



**Organic Knowledge Network on Monogastric
Animal Feed
OK-Net EcoFeed**

**Report on research
needs and barriers to
innovation**

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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 support farmers, breeders and the organic feed processing industry in achieving the goal of 100% use of organic and regional feed for monogastrics, in particular for pigs, broilers, laying hens and parents of broilers and laying hens. The aim of WP2 – ‘Collection of knowledge and best practices’ is to collect research and innovations information relevant for organic and regional feed for monogastrics and to identify knowledge gaps and areas, where knowledge exists but is not yet ready to be implemented. This deliverable D2.3 “Report on research needs and barriers to innovation” synthesises the results of the OK-Net EcoFeed project for future implementation of 100% used of organic and regionally produced feed in monogastrics. Furthermore, it provides recommendations for a better targeted research and innovation agenda.

The research needs and barriers to innovation are extracted and analysed from the D2.2 “Knowledge synthesis of feed production”, the D2.1 “Advisors’ knowledge mapping exercise”, input from the Innovation Groups and Thematic Groups (WP3), the discussion forum on the knowledge platform (WP5-Task 5.3), and reports from the OK-Net EcoFeed practical testing in the Innovation Groups (WP3-Task 3.3).

Recommendations to formulate a better targeted research and innovation agenda proposed in this report point out the need of applying a holistic approach, stakeholder including approach, regionally based solutions and longer lasting experiments.

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I. Introduction

The present deliverable D2.3 “Report on research needs and barriers to innovation” is part of the 3-year OK-Net EcoFeed with the goal to achieve the 100% use of organic and regional feed for monogastrics. The report on research needs and barriers to innovation is led by AU/ICROFS and supported by ORC, AIAB, FiBL, SLU/EPOK and ITAB. It presents the results and outcomes of the OK-Net EcoFeed project recommending research and solutions be considered in future studies and European multi - actor projects can be used for a better targeted research and innovation agenda.

In this document “Research needs” are defined as: “needs for (qualitative or quantitative) scientific studies on specific topics or themes to propose solutions to problems/challenges identified within OK-Net EcoFeed” while “Barriers to innovation” are those “obstacles identified within OK-Net EcoFeed when striving to implement innovative tools or management to feed monogastrics 100% organic and regionally. Barriers can be legislative, (infra)structural, practical or economical.”

The D2.3 considers the knowledge gaps identified at the start of the project, common themes of potential challenges and solutions indicated by the Innovation Groups as well as the discussion forum on the Organic Farm Knowledge and results of the practical testing in the Innovation Groups. Furthermore, the recommendations in this report reflect what organic farmers, advisors and the feed industry have experienced as research needs and barriers to innovation in their daily work combined with needs and barriers discovered by researchers. The recommendations target people working in the area of 100% organic and regionally grown feed for monogastrics.

II. Research needs and barriers categories

Over the course of the OK-Net EcoFeed project, it was identified a variety of topics where further scientific studies are needed to propose new solutions to problems or challenges in organic feed production for monogastrics. For simplicity, the topics were grouped in the following research needs categories:

1. **Amino acids** research on analysing the content, availability and digestibility of amino acids in new feed ingredients.
2. **Animals** research on breeds that are better suited to the organic production systems with longer lifetime and more foraging, like slow-growing breeds, dual-purpose breeds and breeds with more expressed natural foraging behaviour.
3. **Crops, side streams and residues** research to estimate the nutritional value and digestibility of new feedstuffs and to propose the optimal mix of different crops and different mixtures for silage and research on animal health, welfare and performance when fed new feedstuffs. Research to improve the quality of existing feed sources through plant breeding. Research to develop appropriate technique and equipment for seeding of e.g. turnips. Research to develop technology to analyse the nutritional value of locally produced feed.
4. **New protein sources for monogastric animals** research on the extent to which starfish and green protein can be included in the diet for monogastrics. Research to improve the quality, environmental and economic sustainability of the processing of mussel meal and green protein. Research on efficiency, emissions, and energy input concerning the type of diet that insects are reared on.
5. **Antinutritional factor (ANF)** research on the development of on-farm analyses of ANF. Research on how to treat ANF e.g. heating time and temperature.

6. **Technology and infrastructure** to utilise the feed more efficiently, research to develop small-scale on-farm equipment for post-harvest technologies, develop automatic distributors for silage, develop a technique for identifying heat damages in soya bean when processing is carried out locally.
7. **Foraging and management** research to explore regional possibilities for combinations of breeds, feeding and foraging strategies and management.

Furthermore, the following five categories of barriers to innovation:

1. **Legislative, consumers and ethical barriers:** Some bottlenecks need to be discussed and if possible solved when new feedstuffs should be included in organic diets for monogastrics: Legislation, consumers perception of organically products, and in the bigger picture moving towards more climate-friendly and sustainable agriculture the discussion on land use for feed, food or freedom from production needs to be addressed.
2. **Economical barriers:** The feeding cost will increase when changing to 100% organic and regionally produced feed. Decisions need to be made to adapt to increased cost.
3. **Structural and infrastructural barriers:** New feedstuffs might not work with the existing feeding system. The whole supply chain needs inspection and possible adjustments.
4. **Practical barriers:** When feeding new feedstuffs the animals need to get acquainted with the feed and the farmers must learn how to handle the feed.
5. **Availability and cost of protein sources:** One step is to investigate possibilities and solutions another step is to prioritise the solutions. Therefore, discussions on the availability and cost of protein sources would support the change to 100% organic and regionally produced feed for monogastrics. Some of the questions to ask are: How much organic protein can be produced in Europe? To which degree can new sources of protein substitute imported soya and will it be payable?

III. The methodology: Gathering information on research needs and barriers to innovation

Throughout the 3-year OK-Net EcoFeed project, data and information were gathered to define the research needs and barriers to innovation as well as propose recommendations for a better research and innovation agenda. These include:

1. Innovation Groups inputs
2. Knowledge synthesis of feed production
3. A scientific review on alternative protein sources
4. Discussion forum on the Organic Farm Knowledge Platform
5. Results of testing in Innovation Groups

III.1 Innovation Groups inputs

During the second year of OK-Net EcoFeed, data from the Innovation Groups such as type and number of animals, farm size, people employed, were collected to gain an understanding of relevant context factors, particular challenges faced by group members and solutions to feeding regional organic feed. Additionally, knowledge and information sources preferably used by practitioners were also considered. Knowledge from the Innovation Groups was gathered through interviews, using a purpose-designed common framework, and Innovation Group meetings with 100 members attending across 10 Innovation Groups in 8 European countries.

Farmers joining the Innovation Groups come from diverse systems with context-specific and environmental factors influencing the availability of 100% organic and regional feed for their pig and poultry systems. These include the centralised storage systems for animal feed in Italy, the absence of organic feed companies in Serbia and Scotland and climatic factors inhibiting the growing of high-quality protein sources. Nevertheless, some common themes of potential challenges and solutions emerged from the meetings. These are summarised below:

Challenges	Solutions
1. Understanding the needs of animals at different life stages	a) Produce a handbook of requirements for each life stage b) Identify breeds or lines of breeds that do better under organic regimes c) Improve management of amino acid/protein balance
2. Understanding protein availability in all current and potential feed sources	a) Knowledge of process, storage and feeds and industry involvement b) More efficient use of existing feeds more – toasting, sprouting, etc., c) Improving the quality of existing feed sources through plant breeding
3. Innovative feeds (including insects, by-products, fishmeal)	a) Additives or supplements that improve the performance of existing feeds – Determine the availability, improved required infrastructure, legal status and moral acceptability

III.2 Knowledge synthesis of feed production

To contribute to the goal of 100% use of organic and regional feed for monogastrics, the Innovation Groups identified the knowledge and innovations needed to overcome obstacles related to organic monogastrics feeding. Based on common themes mentioned above, the knowledge synthesis “Feeding monogastrics 100% organic and regionally produced feed” aimed to describe:

- the protein needs for organic monogastric animals (pigs, layers and broilers), including different breeds and rearing conditions
- different protein feed resources, mostly new or not commonly used protein sources, their nutrient content, production prerequisites, and their potential feeding value
- small-scale, on-farm equipment for feed processing
- different feeding strategies.

The knowledge synthesis enabled participants in Innovation Groups and Thematic Groups to choose feed materials, feeding strategies, breeds and small-scale on-farm equipment for testing when aiming at 100% organic and regionally produced feed for monogastrics.

In the knowledge synthesis, it is concluded that when feeding pigs and poultry 100% organic and regionally produced feed, getting enough protein and specific amino acids is a challenge. There are two ways to go and they can be combined. One is to utilize by-products, for example, waste from various productions, and explore new protein sources e.g. marine products or to refine already known products such as grass. Also, the development of small-scale on-farm equipment to refine locally produced raw materials is an option. The

other way is to feed the animals less intensively and for this feeding strategy, slow-growing breeds fit better. Some slow-growing breeds are already known, some are rediscovered old breeds. The challenge with the slow-growing and less-yielding breeds is that the productivity is getting smaller and either the farmer will earn less or the prices of eggs and meat will increase. However, the possibilities for combinations of regionally grown feed, low-yielding breeds with different feeding strategies are many and they need to be explored. Finally, the knowledge synthesis identified new research needs on:

- nutritional requirements of alternative breeds. Precise nutrient recommendations for organically produced pigs and poultry do not exist.
- nutritional value of new protein sources for monogastric animals
- various combinations of breeds, grazing and supplemental feed.

III.3 A scientific review on alternative protein sources

To follow up on the knowledge synthesis of feed production (D2.2) a review paper on new protein sources in Europe was published on 20th February 2021 in [Sustainability](#). The title of the paper is: “The Potential of Locally-Sourced European Protein Sources for Organic Monogastric Production: A Review of Forage Crop Extracts, Seaweed, Starfish, Mussel, and Insects”.

The review assessed opportunities and limitations of producing, processing, and using starfish (*Asterias rubens*), mussel (*Mytilus edilus*), insects, green and brown seaweed, and forage crop extracts as ingredients in feed. Protein concentration and amino acid quality of the feed ingredients are evaluated to understand their substitution potential compared with protein-rich soya bean and fishmeal. Protein concentration and amino acid quality of the feed ingredients are evaluated to understand their substitution potential compared with protein-rich soya bean and fishmeal. Feedstuffs’ effect on digestibility and animal performance is summarized.

Except for seaweed, all novel ingredients show potential to partly substitute fishmeal or soya bean fulfilling part of the protein requirement in organic monogastric production. However, improvements during production and processing can be made to enhance protein quality, the sustainability of the novel ingredients, and nutrient utilization of novel feed ingredients.

To move forward using these novel feed ingredients the following research needs are identified:

- For feeding **starfish** and **green protein**, more studies on which extent to they can be included in the diet for monogastrics in organic production are needed.
- Research to improve the quality, the environmental and economic sustainability of the processing of **mussel meal** and **green protein** is needed.
- If **insects** are to be used as a sustainable feed ingredient, more knowledge on efficiency, emissions, and energy input concerning the type of diet that insects are reared on is needed. Furthermore, legislation may be a bottleneck for the use of insect meal in organic diets for monogastrics.

III.4 Discussion forum on the Organic Farm Knowledge Platform

Along with conducting the OK-Net EcoFeed project, the Organic Farm Knowledge Platform has been developed. One purpose of the platform is to provide a space for discussing knowledge gaps and barriers to innovation.

One aim of the platform was the technical maintenance and moderation of the discussion forum, which allows users to discuss their experiences with the practical application of the tools and end-user material stored in the toolbox. Therefore, fora for each of the three animal species addressed by the OK-Net EcoFeed project - pigs, broilers and laying hens - were set up. Additionally, any other specific theme that emerged as part of workshops during OK-Net EcoFeed was added to the fora.

Every tool has a built-in discussion option (Disqus) in the detailed view, where users of the platform can ask questions, suggest corrections or discuss with each other.

Should research needs and barriers to innovation be mentioned by the users of the platform, the idea is that the people responsible for the platform (the project partners of OK-Net EcoFeed or afterwards the members of the executive and editorial board) will collect the needs and barriers and pass them on to TP Organics where they can be incorporated in future calls.

As the platform has just recently been created it is not yet possible to gather knowledge gaps or barriers to innovation from the platform, however, the platform can be useful for these discussions in the future.

III.5 Results of testings in Innovation Groups

Innovation Groups within OK-Net EcoFeed have conducted several practical testing. To get the most possible out of the testing, the facilitator of each Innovation Group was asked to answer some questions regarding knowledge needs and barriers to innovation and barriers to innovation. The questions were:

1. Did any new knowledge needs appear?
2. Did any new barriers to innovation appear?

In Table 1, all the tests are listed and the relative challenges and replies to questions regarding the specific knowledge needs and barriers to innovation are summarised. The challenges include the following categories:

- Processing
- Nutritional value
- Growing
- Feeding
- Ration planning

The specific research needs, and barriers of innovation are also summarised for each of the categories as in chapter II and below:

Research needs:

- Amino acids
- Animals
- Crops, side streams and residues
- New protein sources for monogastric
- Research on efficiency, emissions, and energy input
- Antinutritional factor (ANF)

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- Technology and infrastructure
- Foraging and management

Barriers of innovation:

- Legislative, consumers and ethical barriers
- Economical barriers
- Structural and infrastructural barriers
- Practical barriers
- Availability and cost of protein sources

It is important to be aware that most of the tests are done on one single farm or lab and without repetitions, which means that the results are not scientifically evident, but indications of how the tools tested worked.

Table 1 An overview of research needs and barriers to innovation identified by the tests performed in OK-Net EcoFeed

	IG	Theme	Headline	Challenge	Research needs on:	Barriers to innovation
1	SA	Layers	The potential for sprouted seeds to supply feed for laying hens, UK	Processing Nutritional value	Antinutritional factor (ANF) - assessing toxins and antinutritional factors (ANF) such as tannins and phytates. - developing local tests for ANF	A structural barrier: New feedstuffs might not work with existing feeding systems
2		Broilers	The potential feed value of grain tailings for poultry, UK	Nutritional value	Crops, side streams and residues - the feed value of more different weed seeds.	An environmental and practical barrier: When feeding grain tailings, the risk of weed spread can be an obstacle.
3		Pigs and poultry	The potential for increasing the nutritional value of beans for pig and poultry diets, UK	Processing Nutritional value	Amino acids - heating time and temperature necessary to treat trypsin inhibitors. - the digestibility of toasted Faba beans and animal performance.	A structural barrier: Supply chain support for Faba beans is needed. A practical – equipment barrier: equipment for toasting are needed to be available in the UK
4	Bioland	Layers	Experiments on the cultivation and feeding of nettles, Germany	Growing Processing Nutritional value	Crops, side streams and residues - feeding different duration and content of nettles in ration to chicks.	A legislative barrier: Legislation on nettles as feed is needed.
5		Layers	Test with laying hens for feed preference in the open-air area, Germany	Growing Feeding Nutritional value	Foraging and management - estimating how forage contributes to feeding free-range chickens, and more specifically how methionine-rich run-off vegetation can be taken into account in the feed ration for chickens.	NA

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	IG	Theme	Headline	Challenge	Research needs on:	Barriers to innovation
6	Ecovalia	Pigs	Silage with brewer's yeast silage to Iberian growing pigs, Spain	Processing Feeding		A practical barrier: Pigs need to learn to know the taste of silage with brewers yeast to be willing to eat a sufficient amount.
7	ITAB	Layers	100% organic feedstuffs for laying hens, France	Feeding Ration planning	Crops, side streams and residues & Technology and infrastructure - availability of protein resource to fulfil the demand for 100% organic feeding for layers. - increasing cost with only locally produced feed.	Structural barriers: Barriers like decisions on land use and infrastructure need to be taken to make it possible to produce enough organic protein in France. An economic barrier: Increasing cost with only locally produced feed.
8		Broilers	Alternatives to soya bean cake for finishing broilers, France	Feeding Ration planning	- the quality of expeller pressed oil from camelina, rapeseed and sunflower produced directly at the local farm - the cost of producing expeller pressed oil from camelina, rapeseed and sunflower on local farms	A structural and economic barrier: Availability and costs of new sources of protein
9		Pigs	Foraging pigs – contribution of protein-rich fodder to finisher pigs, France	Growing Feeding	Foraging and management & animals - the nutritional value of the forages ingested by free-range pigs - the direct effect of forages on free-range pigs growth - the quantity of fodder consumed by foraging pigs - pig genetics. Some breeds might be more suitable for grazing and foraging than others	Economics and ethical barriers: when letting pigs forage: - How much can animals be rationed to make the system economically relevant? - How to remunerate this approach: evaluate the gustatory interest for the consumer? - How can the waste of fodder be reduced as much as possible?

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	IG	Theme	Headline	Challenge	Research needs on:	Barriers to innovation
10	AIAB	Layers	Cultivation of organic camelina and use of the cake for laying hens, Italy	Growing Feeding	Ration planning & Technology and infrastructure <ul style="list-style-type: none"> - possible inclusion of camelina in the feed ration - Post-harvest technologies for making camelina cakes 	An economic barrier: <ul style="list-style-type: none"> - Low productivity of camelina
12	AU/ICROFS	Layers	Clover-grass protein by bio-refining Nutrient compositions and shelf life, Denmark	Processing Feeding Nutritional value	Amino acids <ul style="list-style-type: none"> - possible Cysteine additions to biorefined clover-grass protein 	Infrastructure barriers: Drying and storage of the green protein paste locally need to be solved so that the product can be grown more locally and used in larger quantities.
13		Broilers	Adding lactic acid bacteria to drinking water or via maize silage for organic broilers, Denmark	Feeding Animal health	Animals <ul style="list-style-type: none"> - chicken genetics. Some breeds might show more active foraging behaviour than others - to what extent can the good quality of silage contribute to chickens' daily feed intake 	A practical barrier: As maize silage proved to be good for the intestinal health of poultry, the barriers are: knowledge to produce maize silage on farm or where can it be bought and how can it be stored at the farm.
14	Epok/SLU	Pigs	Chicory silage to organic weaning pigs, Sweden	Feeding Animal health	Animals & Crops, side streams and residues <ul style="list-style-type: none"> - the optimal proportion of Chicory in the silage to get expected benefits - the microflora, health status, and pig performance when feeding Chicory - the suitability of including e.g. white clover when feeding weaning pigs 	NA
15		Pigs	Grass-clover silage in an automatic straw-	Feeding Animal health	Technology and infrastructure	Practical barriers:

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	IG	Theme	Headline	Challenge	Research needs on:	Barriers to innovation
			distributor for pigs, Sweden		<ul style="list-style-type: none"> - to what extent can silage fed with an automatic straw-distributor replace parts of the commercial feed - the optimal structure of silage suited for feeding with an automatic straw-distributor 	An automatic straw distributor can be used for feeding silage, however, barriers like loading the silage to the straw distributor and how to increase the proportion of silage loaded on to the distributor need to be solved.
16		Pigs	Grass silage to finishers in addition to liquid feeding, Sweden	Feeding Animal health	Crops, side streams and residues <ul style="list-style-type: none"> - if small particles (silage, cop-corn) add any nutritional value to the feed 	NA
17		Pigs	Establishing forage turnip (Barkant Brassica Turnip) to gestation sows, Sweden	Growing Feeding Animal health	Technology and infrastructure & Crops, side streams and residues <ul style="list-style-type: none"> - appropriate technique and equipment for seeding turnips. - how the level of water in the soil affect the establishment of the turnips - the most suitable types of turnips e.g. fodder turnip or fodder beet to establish - the best feed proportions of turnips gestating sows - the effects of turnips on sow body condition, reproduction and behaviour 	NA
18	Donau Soja	Pigs	Nirs analysis for identifying heat damages in soya bean	Processing	Crops, side streams and residues, Antinutritional factor (ANF) & Technology and infrastructure	Practical and infrastructural barriers: Participants from Serbia and Moldova indicate that a new barrier is the

D.2.3 Research needs and barriers to innovation

	IG	Theme	Headline	Challenge	Research needs on:	Barriers to innovation
			processing, Serbia + 4 other countries		<ul style="list-style-type: none"> - How to improve the processing performance of soya beans - the maximum acceptable TIA for different livestock species - improving processing performance including follow-up activities. This is a complex task and requires close collaboration with the manufacturer of the machine. Steps for improvement are dependent on each processing equipment/process. 	<p>availability of the appropriate NIR testing infrastructure in their countries. These participants also mention that trust in this technology must be built up in the community as the local laboratories and their traditional methods (wet chemistry) have provided the common point of reference so far. Turning the measurements into practice is the third barrier.</p>

IV. Research needs and barriers to innovation: recommendations for a better targeted and shared research and innovation agenda.

As mentioned in the previous chapters, research needs and barriers to innovation have been identified by compiling the information gathered from farmers, advisors, feed companies and researchers all engaged in different ways in the Horizon 2020 project OK-Net EcoFeed. The needs and barriers were identified at face-to-face meetings in Innovation Groups, by literature reviews, at Science Bazaars and during tool-tests in Innovation Groups. The aim was to identify and propose solutions to feeding monogastrics 100% regionally produced protein feed, and so shifting away from feeding mainly imported protein. This important change includes the entire production of pork, eggs and chicken from use of land, animal and plant breeds, feed processing, integration of foraging animals, new technologies, local infrastructures as well as legislation and consumers perception. It has also become clear that challenges and possibilities differ from region to region (e.g. the use of [brewers yeast silage as a feed](#), prerequisites a brewery nearby).

The Innovation Groups have demonstrated that the farmers and advisors are aware of specific difficulties and limitation, which has led to innovative discussions on knowledge needs and what to test. As an example, one Innovation Groups agreed about the importance to find and evaluate the practical solutions on how to feed silage. They were inspired by each other to find solutions that could enable better utilization of the silage both as a feed resource and enrichment, despite different farm conditions (e.g. feeding system, pig category etc.). However, it also became clear that some needs can be fulfilled with quick-fix results from one season or one farm experiments whereas others, e.g. experiments on breeds, foraging and land use, require several years before valid conclusions can be made. For this reason, longer lasting experiments, and multi-annual schemes, which include scientific set up, scientific review procedures (studies for publication) and dissemination and research in relations to other fields of organic farming besides animals are pivotal. Nevertheless, longer-lasting experiments also have economical barriers, mainly due to limited funding opportunities.

Four main points appeared important when heading for a better targeted and shared research and innovation agenda:

- A holistic approach
- A stakeholder including approach
- Regionally based solutions
- Longer lasting experiments

In the following sub-chapters research needs are barriers of innovation identified over the course of OK-Net EcoFeed are deepened.

IV.1 Research needs

Research needs, identified throughout the OK-Net EcoFeed, are compiled into seven themes. It is important to be aware that needs and barriers can vary and be dependent on country, climate, conditions on farms, animal species, animal breeds, specific crop rotations, the age and size of the farm, current economic and market situation etc. However, the seven themes cover topics that are essential for most of the conditions, but the solutions can be different.

The following seven research themes are on top of the agenda when changing to feeding monogastrics 100% organic and regionally produced feed:

1. Amino acids

The main issue of changing to 100% organic and regionally produced feed is the availability of essential amino acids. For every single crop, the content, availability and digestibility of amino acids must be taken into account. Until now many crops are analysed, but a lot more analyses of crops are needed to be able to suggest nutritionally optimised diets based on 100% organic and regionally

produced feed. Further research is needed to analyse the content, availability and digestibility of amino acids in new feed ingredients.

2. Animals

Recommendations on nutritional requirements for farm animals are mostly based on indoor rearing. On the other hand, in organic production research is needed on nutritional requirements of animals reared under organic conditions, e.g. foraging and varying climate, animals at different life stages, and of alternative breeds, to feed the animals adequately and not excessively.

Within this context, further research is needed on breeds that are better suited to the organic production systems with longer lifetime and more foraging, like slow-growing breeds, dual-purpose breeds and breeds with more expressed natural foraging behaviour.

3. Crops, side streams and residues

Crops that are not commonly used for feeding and side streams and residues from different kinds of productions can be of interest when replacing soya e.g. nettles, chicory, camelina, residues from breweries and juice production. The nutritional content and the digestibility of the new feedstuffs are crucial and mostly unknown. Growing, harvesting, and processing new crops, side streams and residues demand new or customized techniques and technology. More products need to be bio-refined to have better palatability and lower content of antinutritional factors.

Research is needed to estimate the nutritional value and digestibility of new feedstuffs and to propose the optimal mix of different crops and different mixtures for silage and research on animal health, welfare and performance when fed new feedstuffs are needed.

OK_Net Ecofeed has identified the need of further research to improve the quality of existing feed sources through plant breeding. For example, new rapeseed breeds could be a solution for cysteine production in regions where rape can be cultivated.

4. New protein sources for monogastric animals

The review paper “The Potential of Locally-Sourced European Protein Sources for Organic Monogastric Production: A Review of Forage Crop Extracts, Seaweed, Starfish, Mussel, and Insects”, published on 20th February 2021 in [Sustainability](#) and produced within the OK-Net EcoFeed: states:

- For feeding **starfish** and **green protein**, more research on the extent to which it can be included in the diet for monogastrics in organic production are needed.
- Research to improve the quality, the environmental and economic sustainability of the processing of **mussel meal** and **green protein** is needed.
- If **insects** are to be used as a sustainable feed ingredient, more research on efficiency, emissions, and energy input concerning the type of diet that insects are reared on is needed.

5. Antinutritional factor

Antinutritional factors (ANF) are deleterious compounds present in the feed. ANFs interfere with the animal's ability to digest plant nutrients and it can also influence the palatability. There is a need to know the content of ANF in different feed sources. As more feed will be grown and processed at local farms, research on the development of on-farm analyses of ANF is needed. Furthermore, research on how to treat ANF (e.g. heating time and temperature necessary to treat trypsin inhibitors in e.g. faba beans is needed). Finally, the maximum acceptable trypsin-inhibitor activity TIA for different livestock species needs to be specified.

6. Technology and infrastructure

New technology, improved infrastructure and storing facilities are essential if feed is grown and processed on farms or locally. Hence, research is needed to:

- Develop small-scale on-farm equipment for post-harvest technologies to utilise the feed more efficiently e.g. making cakes, toasting, sprouting, drying and storing.
- Develop automatic distributors for silage or similar ingredients to ease the process of increasing the proportion of silage in the feed.
- Develop a technique for identifying heat damages in soya bean when processing is carried out locally.
- Furthermore, research is needed to develop appropriate technique and equipment for seeding of e.g. turnips.
- Research is needed to develop technology to analyse nutritional value locally.

7. Foraging and management

The possible combinations of regionally grown feed, low-yielding breeds, different feeding and foraging strategies are infinite. Research to explore regional possibilities for combinations of breeds, feeding and foraging strategies and management is needed. Moreover, knowledge-sharing and development of decision support tools would help farmers to form and adopt new sustainable production systems in a holistic approach.

IV.2 Barriers to innovation

Besides research needs, barriers to innovation are identified within OK-Net EcoFeed project when striving to implement innovative tools or management to feed monogastrics 100% organic and regionally". The barriers are described and grouped in five themes:

1. Legislative, consumers and ethical barriers

Some bottlenecks need to be discussed and if possible solved when new feedstuffs should be included in organic diets for monogastrics:

- Legislation may be a bottleneck for the use of insect meal in organic diets for monogastrics and possibly also for other resources not yet considered as feedstuffs e.g. nettles.
- Consumers perception of organically produced pork, eggs and chickens is essential. A huge task to inform consumers how the animals are raised and how they are fed is needed to explain the price of the organic pork, eggs and chickens.
- As consumers are moving towards more vegetarian food, legumes for monogastric might be perceived as a threat to vegetarians and vegans.
- In the bigger picture moving towards more climate-friendly and sustainable agriculture, the discussion on land use for feed, food or freedom from production needs to be addressed.

2. Economical barriers

The feeding cost will increase when changing to 100% organic and regionally produced feed. Decisions need to be made to adapt to increased cost e.g. which crop to grow, processing on-farm or buying processed feed. Maybe reduce waste as much as possible.

3. Structural and infrastructural barriers

New feedstuffs might not work with the existing feeding system. The whole supply chain needs inspection and possible adjustments. Equipment e.g. toasting need to be available for purchase and

space for storage to be considered. The share of local land between foraging and production of feed needs to be reconsidered.

4. Practical barriers

When feeding new feedstuffs the animals need to get acquainted with the feed and the farmers must learn how to handle the feed e.g. produce silage, process e.g. faba beans, feed silage automatically, test for contents in the feed, feeding grain without sewing weeds etc.

5. Availability and cost of protein sources

This theme could also have been placed on the top of the list since it is the core challenge of how to feed monogastrics 100% organic and regionally produced feed. The theme is placed together with barriers to innovation as one step is to investigate possibilities and solutions another step is to prioritise which solutions to choose. Therefore discussions on the following topics would be mitigating support to the change to 100% organic and regionally produced feed for monogastrics.

- How much organic protein can be produced in Europe?
- To which degree can new sources of protein substitute imported soya and will it be payable?

To be noticed that not all themes are equally relevant across the whole of Europe. There are problems and needs which exist only in certain regions. Therefore, besides a common European strategy, regional approaches are also needed: projects and solutions for regionally relevant topics should be developed in the respective regions only, in collaboration with stakeholders, rather than aiming for a general solution across Europe. Many smaller elements in growing and feeding 100% organic and locally produced protein are known, longer-lasting systemic experiments including the development of decision support tools would be a comprehensive next step in making it possible to develop sustainable production of pork, eggs and chickens.

As mentioned at the beginning of this chapter, participants within Innovation Groups inspired each other to find and test appropriate solutions, which means that farmers, industry-partners and farm-advisors are important participants together with researchers in a co-development process.

V. Conclusion

Over the course of the OK-Net EcoFeed project, research needs and barriers to innovation regarding feeding monogastrics 100% organic and regionally produced feed have been identified by farmers, advisors, feed companies and researchers. The change of feed is demanding and includes the entire production of pork, eggs and chicken from use of land to animal and plant breeds, processing of the feed, integration of foraging animals, new technologies, local infrastructures and not the least legislation and consumers perception. The goal of feeding 100% organic and regionally can be achieved with the support from more knowledge. Some research needs can be fulfilled with quick-fix results from one season or one farm experiments whereas others, e.g. experiments on breeds, foraging and land use, require several years before valid conclusions can be made. In conclusion, much has been achieved in the goal of 100% use of organic and regional feed in pig and poultry but much more can still be done. The research needs, barriers to innovation and the recommendations proposed by the OK-Net EcoFeed project and compiled in this report will further support the European research and multi actor projects in relations to organic animal farming and beyond.

VI. References

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