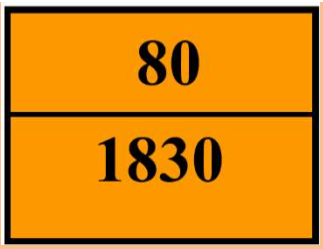
The EU Directives apply as follows:

- Council Directive 95/50 / EC of 6 October 1995 on uniform procedures for the control of the transport of dangerous goods by road.

In Poland, a coding system is also used in the transport of dangerous goods. For road transport ADR system is used, while for rail transport it is known as RID. ADR is an international convention for carriage of dangerous goods by road. This system is applicable almost throughout Europe and also in Poland.

ADR / RID provide for signs of means of transport of hazardous materials with orange warning signs measuring 30 x 40 cm, reflective orange with the black non-reflective strip around.

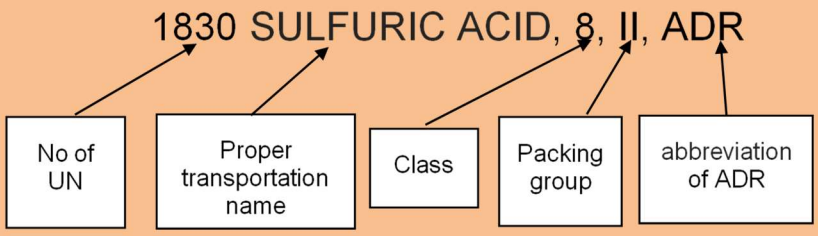
Each of the most dangerous materials has been given two relevant identification numbers, i.e. the hazard identification number consisting of two or three digits and the distinguishing number of the material (according to the catalogue) consisting of four digits.



80 - corrosive or slightly corrosive material

1830 - Sulfuric acid containing up to 98 % of pure acid

In contrast, each tanker carrying sulfuric acid should be labelled according to ADR as follows:



In addition, the transport should have also the pictogram:

ADN – European Agreement concerning the International Carriage of Inland Waterways of Dangerous Goods (ADN), signed in Geneva on 26 May 2000 (Journal of Laws of 2010, No. 235, item 1537), as amended from the date of entry in relation to the Republic of Poland.

Regulation of transportation of hazardous materials from 19 of August 2011 (Dz.U. 11.227.1367). It is possible to provide acid transportation in Poland without any special government agreement, but to the capacity of 333 liters only.

Annex G.3: Economic and environmental performance

[estimates of the environmental and economic implications of the technology at the specific premises, such as expected consumption of electricity, sulfuric acid, labour, etc. and the costs for that, and any possible benefits, for instance in the form of possible saved sulphur and nitrogen fertiliser]

Checklist information:

Quality of the material to be treated:	Values	
Content of ammonium (NH_4^+-N)	2,09	kg/ton
Content of total N (N_{tot})	2,19	kg/ton
Content of dry matter (DM)	8,00	%
Content of P (optional)	0,99	kg/ton

Content of K (optional)	3,29	kg/ton
Content of S (optional)	0,47	kg/ton
pH	7,09	
Buffer capacity of material to be treated:		
pH after adding 15 ml/litre (1.5 litres per ton) of 98% pure sulfuric acid	6.7	
ml/litre of 98% pure sulfuric acid needed for pH 6.4	0.8	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	1.6	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	3.1	
Prices:		
N as mineral fertiliser with delivery to farm	0.93	€/kg
S as mineral fertiliser with delivery to farm	0.29	€/kg
98% sulfuric acid with delivery to farm	220	€/1000 litres
Electricity	0.18	€/kWh
Diesel	0.98	€/l
Labour (gross)	3.8	€/h
Amount of material to be treated:	3,800	m^3/year
Area for spreading, normal dose:	ha/year	Dose, ton/ha
Winter wheat	30	30
Winter rape		
Rye		
Spring wheat	20	30
Spring barley	20	30
Spring rape		
Oats		
Maize	30	30
Grassland	20	40
Other (please specify)		
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	210	40
Winter rape		

Rye		
Spring wheat	200	45
Spring barley	200	40
Spring rape		
Oats		
Maize	220	45
Grassland	220	50
Other (please specify)		

Annex H.4: Conclusions

H.4.1: Summary of advantages and disadvantages of the investment

The advantages of using slurry acidification system are as follows:

- we get friendlier product as fertiliser for field crop production in general,
- because animal production scale is going to be bigger and bigger, so amount of slurry is getting also larger, but agriculture land area is going to be smaller year by year, we have to use such novel technology to make slurry more environmentally friendly,
- we can save on chemical fertilisers N and S by about from € 0,5 - 1 from each 1 cubic meter of slurry,
- we can get better air quality in the area of country side, ground water quality can be better, and has big influence on people and animal welfare in the area of village infrastructure,
- introduction of new technology is also the advantage of the investment.

The disadvantages of the investment are: using concentrated sulfuric acid is usually taken by farmers as something very dangerous and difficult to utilize on the farm – very harmful product, each new development has to be implemented into the practice in very delicate way, with clear understanding for the farmers, what is not easy to do, even there would no financial real profit in the first years of application of slurry acidification system, it would be already the success.

H.4.2: Investment costs

ITP plan to buy an in-storage acidification system, including delivery and installation. This would thus provide training for our tractor drivers and other staff that will be involved in slurry acidification. The budget for the in-storage acidification system is € 39,000.

H.4.3: Annual operational costs

Annual operational cost covers would include purchase of sulfuric acid, amounting to 3.1 litre x 3,800 m3 slurry x € 0.22/litre = € 2,592.

H.4.4: Annual savings and benefits, including fertiliser savings

Annual savings will be purchase of 8,740 kg N in mineral fertiliser, equal to a value of € 8,128, based on the above market price for nitrogen fertiliser. In addition, the saving of 1.84 kg/litre sulphuric acid x 3.1 litre/m3 x 3,800 m3 x 0.32 kg S/kg sulphuric acid = 6,936 kg S in mineral fertiliser, equal to a value of € 2,011 on basis of the abovementioned market price of S fertiliser.

The total savings in purchase of mineral fertilisers are thus in the level of € 10,139.

H.5.5: Time plans for tender / procurement and installation

Tender, procurement and installation will be completed by the end of November 2017. The amount of investment for in-storage system will be max € 39,000 plus another € 22,000 for laboratory equipment.

H.5.6: Any deviations from initial plans

Different solutions were considered, confirming the originals plan to invest in in-storage acidification.

Annex I – Feasibility study for Swedish installation

Annex I.1: Description of the planned installation

The pilot installation of a SAT system in Sweden will be organised by PP17, Br. Göransson in Southern Sweden. Br. Göransson is a small, independent agricultural contractor in Kvidinge that serves farmers in the region with transport and manure handling services and other agriculturally related services. Field spreading of animal slurry and biogas digestate is among the most important services Br. Göransson provides to farmers.

Br. Göransson has long considered animal slurry a valuable resource in Agriculture and their company's vision has been to help their customers to utilize this resource as best as possible. For instance, when spreading slurry for a farmer, they always start by taking a quick ammonium nitrogen analysis of the slurry to determine the most appropriate application dosage. They also, for instance, invest in the largest wheel diameter possible on slurry tankers in order to minimize soil compaction risks despite the added cost for tires. Before this project started, Br Göransson had been following the development and implementation of slurry acidification in Denmark and was already interested in the techniques for improving the value of animal slurry.

An important activity for Br. Göransson is to service farmers with field-spreading of slurry.

Slurry acidification is an effective treatment for reducing ammonia loss from slurry spreading and therefore increasing the nitrogen use efficiency of the slurry and

reducing the need to purchase mineral N fertilizers. Furthermore, since sulfuric acid is used, the acidification treatment will provide all the S fertilization that is needed for the plants.

The business plan for this investment is based on the benefits of increasing the fertilizer value of slurry and decreasing the need to purchase mineral N and S fertilizers will compensate the costs of the treatment while also improving the environment. Br. Göransson determined that the in-field SAT would be most appropriate for introducing slurry acidification to their current customers. After joining the project, they planned to procure an in-field SAT and to set up a number of demonstrations to raise awareness and interest in slurry acidification among farmers in the region.

Three parts of the investment are planned: 1) the slurry tanker with trailing hose boom, 2) in-field SAT and 3) storage area for sulfuric acid depo. In order to ensure a high spreading capacity with the in-field SAT, Br Göransson is planning to install it on a 28 m3 tanker with a 24-meter-wide trailing hose boom. In order to minimize soil compaction risks with such a large system, the tanker should have triple axels with a minimum wheel diameter of 2 meters.

Checklist information:

Type of material to be treated:	
Cow slurry	20,000 m^3/yr
Pig slurry	30,000 m^3/yr
Digestate	50,000 m^3/yr
Other	
Separated or not	Not separated
SAT type chosen:	
In house	
In storage	
In field	x
Building requirements:	
None	
Basement for mixing tank	
Basement for acid tank	
Place for storage containers of acid	x
Modification of the existing barn	
Electricity supply	For lights
Water supply	For safety shower etc.
Other (please specify)	

Purchase requirements:	
Whole in house SAT	
Whole in storage SAT	
Whole in field SAT	x
Tanker	28
Machinery availability to operate the SAT:	Tractor JD 8000-serie

Almost half of the slurry they spread each year by Br. Göranssons is biogas digestate. In general, there is a greater potential for ammonia loss when spreading biogas digestate than regular animal slurry since it has a higher pH and it can have a higher ammonia nitrogen concentration as well. So, the potential benefits of acidifying digestate can be even greater than for undigested slurry, however, because the pH value in general is rather high, it will take more acid to lower the pH to the appropriate level and this will therefore increase the cost of treatment. Keeping the cost of the acid as low as possible is therefore essential to make the acidification treatment profitable for farmers.

Br. Göransson provides slurry spreading services for farmers within quite a large area around where they are centrally located. They deal with this through logistical planning by sending certain equipment to farms far away to complete the job before coming back. However, this will create logistical challenges for handling the acid when using the in-field SAT, which will have to be dealt with in order to keep acid costs down.

Annex I.2: Legal implications

Checklist information:

Legislation which limits handling of the acid (title, number, date and text of the specific article):

According to the Swedish Chemical Agency regulations (2008:245) and (2008:2) for permits for particularly hazardous chemicals, the use of sulfuric acid by a company or business does not require a permit. Nor are permits required for handling and storing sulfuric acid within a business according to the Swedish Environmental Assessment Ordinance (2013:251).

Legislation which limits the procurement (title, number, date and text of the specific article):

Public procurement legislation in Sweden is not intended for private companies and therefore it would be very difficult for private companies to comply with the legislation. After consultations with the National Agency for Public Procurement, the

Swedish Competition Authority and the Swedish Agency for Economic and Regional Growth, it was unclear about what rules actually applied in Sweden. Another issue without clear clarification was that total cost of the slurry tanker was above the national threshold for open procurement, however, the amount that would be reimbursed to our partner through the de minimus state aid element for the tanker was under the national threshold and within the "bid-at-three" procurement range. After further discussions with the abovenamed authorities, it was decided that bid-at-three procurement would be sufficient for the tanker as well since the amount of reimbursement from the Interreg program is under the national threshold. The amount for the SAT was under the national threshold for open procurement so it was the Interreg "bid-at-three" rule that was applied for procurement for the in-field SAT.

Legislation which limits the training of operators (title, number, date and text of the specific article):

There is no legislation which states specific training requirements for operators. The Swedish Work Environment Authority's provisions state that the employer is responsible for determining how ill health and accidents caused by chemical hazards at work are to be prevented.

Legislation which limits the transportation of acid (title, number, date and text of the specific article):

ADR-S regulations dictate how sulfuric acid can be transported on roads in Sweden according to (MSBFS 2016:8). In general, a valid ADR certificates required by drivers who are transporting sulfuric acid and the vehicle must meet ADR-S specific requirements. However, according to 13.2.1 (MSBFS 2016:8) there is an exception for the ADR requirement for transport of packaged dangerous goods if the transport is intended for agricultural or forestry purposes, only if the transport is done with a tractor. This means that transport of an IBC full of acid with a tractor is acceptable within the exemption, but not a 1000 litre tank of sulfuric acid transported with a tractor.

Even though there does not seem to be the need for providing any certification for Br. Göranssons to be able to start using sulfuric acid to treat slurry, they decided that the two employees who would be initially responsible for working with the in-field SAT should receive an ADR-S education in order to ensure safety for everyone. This will also allow them the flexibility to legally transport acid to different locations if logistically this could help to reduce costs.

Annex I.3: Economic and environmental performance

Checklist information:

Quality of the material to be treated:	Values		
	Digestate 1[5]	Digestate 2	
Content of ammonium (NH_4^+-N)	3.5	2.9	kg/ton
Content of total N (N_{tot})	6.4	3.5	kg/ton
Content of dry matter (DM)	10.4	1.7	%
Content of P (optional)	0.87	0.16	kg/ton
Content of K (optional)	4.11	0.29	kg/ton
Content of S (optional)	0.61	0.14	kg/ton
pH	7.6	8.3	
Buffer capacity of material to be treated:			
pH after adding 15 ml/litre (1.5 litres per ton) of 98% pure sulfuric acid	6.7	6.9	
ml/litre of 98% pure sulfuric acid needed for pH 6.4	2.4	3.6	
ml/litre of 98% pure sulfuric acid needed for pH 6.0	3.8	4.8	
ml/litre of 98% pure sulfuric acid needed for pH 5.5	4.6	5.3	
Prices of:			
N as mineral fertiliser with delivery to farm[6]		1.1	€/kg
S as mineral fertiliser with delivery to farm[6]		0.43	€/kg
98% sulfuric acid with delivery to farm		250[7]	€/1000 litres
Electricity		0.8	€/kWh
Diesel		1.1	€/l
Labour (gross)		27	€/h
Amount of material to be treated:		18,000	m^3/annually
Area for spreading, normal dose:	ha/year		Dosis, ton/ha (C, P, D)[8]
Winter wheat		35%	30, 25, 30
Winter rape		10%	30, 25, 30
Rye			
Spring wheat			
Spring barley			

[5] Chemical analyses 1 and 2 are digestates from different biogas plants.
[6] €/kg Based on costs of mineral fertilisers with N and S.
[7] €/1000 litres Bulk delivery of 10-30 t, not including cost for IBC tanks
[8] C, P and D stands for cattle and pig slurry, and digestate, respectively.

Spring rape		
Oats		
Maize	10%	30, -, 30
Grassland	30%	30, -, 30
Other (please specify)	15%	
Fertiliser norms of N and S (kg/ha):	N	S
Winter wheat	150	10-15
Winter rape	180	15-25
Rye	100	10-15
Spring wheat	140	10-15
Spring barley	110	10-15
Spring rape	130	15-25
Oats	110	10-15
Maize	160	10-15
Grassland	160	10-15
Other (please specify)		

Determining the quality of the material to be treated and the quantity of acid need for acidification was difficult since Br Göransson is a contractor and provides services for many different customers. The chemical values and buffer capacity presented above are from digestate from two biogas plants that they normally spread for customers. The dry matter content from digestate 1 seems very high but it was difficult to obtain a representative sample from the storage tank which could not be mixed.. We titrated a dairy slurry that they spread and the amounts of acid needed were 2.0, 3.2 and 4.3 l/m3 to reach pH 6.4, 6.0 and 5.5 respectively. Due to an issue during transport of the dairy slurry samples, there was not enough to due a chemical analysis so unfortunately it is hard to say why this dairy slurry might have needed more acid than is typically required for dairy slurries in Denmark. Br Göransson assumes that in general their experiences in Southern Sweden with acidifying slurry using the in-field SAT, in terms of acid use and expected yield results, should be similar to Danish experiences.

No matter how much acid is need for treatment, it is obvious that keeping acid costs low is a high priority for the treatment to be profitable for farmers. The purchase and delivery cost for sulfuric acid in IBC tanks is between 0,55 – 0,71 EUR/l depending on how many tanks are bought at once, however this does not include the handling costs for the empty IBC tanks. Bulk purchase and delivery of sulfuric acid costs about 0.25 EUR/l if between 10-30 tonnes is ordered per delivery, or 0.24 EUR/l if t between 30-36 tonnes is ordered and delivered. IBC tanks costs 220 EUR each and have a life span of about 2.5 years. So obviously it would be most economical to purchase at least 7 IBC tanks to meet the minimum bulk filling requirement of 10 tonnes and have the tanks re-filled to reduce costs. Bulk filling each tank 2 times would reduce acid costs to 0.39 EUR/l and re-filling them 10 times during their life span would reduce costs to 0.28 EUR/l. The acid delivery company keeps track of the age of the IBC tanks and will not refill tanks that are damaged or have passed their expiration date for safety reasons.

Buying acid in Bulk in order to keep costs down means there needs to be a central storage area for the IBC tanks. This creates logistical challenges when they are spreading slurry on farms that are far away. What is the best way to get the acid to the farm? Considering spreading 25 m^3/ha of slurry that needs 1.5 l/m^3 for treatment, this means about 545 m^3 of slurry could be treated with one IBC tank and would be enough for 21.7 ha. If 2 l/m^3 is needed then one IBC tank would be enough for treating about 410 m^3 of slurry or spreading on about 16.3 ha. Or if the spreading rate is 30 m^3/ha then the range of one IBC tank is between 18.1- 13.6 ha for 1.5 to 2.0 l/m^3 acid use respectively.

In the beginning, they will have to determine for each situation if it's better for them to transport the acid to the farm or to have single tanks delivered directly to the farm for the higher costs. Eventually, it might be worth establishing a remote storage of IBC tanks that could be bulk filled closer to where they will be used.

Br. Göranssons testing their in-field slurry acidification equipment.

Annex I.4: Conclusions

I.4.1: Summary of advantages and disadvantages of the investment

The environmental advantages of slurry acidification are quite clear as the in-field SAT will reduce ammonia emissions during slurry spreading. This will lead to increased N use efficiency in animal manure and a decreased need for mineral N fertilizers as well as mineral S fertilizers.

Hopefully, there will be a clear economic advantage to slurry acidification in Sweden as well, so farmers do not only see it as a cost for the environment.

There are no requirements for acidification in Sweden and there is generally no requirement s for injection of slurry that could be replaced with acidification

techniques. This means that farmers need to be enticed to try acidification based on claims that it will increase yields enough to pay for the costs. This will be a challenge especially if introduction years offer circumstances that are not conducive to positive results from acidification.

Clearly a disadvantage of this investment is that in order for SATs to be attractive for farmers, the costs need to be low, however the cost for treatment will only start to decrease after farmers start to use it.

I.4.2: Investment costs

The investment costs for the SyreN in-field SAT through the project was € 55,000, which was about € 20,000 less expensive than current market price in Denmark. The investment cost will account for the fixed portion of the acidification price that Br. Göransson will charge farmers for the service. The investment cost of € 55,000 at 5% yearly interest depreciated over 7 years gives a yearly cost of € 9,500. Therefore, the fixed cost for farmers buying the treatment will depend on how much slurry in total Br Göransson is able to treat annually. If 20% of all the slurry they spread is acidified, which is the current level of slurry acidification in Denmark, this would be equivalent to the acidification of 18,000 m3/yr and the fixed treatment cost would be about € 0.53 per m3. If they could increase the treatment volume to 21,000 m3/yr. the cost would be € 0.45 per m3. Of course, we should point out that this does not including maintenance and repair which should also be included into the fixed costs.

Through the project, Br Göransson was able to receive 75% reimbursement for the SAT investment cost from the EU through Interreg BSR program. This decreased investment costs will help finance the cost of introduction of the technology to the Swedish market since it will take some time and effort to get interests in the treatment to the level that it currently is in Denmark. Even with this help, it is difficult to get farmers to try something that will up front cost more money. To help encourage farmers to try the technique, Göranssons is offering a "special project price" of 0.2 EUR/m3 for the fixed portion. However, for this price to cover their fixed costs, even considering the investment support, they need to treat almost 12,000 m3/yr or about 13% of the total volume of slurry they spread. This definitely won't be able to be achieved during the first year of introduction. In other words, Br. Göranssons is paying to try to introduce this technique to the Swedish market and to convince farmers that it is the best way to improve the value of their slurry. Hopefully they can get enough interest among farmers to where their investments can pay off in the long run, so the environment and the Baltic Sea will benefit from it.

I.4.3: Annual operational costs

a) Approximately 1,000 EUR/yr. for service and maintained of the in-field SAT.

b) The acid cost is considered is an annual cost and will depend on how much slurry is treated annually. Initially, Br Göransson will invest in 10 IBC tanks that will be bulk filled as needed, to keep the acid costs down.

c) Costs for labour are not expected to increase due to use of in-field SAT (with reservation)

d) Fuel costs are not expected to increase due to the use of the in-field SAT (with reservation)

The reservation is for the case when an extra tank of acid would need to be transported to a farm in order not to disrupt the slurry spreading. They have not decided on a solution for these logistical issues.

I.4.4: Annual savings and benefits, including fertiliser savings

Calculations for reductions in ammonia-N lost were based on assumed slurry application rates of 30, 25, and 30 t/ha for dairy, pig and digestate slurry respectively. Standard Swedish ammonia emission factors for bandspreading with trailing hose applicators is 30% of TN and the ammonia emission reduction factor for using in-field SAT was 50%. This would give an expected saving of 10,000 kg N per year if they spread 20% of all their slurry. The potential savings if all of their slurry was acidified would be 50,000 kg N per year.

There would also be a savings in the cost of sulphur fertiliser, which instead is provided by the acidification treatment.

If extra fertilization after slurry spreading is not commonly applied, then the increased N use efficiency and sulphur application can be counted as a yield increase, as it is usually accounted for in Denmark. If the size of the yield increase is comparable to that in Denmark, then it will on average cover the total treatment costs for farmers.

I.5.5: Time plans for tender / procurement and installation

Br. Göransson wanted to complete the tendering, procurement and installation of the investment already in the spring of 2016, so that there would be 3 growing seasons under project time to help introduce the technology to the market in Sweden. However due to difficulties with the public procurement procedures and which rules should be followed, plans for tendering and procurement of the SAT investment were delayed until the winter 2016-2017.

The tender material for the in-field SAT was sent out in December of 2016 and thereafter they decided on procuring the SyreN in-field SAT. The procurement was initiated in February and completed in March; however, it took a couple more months for the system to be delivered and installed.

I.5.6: Any deviations from initial plans

There were no real deviations from the initial plans, only delays. The first delay was the time plan for tendering, procurement and installation described above. The other delay was that it took longer time than planned to have the acid delivered. First Br Göransson contacted different companies that could deliver sulfuric acid and asked for price offers and delivery options. One of the companies, Brenntag, has a long experience of selling sulfuric acid for slurry acidification in Denmark, and they were very helpful in dealing with the specific needs of Br. Göransson. They organized a visit to Br Göranssons in Kvidinge, Sweden with several representatives from Denmark and their representative from Sweden in order to discuss their expectations and requirements in order to deliver acid and to provide support for Br Göranssons to start dealing with such large quantities of acid. This went on during the spring spreading season so essentially, they missed the opportunity for demonstrations here.

Interreg Baltic Sea Region

Baltic Slurry Acidification

EUROPEAN REGIONAL DEVELOPMENT FUND

EUROPEAN UNION

www.balticslurry.eu

Summary of the project

'Baltic Slurry Acidification' is an agro-environmental project, co-financed by Interreg Baltic Sea Region under the priority area 'Natural resources' and the specific objective 'Clear waters'. The aim of the project is to reduce nitrogen losses from livestock production by promoting the use of slurry acidification techniques in the Baltic Sea Region and thus to mitigate eutrophication of the waters, including airborne eutrophication.

Summary of the report

This feasibility study report describes the background, conditions, planning issues and expected environmental and economic impacts of seven pilot installations of slurry acidification technology equipment in Estonia, Latvia, Lithuania, Poland, Germany and Sweden.

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