Final report

for the CORE Organic Cofund funded project

"*Proven welfare and resilience in organic pig production*" POWER

Period covered: 01-05-2018 -> 01-11-2021

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1. General information

1.1 Project information

Project information			
Project acronym	POWER	**Project ID**	1883
Project title	Proven welfare and resilience in organic pig production		
Project website	https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/		
Details of the project coordinator			
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Institution	Aarhus University	**Country**	Denmark
Start of project	01-05-2018	**End date of project**	30-04-2021
Duration in months	36 (42)	**New end date in case of a project extension due to COVID-19**	01-11-2021

1.2 Consortium

Partner no.:	**Country:**	**Institution/ organisation name:**	**Type of institution/ organisation[1)]**	**Functions[2)]**	**Involved in WPs:**	**Contact person with e-mail address:**
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1) University, Public research centre, Private research centre, Company, Other.
2) PC = Project coordinator, WPL = Work package leader, WPCL = Work package co-leader, P = Participant
3) inclusive e-mail address 4) Work package co-leader

2. Summary

2.1 Final project summary suitable for web publication for a wider audience

Despite a huge diversity in system design and practice between and within countries, European organic pig producers face common challenges related to animal welfare, nutrient losses and system resilience. Shared animal welfare issues are piglet mortality, health problems around weaning and housing systems for growing-finishing pigs poor in environmental stimuli. Environmental challenges include risk of ammonia emissions from outdoor runs and nutrient leaching from pasture contributing to GHG emissions. In the POWER project, we addressed these challenges in close cooperation with producers throughout Europe.

Actions to promote piglet health and welfare

Several types of actions were evaluated to promote maternal behaviour, reduce piglet mortality and improve piglet growth and health. Enlarged farrowing pens improved maternal nest building behaviour, and confinement of piglets in the nest during sow feeding was the best way to increase piglet nest use in early lactation. Regarding the prevention of health problems before and after weaning, iron supplementation to prevent anemia was only required for indoor piglets, and daily oral supply of small amounts of iron rich substrates might be even more efficient than iron injection. Supplying sows and piglets with microorganisms from the natural environment through fermented products was a promising option to modulate piglet gut microbiota. Later weaning is another way to improve health after weaning, and extending lactations to ten weeks caused good piglet health and very high growth rates. Separation of sows and litter overnight allowed a lactational oestrus, a strategy that could be useful in farms opting for extended lactation. Solutions applied to decrease multifactorial challenges like piglet mortality and weaning diarrhea, should simultaneous target the mother, the young and their housing environment.

How to design and manage concrete outdoor runs for growing-finishing pigs?

Pigs following their natural behaviour choose “functional areas” for resting, activity and elimination, thereby minimising the surface soiled with excreta. This is not only advantageous with regard to hygiene and animal welfare but also necessary to reduce ammonia emissions which increase, when faeces and urine mix and cover large areas of the outdoor run. Based on scientific research and practitioners’ experiences three innovations (rooting areas, roughage in racks, showers), to stimulate the use of functional areas were identified. Across all experiments, the introduced resources affected pigs’ use of the outdoor area, which has the potential to reduce the area used for elimination. However, the variation between groups and farms was considerable. Moreover, removal of excrements in the outdoor area remains essential to reduce emissions especially in summer. The optimal outdoor run design should take various (geographical) location- and farm specific factors into account. Furthermore, management of resources is essential, therefore, practicability needs to be ensured.

Combined housing and pasture systems

Combining indoor- and pasture access in various combinations allows the organic pig producer to tailor their system to local climatic conditions, farm and soil structure while allowing the animals to perform a wide range of species-specific behaviour in compliance with the organic principles. To promote further development of combined systems, “farmer-to-farmer inspiration” was encouraged through involvement of 18 diverse systems across Europe representing best practice examples or innovative concepts. Based on comprehensive farm and animal data collected, each farm was thoroughly evaluated according to animal welfare, environmental performance, labour and costs, and take away lessons were put forward in 18 fact sheets. Huge variation in productivity and feed efficiency caused huge variation in GHG emissions between farms, and although some of this variation indisputable relates to the diversity in system concepts, it indicates a major improvement potential.

What makes a system resilient?

Based on interviews of organic pig producers, the resilience capacity and attributes were analysed for e.g. price shocks, disease outbreaks, climate change, legislation change and labour fluctuations. The perceived

risk of being non-resilient were associated with a low feed self-sufficiency among producers with an all-year outdoor production but also among producers that were unable to accumulate sufficient reserves on farm to cope with shocks. Farms with direct marketing and a large diversification were labour intensive and required the ability to pay decent wages to avoid perceived risk of being non-resilient. For all used strategies the producers' attitude, meaning making and social capital played an important role to cope and adapt to shocks. Different resilient strategies call for different policies for different types of producers.

Diversity is key

Diversity in organic pig system design and practice calls for diversity in research questions and methodology, marketing strategies and policies to further support a variety of sustainable and resilient organic pig systems across Europe with high level of animal welfare.

2.2 Process update of the whole project

Despite Covid-19 restrictions delaying and influencing experimental activities, deliverables and milestones as described in 3.2, the overall project objectives have been fulfilled as shown below.

WP	Objectives	Status
1	To investigate the effect of selected innovative designs of concrete outdoor runs in organic housing systems on animal welfare and pen hygiene, as a mean to reduce the risk of ammonia losses and impaired behavioural needs	√
2	To investigate the effects of i) the farrowing pen design, as well as improved genetics on maternal behaviour and piglet mortality, and ii) of different management strategies (e.g. iron or probiotic supply, prolonged lactation) on piglet growth and health during lactation and after weaning	√
3	To identify and evaluate best practice examples in different combinations of housing and pasture systems as regards animal health and welfare, productivity, feed efficiency and manure/pasture management.	√
4	To evaluate the overall effect of the identified innovative solutions of WPs 1-3, on cost effectiveness, system resilience and ecological footprints of a variety of systems practiced across Europe	√*
5	To provide guidelines for organic pig producers across Europe on the development of ecological and economically competitive pig systems with high standards for animal welfare	√

* Since the innovations identified and tested in WP1+2 would have only minor effects on overall environmental and climatic footprints in a classical LCA approach (when expressed e.g. as kg CO_2 eq. per kg pig produced, which is largely depending on overall farm productivity and feed efficiency), it was decided not to perform complicated and time-consuming LCA modelling to quantify the environmental impacts of these (additional to the LCA analyses of the best-practice and innovation farms). Consequently, these innovations were evaluated qualitative according to environmental performance as presented in the Fact sheets.

3. Outcomes of the project

The project was organised in five WPs as shown in Figure 1. The two vertical WPs were dedicated to providing new knowledge on two focus themes. They were the development of outdoor runs to offer growing-finishing pigs a more stimulus-rich environment while reducing the risk of emissions (WP1) and improved health and welfare in young pigs with emphasis on survival at birth, and survival and health before and after weaning (WP2). In addition, two horizontal WPs were dedicated to link to WPs 1-2 through stakeholder driven initiatives. We identified and evaluated best practice and innovative systems combining housing and pasture (WP3). Furthermore, the overall impact of the identified innovations on system resilience and ecological footprint was analysed (WP4). The coordination and dissemination activities were clustered in WP5. Below, main results etc. are presented for the five WP's.

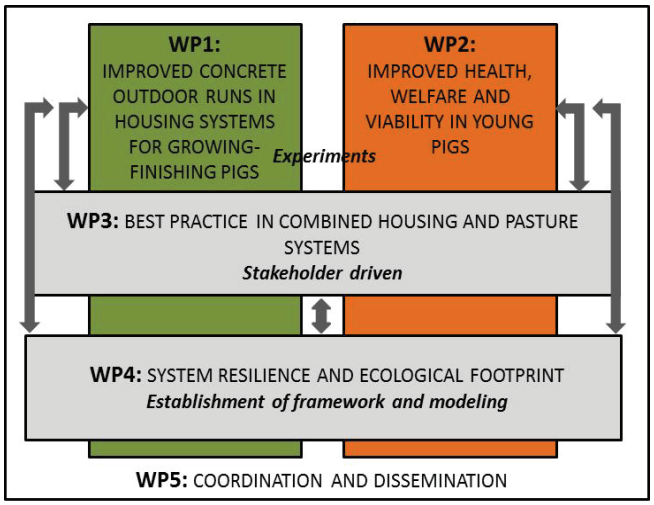

Figure 1. WP structure of POWER

3.1. Main results, discussion, conclusions and fulfilment of objectives

WP1	**Improved concrete outdoor runs in housing systems for growing-finishing pigs**

WP leader: Christine Leeb, BOKU

Responsible partners: AU-AGRO, BOKU, CREA-SUI, FiBL, CFF, WUR

Overall summary of main results, discussion and conclusions of WP1

The aim of WP1 was to improve concrete outdoor runs for organic growing-finishing pigs regarding animal welfare, pen soiling and related ammonia emissions. The identification of improvement measures based on scientific literature and practical knowledge from stakeholder workshops across all partner countries. Three improvement measures were identified as particularly beneficial for animal welfare, potentially reducing pen soiling and associated emissions and feasible to implement in on-farm experiments across countries. These were: 1) showers during summer (AT, CH), 2) providing roughage in racks outdoors (DK, AT) and 3) rooting areas (CH, DK). Additionally, a case study on ammonia emission in outdoor runs in relation to cleaning frequency was conducted in Sweden.

The improvement measures in themselves were beneficial for the welfare of the pigs (especially considering species-specific behaviour). Showers increased thermal wellbeing but did not increase the use of the outdoor run. Providing roughage outdoors compared to indoors increased the use of the outdoor run and interaction with roughage, but changing the type of roughage did not affect pig behaviour. Rooting areas were well-used by the pigs especially when filled with earth-like substrates. However, concerns about cleanliness and high maintenance requirements remain an issue to be addressed. Across the experiments, the introduced resources affected how pigs use the outdoor area, which has the potential to reduce the area used for elimination and consequently decrease ammonia emission. However, the variation between groups and farms was considerable. Moreover, removal of excrements in the outdoor runs remains essential to reduce emission especially in summer, as shown by the case study conducted in Sweden. The optimal outdoor pen design should take various (geographical) location- and farm specific factors into account. Furthermore, management of resources is essential, therefore, practicability needs to be ensured.

Report on the results obtained (A), and fulfilment of objectives (B) comparing to the original project proposal

A- results obtained and structured in relation to the user groups they are relevant for:
The main results are presented below categorised according to the relevance for Farmers and Consultant, Policy Makers, General Public including consumers and the Scientific Community.

Farmers & Consultants

- High animal welfare and low environmental impact are not exclusive and both of these sustainability aspects should be equally taken into account when designing outdoor runs (Wimmler et al., 2022).
- Manure should be removed frequently from the pen including the outdoor run, kept in covered storage and, after spreading on arable land, be incorporated in the soil within a few hours. Daily removal of urine and faeces from the outdoor run has the potential to significantly decrease ammonia emissions (Salomon et al., 2020). It is also important to have good drainage to dry up wet concrete areas and separate urine from faeces, which also reduces emissions.
- Manure scrapers can be used for frequent and efficient cleaning of the outdoor run. The electrical motor can be fitted with safety stops that are activated if a pig blocks the scraper. Supervision of the pigs or locking them indoors during scraping is recommended (Salomon et al., 2020).
- The provision of roughage in a rack is preferable in the outdoor run. This increases the use of the outdoor run and the roughage and helps structuring the outdoor run in order to reduce the area used for elimination. The racks should be adapted to the group-size and type of roughage. Fresh and high-quality (preferably home-grown) roughage should be provided on a daily basis (final workshop: roughage, in German).
- Showers improve the thermal wellbeing of pigs during hot days and increase cleanliness (Wimmler et al., 2021a; Kunert, 2021) They should be used especially for finishing pigs (>60 kg), while smaller pigs do not use them. Shower activation of more than 10 minutes/hour did not further improve the beneficial effect. Therefore, 10 minutes might be sufficient when aiming for a low water usage. As pigs avoid spending longer time in the shower area during activation, pigs should have adequate dry space in the outdoor run (final workshop: showers, in German).
- Rooting areas correspond to pigs' behavioural need for rooting, especially when filled with earth-like materials such as compost, earth or peat (Wimmler et al., 2022; final workshop: rooting areas, in German). Adding feed pellets to the substrate increased the number of pigs in the rooting area but did not improve cleanliness (Knoll et al., 2021). As soiling of the rooting area remains an issue, the planning of rooting areas must consider easy removal and refilling of the substrate, currently no standard solutions are available, especially in existing systems.
- All above mentioned results are presented in several fact sheets in the POWER manual: Fact sheets 1.0 (outdoor runs), 1.1. (rooting area), 1.2. / 1.3 (roughage), 1.4. (showers), 1.5. (automatic manure scrapers).

Policy makers

- Precise definitions are needed to implement EU standards across countries (e.g. "indoor"/ "outdoor", "roughage"), but with sufficient flexibility to adapt to local conditions and to allow for innovations (Wimmler et al., 2022).
- Evaluation of the environmental impact and nutrient losses in a husbandry system requires a whole-farm approach considering all steps in the manure management (Salomon et al., 2020; Wimmler et al., 2022).
- Increasing global temperatures require additional means for thermoregulation (e.g. showers) in pens with concrete outdoor runs, however, depending on the age of the pigs (Wimmler et al., 2021a; Kunert, 2021).
- Rooting areas meet behavioural needs of pigs, but they are difficult to implement due to practicability issues. Their implementation should be supported but not required legally before practicability issues are solved (Knoll et al., 2021; final workshop: rooting areas, in German).
- The cooperation of researchers and farmers should be supported for further improvement of organic husbandry systems. Cross-border, multi-farm studies are especially important to ensure high

relevance and validity of research for practical farming (Wimmler et al., 2020; Wimmler et al., 2021b).

General public

- Access to an outdoor run has considerable benefits for animal welfare as it provides more opportunities for pigs to choose between different climatic conditions and resources provided outdoors, which might create a greater sense of autonomy (Wimmler et al., 2022). It allows certain aspects of normal pig behaviour, even when the full behavioural repertoire is only possible in pasture based- or even agroforestry systems (see WP3). However, as it can be difficult to implement free-range systems for several reasons (climate, soil, diseases, number of pigs), concrete outdoor runs offer a suitable compromise, especially when enriched with design elements.

Scientific community

- Deeper understanding of eliminative behaviour is necessary to develop the design of outdoor runs, especially studies under organic conditions as until now most studies have been carried out under conventional conditions, mostly in indoor housed pigs (Andersen et al., 2020; Wimmler et al., 2022).
- To understand the interaction of various influences in the outdoor climate on soiling and ammonia emissions, extended research and measurement of ammonia emissions in concrete outdoor runs is needed, even when this requires considerable (technical, financial) research efforts (Salomon et al., 2020; Wimmler et al., 2022).
- To improve the use of showers for high effectiveness and low water usage, research regarding activation schedules and types of showers should be further pursued, with special consideration of various environmental influences in the outdoor run (final workshop: showers, in German). Research may further support to find viable solutions to rooting areas in the outdoor run with acceptable workload and hygienic conditions (Knoll et al., 2021).
- Multi-farm studies involving practical farms are challenging with regard to standardisation and statistical analysis, time consuming and resource intensive. Also, it can be difficult to publish, as so far, commonly very controlled experimental design on one research facility is requested by reviewers. However, these types of studies are essential to ensure external validity of results and relevance of research for practical farming (Wimmler et al., 2021b). Therefore, longer project durations should be considered and multi-farm studies promoted in scientific journals and communities.
- Involving practitioners in an applied research project from the beginning to the end is important to identify the relevant questions and practicable solutions (Wimmler et al., 2020).

B- fulfilment of objectives:

The objective of WP1 was to investigate potential improvements of concrete outdoor runs in organic housing systems for high animal welfare and pen hygiene, as a mean to reduce the risk of ammonia losses and impaired behavioural needs.

Task 1.1 Identification of innovative strategies by means of literature review and stakeholder inputs

- Review paper on elimination behaviour in pigs (AU-AGRO; Andersen et al., 2020).
- Review paper on the design of concrete outdoor runs for organic pigs (BOKU, WUR, AU-AGRO, RISE; Wimmler et al., 2022).
- Stakeholder workshops to identify innovations for on-farm experiments (all partners).

Task 1.2 Selection of 2-4 key factors to improve outdoor runs for experimental design

- Step-wise selection process based on results from literature reviews and stakeholder workshops, resulting in three innovations (shower, rooting area, roughage) to be tested in on-farm experiments (BOKU and all WP1 partners; Wimmler et al., 2020).

Task 1.3 Controlled on-farm experiments

- Development of a common research approach, ethogram and animal welfare assessment protocol

including training (on-farm and online) and inter-observer reliability testing (BOKU, all partners; Wimmler et al., 2021b).

- Conducting and analysing on-farm experiments on showers in the outdoor run on 2 farms in Austria and 2 farms in Switzerland (BOKU, FiBL): Experiment 1 (2019) on the effect of showers (Wimmler et al., 2021a; Kunert, 2021), and experiment 2 (2020) on the effect of different shower durations (final workshop: showers, in German).
- Conducting and analysing on-farm experiments on roughage in the outdoor run on 2 farms in Denmark and 2 farms in Austria (AU-AGRO, CFF, BOKU): Experiment 1 (AT and DK) on the effect of rack position, and experiment 2 (DK only) on the effect regularly changing the type of roughage (final workshop: roughage, in German).
- Conducting and analysing on-farm experiments on rooting areas in the outdoor run on 1 farm in Switzerland (FiBL) and 1 farm in DK (AU-AGRO, CFF): Experiment 1 on the effect of adding corn pellets to the rooting substrate (Knoll et al., 2021), and experiment 2 on the effect of different rooting substrates (final workshop: rooting areas, in German).
- Completion of two master theses (FiBL: Knoll et al., 2021; BOKU: Kunert, 2021) and one bachelor thesis (FiBL: Bühl, 2021),
- Preparation of six fact sheets based on WP1 results and presented in the POWER manual (all WP1 partners).

Task 1.4 Experiment on ammonia emissions

- Conduction of the case study in August 2020 (RISE).
- Presentation at international conference (Salomon et al., 2020).

Task 1.5 Collection of data for use in WP 4

- Contribution in the development of assessment protocols for WP4 (all partners).
- Preparation of model farm data and detailed description of the improvement measures. (BOKU, all partners).

WP2	**Improved health, welfare and viability in young pigs**

WP leader: Elodie Merlot (previous: Armelle Prunier), INRA
Responsible partners: AU-AGRO, CREA-SUI, TI-OL, WUR

Overall summary of main results, discussion and conclusions of WP2

In organic pig systems, piglet neonatal mortality is high, varying between 13 to 40% depending on the type of farm and management, and after the neonatal period, health problems often related to gut health disorders are frequent. The aims of WP2 were to test solutions to: 1) promote maternal behaviour and reduce piglet mortality around birth and during lactation, and 2) improve growth and health of piglets during lactation and after weaning with emphasis on gut health.

We evaluated the efficacy of several types of actions. Regarding the farrowing pen design, we concluded that maternal nest building behaviour was improved in farrowing pens larger than 7.5 m^2. The best way to increase piglet nest use by the neonates was not relying on nest design but on a practice, that is to say confinement of the piglets in the nest during the first four feeding times of the sow after farrowing. Regarding the prevention of health problems during lactation and after weaning, we observed that iron supplementation to prevent anamia was required only for piglets raised indoors, that a minimal injection of 200mg iron was needed, and that oral solutions based on a daily supply of very small amounts of iron rich substrates might be even more efficient than iron injection. For indoor piglets, the provision of fermented products supplying sows and piglets with microorganisms from the natural environment was found to be a promising option to modulate their gut microbiota, and maybe their gut health. Another way to reduce diarrhoea in piglets is to delay the age at weaning. We observed that extending lactations to 10 weeks was suitable to obtain good piglet health and very high growth rates. We also found that that the separation sows and litter overnight allowed a lactational oestrus, a strategy that could be useful in

farms opting for extended lactation.
However, the solutions tested in the project were tested in a limited number of farms, and we often evaluated the efficacy of these solutions by measuring physiological and behavioural variables, that we estimated relevant for piglet fitness. The estimation of their impact on piglet variables such mortality, morbidity and growth, which are highly variable depending on seasons, farms and practices, would require studies with higher number of animals, in a diversity of rearing environments. Finally, to efficiently decrease neonatal mortality and post-natal morbidity which are multifactorial problems, the solutions applied by the farmers should be a combination of good practices targeting simultaneously the mother (her genetic and behaviour, duration of her lactation), the young (its genetic and behaviour, its nutritional status especially regarding iron, feeding practices increasing gut health), and during the neonatal period, their housing environment (promoting adequate mother-young interactions, and providing protection of the young against maternal crushing and cold environment).

Report on the results obtained (A), and fulfilment of objectives (B) comparing to the original project proposal

A- results obtained and structured in relation to the user groups they are relevant for:
The main results are presented below categorised according to the relevance for Farmers and Consultant, Policy Makers, General Public including consumers and the Scientific Community.

Farmers and Consultant

- The project lead to some clear conclusions that can be applied directly by farmers. Regarding the design of the piglet nest, a temporary confinement increases the use of the nest by piglets. This practice can be easily implemented in the farms (Baldinger et al. 2022).
- Regarding the farrowing pen area, a space larger than the required 7.5 m² seems to be beneficial to sow behavior around parturition (Vermeer, 2021 OrgEpr#43533; POWER manual: #2.1).
- The role of genetics to achieve a sustainable level of production per sow and decrease piglet mortality must be highlighted to the farmers.
- Regarding iron supplementation, a minimal dose of 200 mg of iron is recommended if injectable iron is used, but the daily supply of a natural substrate rich in bioavailable iron might be more adapted to piglet needs (e.g. Merlot, 2019, 2021, Prunier et al, 2022).
- Regarding extended lactation, very high growth rates (35 kg LW at ten weeks) indicate huge unexploited piglet growth performance in commercial herds (Kongsted, 2021).
- Above mentioned results are presented in Fact sheet 2.0 (Piglet health, general introduction), 2.1 (Farrowing pen), 2.2 (Piglet nest), 2.3 (Breeding), 2.4 (Iron supply), 2.5 (Microorganisms), and 2.6 (Extended lactation) in the POWER manual.

Policy Makers

- Regarding the size of the farrowing pen, considering the upcoming evolution of European welfare regulations for conventional sows, and considering our results showing than pens bigger than the current organic rule (7.5 m²) are beneficial for animal welfare (Vermeer, 2021 OrgEpr#43533; POWER manual: #2.1) performance and pen fouling, pens larger than 7.5 m² could help to maintain a welfare difference with conventional production.
- Regarding iron supplementation (e.g. Merlot et al., 2019, 2021), it is recommended that it be made clear in the organic farming rules that the injection of iron to piglets is not counted as a drug treatment, to avoid the risk of anaemia in piglets raised indoors.
- In general, flexible rules are needed to support innovative strategies improving piglet health and welfare, and to adapt these practices to the specificities of each farming system (very diverse in organic farming) and geographical and climatic situations.

Scientific Community

- Regarding the farrowing pen and piglet nest design (Heidbüchel et al., 2022 in POWER manual: #2.1,

2.2); Baldinger et al. 2022), technical details of measuring the temperature perceived by animals in a specific area, such as the nest, should be improved, because it remained unclear if piglets perceive heat from infrared and electrical heating differently. Further research on the effect of temporary confinement of piglets to the nest on nest use and piglet losses could also be beneficial. Regarding the influence of farrowing pen size, a detailed dose-response experiment could be helpful to determine the optimal size. The influence on piglet localization and survival of the distance between the nest built by the sow and the piglet nest proposed by the farmer needs to be investigated. Research efforts might be also done to determine how to improve the heating of the sow nest, which seems to be preferentially used during the first two days.

- Regarding the genetic selection of sows improved for maternal performances and neonatal survival (Canario, 2022 POWER manual: #2.3), more research is needed to explore the causes of neonatal mortality (physiological development of the piglets, sow physiology and behaviour before, at and after farrowing, especially nesting behaviour), and to better understand the strong environment x genetic interaction effect on neonatal mortality.
- Regarding the improvement of suckling and weaned piglets, more data are needed in general about the behaviour and the physiology of piglets weaned at an older age than in conventional systems (after 42 days of age) (e.g. Kongsted, 2021a).
- To confirm the positive effect on piglet health and growth of the solution tested in Power project (iron supplementation by oral peat, gut microbiota improvement and decreased diarrhoea using fermented forest litter, extended lactation), additional studies, involving more animals and using different farm environments, are needed. Regarding prevention of anaemia, we must determine the benefits and limitations regarding health and welfare of the piglets of regular iron intake along lactation rather than a single bolus at birth e.g. Merlot et al., 2021a and b. Regarding fermented forest litter (Bochicchio, 2022, in POWER manual: #2.5), further trials need to be done to evaluate the effect of different dosages, and the variability of the product depending on the origin of the litter. Regarding extended lactations (e.g. Kongsted, 2021-b), there is a need to know better the short- and long-term effects of extended mother-offspring interaction on piglets´ coping abilities in response to various stressors. The impact of short-term mother-offspring separation to induce lactational oestrus (e.g. Kongsted, 2021-c) on milk yield, piglet behavior and welfare must be determined.

B- fulfilment of objectives:

Objective:

- To promote maternal behaviour and reduce piglet mortality around birth and during lactation
- To improve growth and health of piglets during lactation and after weaning with emphasis on gut health

Task 2.1: Experimental evaluation of farrowing pen design on piglet survival and growth

- We tried to optimize the design and management of piglet nest to improve its use by piglets. In order to find the optimal design and management, we compared the following measures: heating the piglet nest with electric floor heating or an electric infrared lid heating, lighting the piglet nest with a small red LED light, or not, and confining the piglets in the piglet nest during the sow's first four feeding times after farrowing, or not. The final dataset included data from 113 litters from 53 sows. We also tested the usefulness of providing a larger farrowing pen for sows to improve maternal behaviour and neonatal piglet survival. Behaviour and performance of 60 sows and litters were studied on a commercial organic pig farm during 1.5 years.

Task 2.2: Genetic evaluation of maternal behaviour and piglet survival under organic farming conditions

- We tested the possibility to genetically select sows for high piglet survival in organic conditions. Young females (G1 generation) were chosen from sows (G0) reared in conventional herds, and selected by us for high piglet survival, large number of weaned piglets, and indications from breeders about their ease of farrowing and good maternal behaviour. Forty-eight G1 females were raised from weaning in the organic pig farm from INRAE, half being crated around farrowing and half being loose

around farrowing. G0 and G1 females were inseminated with semen from boars selected for high breeding values.

Task 2.3: Experimental evaluation of management practices on piglet gut health and growth

- After the neonatal period, health problems can occur due to a risk of anaemia during lactation and problems of diarrhoea at weaning. In a field study carried out in 21 organic farms located in the West of France and involving a total of 606 piglets, we found that piglets from outdoor farms do not require iron supplementation, unlike those raised indoors, for which a minimal dose of 200 mg of injectable iron is recommended (Prunier et al, 2021 and 2022). For farmers who do not wish to use injectable iron, we tested alternatives in an experiment involving 301 piglets, where. we compared the efficiency of iron dextran intramuscular injection (n=98 piglets) at 5 days of age, daily ad libitum supply of dried soil (n=101) from day 5 to weaning on d49 and daily supply of dried peat-like mud extracted from the Brière river in France (n=102). To reduced post-weaning diarrhoea, we tested an agroecological solution based on the distribution of a natural probiotic (made from the litter of a forest) mixed to the sow, and then piglet feed. Thirty-six Large White pregnant sows and their litter (from birth to approx. 30 kg of live weigh) were used.
- We also explored the strategy of extending the lactation period to reduce the risk of post weaning diarrhoea. Twenty free-range sows and litters were randomly allocated to either seven or ten weeks of lactation in an experimental design at the Organic Research Platform at Foulum.. We also performed a case study by separating sows and litter overnight (12 h) at 28 days of lactation, and observed that this strategy allowed a lactationnal oestrus.

WP3	**Best practice in combined housing and pasture systems**

WP leader: Rikke Thomsen (previous: Marianne K. Bonde), CFF
Responsible partners: All

Overall summary of main results, discussion and conclusions of WP3

The aim of WP3 was to identify and evaluate best practice examples in different combinations of housing and pasture systems as regards animal welfare, productivity, feed efficiency and manure/pasture management. Stakeholder inputs from workshops or interviews in all partner countries, indicated that although complying well with organic principles, pasture access are under pressure in many countries. Key challenges mentioned were e.g. heavy workload combined with low or no premium price for the pork produced, risk of nutrient leaching in soil and low biosecurity. In total 18 diverse farms representing best practice examples (n=12) and innovative systems or practices (n=6) were identified across Europe (in AT, DE, DK, IT, CH, SE) and evaluated based on comprehensive farm and animal data collected (in four seasons over one year) according to a common protocol. In 18 Fact sheets, the farms were individually described and evaluated according to animal welfare, productivity, feed efficiency, labour and costs, overall environmental performance and take away lessons were put forward. Thus, "Farmer-to-farmer inspiration" regarding best practice examples and innovations in combined housing and pasture systems was a key output of WP3. In general, there was a good level of animal welfare in combined housing and pasture systems with no large differences in the observed welfare indicators between seasons and production stages kept indoor or on pasture. There was a huge diversity in productivity and feed use between farms and although some of this variation relates to the diversity in system layout and management, it indicates a major improvement potential in many herds. There is a need for research supporting valorisation of "free-range/pasture access" e.g. research in positive animal welfare indicators, effects on animal robustness and work life quality. Finally, it is important to initiate initiatives to support overall system resiliency of combined systems through reduced reliance on imported feed and improved biosecurity (further discussed in WP4).

Report on the results obtained (A), and fulfilment of objectives (B) comparing to the original project proposal

A- results obtained and structured in relation to the user groups they are relevant for:

The main results are presented below categorised according to the relevance for Farmers and Consultant, Policy Makers, General Public including consumers and the Scientific Community.

Farmers and Consultant

- "Farmer-to-farmer inspiration" regarding best practice examples and innovations in combined housing and pasture systems was a key output of WP3. Throughout Europe, organic pig producers combine indoor and pasture concepts in diverse setups depending on animal category (e.g. sows on pasture, growing-finishing pigs indoor, production stage (sows on pasture during gestation and indoor during lactation), and season (growing pigs on pasture summer and indoor winter). Each of 12 best practice farms (Fact sheet 3.0->3.9) and each of six innovative combined systems (Fact sheet 4.0->4.4) included in POWER were illustrated, described and discussed in terms of animal welfare, environmental performance, labour and costs, and take away lessons in the POWER manual
- In general, there was a high level of animal welfare in combined housing and pasture systems with no large differences in the observed welfare indicators between seasons and production stages kept indoor or on pasture. This was shown through methodical on-farm data collection (productivity, feed use etc.) and animal welfare assessments (Jenni et al., 2020) in six partner countries (AT, DE, DK, IT, SE and CH) four times from summer 2019 to autumn 2020.
- There was a huge diversity in productivity and feed use among farms (fact sheets 3.0->4.4 POWER manual). Although some of this variation relates to the diversity in system layout and management, it indicates a major improvement potential in many herds.

Policy makers

The initial stakeholder workshops in all partner countries revealed:

- A huge diversity across Europe in system layout and management in organic pig production (Dinesen et al., 2020) - see further explanation in the specific WP1-2 descriptions - indicating a large variety in the interpretation and/or implementation of EU legislation according to national climatic conditions, traditions and industry agreements/private standards. For a thorough review of the diversity regarding outdoor runs and overview of EU organic regulations, national regulations and private standards, see Wimmler et al. (2022).
- Free-range access is under pressure in organic pig production in many European countries, although still common practice in DK, FR and SE depending on animal category and/or season. This is partly related to biosecurity concerns (e.g. African Swine Fever), heavy workload, risk of nutrient leaching combined with (often) no premium price for pasture-based pork (Dinesen et al., 2020).

General Public including consumers

- Pasture access allows the animals to perform a wide range of species-specific behaviour in compliance with the organic principles. Combining indoor- and pasture access in various combinations allows the organic pig producer to tailor his/her system to local climatic conditions, farm and soil structure.

Scientific Community

- Despite compliance with consumer expectations and the organic principles, pasture systems are under pressure (Dinesen et al., 2020). There is a need for research supporting valorisation of "free-range/pasture access" e.g. research in positive animal welfare indicators, effects of free-range access on animal robustness (immunity parameters etc.) and work life quality
- More knowledge is needed on effects of pasture/paddock management on soil quality, biodiversity and nutrient losses
- It is important to initiate initiatives to support overall system resiliency of combined systems through reduced reliance on imported feed and improved biosecurity (see WP4 results)

B- fulfilment of objectives:

Objective:

- To identify and evaluate best practice examples in different combinations of housing and outdoor systems as regards animal health and welfare, productivity, feed efficiency and manure/pasture management.

Task 3.1: Stakeholder-driven identification of existing best practices, key challenges and innovations

- A common protocol for stakeholder workshops to identify existing best practice, challenges and possible innovations was developed in collaboration with all partner countries in October 2018. The workshops were completed in all partner countries in November/December 2018. In total, 120 producers, advisors and veterinarian participated. The output from the workshops was used in WP1 (Wimmler et al., 2020) to select three innovations for further evaluation in outdoor runs and in WP3 as a basis for choosing innovative farms with combined housing and pasture systems. Stakeholder inputs from the workshops indicated that although complying well with organic principles, pasture access are under pressure in many countries.

Task 3.2: Evaluation of existing best practice examples

- A "Best practice farm" was defined as a representative example of a combined housing and pasture system per country with stable level of productivity
- Despite the above-mentioned challenges related to pasture access, it was possible to identify 12 diverse systems across Europe with combined housing and pasture systems representing best practice examples. Comprehensive farm and animal data were collected (in four seasons over one year) from these farms according to a common protocol to identify best practice and development paths for combined systems as well as to provide data for use in the overall assessment in WP4. All farm visits were carried out by trained observers and according to a common standard operating procedure.
- The 12 best practice herds from AT (4), DE (1), DK (2), IT (2), SE (1), and CH (2) represented diversity not only in herd size but also in the combination of housing and pasture as illustrated in Fact sheet 3.0->3.9 (POWER manual). Each herd was evaluated in terms of animal welfare, environmental performance (WP4), labour and costs, and take away lessons in the POWER manual.
- For further evaluation of the best practice herds (environmental, resilience), see WP4

Task 3.3: Evaluation of innovations

- An "Innovative system" was defined as a farm representing a *novel* system layout, concept or management practice related to combined indoor- and pasture systems.
- Six innovative combined systems for weaners, fatteners and sows in DK, IT and CH were included in this task. The systems included e.g. a self-constructed mobile pen on a trailer, which is large enough to keep the pigs on the trailer if the weather does not allow them to use the pasture. Another example was a mobile pen that can be moved, including the attached fences. Moreover, farms with innovative management practices were included, like the alternating use of grassland, cropland and forest (Jenni et al., 2020).
- Data were collected from these farms following the same procedure and using the same protocols as developed in T3.2. As for best practice herds, each herd was evaluated in terms of animal welfare, environmental performance, labour and costs, and take away lessons in the POWER manual in Fact sheet 4.0->4.4.
- For further evaluation of the innovative herds (environmental, resilience), see WP4

WP4	**System resilience and ecological footprint**
WP leader: Eva Salomon Responsible partners: All	

Overall summary of main results, discussion and conclusions of WP4

The POWER project aimed to examine the effectiveness of innovations and best practises in achieving improved pig welfare where we also examined potential environmental or economic trade-offs as well as pig farmers perceived resilience to shocks. The aim of WP4 was to assess the overall effect of

implementing the identified innovative solutions (WPs 1-3) on system resilience and environmental footprints of combined pig housing- and pasture systems across Europe.
The system resilience of pig farms was assessed by investigating how 18 pig producers coped with economic, legislations, labour and climate related shocks. Based on open question interviews the resilience capacity and attributes were analysed for input and output price shocks, disease outbreaks, climate change, legislation change and labour fluctuations. The results showed that the pig farmers were grouped in three main resilience strategies: an efficiency-based strategy, a nutrient substitution strategy and a farm diversification strategy. The perceived risk of being non-resilient were associated with a low feed self-sufficiency among pig farmers with an all-year outdoor production but also among pig farmers that were unable to accumulate sufficient reserves on farm to cope with shocks. Pig farmers with direct marketing and a large diversification were labour intensive and required the ability to pay decent wages to avoid perceived risk of being non-resilient. For all used strategies the pig farmer's attitude, meaning making and social capital played an important role to cope and adapt to shocks. Policy makers should recognize that different resilient strategies exist among European organic pig producers and tailor policies differently for different types of producers.
Environmental footprints were evaluated by utilising a life cycle approach. Data from 13 breeding and 9 finishing systems were assessed against four environmental impact categories, including air and water pollution and climate impact from greenhouse gases. Overall, the life cycle assessment (LCA) indicated lower pollution and emissions from productive, outdoor housed breeding and finishing systems, but also lacked the ability to assess non-quantitative aspects of traditional pig systems that rely on local breeds that are less productive, but provide cultural and other public goods.

Report on the results obtained (A), and fulfilment of objectives (B) comparing to the original project proposal

A- results obtained and structured in relation to the user groups they are relevant for:
The main results are presented below categorised according to the relevance for Farmers and Consultant, Policy Makers, General Public including consumers and the Scientific Community.

Farmers and Consultant

- The assessment of environmental impact and cost effectiveness of selected strategies was conducted with compiled data for project farms and for 12 innovative strategies. Overall results for breeding and growing finishing stage showed that fast growing breeds that used less kilogram feed per produced kg weaner or finisher decreased greenhouse gas emissions from feed and manure storage. Thus, a higher feed efficiency and improved manure management decreased environmental impact (Moakes & Pfeifer, 2021 OrgEpr#42999; POWER manual: #3.0). The assessment of potential effects of manure/pasture management on nitrogen and phosphorus losses, were conducted using data from 8 project farms with pigs on pasture. Overall, the nitrogen and phosphorus load varied greatly depending on pig density in the paddock, where some paddocks had a too high nutrient load which increased risk of nitrogen and phosphorus losses. The recommendations are to have enough pasture area for the pigs or limit the period the pigs are in the paddock (Myrbeck, 2022 in prep).

Policy Makers and General Public including consumers

- A study of how 18 pig producers with a variety of systems in Europe coped with different chocks that could threaten their farm identified three used resilient strategies: an efficiency-based strategy, a nutrient substitution strategy and a farm diversification strategy. Policy makers should therefore recognize that different resilient strategies exist among European organic pig producers and tailor policies differently for different types of producers (POWER manual, p121-123).
- Overall, the life cycle assessments (LCA) of 22 project farms indicated lower environmental impact from breeding and finishing systems with higher productivity. However, policy makers should be aware of that LCA lacks the ability to assess non-quantitative aspects of traditional systems that rely on local breeds that are less productive, but provide cultural and other public goods (Moakes &

Pfeifer, 2021 OrgEpr#42999).

Scientific Community

- In the study of 18 pig producers and how they coped with different shocks, three resilient strategies were identified. However, across all strategies the farmer's attitude, meaning making and social capital played an important role. More knowledge about which attributes and how they support a farmer's propensity for a change could give a better understanding of what kind of support a farmer need to become more resilient.
- A scientific paper in English was submitted: The role of diversity and circularity to enhance resilience of pig producers in Europe.

B- fulfilment of objectives:

Objective:

- To assess the overall effect of implementing the identified innovative solutions (WPs 1-3) on system resilience and environmental footprints of combined housing- and pasture systems across Europe

Task 4.1 Developing draft framework

We had a joint internal workshops together with WP1 and WP3 to plan and perform national stakeholder interviews and workshops in all project countries. A framework was developed in order to compile and group results from stakeholder interviews and workshops. We jointly identified best practice and innovative solutions promoting animal welfare but also that can contribute to assess resilience criteria.

Task 4.2 Updating/revising framework for assessing system resilience

We performed a workshop with all POWER partners to discuss definition of system resilience in the context of compiled data from interviews and workshops. All partners agreed on identifying key areas affecting organic pig production systems and the factors that can influence the resilience of the system. The identification of areas and factors were conducted together, where we identified lack of knowledge about the farmer's perception of chocks. WP3 and WP4 agreed on performing additional deep interviews with 17 pig farmers representing all countries (POWER manual, p121-123).

Task 4.3 Finalizing framework for assessing system resilience.

We used a published framework from scientific literature to compile and analyse results from 18 pig farmer interviews. The analysis included resilience capacity and attributes to different shocks, namely input and output price shocks, disease outbreaks, climate change, legislation change and labour fluctuations. Based on narratives of 18 farmer interviews three used resilience strategies were identified: an efficiency-based strategy, a nutrient substitution strategy and a farm diversification strategy.

Task 4.4. Selection innovative strategies from literature.

We performed an internal workshop with WP1 and WP3 to select knowledge-based parameters to be included in protocol for quantifying environmental load and economy on pig farms. In a joint work these parameters were merged with WP1 and WP3 health and welfare parameters into one main protocol used to collect farm data at joint farm visits.

Task 4.5. Selection innovative strategies from experiments/practice.

We performed an internal workshop with WP1, WP2 and WP3 to select tested innovations from experiments/practice with a potential impact on environment and farm economy. Those innovative strategies that were jointly agreed on having a direct effect on environment and farm economy were chosen to be analysed by the farm assessment model.

Task 4.6 Assessment of potential effects of manure/pasture management on N and P losses.

In a joint work with WP3, we collected and compiled data from best practice farms with pigs on pasture . The aim was to calculate potential nitrogen and phosphorus point-loads on pasture using collected data and assess risk of nitrogen and phosphorus losses from pasture. Due to viability in farm data quantity/quality a complete assessment was not performed. The results showed a large variation in nitrogen and phosphorus load in paddocks where the loads tended to increase with increasing pig density (Myrbeck, 2022 in prep).

Task 4.7 Building the environmental/economic farm assessment model.
We utilised a model previously developed at FiBL and significantly developed, to enable assessment of the variety of pig production systems represented on project farms. The assessment model utilises a farm modelling approach to quantify herd structures, crop and forage production, inputs and outputs as well as internal flows within the farm. This is particularly important for organic and other more integrated production philosophies due to the internal flows of materials such as feed and manures between livestock and cropping. Farm data was consistency checked and processed through the farm system model, before a life cycle impact assessment was undertaken.

Task 4.8 Modelling of the overall environmental impact and cost effectiveness of the selected strategies.
WP 3 collected primary data for all pig enterprises and associated pasture or cropping systems and submitted data to WP4 for each project farm, in the form of a completed Excel data protocol. This data we then processed through a farm system model to generate each life cycle inventory (LCI). In addition to the primary data and processed primary data values, further data was sometimes required. For this purpose, the extensive ecoinvent LCI database was utilised.

WP5	**Coordination and Dissemination**
WP leader: Anne Grete Kongsted, AU-AGRO (co-lead, Dissemination: Barbara Früh, FiBL) Responsible partners: All	
Overall summary of main results, discussion and conclusions of WP5 Besides coordinating and managing the consortium, the objectives of WP5 were to communicate the project's findings and to support organic pig producers' decision making and serve as a resource base for policy makers, consumers and other stakeholders across Europe. Due to project partners' strong commitment, team spirit, respect for deadlines, and transnational project experience, the project management was in general a smooth process. Two very successful in-person consortium meetings within the first 18 months, were essential for a common understanding of the POWER project and engagement of all project participants. Quarterly online meetings with one representative from all partners to follow general project progress in a structured format were fruitful especially in the beginning of the project when a large range of experimental and on-farm activities were initiated. Four on-line consortium meetings proved valuable in terms of sharing project findings but a challenge in terms of encouraging discussions of results across WP's. Regarding dissemination, the project had a strong focus on the primary target group of the project, i.e. the organic pig producers and consultants throughout Europe. This was unfolded in a Handbook comprising 27 Fact sheets with knowledge-based practical recommendations and farmer-to-farmer inspiration to support producers' decision making in system layout and management, six tutorial videos, three articles in farmer magazines, and stakeholder workshops in the beginning and at the end of the project. Policy makers were reached through a Synthesis report including a list of policy needs to further support a development of a sustainable organic pork production in Europe. The general society including consumers have easily accessible knowledge of organic pig practice, challenges and innovations implemented to support animal welfare and sustainability at the POWER website. Finally, the scientific community was reached through six peer reviewed papers (six additional planned) in international journals, 21 conference contributions and a Synthesis report presenting a wide range of knowledge needs related to organic pig production.	
Report on the results obtained (A), and fulfilment of objectives (B) comparing to the original	

project proposal

A- results obtained and structured in relation to the user groups they are relevant for:
The main **dissemination** results of the POWER project are listed below categorised according to the relevance for Farmers and Consultants, Policy Makers, General Public including consumers, and the Scientific Community. WP-specific dissemination products are further presented in the WP1-4 descriptions and in 3.2.

Farmers and Consultants
- In total 27 Fact sheets with practical recommendations compiled in a Management Manual in English. Specific fact sheets will be translated to national languages according to national relevance.
- Videos with English speech or subtitles presenting project findings, best practice examples and innovative systems from across Europe. For the majority of videos, subtitles in additional languages can be selected.
- Holding of initial stakeholder workshops/interviews in all partner countries (Dinesen et al., 2020; Wimmler et al., 2020) and final farmer workshops in national languages combined with a few presentations in English from specific project partners, DK, AT/CH/ DE (joint), NL, IT, SE, and FR.
- Articles in farmer journals (Kongsted & Bonde, 2018; Hollinger, 2021; Rémond, 2021) and additional two in preparation.

Policy Makers
- Synthesis report presenting main project results and conclusions followed by a discussion on policy needs and knowledge/research gaps related to future organic pig production. Some of the knowledge needs are presented in paragraph 7 and in the specific WP description.

Consumers
- The POWER findings are also relevant for the consumers. From other studies we know that expectations of improved animal welfare ("Pigs are reared properly", "Pigs are happy, less stressed") and reduced antibiotics are very important drivers when consumers choose to buy organic pork. The good stories from research and practice (e.g. the farmer-driven innovative pasture concepts evaluated in POWER) need to be communicated to the general public to support consumers' interest in organic pork (need more focus in future projects – how to reach the general public). It is crucial that the organic pork sector continues to develop in compliance with the consumers' expectations to increase the market share of organic pork, which is still very low compared to e.g. organic milk (more studies needed on consumer motives, drives etc.)

Scientific Community
- In total six scientific peer-reviewed papers - and 21 conference contributions (links are listed in the specific WP1-4 descriptions). Additional six papers expected the coming year.

Further, the project established a website with easy access to project dissemination products. Finally, the project authored/co-authored several CORE Organic Cofund Newsletters, press releases etc. (Bochicchio, 2018; Kongsted, 2018; Merlot et al., 2019; Vaarst et al., 2020; Wimmler et al., 2021) relevant for policy makers as well as the General Public.

See 3.2 for a complete list of dissemination activities related to the specific WP tasks and 4.6 for an overview of dissemination activities ordered according to the main user groups.

B- fulfilment of objectives:

Objectives:
- To coordinate and manage the consortium. This includes organising the meetings, assuring timely

information exchange between WP partners and progress reporting;
- To communicate the project's findings, to support organic pig producers' decision making and serve as a resource base for policy makers, consumers and other stakeholders across Europe.

Task 5.1 Project coordination
- Project Intranet Web Site (SharePoint) established
- Consortium agreement established and signed by all partners
- Kick-off meeting in Hovborg, Denmark, with representatives from all partners
- Project meeting in Trenthorst, Germany, with representatives from all partners
- The two in-person meetings were followed by four on-line project meetings in February 2021, June 2021, October 2021 and January 2022, respectively, with representatives from all partners
- Quarterly progress on-line meetings with 1-2 representatives from all partners
- The project coordinator participated in two national CO Cofund seminars and one international CO Cofund seminar in Italy
- The project coordinator presented overall project results at the joint online conference "Improving sustainability and welfare in organic poultry and pig production" (OK-Net EcoFEED, PPILOW, Freebirds and POWER projects) (Kongsted et al., 2021)
- The project coordinator co-authored a joint Core Organic (GrazyDaiSy, MixEnable, FreeBirds, POWER, ProYoungStock, OrganicDairyHealth) IAHA conference paper and oral presentation of "Potentials, challenges and visions for future European organic animal farming" (Vaarst et al., 2020).

Task 5.2 Dissemination plan, project website and FB account
- A Dissemination plan was completed
- POWER logo and presentation (PPT) template were designed
- Project Web site was established (https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/) and updated throughout the project
- A Project leaflet was completed, and translated by partners into French, German and Italian. These are available on Organic Eprints.
- A press release was prepared to promote the project. The press release was translated by the partners into Danish (and published in a farmer magazine) and Italian (available on Organic Eprints).
- FB account: As a general CORE Organic Facebook account was established, it was decided not to create a specific POWER account

Task 5.3 Manuals for organic pig producers
- A Management Manual comprising 27 Fact Sheets in English were completed and are available on Organic Eprints and on the POWER website. A translation process has been initiated.
- In total six tutorial videos have been prepared and are available on the POWER website. All videos have English speech or subtitles, and for the majority of videos, subtitles in additional languages can be selected.

Task 5.4 Workshops to exchange practical and scientific knowledge
- Final project results and practical recommendations were presented at stakeholder workshops in DK (in-person) and IT, on-line meetings in NL, FR, SE, and at a joint workshop for German-speaking countries D/CH/AT (on-line). The presentations are available on the POWER website.

Task 5.5 Overarching policy supporting document
- Final scientific and practical project findings were presented and synthesised in a report including recommendations for future research and policy. The synthesis report is in its final stage and will soon be available on Organic Eprints (draft uploaded Eprint/43528) and on the POWER website.

3.2 Deliverables and milestones status

D No.	Deliverable name	Nature (from the proposal)	Link to the document[2] And nature of final deliverables	Plan. deliv. month [1]	Actual deliv. month [1]	Reasons for changes/delay and explanation of consequences
D1.1	Review: Pig excretory behaviour and design of outdoor runs	Scientific paper	The planned paper was split into two papers. • Paper1: orgprints.org/36886/ doi.org/10.1016/j.applanim.2019.104888 • Paper 2: https://doi.org/10.1016/j.animal.2021.100435	12	P1: 20 P2: 44	Extensive literature review and elaboration of the paper 2 structure in a transnational cooperation required more time than expected.
D1.2	Effect of innovations to improve outdoor runs (internal dataset for WP4)	Dataset	Preparation of model farm data (representative for European organic pig fattening)[2]	28	42	As a qualitative assessment was included in factsheets (D5.8) no farm individual datasets were delivered [2] but WP1 created a 'model farm' for use in future projects.
D1.3-8	Innovations to improve outdoor runs (on-farm experiments)	Fact sheets	Fact sheets: • orgprints.org/43490/ (#1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.5, 1.6) Additional products: Conf. (internat.): • orgprints.org/34155/ (ICOAS, 2018) • orgprints.org/42702/ (WAFL, 2021) • orgprints.org/38459/ (IAHA, 2020) • orgprints.org/42765/ (IAHA, 2021) • orgprints.org/42770/ (WAFL, 2021) Sci. papers: • orgprints.org/40161/ Theses: • orgprints.org/39165/ • orgprints.org/42908/ Conf. (national): • orgprints.org/34156/ (AT Agric. Fair) • Org/43535 (NA yet[3])	30	42	Minor delays in completion of experimental activities due to Covid-19 implications.
D1.9	A synthesis of overall effect of innovations to improve outdoor runs	Report	Report: • Org/43528 (NA yet[3])	32	42	It was decided to include this in the project synthesis (policy supporting document) (see D5.8)
D1.10	Results of ammonia emission case-studies	Conf. pres.	• Conf. contribution (2020): orgprints.org/38458/ (IAHA, 2020) Additional products: • Factsheet: orgprints.org/39893/ / orgprints.org/id/eprint/43490/ (#1.5)	32	29	-
D2.1	Variability of the iron status at weaning in commercial farms	Scientific paper	• Scientific paper in French: http://www.journees-recherche-porcine.com/texte/2021/santeanimale/s08.pdf Additional products: • Conference paper (IAHA, 2021): orgprints.org/42768/ • Scientific paper in English (2022) • Fact sheet: orgprints.org/43490/ (#2.4)	24	Paper: 34 Conf. paper: 42	Minor delay in completion of the conference paper due to the date of the conference.
D2.2	Data generated in Tasks 2.1–2.3 for WP4	Data set	-	30	42	As a qualitative assessment was included in factsheets (D5.8) no farm individual datasets were delivered [2]
D2.3	Design and use of piglet nests in commercial farms and the effects of improved piglet nest	Report	Report: orgprints.org/43376/ Additional products: Conf. (internat.): • orgprints.org/38460/ (IAHA, 2020) • orgprints.org/42907/ (IAHA, 2021)	30	42	Analysis of the comprehensive video data took more time than expected and was challenging due to Covid-19 restrictions.

	design		Conf. (national) • orgprints.org/36921/ (2019) • orgprints.org/42820/ (2021) • Fact sheet: orgprints.org/43490/ (#2.1, 2.2) • Video on POWER website: Videos from POWER (au.dk)			
D2.4	Litter performance of LW sows selected for low piglet mortality	Fact sheet	• Fact sheet: orgprints.org/43490/ (#2.3) Additional products: • Orgprints.org/42949 (2021)	30	42	Completion postponed as the Factsheet was included in the Management Handbook (collection of factsheets)
D2.5	Effects of lactation length on piglet, sow and herd efficiency	Conf. paper	• Conf. (international): Org/43531 (NA yet[3]) (restricted) Additional products: • Fact sheet: orgprints.org/43490/ (#2.6) • Video on POWER website: Videos from POWER (au.dk)	34	42	Delay in experimental activities due to Covid-19 restrictions. A conference contribution has been prepared. Expected to be submitted for EAAP 2022.
D2.6	Effects of probiotic from natural microorganisms on piglet performance and faecal microbiota	Scientific paper	• Paper: In prep (expected end 2022*) Additional products: • Fact sheet: Fact sheet: orgprints.org/43490/ (#2.5)	34	42*	Delay due to the statistical analysis of microbiota data, which took longer than expected
D2.7	Effect of extending farrowing pens on maternal behaviour and piglet survival	Fact sheet	• Fact sheet: orgprints.org/43490/ (#2.1) Additional products: • Poster: Preliminary results presented as poster in the Free Farrowing Workshop: Org/43533 (NA yet[3]) • Report: Farrowing pen size and maternal behaviour (restricted access, Org/43864, (NA yet[3]))	36	42	Completion postponed as the Factsheet was included in the Management Handbook (collection of factsheets)
D2.8	Effect of various types of iron supplementation on piglet performance and health	Report	Conf. (international) • orgprints.org/42769/ (EAAP, 2021) Conf. (national): • orgprints.org/42901/ (Sep, 2021) • Factsheet: orgprints.org/43490/ (#2.4)	36	40-42	It was decided to substitute the "Report" with a number of "Conference contributions" Minor delay due to Covid-19 restrictions
D3.1	Data on characteristics of combined organic pig production systems for use in WP4	Dataset	• Internal dataset (available at the internal POWER SharePoint site, no link)	24	32	Decision to use data collected in present project delayed the process.
D3.2	Study of stakeholder driven innovations, e.g. partly access to pasture	Fact sheets	• Factsheet: orgprints.org/43490/ (#4.0, 4.1)	36	41	Data collection delayed due to covid-19 (see M3.5)
D3.3	Study of stakeholder driven innovations, e.g. Pasture access throughout the year	Fact sheets	• Factsheet: orgprints.org/43490/ (#4.4)	36	41	Data collection delayed due to covid-19 (see M3.5)
D3.4	Study of stakeholder driven innovations, e.g. indoor vs. outdoor weaning systems	Fact sheets	• Factsheet: orgprints.org/43490/ (#4.2, 4.3)	36	41	Data collection delayed due to covid-19 (see M3.5)
D3.5	Characteristics of combined systems and best practice examples	Fact sheets	Factsheets: orgprints.org/43490/ (#4.x) Additional products: • Report: orgprints.org/ 38632/ • Conf. (international): orgprints.org/ 42766/ (IAHA, 2021) • Report in Danish, orgprints.org/43539/	36	41	Data collection delayed due to covid-19 restrictions.
D4.1	Selected innovative strategies based on literature/exp./ practice	Fact sheet	• Factsheet: Factsheet: orgprints.org/43490/ (#4.x) Additional products: • Conf. (national):	36	42	Final completion postponed as the factsheets were included in the Handbook

			orgprints.org/35253/			
D4.2	An assessment framework for system resilience	Fact sheet	• Factsheet: orgprints.org/43490/ (p121-123) Additional products: • Scientific paper accepted for publication in Animal Feb 2022	36	42	-
D4.3	Assessment of effects of manure/pasture management on N and P losses	Conference paper	• Report in prep. (expected available at OrgEpr April 2022)	36	42*	As no suitable conference currently open for submission, it was decided to substitute the "Conference paper" with a report.
D4.4	Modelling of the overall environmental impact and cost effectiveness of selected strategies	Scientific paper	• Report: Org/42999, NA yet[3]) • Fact sheets: orgprints.org/43490/ (#3.0)	36	42	Due to huge viability in data quantity/quality, data was estimated as unsuitable for publication in a scientific journal. It was decided to change the deliverable type to a scientific report and a fact sheet, and instead to publish the farm data on resilience in a scientific paper (D4.2).
D5.1	Project description published	Fact sheet	• Leaflet (UK): orgprints.org/34160/ • Leaflet (DE): orgprints.org/ 34158/ • Leaflet (IT): orgprints.org/ 34159/ • Leaflet (FR): orgprints.org/ 34157/	3	3	-
D5.2	Web resources	Website	• Web site: power	6	6	-
D5.3	Kick off and project meetings	Minutes	• Minutes only for internal use (no link)	3, 15, 33	1, 18, 34, 38, 42, 45	Two in-person meetings: 1, 18 Four on-line meetings: 34, 38, 42, 45
D5.4	Tutorial videos based on project findings	Video	• Six videos available on the POWER website: videos	34	42	Needed final project results to complete videos.
D5.5	Management handbook	Manuals	A collection of factsheets (in total 27 factsheets: orgprints.org/id/eprint/43490/, also available at: https://www.fibl.org/en/shop-en/1300-hb-power-en	34	44	Needed final project results to complete the handbook.
D5.6	Participation in CORE Organic seminars	Minutes	• In DK: orgprints.org/36882/ • In Italy: orgprints.org/36880/ Participation in joint conferences: • Joint conference (OK-Net EcoFeed final conf.): orgprints.org/42692/ (press release) and orgprints.org/43001/ (presentation) • Joint conf. paper (IAHA, 2020): orgprints.org/38457/	3, 18, 35	1, 9, 12, 21	-
D5.7	Publications in farmer journals	Articles	• orgprints.org/34452/ (WP5, AU) • orgprints.org/42900/ (WP2, INRAE) • orgprints.org/39988/ (WP3, FiBL)	36	42	-
D5.8	Policy supporting document	Report	Report: • Org/43528 (NA yet[3])	36	44	Needed final project results to complete report.
D5.9	Brief annual project updates as required by Core Organic Cofund	Articles	CO Cofund newsletter: • orgprints.org/36884/ (WP2) • orgprints.org/41892/ (WP1) • news-and-events/ (WP5) • orgprints.org/36883/ (WP5) – also translated to I: orgprints.org/35221/	12, 24, 36	1, 18, 29, 38	-
D5.10	Reporting to CORE Organic (mid-term and final scientific report)	Report	-	18, 36	18, 45	-

1) Measured in months from the project start date (month 1)

2) Since the innovations identified and tested in WP1+2 would have only minor effects on overall environmental and climatic footprints in a classical LCA approach (when expressed e.g. as kg CO_2 eq. per kg pig produced), it was decided not to perform complicated and time-consuming LCA modelling to quantify the environmental impacts of these (additional to the LCA analyses of the best-practice and innovation farms).

3) "NA yet": The product submitted to OrgEpr but not available yet and therefore no link.

M No.	Milestone name	Planned delivery month[1)]	Actual delivery month[1)]	Reasons for changes/delay and explanation of consequences
M1.1	Stakeholder input compiled	6	7	-
M1.2	Selection of 2-4 innovative strategies for concrete outdoor areas to be tested in experiments	9	9	-
M1.3	Measurements of ammonia emissions completed	24	16	-
M1.4	On-farm experiments in five partner countries completed	27	32	Minor delay due to Covid-19 restrictions
M2.1	Sows with high performance and sires with high EBV for piglet survival identified in national data bases and farmers accepting to sell selected sows identified	2	4	No consequences on the experiment, since we already knew that there would be a delay in the construction work of the INRA organic farm, where the experiment will take place
M2.2	Farrowing by breeding sows (dams) at the PORGANIC experimental unit completed	6	11	G0 sows insemination has been delayed for a few months because of a delay in the construction work of the INRA organic farm
M2.3	10 farms have been visited for an analysis of “piglet nest design”	12	12	-
M2.4	Evaluation of the iron status of piglets at weaning in outdoor farms completed	18	18	-
M2.5	1st cycle of reproduction for G1 sows, start of phenotypic records	18	24	G1 sows insemination has been delayed for a few months because of a delay in the construction work of the INRA organic farm
M2.6	Experimental trial on “piglet nest design” completed	24	32	Minor delay due to Covid-19 restrictions
M2.7	Experiment on probiotic from natural microorganisms completed	24	24	-
M2.8	On-farm experiment comparing two lactation lengths	28	38	On-farm exp. not possible to complete due to Covid-19 restrictions. A later exp. carried out at the research platform at Foulum instead.
M2.9	DNA analysis of piglet faecal microbiota completed	28	42	Microbiota statistical analysis longer than expected
M2.10	Experiment comparing the size of farrowing pens completed	30	30	-
M2.11	Experiment comparing different sources of iron supply in piglets completed	30	30	-
M3.1	Workshop/interview protocol developed	6	6	-
M3.2	Workshop/interviews completed	12	8	The workshops were advanced to be able to use the output of the workshop as a basis for selection of innovations in WP1 and WP3. The report was delayed due to discussion on outline and content among partners
M3.3	Qualification of existing farm data for use in WP 4 (as baseline data) completed	24	27	Decision on what data to be used by WP4 delayed the process on making data ready. No consequences
M3.4	Completed on-farm study of best practice examples in 6 countries for use in WP4	27	30	Delay due to Covid-19 and missing farm visits for data collection
M3.5	Completed study on pasture for grower/finishers (or other stakeholder-driven innovations)	30	37	Delay due to Covid-19 and missing farm visits for data collection
M3.6	Completed study on partly access to pasture (or other stakeholder-driven innovations)	30	37	Delay due to Covid-19 and missing farm visits for data collection
M3.7	Completed study on pasture for weaners (or other stakeholder-driven innovations)	30	33	Delay due to Covid-19 and missing farm visits for data collection
M4.1	Evaluated innovative strategies	6	24	Partly depended on D1.1
M4.2	Draft framework for assessing system resilience in organic pig production	12	24	Awaited farmer input to complete
M4.3	Selected innovative strategies	30	42	General delay in project activities

				(project extension due to Covid-19)
M4.4	Potential effects of manure/pasture management on N and P losses	32	42?	General delay in project activities (project extension due to Covid-19)
M4.5	Modelling of the overall environmental impact and cost effectiveness of the selected strategies	33	42	Delay in data collection and the validation of the collected farm data took longer than expected
M5.1	Dissemination plan developed	3	3	-
M5.2	Intranet Web site developed	6	1	-
M5.3	Workshop protocols developed	24	38	General delay in completion of experimental activities due to Covid-19 restrictions
M5.4	Main outcomes from national workshops compiled	33	38	A plan for tutorial videos discussed and agreed on
M5.5	Main results from WP1-4 compiled	33	42 (44)	Awaited all project findings and the final national workshops to complete (policy supporting document)
M5.6	Quarterly WP-leader meetings	quarterly	quarterly	Five project meetings (see D5.3) and additional meetings: M1, 8, 12, 17, 24, 29, 37, 41

4. Publications and dissemination activities

4.1 List extracted from Organic Eprints

Journal papers: Two not yet visible in Organic Eprints and Prunier et al., 2022 is categorised as conference paper.

Journal paper

Andersen, Heidi Mai-Lis; Kongsted, Anne Grete and Jakobsen, Malene (2019) **Pig elimination behavior — A review.** *Applied Animal Behaviour Science*, x, pp. 1-9. [In Press]

Knoll, Maximilian; Bokkers, Eddie A.M.; Leeb, Christine; Wimmler, Cäcillia; Andersen, Heidi Mai-Lis; Thomsen, Rikke; Früh, Barbara and Holinger, Mirjam (2021) **Rooting for feed: Mixing corn pellets into rooting material tends to increase the presence of grower and finisher pigs in the rooting area but not its cleanliness.** *Appleid Animal Behaviour Science*, 241, p. 105379.

Prunier, Armelle; Pauwels, Maud; Jaillardon, Laetitia; Leblanc-Maridor, Mily; Belloc, Catherine and Merlot, Elodie (2022) **Evaluation of the potential benefits of iron supplementation in organic pig farming.** *Open Research Europe*, 2, p. 11. [In Press]

Newspaper or magazine article

Holinger, Mirjam (2021) **Des plaisirs mouillés pour les jours chauds.** *Bioactualités*, 2021 (4), p. 10.

Holinger, Mirjam (2021) **Nasses Vergnügen für heisse Tage.** *Bioaktuell*, 2021 (4), p. 10.

Jenni, Anna (2021) **Méthodes astucieuses en comparaison.** *Bioactualités*, 2021 (6), pp. 14-15.

Jenni, Anna (2021) **Schlaue Schweinehaltung im Vergleich.** *Bioaktuell*, 2021 (6), pp. 14-15.

Kongsted, A.G. and Bonde, Marianne (2018) **Fokus på indretning af løbegårde.** *Økologisk Landbrug*, February 2018, p. 8.

Rémond, Morgane (2021) **Pas de supplémentation en fer en plein air.** *La semaine vétérinaire*, 18 June 2021, 1904, p. 29.

Wimmler, Cäcillia; Leeb, Christine; Andersen, Heidi Mai-Lis; Holinger, Mirjam and Thomsen, Rikke (2021) **What makes outdoor runs clean and attractive for pigs?** *Core Organic Cofound Newsletter*, 24 June 2021, p. 1.

Conference paper, poster, etc.

Canario, Laurianne (2021) **Capacité d'adaptation des truies et amélioration de la survie des porcelets.** [Adaptability of sows and improved piglet survival.] Workshop at: The International exhibition or animal productions, Rennes, France, September 14-16 2021.

Heidbüchel, Katharina; Baldinger, Lisa and Bussemas, Ralf (2021) **Behavioural observations of piglets in an organic free farrowing pen.** Poster at: IAHA Pre-Conference on Organic Animal Husbandry, FiBL Schweiz, 6. and 7. September 2021.

Heidbüchel, Katharina; Baldinger, Lisa and Bussemas, Ralf (2021) **Nest oder Mutter – Kann das Liegeverhalten neugeborener Ferkel beeinflusst werden?** [Nest or mother sow - can the lying behavior of newborn piglets be influenced?] Paper at: 20. Internationale Bioland Schweinetagung, virtuell, 9.-10. Februar 2021.

Heidbüchel, Katharina (2019) **Einfluss von Haltung und Management auf Ferkelverluste in einer freien Abferkelbucht.** [Influence of husbandry and management on piglet losses in a free farrowing pen.] Paper at: 51. Internationale Tagung Angewandte Ethologie, Freiburg im Breisgau, Deutschland, 28.-30.11.2019. [Completed]

Heidbüchel, Katharina; Baldinger, Lisa and Bussemas, Ralf (2020) **Behavioural observations of sows and piglets in an organic free far-rowing pen with a focus on the piglet nest.** In: *Proceedings of the IAHA Video-Conference on Organic Animal Husbandry*, Otto Schmid, Marion Johnson, Mette Vaarst, Barbara Früh (Eds.), pp. 109-110.

Jenni, Anna; Holinger, Mirjam; Früh, Barbara; Eppenstein, R.C.; Bochicchio, Davide; Kongsted, A.G. and Thomsen, Rikke (2021) **Case studies on innovative combined indoor/outdoor organic pig systems.** In: Schmid, Otto; Johnson, Marion; Vaarst, Mette and Früh, Barbara (Eds.) *Organic Animal Husbandry systems – Ways to improvement*.

Knoll, M.; Bokkers, E.A.M.; Leeb, C.; Wimmler, C.; Andersen, H.M.-L.; Thomsen, R.; Früh, B. and Holinger, M. (2021) **Mixing feed in compost increases use but not cleanliness of rooting areas for growing-finishing pigs.** In: *Book of Abstracts of the 72nd Annual Meeting of the European Federation of Animal Sciences. Davos, Switzerland. 30 August - 3 September 2021*, Wageningen Academic Publishers, The Netherlands, no. 27, p. 534.

Knoll, Maximilian; Bokkers, Eddie A.M.; Leeb, Christine; Wimmler, Cäcillia; Andersen, Heidi Mai-Lis; Thomsen, Rikke; Früh, Barbara and Holinger, Mirjam (2021) **Mixing feed in compost increases use of rooting areas for lying behaviour but not cleanliness for growing-finishing pigs.** Paper at: 8th INTERNATIONAL CONFERENCE ON THE ASSESSMENT OF ANIMAL WELFARE AT FARM AND GROUP LEVEL, Virtual Conference, 16 - 19 August 2021. [Completed]

Kongsted, A.G. (2021) **Pig welfare from birth to slaughter in sustainable concepts.** Keynote presentation at: Organic Knowledge Network on Monogastric Animal Feed, 26.01.2021.

Kongsted, A.G. (2019) **Proven welfare and resilience in organic pig production - POWER.** Poster at: The National CORE Organic and Organic RDD project meeting organized by ICROFS, April 2019.

Kongsted, A.G. (2019) **Proven welfare and resilience in organic pig production.** Poster at: The CORE Organic Research Seminar, Bari, Italy, January 2019.

Merlot, Elodie; Belloc, Catherine; Clouard, Caroline; FERCHAUD, Stéphane and Prunier, Armelle (2021) **Méthodes alternatives pour la supplémentation en fer des porcelets.** [Alternative methods for iron supplementation of piglets.] Workshop at: The International exhibition or animal productions, Rennes, France, September 14-16 2021.

Merlot, Elodie; Pauwels, Maud; Herve, Gwendoline; Müller, Vincent; Belloc, Catherine and Prunier, Armelle (2021) **Do piglets need iron supplementation in organic farms?** In: Schmid, Otto; Johnson, Marion; Vaarst, Mette and Früh, Barbara (Eds.) *Proceedings of the IAHA Pre-Conference on Organic Animal Husbandry*.

Merlot, Elodie; Pauwels, Maud; Leblanc-Maridor, Mily; Herve, Gwendoline; Müller, Vincent; Belloc, Catherine and Prunier, Armelle (2021) **Do piglets need iron supplementation in organic farms?** In: Schmid, Otto; Johnson, Marion; Vaarst, Mette and Früh, Barbara (Eds.) *Proceedings of the IAHA Pre-Conference on Organic Animal Husbandry*, 1.

Merlot, Elodie; Robert, C; Clouard, C; Resmond, Rémi; Ferchaud, S and Prunier, Armelle (2021) **Testing natural alternatives to iron injection for organic piglets.** Paper at: EAAP 2021, Davos - Switzerland.

Merlot, Elodie; Robert, Camille; Clouard, Caroline; Resmond, Rémi; FERCHAUD, Stéphane and Prunier, Armelle (2021) **Testing natural alternatives to iron injection for organic piglets.** In: *Book of Abstracts of the 72nd Annual Meeting of the European Federation of Animal Science*, 1, p. 361.

Prunier, Armelle; Pauwels, Maud; Jaillardon, Laetitia; Leblanc-Maridor, Mily; Herve, Gwendoline; Muller, Vincent; Belloc, Catherine and Merlot, Elodie (2021) **Evaluation de l'intérêt de la supplémentation en fer en élevage porcin biologique.** [Evaluation of the value of iron supplementation in organic pig farming.] Paper at: 53e Journées de la Recherche Porcine, Paris, France, 01/02/2021 to 04/02/201.

Salomon, Eva; Mjöfors, Kristina and Tersmeden, Marianne (2020) **Ammonia emissions from outdoor fattening pigs on concrete pad – a farm case study.** In: *Proceedings of the IAHA Video Pre-Conference on Organic Animal Husbandry*, pp. 44-47.

Solomon, Eva (2019) **Ekologisk smågrisproduktion för livskraftiga grisar, foretag och miljön.** Keynote presentation at: FoU-dagar 2019, Uppsala, 6-7 februar 2019.

Vaarst, Mette; Roderick, Stephen; Martin, Guillaume; Gunnarson, Stefan; Neff, Anet Spengler; Bieber, Anna and Kongsted, A.G. (2020) **Potentials, challenges and visions for future European organic animal farming.** In: Schmid, Otto; Johnson, Marion; Vaarst, Mette and Früh, Barbara (Eds.) *Proceedings of the Organic Animal Husbandry systems – challenges, performance and potentials*, pp. 11-22.

Vermeer, Herman (2021) **Preliminary experiences on organic farrowing pen size.** In: *Free Farrowing / Workshop Proceedings*, OpenAgrar Repository.

Vermeer, Herman M. (2021) **Preliminary experiences on organic farrowing pen size.** Poster at: FFL21 (Freedom in Farrowing and Lactation), Wageningen, August 2021.

Wimmler, Cäcillia; Holinger, Mirjam; Knoll, Maximilian; Andersen, Heidi Mai-Lis; Thomsen, Rikke; Bochicchio, Davide; Kongsted, A.G. and Leeb, Christine (2021) **Multi-centre approach to improve outdoor runs for organic pigs:Preliminary results of on-farm experiments.** In: Schmid, Otto; Johnson, Marion; Vaarst, Mette and Früh, Barbara (Eds.) *Organic Animal Husbandry systems – Ways to improvement*.

Wimmler, Cäcillia; Kunert, Esther; Leeb, Christine and Holinger, Mirjam (2021) **Showers in outdoor runs of organic growing-finishing pigs: effects on behaviour, soiling and skin surface temperature.** Paper at: 8th International Conference on the Assessment of Animal Welfare at the Farm and Group Level.

Wimmler, Cäcillia; Leeb, Christine; Andersen, Heidi Mai-Lis; Bochicchio, Davide; Früh, Barbara; Holinger, Mirjam; Salomon, Eva; Thomsen, Rikke; Vermeer, Herman and Kongsted, A.G. (2020) **Transdisciplinary approach to improve concrete outdoor runs for organic pigs: Identification of innovations.** In: *Organic Animal Husbandry systems – challenges, performance and potentials*, pp. 48-52.

Report

Baldinger, Lisa; Bussemas, Ralf and Heidbüchel, Katharina (2022) **Design and use of piglet nests in commercial farms and the effects of improved piglet nest design.** Thünen-Institut für Ökologischen Landbau .

Bark, Linnea and Salomon, Eva (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs: automatic manure scrapers.** POWER-Factsheet, no. 1.5. Research Institute of Organic Agriculture FiBL, CH-Frick.

Bark, Linnea; Salomon, Eva and Eppenstein, Rennie (2021) **Automatic manure scrapers for reduced ammonia emissions.** POWER Practice Abstracts. Research Institute of Organic Agriculture FiBL, CH-Frick .

Bark, Linnea; Wahlund, Lotten and Salomon, Eva (2022) **Combined pasture and housing systems in Sweden: multi-suckling pens with access to pasture in the summer.** POWER-Factsheet, no. 3.9. Research Institute of Organic Agriculture FiBL, CH-Frick.

Bochicchio, Davide (2022) **Combined pasture and housing systems in Italy: year-round access to pasture for growing-finishing pigs.** POWER-Factsheet, no. 3.8. Research Institute of Organic Agriculture FiBL, CH-Frick.

Bochicchio, Davide (2022) **Improved health, welfare and viability in young pigs: using microorganisms to improve piglet health.** POWER-Factsheet, no. 2.5. Research Institute of Organic Agriculture FiBL, CH-Frick.

Bochicchio, Davide (2022) **Innovative farming in Italy: pasture rotation in the forest.** POWER-Factsheet, no. 4.4. Research Institute of Organic Agriculture FiBL, CH-Frick.

Canario, Laurianne (2022) **Improved health, welfare and viability in young pigs: breeding for improved piglet survival.** POWER-Factsheet, no. 2.3. Research Institute of Organic Agriculture FiBL, CH-Frick.

De Simone, Ambra and Moeskops, Bram (2021) **Press release at the final conference (Deliverable 1.12 OK-Net EcoFeed Project).** .

Dinesen Jensen, Line; Thomsen, Rikke and Kongsted, Anne Grete (2020) **IDENTIFICATION OF BEST PRACTISES AND INNOVATIVE IDEAS WITHIN ORGANIC PIG PRODUCTION SYSTEMS IN EUROPE.** .

Eppenstein, Rennie (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs: temporary access to pasture.** POWER-Factsheet, no. 1.6. Research Institute of Organic Agriculture FiBL, CH-Frick.

Eppenstein, Rennie and Jenni, Anna (2022) **Innovative farming in Switzerland: breeding Berkshire Pigs outdoors year-round.** POWER-Factsheet, no. 4.1. Research Institute of Organic Agriculture FiBL, CH-Frick.

Eppenstein, Rennie and Jenni, Anna (2022) **Innovative farming in Switzerland: the "pig caravan".** POWER-Factsheet, no. 4.0. Research Institute of Organic Agriculture FiBL, CH-Frick.

Eppenstein, Rennie; Jenni, Anna and Moakes, Simon (2022) **Combined pasture and housing systems in Switzerland: evening outings for increased welfare.** POWER-Factsheet, no. 3.4. Research Institute of Organic Agriculture FiBL, CH-Frick.

Eppenstein, Rennie; Jenni, Anna and Moakes, Simon (2022) **Combined pasture and housing systems in Switzerland: large scale production inclusive of animal welfare.** POWER-Factsheet, no. 3.3. Research Institute of Organic Agriculture FiBL, CH-Frick.

Haidl, Viktoria; Leeb, Christine; Moakes, Simon and Wimmler, Cäcillia (2022) **Combined pasture and housing systems in Austria: benefits of keeping sows and piglets on large pastures and growingfinishing pigs indoors.** https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/, no. 3.1. Research Institute of Organic Agriculture FiBL, CH-Frick.

Haidl, Viktoria; Wimmler, Cäcillia and Leeb, Christine (2022) **Combined pasture and housing systems in Austria: indoor reared pigs are finished on the pasture.** POWER-Factsheet, no. 3.2. Research Institute of Organic Agriculture FiBL, CH-Frick.

Heidbüchel, Katharina and Baldinger, Lisa (2022) **Combined pasture and housing systems in Germany: year-round outdoor housing for pregnant sows.** POWER-Factsheet, no. 3.5. Research Institute of Organic Agriculture FiBL, CH-Frick.

Heidbuechel, Katharina (2022) **Improved health, welfare and viability in young pigs: how to encourage piglets to use their nest.** POWER-Factsheet, no. 2.2. Research Institute of Organic Agriculture FiBL, CH-Frick.

Heidbuechel, Katharina; Baldinger, Lisa and Vermeer, Herman (2022) **Improved health, welfare and viability in young pigs: designing an organic farrowing pen.** POWER-Factsheet, no. 2.1. Research Institute of Organic Agriculture FiBL, CH-Frick.

Knoll, Maximilian (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs: rooting area.** POWER-Factsheet, no. 1.1. Research Institute of Organic Agriculture FiBL, CH-Frick.

Kongsted, A.G.; Salomon, Eva; Leeb, Christine and Merlot, Elodie (2022) **Welfare and resilience in organic pig production in Europe.** .

Kongsted, Anne Grete (2022) **Improved health, welfare and viability in young pigs: extended lactation to improve pig health and growth.** POWER-Factsheet, no. 2.6. Research Institute of Organic Agriculture FiBL, CH-Frick.

Merlot, Elodie (2022) **Improved health, welfare and viability in young pigs: general information and legislation.** POWER-Factsheet, no. 2.0. Research Institute of Organic Agriculture FiBL, CH-Frick.

Merlot, Elodie (2022) **Improved health, welfare and viability in young pigs: oral iron supply in neonatal piglets to avoid anaemia.** POWER-Factsheet, no. 2.4. Research Institute of Organic Agriculture FiBL, CH-Frick.

Pfeifer, Catherine and Moakes, Simon (2022) **Resilience of organic pig producers.** POWER-Policy briefing. Research Institute of Organic Agriculture FiBL, Switzerland .

Thomsen, Rikke (2022) **Combined pasture and housing systems in Denmark: special outdoor feed troughs for pregnant sows.** POWER-Factsheet, no. 3.7. Research Institute of Organic Agriculture FiBL, CH-Frick.

Thomsen, Rikke (2022) **Combined pasture and housing systems in Denmark: year-round outdoor housing for sows and piglets.** POWER-Factsheet, no. 3.6. Research Institute of Organic Agriculture FiBL, CH-Frick.

Thomsen, Rikke (2022) **Innovative farming in Denmark: mobile wagons with fenced pasture area.** POWER-Factsheet, no. 4.3. Research Institute of Organic Agriculture FiBL, CH-Frick.

Thomsen, Rikke (2022) **Innovative farming in Denmark: special huts for sows on the pasture.** POWER-Factsheet, no. 4.2. Research Institute of Organic Agriculture FiBL, CH-Frick.

Thomsen, Rikke and Buus, Marie Lund (2021) **IDEKATALOG: Attraktive udearealer til grise i vækst.** .

Thomsen, Rikke; Eppenstein, Rennie and Moakes, Simon (2022) **Best practice examples in combined housing and pasture systems.** POWER-Factsheet, no. 3.0. Research Institute of Organic Agriculture FiBL, CH-Frick.

Wimmler, Cäcillia (2022) **POWER - WP1 model farm.** .

Wimmler, Cäcillia; Andersen, Heidi Mai-Lis; Dinesen Jensen, Line; Leeb, Christine and Thomsen, Rikke (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs roughage in a rack – how to do it?** POWER-Factsheet, no. 1.3. Research Institute of Organic Agriculture FiBL, CH-Frick.

Wimmler, Cäcillia; Holinger, Mirjam and Leeb, Christine (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs: showers.** POWER-Factsheet, no. 1.4. Research Institute of Organic Agriculture FiBL, CH-Frick.

Wimmler, Cäcillia; Knoll, Maximilian; Andersen, Heidi Mai-Lis; Dinesen Jensen, Line and Leeb, Christine (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs: benefits of roughage as nutritive enrichment.** POWER-Factsheet, no. 1.2. Research Institute of Organic Agriculture FiBL, CH-Frick.

Wimmler, Cäcillia; Knoll, Maximilian; Leeb, Christine and Vermeer, Herman (2022) **Improved concrete outdoor runs in housing systems for growing-finishing pigs: general information and legislation.** POWER-Factsheet, no. 1.0. Research Institute of Organic Agriculture FiBL, CH-Frick.

Book

Früh, Barbara; Andersen, Heidi M.-L.; Baldinger, Lisa; Bark, Linnea; Bochicchio, Davide; Canario, Laurianne; Eppenstein, Rennie; Heidbuechel, Katharina; Holinger, Mirjam; Jenni, Anna; Knoll, Maximilian; Leeb, Christine; Merlot, Elodie; Moakes, Simon; Prunier, Armelle; Salomon, Eva; Thomsen, Rikke; Vermeer, Herman; Wahlund, Lotten; Wimmler, Cäcillia and Kongsted, Anne Grete (2022) **Welfare and environmental impact of organic pig production.** 1 edition. Leitfaden / Handbuch. Research Institute of Organic Agriculture FiBL, CH-Frick.

Thesis

Bühl, Verena (2021) **Die Bedeutung von Individualität in der Biomastschweinehaltung. Wie nutzen unterschiedliche Tiere einer Gruppe den angebotenen Auslauf?** Thesis, Zürcher Hochschule für angewandte Wissenschaften ZHAW, Wädenswil . .

KUNERT, Esther Elisabeth (2021) **Effektive Kühlung durch Schweineduschen im Auslauf: Was sagt die Infrarotthermografie?** Masters thesis, University of Natural Resources and Life Sciences, Vienna Institut für Nutztierwissenschaften , Department für Nachhaltige Agrarsysteme. . [Unpublished]

Project description

{Project} POWER: ***Überprüfung von Maßnahmen zur Optimierung der Ferkelnestnutzung im ökologischen Landbau.*** [Measures for optimizing the use of a piglet nest in organic pig husbandry.] Runs 2018 - 2021. Project Leader(s): Baldinger, Dr. Lisa and Bussemas, MSc Ralf, Thünen Institut für Ökologischen Landbau, D-Westerau .

{Project} ***I produttori di suini biologici di tutta Europa aprono la strada alla ricerca per migliorare il benessere degli animali e ridurre le emissioni di ammoniaca.*** [Organic pig producers across Europe set the scene for research to improve animal welfare and reduce ammonia emission.] Runs 2018 - 2021. Project Leader(s): Kongsted, Anne Grete.

{Project} ***Power per aumentare il benessere e la resilienza nell'allevamento del suino biologico.*** Runs 2018 - 2021. Project Leader(s): Kongsted, Anne Grete.

{Project} POWER: ***Power to strengthen welfare and resilience in organic pig production.*** Runs 2018 - 2021. Project Leader(s): Kongsted, Anne Grete.

{Project} ***POWER Assurer le bien - être et la résilience des porcs biologiques.*** Runs 2018 - 2021. Project Leader(s): Kongsted, Anne Grete.

{Project} ***Power – Für Tierwohl und Resilienz in der Bio-Schweinehaltung.*** Runs 2018 - 2021. Project Leader(s): Kongsted, Anne Grete.

{Project} ***PrOven WElfare & Resilience in organic pig production.*** Runs 2018 - 2021. Project Leader(s): Kongsted, Anne Grete.

Practice tool

{Tool} ***Automatic manure scrapers for reduced ammonia emissions (POWER Practice Abstract).*** Creator(s): Bark, Linnea; Salomon, Eva and Eppenstein, Rennie. Issuing Organisation(s): FiBL - Research Institute of Organic Agriculture. CORE Organic Practice Abstracts. (2021)

{Tool} ***Welfare and environmental impact of organic pig production (POWER factsheets).*** Creator(s): Früh, Barbara; Andersen, Heidi; Baldinger, Lisa; Bark, Linnea; Bochicchio, Davide; Canario, Laurianne; Eppenstein, Rennie; Heidbuechel, Katharina; Holinger, Mirjam; Jenni, Anna; Knoll, Maximilian; Leeb, Christine; Merlot, Elodie; Moakes, Simon; Prunier, Armelle; Salomon, Eva; Thomsen, Rikke; Vermeer, Herman; Wahlund, Lotten; Wimmler, Cäcilia and Kongsted, Anne Grete. Issuing Organisation(s): FiBL - Research Institute of Organic Agriculture Switzerland, Univ. BOKU Wien, Center for Frilandsdyr, CREA, INRAe - Institut national de recherche pour l'agriculture, l'alimentation et l'environnement, RISE Research Institutes of Sweden, Thünen-Institut, Wageningen University & Research (WUR). (2022)

Web product

Jenni, Anna (2021) **Porcins: Méthodes astucieuses en comparaison.** Institut de recherche de l'agriculture biologique FiBL, CH-Frick . Online at **https://www.bioactualites.ch/production-animale/porcins/general-porcins/methodes-astucieuses-en-comparaison.html**, accessed on: 1 February 2022.

Jenni, Anna (2021) **Schweinehaltung im Vergleich.** Forschungsinstitut für biologischen Landbau FiBL, CH-Frick . Online at **https://www.bioaktuell.ch/tierhaltung/schweine/allgemein/vergleich-von-systemen-zur-schweinehaltung.html**, accessed on: 1 February 2022.

Merlot, Elodie; Armelle, PRUNIER; Maud, PAUWELS and Catherine, BELLOC (2019) **Do piglets in organic farms need iron supplementation?** . Online at **https://projects.au.dk/coreorganiccofund/news-and-events/show/artikel/do-piglets-in-organic-farms-need-iron-supplementation/**, accessed on: 6 December 2019.

Video

Internationalt Center for Forskning i Økologisk Jordbrug og Fødevaresystemer (2021) **Innovative frilandssystemer fra Danmark og Italien.** .

International Centre for Research in Organic Food Systems (2021) **Innovative pasture systems from Denmark and Italy.** International Centre for Research in Organic Food Systems.

International Centre for Research in Organic Food Systems (2021) **POWER.** International Centre for Research in Organic Food Systems.

Pfister, Christian and Jenni, Anna (2021) **Sau Karavan - Bodenschonende Schweinehaltung auf Dauergrünland (CORE Organic POWER).** Forschungsinstitut für biologischen Landbau FiBL , CH-Frick.

Other

Kongsted, A.G. (2018) **Organic pig producers across Europe set the scene for research to improve animal welfare and reduce ammonia emission.** .

Wimmler, Cäcillia et al. (2018) **Tierwohl und Resilienz in der biologischen Schweinehaltung.** .

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4.2 Stakeholders oriented articles in the CORE Organic newsletter

1. Organic pig producers across Europe set the scene for research to improve animal welfare and reduce ammonia emission Link [policy makers, farmers & consultants, scientific community, consumers/general public]

2. Do piglets in organic farms need iron supplementation? Link [Farmers & Consultants; scientific community]

3. Potentials, challenges and visions for future European organic animal farming across species: Link [Policy makers, scientific community, farmers, consumers/general public]

4. What makes outdoor runs clean and attractive for pigs? Link [Farmers & consultants, policy makers]

4.3 Practice abstracts

- Organic Farm Knowledge: Bark, 2021: Automatic manure scrapers for reduced ammonia emissions (POWER Practice Abstract)

- Additional 27 fact sheets (practice abstracts) produced and compiled in a Management Manual.

4.4 Other dissemination activities and material

Country	Partner	Date	Event	Type	Author/main responsible
AT, CH, DE, DK, FR, I, NL, SE	BOKU, CREA-ZA, FiBL, INRA, RISE, TI-OL, WUR, CFF	2018/19	Initial stakeholder workshops in eight countries (presentation of project)	Producer/ Stakeholder event	Rikke Thomsen et al.
AT, CH/DE/D (joint), DK, FR, I, NL, SE	AU, BOKU, CREA-ZA, FiBL, INRA, TI-OL, WUR, CFF	2021	Final stakeholder workshops/presentation of results. Presentations available at POWER website: Presentations from final farmer workshops (au.dk)	Producer/ Stakeholder event	Früh et al.
CH	FiBL	Sept 2019	Group meeting FiBL	Presentation of experimental design of experiment on rooting area, WP1	Maximilian Knoll
DE	BOKU	29.November 2019	DVG Conference on Applied Animal Behaviour	Short oral presentation to scientific audience	Cäcilia Wimmler
DE	TI-OL	12th of December 2019	2nd Trenthorst Organic Science Slam	Event for general public, organised by the association Friends of Trenthorst	Katharina Heidbüchel
DK	AU	24 Nov 2021	Webinar about Pig's welfare	Presentation of POWER at a meeting for consultants and scientists organised by Jordbruksverket (Sweden)	Anne Grete Kongsted

DK	CFF	Nov. 2021	Trainee project	Examination paper and oral examination Copenhagen University	Rikke Thomsen
FR	INRA	June 2019	Veterinarian student project (public defence, presence of farmers involved in the study)	Thesis on iron supplementation in organic piglet production	French Vet. Student (ONIRIS) supervised by Armelle Prunier and Catherine Belloc
FR	INRAE	Aug 2020	Master student project	Internship report on the testing of alternatives to injectable iron for organic piglets	French agronomist student (ESA Angers Loire) supervised by Elodie Merlot
FR	INRAE	Sep 2021	The International exhibition of animal productions (SPACE) in Rennes, France	Event of producers, stakeholders and general public (approx. 60 people)	Elodie Merlot and Laurianne Canario
FR	INRAE	Oct. 2021	AI VETS congress organized by IFIP (French swine technical institute)	Event for veterinarians and stakeholders	Laurianne Canario Armelle Prunier
FR	INRAE	Jan. 2021	INRAE experimental unit annual meeting	INRAE scientist and animal technicians	Elodie Merlot
SE	RISE	26 June 2018	Stakeholder workshop (presentation of project)	Science Bazar organized by OK-NET Ecofeed	Eva Salomon

4.5 Future dissemination actions

– List publication/deliverables/activities arising from your project that you are planning for the future;

- Scientific (full) paper (WP1): Showers in the outdoor run for growing-finishing pigs. Expected deliverable date June 2022. BOKU.
- Scientific (full) paper (WP1): Effect of roughage position on pig behaviour and soiling. Expected deliverable date Oct. 2022. BOKU.
- PhD Thesis (WP1) on the design of concrete outdoor runs for organic growing-finishing pigs and how to improve it. Expected deliverable date December 2022. BOKU.
- Scientific (full) paper (WP2): Extended lactation in organic piglet production – effects on sows and piglets. Expected deliverable date Dec. 2022. AU-AGRO
- Scientific (full) paper (WP2): Oral alternatives to iron injection supplementation. Expected deliverable date June 2022. INRAE
- Scientific (full) paper (WP2): Effects of probiotic from natural microorganisms on piglet performance and faecal microbiota, Expected deliverable date Dec 2022. CREA-ZA

- Master thesis on combined pasture and housing systems in Austria (seasonal effects). Expected deliverable date September 2022 (WP3). BOKU
- Article in farmer journal presenting main conclusions from the POWER project. AU-AGRO

– List publications/deliverables arising from your project that more specifically Funding Bodies could disseminate in the respective national contexts;

- Assessment of potential effects of manure/pasture management on N and P (2022) Å Myrbeck and E Salomon. National conference organic production and consumption. Organized by Swedish board of agriculture.
- Handbook (27 fact sheets)
- Synthesis Report
- POWER website

– Indicate publications/deliverables that could be useful to translate (Please indicate targeted language and user groups).

- The entire Handbook (fact sheets) to all partner languages: Selected fact sheets will be translated, but it will probably not be possible to translate all fact sheets due to lack of resources. User group: Organic pig producers and consultants

4.6 Specific questions regarding dissemination and publications

– Is your CORE Organic Cofund project website up-to-date (Please contact the webmaster);

- Yes (https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/)

– List the categories of end users relevant to the research results and how they have been addressed or will be addressed by dissemination activities (Please order them according to the user groups).

POWER End-users/target groups	How have they been addressed? **Selected examples** - See **WP descriptions** for further products and details
Farmers & consultants	• Handbook comprising 27 Fact sheets • Six videos • Presentation of final POWER results at stakeholder workshops/meetings
Policy makers	• Synthesis report listing policy needs
Consumers (general public)	• Five Newsletters
Scientific community	• Six full paper manuscripts, hereof one in French (additional five planned) • 21 conference contributions

5. Project impact

The project has been successful in reaching all the key target groups as explained in 4.6 and in the individual WP descriptions. The main target group of the POWER project, the *organic pig producers*, have

been reached e.g. through a number of participatory activities e.g. a) Initial stakeholder workshops and interviews in WP3 targeting farmers, consultants and veterinarians (n = 120), b) farmers hosting experimental activities in WP1 and WP2 (n = 45), c) farmers providing farm data (including resilience data) in WP3 and WP4 (n = 18), and d) final presentations of POWER results at national workshops and meetings (n=100+). Additionally, for the selection of G0 sows, and reception of boar semen for G0 and G1 generations in WP2, there was a collaboration with two French genetic breeder firms (Nucleus https://www.nucleus-sa.com/ and Axiom https://www.axiom-genetics.com/). Finally, several of the project partners have recently/are currently involved in policy-supporting activities with focus on outdoor areas building on the POWER findings.

Suggestions for activities to create further impact after the project

- Translation of all fact sheets into a wide range of European languages (not only the partner country languages) to support producer decision-making *also* in countries with low share of *organic* pork production
- Consumer-targeted dissemination (presenting research supporting the organic principles) across Europe to support consumer interest and trust and eventually a further increase in the market share of organic pork

6. Added value of the transnational cooperation in relation to the subject

Advantages

- Discovery and sharing between partners of the diversity of practices and pig farming systems across geographical areas, and of the differences in application of the European regulation on organic farming in the different countries.
- Capturing of the diversity of European systems, and not least the diversity of the solutions
- Extended data set; one country has too few farms
- Research stays of individual researchers in other institutions (Cäcilia Wimmler at FIBL for 2 months for data analysis and paper preparation; Max Knoll at FIBL) were fruitful in sharing knowledge and competences

New research funding obtained within the consortium:

- CORE Organic cofund third call: Robust animals in sustainable mixed free-range systems (ROAM-FREE, 2021-2024) coordinated by Copenhagen University (Stig Thamsborg) with participation of AU (AG Kongsted) and CREA-ZA (Davide Bochicchio) [of all project partners, only DK and IT had funding possibilities within the relevant sub-call]
- H2020, grant agreement No 816172 : Poultry and PIg Low-input and Organic production systems' Welfare (PPILOW, 2019 – 2023) coordinated by INRAE (Anne Collin) with participation of TI-OL (Lisa Baldinger) and INRA (Laurianne Canario, Armelle Prunier, Elodie Merlot)

7. Suggestions for future research

Piglet health and welfare

Farrowing area

- The effect of temporary confinement to the nest could be studied further because of its clear positive effect on nest use
- Technical details of measuring the temperature in the nest should be improved, because it remained unclear if piglets perceive heat from infrared and electrical heating differently

- Farmers were interested in effects of different positions of the piglet nest in the farrowing pen
- More space than the required 7.5 m² seems to be beneficial; a more detailed dose-response experiment could be helpful
- Effect of distance between sow build nest and piglet nest

Management strategies

- Role of genetics to achieve sustainable level of production
- Confirm the possibility to use daily peat or Briere river peat provision instead of iron injection, and control the interindividual variability in peat ingestion.
- Explore the benefits and limitations regarding health and welfare of the piglets of regular iron intake along lactation rather than a single bolus at birth
- Probiotic from natural microorganisms: Effect of forest litter origin and further evaluation of the effect of different dosages
- Short and long-term effects of improved (extended) mother offspring interactions on piglets' coping strategies/abilities in response to various stressors (social, environmental, nutritional etc.)
- Effects of short-term mother-offspring separation (to induce lactational oestrus) on milk production, piglet behavior, welfare and growth

Outdoor runs

- Influence of specific pen elements (shape of the pen, degree of roofing, feeder location and provision of brushes) on pig behaviour and use of functional areas in the outdoor run.
- How pigs' choice of where to eliminate is influenced in particular by open pen partitions, drinker position, showers or wet areas.
- Potential benefit of exposure to natural climatic conditions (rain, sunshine etc., unobstructed view) for pig welfare.
- Interaction of various influences in the outdoor climate on soiling and ammonia emissions, which entails extended research and measurement of ammonia emissions in the outdoor run.
- Comparing different types of showers (e.g. with regard to droplet size, flow rate) and schedules (e.g. combinations of different duration and frequency).
- Find practical solutions for rooting areas with regard to work load and cleanliness.

Pasture concepts

- How much pasture access is enough? How much time do sows spend on pasture if they can choose?
- Considering pasture / grazing in pigs' diet (nutritive contribution of grazing).
- Keeping pigs in forests/forest-like areas.
- Suitable types of pasture (cultures, grass mixtures etc) and how to integrate it in crop rotation for good nutrient utilisation.
- Future of pasture systems facing the challenge of African swine fever.
- Epidemiological study about African swine fever and possible differences between housing systems with and without access to an outdoor area.

Environmental impact

- Research on environmental sustainability in pig production should focus on the impact of circularity within systems – purchased vs home-produced feed impacts. This study showed positive impacts from home production, but more detailed assessments needed.
- Research on pig and pasture management systems should focus on identify potential management systems that promote a good pig health and welfare, a good working environment for the farmer (safe and secure) and a nitrogen and phosphorus load in balance with environmental goals. Interesting trade-offs having pigs on pasture to be examined are: effects on vegetation cover and natural recovering of damaged sward

Resilient organic farm systems

- Research of resilience on farm level – the entrepreneur context - gives valuable knowledge about what is the resilience capacity and attributes for farmers to cope and adapt to shocks. We found that across all resilient strategies the farmers' attitude, meaning making and social capital played an important role which needs more deep knowledge to understand farmers' driving forces and what internal attributes that have an influence (attitudes and behaviours) in relation to external chocks.