FERTICOOP-GO Innovations to adapt to the best available techniques (BAT) in the Catalan cooperative agricultural sector

Abstract

Development of innovative tools for better management of livestock manure and agricultural fertilisation with an environmental approach in a collaborative framework, achieving enhanced agricultural management of manure and thus making better use of the production and quality of the extensive crops which are produced.

Objectives

- Reduce GHG and ammonia emissions by optimising fertilisation and taking measures in livestock manure management.
- Find the BAT for application on farms and in the field other than those stipulated in the official guides.
- Achieve sustainable and precise manure and fertilisation management.
- Provide the cooperatives' technical advisory staff with the tools and knowledge they need to carry out recommendations based on sustainability criteria.
- Valorise livestock manure by precise knowledge of its fertiliser content.
- Adapt the technological and digital tools available to the needs of advisory fertilisation and environmental specialists of the participating livestock cooperatives.
- Provide comprehensive management and advice on fertilisation.

Description of the actions carried out in the project

Activity 1. Strategies to reduce the phosphorus (P) content of soil where livestock manure is applied.

Task 1.1- Demonstration plots of strategies to reduce P in the soil.
Task 1.2- Drawing up recommendations for agricultural action to reduce phosphorus in the soil in different agricultural systems.

Activity 2. Testing and development of quick methods to estimate the chemical fertility of agricultural soils in extensive crops.

Task 2.1- Gathering information on existing field methodologies.
Task 2.2- Practical evaluation of different methodologies.
Task 2.3- Recommending methodologies to be applied in different farming systems.

Activity 3. Digitalisation and integration of databases containing agricultural plots and their management by fertilisation recommendations.

Task 3.1- Definition of the specifications of the platform.
Task 3.2- Implementation of the platform.

Task 3.3- Integration with other tools commonly used by specialists.

Activity 4. Evaluation of biogas production in slurry storage in flexible pools.

Task 4.1.- Test in hot period (spring-summer).
Task 4.2.- Test in cold period (autumn-winter).

Activity 5. Assessment of ammonia and greenhouse gas emissions in the storage of slurry and other fractions extracted from it.

Task 5.1.- Selection of emission control techniques and slurry/fraction types.
Task 5.2.- Sampling and transport of slurry and fractions.
Task 5.3.- Test in cold period
Task 5.4.- Test in hot period.

Activity 6. Evaluation of emissions from farms in the pig and poultry sector and of how to minimise them.

Task 6.1.- Selection of livestock farms.
Task 6.2.- Monitoring immissions.

Activity 7. Calculation of the final quality of the compost with different substrates and losses due to ammonia emissions.

Activity 8. Project management and coordination.

Activity 9. Dissemination and transfer.

Expected results and practical recommendations

Activity 1: Strategies to reduce the phosphorus (P) content of soil where livestock manure is applied.

The recommendations are tailored to the different farming systems and/or agro-climatic zones which have been studied.

- **Semi-rainfed dry farming in Central Catalonia:**

The strategy of including a summer crop, namely sorghum, if properly managed. The viability of sorghum for grain has not been entirely positive so far, although sorghum grass has been. Sorghum responds better than maize to water shortages. Furthermore, the most commonly used varieties are shorter-cycle than maize.

- Use manure containing a lower proportion of phosphorus and/or dose on a P basis rather than on an N basis.
- Include one sorghum crop per grain as a second annual crop:
  1. Where possible, sowing should take place in the first fortnight of June at the latest, and most importantly if sowing takes place at the end of June, sow SHORT-CYCLE VARIETIES (which are early).
  2. Use a single-seed drill for this type of crop as this will solve many problems of crop emergence and development and/or prioritise direct seeding if possible.
  3. Do not fertilise the sorghum crop or apply nitrogen with mineral fertilisers which do not contain phosphorus or use manure/effluent with lower phosphorus content.
  4. Provide for pre-emergence or post-emergence treatment to combat weeds.
  5. Export straw at harvest whenever possible.
  6. Include cow pasture with a low stocking rate after the sorghum crop if it is not possible to utilise the sorghum crop.
- Alternate a winter crop for grain and a winter crop for fodder.

- **Semi-rainfed dry farming:**

The strategy focused on reducing the phosphorus (P) content of the soil in a double-cropping agricultural system while maintaining the productivity of the system and consisted of treatment with clarified slurry obtained from a slurry concentrator with a lower ratio of P to N than the original slurry.

- Use treated manure in which part of the phosphorus has been removed.
- Alternate a winter crop for grain and a winter crop for fodder.

- **Arid dry farming:**

Including plant covers between rows of an olive tree crop can be a useful strategy in plots where slurry is applied in the passages between rows of olive trees. These covers also protect the soil from erosion.

- Include the sowing of a cover crop in olive trees:
  1. Sow a mixture of cereal and legume, thus increasing cereal production.
  2. Use machinery that does not damage the olive trees.
  3. Remove most of the plant cover, including pruning debris.

Activity 2. Testing and development of quick methods to estimate the chemical fertility of agricultural soils in extensive crops.

- ✓ For the various types of equipment tested, the extract should be prepared with soil dried at room temperature for 8-10 days if specialised equipment (oven) is not available; the results correlate best with those of an accredited laboratory.
- ✓ When using sensors, it is crucial to use the same standardised protocol as slight variations in protocols can lead to differences in results.
- ✓ None of the devices tested can achieve the same accuracy as an accredited laboratory, although some of the sensors may be a sufficiently accurate alternative in situations where sending samples to a laboratory is too costly or time-consuming.
- ✓ In the case of the sensor tested to estimate the available potassium in the soil, in order to make recommendations it is advisable to use the classification into different levels of fertility, thus enabling reliable detection of contents close to the thresholds set in Spanish Decree 153/2019.

Activity 3. Digitalisation and integration of databases containing agricultural plots and their management by fertilisation recommendations.

- ✓ A tool has been prototyped which allows the management of all spatial and time information on crops, applications and plots quickly and in an uncomplicated way while at the same time generating a viable and simple relationship with other tools already in place at the cooperative (e.g. manure management tools, fertilisation recommendation tools).
- ✓ The platform for handling the data gathered makes it possible to plan fertilisation at plot level and implement it in the regular operations of the cooperatives' specialists. All this is associated with the idea of helping with the challenge of interpreting the data and making recommendations on fertilisation or other aspects of management.
- ✓ Characterisation of all the data gathered on the plots (analytics, inputs, history, limitations according to field location area, etc.) has been put in place to enable them to be managed and draw overall conclusions on the holding or groups of holdings.
- ✓ In conjunction with the participating cooperatives, data was compiled on the current situation in the cooperatives with reference to the objectives of this activity, defining the needs of the specialists in their regular information management operations for the various plots and identifying the required features of the platform to be set up.
- ✓ The development of this pilot solution has enabled users from the cooperatives to conduct consultations for the current 2022-2023 season with satisfactory results.

Activity 4. Evaluation of biogas production in slurry storage in flexible pools.

- ✓ The low concentration of VFA in the effluent shows that the slurry has stabilised. However, the difference in composition between the input slurry and the digested slurry suggests that the slurry fed to the reactor has a very different composition depending on the source unit.
- ✓ The high methane content of the biogas composition in all samples is significant. It is also worth noting the high concentration of hydrogen sulphide in some samples which may compromise the proper operation of the boiler.
- ✓ The difference in methanisation potential between slurry from different units suggests that sound input management may be a very good way to maximise biogas production and ensure constant production over time.

- ✓ It can be concluded from the results of the characterisation of the samples and the activities that in spite of the low methane production, the inoculum is in an adequate, albeit not optimal, condition. Low methane production may be due more to the low concentration of the treated slurry, most likely caused by the use of the new feed additive. However, inhibition episodes cannot be ruled out from which the reactor is recovering as the activities inside the reactor (inoculum) are higher than the effluent.

Activity 5. Assessment of ammonia and greenhouse gas emissions in the storage of slurry and other fractions extracted from it.

- ✓ The high emission factor, with the exception of one sample where the pool was practically empty, can be attributed to the high pH of the digestate and the high % of ammonia compared to TKN. The emissions are more than twice as high compared to the emissions from raw slurry pools. It would be advisable to take some kind of measures (e.g. floating parts, acidification, etc.) to minimise these emissions. However, a larger number of measures would be needed to confirm this large difference.
- ✓ Based on the values obtained, the reduction of ammonia emissions is 52%, although to confirm this it would be necessary to step up the measures and run a campaign over a longer period of time. It should also be noted that the surface of the pool must be completely covered with floating parts in order to achieve the best possible control of ammonia emissions.

Activity 6. Evaluation of emissions from farms in the pig and poultry sector and of how to minimise them.

- ✓ With the sampling campaign carried out, no clear conclusion can be drawn on the effect of the depth of the pit and the % of slat flooring on NH3 and GHG emissions. A much more intensive sampling campaign would have to be conducted over time to reach more consistent conclusions.

Activity 7. Calculation of the final quality of the compost with different substrates and losses due to ammonia emissions.

For holding 1:

- ✓ The compost samples from holding 1 have a pH value between 6.11 and 8.69. They have a high moisture content, always above 60%. They have a high nutrient content (N, P and K). In the nitrogenous forms, it has concentrations between 25 and 35 g TKN/kg dm: it should be noted that in the first two samplings there is a high concentration of nitrates and organic nitrogen is low, while in the other two samplings organic nitrogen is at 90% of total nitrogen and the nitrate concentration is much lower. Phosphorus concentration varies between 1.7 and 5.31 g P/kg dm and potassium between 7.9 and 11.8 g K/kg dm.
- ✓ The carbon to nitrogen (C/N) ratio of the compost samples is optimal according to Spanish Royal Decree 506/2013.
  It is a highly stable compost (Class V); as can be seen in Figure
  Table 37 the temperature of the compost is in no case higher than 10ºC above ambient temperature.
  There is no presence of Salmonella, E. coli or enterococci; therefore, we can assure that it is sanitised.

For holding 2:

- ✓ Compost samples from holding 2 have a slightly basic pH, between 7.9 and 9.17. It should be noted that odours and ammonia emissions can occur at high pH values. Some samples have presented a humidity higher than the maximum set in Spanish Royal Decree 506/2013 of 28 June on fertiliser products, as amended by Royal Decree 999/2017 of 24 November amending Royal Decree 506/2013 of 28 June on fertiliser products.
- ✓ They have high nutrient content (N, P and K). In the nitrogenous forms, it has a concentration between 29 and 52 g TKN/kg dm with a high presence of nitrates, although organic nitrogen is above 85% of total nitrogen in three of the four samplings. Total phosphorus content varies between 2.5 and 6.1 g P/kg dm, as does potassium concentration which ranges between 9.11 and 19.47 g K/kg depending on the sampling.
- ✓ The carbon to nitrogen (C/N) ratio of all compost samples from holding 2 is optimal according to Spanish Royal Decree 506/2013.
- ✓ It is a highly stable compost (Class V); the temperature of the compost is in no case higher than 10ºC above ambient temperature. There is no presence of Salmonella, E. coli or enterococci, except for the first sampling where a slight presence of E. coli and enterococci is found, attributable to possible cross-contamination due to being stored in the vicinity of the farm.

With regard to heavy metals, some results were obtained for Cu content above 70 mg/kg, Pb content above 45 mg/kg and Zn content above 200 mg/kg; in all cases this means that it is classified as a class B compost (Spanish Royal Decree 506/2013).

For holding 3:

- ✓ It has a slightly variable pH between 6.2 and 8.6. They have high humidity at between 62 and 70%, higher than the maximum set in Spanish Royal Decree 506/2013 of 28 June on fertiliser products, as amended by Royal Decree 999/2017 of 24 November amending Royal Decree 506/2013 of 28 June on fertiliser products .
- ✓ They have high nutrient content (N, P and K). In the nitrogenous forms, they have a high concentration of between 33 and 56 g TKN/kg dm with the presence of nitrates in all cases, although organic N content is higher than 85% of the total in all cases. Total phosphorus content is between 2.2 and 4.7 g P/kg dm and potassium content is high and varies between 8.9 and 21.73 g K/kg dm.
- ✓ The carbon to nitrogen ratio (C/N) is optimal according to Spanish Royal Decree 506/2013. It is a highly stable compost (Class V); as can be seen in Figure 102, the temperature of the compost is in no case higher than 10ºC above ambient temperature. There is no presence of Salmonella, E. coli or enterococcus is found. It can therefore be said to be a sanitised compost.

Operational Group Leader

ENTITY: Agrària Plana de Vic i Secció de Crèdit, SCCL

Operational Group Coordinator

ENTITY: Federació de Cooperatives Agràries de Catalunya

Other Operational Group members (aid recipients)

ENTITY: Gestió Agroramadera de Ponent GAP, SCCL

ENTITY: Linyola Agropecuària i Secció de Crèdit, SCCL

ENTITY: Agropecuària Catalana, SCCL

Other Operational Group members (not aid recipients)

ENTITY:

Territorial scope(s) of application

PROVINCE(S)	COUNTY(IES)
Barcelona, Lleida	Osona, Pla d'Urgell, Les Garrigues, Bages

Project dissemination (publications, conferences, multimedia, etc.)

Technical conference. Ivars d'Urgell, 10 March 2023. https://transferencia.irta.cat/wp-content/uploads/2023/04/230673_compressed.pdf

Project website

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Other project information

PROJECT DATES	TOTAL BUDGET
Start date (month-year): July 2020	Total budget: €178,959.58
End date (month-year): March 2023	DACC funding: €73,137.06
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	Own funding: €50,648.94

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Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural

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