EIP-AGRI Focus Group

New feed for pigs and poultry

FINAL REPORT
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1. Executive summary

The Focus Group on New Feed for Pigs and Poultry of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) addressed the question `Which are the promising new sources and strategies to reduce pressure on natural resources while feeding or producing feed for pigs and poultry?` This group of 20 experts from across Europe assessed the challenge and identified possible solutions. The expert group identified 'knowledge gaps' and needs, generated recommendations on how to ensure future implementation of new feed for pigs and poultry, and proposed innovation actions and ideas for Operational Groups.

One of the key issues to be addressed by the Focus Group was to identify and characterise the potential new feed options for pigs and poultry. Based on a rationale focusing on economy, nutritional value and sustainability, outlined in the **Starting paper**, the experts assessed the most promising new feed options during two workshops held in Finland and Belgium. The Focus Group experts identified the following top five new feed options:

- Bakery products
- Green biomass (grass/clover)
- Insects (black soldier fly – *Hermetia illucens*)
- Micro-algae
- Single cell protein (bacteria)

The selected top five new feed options have different pros and cons regarding nutritional value, economy and sustainability (**Chapter 4**). Overall, bakery products are a potential feed ingredient which would be relatively easy to introduce/use more widely in the EU. Yet, the nutritional value is not as high as the other new feed options in the Focus Group`s top five. Although green biomass (grass/clover) is slightly more mature than insects, micro-algae and single cell protein from bacteria, the remaining four new feeds are relative immature; and require a lot of research and development before they can be fully implemented at both farm and industry level. To promote implementation, several ideas for Operational Groups were suggested for these top five new feed options (**Chapter 5**).

Recommendations regarding future needs were likewise discussed by the experts both from a practical as well as academic perspective. The consensus was that there is a great need for fast(er) analysis of new feed materials. NIRS (Near InfraRed Spectrometry) was identified as one of the promising techniques to do this. The experts also discussed the need for more insight on the processing of novel (and current) feedstuffs, particularly insects. They also pointed out that more knowledge is needed on the optimal or maximum percentage of these new feed ingredients in feed mixes.

The work of the Focus Group provides a broad overview of how stakeholders from the feed sector can contribute to addressing practical and research related issues.

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2. Introduction

According to the International Feed Industry Federation (IFIF) the global production of compound feed for livestock (including dairy and fish) was estimated at 1 billion tons in 2016 with the European region accounting for approx. 159 million tons[1]. Within the meat production industry, pig and poultry are the fastest growing livestock subsectors; and the demand for pigs and poultry is expected to increase by 38% and 104%, respectively, compared to current production levels[1,2]. Hence, there is a growing need to find feed sources that can supply the expected increase in pig and poultry production, taking into account the increased focus on sustainable farming.

The Focus Group on New Feed for Pigs and Poultry of the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) addressed the challenge of identifying new feed sources to improve economy, supply and sustainability for European stakeholders. A group of 20 experts from across Europe assessed this challenge and identified possible solutions.

The overall objective of the Focus Group was to identify the 'knowledge gaps' and needs, and to generate recommendations on how to ensure future implementation of new feed for pigs and poultry, proposing innovation actions and ideas for Operational Groups. More specifically, these objectives and tasks were to:

- Make an inventory of alternative strategies and sources for pig and poultry feed, including both new and underused sources.
- Analyse the most important pros and cons of these alternative feed sources, strategies and supply chains.
- Analyse their general economic and environmental sustainability, analyse their technical viability and safety, and identify potential tools/barriers affecting a broad uptake.
- Propose potential innovative actions and ideas for Operational Groups (funded under the Rural Development Programmes) to stimulate the use and improvement of alternative resources.
- Identify needs from practice and possible gaps in knowledge which may be solved by further research.
- Identify how new and emerging alternatives may be transferred to other conditions (location, type of production) and how they may be checked and standardised in a cost-effective way to obtain safe and steady products at farm level.
- Identify innovative business models for farms and/or third parties.

This report presents the result of the work of the Focus Group experts and is intended to inform stakeholders that have an interest in developing the supply chain of new feed for pigs and poultry. The report summarises the views of a Europe-wide group of experts covering 14 Member States and representing academia, advisers, primary producers and industry stakeholders; highlighting the need for innovative collaboration across sectors, locally, regionally and across Europe.

The members of the Focus Group are listed in **Annex B** - they contributed as individuals rather than as representatives of an organisation.

[1]IFIF (2017). International Feed Industry Federation Annual report 2016-2017. http://annualreport.ifif.org/wp-content/uploads/IFIF-Annual-Report-2016-2017-download.pdf
[2]Alexandratos N, Bruinsma J (2012). World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO. http://www.fao.org/docrep/016/ap106e/ap106e.pdf

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3. Brief description of the process

The Focus Group on New Feed for Pigs and Poultry met on two occasions during 2018 and 2019. The first meeting was held in **Espoo, Finland on 7-8 June 2018**, while the second meeting was held in **Brussels, Belgium on 30-31 January 2019**. The EIP-AGRI Service Point facilitated the meetings, supported by the coordinating expert (see **Annex B**).

To open the meeting in Espoo, the Focus Group **Starting paper** was presented, this document had been prepared by the coordinating expert with support from the EIP-AGRI Service Point. This was followed by break-out sessions where the inventory of suggested new feed for pigs and poultry was further developed and discussed by the expert group in smaller groups and in the plenary. The second part of the meeting focused on outlining the mini-papers (see **Annex C**), which constitute a significant part of the group's work.

The Brussels meeting started with presentations of the four mini-papers that had been initiated in Espoo covering: i) overview of existing novel feedstuffs; ii) characterisation of novel feed; iii) sustainability; and iv) production and processing of novel feed. Subsequently, success factors and barriers were discussed for a wide range of specific new feeds and from these a list of top five options was identified. The second part of the Brussels meeting focussed on identifying innovative solutions and ideas for EIP Operational Groups and innovative projects as well as identifying gaps related to research and knowledge needs.

The discussions, views and findings of these meetings are the basis of this report.

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4. State of play

a. Framing key issues

One of the initial key issues to be addressed by the Focus Group was to identify and characterise the potential new feed options for pigs and poultry. Overall, the new feed options should meet several of the requirements listed below:

- Moderate to high protein content (this is a major advantage as protein is in high demand)
- Good protein digestibility and nutritionally relevant amino acid profile
- Moderate to high content of relevant micronutrients (minerals and vitamins)
- No (or limited content of) anti-nutritional factors
- Health-benefitting properties (*e.g.* pre-biotics, feed fibres etc.)
- Sustainable production (this may also cover economics and ethics)
- Competitive price (preferably comparable to soybean meal but depending on the feed it may also be
- relevant at fishmeal price levels).

Theoretically, there was a very large number of options to choose from. Based on a rationale focusing on economy, nutritional value and sustainability, the frame work for the Focus Group experts had been outlined in the **Starting paper** and a decision was made that the Focus Group`s work would focus primarily on new feeds from: i) aquatic biomass, ii) industrial residuals and former foodstuffs, iii) insects and iv) single cell protein.

The experts initially discussed a number of new feed options within these four categories. They also added a fifth category - green biomass - to the overall list. Based on the requirements highlighted above, table 1 below lists the potential new feed options according to the five major categories.

Table 1: List of potential new feed options for pigs and poultry

Aquatic Biomass	Industry residuals and former foodstuffs	Green Biomass	Insects	Single cell protein (SCP)
Macro-algae (*e.g.* Kelp) **Micro-algae** (*e.g.* Chlorella, Spirulina) Duck weed Mussel meal	Dairy residuals (*e.g.* yoghurt, milk) Hydrolysed animal protein Okara (by-product of soy fermentation) Crop by-products (*e.g.* oil-seed rape, cereals, EU soy) Catering waste Retail waste **Bakery products** (*e.g.* bread, cookies)	**Grass/clover** (and protein extract made from grass/clover) Legumes (*e.g.* Beans) Locally-grown whole plant silage for production and processing Tree protein Microbial protein from tree production	**Black Soldier Fly** (*Hermetia illucens*) Mealworm (*Tenebrio molitor* and *Alphitobius diaperinus*) Crickets (*Acheta domesticus*)	Yeast protein concentrate **Bacterial protein concentrate**

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	Bakery by-product (*e.g.* batch production intermediates) Food waste/agro-food industry			

In the subsequent progress of the Focus Group, during the second meeting in Brussels, a top five of new feed options (highlighted in bold in Table 1) was selected based on a number of different criteria as outlined in **section c of Chapter 4** - these included:

- Bakery products
- Green biomass (grass/clover)
- Insects (black soldier fly – *Hermetia illucens*)
- Micro-algae
- Single cell Protein (bacteria)

b. Good practices

As outlined in the introduction there is an increasing demand for sustainable, nutritionally relevant and economically viable feed for pigs and poultry. Yet, many new feed options will, at present, have the disadvantage of being immature in one or several areas (*e.g.* market-relevant supply); hence, their inclusion in the pig or poultry value chains may initially be slow. This issue is currently relevant for *e.g.* insects, micro-algae and single cell protein (SCP), while former foodstuffs such as bakery products may not have supply issues. Nevertheless, once developed, insects, micro-algae and SCP may be worthwhile to include, both for nutritional and sustainability reasons. However, currently there are only few examples of good practice with the 'immature' new feed options at full industrial scale; although both the insect and SCP sectors are expanding fast (see example of companies in **Annex A**).

At farm-level it may be possible to implement some new feed options through local cooperatives or in co-production with other on-farm activities; an approach that many farmers already use in their daily operation. Several of the new feed options offer great potential to enhance farm circularity. For instance, micro-algae may be produced on slurry on-farm in co-production with pigs or poultry and subsequently be used as feed supplement. Supplemented with locally available biomass (ensuring a nutritionally-balanced diet), insects may also be produced on on-farm vegetable residues from crop or horticulture production, and subsequently used on-farm for pig or poultry production; enabling regional circular bioeconomy (Fig. 1).

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Figure 1. On-farm feeding of poultry with insects (© Shutterstock)

Many of the new feed options likewise have great potential to implement circular economy in the pig and poultry value chains. This may, initially, be most obvious regarding application of industrial residues and former foodstuffs such as bakery products. Here several EU-based companies provide good cases of how using former foodstuffs, *e.g.* from the bakery industry, in feed supplements for poultry and pigs, can provide a sustainable business and supply. Some of the major challenges for this sector are logistics, including securing relevant products based on transportation costs and volumes available at customers, as well as downstream processing (*e.g.* removal of residual packaging). Nevertheless, bakery products are used widely in the EU, particularly for pigs. Good examples also exist for poultry. For instance, the Dutch farm **Kipster** produces sustainable eggs using a feed based primarily (97%) on leftovers like bakery products.

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c. Success and fail factors

A major outcome of the second meeting in Brussels (Fig. 2) was the identification of a top five of new feed options that the Focus Group experts assessed as the most promising - as outlined above (see Table 1). The top five new feed options were: i) Bakery products, ii) Green biomass (grass/clover), iii) Insects (black soldier fly – *Hermetia illucens*), iv) Micro-algae and v) Single cell Protein (bacteria).

Figure 2. Workshop in Brussels, 30-31 January 2019

Before getting to this outcome, the experts evaluated several different criteria. Initially, the experts discussed the new feed options from Table 1 to identify how they could be transferred across application and/or geographical levels. They also discussed how the feed options could be standardised and applied in a cost-effective way to obtain safe and steady products at farm or industry level. For instance, as illustrated in Figure 3, how can insects be transferred from farm to industry level, or how may Kelp (macro-algae) be utilised to a higher extent at regional level?

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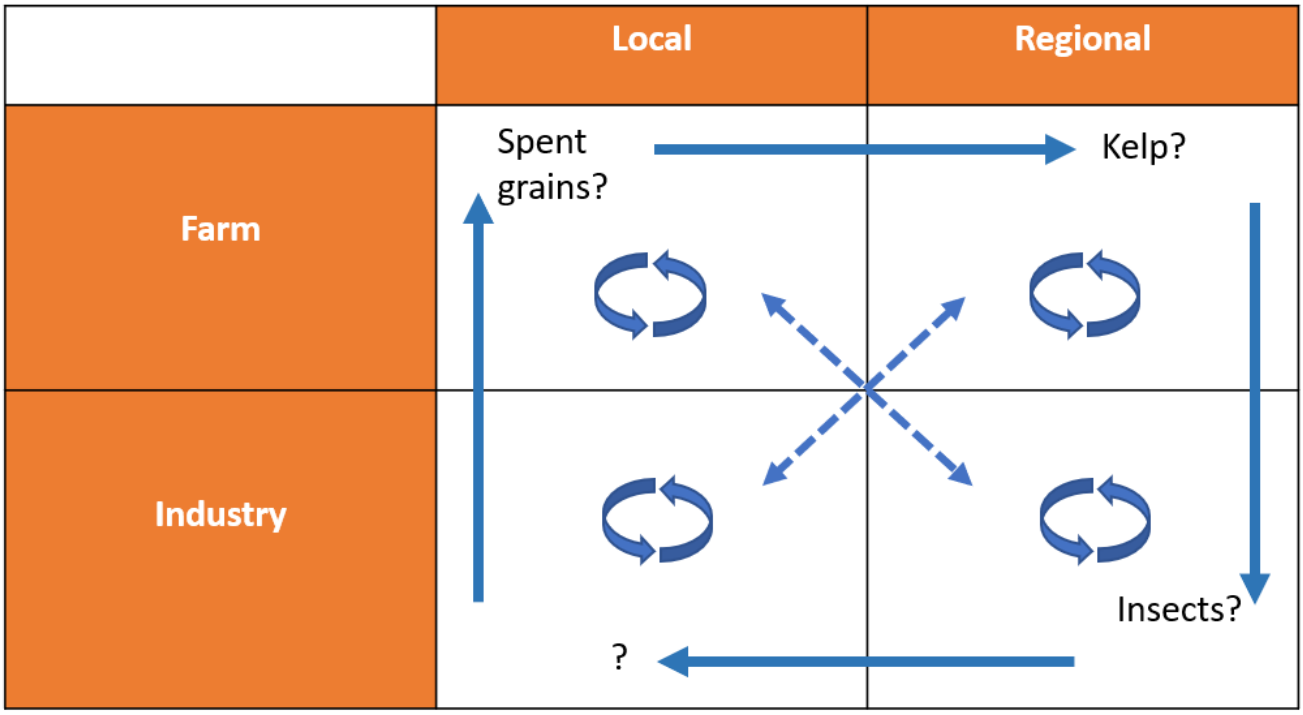

Figure 3. Transferring new feed alternatives across application and geographical levels

Algae, bakery products, grass/clover and okara were selected and discussed independently in four sub-working-groups focussing on possible obstacles related to 'transferring' the new feed option. Table 2 below outlines the baseline of the new feed options discussed followed by different ideas and concerns related to transfer between application and geographical levels.

Table 2: Examples of transferring new feed options across application and geographical level

Algae	Bakery products
Baseline A high protein feed that is easy to grow and with potential bioactive properties *Transferring – Local to regional level* R&D example from Denmark: On farm application of manure in anaerobic digestion (AD) facilities utilised as energy for production of micro-algae production to be used as feed for pigs. Sufficient availability of manure and infrastructure to grow micro-algae *Transferring – Industry to farm level* Example from Ireland: Industrial drying of seaweed, for use on farms. **Example from Portugal**: Application of industry excess heat from cement works to produce micro-algae as feed for pigs *Risk* Excessive use may influence the colour of the meat and feed palatability. An acceptable level of micro-algae in feed needs to determined.	*Baseline* High volume energy-rich feed from mature industry *Transferring - Industry to farm level* Challenges may involve legislation (*e.g.* distinguishing between waste and food residues), processing (*e.g.* residual packaging material in the feed) and availability *Transferring - Local to regional level* Availability, collection/logistics and demand *Risk* Development of competing industry (*e.g.* biogas) Lack of standardisation (regional)

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Grass/clover	Okara
Baseline Locally grown crop(s) with benefits regarding soil quality, carbon footprint and animal welfare (*e.g.* gut health). *Transferring – Local to regional level* Farm to regional use, including local drying, transport and supply of standardised silage (farmers deliver grass/clover as raw material) - could also go to feed industry *Transferring – Farm to industry level* Industrial extraction of green biomass protein (produced on-farm) to create standardised output *Risk* How to ensure feed intake? Dilution of diet and inclusion level? Which form to offer, processed, controlled? High costs?	*Baseline* High protein (20%) by-product from EU soya-production, available all year. *Transferring – Industry to farm level* Use okara at local farms as concentrate in liquid feed, possibly mixed with other by-products. Challenges relate to transport (high moisture level), logistics, residual water (left after pressing water out of the biomass in question), fat content, application of drying process (mechanical)? *Transferring – Local to regional level* As okara is produced cost-effectively at industry level it may have potential for use by regional producers of compound feed producers *Risk* Salmonella as well as preservation/oxidation

After discussing the transfer potential (as an overall evaluation of robustness and flexibility) of the new feed alternatives, the experts assessed the success and fail factures of the top five feed options. The overall input from the experts is highlighted in Table 3-7 and summarised below. Additionally, the mini-papers (see **Annex C**) cover a wide range of relevant parameters that provide an overview of the top five new feeds regarding their: i) maturity as feed (both from an economic, logistical and development/R&D perspective), ii) their nutritional value, iii) sustainability profile as well as iv) how they are produced and processed.

Bakery products (Table 3) is overall an 'easy' applicable new feed that is available in large quantities throughout Europe year round; although it may be scattered in some European regions (*e.g.* South-East) which would require regional consolidation to ensure that the resources are collected, processed and distributed to local farmers. From a developmental perspective, bakery products are at a relatively mature level. Moreover, using bakery products as feed has very clear sustainability benefits. However, one of the challenges is the lower protein content (mainly a source of carbohydrates) as compared to some of the other new feed options (*e.g.* SCP and insects); and there may be a risk of residual packaging material (mainly plastics) in the processed bakery products.

Table 3: Success and fail factors of bakery products

Success	Barrier
	Technical
Standard	Additives - risk of dangerous ingredients (chocolate/theobromine) Packaging Standardisation (reactive usage) Transportation/collection Biological quality (energy) Regulatory issues (*e.g.* organic certification)
	Social
Re-food Environmental 'credits'	No issues
	Economic

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Competition with other uses (anaerobic digestion, beer-making) Effects on product price green label Low moisture/dry product, low mycotoxins	'Cheaper label'?

Green biomass (Table 4), with emphasis on grass/clover, is a relatively mature feed that can be applied with a moderate effort as new feed. Particularly silage from green biomass is a technique that has been used widely and for many years; and it is readily applicable at farm level. On the contrary, protein extracted from green biomass still needs development to be competitive. Green biomass provides good nutrition as feed, although the protein content is low. Moreover, monogastrics, especially pigs, may have increased enteric greenhouse gas (GHG) production when fed on green biomass, which is a challenge from a sustainability perspective. The current lack of production facilities hampers the use of green biomass as a feed ingredient at farm and industry level, despite the potentially large supply.

Table 4: Success and fail factors of green biomass (grass/clover)

Success	Barrier
	Technical
Silage (low-tech processing)	Technical demand for primary production Processing to obtain final concentrate High concentration of pigments (chlorophyll) For non-ruminants, fresh green biomass may be harder to digest Requires technology for better use of new fractions Seasonally dependent (except if dried or as silage) Dependent on local (regional) production, as it will not be economically viable to transport green biomass over long distances Dependent on production system and facilities
	Social
Natural product Gut health High quality co-products Reduced GHG ruminants Accepted by organic rules	Competition with other species (ruminants) Antimicrobial use Increase enteric GHG for monogastrics (pigs)
	Economic
Emerging plant-derived markets demand for new products Use fibre fraction for biofuel	Competition, availability, cost and demand Soybean meal dependency

Insects (Table 5) - with special focus on black soldier fly larvae (BSF) - have a high nutritional value for both pigs and poultry; and may provide a sustainable solution if produced on the right substrate(s). Moreover, there may be potential benefits related to improved health and bio-sanitation (*i.e.* BSF larvae appear to be able to metabolise certain mycotoxins and other contaminants)[3]. Yet, although the insect sector is expected to expand rapidly in the coming years[4], the volumes and price levels that the BSF producers can deliver are still not fully competitive with established alternatives such as soybean meal and fishmeal. Furthermore, there is lack of knowledge regarding how to ensure optimal use of BSF as feed for both poultry and pigs; *e.g.* both regarding nutritional needs of BSF, inclusion level of BSF in feed and standardisation to mention a few knowledge needs.

[3]See recent articles from AllAboutFeed for more details - health: https://www.allaboutfeed.net/New-Proteins/Articles/2018/3/Insects-3-healthy-compounds-for-animal-feed-264878E/ and bio-sanitation: https://www.allaboutfeed.net/Mycotoxins/Articles/2019/10/Can-insects-hold-the-key-to-safe-feed-479880E/?dossier=26709&widgetid=1

[4]For an overview of the current status of the European insect sector please refer to: http://ipiff.org/ipiff-vision-paper/

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Table 5: Success and fail factors of black soldier fly (BSF)

Success	Barrier
Technical	
Re-use pig farms as BSF farms Easy to produce Opportunities for organic farming Upgrading nutritional value of 'waste' (leftovers) Low environmental impact (especially on 'waste' substrate) Bio-sanitation function (*e.g.* regarding mycotoxins and anti-nutritional factors)	Managing heat production efficiently Accumulation of heavy metals, etc. How to separate larvae from substrate Biosecurity/traceability Produce constant product on variable substrate Grow on liquid substrates Chitin (can be problematic if content is too high)
Social	
Accepted in poultry Suitable as human feed Creates new jobs (collection business of 'waste' substrate) Use of 'waste' as substrate-circularity Potential reduction in use of antibiotics	Not accepted in swine production Insect housing and management in relation to communication Registration as animal protein or separate (*i.e.* insect protein) regarding labels/concepts (*e.g.* vegetable-based) Insect welfare unknown The idea of eating insects
Economic	
Use of 'waste' products, biogas products (fat-/protein-rich) Digestibility and protein composition of insect meal Efficient protein conversion of BSF	Cost price of raw material Competing for substrate (retrieval systems: logistics of raw material in relation to cost price)

Micro-algae production (Table 6) is still a relatively immature sector; although, like insects, there is an increased focus on their potential as a feed of high nutritional value. They contain both macro-nutrients like protein and lipids, but also micro-nutrients such as vitamins and minerals and they provide health benefits related to gut health[5]. It could be very interesting to add micro-algae to the drinking water or as liquid feed. On the other hand, one of the main challenges with micro-algae is the very high water content, which requires a lot of energy for either transportation or processing (drying) of the biomass. Micro-algae could potentially be produced and used on-farm, however, from a technical perspective, this is still a few years into the future. Yet, like for insects and SCP (Single Cell Protein, see below), there is in principle no need to use arable land in the production of micro-algae.

Table 6: Success and fail factors of micro-algae

Success	Barrier
Technical	
Energy source Protein source with good amino acid profile Carotenoids and other beneficial nutrients (*e.g.* omega-3, vitamins, etc.) Add to drinking water or liquid feed Can be dried Boosts immunity, reducing the need for antibiotics	Low dry matter content Risk of contamination with toxic spp. (other micro-algae) Storage tanks or drying capacity needed Digestibility Traceability of heavy metals
Social	
No competition for land	Need energy for heating

[5]See recent article from FeedNavigator: https://www.feednavigator.com/Article/2018/09/11/Microalgae-coproducts-may-boost-health-support-growth-in-nursery-pigs

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Can be cultured on manure Potential animal health benefits Culture possible in desert or even in space Potential reduction in use of antibiotics	Need a lot of water Traceability of heavy metals
Economic	
Upscale fermenters - compact production system Highly controlled and closed system	Need energy for heating Need a lot of water Substrates to grow them on are limited (*e.g.* minerals)

Single cell protein (SCP) from bacteria (Table 7) has many of the same pros as both insects and micro-algae, *e.g.* regarding nutritional value and the potential for production in a circular, economic way - looping 'waste' and by-products back into the feed/food chain. From a sustainability perspective, the emission of greenhouse gases associated with the production with SCP from bacteria appears to be low. Yet, as the SCP production platform is still relative immature there is not a lot of data available related to assessing sustainability more widely. Moreover, like with green biomass, insects and micro-algae, there is also lack of knowledge regarding how to ensure optimal utilisation of SCP from bacteria as new feed for both poultry and pigs.

Table 7: Success and fail factors of single cell protein (SCP) – bacteria

Success	Barrier
	Technical
Amino acid profile Easy to handle Production of SCP industry on waste Probiotic effect	Risk of contamination with toxic spp. (other bacteria) Immunology issues Content of nucleic acids
	Social
Production of SCP industry on waste Less antibiotics? Palatability	Consumer perception Future legislation Antibiotic resistance?
	Economic
	Competitiveness

In summary, the top five new feed options have different pros and cons regarding nutritional value, economics and sustainability. Overall, bakery products are a potential feed ingredient which would be relatively easy to introduce/use more widely in the EU. Yet, the nutritional value is not as high as the other top five new feed options. Although green biomass (grass/clover) is slightly more mature than insects, micro-algae and SCP, the remaining four new feed options are relative immature and still require a lot of research and development before they can be fully introduced at both farm and industry level. This is further elaborated in **Chapter 5** below, and particularly in **section b** regarding research needs.

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5. What can we do? Recommendations

a. Ideas for Operational Groups and other innovative actions

Operational Groups (OGs) are groups of people who come together to work on concrete, practical solutions to a problem or innovative opportunity and whose project is funded by the EU Rural Development policy[6]. OGs are intended to bring together multiple actors such as farmers, researchers, advisers, businesses, environmental groups, consumer interest groups or other NGOs to find innovative solutions for the agricultural and forestry sectors. The OG projects have to share their results through the EIP-AGRI network and other appropriate channels.

After identifying and discussing success and fail factors (section c of Chapter 4), the next task of the Focus Group experts, during the Brussels meeting, was to define and outline a number of ideas for OGs and other innovative actions for each of the top five need feed options. Table 8 below summarises the 21 ideas for OGs and other innovative actions that were generated during this process. It highlights the problem to be addressed, the general idea, where in Europe the innovative action would likely be most relevant, which stakeholders would be the most obvious to include and a contact(s) from the Focus Group for stakeholders requiring more information to develop an OG or other innovative action[7].

Table 8: Ideas for Operational Groups and other innovative actions - generated by the Focus Group

Problem **Bakery products**	**Idea**	**Where**	**Who**	**Contact**
Inconsistent quality of bread from small(er) scale producers	Find methods to guarantee more uniformity of final product Investment in separate lines NIR analyses	Central Europe	processors who prepare feed ingredients for compound feed mills from food waste Feed mills	Kees van Gorp Nuria Llanes
How to analyse and get 'on-line' (fast) nutrient value for (by-)products (liquid/solid pasty)	Develop fast, robust and feasible regression methods to analyse and upload results to update the feed formulation Know composition - proximal analysis for starch (carbohydrate) fractions and gelatinized carbohydrates	Central Europe *e.g.* implement-ted with other interacting by-products (*e.g.* Okara)	By-product dealers Feed mills Farmers (liquid feeding)	Kees van Gorp David Sola-Oriol Nuria Llanes
Standardisation of the end product	Mapping of bakery producers and improve logistics	Regional/national	Bakery by-product processors Bakery industry	Kees van Gorp

[6]For more information on the formation of OGs and opportunities for funding please refer to: https://ec.europa.eu/eip/agriculture/en/eip-agri-operational-groups-%E2%80%93-basic-principles
[7]Contact details are available on the Focus Group website: https://ec.europa.eu/eip/agriculture/en/focus-groups/new-feed-pigs-and-poultry

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	Create database of product producers			
To establish a platform where supply and demand meet	Establishing a platform for producers of bakery products and feed mills or farmers	EU-wide	Bakeries Feed mills Farmers	Kees van Gorp
Separation of packaging from bakery products	Automation to improve the process, especially of smaller items that risk ending up in the food chain	EU-wide	Processors of bakery products (separation technology) Feed mills	Kees van Gorp
Black soldier fly (BSF)	**Idea**	**Where**	**Who**	**Contact**
How to involve local authorities and citizens in decisions on large-scale BSF facilities, so that these will be acceptable to them	Involve local authorities and citizens in testing, measuring and demonstrating the benefits and impacts of insect production in a circular economy approach	Local	Insect producers NGOs Citizens Local authorities Farmers?	Daniel Murta
Increase market pene-tration of insect meal in an EU region	Test and disseminate good approaches to help producers to put their insect products in the market Develop a market campaign about the benefits of insect consumption	National	Insect producers Feed producers Animal farmers	Daniel Murta
Availability of by-products for insect farming	Help insect farmers to get by-products to use as feed for insect farming Mapping availability of vegetable by-products at regional level Logistics	Regional	Insect producers Agri-food factories Logistic experts	Daniel Murta
Green biomass	**Idea**	**Where**	**Who**	**Contact**
Efficiency of separators on-farm related to screw presses on green biomass (*e.g.* grass or maize silage)	Compare available screw presses and other technologies regarding the efficiency with which they extract grass protein to the liquid fraction	National (IRL/UK)	Applied research Farmers	Edgar Garcia Manzanilla Katie Owens

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	during processing. In addition, assess the efficiency with which pigs utilise this grass-protein-rich liquor, in terms of live-weight gain and feed conversion efficiency to carcass gain at different inclusion rates in the total diet.			Wallace Henry
Tail biting and gut health of piglets	Test the use of grass/clover to control tail biting and feed piglets following evidence of good palatability of clover for piglets in Germany	National (IRL/UK)	Farmers (Livestock and grass producers) Mills Applied research institutes	Wallace Henry Edgar Garcia Manzanilla Katie Owens
Can grass/clover be used for monogastrics and how to incorporate it into the farming systems?	Testing the use of free range areas for laying hens to grow grass/clover	North-western Europe	Farmers	Corine Walvoort Magdalena Presto Åkerfeldt
The use of legumes is associated with some nutritional problems (*e.g.* antinutritional factors)	Testing the use of technology that reduces the impact of antinutritional factors. Gather *e.g.* cooperatives and farmers to use the same technology	Ireland Denmark Spain Bulgaria	Cooperatives Farmer	Belen Blanco
Growing peas in a new area. Not enough yield and lack of knowledge on how to grow them	Test different varieties adapted to the specific climate Visit an area with experience in growing peas and a feed plant or farm with experience using it	Northern Spain Northern Italy	Cooperative d´Ivarcs (France) AC3A (farmers union in France) SOS protein And also farmers, advisers and feed producers, I presume?	Nuria Llanes

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Micro-algae	Idea	Where	Who	Contact
Information/alignment gap; Gap between industry and end-users	Demonstration action Stakeholder network Dissemination	Region with leading algae producers (to link to farmers)	Algae industry Farmers	Lars-Henrik Lau Heckmann
What is the 'optimal algae' Get the overview of utilisation Categorize micro-algae usable at local/farm or industry level	Test the applicability for different feed purposes of different micro-algae Candidate both from a nutritional and production perspective	Academic level with link to industry and engineering	University and applied science institutes Leading industry companies (micro-algae)	Lars-Henrik Lau Heckmann
Water and nutrient supply (for production at farm level)	Product improvement: Applying micro-algae in drinking water Laying hens: Opportunity to get added value through omega-3 eggs. NB This may also require more research on the following questions: Do birds ingest enough micro-algae to take in enough omega-3 to produce the enriched eggs? General (research) question: How much protein/nutrients can laying hens ingest per unit of water?	Pig farms liquid feed/drinking water Laying hens farms drinking water	Farmers Algae producers	Lars-Henrik Lau Heckmann
Single cell protein (SCP) – Bacteria	**Idea**	**Where**	**Who**	**Contact**
How to combine liquid at pig feed farms with potential SCP production sites such as washing water from food production sites (*e.g.*, potato, milk, cheese)	Test system based on SCP using washing water to upgrade it so it can be used in liquid pig feed	Area with production plants and pig farms in same area; *e.g.* Benelux, Germany, Scandinavia	Pig farmers (liquid feeding) Food industry	An Cools Corine Walvoort
SCP at early stage of development	There are parallel industrial production processes running (*e.g.*	EU-wide	Applied research institutes	Lars-Henrik Lau Heckmann

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	production of penicillin) that could provide inspiration for 'technology transfer'		SCP industry	
Consumer acceptance	Testing ways to change consumer acceptance by increasing transparency at farm level – finding ways to show good practices at farm level The possible solution of the problem is to disseminate good practice at farm level combined with information-sharing in the market	Bulgaria	Applied research institutes Processors' associations Food industry	Mariana Petkova
Technical issues	**Idea**	**Where**	**Who**	**Contact**
No methodology for sampling products with high water content and with different fractions	Develop methodology for a particular product	Wherever the product is available	Farmers Applied research institutes Industry producing the product	Edgar Garcia Manzanilla Belén Blanco An Cools

In summary, the OGs and innovation actions suggested for the respective top five new feed options were very different, highlighting the unique issues with regards to ensuring their future uptake at farm and industry level. Apart from feed specific OGs, a technical OG was also suggested by a sub-group of experts. As outlined under the section on 'success and fail factors' (**section c in Chapter 4**), the limited market maturity of most of the new feed options reflects their need for further research and development. This is described in more detail below.

b. Research needs from practice

The final part of the Brussels meeting was dedicated to discussing the needs from practice and the needs for research regarding the top five new feed options. The Focus Group experts were divided into two large sub-groups comprising 'practitioners' (farmers, advisers and industry members) and 'academia' (researchers); the former group worked on the needs from practice, while the latter group worked on needs for research. The outcome of the sub-groups is highlighted in Table 9 and Table 10, respectively.

Table 9: Needs from Practice

Problem	Need for research/knowledge gap	Comments
Gap between research and practice	Establishment of network	No need for theory (papers) but solutions
Mapping of available feed (seasonal availability)	Establishment of database of producers	
Lack of fast/reliable/cheap	Calibration curves for new products NIRS (Near Infra-Red Spectrometry) Mycotoxins	

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analytics methods on site/real time		
Real requirements of animals in real conditions (new breeds)	Transfer of genetic potential to feed producers Modelling, integration of chain data and block sampling	
Nutrient requirements of insects feed that does not compete with other livestock	Micro-nutrient requirements Treat them as livestock How to measure? Standards?	
(In)breeding of insects	Breeding programme	
Processing methods for insects	Variability of end-product Influence of feed on insects	
Lack of economic data	Survey on economics on insects farming	

Table 10: Needs for Research*

Problem	Need for research/knowledge gap	Comments
Nutrient requirements of black soldier fly (BSF) unknown[a]	How to influence the ratio fat/protein Micronutrients needs	Horizon Europe (FP9)
Breeding schemes of BSF missing[a]	Selection pressure (which env. parameters) substrates selection pressure (substrate unique)	Co-ordination
Substrates for novel protein unknown[a]	Research on applicability of various substrates as feed for BSF	Horizon Europe (FP9)
Calibration of NIRS for novel feedstuff (insects, SCP, micro-algae)[b]	Feed reference database for novel feedstuff (linked with substrate used) Link with production conditions Application of blockchain technology	OG, COST, TN
Correct analytical methods to validate novel feedstuff - what to measure and how to interpret the results[b]	Composition/safety	
Limits of inclusion levels of novel feedstuff[c]	Palatability, health, body composition (*e.g.* of BSF larvae)	
What is the right level and way to include green protein (grass/clover) in feed? Effect on performance, microbiota, health, animal welfare[c]	Digestibility studies	
Need for more insight on how to process novel and current feedstuff[b]	Development and testing of various processing methods Effect of processing steps on all feedstuff	
Faster methods for nutrient utilisation by animals[b,c]	Field based artificial intelligence multivariable metabolomics, big data, faeces, saliva, blood, biomarkers	Horizon Europe (FP9)
Sustainability criteria of novel feedstuff[b,c]	Environmental impacts (LCA) Meat/egg quality parameters (processing) Social impact	User driven innovation
Balanced diets with amino acids and novel feedstuff[c]		

* The needs for research are categorised into three major themes including: [a]Production of novel feedstuffs and how do we produce the novel feedstuff in a sustainable way, [b]Inclusion & analysis (characterisation) what are the characteristics? [c]Use (species, levels, effects) How to use them? What are the effects/impacts?

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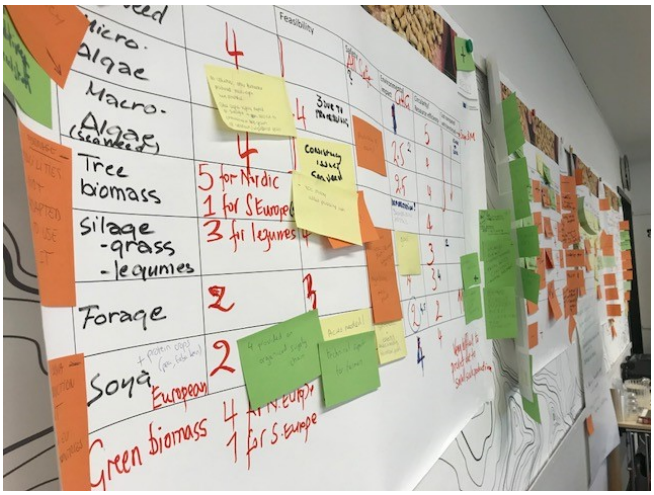
As expected, the issues displayed in Table 9 and Table 10 are very different and mostly represent short-term issues (Table 9) and mid- to long-term issues (Table 10). However, there are overlaps in the needs highlighted by the 'practitioners' and 'academia' sub-groups. First, both groups identified a great need for fast(er) analysis of new feed materials; one of the promising techniques identified was NIRS (Near InfraRed Spectrometry). Secondly, more insight into processing methods for novel (and current) feedstuff, particularly insects, was also a common need identified by the two sub-groups. The OG ideas presented in the previous section (see *e.g.* Table 8) provide one approach to move forward with (some of) the needs from practice. Moreover, the research needs outlined above (Table 10) will have to be addressed in future European research and innovation programs. Yet, research is already underway that will provide more knowledge on several of the research topics listed above (for more details please refer to **Annex D**).

c. Other recommendations, including improving take up

Safety and quality standardisation must be ensured in order for the novel feedstuff to be successful as alternative to current feed ingredients. Moreover, for several of the feed options, the number of producers and the level of production must be increased dramatically in order to develop critical mass. The existence of several companies and sources is important for the sectors.

Sustainable feed is particularly important for organic farming. However, additional challenges arise for organic farming in order to meet the requirements for the development and use of the new feedstuffs presented in this report. The separation of the original components or, for example, the substrates for insects are an additional requirement. When developing new feedstuff for the organic farming market, rules on organic production should be taken into account.

Furthermore, some of the new feed options, *e.g.* BSF, will require coordinated communication with the general public to ensure acceptance and recognition of the novel feed strategies and their impact on the sustainability of animal production.



Annex A. Good practices and case studies

Table A: Overview of companies producing new feed based on black soldier fly (BSF), single cell protein (SCP) and micro-algae

Company	Country	Link
Black soldier fly (BSF)		
Nasekomo	Bulgaria	http://www.nasekomo.life/
Enorm Biofactory	Denmark	https://enormbiofactory.com/
InnovaFeed	France	https://innovafeed.com/en/
Mutatec	France	http://en.mutatec.com/
NextAlim	France	http://www.nextalim.com/
Hermetia	Germany	http://hermetia.de/
Insectum	Lithuania	http://www.insectum.eu/en/
Koppert	Netherlands	www.koppert.com
Protix	Netherlands	https://protix.eu/
Hexafly	Ireland	http://hexafly.co/
Hipromine	Poland	http://www.hipromine.com/
EntoGreen	Portugal	https://www.entogreen.org/home
Entomo Agroindustrial	Spain	https://entomoagroindustrial.com/
EntoCycle	United Kingdom	https://www.entocycle.com/
Insect Technology Group	United Kingdom and Belgium	https://insecttechnologygroup.com/
Single cell protein (SCP) – bacteria		
Unibio	Denmark	https://www.unibio.dk/
Calysta	USA	http://calysta.com/
Micro-algae		
Phycom	Netherlands	https://phycom.eu/
Allmicroalgae	Portugal	https://www.allmicroalgae.com/
Cellana	USA	http://cellana.com/

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Annex B. Members of the Focus Group

Name of the expert	Profession	Country
Mr Daniel Murta	Farmer	Portugal
Mr Ilias Kyriazakis	Researcher	United Kingdom
Mrs Magdalena Presto Åkerfeldt	Researcher	Sweden
Ms An Cools	Researcher	Belgium
Ms Belén Blanco	Researcher	Spain
Mr Bertrand Méda	Researcher	France
Mrs Barbara Früh	Researcher	Switzerland
Mr Kees van Gorp	Industry	Netherlands
Ms Corine Walvoort	Industry	Netherlands
Mr Edgar Garcia Manzanilla	Researcher	Ireland
Mr David Solà-Oriol	Researcher	Spain
Mr Wallace Henry	Advisor	United Kingdom
Mr Alberto Sartori	Researcher	Italy
Ms Núria Llanes Baró	Industry	Spain
Ms Mariana Petkova	Researcher	Bulgaria
Ms Giovanna Parmigiani	Farmer	Italy
Ms Katie Owens	Industry	United Kingdom
Ms Aija Rozenfelde	Advisor	Latvia
Mr Jernej Vrtacnik	Advisor	Slovenia

Facilitation team

Lars-Henrik Lau Heckmann	Coordinating expert
Remco Schreuder	Task manager
Emilie Gätje	Co-task manager

You can contact Focus Group members through the online EIP-AGRI Network.
Only registered users can access this area. If you already have an account, you can log in here
If you want to become part of the EIP-AGRI Network, please register to the website through this link

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Annex C. List of mini-papers

Table B: Overview of mini-papers

Mini-paper title	Contributors
Overview on existing and novel feedstuffs	Kees van Gorp, Barbara Früh, An Cools, Corine Walvoort, Aija Rozenfelde, Jernej Vrtacnik, Mariana Petkova, Belen Blanco
Nutritional evaluation of potential new feed ingredients	An Cools, Kees van Gorp, David Sola-Oriol, Katie Owens, Giovanna Parmigiani, Wallace Henry, Alberto Sartori, Nuria Llanes
Production and processing of novel protein feed ingredients for monogastric animals	Daniel Murta, Katie Owens, Alberto Sartori, Nuria Llanes, Belen Blanco, Wallace Henry, Magdalena Presto Åkerfeldt
Overview of sustainability issues regarding new protein sources in pig and poultry feeds	Bertrand Méda, Illias Kyriazakis, Daniel Murta, Jernej Vrtacnik

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Annex D. Relevant research projects

Table C: Overview of selected ongoing large research and development projects in the EU covering black soldier fly (BSF), micro-algae, single cell protein (SCP) from bacteria and green biomass

Research project	Relevance for pigs and poultry	Link
inVALUABLE	Large national research project on **insect** funded by Innovation Fund Denmark. The project has (or will) provide results and Information on production of insects as well as nutritional data on pigs and broilers for **black soldier fly** and mealworms Coordinator: Danish Technological Institute	http://www.invaluable.dk
EntoValor	Large national research project on circular economy with insects as its main driver. Focus on **black soldier fly** larvae bioconversion of vegetable by-products, using insects as poultry feed and insect frass as agriculture soil fertilizer, closing the cycle. Coordinator: Ingredient Odyssey Lda (EntoGreen)	https://www.entogreen.org/en/entovalor/
InDIRECT	Large international research project funded by BBI JU (H2020) focusing on bioconversion of **black soldier fly**, mealworms and crickets including feed application test Coordinator: VITO	http://www.bbi-indirect.eu/Home/
SUSINCHAIN	Recently funded large EU H2020 project on making insect production more cost efficient and developing knowledge of **insects as feed** Coordinator: STICHTING WAGENINGEN RESEARCH	https://cordis.europa.eu/project/rcn/225255/factsheet/en
ReMAPP	Large national research project on **micro-algae** biomass for protein production through cultivation in a closed environment supplied with CO2 and nutrients from the biogas industry. Relevance relates to considerable reduction of production costs and unseen bio-economical advantage for feed production Coordinator: Danish Technological Institute	https://www.dti.dk/projects/project-fields-of-microalgae-to-create-future-sustainable-protein/40798?cms.query=remap
ValgOrize	Interreg (EU) project aiming to stimulate sustainable, controlled cultivation of high quality, safe algal biomass that meets the requirements of the European market. Activities include **micro-algae** feed trials with laying hens and broilers will assess the effects on chicken growth and egg quality. Coordinator: ILVO	https://www.ilvo.vlaanderen.be/language/en-US/EN/Press-and-Media/All-media/articleType/ArticleView/articleId/5332/The-ValgOrize-project-is-launched-Research-towards-the-valorization-of-seaweed-and-microalgae-

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		as-food-on-the-European-market.aspx#.XcHXxjNKiUk
VALUEWASTE	The general objective of this H2020 project is to develop a system for urban biowaste valorisation through the development of three value chains that can be integrated following a cascading approach; including the application of **single cell protein from bacteria** used for poultry feed. Coordinator: CETENMA – Centro Tecnológico de la Energía y el Medio Ambiente	http://valuewaste.eu/
PROVIDE	Large national research project on production of **single cell protein from bacteria** as feed Coordinator: Technical University of Denmark	https://www.unibio.dk/press-release-unibio-and-dtu-to-take-food-step-within-bacterial-protein/
SuperGrassPork	National research project aiming to establish a sustainable solution in relation to achieving expanded and resource efficient organic pig production, based on biorefined **feed protein from organic grassland crops** Coordinator: SEGES	http://icrofs.dk/en/research/danish-research/organic-rdd-3/supergrasspork/
OrganoFinery	National biorefinery of **green biomass for protein feed**, fertilizer and energy. The project develops a new platform for organic growth delivering solutions to the following key challenges to the organic sector: Supply of climate-friendly organic protein feed to monogastric livestock and robust crop rotations in areas with a low density of livestock Coordinator: Aalborg University	http://icrofs.dk/en/research/danish-research/organic-rdd-2/organofinery/
Increased utilization of ley crops in diets to pigs	This Swedish research project at SLU, aims to evaluate the usefulness of **grass/clover** silage as a locally grown feed resource in diets to pigs. The project will evaluate how silage can be utilized at farm level. A special focus will be put on feeding strategies and form of the silage, effect on production, nitrogen utilization, gut health and pig behaviour. Further, the metabolism of phytoestrogens in red clover and its effect on sow fertility and reproduction will be studied. Coordinator: Swedish University of Agricultural Sciences	https://www.slu.se/en/faculties/vh/research/forskningsprojekt/gris/increased-utilization-of-ley-crops-in-feed-for-organic-pigs/
Green Valleys	Green Valleys is an EU project with the goal of establishing a biorefining development platform. The aim is, through a Swedish-Danish research collaboration, to demonstrate how biorefining can **utilize grasslands** to deliver sustainably produced energy products and **protein feed** and show how circular green bioeconomy can utilize the potential of agriculture. Coordinator: Agroväst	https://agrovast.se/eu-projekt/green-valleys/

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Feed-a-Gene	Feed-a-Gene is an EU project that aims to better adapt different components of monogastric livestock production systems (i.e., **pigs, poultry** and rabbits) to improve the overall efficiency and to reduce the environmental impact. This involves the **development of new and alternative feed resources** and feed technologies, the identification and selection of robust animals that are better adapted to fluctuating conditions, and the development of feeding techniques that allow optimizing the potential of the feed and the animal. Coordinator: INRA	**https://www.feed-a-gene.eu/**

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AGRICULTURE & INNOVATION

The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- ✓ the EU Research and Innovation framework, Horizon 2020,
- ✓ the EU Rural Development Policy.

An EIP AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

The concrete objectives of a Focus Group are:

- ✓ to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- ✓ to identify needs from practice and propose directions for further research;
- ✓ to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on:
http://ec.europa.eu/eip/agriculture/sites/agri-eip/files/charter_en.pdf

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register via www.eip-agri.eu

servicepoint@eip-agri.eu | +32 2 543 73 48 | Koning Albert II laan 15 | Conscience Building | 1210 Brussels | Belgium