

A10. Keywords

Max. 5 keywords to describe the project activity.

Boartaint, salmonella, parasites, feeding, production systems

A11. Short project description/summary on objectives, activities, and expected results, both in Danish and English language (max 1500 characters, incl. spaces for both languages)

Økologisk svinekød er et klart alternativ til konventionelt svinekød fordi økologisk svineproduktion med adgang til ude arealer og grovfoder er markant anderledes. Med en markedsandel på kun 1 % har økologisk svineproduktion et stort udviklingspotentiale. Forbrugernes forventning om et naturligt produkt betyder at et ophør med kastrering af hangrise vil give nye markedsføringsmuligheder. Pilotstudier viser, imidlertid, at andelen af økologisk producerede hangrise med ornelugt er så stor at det er en væsentligste barriere for en markedsbaseret vækst i økologisk svineproduktion. I dette projekt udvikler vi et helhedsorienteret management koncept for fremtidens økologiske svineproduktion uden kastrering. Projektet leverer et koncept med et dokumenteret lavt niveau af hangrise med et for højt niveau af skatole og androstenon i spækket og dermed en minimal risiko for ornelugt. Risikoen for ornelugt kan reduceres ved fodring med de rigtige fodermidler i den rette fodersammensætning. De bedste fodringsrationer udvælges ud fra deres evne til minimering af ornelugt og vurderes kritisk for konsekvenser for produktivitet, miljøbelastning og grisenes modstandskraft mod smitte. Herefter kombineres de bedste foderstrategier med de mest effektive og ornelugtsminimerende valg af: vægt ved indsættelse fra friland, gruppestørrelse og grupperingsmetode og slagtevægt. De samlede konsekvenser for økonomien og arbejdsglæden demonstreres overfor økologiske landmænd og borgere.

Organic pork is a clear alternative to conventional pork because organic pig production, with outdoor access and roughage, is quite different. The low market share (1 %) for organic pork provides a promising development potential. Consumer expectation for a natural product means that a stop for castration could provide new marketing possibilities. A recent pilot study on production of entire males on commercial organic farms indicates that the proportion of organic produced entire male pigs with boar taint is so high that it is a major barrier for a marked orientated growth in organic pig production. In this project we develop a management concept for future organic pig production without castration, with a documented low level of entire male pigs with a high level of skatol and androstenone in back fat and therefore a minimum risk for boar taint. The risk of boar taint can be reduced by feeding the right feeds in the right combination. The best feed rations are selected based on their ability to minimize boar taint and tested for consequences for productivity, nutrient utilization and natural disease resistance. Subsequently the best feeding is combined with the best decisions concerning, pig weight when taken from pasture, group size and grouping strategy and slaughter weight and the concept is tested for the overall effect on skatole and androstenone level in male pig. The consequences for economy and working conditions are demonstrated for farmers and citizens.

A12. Project description

(All parts of A12 must be filled out. Use "Garamond" as font, and font size 12, single spaced)

A12.1 The project objectives (2-3 lines). The objective of the project is to develop an optimum feeding and management praxis that eliminate the requirement for castration of male pigs and increase the pig's natural resistance against infection with zoonotic bacteria and parasites

A12.2 The background and idea (hypotheses) incl. the national and international "state of art" and incl. references relevant for the section (max. ¾ page). Organic pork is a clear alternative to

conventional pork, offering an entirely different production system with outdoor access and roughage. A stop for castration in organic pig herds could fulfil consumer expectations of a high animal welfare product and provide new marketing possibilities. However, recent pilot studies in commercial organic farms indicate that the proportion of entire male organic pigs with boar taint is so high, that it is a major barrier for a market orientated growth in organic pig production. That has put pressure on the organic pig producers for development of production systems, which can produce male pigs without boar taint.

Boar taint is an off-flavour and off-odour of pork, mainly caused by elevated concentrations of androstenone and skatole in the adipose tissue. The androstenone concentration depends on age, body weight, breed and sexual maturity as well as feeding regime, rearing conditions and season (Claus et al., 1994; Whittington, 2004). Bioactive compounds in plants have been shown to affect the metabolism of androstenone by influencing the activity of key enzymes. Chicory (*Cichorium intybus*) is capable of significantly up regulating these enzymes (Rasmussen et al., 2010), and recently effects have been suggested of *Artemisia* (Wormwood) and other Asteraceae plants. Skatole is produced as a natural metabolite of tryptophan in the hind gut of pigs (Jensen and Jensen 1998). The skatole concentration depends mainly on the nutrient composition of the diet and the rearing conditions (Jensen et al., 1995, Hansen et al., 1994). The feeding of easily fermentable fibres such as inulin, raw potato starch or sugar beet pulp a few days before slaughter have proven effective in reducing skatole in conventional pigs (Jensen and Jensen, 1995, Mentschel and Claus, 2003, Maribo et al., in press). However, organic pig feed often consist of different protein sources than conventional pig feed. That may result in an unfavourable ratio of tryptophan to fibre reaching the hind gut, and there is strong indication that skatole production is higher in organic pigs compared to conventionally reared pigs. Another factor, which may affect organic pigs negatively is that organic pigs in general grow slower and are older at slaughter compared to conventionally reared pigs.

There is strong evidence that easily fermentable carbohydrates and bioactive feed components also can have a positive impact on reducing gastrointestinal parasitic worms (Jensen et al., in press), as well as *Salmonella*. Production of entire male pigs might also affect animal welfare negatively. There is evidence from conventional systems that male pigs show increased levels of aggression (e.g. Giersing and Andersson 1998, Cronin et al., 2003, Rydhmer et al., 2006, Fredriksen et al., 2008, Rydhmer et al., 2010). The welfare consequences of rearing entire male pigs in organic production systems are less documented, but it is important that animal welfare is ensured in future organic production concepts. The housing of pigs indoor or outdoor, pen hygiene, use of outdoor area, and the sorting of pigs by gender instead of weight, as normally employed in commercial pig production, may affect animal welfare as well as the boar taint problems. It is the hypothesis of the consortium that it is possible through optimised feeding and management systems to reduce the need for castration and encourage natural resistance against infection and zoonoses and at the same time increase animal welfare in organic pigs.

A12.3 The projects contribution to solving important challenges for the organic food, agriculture and aquaculture sectors and the general political goals regarding food, agribusiness and environment as expressed in the governments Green Growth programme. Including an explanation of the projects focus on respectively the entire product/value chain or selected parts here of (e.g. primary production, processing, trade and transport) – max. ½ page.

The full utilization of non-castrated male pigs in pork production is an important challenge to the organic farming and with natural means of feeding and management try to reduce the boar taint risk as much as possible

A12.4 The projects innovative value, relevance and effect including the specific barriers and development potential for the organic sector the project will solve and/or support (max. ½ page).

The innovative value of knowing more about the beneficial effect of bioactive feed in the whole production chain will be great, so far there is no practically available solution of the boar taint problem based entirely on feed and handling, the present alternative solutions all include castration or seed separation. Early slaughtering is causing restricted profit margins in production.

This project will carry out research into feeding and management strategies applicable in commercial organic pig herds and will thus substantially increase the possibilities for male pig production in organic herds without compromising product quality or animal welfare.

A12.5 Description of activities, methods and expected results divided into work packages with clear denotation of which activity the applicant consider to be either Research, Development or Demonstration. The coherence between work packages must be clearly described and the relation between activities and the tables with milestones and deliverables must be logical and consistent. Moreover, the primary target groups should be clearly identified with a description of how these will be met by the project (max. 1 page per WP and max. 3 pages in total).

The project is organized in four work packages (WP's). WP1 and WP2 include research and development and WP3 aggregates all demonstration activities. WP4 is dedicated organisation of the project. Knowledge at pig or pen level generated in WP1 is used at pen and herd level in WP2 and is demonstrated at herd and farm level in WP3. WP2 and WP3 use the same commercial herds.

WP1 Best feeding (R=90 %, D=10)

The development of the best feeding for minimizing the risk of boar taint in entire male pigs and for protection against Salmonella and parasites is orchestrated through 7 tasks.

Task 1.1. Production of feeding components:

Goal: To select and produce the best and most uniform organic plant material for the feeding trials.

Methods: The plant materials are produced in controlled organic field experiments. A series of high inulin varieties of root-chicory, Jerusalem artichoke and sweet lupin varieties are cultivated to give high yields and high inulin yields. The best development stage of the plant at harvest is important for content of carbohydrates and bioactive compounds. The plant material is dried and analyzed for inulin and bioactive compounds. Feeding materials are delivered to experiment in tasks 1.4 and 1.8.

Results: Guidelines for production of efficient plant feeding material for controlling boar taint.

Task 1.2 A HPLC method to measurements androstenone in blood and fat samples:

Goal: Implementation of an “in house” method for measurements of androstenone

Methods: A high throughput LC method for measurement of androstenone will be implemented at DJF. HPLC methods for analyses of skatole is already running at HBS-DJF

Results: The method will be used to analyse all tissue samples taken in WP1, WP2 and WP3.

Task 1.3 The proteomic effects of bioactive components in feedstuffs:

Goal: To establish and perform the proteomic methods, enzyme and gene regulation assays, in liver tissue and liver cell cultures.

Methods: The specific expression of key enzymes will be analysed by RT-PCR, Western blotting, and enzyme activities. All standard assays set up in our laboratory

Results: The proteomic effects on liver metabolism in relation to bioactive components in feed stuff. The results will be used to select the feed ingredients used in Task 1.4.

Task 1.4 Effect of feed ingredients on skatole and androstenone:

Goal: To rank various feed ingredients for their effect on the gastrointestinal microbiota, skatole production in the gut and on skatole and androstenone levels in blood.

Methods: The investigation will be carried out using the method described by Jensen and Jensen 1998 using pigs as their own control. That eliminates the effect of liver metabolism on the results. Pigs caterized in the jugular vein will be used to allow repeated blood sampling.

Results: A ranked list for protein-, fiber- and bioactive component sources for their effect on skatole and androstenone production. The results will used in task 1.7.

Task 1.5. Natural resistance against Salmonella infections

Goal: To study the anti salmonella effect(s) of a fibre rich feed ingredient using a well established porcine Salmonella model.

Methods: Slaughter pigs will be oral infected with Salmonella. The excretion of Salmonella in faeces will be followed daily. After 3 weeks on the exponential diets the pigs will be slaughtered and the composition and the activity in the gastrointestinal tract will be investigated using classical and molecular biology methods. The presence of salmonella in gut contents and organs will be investigated using Q-PCR.

Results: The ability of low boar taint risk feed rations to protect against Salmonella infections

Task 1.6. Natural resistance against gastrointestinal parasites

Goal: To study the antiparasitic effect(s) of a fibre rich feed ingredient using a well established porcine parasite model (*Oesophagostomum dentatum*).

Methods: Serial slaughter of experimentally infected pigs to collect data on parasite establishment, development, fitness (using scanning electron microscopy) and population composition in relation to the physico-chemical characteristics and immunological responses (expression of cytokine, antibody and receptor genes in the tunica mucosa using Q-PCR) in the intestinal tract.

Results: The ability of low boar taint risk feed rations to protect against gastrointestinal parasites

Task 1.7. Identification of best feed ration:

Goal: To identify feeding strategies that reduces the frequency of entire male pigs with boar taint.

Methods: Feeding experiments with groups of pigs with feed consumption recordings based on best feeding ingredients and feed compositions identified in tasks 1.4, 1.5, and 1.6. The experiments will be in 3 series each containing 6 treatments. Feed consumption, liveweight gain, diseases, skatole and androstenone in blood will be recorded. Nutrient utilization at pig level is calculated

Results: The effect of the chosen feed rations on boar taint risk, productivity and nutrient utilization.

Quantification of the needed component level and the feeding prior to slaughter in order to reduce boar taint risk.

WP 2 Whole herd management concept (R 80 % D 20 %)

Development of the best herd management concept taking into account risks of boar taint, animal welfare and productivity. An on-farm research methodology is used including five large commercial organic pig herds producing 1800 entire male during a two year period. Major parts for an optimal management strategy are developed through a combined research and development activity conducted through three tasks.

Task 2.1 Best group size and grouping strategy in systems with entire male pigs.

Goal: To evaluate indoor/outdoor housing strategies, group size and timing of the separation into gender groups as regards the effect on animal welfare and skatole and androstenone levels in male pigs.

Methods: Batches of entire male pigs are housed either indoor from weaning or indoor from 30 kg at two different group sizes (2 x 2 factorial design). The sorting into separate gender groups is carried out either at weaning, at 30 kg, or at 60 kg. Animal welfare for each batch is assessed based on behavioural and clinical observations during the weaner, grower and finishing period, as well as from data collected by the farmer regarding medicine use and mortality, and meat inspection data from the abattoir. Analysis of skatole and androstenone level in fat samples is performed for all entire male pigs.

Results: Identification of best group size and grouping strategy combining high animal welfare and low levels of skatole and androstenone in the entire male pigs.

Task 2.2 Best pen hygiene and outdoor access strategy:

Goal: Test of the effect of hygiene measures and outdoor access on boar taint problems in organic production

Methods: The study is carried out in five organic pig herds. Batches of un-castrated male pigs from 60 kg until slaughter are included in the study. The pigs are housed indoor with access to an outdoor run. Experimental treatments consist of two hygiene levels of the outdoor area as well as two different outdoor facilities (2 x 2 factorial design). Animal cleanliness and use of pen area is recorded by behavioural and clinical observations of the pigs. Analysis of skatole and androstenone level in fat samples is performed for all slaughter pigs.

Results: Identification of best pen hygiene and outdoor access strategy for minimizing the boar taint problems

Task 2.3 Slaughter weight as a tool to prevent boar taint:

Goal: To test if a reduction in slaughter weight is an effective means of preventing boar taint problems.

Methods: The pigs are slaughtered either at 90 kg or 110 kg. Analysis of skatole and androstenone level in fat samples is performed for all slaughter pigs.

Results: Comparison of boar taint problems in 90 kg slaughter pigs compared to 110 kg slaughter pigs.

WP3. Demonstration of practicality, production economy and environmental impact (Dm 100 %)

In order to exploit the expected momentum in organic pork sales an important effort is focussed on demonstration activity. These activities take place in parallel with the research and development in WP1 and WP2. The demonstration activities are conducted through two tasks.

Task 3.1 Farm specific implementation of the developed management concept:

Goal: Demonstration of different operational ways to exploit farm specific possibilities for gaining optimal effect of the management concept developed.

Methods: A project home page site will be established and video tape clips, case stories and results will continuously be uploaded. As results evolve in WP1 and WP2 open house activities focusing on organic pig farmers will take place followed by workshops discussion practical possibilities and barriers for implementing different elements. Based on operational elements such as pen interior and specific operational procedures (i.e. hygiene, feeding and grouping prior to slaughter) will be tried and discussed at workshops with case farmers and interested organic pig farmers.

Results: Guidelines for farm specific implementation of the management concept

Task 3.2 Effect on production economy and the environment

Goal: Demonstration of production consequences of implementing the management concept in different types of organic pig production systems.

Methods: Production economy calculations based on e.g. feed costs and feed efficiency, weight gain, carcass quality and income per pig, usable pen spaces, work load, pig mortality and medicine use. Based on data from task 1.7 the expected environmental effects on different farms is assessed.

Results: Scenarios for short and long term economic consequences and likely environmental effects of implementation of the management concept in different types of organic pig production systems

WP4. Project organisation, management and administration (see A12.9 for a detailed description)

A12.6 Description of how it will be ensured that the project results can be implemented in practice and perhaps commercialized (max. ½ page).

The involvement of the organic farmer's organizations in this project will make it possible for immediate implementation of the developed management concept for future organic pig production without castration.

General dissemination:

Information on the project will be disseminated to a range of users with the support of VFL and the communication team of ØL: articles in farm magazines, information to the advisor team, information to experience groups of farmers, part of a training course for farmers and through Internetmedia "Landbrugsinfo" (Agricultureinformation)

Implementation of the new management concept:

The five large organic pig farms used in WP2 and WP3 will be involved throughout the project. The formulation of guidelines in collaboration with farmers is expected to improve the rate of adoption in the farming community. Organic farmers' organizations will be involved in the dissemination activities, e.g. joint publications. Furthermore, the demonstration part on selected farms (WP3) will ensure immediate transfer of information to other farmers. These strategies are not considered possible to commercialize.

Innovative tools:

If successful the result will be commercialized throughout a better production economy for the farmers and for the selling company it is an important argument in the animal welfare discussion towards the consumers.

The demonstration will be aimed at organic pig farmers, advisors, potential new organic pig farmers and the consumers. To reach these groups of people we make a website linked to okologi.dk which is a platform for both farmers and the public. Online webcam will be used for direct communication to the end user and public. Groups of farmers will visit these demonstration farms as part of their meetings. Videncenter for landbrug who is part of WP3 has access to these groups.

A12.7 Description of possibilities for a general utilisation of the results (max. ½ page).

Throughout the project the scientific results obtained will be presented at relevant meetings, seminars, workshops and congresses. Results will be published in international journals with peer-review, along with a number of abstracts, proceedings and popular scientific papers in appropriate magazines.

The knowledge about how feed can change uptake and metabolism and improve meat quality can be utilised for both organic and conventional farming to optimize the feeding strategy for better animal health and meat quality. If the incidence of boar taint can be reduced the production of entire male pigs will be with less risk and better economy. The information obtained regarding parasites and Salmonella prevalence can ultimately benefit not only organic but also conventional production systems

The result will give knowledge that can improve animal welfare and production economy for the farmers.

A12.8 Description of the coherence between the research, development and demonstration activities in the project, including involvement of relevant users of the results (max. ½ page).

The project is build up to utilize a sequence of knowledge and methods obtained through research, which is conducted in the lab, in intensive studies on few pigs, in production trials at an experimental station (WP1) and on-farm research studies in parallel on five large commercial organic farms (WP2). The research is conducted across four research groups from three AU research departments and the Pig Research Centre. Further the research results are used in the development of the management concept (WP2). The demonstration activities are conducted in parallel to the research across three extension organizations using the same five organic pig farms as used in WP2. The demonstration activities are targeting organic pig producers for promoting a fast implementation of developed management concept. Demonstration addressing consumers in general are conducted for promoting a future market for pork from entire male pigs.

A12.9 Project organisation, management and administration (max. ½ page).

Project manager:

The project manager (Bent Borg Jensen) is responsible towards the authorities for carrying out the project and will be responsible for the daily management and coordination of activities. A kick-off meeting will assure that the aims of the project are in focus from the beginning. It is the project managers responsibility to inform the management team about project status and results. A report including publication performance etc., and a management report, which will form the basis for further decisions, will be drawn up at least once a year before the meeting in the steering committee. Bent Borg Jensen has more than 15 years of experince in managment and coordinating of big research programs.

WP-managers

The WP-managers will be responsible for the daily management and carrying out of the scientific research in compliance with the budget and the milestones. The project will be evaluated at the end of each year. Bent B. Jensen (AU-HBS) will be WP manager for WP1; Marianne Bonde (AU-HBS) will be WP manager for WP2, and Karsten Støvring (ØL) will be WP manager for WP3

Management team:

A management team consisting of the WPmanagers will be established. For details please see attached CVs. The project will be managed by frequent meetings in the management team. The project group will have one to two meetings per year to ensure complete co-ordination of activities of the different WPs according to the described work plan, milestones and timetable scheduled above. Small half-yearly reports from each WP manager will help the project manager to follow the progress of the project. The management team will be responsible for publication, contact to the organic pig industry and other national and international institutions

A12.10. The technical competences of the partners and their contribution to the project including how they complement each other (max. 5 lines per partner).

The Department of Food Science is part of the Faculty of Agricultural Sciences at Aarhus University. The main research areas are quality differentiation of raw materials, healthy foods creating well-being and finally food processing technology. Dep of Food Science, Aarhus University, is well equipped for and has a long-standing experience of using systemic biology and omics to study factors related to meat quality on both a

whole animal and a cellular level. Methods like RT-PCR, Western blotting, LC-MS, and NMR for study of the gene expression and metabolic pathways.

The research group Epidemiology and Management, Dept. of Animal Health and Bioscience is part of the Faculty of Agricultural Sciences at Aarhus University. The research group has several years experience in applied research projects focusing on animal health and welfare in organic pig production, and will contribute to this project evaluating potential production concepts in terms of animal health and welfare. The research group primarily uses system orientated research methods with expertise in case studies, veterinary The research group Immunology and Microbiology, Dept of Animal Health and Bioscience is part of the Faculty of Agricultural Sciences at Aarhus University. People in the group has more than 25 years experiens in studies of the gastrointestinal microbiota in pigs and how it is affected by diet. The group is weel equiped to conduct as well animl studies as well as microbial determinations using both clacical and molecular biological tools. PSU, KU-LIFE is based on the former Danish Centre for Experimental Parasitology and the staff includes both veterinarians and biologists with a strong track record of basic and applied porcine parasitology with extensive experience of experimental infection models in pigs. One main research area is the population dynamics and epidemiology of common pig parasites and the group has a long standing tradition for the involvement in alternative parasite control in relation to organic farming. The Danish Agriculture & Food Council represents the farming and food industries of Denma. Agriculture and food is Denmark's largest industry employing some 150,000 people and exporting agricultural products to an annual value of around € 15 billion. The Pig Research Centre (PCR) is a division in The Danish Agriculture & Food Council. PCR has the technical responsibility for research and development tasks regarding the living pig as well as dissemination of knowledge. One of PCR's main activities is the Danish Applied Pig Research Scheme. Research and development tasks under this scheme are conducted in regular Danish pig herds - often in close cooperation with the advisors of the herds. Approximately 100 pig producers are affiliated. The Pig Research Centre has more than 25 years experience in conducting trials with pigs.

Økologisk Landsforening (Organic Denmark) is an association of farmers, companies and consumers that are assembled to create new ways for more organic food and sustainable change. The association is working on a number of areas to increase production and consumption of organic food and cover the whole chain from farm to table. Areas and work include: Development of organic farming and extension service/advisory service, strengthening of the organic food position in the supply chain with particular focus on Danish retail chains, export and food service sector, maintaining the credibility of organic food including the safeguarding of the organic sector's political interests and standards, information about organic production and food to a variety of target groups through media, events, web, magazine, newspaper, etc. The association has 47 employees and is headquartered in Åbyhøj near Aarhus

VFL – The Danish Knowledge Centre for Agriculture has extensive experience and expertise in advising farmers, developing advisory tools, and conducting development projects, and it is in close cooperation with advisory service centres in other countries. VFL collect, develop and impact present methods for assessment of agricultural production, organize the development and testing with selected farmers and advisers, and organize the demonstrations for farmers and advisers.

An illustration showing how the distribution between partners of the expertise required for a successful outcome of the present project is shown in appendix 15.

A12.11. Expected collaboration with other research institutions/companies nationally and internationally (max. ½ page).

Dep. Food Science, Swedish university of Agricultural Sciences, Uppsala,

Dep. Molecular Biology, Aarhus University,

Dr. Olena Doran, University of Bristol, UK

Dr. Hervé Hoste, Department of Animal Health, UMR 1225, INRA: Institut National de la Recherche Agronomique, France (elctron scanning microscopy)

Dr Joe Urban, Research Leader, Diet, Genomic and Immunology Laboratory, USDA, Beltsville, USA (Q-PCR)

A12.12. The relation to previous projects within the projects focus areas (if any) including references to these (max. ½ page).

Marianne Bonde and Jan Tind Sørensen, HBS-EMA, and Allan Roepstorff and Helena Mejer, KU-Life currently participate in a European trans-national project Prevention of selected diseases and parasites in organic pig herds – by means of a HACCP based management and surveillance programme in the ERA-net Core Organic. The project provides a network of European researchers working in the field of animal health and welfare research in organic pig production.

HBS-EMA participates in a current project Økologisk svineproduktion uden kastration funded by “Fonden for økologisk landbrug” (2009-2010). The project focuses among other on the welfare of organic male pigs when housed indoor with outdoor access in single-sex groups from weaning to slaughter. The data collection is still being carried out, but preliminary data have been discussed as part of a Master thesis produced in the project. Aspects of the welfare assessment employed can be applied in this project. However, strategies to reduce boar taint problems were not investigated as part of the project, neither related to feeding, hygiene, social grouping nor slaughter age.

This project will carry out research into feeding and management strategies applicable in commercial organic pig herds and will thus substantially increase the possibilities for male pig production in organic herds without compromising product quality or animal welfare.

A13. Tables with milestones and deliverables with information as requested in the table in A16.

WP1:

M 1.1: High throughput analyse method for skatole and andrestonone implemented. Responsible HBS-IMI. 30/06 2011

M 1.2: Field experiments with chicory, Jerusalem artichoke and lupine have been conducted and plant material for feeding trails delivered. Responsible DH-AU. 31/10 2011

M 1.3: 2nd year field experiments have been conducted and feeding material delivered. Responsible DH-AU. 31/10 2012

M 1.4: Short term feeding trails conducted. Responsible HBS-IMI-AU. 31/3 2013

M 1.5: Liver cell investigation conducted. Responsible IFK-AU. 31/3 2013

M 1.6: First feeding trail completed 31/3 2012. Responsible VSP-Co.

M 1.7: Second feeding trail completed 31/10 2012. Responsible VSP-Co.

M 1.8: Third feeding trail completed 31/3 2013. Responsible VSP-Co.

M 1.9: Infection studies with parasites completed 31/6 2013. Responsible PSU- KU-LIFE.

M 1.10: Infection studies with Salmonella completed 31/6 2013. Responsible HBS-IMI-AU.

WP 2

M2.1: Grouping strategies experiments completed. 30/06 2012. Responsible HBS-EMA-AU

M2.2: Pen hygiene experiment completed 31/12 2012. Responsible HBS-EMA-AU

M2.3: Slaughter weight experiment completed 30/06 2013. Responsible HBS-EMA-AU

WP 3

M2.1: Demonstration trail facilities established 31/12 2011. Responsible ØL

M2.1: M2.2: Production economy calculations completed 31/12 2013. Responsible HBS-EMA-AU.

A14. List of deliverables from the project (also fill out the table in A17)

WP1 (R: 90%; D 10%)

D1.1: Protocol on high throughput analysis of androstenone and skatole (9 months: 3 VIP, 6 TAP) 31/12 2011 (D) (C4)

D1.2: Scientific paper on production of feed ingredients with high concentrations of bioactive components 30/06 2013(7.9 months, 3.4 VIP, 4.5 TAP) (R) (S1)

D1.3: Scientific paper on various feed ingredients on the gastrointestinal microbiota and on skatole and androstenone levels in blood (7.1 months 3 VIP,4.1 TAP) (R) (S1) – 31/12 2013.

D1.4: Scientific paper on bioactive feed components on liver metabolism (7.1 months 3.0 VIP 4.1 TAP) (R) (S1) -31/12 2013

D1.5: Public report from first feeding trail (4.4 months 2.5 VIP, 1.9 TAP) (R) (P1) – 31/12 2012

D1.6: Public report from second feeding trail (4.4 months 2.5 VIP, 1.9 TAP) (R) (P1) - 30/06 2013

D1.7: Public report from third feeding trail (4.4 months 2.5 VIP, 1.9 TAP) (R) (P1) - 31/12 2013

D1.8: Scientific and public paper on natural resistance against Salmonella (7,2 months: 3 VIP; 4,2 TAP) – 31/12 2013 (R) (S1, P1)

D1.9: Scientific and public paper on natural resistance against parasites (7,1 months: 3 VIP, 4,1 TAP) – 31/12 2013 (R) (S1, P1)

WP2 (R: 83%; D: 17%)

D2.1: Scientific paper with focus on the effect of grouping strategy on welfare and boar taint in male pigs slaughtered at 90 kg or 110 kg, respectively (10.4 months 3,4 VIP; 7 TAP) 31/12 2013 (R) (S1)

D2.2: Scientific paper with focus on the effect of pen hygiene and pen usage on welfare and boar taint in male pigs slaughtered at 90 kg or 110 kg, respectively (9.8 month 7 months: 4 VIP, 5.8 TAP) 31/12 2013 (R) (S1)

D2.3: Article in farmer magazine about management of un-castrated male pigs to optimise animal welfare and reduce boar taint problems (1,5 months: 1 VIP; 0,5 TAP) - 31/12 2013 (D) (P1)

WP3 (Dm: 100 %)

D3.1 Article in “Økologi & Erhverv “ on “how to avoid aggression” 30/06-2012 (Dm) (P1) 6.9 months, 2.6 VIP; 4.3 TAP)

D3.2: Article in “Svin” on “how to keep your pigs clean” 31/12-2012 (Dm) (P1) (6.4 months; 3.0 VIP; 3.3 TAP)

D3.3: Public report with recommendations on guidelines for farm specific implementations. 31/12-2013. (Dm) (P1) (7.7 months; 4.3 VIP; 3.1 TAP)

D3.4: Report on production economy associated with the different production concepts investigated in WP1 and WP2 (1,75 mdr: 0,75 VIP, 1 TAP) – 31/12 2013 (Dm) (P1)

A15. List of appendices

Appendix 1. List of references

Appendix 2. Gant-diagram

Appendix 3. Illustration of expertise distribution between the partners of the project

Appendix 4 .Letter from Friland accepting slaughtering of entire male pigs from the project

Appendix 5. CV Bent Borg Jensen

Appendix 6. CV Jan Tind Sørensen

Apendix 7. CV Marianne Kjær Bonde
Apendix 8. CV Nuria Canibet
Apendix 9. CV Bo Ekstrand
Apendix 10. CV Martin Krøyer Rasmussen
Apendix 11. CV Hanne Maribo
Apendix 12. CV Niels Peder Nielsen
Apendix 13. CV Lisbeth Brogaard Petersen
Apendix 14. CV Karsten Støvring
Apendix 15. CV Tove Serup
Apendix 16. Kai Grevsen
Apendix 17. Stig Malling Thamsborg
Apendix 18. Helene Mejer

A17. List over deliverables (D=deliverables) for the entire project, stating whether the deliverable belongs to the research part of the project (R); the development part (D); and/or demonstration (Dm).

| D. no. | Deliverable | Responsible project participant | Date/year | R, D, or Dm Effective working time, months ¹ | Type of deliverable* |
|--------|--|---------------------------------|------------|---|----------------------|
| D1.1 | Protocol on high throughput analysis of androstenone and skatole | BBJ | 06/2011 | D 9.0 months | C4 |
| D1.2 | Scientific paper on production of feed ingredients with high concentrations of bioactive components | KG | 06/2013 | R 7.9 months | S1 |
| D1.3 | Scientific paper on various feed ingredients on the gastrointestinal microbiota and on skatole and androstenone levels in blood | BBJ | 12/2013 | R 7.1 months | S1 |
| D1.4 | Scientific paper on bioactive feed components on liver metabolism | BE | 12/2013 | R 7.1 months | S1 |
| D1.5 | Public report from first feeding trail | HM | 06/2012 | R 4.4 months | P1 |
| D1.6 | Public report from second feeding trail | HM | 12/2012 | R 4.4 months | P1 |
| D1.7 | Public report from third feeding trail | HM | 06/2013 | R 4.4 months | P1 |
| D1.8 | Scientific and public paper on natural resistance against Salmonella | BBJ | 12/2013 | R 72 months | S1 |
| D1.9 | Scientific and public paper on natural resistance against parasites | SMT | 12/2013 | R 7.1 months | S1 |
| D2.1 | Scientific paper with focus on the effect of grouping strategy on welfare and boar taint in male pigs slaughtered at 90 kg or 110 kg, respectively | MKB | 12/2013 | R 10.4 months | S1 |
| D2.2 | Scientific paper with focus on the effect of pen hygiene and pen usage on welfare and boar taint in male pigs slaughtered at 90 kg or 110 kg, respectively | MKB | 12/2013 | R 9.8 months | S1 |
| D2.3 | Article in farmer magazine about management of un-castrated male pigs to optimise animal welfare and reduce boar taint problems | MKB | 12/2013 | D 3.2 months | P1 |
| D3.1 | Article in "Økologi & Erhverv" on "how to avoid aggression" | KS | 30/06 2012 | Dm 6.9 months | P1 |
| D3.2 | Article in "Svin" on "how to keep your pigs clean" | KS | 31/12 2012 | Dm 6.4 months | P1 |
| D3.3 | Public report with recommendations on guidelines for farm specific implementations | KS | 31/12 2013 | Dm 7.7 months | P1 |
| D3.4 | Report on production economy associated with the different production concepts investigated in WP1 and WP2 | MKB | 31/12 2013 | Dm 1.8 month | P1 |
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¹ The total amount of months must be consistent with the total number of months in the budgets, and will therefore show the relative working effort per work package.

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* Fill in the type of deliverable. Use the List of type of deliverables on the last page in Annex 3 "Instructions for filling in the application form".