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Evaluation and assessment of sedimentation and separation efficiency

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1. Background and objectives

In the LCASP project there is several demonstration packages whereas utilization of manure separators for waste treatment is one very important task to improve manure management and reduce overloading of biogas digesters. Manure separators are a well known technology to separate part of the dry-matter and nutrient from liquid animal manure slurry. There are different systems for separating slurry into a nutrient and dry-matter rich fraction and a liquid fraction; for instance, mechanical screen separators, screw presses, sedimentation, centrifugation and reverse osmosis. In the LCASP project mechanical screw press separators from the Austrian Company Bauer and from Italian company Cri-man have been selected. Screen separators are in general very reliable and cost efficient equipment but the efficiency is only high when treating slurry with a dry-matter at 6% or above, usually up to 35% of the initial dry-matter of slurry can be separated to a solid fraction with a dry-matter content about 30%. This document is prepared as an initial description and proposal of methodology for evaluation of separation efficiency both technically and economically.

2. Methodology

2.1 Overall methodology

The used separators are Bauer or Cri-man screw press used on liquid manure after an initial sedimentation. The reason implementing an initial sedimentation step is to increase the dry-matter concentration in the liquid manure to a suitable level where the separator works optimal. The dry-matter concentration in liquid manure in Vietnamese pig production is very low, often less than 1% due to high use of water for washing and cooling the pigs. This very dilute manure will not give an optimal separation with a screw press where more than 6% is desirable. For this reason an initial sedimentation tank is installed. By natural sedimentation, the fact that the particles and liquid in the liquid slurry have different densities is exploited and require low throughput. Low throughput sedimentation tanks collects the precipitate, which has consistency as a viscous slurry.

2.2 Sedimentation

Sedimentation (gravity settling) is one of the many solid-liquid separation techniques, which have been used to remove solids from dilute swine manure (Ndegwa et al., 2001). Suspended solids with densities greater than that of the water in which they are suspended tend to settle under the influence of gravity. Large or coarse solids settle much faster than fine suspended solids that contain most of the P. In contrast, fine suspended solids contained in liquid swine manure take much longer to settle by natural sedimentation. In fig 1 the different categories of particles in liquid animal manure is illustrated. The drymatter (TS) can be divided between the dissolved solids (TDS) and suspended solids (SS). Only the suspended solids can be settled.

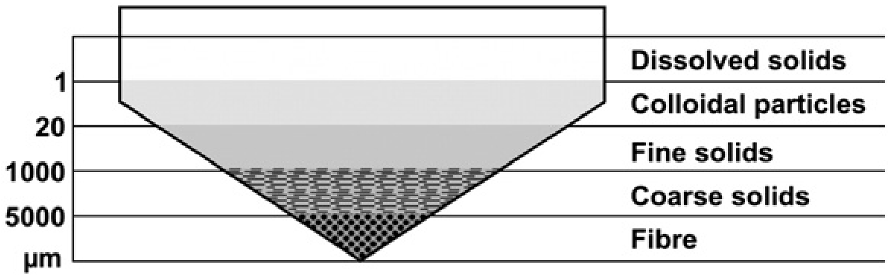

Figure 1. The division of the solid matter of animal manure into fractions.

The settling time of particles depends on different factors and it seems that the dry-matter concentration of the manure is the most important factor. The effects of solids concentration on the natural sedimentation are presented in Fig. 2. In general, the sedimentation process seems to have been complete during the first hour of retention time and only a marginal improvement was achieved with a retention time of 4 h. The effective SS removals were approximately 8, 39, 62, 66, and 37% for manure solids levels of 6.0, 4.0, 2.0, 1.0, and 0.5%, respectively. These data suggest that both too high and too low levels of solid content in the manure result in a reduced removal of SS by sedimentation. In this study, 1.0 and 2.0% solids levels gave a much better SS removal after 4 h. The general trend of these results compared well with the trend of the results of a similar study by Moore et al. (1975). Their sedimentation study with swine manure (although conducted for a longer duration) simulated at 0.01, 0.1, and 1.0%, showed that solids removal after 1,000 min were 59, 68, and 70%, respectively, i.e., the separation efficiency decreased with decreasing solids levels below 1.0%. Martinez et al. (1995) also reported somewhat similar results. In their studies, dilute slurries with less than 25 kg/m3 (2.5%) TS were found to be most effective for natural sedimentation, while solids with more than 40 kg/m3 (4.0%) TS did not separate effectively.

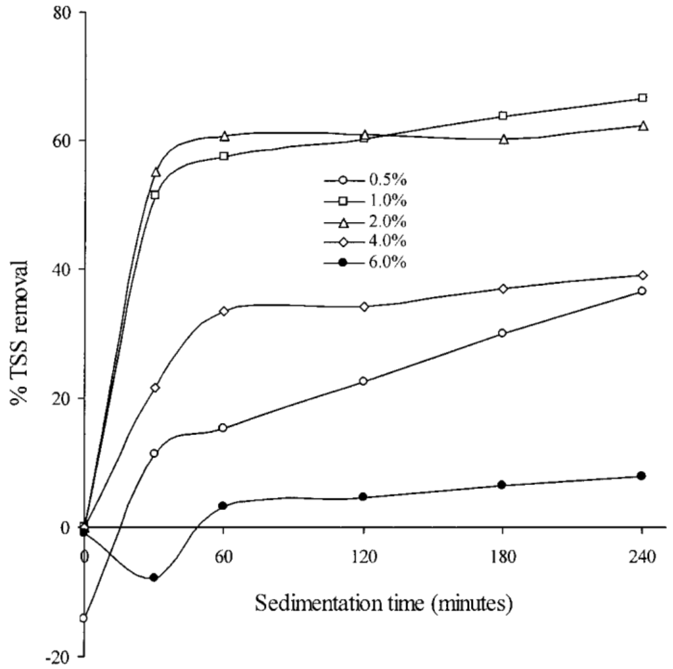

Figure 2. Effects of Solids Concentration on Natural Sedimentation of Swine Manure (Ndegwa et al- 2001)

In another study by Zhu et al. 2004 made an experiment with liquid pig manure with 1,9% TS and the sedimentation as a function of time is illustrated in figure 3.

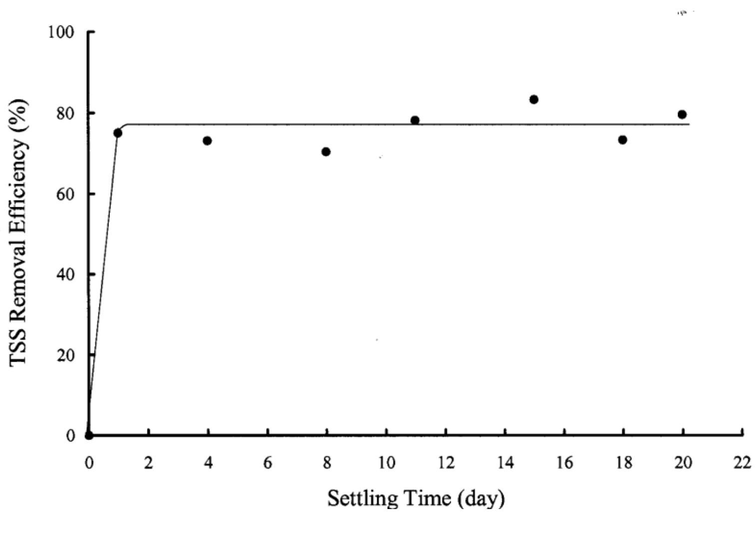

Figure 3. The effect of preliminary settling time on TSS removal efficiency.

From the different studies it seems that the optimal drymatter (TS) concentration in the liquid manure before separation is around 2% and that the sedimentaion is quite fast at this drymatter. Less than 24 hours seems sufficient and some studies shows that sedimentation of most of the TS takes place within 2-4 hours.

2.3.4 Design of sedimentation tanks

Sedimentation tanks may function either intermittently or continuously. The intermittent tanks also called quiescent type tanks are those which store water for a certain period and keep it in complete rest. In a continuous flow type tank, the flow velocity is only reduced and the water is not brought to complete rest as is done in an intermittent type.

Sedimentation tanks may be either long rectangular or circular in plan. Long narrow rectangular tanks with horizontal flow are generally preferred to the circular tanks with radial or spiral flow. Long rectangular basins are hydraulically more stable, and flow control for large volumes is easier with this configuration. A typical long rectangular tank have length ranging from 2 to 4 times their width. A long rectangular settling tank can be divided into four different functional zones:
Inlet zone: Region in which the flow is uniformly distributed over the cross section such that the flow through settling zone follows horizontal path.
Settling zone: Settling occurs.
Outlet zone: Clarified effluent is collected
Sludge zone: For collection of sludge below settling zone.

There is several parameters to consider for optimal sedimentation below some of the most important is listed

1. Detention period: for plain sedimentation: 3 to 4 h,
2. Velocity of flow: Not greater than 30 cm/min (horizontal flow).
3. Tank dimensions: L:W = 3 to 5:1.
4. Depth 2.5 to 5.0 m (3 m).
5. Surface Overflow Rate: For plain sedimentation 12000 to 18000 L/d/m2 tank area;
6. Slopes: Rectangular 1% towards inlet is preferred

Furthermore devices for retaining parameters like perforated tubes where the slurry has to penetrate before flowing out could be a good option.

In Ben Tre, Bac Giang, Phu Tho provinces information on the design of sedimentation tanks has been collected. In Ben Tre a standard design of sedimentation tanks has been used at all farms consisting of two tanks where the fist tank is a small pre-sedimentation (1mx1mx0,9m) and main sedimentation tank (3mx3mx2,7m) with 24,3 m3 of volume. In two of the visited farms a daily amount of around 25 and 45 m3/day was loaded to the sedimentation tank giving a detention period of 1-1,9 days. This means a very high dedention period which is longer than recommended. Therefore it seems that the tanks are two big for the given number of animals and the pre-sedimantion tanks seems not necessary. Ideally the tank should also have been longer and narrower.In Bac Giang the visited farm had 1 rectangular sedimentation tank with two chambers in total 6 m long, 2,5 m broad and 3,5 m deep. Only the first tank is for sedimentation and separation of solid manure giving a tank with the dimensions 3mx2,5mx2,7m equal to 20,25 m3. The calculated amount of manure for the farm is 43 m3/day giving 11,1 hour detention period which is in the higher end of what is recommended but still at a reasonable level. In Phu Tho the standard design of sedimentation tanks are 3mx3mx3m.

2.4 Separation

2.4.1 Cri-man separator

The selected Cri-man separator is a 260/50Mini with a capacity of 5-8 m3/hour with a 0,5 mm screen size. The engine max. capacity is 3 Kw but during visit it seemed that only 50% of the capacity of engine was used meaning an energy consumption of 1,5 kwh/h corresponding to 0,2 kwh/ton treated with a treatment capacity of 7 m3/hour. By assuming 1,5 kw for pump and mixing in average this will result in a total consumption of 0,4 kwh/tons material treated.

Picture. Cri-man separator and sedimentation tank in Ben Tre province.

2.4.1 Bauer separator

The selected Bauer separator is a Bauer compact with a capacity up to 15 m3/hour with a 0,5 mm screen size. The engine max. capacity is 3 Kw. With a capacity of 10 m3/hour and 70% load of the engine it means 0,21 kwh/tons of material treated. Besides the separator need a pump to feed the separator and a mixer is running during the first 15 minutes. By assuming 1,5 kw for pump and mixing in average this will result in an estimated total consumption of 0,46 kwh/tons material treated.

Picture. Bauer separator and sedimentation tank in Bac Giang province

2.4 Separation efficiency

The separation efficiency of elements like dry-matter can be expressed in term of percentage of constituents removed from manure. The equation [1] allows determining this efficiency when the concentrations of the analyzed constituent are known. The easiest component to measure is the dry-matter and hence focus in initial phase will be on that parameter:

$$Eff(\%) = \frac{W_{solid} \times C_{solid}}{W_{manure} \times C_{manure}} \times 100 \qquad [1]$$

Eff.: Separation efficiency (%)

W_{solid}: Weight of separated solid phase (kg)

Csolid: Concentration of component in fraction, dry-matter concentration in %

Wmanure: Liquid slurry weight (kg)

Cmanure: Concentration of component in liquid slurry, dry-matter concentration in %

When the separation is done in two step with an initial sedimentation followed by a screw press there will be two separation efficiency to deal with. Because of this the overall separation have to be optimized by having optimal separation in both step and a very high sedimentation efficiency is needed to have a good separation.

The maximum efficiency for dry-matter by sedimentation will in general be around 80%. Only the particulate matter in the form of suspended solids can sediment while the dissolved solids will not be able to sediment and since at least 15% of the dry-matter in liquid slurry is dissolved solids it will not be possible to exceed 85%. However, in practice sedimentation of less than 80% of the dry-matter is considered as more realistic. The separation of dry-matter with a screw press depends on several parameters like the screen size, pressure induced etc. In literature a separation efficiency of more than 35% is not found as realistic.
The amount of solid fraction produced by separation depends besides the separation efficiency on the dry-matter concentration in the solid fraction. In most studies the concentration of dry-matter is at around 30%.

2.3 Economical efficiency

The economical efficiency of a separation can be calculated as the yearly income subtracted all costs and expenses. The income from separation is the selling value of the organic fertilizer either directly or after a composting process. The cost of separation can be divided in fixed costs (FC) and variable costs (VC). Fixed costs are independent of how much the equipment is used. Fixed costs include depreciation (D) and interest on construction and machinery investment. Depreciation measures the amount by which the value of a machine/plant decreases with the passage of time whether used or not. The value declination of machinery/plant with the passage of time is the depreciation cost

Operating cost of a separator is reflected by the cost of daily labor, repair & maintenance, lubrication and electricity consumption.

a) Labour cost per yr, LC = No. of labour x Rate of labour (VND/hr) x Labour used (hr/yr)

b) Repair and maintenance cost per year, R&M = Annual repair & maintenance cost (VND)

c) Lubricant cost (VND/yr)

d) Electricity (VND/yr)

Total variable cost (VND/yr) VC = (a + b + c+d)

Total Operating Cost (VND/Yr) = Annual Fixed Cost + Total Variable Cost
i.e, OC = FC + VC

Annual cash flow/Net cash flow refers that the difference between annual revenue (REV) and annual operating cost (OC) of the biogas plant.
NCF (VND/yr) = REV- OC

The only revenue for the farmer is the selling of the organic fertilizer meaning that the selling price and the amount of the solids produced is the most important parameters.

3. Calculations and results

The overall success criteria for the separation is that as much solid material as possible is produced at the lowest possible costs.

3.1 Sedimentation and separation efficiency

3.1.1 Production of solid fraction

The aim of the separation is to produce as much solid fraction as possible. The amount of solid fraction that can be produced depends on two factors: 1) the overall efficiency of sedimentation and separation (SEP) 2) the amount of dry-matter being produced in the farm, 3) Dry-matter concentration in the solid fraction.
The SEP efficiency depends on several factors and is depending on both sedimentation and separation. The sedimentation efficiency depends on how efficient the particles are retained in the sediment tank while the separation efficiency depends on the dry-matter concentration obtained in the sediment tank, which preferably should exceed 6%.

The amount of dry-matter being produced at the farm depend on the number animals, the size of the animals, the animal category and the amount and type of feed being used. However for initial assessments it is recommended to only consider the amount of animals and average weight where the fattening pigs are the most abundant category often with an average weight around 50 kg. In general an amount of feces and urine around 2,5 kg per animal (50 kg average weight) per day with an average dry-matter content of 10% is regarded as representative for Vietnamese conditions. If the average weight is higher than 50 kg the amount of dry-matter excreted from the pigs will increase and it is suggested to use a factor of 10% increase for each 10 kg higher weight than 50 kg, but this should be further elaborated. For sows it is suggested to use 50% higher dry-matter excretion than for fattening pigs but this value should also be confirmed by literature review.
To be able to compare the efficiency between the farm is suggested to introduce the term fattening pig equivalent (FPE) where one FPE corresponds to 1 fattening pig with an average weight of 50 kg, and for each 1 kg higher average weight one fattening pigs count 1% extra and one sow is equal to 1,5 FPE.
The following formula can be used:

$$Amount\ of\ FPE = N_{FP} * (1 + \frac{1{,}01*(AWeight-50)}{AWeight})) + N_{sows} * 1{,}5$$

Where N_{FP} is the number of fattening pigs AWeight is the average weight of fattening pigs and N_{sows} is the amount of sows. The minimum AWeight value that can be used in the is 40 kg and if weight is lower than 40 kg should be inserted in the formula.
The SEP efficiency can differ and overall efficiency of separation of 30% is regarded as achievable by having 85% efficiency of sedimentation and a 35% efficiency of separator but if sedimentation

and separation are optimized 40% might be achieved. However if sedimentation and separation is not optimal and done with long intervals lower efficiency will be obtained (20% or less).

The amount of solid that can be obtained also depends on the dry-matter concentration in the solid fraction. The higher dry-matter concentration the lower the amount of solid fraction will be. In general a high dry-matter concentration is desirable but since more water is squeezed out of the fibers but the amount will be lower when the dry-matter concentration is high. In general a dry-matter concentration around 30% is expected and will be used in calculations when there is no measured data available.
In figure 4 the amount of solids produced is calculated as a function of FPE and with different assumptions of overall dry-matter separation efficiency. The overall technical success criteria would be an amount of solid equal or higher to the 30% total separation efficiency.
In Bac Giang province data has been collected at two farms and the points for the farms are included in the graph. For the two farms the amount of solid fraction is at the 30% breakeven line for one farm and for the other well above the line indicating that the separation from a technical point of view have an very efficient separation.

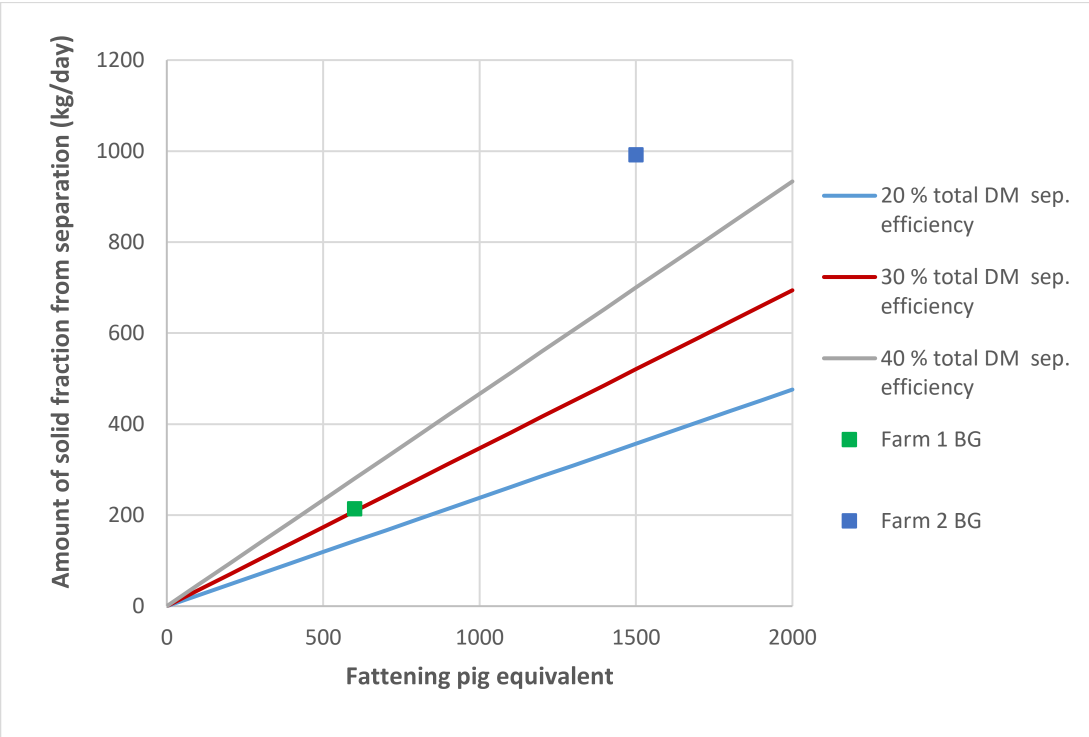

Figure 4. Calculation of theoretical amount with different assumptions if overall separation efficiency. Actually observed amount of solids produced in two farms in BG province is included.

To calculate the amount of solid fraction produced by different assumptions a spread sheet model has been developed and the outline is shown in appendix.

3.1.2 Sedimentation tanks

The sedimentation process is essential to achieve a good separation since dry-matter flushed out of the sedimentation or particles converted from suspended solids to dissolved solids due to long detention time can't be subject for separation. The dry-matter concentration in the liquid manure entering the sedimentation tank can both be too low and too high for efficient sedimentation. The optimal dry-matter concentration is between 1 and 2%. In Vietnamese pig production a high amount of water is used and around 40-50 liter per pig is often used resulting in dry-matter concentrations that is not ideal for sedimentation. In figure 5 the influence of the amount of washing water on the dry-matter concentration is illustrated and it can be seen that the optimal amount of water for good sedimentation is 15-30 liter/head/day which is significant lower than what most farmers use. Farmers should therefore be encouraged to use maximum 30 liter/head/day.

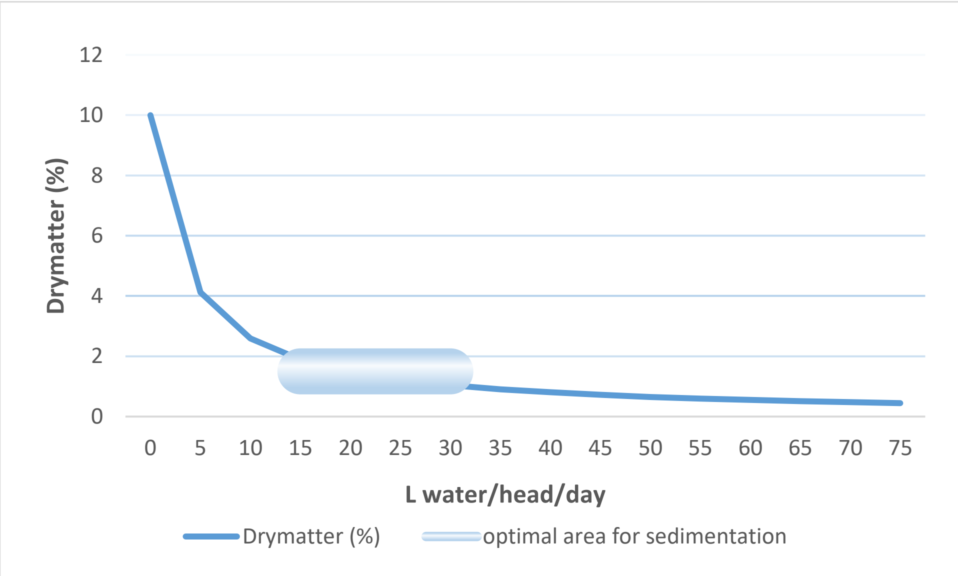

Figure 5. Dry-matter concentrations in pig manure and the influence of the water use. The area for optimal separation is indicated in the shaded area between 15 and 30 liter of water per head per day.

The average detention time in sediment tank is the theoretical (calculated) time required for a given amount of water or wastewater to pass through a tank at a given rate of flow. The detention time in hour is calculated by dividing the tank volume in m^3 with the average amount of wastewater entering the sedimentation tank in m^3/hour. It is recommended that this value should be around 3-4 hours.

The actual detention time in the sedimentation tanks in farms visited in the different provinces is shown in figure 6. It can be seen that the detention time in general is much higher than the recommended meaning that it will take too long time for the sediment to build up and the particles will stay too long in the tank and start to degrade before the dry-matter concentration reach a level where separation is optimal (around 6% dry-matter). This is especially a problem in the provinces in south where temperature is high and the degradation of particles will take place much faster than in colder regions.

In general the sedimentation tanks are build too large and it is recommended to make the sedimentation tanks smaller and make the sizes so they comply with the actual amount of animals instead of making the same sizes of sedimentation tanks for all sizes of farms.

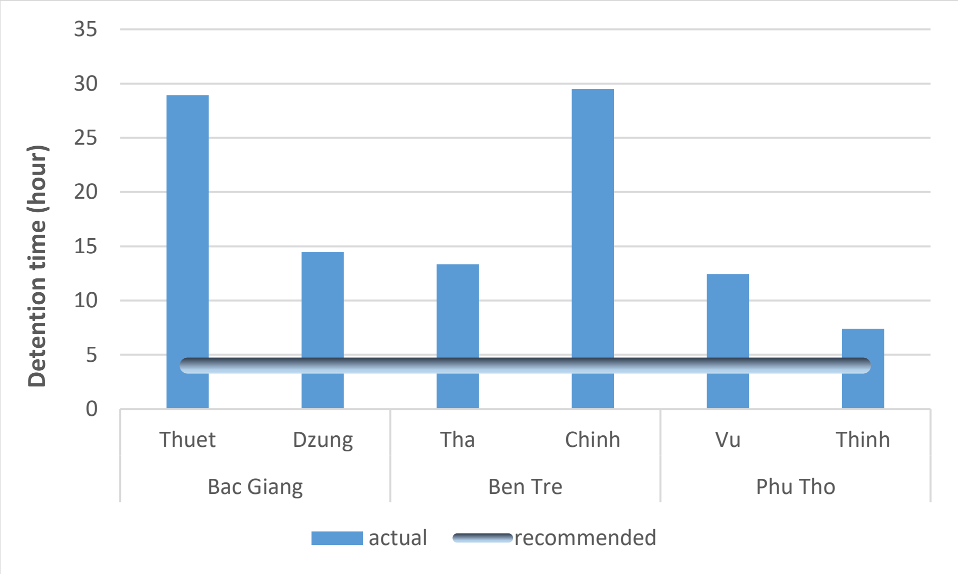

Figure 6. Detention time at the different farms

In figure 7 the average detention time as a function of the amount of pigs is illustrated and it can be seen that the present size of sedimentation tanks is only well dimensioned for farms with 2500 fattening pigs and most farms has less pigs than this.

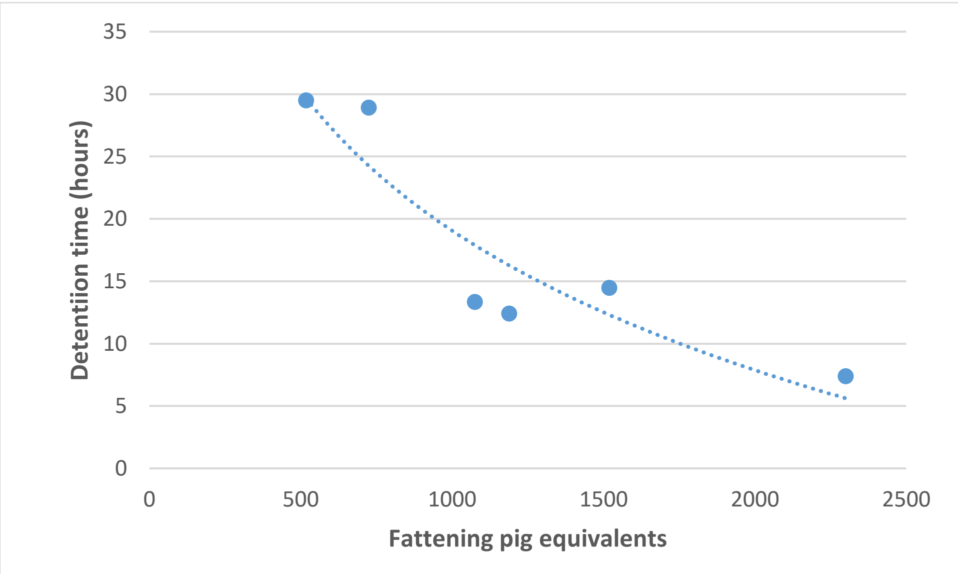

Figure 7. Detention time at the different farms as a function of fattening pigs.

The form of the sedimentation tanks are also very important. The forms of sedimentation tanks today are made with almost the same length and width (design 1 in figure 8) which is not optimal for efficient sedimentation where it is recommended that the sedimentation tanks are 3 to 5 times longer than they are broad as illustrated in design 2.

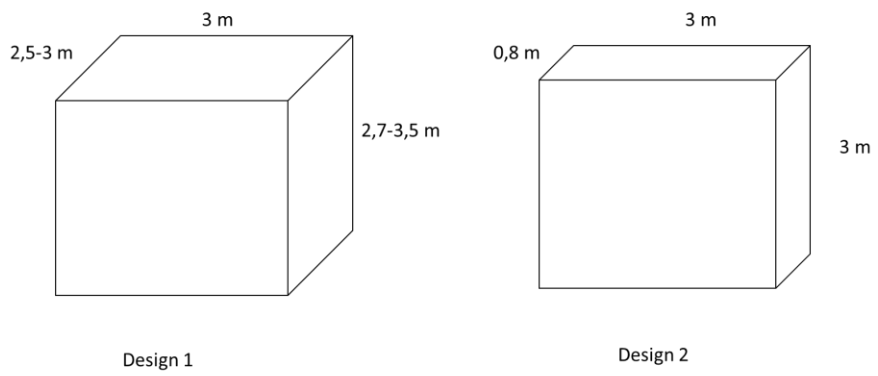

Figure 8. Dimensions of sedimentation tanks. Design 1 are the present design used in most provinces whereas design 2 is optimized design for an animal size of 1000 fattening pigs (50 kg average weight)

The general picture is that the sedimentation tanks are build too big for the amount of pigs unless the farms has 2500 fattening pig equivalents and that the dimensions are not ideal. It is recommended that the sizes should be reduced to fit the actual size of farms and that the design should be changed so that they are 3-4 times longer than they are broad.

3.3 Economical evaluation

3.3.1 Electric consumption and operational costs

The electric consumption will depend on the amount of animals and how often the separator will run. The necessary time for running the separator will depend on how well the sedimentation takes place and the dry-matter concentration that can be obtained in the sedimentation tank. In figure 9 the daily electric consumption and the time the separator need to run in average per day. It can be seen that with 1000 fattening pigs the separator needs to run 0,7 to 1,25 hours per day with respectively 6% and 3% drymatter in sediment and the capacity of the separator is therefore much higher than needed even with 2000 fattening pigs.

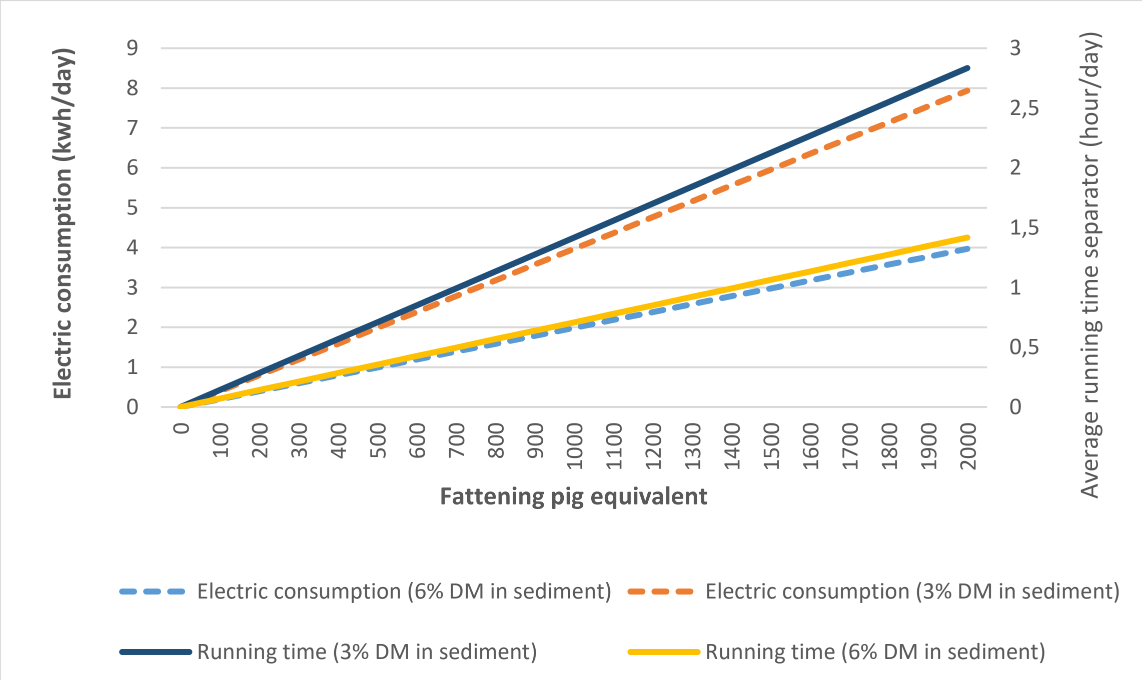

Figure 9. Electric consumption and average time needed for running the separator with different dry-matter concentrations obtained in sedimentation tank. 85% of dry-matter is assumed to be in sediment and the capacity of the separator is set to 7 m3/hour (Cri-man) and 0,46 kwh/tons material separated.

Since the produced organic fertilizer is the only income from the separation process the electric consumption should be related to this fraction. In figure 10 the electric consumption per tons of solid fraction produced is illustrated. With an efficient sedimentation process the average electric consumption will be around 6 kwh/tons corresponding to ca. 9.600 VND/tons solid produced (1.600 VND/kwh). However If sedimentation is poor the electricity cost will be the double.

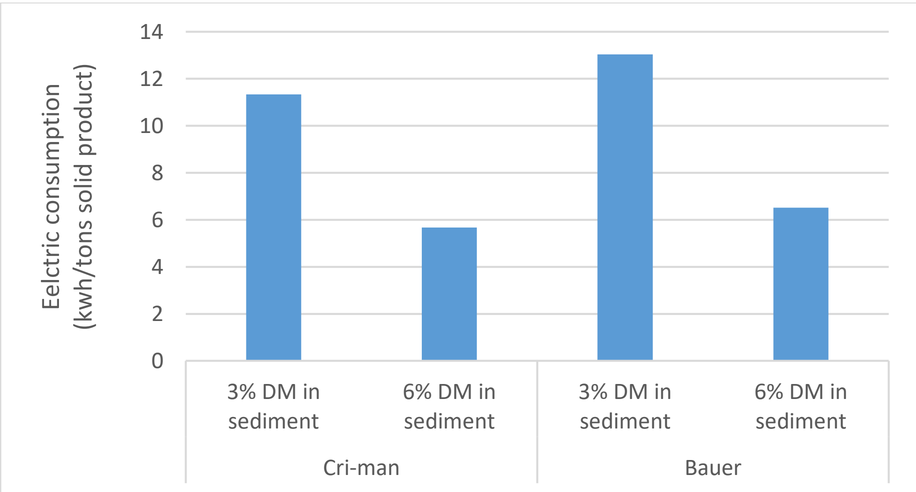

Figure 10. Electric consumption for producing in tons of solid material with different dry-matter concentrations in sediment assuming 70% load of engines max. capacity, including pump and mixers**.**

3.3.2 Sales value of organic fertilizer

The value of the solid fraction is the only income from the separation and thus is a very important parameter.
The value seems to differ significant among provinces with the highest values being in the provinces in the South. In Bac Giang province the visited farmer could sell the solid fraction in 37 kg bags for around 1000 VND/kg, while in Ben Tre province the selling price for the solid fraction is 2-3000 VND/kg with an average 2500 VND/kg.

3.3.3 Investment

The investment in the separation system includes besides the separator a sedimentation tank, house for separator, mixer and pump. In the table below estimated investments are given.

Table 1. Investment for installation of separation technology

	Unit	Units	Unit price	Total mill. VND
Sedimentation tank	mill. VND/m3	25	0,8	20
House for installation	VND/m2	30	1	30
Separator and installations	VND	1	520	520
Total Investment				**570**

In the LCASP project the farmers are not paying for the separators, but to evaluate viability of the investment it is recommended that the economical evaluation is including the total investment though this in not the case in the project period.
The capital cost for a given investment depends on the interest rate and the expected period the equipment will last (depreciation period). I the table below the yearly capital costs are calculated with assumptions of 10 years depreciation and 4% interest rate (Table 2).

Table 2. Capital costs for separation

Investment	570	mill VND
Interest	4%	
Depreciation period	10	Year
Yearly capital costs	70	Mill. VND

3.3.4 Overall assessment

In table 3 the income, costs and revenue is calculated with the assumptions of an efficient separation and a selling price of 1500 VND/kg for the solid fraction. In the calculation the labor cost are not included since there is little knowledge on how much time is needed. The calculations indicate that if a reasonable economic surplus should obtained at least 750 fattening pigs are needed. For farms with more than 1500 fattening pigs the technology seems like a very good business case if the solid fraction is sold.

Table 3. Income and costs for a farm with 250-1500 fattening pig and a selling price for the solid fraction of 1500 VND/kg.

FPE	250	500	750	1000	1500	
Income	47	95	142	190	285	mill VND/year
Capital costs	70	70	70	70	70	mill VND/year
Electricity costs	0,3	0,6	0,9	1,2	1,8	mill VND/year
Repair	2,5	5,0	7,5	10,0	15,0	mill VND/year
Total revenue excl. Labour costs	-25	19	64	108	198	mill VND/year

3.4 Case studies

3.4.1 Bac Giang province

In Bac Giang province data has been collected from two farms where amounts of solid fractions has been registered. The data and the calculations for the farms are listed in table 4.

Table 4. Calculation of theoretical and actually observed amount of produced solids in two farms. The assumption are 80% sedimentation efficiency, 35% separation efficiency and 30% drymatter concentration in solid fraction. The value for maximal separation is theoretical if 100% of drymatter ends up in solid fraction

Parameter	Unit	Farm 1 (Nguyen The Thuyet)	Farm 2 (Pham Van Dung)		
Animal category		Fattening pigs	Fattening pigs		**Total**
Amount of pigs		**600**	500	500	**1000**
Average weight	kg	**85**	90	120	**105**
Fattening pigs equivalent		**600**	724	795	**1519,**
Manure	kg ab animal/day	**3,5**	3,5	3,5	**3,5**
Manure	DM (%) ab animal	**10**	10	10	**10**
Drymatter	kg DM/day	**210**	254	278	**531**
Washing water	kg/day	**24000**	20000	20000	**40000**
Total slurry	kg/day	**26100**	21750	21750	**43500**
Drymatter in slurry	%	**0,80**	1,2	1,3	**1,81**
Solid fraction					
Calculated	kg/day	**208**			**527**
Produced	kg/day	**214 (average 7 days)**			**992 (average 9 days)**

In the table it can be seen that the actual amount of solid fraction produced during first test period is higher than the theoretical calcualted with the assumptions used. In farm 2 almost double amount is produced compared to the expected while for the first farm the calculated and measured amount is almost the same. However the data survey need to take place over longer time and with precise data collection to have a clear picture of the long term efficiency.

4. Recommendations

In the LCSAP project a large number of separators has been installed and more will be installed in the coming period. This offers an unique possibility to collect data from a large number of installations with many varying parameters like number and type of animals, amount of washing water, size and proportion of sedimentation tank, detention in sedimentation tank etc. To be able to make statistics and evaluate which parameters determines the efficiency of separators data it is recommended to collect data for all separator and a survey and test report should be developed for all installations. The test should be done for a period of at least one month and the separator should run 2 times per week. Each time the separator is running the sedimentation tanks need to be emptied for sediment as well as possible, i.e. until the pump can not pump any more material. During the test period the table in appendix should be filled in every day the separator is running.

In general it seems that the dimensions of the sedimentation tanks are too big and they don't have the ideal proportions between length and width. If possible some of the sedimentation tanks that have not yet been installed should be constructed in the recommended size and proportions and in general the sedimentation tanks should be designed so that they fit the actual animal population on the farm instead of using standard design.

In cases where sedimentation tanks are too big in relation to the amount of animals on the farm, addition of organic bulk material could be an option to increase the amount of solid fraction produced and making a suitable dry-matter concentration for separation in the sedimentation tanks (>6%) by adding bulk material so that separation can be done with frequent intervals (2 times or more per week). The bulk material could be fibrous material in the form of straw, ricehusk, sawdust, residues form coconuts or similar which could be added to the tank some hours before separation.

For all farms there should be initiatives to reduce the water consumption to maximum 30 liter per pig per day to reach the ideal dry-matter concentrations for separation.

Literature

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Appendix

Model for calculation of separation efficiency

Yellow cells:	Input values
Orange cells:	default values, can be changed if more precise figures are available
Grey cells	Calculated values, can't be changed

Livestock production

		Category 1	Category 2	Category 3	All	Note
Animal category		Fattening pigs	Fattening pigs	Sows	Total	
Amount		1000	0		1000	
Average weight	kg	50	120		85	
FPE		1000	0	0,000	1000	
Manure ab animal	kg/day	3,5	3,5	3,5	3,5	1
Manure ab animal	DM (%)	10	10	10	10	2
Drymatter	kg DM/day	350	0	0	350	
Washing water	kg/day	40	40	40	40	3
Total slurry	kg/day	43500	0	0	43500	
Drymatter in slurry	%	0,8	#DIV/0!	#DIV/0!	0,8	

[1] Default values for fattening pigs are 3,5 kg/day and for sows 4,5 kg/day

[2] Default values are 10% DM

[3] Default values are 40 liter/pig day

Sedimentation and separation

Sedimentation tank

			Note
Form		rectangular	4
length	meter	3	
Width	meter	0,8	
Depth	meter	3	
Volume	m3	7,2	
Load	m3/day	43,5	
Surface loading	m3/m2/day	3	5
Dedention time	hours	4,0	6

[4] If tank is not rectangular calculate volume and insert under volume

[5] Recommended value is <40

[6] Recommended value is 3-4 hours

		default value	Note
Drymatter in sediment tank	%	6	
Drymatter in solid fractio	%	30	
Separation efficiency sedimentation	%	85	
Separation efficiency screw press	%	35	
Total separation efficiency of drymatter	%	30	
Amount of solid produced	kg/day	200	

Results

			Note
Amount of solid fraction expected	kg/day	347,08	
Amount of solid fraction measured	kg/day	200,00	
Separation efficiency	% of theoretical	57,62	