Solid fraction treatment for cattle bedding production

Introduction

Beef production is the second livestock type most produced in Osona (Catalonia, Spain) after the pig production. Mecaniques Segalés has been specialized in slurry treatments from livestock. A research study has been carried out by this company in order to protect environment and to save costs in cattle manure handling. Its aim is to get profit from the manure produced in an intensive farm.

The aim of the research is to transform the cattle manure mixed with water into a clean, dry, comfortable bedding in which to lie down. Farmer not only cuts costs in preparing the bedding also all manure produced is recycled into bedding. On this way, farmers will know perfectly its bedding quality as would be produced by himself. To make this possible, control of humidity and bacteria population is required.

This research allowed us to value best way to sanitize solid fraction manure from cattle in order to produce bedding for cattle. First step is to remove as much water content inside the manure by a screw press. Solid fraction obtained is treated by a natural aerobic-thermophilic process, in order to obtain as much low pathogen concentration inside bedding.

Result has demonstrated sanitation of solid fraction is possible by low energy consumption; about a 99% of reduction is possible.

AIM

The aim of the present research is to know the best way of management for bedding production from the separated solid fraction. Other aims subjected into this study:

- Empirical demonstration that initial entrance to a sanitize process is optimal.

- To make sure the required energy of the process is affordable.

- To evaluate the differences obtained between the two different piles based on this experimental research.

- Identify what can be improved from the process.

MATERIALS AND METHODS

Initial separation

The manure first is separated by the screw press from Mecaniques Segalés. The manure is introduced into the screw press by a pipe. It is pressed by a screw conveyor inside and all liquid fraction goes outside through the sieve and collected by a pipe; solid fraction remains pressed inside the screw press and goes out through the front part of the screw press. So, two different fractions are obtained from: liquid fraction to be used as fertilizer and solid fraction to be subject of study in this experimental research.

Stockyard preparation

Solid fraction is amounted into two different stockyards. An on-floor aeration pipes connected with the fan and laid down on the stockyard. Three lines of pipes connected as shown into **figure 1**.

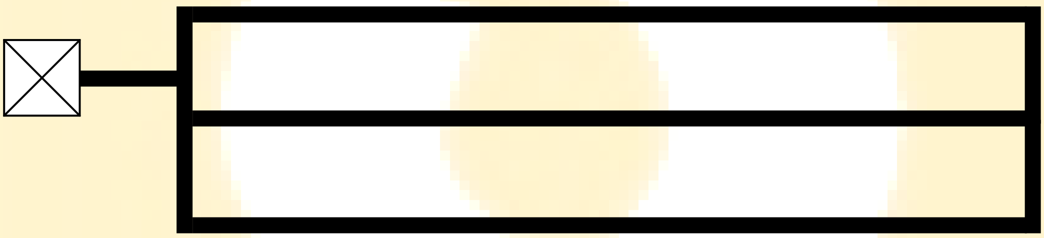


Figure 1: On-floor aeration pipes structure settled under the stockyard of manure.

Holed pipes make and optimal spreading of the air. Two manometers installed into the most distant and closest to the pump in order to check any loss of air pressure along the system.

Aeration pipes need to be running at the same moment the stockyard is being laid on its surface in order to prevent its obstruction. Furthermore, solid fraction was applied at a prudence height to prevent its compaction. The aim is to get as spongier as possible solid fraction in order to increase as much space contact for the air inlet.

The study was carried out by two different tests: **stockyard 1** was only solid fraction material. And **stockyard 2**, four shovels of wood ships were added and proportionally well mixed with the solid fraction.

Stockyard 1 and 2 were piled on the floor aeration pipes separately.

Thermal monitoring and tracking

Tests have been standardized for both stockyards. To check the temperature, a 1 meter long digital thermometer brand Hanna was used, easier to read the temperature from the inside of the pile. A daily test of temperature was done during the study, every same time in the evening and same place (in the shade, please see **figure 2**) during May month.

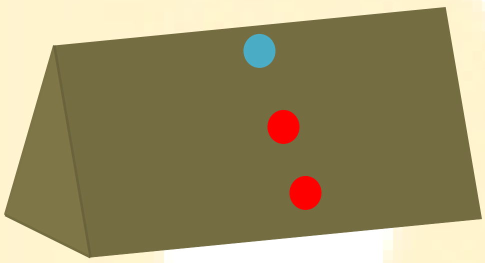


Figure 2: Here is shown 3 different points of the temperature test. Blue colour: two tests done every day (one test 0cm and another test at 50cm depth). Red colour: tests done at 0cm, 50cm and 100cm depth.

Maintenance

Depending on the temperature from the stockyard, air inlet has been adjusted accordingly to the bacterium type alive per each stage. An electronic system has been used to regulate the air inlet.

Laboratory tests

Some of samples were analyzed into an independent laboratory. On **table 1** are shown the results per each parameter analyzed from the initial process, from the stockyard once sanitized and from the final process.

sample	Initial	Sanitized	Final
Analisation			
Total soil			
Volatile soil			
Total Nitrogen			
Nitrogen NH4			
Total coliforms			
Fecal coliform			
Enterobacter			
Clostridium			
Staphylococcus			
Salmonella			

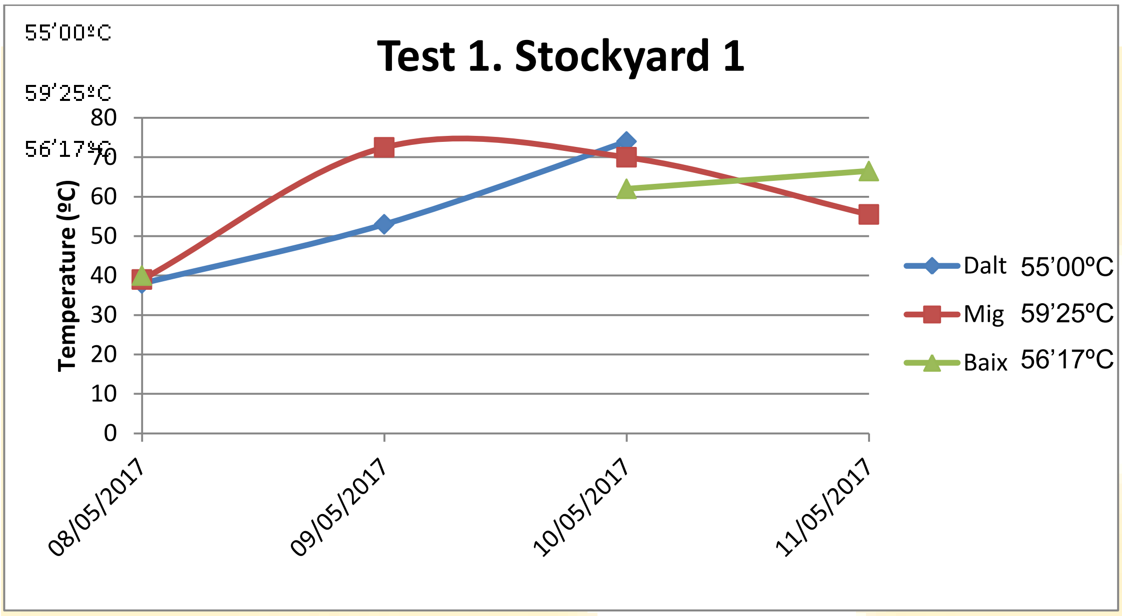
Table 1: Physical-Chemical properties of 3 samples from the stockyard. Ones ample from the initial process, from the stockyard once sanitized and from the final process. Into green colour analysis obtained and red colour not obtained.

The method to obtain all samples was always the same. Samples was taken by a spade from different points from the stockyard (external, internal, more and less depth, one side and opposite side). Eight spades was taken finally and put all them into each plastic bag and mixed from the outside. Each bag was introduced into a container and moved to the laboratory for its study.

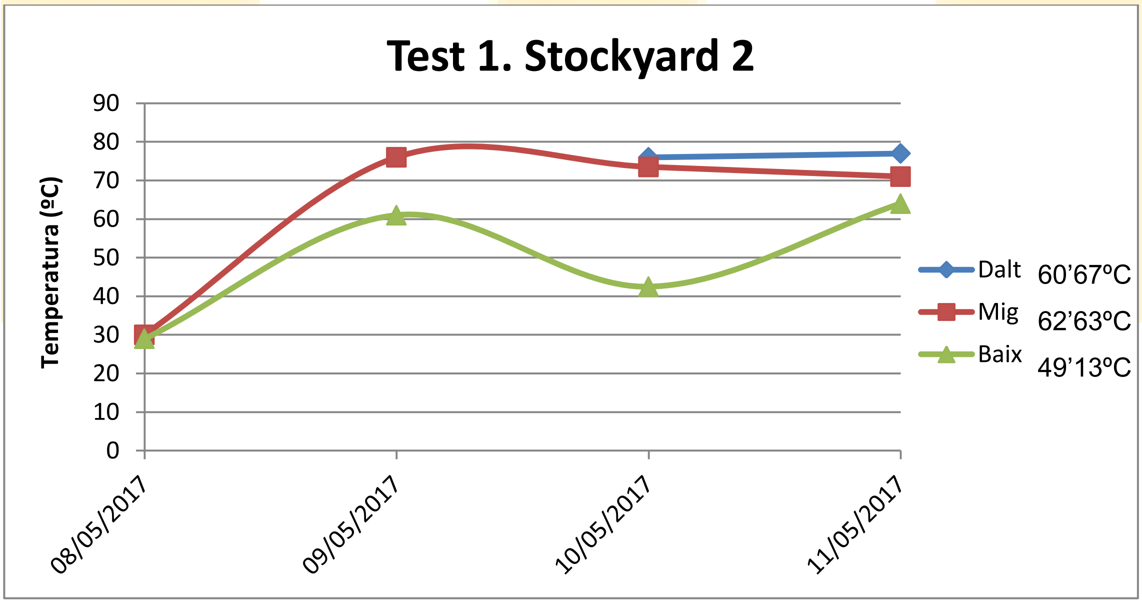
Results

Temperature curve from the stockyard

The temperature curve from each stockyard 1 and 2 are represented in graphic 1 and 2. Each line represents one of the three points tested from the stockyard. An average from the temperatures tested was done. Except those cases there was only one test done.

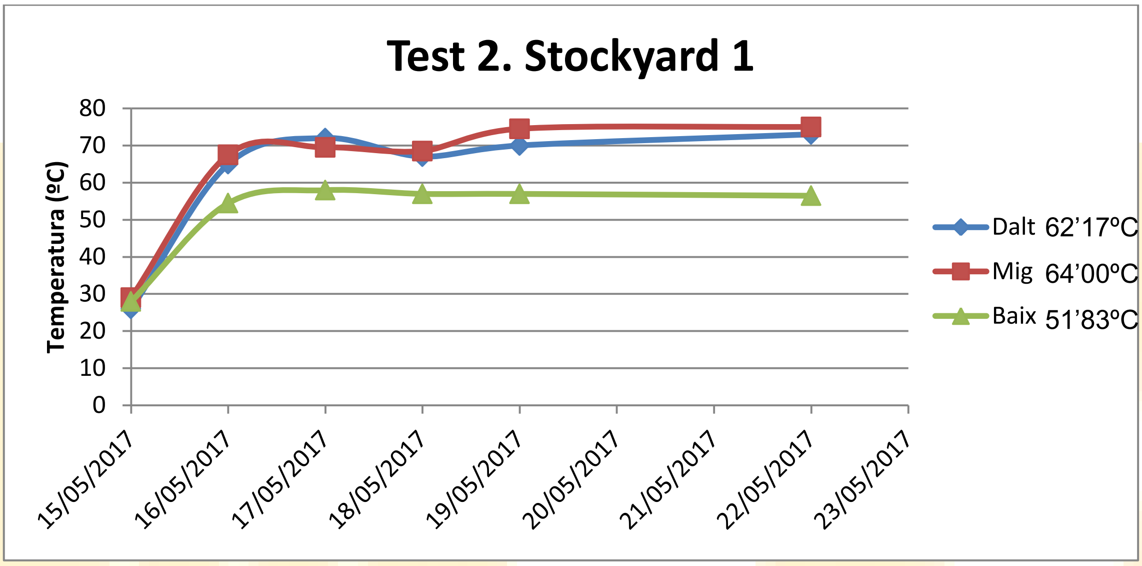


Graphic 1: Temperature curve from Stockyard 1. Test 1

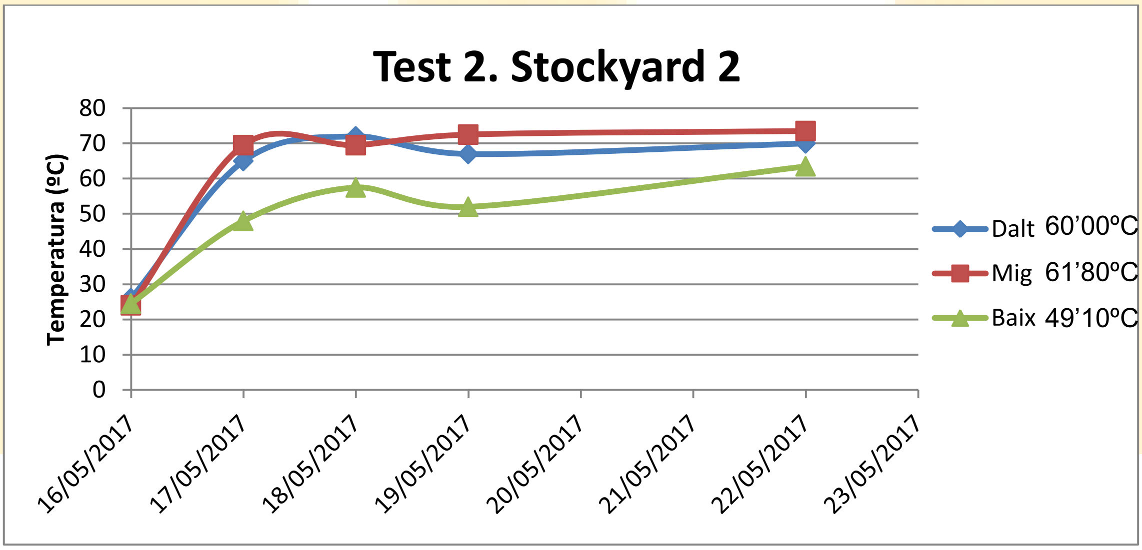


Graphic 2: Temperature curve from Stockyard 2. Test 1

As can be seen from the graphic the curve increases up more than 70ºC during the 24h test in the middle point (brown colour line). Between 24h-48h temperature reaches highest registration and the rest of test temperatures are higher than 65ºC. Stockyard 2 (with wood ships + solid fraction) registered highest temperatures in compares to the stockyard 1.



Graphic 3: Temperature curve from Stockyard 1. Test 2

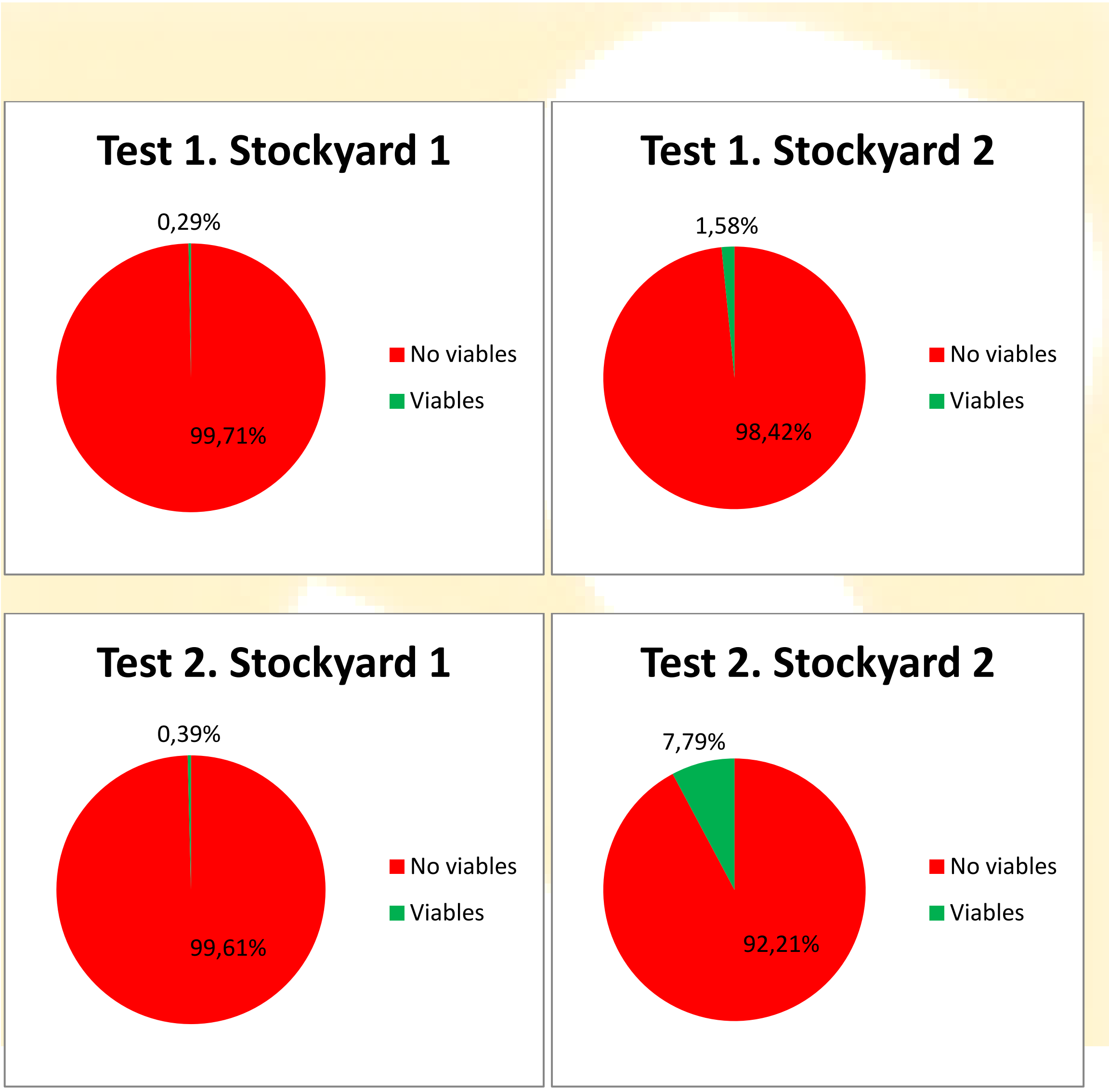


Graphic 4: Temperature curve from Stockyard 2. Test 2

These registrations of temperature are more accurate in compares test 1. Red and blue line registered highest temperatures, about 70ºC starting from the 24h test. This test is the stockyard 1 (only solid fraction content) the one which reaches highest temperatures in compares of stockyard 2

Laboratory analyzes

Figure 3 shows bacterial levels were reduced considerably except on stockyard 2, Test 2 the bacterial concentration was reduced only 10 times. Concerning to stockyard 2, Test 1 the bacterial concentration was reduced 50 times, considered as an optimal sanitize. Both tests confirm sanitize process is better without wood ships + solid fraction as stockyard 1 from both tests shows more than 200 times of sanitization. Per each bacteria found at final test there were more than 200 at the beginning.



Graphic 5. These 4 graphics show the bachterias reference and the final results of the research, so that it is easy to perceive the differences between the two. Variable parameters are active status and can be reproduced while non variables are not active and so pose no threat.

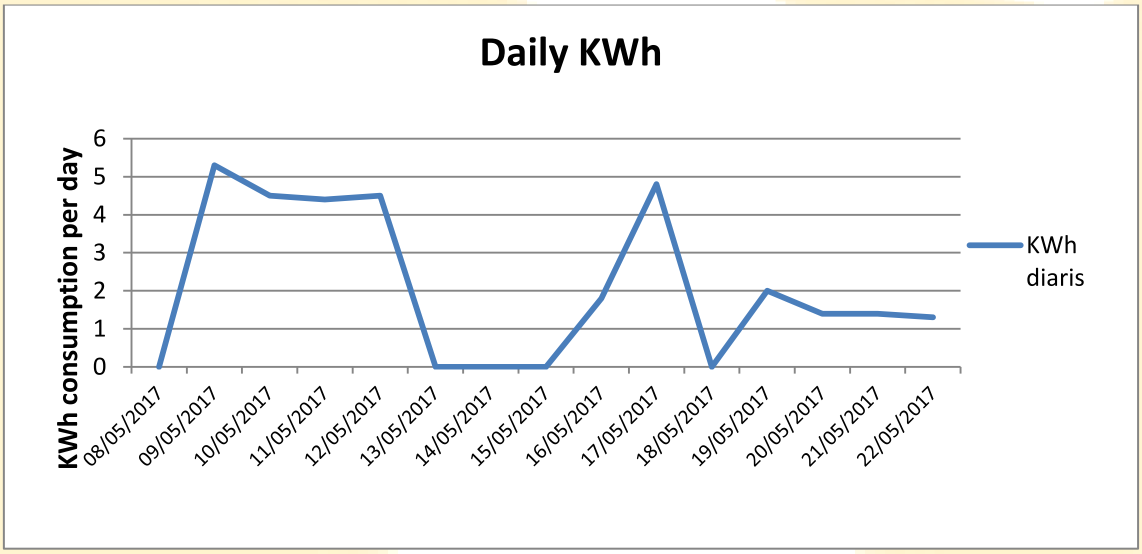
Energy consumption

An energy consumption analysis of using manure solids as bedding was performed. It is represented on graphic 5.

The first test was carried out from the 8th to the 15th of May, both included. As shown in the graphic 5 there was an important waste of electric consumption, due to air inlet was not programmed properly (more days of air inlet injection than required).

The 13th and 14th of May, there was no electric consumption as was weekend and test was interrupted.

The second test, from the 15th to the 18th of May, the maximum electric consumption took one day longer in compares to the previous test because there was not solid fraction enough. Day 18th the power supply was cut for 24h along, so electric consumption was 0. The energy from making the stockyard also is considered in the graphic 5.



Graphic 6: Daily electric consumption during test 1 and test 2.

The analysis excluded those days air inlet was cut. Considering the approximate stockyards volumes, the average of electricity cost was 1,01 KWh/m3.

$$V_{stockyard} = \frac{\sqrt{3}}{4} \times c \times L = \frac{\sqrt{3}}{4} \times 3 \times 6 = 7{,}7942 \approx 7{,}8m^3$$

The approximate volume per each stockyard is 7'8m³. This result was extrapolated to each lineal meter of stockyard: 1,3m³.

$$V_{1m^3} = \frac{V_{stockyard}}{L} = \frac{7'8}{6} = 1'3m^3$$

So,

$$Cons_{m^3} = \frac{Cons_{total}}{m^3_{total}} = \frac{31'4}{7'8 \times 4} = 1'006KWh/m^3$$

Conclusions

The following conclusions were obtained:

- Following to the literature referenced, the research can confirm that first steps of composting process are enough to obtain a high quality sanitization from dried manure as bedding.

- The sanitization process done in this research is effective enough, getting 100 times of bacteria reduction in compares to initial bacterial concentrations.

- The energy consumption analysis determinates a very low cost process: 1 KWh/m³.

- Comparing the results of research obtained from each stockyard, we confirm better results were obtained from stockyard 2 with no wood ships content.

With respect to those issues to improve, could be interesting to make another research test to confirm this study. Results obtained from stockyard 2, test 2 would need to be reviewed as the bacterial increasing is not normal, as it should be sanitized. When this system would be implemented, air inlet lines should be undergrounded and concrete walls should be built to make easier the job during the proper amounting of stockyard.