Organic Knowledge Network on Monogastric Animal Feed

OK-Net EcoFeed

Report of testing activities

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Executive summary

This deliverable is part of the Horizon 2020 project – OK-Net EcoFeed. The overall aim of OK-Net EcoFeed is to help farmers, breeders and the organic feed processing industry in achieving the goal of 100% use of organic and regional feed for monogastrics, in particular pigs, broilers, laying hens and parents of broilers and laying hens. The aim of WP3 – "Coordination of Innovation and Thematic Groups"- is to adopt a multi-actor approach to reach the goal of 100% organic and regional feed in the monogastric ration, also by reducing the soya portion. In particular, the objectives of Task 3.3 "Testing of innovative tools and practices" is to help all the Innovation Groups (IGs) in testing selected practices or approaches in terms of innovation, applicability, and user-friendliness. This deliverable D3.2 "Report of testing activities" by AIAB presents and compiles the reports, practice abstracts and videos relative to the testing activities carried out by the Innovation groups (IGs).

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I. Introduction

The present deliverable D3.2 “Report of testing activities” describes the selected testing activities and the results obtained by the Innovation Groups (IGs) within the WP3 - Task 3.3 “Testing of innovative tools and practices” of the OK-Net EcoFeed project (M8-M34). IGs selected practices and approaches to test based on the outcomes of the Science Bazars (Task 3.1), the “Knowledge synthetises of feed production” (D2.2) as well as the “Description of innovation groups” D3.1.

The Italian Association for Organic Agriculture (AIAB) led the Task 3.3 and coordinated the knowledge exchange among practitioners involved in the OK-Net EcoFeed project. The D3.2 “Report of testing activities” presents the outcomes of this task from each IG on the usefulness, potentials, limits and recommendations for the future development of the tested practices. Furthermore, the results of each of the testing activities are translated into easy-to-use dissemination materials including practice abstracts (PAs) according to the EIP-AGRI common format and at least one short video in local language with English sub-titles. Both PAs and videos are available on the Organic Farm Knowledge which is the knowledge platform that was created by OK-Net Arable and is being further developed by the OK-Net EcoFeed project.

II. Themes

In accordance with the multi-actor approach and the objectives of the OK-Net EcoFeed project, farmers, advisers, and researchers, closely cooperated throughout the whole project to find innovative solutions in achieving the goal of 100 % feeding for monogastrics (pigs and poultry) in organic farming. The testing activities were divided in themes to help identifying the right solutions relevant to practitioners. A first division of the themes was made by species (poultry and pigs) having very different dietary needs. After having identified problems to be solved and specific research needs concerning the poultry and pigs, further groups to better divide the material flows was produced. Furthermore, a category on technological and food processing was added later. In fact, process aspects also play a central role in achieving the objectives of achieving 100 % feeding for monogastrics, even though they are not attributable to one of the two species under study.

Hence, the main themes of the trials that are dealt with the practical testing are:

- Processing and handling of harvested feed
- Pigs
- Poultry

III. The process

The procedure of the testing of innovative tools and practices and the dissemination of the outcomes were discussed and decided during the 2nd project meeting (MS3.5, M9). The process included 3 steps:

1. planning of the testing activities
2. testing activities
3. collecting the results

In the subchapters below each of the steps are explained in details.

III.1 Planning of the testing activities

Based on the outcomes of the Science Bazars (Task 3.1) as well as the D2.2 "Knowledge synthesis of feed production" and D3.1 "Description of innovation groups", each IG had selected 1 to 2 tools to test.

During the science bazaar, the IG's participants (farmers, technicians, scientists and feed companies) discussed the issues that emerged from D2.2 "Knowledge synthesis of feed production", identifying problems that needed a solution and developing innovative practices to be tested in order to achieve the project objectives. Once the topics were identified, each IG drew up an experimental design for each practice to be tested. The possible benefits of using the practice were highlighted, as well as its weaknesses. Knowledge gaps and barriers to be overcome were also indicated, and whether new issues arose during the test.

III.2 Testing activities

A total of 18 practical tests took place from June 2019 and were due to end in August 2020. Due to the emergence of Covid-19 and the containment measures, many trials have been delayed because logistic restrains. Contingency plans for the delayed trials were developed and testing activities were carried out within the new deadlines with some minor deviations. Finally, all the trials concluded in October 2021.

For each trial, photos and videos were produced to document and disseminate the results achieved. In addition to a detailed report, a practice abstract (PA) containing the essential information for the dissemination of the practice was produced. The content of the material was checked by AIAB and ORC while ORC also performed language checks. The dissemination of the tools was carried out by FiBL via social media posts.

III.3 Collecting the results

After completing the trials, IGs analysed the data, and summarised the results in reports, produced PAs and videos. To facilitate the knowledge flows of innovative tested practices, FiBL created the PAs template based on the EIP-AGRI common format, while AIAB created the feedback form taking into account the knowledge and experience acquired during the Horizon 2020 project OK-Net Arable. Furthermore, for each test, IGs have collected photos and produced at least 1 video of the various stages of each trial.

Once the PAs, videos and a feedback form were submitted by partners, AIAB and ORC did a first content check. Once the review was done, the feedback was communicated to the author(s), who then implemented the reviewers' comments and adapted it accordingly. In some cases, the reviewers were consulted a second time. Once the review was done, a language check was carried out by ORC and the layout was finalized.

The following PAs are available on Organic Eprints/Organic Farm Knowledge platform. The table also show the IG responsible for each of the to testing activities, PAs and videos.

	Theme	**PA**	**IG**	Link
1	Processing and handling of harvested feed	Using near-infrared tools to monitor heat damage in soya bean products	Donau Soja	https://youtu.be/VWC79HqlAXs https://organic-farmknowledge.org/tool/39510
2	Processing and handling of harvested feed	Heat treatment and dehulling effects on feed value of faba beans	Soil Association	https://youtu.be/0QxxjbimLG8 https://organic-farmknowledge.org/tool/39516

3	Processing and handling of harvested feed	Clover-grass protein by bio-refining: nutrient composition and shelf life	ICROFS	https://youtu.be/d3VWZbCo83c https://organic-farmknowledge.org/tool/39520
4	Poultry	Nettle cultivation for feeding poultry	Bioland	https://youtu.be/-a2-HCyLXys https://organic-farmknowledge.org/tool/39136
5	Poultry	Varieties of clover in poultry ranges: feed value and feeding preference	Bioland	https://youtu.be/xeyPFPUJgJc https://organic-farmknowledge.org/tool/39505
6	Poultry	Nettles for feeding	Bioland	https://youtu.be/-a2-HCyLXys https://organic-farmknowledge.org/tool/39138
7	Poultry	Sprouted wheat and vetch seeds as a green feed for poultry	Soil Association	https://youtu.be/GPC66lDYFlY https://organic-farmknowledge.org/tool/39518
8	Poultry	Camelina organic cultivation experiences in Italy Camelina processing: experience in Italy Use of organic Camelina in laying hen feed	AIAB	https://www.youtube.com/watch?v=cFjbWN8hJvc&t=10s https://organic-farmknowledge.org/tool/39649 https://organic-farmknowledge.org/tool/39648 https://organic-farmknowledge.org/tool/39637
9	Poultry	100 % organic feedstuffs for laying hens	ITAB	https://www.youtube.com/watch?v= cEkTy-OgjQ https://organic-farmknowledge.org/tool/39512
10	Poultry	Alternative to soya bean cake for fattening broilers	ITAB	https://www.youtube.com/watch?v=un0epC6c7rw https://organic-farmknowledge.org/tool/39576
11	Poultry	The potential feed value of grain tailings for poultry	Soil Association	https://youtu.be/vzWM0VVDuCw https://organic-farmknowledge.org/tool/39517
12	Poultry	Lactic acid bacteria supplements for organic broilers	ICROFS	https://youtu.be/qvqBQSUHrWE https://organic-farmknowledge.org/tool/39521
13	Pigs	Foraging of organic finishing pigs on protein-rich fodder	ITAB	https://www.youtube.com/watch?v=hAhMjzJoXx8 https://organic-farmknowledge.org/tool/39563
14	Pigs	Silage as bulk feed for pigs with restricted feeding	Ecovalia	https://www.youtube.com/watch?v=e7tRD3cTyp4 https://organic-farmknowledge.org/tool/39511

15	Pigs	Feeding silage to pigs with an automatic straw distributor	SCANIA	https://youtu.be/Zl2UR5xNHqQ https://organic-farmknowledge.org/tool/39513
16	Pigs	Establishing forage turnips in the pasture for gestating sows	SCANIA	https://youtu.be/G6EZLYXUO-0 https://organic-farmknowledge.org/tool/39514
17	Pigs	Feeding silage to organic weaning piglets: diarrhoea, gastric health and growth	SCANIA	https://www.youtube.com/watch?v=zNCyNYp2MxU&feature=youtu.be https://organic-farmknowledge.org/tool/39515
18	Pigs	Grass silage to finishers in addition to liquid feeding	SCANIA	https://youtu.be/m1XU-mm9kZ4

IV. The 18 testing activities

The 18 testing activities were carried out by IGs and supported by IG facilitators. The overall process of the trials was managed by AIAB in coordination with IFOAM Organics Europe for administrative aspects.

In total the tests were allocated as follows:

- 3 for Processing and handling of harvested feed
- 9 for Poultry
- 6 for Pigs

The explanation of the testing activities for each of the selected themes, include methods, results and knowledge gaps/barriers to innovation. The details can be found in the subchapters below.

IV.1 Theme: Processing and handling of harvested feed

The processing and handling of harvested feed theme was selected because some practices related to processing and handling of harvested feed have been tested and are applicable for both pigs and poultry. The trials below describe the process and the products quality, to provide all the information needed to reproduce the process.

IV.1.1 Using near-infrared tools to monitor heat damage in soya bean products (IG: Donau Soja)

An analytical tool to evaluate the quality of soya bean processing was tested by Donau Soja in this trial with near-infrared spectroscopy (NIR) instruments.

The antinutritional compounds in soya bean can affect animal health and performance. Heat treatment can solve this problem, but if the combination of time and temperature is not correct, the ammino acids and protein can decrease in terms of quality and bioavailability for the animals; and the antinutritional factors are not fully deactivated.

These knowledge gaps are solved by the tested practice allowing technicians to formulate very accurate rations, maximising the inclusion levels of different ingredients, and achieving a precise amount of amino acid inclusion.

Results:

The most common quality evaluation for soya is wet chemistry, an expensive and slower technology compared to near-infrared spectroscopy (NIR). Furthermore, wet chemistry usually evaluates only a small range of indicators instead of the tested practice, which measures a very large spectrum of parameters. In order to obtain the best analysis, it is necessary to define the standard error of calibration (SEC), which is essential to understand the variance and accuracy of measurements. The NIR technology can be used not only for soya bean, but for several feedstuff and in a few seconds can provide important information like dry matter, crude protein, sugar and oil content, main amino acids and processing indicators.

Knowledge gaps and barriers to innovation:

As a result of the test new gaps in knowledge appeared like the measurement level of trypsin-inhibitor activity (TIA) for different species. An innovation barrier is that this task is very complex and require close collaboration with the manufacturer of the machine to define the optimum balance between the results and the process.

The weakness of this practice tested in the trial lies in its novelty and thus low availability on the ground; but the IG suggest adopting the practice especially for the small-scale processing systems.

Speaking of results, they were very close to those obtained by Evonik (2017) and the Bavarian State Research Center (LfL) (2012-2017).

IV.1.2 Effect of bean toasting and dehulling on feed value (IG: SOIL ASSOCIATION)

The aim of the trial was to increase the inclusion of beans in monogastric ration, according to the objective of the project, by reducing the antinutritional factors like trypsin inhibitors. Heating is a common method to reduce these toxins.

In the tested practice samples of beans were heated to 150 degrees centigrade for 15 minutes in a conventional electric oven. Beans were also dehulled manually and through separation from the bulk to reduce tannins amount; sent to an independent laboratory for analysis. Protein, ammino acids and trypsin inhibitor activity (TIA) were investigated.

Results:

The results show that heat treatment does not affect the amino acids content, but there is a small reduction in protein amount (- 2%) and an important reduction (35%) of TIA.

Dehulling resulted in an increase of protein content (+6,6%), with no modification in amino acids amount. However, TIA significantly increased (+112%) since TIA was found in the cotyledons and not in the hull.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were solved, showing that heat treatment on beans can increase their use for pigs and poultry ration. However new gaps in knowledge appear such as digestibility of the treated product and possible combination of heat and dehull process. Further studies are also needed to find the optimum balance between time and temperature, for heat treatment, to obtain the best product quality.

IV.2 Theme: Poultry

In the poultry section of this report, will be noted all the trial related to layers and broiler. The tested practices can be used in both category of animals belonging to the same species.

IV.2.1 Nettle cultivation for feeding (IG: BIOLAND)

The aim of the trial was to search for alternative protein sources for feeding laying hens. To achieve this, the effect of fertilising nettle crops on the amino acid content was investigated. Specifically, the cultivation methods, sowing with selected seeds and vegetative reproduction by stolon were tested in two different plots. To evaluate the effects on the methionine content of harvested nettles, poultry manure and sulphur were used as fertilisers. Fertiliser was applied pre-sowing and after the first cut. Analysis of dried nettle samples made it possible to estimate the nutritive value.

Results:

The results showed no difference in the amino acid content due to fertiliser application.

However, vegetative propagation was shown to be more effective than sowing seeds. The methionine content was high, while the Lysine Methionine ratio was too low for the sought-after methionine concentrate. The yield was 3 tons DM/Ha per year, obtained with multiple cuts, and the cost of the crop was high compared to alfalfa or other green meal which were easier to produce.

Knowledge gaps and barriers to innovation:

These weaknesses led the IG participants not to adopt the practice.

IV.2.2 Nettles for feeding (IG: BIOLAND)

The aim of the trial was to evaluate nettles as alternative source of protein and amino acids, as a replacement for alfalfa and supplements, in layer hens' diets. Two rations were tested with different level of nettle inclusion, 10 % and 5% respectively. Laying performance and eggs quality characteristics were compared with a control group; feed intake was measured. No differences were noted.

In the trial 1, 5% of lucerne meal (milled grass) and 5% of supplements were replaced by 10% nettle; the ration differed in protein and methionine content, minus 0.5% and 0.01% respectively. In the trial 2, supplements were reduced by 5% and replaced by 5% nettles.

Results:

Feed intake and palatability were good and manure score (faecal consistency measurement) gained a positive score.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were solved and respect the objective of the OK-Net EcoFeed project. However, new gaps appeared, such as the nutritional value and the cost of the practice. The agronomic difficulties described in the PA: Nettle cultivation, and the related costs, led the IG participants not to adopt nettle in laying hen rations.

Moreover, the use of nettle in animal feed is currently not authorised by the competent authorities.

IV.2.3 Varieties of clover in chicken runs: experiment on feed preference (IG: BIOLAND)

The aim of the trial was to find the best clover varieties for a free-range layer's farm, to gain a contribution in protein supply for laying hens. Four plots were created with different varieties which were: red clover “Lucum”, red clover “Titus”, white clover “Hebe”, alfalfa “Daphne”. In spring a topping cut was made, and hens were left in the field for 2 months and their behaviour observed by the farmer and a wild camera. Analysis to define the feed value of the four crops was made.

Results:

Alfalfa shows a strong drought tolerance and the best growth rate, compared to the others crop tested. White clove has the best methionine and sugar content. Due to these results, the IG suggest the combination of the two crops, alfalfa and with clover to avoid aby laying hens.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were not fully solved, it remains unclear how the feed intake in the fodder can be measured to draw conclusion about the ration contribution and balance.

Furthermore, new gaps appeared such as the feeding contribution of the pasture and its feed value.

Barriers to innovation have not been removed, there is still little information on the nutritional value of white clover, despite its interesting methionine content and good palatability demonstrated by the ingestion of laying hens. Further investigations are necessary according to IG experience.

IV.2.4 The potential for sprouted seeds to supply feed for layers (IG: SOIL ASSOCIATION)

The aim of this trial was to evaluate sprouted seeds as potential green feed source for organic layers farm, and to evaluate the possible reduction of antinutritional factors due to the sprouting process. In circumstances where access to pasture for laying hens and broilers is restricted, such as bird flu or snow, the use of sprouted seeds could be a valuable aid in providing green fodder and ensuring good animal welfare. Furthermore, small scale sprouting machinery can be easily developed and used on farm, in accordance with the objective of the project.

Sprouted seeds were analysed in laboratory to estimate their nutritional value including amino acid content. The seeds used in the trial were wheat and vetch, which also was tested for trypsin inhibitor activity (TIA).

During the feeding of the sprouted seeds, measurements were made of the intake and general observation of animal health as well as the evaluation of production performance.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were solved: the nutritional value after the treatment doesn’t change and after five days sprouting for vetch, TIA were reduced. Due to this results the IG imagine a higher inclusion of vetch in the ration. During the process, the starch in the seeds is converted into sugar, an important source of energy.

However, new gaps have appeared as there is currently no information on the level of toxins allowed in different animal species to avoid nutritional and health problems. In addition, some weaknesses of the practice emerged: sprouted seeds do not fit easily into an automated feeding system. Furthermore, the germination rate for wheat and vetch is different, which makes it difficult to apply the procedure to seed mixes unless they are well balanced in this aspect.

IV.2.5 Cultivation of organic camelina and use of the cake for laying hens feeding (IG AIAB)

The aim of the trial was to evaluate the possibility of growing camelina in Italy, a new crop that fits well into the crop rotation, increasing the farm's self-production. Different varieties were used. The possibility of pressing camelina to produce expeller was also investigated. The final aim was to use the protein-rich expeller in the feeding of laying hens, reducing the protein intake of soya, in line with the project's objectives. Evaluating the production and quality performance of the hens was also carried out.

Camelina is a new crop for Italian farmers and there is no experience in post-harvest and processing operations. The most important product is the oil rich in polyunsaturated fatty acids like omega 3 and omega 6, but the cake as by product can be used in animal feeding.

The trial lead by AIAB consists of three stages:

a) cultivation
b) process and cake production
c) feeding hens with the cake

Since the crop is sowed in October and harvested in May-June, it allows the subsequent cultivation on the same plot of soybean or other crops. The seed is very small and requires a well-prepared seedbed. Hence, the machinery must be properly calibrated.

The limited leaf growth leaves portions of the soil uncovered and encourages weed development so one or more harrow steps are necessary to reduce this problem.

Results:

It is suggested to use a harvester for alfalfa seed, if available. Otherwise, a combine harvester for wheat but at a low speed and, preferably, with straw separation to avoid products losses can also be used.

The seeds should be cleaned from weeds to obtain a high purity and avoid low quality oil and cake production. Oil extraction by cold pressing preserves all nutritional components and cake as by product.

The camelina cake was analysed using the NGD B2-1976 method and it showed very interesting results which go as follows:

Humidity: 8-10%

Protein: 32-34%

Fiber: 9-11%

Fat: 8-10%

The cake was included in laying hens' diet from 3,5% to a maximum 10%, due to antinutritional factors. 1,5% camelina oil was added to the ration.

Interestingly, the results of the feed trial showed that:

- no negative effects on laying parameters (number of eggs, dimension of eggs etc.)
- no negative effect on physical egg parameters (i.e albumen viscosity does not change, the shell is reported to be more resistant)
- higher omega-3 contents in eggs
- longer productive life of hens

Overall, the value of the eggs increased, the production costs decreased and animal welfare improved.

Knowledge gaps and barriers to innovation:

The indicated knowledge gaps were solved but new gaps appeared. The low productivity of the crop can negatively affect the cost of the practice. Further investigation with high cake inclusion level in the ration is required, also testing camelina varieties with lower antinutritional factors content.
The oil has a great value and can be used for human consumption, cosmetics, and as source of feed for fish. The creation of a supply chain for the oil guarantees the possibility of using the cake in organic animal feed.

IV.2.6 100% Organic feedstuff for laying hens (IG: ITAB)

The aim of the trial was to test a 100% organic feeding in laying hens' diet, because of ethical issue and wishes to be coherent with organic principles, in accordance with the objectives of the project.

The trial evaluated the impact on the technical and economic results of laying hen's production, in a feeding system with 100% organic feed compared to a control group receiving 95% organic feed. The field trial took place on a commercial farm and a local feed producer that usually works with the farmer propose a 100% organic feed, for peak and single egg laying phase. The study monitored animals during a 12 month period.

The following data were recorded:

a) Number of eggs/days
b) Egg's weight (3 sizes from 53 to 80)
c) Feed intake per animal
d) Culling hen's weight

Results:

The results with 100% organic can be compared to the control group 95% and the reference of Lohmann. However, in the 100% feed system the egg production is less high than the 95% batch, and in the trial group the impact of heat wave during the summer is visible, within a 30% reduction of production. Except for this short period, the test results are close to reference from Lohmann (https://lohmann-breeders.com/publications/poultry-news/) and the 2017 reference curve.

About cost with 100% organic feed total charges per layer is below the National Average. However, these results must be placed in farm context: the farmer used second-hand building materials and did a lot of work by himself, so building amortization is reduced. Furthermore, he had already achieved good cost results in his 95% system, with selling his eggs locally.

Knowledge gaps and barriers to innovation:

The 100% organic feeding did not affect culling hen's weight, mortality or feed conversion ratio. Observing these results, the IG confirmed that the identified knowledge gaps were solved, but new gaps appeared such as finding enough sources of 100% organic protein. A new gap is the possible increasing cost with locally produced feed stuff; weakness of the practice is that soya cake consumption increased to afford the laying hens production and reduce the heat damage. Costs increased by 6% but compensated by higher price of eggs in sale.

IV.2.7 Alternative of soya bean cake for fattening broilers (IG: ITAB)

The aim of the trial was to evaluate the possible inclusion in finishing broiler ration of camelina cake, rapeseed expeller, sunflower expeller, to replace soya bean cake. All the by products are locally produced according to the objective of the project.

The following data were recorded:

a) Chemical analysis of new feed stuff from the mill
b) Chemical analysis of finishing feed manufactured on farm
c) animal growth over time
d) chicken weight
e) carcass quality (skin colour which is an aspect for direct selling)

The trial and the control batch received the same feeding until the fattening phases. The finish feed composition had the same protein and energy content, also lysine and methionine were at the same value in the two groups. Fat values in the trial were double compared to the control diet.

Results:

The feed stuff analysis showed values close to an ITAB reference diet (Alimentation des volailles en agricolture biologique. 2015), allowing a formulation able to meet broiler requirements. Also finishing feed results were compared to the National Average, to evaluate nutritional value. The product met expected protein and fat content, confirming that finishing feed is well manufactured on farm.

Growth over time showed no significant differences between each batch, but the trial group did have more birds with heavier weights at the end. The carcass quality of the trial group looked better with skin more yellow compared to the control batch.

Knowledge gaps and barriers to innovation:

Thanks to these results, the IG confirm that the identified knowledge gaps were solved and camelina, rape seed, sunflower cake can replace soya cake without decreasing chicken performance. However new gaps appeared such as the cake quality if the products are pressed on farm in a small-scale process, and define what is the cost for the farmer.

Further investigation is needed to evaluate the availability on the ground of these protein source and new challenge regarding the growing phase are ready to be explored.

IV.2.8 The potential feed value of grain tailings for poultry (IG: SOIL ASSOCIATION)

The aim of the trial was to evaluate the nutritional value of grain tailings, the by-product of the cleaning process of grain, improving at the same time the quality grain for sale. The tailings are often feed to poultry or burnt or composted. The tailings and cleaned grain were both tested at a laboratory to collect results.

Results:

The results show that starch decreases compared to cleaned grain, but sugar and oil increase, due to the weeds seeds not yet reaching maturity. Proteins and amino acids are higher compared to those in cleaned grain, as well as ash, fibre and lignin content.

Knowledge gaps and barriers to innovation:

The knowledge gaps were solved, broilers fed with tailings gained a higher weight compared to the control group, and farmers can obtain a higher price for cleaned grain based on quality. However new gaps appeared such as the feed value of different weed seeds and how they can affect animal performance and health, related to the risk of possible toxins.

IV.2.9 Clover-grass protein by bio-refining (IG: ICROFS)

According to the objective of the project, the focus of this trial was to evaluate the quality of green protein, as a potential new protein source for poultry. This solution can increase the sustainability of organic egg production, by raising locally grown protein source. The green protein has an important content in essential amino acids, such as methionine, for poultry diet.
The process of bio-refining concentrates the protein in different steps; nutritional value and shelf life of the protein concentrate were examined continuously for 6 months. The effect of temperature as well as addition with lactic acid bacteria to some of the samples will be studied over time.
Harvested green material was processed with a screw press into a press cake and green juice. The protein in the green juice was precipitated by heating, where after a wet protein paste was produced by decanter centrifugation, resulting in a separation in a liquid and protein fraction.
Wet protein pastes weas produced from clover grass (red-clover and ryegrass), and 28 samples were made to study the effect of temperature and addition with lactic acid bacteria on their shell life for 6 months. The samples were stored at room temperature (approx. 24°C) and in a refrigerator (approx. 4°C). Half of the samples will have lactic acid bacteria added. The following parameters were measured at different time intervals:

a) pH
b) lactic acid presence
c) coliform bacteria presence
d) dry matter
e) ash
f) nitrogen
g) amino acids
h) raw material
i) short chain fatty acids

Results:
The results show how protein content of green protein (48.5% harvesting time) increased during the 6 months storage process at 24°C; the samples with addition of lactic acid had a faster increase during the 1-2 month compared to the samples without lactic acid. However, during 6-month storage period, the protein content increased by 9.5% (plus lactic acid) and 12% (minus lactic acid).
The protein concentration in 4°C storage samples, increased in a less pronounced manner following the same pattern described above.
For Methionine and phenylalanine, the same effect of temperature on protein content, was observed during the 6 months storage period.
The lysine the content increased after the first month and then decreased, but generally for most amino acid, the corresponding increase in concentration over time was observed.
The increase in protein content can be considered an advantage to achieve the objective of the project; however, it is crucial that the product maintains a good quality during storage period.
The number of lactic acid bacteria increased sharply in all samples during the first 14 days, after which the concentration began to decrease continuously over the storage period, for samples stored at 24°C, while remaining fairly stable in samples stored at 4°C. This result is strongly dependent to the pH value. The pH of the samples dropped sharply during the first 14 days, especially at 24°C storage temperature, after which the pH rose slowly again. Due to the delayed microbial growth, samples stored at 4°C showed a somewhat more moderate pH drop at the beginning of the storage period. After that the pH was more or less stable over the entire storage period. In the first 14 days of storage, the number of coliform bacteria increased sharply. However, the growth of these bacteria appears to be inhibited when the sample was stored at 24°C and by the addition of the silage agent.

Based on the results of the microbiological measurements, it can be concluded that the shelf life of green protein is limited especially when stored at 24°C and should therefore take place at refrigerator temperatures, where the samples can be stored for up to 3 months. To avoid microbial spoilage of green protein during storage, it will be desirable that the water content should be further reduced.

Knowledge gaps and barriers to innovation:

The limitation of this practice is the dry matter (DM) content, which in the green protein is around 45%. The challenge is to dry the protein paste sufficiently (DM >90%) to use it in a mix for poultry diet. The drying process and the transport to the bio-refineries of green protein, have an important energy cost.
However, the identified knowledge gaps were solved: analyses of various nutrients have shown that the green protein has a high protein and amino acids content.
New gaps appeared such as the best source for the green protein production.
The identified barriers to innovation have been removed, the storage trial show that the maximum shelf life depends on the temperature, and the level of dry matter in the products need to be high to assure an optimal storage.
New barriers appeared such as le low level in cystine; will be necessary to use other raw material with a high level of this amino acids, to balance the ration.

IV.2.10 Effect of lactic acid bacteria as supplement to organic broilers (IG: ICROFS)

The aim of these trial was to increase the gastrointestinal health of poultry, giving lactic acid bacteria in two different ways: via drinking water, or vi maize silage. Adding lactic acid bacteria to the drinking water once daily, may result in some animals receiving a lower dose, as the troughs are shared. However, as feeding takes place daily it can be assumed that all animals receive the correct dose in the treatment time.

A healthy intestine can have a positive effect on the digestibility of nutrients, better growth, and lower mortality.

Results:

The results shows that the concentration of lactic acid bacteria in the ileum part of the intestinal tract, was higher in both the treatments groups, compared to the control one. The higher concentration of lactic acid results in a lower pH int the intestine, which can reduce the concentration of unwanted bacteria such as E. Coli. Furthermore, the maize silage increases the poultry activity in the roughage area, for a higher animal welfare.

Body weight were evaluated at 4 and 8 weeks. There was no great difference between the three treatments until 4 weeks of age. From 4-8 weeks, the chickens from treatment maize silage allocation(C), had a lower growth rate than the other two treatments, where the final weight was 2052g for treatment C, while it was 2158g for control treatment (A). Drinking treatment (B) was close to treatment A with a weight of 2138g.

The average feed consumption per chicken (g/day) in the test period from 0-8weeks was lowest in treatment A with 99.36g / day, while treatment C had the highest feed consumption with 105.3g / day. As chickens from treatment C also had the lowest growth, it resulted in the highest consumption of feed in g per g of chicken produced. As the allocation of maize silage increased with age, it may have affected production results in several ways. There was no significant difference in feed consumption between the treatments in the first 4 weeks, but then the feed consumption increased more in chickens from treatment B and C (155 and 157 g / chicken / day, respectively) compared with 147g / chicken / day for treatment A.
At the age of 8 weeks, 12 chickens were taken from each house. The content of small intestine and caeca were taken for measurement of pH and concentration of lactic acid bacteria and E-coli. After the chickens were killed (cervical dislocation), pH of the intestinal contents was measured immediately.

Knowledge gaps and barriers to innovation:

These results assure that the identified knowledge gaps were solved, but new gaps appeared, such identify the genotypes with the highest foraging behaviour. Other studies will be necessary to determinate the composition of microflora in the intestinal system and compare this information between conventional and organic system.

IV.3 Themes: Pigs

In this section of the report, where noted all the trials related to pig group.

IV.3.1 Foraging pigs: contribution of protein-rich fodder to finish pigs (IG: ITAB)

In accordance with the objectives of the project, the trial aims to design and evaluate a year-round feeding strategy that maximizes foraging of protein-rich fodder to finisher pigs. The aim was to use the forage resources produced on farm, to reduce the cost of feed, by reducing the amount of concentrates. Animal behaviour was also observed. Other purpose was to increase carcass quality (including lean meat) and nutritional value.

During the trial, the pigs were all raised outdoor up to 18 weeks.

The trial took place in three different phases:

a) Methodological organization, design of a provisional grazing schedule and testing of the practice on a plot of maize-bean-courgette. The aim of the test was to observe animal behaviour, organize the plot with mobile fences and adapt animal management.
b) comparison between a batch of pigs finished indoors (control), and a batch of pigs finished outdoors (trial 1) on a grassland that was not sown specifically for its nutritional value via foraging.
c) comparison between a batch of finished pigs indoors (control), and a batch of pigs finished in a building with permanent access to a fodder plot, that was sown to contribute to the pigs' ration via grazing (trial). Concentrates feeding was reduced for the test batch (objective = -30%). The grazed plots were successively a moha-clover mixture, then a maize-bean mixture (trial 2).

The two fodder crops were monitored following the same protocol. The objective was to estimate the plant species and accordingly to the results, their nutritional value and the evolution during the grazing period. Animal eating preference was also evaluated.
It seems that pigs prefer maize and clover and the soil was relatively preserved after the passage of the animals.
Results:
About the performance results: pigs from the first batch were not weighed and the meat non analysed because the aim was to observe the animal behaviour and test the new breeding system. A disease outbreak affected the animals in lots 2 and 3 and growth results are difficult to interpret.
However, pigs in trial 1 were generally lighter in weight and less fatty than the control group at slaughter.

The disease outbreak (SDRP) affected the animals in trial 2. For this reason, the control group pigs were abnormally light entering in the finishing period and there are no growth data available.

An error in the protocol for sample collection made the results of fatty acids profile impossible to analyse.

The economic costs, must be very carefully considered, composed by several items such as seeds used, nutritional value, labour and others.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were solved but new gaps appeared. Further investigation to estimate the nutritional value of the forages ingested and estimate the direct effects of forages on pig growth. Another interesting topic is looking for swine genetics more suitable for grazing.

The barriers to innovation were removed, but new barriers appeared such as the precise number of animals needed to make the system economically relevant and how reduce the waste in the fodder.

The IG suggest using more perennial varieties and to pasture the fodder at the correct vegetative stage to reduce waste and increase the intake.

IV.3.2 Silage containing brewer's yeast as bulk feed for pigs with restricted feeding (IG: ECOVALIA

The aim of this trial was to test alternative source of protein, such as brewer's yeast, an industry by-product rich in protein and vitamin B.

During the summer, pigs in the Dehesa system have difficulties to find forage, with risk of soil consumption. The animals in this trial were in restricted feeding to make advantage in a compensatory growth during the finishing period when pigs are fattened on acorns. Silage containing brewer's yeast and cereal straw can be a valuable source of protein and fibre, available for a long period.

In the trial the treatment group performance was compared to the control one. Animals were weighed once a month. A problem during the calculation of growing pigs, caused a slower weight gain due to a less energy intake.

Results:

No health problems were noticed, furthermore the piglets eating silage had a calmer behaviour. The farmer was satisfied with pigs' performance. It is important during the changing diet, to give silage progressively, because of the pig's appetite. Silage moisture content can affect the intake and should be considered to avoid malnutrition.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were solved and show that an industry by product can be feed to pigs with satisfactory results. New gaps appeared such as how to increase the silage consumption.

The IG recommend the practice to other farmers.

IV.3.3 Feasibility of including cut grass/clover silage in an automatic straw-distributor and its potential to increase pigs' silage consumption and effect on behaviour and cleanliness of the pen (IG: SCANIA)

The aim of the trial was to evaluate the inclusion of silage in an automatic straw distributor, as a potential alternative way to feed pigs with silage. The objective of the trial was to obtain an optimal feed consumption and greater possibilities for the pigs to perform species-specific behaviours, promoting good animal health and welfare.

The test was carried out in the building where pigs are housed on deep straw bedding. Two automatic straw-distributors were available at the test-farm. The loading of straw and silage was done in a separate building.

Silage was put on top of the straw and the distributors were driven along a rail in the ceiling of the buildings. Silage and straw were supplied 4-5 times per day.

Additionally, groups of pigs in another test, at another farm, did not receive silage/straw by a distributor but instead in racks in the indoor pen environment.

The following data were recorded:

• Amount of silage and straw (in total) distributed in the pens during 24 h.
• The evenness of the distribution of the silage/straw in the pens.
• Estimations of silage and straw distributed per pig and amount of silage residuals.
• Visual judgement of the cleanliness of the pens.
• Assessment of which factors that influenced the spreading of silage.
• Observations of the pigs' behaviour (location in the pen, response when the distributor entered the pen and occurrence of eating, rooting or manipulating the silage/straw).

Results:
The results show that the identified knowledge gaps were solved. Automatic silage distribution is possible and consumption is not compromised. Furthermore, compared to feeding silage in racks, in the automatic distribution all the pigs can consume silage at the same time, with reducing competition. Their behaviour can be naturally expressed, and after an activity phase during 30 minutes from the distribution, the pigs were perfectly calm. The pen remained clean.
Knowledge gaps and barriers to innovation:

However, new gaps in knowledge appeared such as the moisture content of silage, that can affect a correct distribution in the pen, with wetter silage reducing the spreading distance. Reducing the length of silage could solve the problem, but further investigation is needed. Also, the amount of silage intake should be increased, but loading capacity and technique were a limiting factor.

The high cost for the automatic system can be a problem for many farmers but this may be a useful approach here the system is already installed.

IV.3.4 Establishing forage turnip (*Barkant Brassica Turnip*) in the pasture outdoor area as supplementary feed to gestating sows (IG: SCANIA)

The aim of the trial was to evaluate if forage turnip in the field can contribute as a complementary nutrient supply and behaviour enrichment activity for restrictively fed gestating sows. Furthermore, if in already foraged outdoor areas forage turnips can lower the nutrient leakage, increase the utilization of the outdoor areas.

Two groups were created, a control group (C) and the trial group (T). Sows were weighted at the beginning and at the end of the trial. The following data were recorded:

a) Body weight
b) Piglets born per sow
c) Piglets born alive and number of weaned piglets

Results:

The average number of total piglets born was similar among sows in both groups. On average, the sows in the C-group had 0.5 stillborn piglets whereas sows in the T-group had 1.0 stillborn piglets. The mean number of weaned piglets were 8.5 and 8.4 piglets per sow in the C-group and T-group respectively, thus the average piglet mortality corresponded to 34.5 and 36.9%, respectively. This data could be affected by a fire in a nearby building, that caused stress for the animals.

The control group received a 100 % ration compared to a 60% reserved to the trial group.

The sows consumed the forage turnips, rich in starch, and also leaves. Gestating sows are hungry even in the 100% commercial feed group, their need is very high even with an important consumption at pasture. This information led to the conclusion that in the trial group with 40% feed restriction, there must be enough turnips available to cover the energy requirements.

Animals can manifest species-specific behaviour in the field including foraging and rooting behaviour.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were solved but new gaps appeared. The sowing technique, evaluating the possibility of intercropping with legumes; as well as other beet varieties should be tested. Weeds should also be reduced.

The loss of body condition should be addressed as it causes reproductive and performance problems (number of weaned piglets and live births). A dietary restriction of less than 40% could be adopted in the treated group.

IV.3.5 Silage for organic weaning pigs – a potential to lower the risk for weaning diarrhoea and promote gastric health and growth (IG: SCANIA)

The aim of the tested practice was to evaluate if chicory silage can have beneficial effects on gut health and might be a way to lower the risk for weaning diarrhoea and promote pig health and growth in diets were without zinc oxide). Piglets can reduce their stress and increase growth performance.

Chicory silage should promote the development of lactobacillus in the intestinal flora with a possible probiotic effect. Silage was evaluated for quality and nutritional value. Piglets were randomly weighed to evaluate their growth.

In batch 1 the treatment group piglets received daily rations of ley crop silage with high inclusion of chicory during 4 days prior to weaning. After weaning, and for 10 days after weaning. The control group did not receive any silage batch 2 included two treatment groups; one that received ley crop silage with high inclusion of chicory and one that received ley crop silage with grass/clover and a control group without any silage, according to the same procedure as in batch 1.

Health problems in all groups required some animals to be treated. The weights of these pigs were excluded from the first weighing occasion (W1), as their weights were not representative.

Results:

The results in batch 1 show that piglets feed with chicory silage gained most weight during the treatment period, compared to the control group. At the delivery, the weights of the groups were similar. The results in batch 2 show that the average pig weights at delivery was higher among control pigs compared with pigs in treatment groups.

Knowledge gaps and barriers to innovation:

The identified knowledge gaps were removed, piglets consumed silage without problems. The treatment group with chicory obtained higher growth, compared to the others. Sufficient space for piglets to avoid competition is recommended.

However, the limited silage intake, represents a weakness point of the practice.

New knowledge gaps appeared such as studies on intestinal microflorae, gut health and piglets performance. The IG suggested to mix chicory with other crops like clover, to increase the silage palatability.

IV.3.6 Grass silage to finishers in addition to liquid feeding - video (IG: SCANIA)

The aim of this trial was to evaluate the addition of grass/clover silage to a liquid feed diet, for growing and finishing pigs, to increase their natural behaviour and reduce social and harmful interactions between pigs. To be noticed that due to unforeseen technical problems, the trail did not obtain conclusive results to produce a PA. Nevertheless, a video explaining the practice was recorded and made available on the Organic Farm Knowledge platform. The details of the trial go as follows:

The trial batch was fed with 80% liquid feed and 6 Kg grass/clover silage. The control group fed 100% liquid feed, did not receive any silage.

The silage contained 64% dry matter (DM) and was fed 10 minutes prior to the liquid feed, two times per day.

Pigs were weighed to monitoring their growth.

Results:

The results show that the animal in the trial group were more active around feeding times and less anxious, spending their time eating silage. However, the silage did not cover the less 20% liquid feed. The IG concluded that to cover the energy gap silage intake should be 0,8-0,9 Kg per pigs per day; about twice the estimated share taken.

Knowledge gaps and barriers to innovation:

Due to an unexpected problem at the farm, the IG could not identify the knowledge gaps to be solved, but new gaps appeared such as the length of the silage; a chopped silage could be mixed with the liquid feed and increase the silage intake. Further trials are needed.

V. Conclusions

The practical testing carried out within the OK-Net EcoFeed successfully contributed to the project objectives in achieving 100% regional and organic feed in monogastrics. From these activities, several positive outcomes were produced, knowledge gaps were identified and barriers to the innovation were solved. Nevertheless, during the course of the trials, new knowledge gaps and barriers appeared. OK-Net EcoFeed IGs proactively overcame these problems or when needed, they proposed innovative solutions and recommended further research.

While many tests showed that the practices can be used in poultry or pig's nutrition management without constrains or reduction in performance, in other cases there is the need of further investigation. For this reason, longer lasting experiments, and multi-annual schemes, which include scientific set up, scientific review procedures and dissemination to further quantify the contribution to the animals' dietary needs and ro balance the ration plan are pivotal.

In conclusion, achieving the goal of 100% regional and organic feed is possible but this can lead to higher costs. To mitigate the costs, OK-Net EcoFeed project results strongly suggest diversifying the protein source used in the ration.

VI. References

Alimentation des volailles en agricolture biologique. (ITAB 2015)

http://itab.asso.fr/publications/cahier-volaille.php?request_temp=cahier%20alimentation

https://organic-farmknowledge.org/tool/38690

Tableau 1 : Apports nutritionnels recommandés couramment admise pour le poulet de chair biologique (source : ITAB)

Âge du poulet	Démarrage (1 - 4 semaines)	Croissance-finition Abattage précoce (5 - 12 semaines)	Finition Abattage tardif (9 - 16 semaines)
Energie métabolisable (en Kcal EMA)	2750 - 2850	2800 - 2900	2700 - 2800
Protéines brutes (%) maxi	21	19	16
Lysine digestible (%) mini	0,90	0,74	0,65
Méthionine digestible (%) mini	0,35	0,30	0,25
Méthionine + cystine digestible (%) mini	0,68	0,56	0,49
Matière grasse (%) maxi	2 - 5	2 - 7	2 - 7
Calcium (%) mini	1,1	1	1
Phosphore disponible (%) mini	0,42	0,35	0,35
Sodium (%) mini	0,15	0,15	0,15

https://lohmann-breeders.com/publications/poultry-news/