

# Nutrition of monogastrics

A summary of research conducted under the German Federal Programme for Organic Agriculture and other forms of Sustainable Agriculture

BÖLN

Bundesprogramm Ökologischer Landbau  
und andere Formen nachhaltiger  
Landwirtschaft



# Summary of research results of the German Federal Programme for Organic Farming (BÖLN), 2001-2011

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1. Soil fertility – <http://www.orgprints.org/21868>
2. Plant protection in organic arable and horticultural production - <http://orgprints.org/21869>
3. Plant protection in organic apple production - <http://orgprints.org/21875>
- 4. Nutrition of monogastrics - <http://orgprints.org/21874>**
5. Animal health of ruminants - <http://orgprints.org/21872>
6. Food quality and processing - <http://orgprints.org/21871>
7. Knowledge transfer - <http://orgprints.org/21870>
8. Regional marketing - <http://orgprints.org/21873>

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## 1. Introduction

The German Federal Programme for Organic Agriculture (BÖLN) was founded in 2001, with the goal of improving the conditions for organic farming and food industry in Germany, and to achieve the conditions for a balanced growth of supply and demand. The programme is funded by the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), and implemented and coordinated by the Federal Agency for Agriculture and Food (BLE) in Bonn. Since 2008, the programme is part of the German National Action Plan (2005-2014).

Since the beginning of 2011, the second evaluation of the programme (project ID 09OE027) is carried out by the international contractor group Organic Research Evaluations; consisting of the partners InterVal GmbH in Berlin, The Organic Research Centre, Elm Farm, United Kingdom and the University for Sustainable Development in Eberswalde, Germany.

The focus is on the programme of the BMELV to support research projects in organic farming, where more than 650 projects have been funded since 2002. The evaluation is in particular to clarify the extent to which research results helped to strengthen organic agriculture in Germany and expand its market share. The evaluation results, which are expected to be publically available in early 2013, shall also benefit a future optimisation of research funding.

The summaries of research results in eight focus topics (soil fertility, plant protection in arable and horticultural production, plant protection in apple production, nutrition of monogastrics, animal health of ruminants, food quality and processing, regional marketing and knowledge transfer) from the whole period of the programme since 2002. All projects can be identified with the individual project ID number, shown in brackets in the title; and following the link below, further information can be found on the German BÖLN website. Where available, links to the final-reports of individual projects on the Organic Eprints website are added. Further results of running projects of the BÖLN research programme are regularly published at [www.bundesprogramm-oekolandbau.de](http://www.bundesprogramm-oekolandbau.de).

## 2. Summary

The thematic focus of monogastric nutrition runs very regularly through the entire federal programme. A strong focus was on the use of feed made from 100% organic origin (EC Eco-Regulation). In experiments in 2006 on the use of roughage in outdoor rearing pigs, for example, it was shown that Jerusalem artichoke can lead to significantly higher weight gains, compared to the control, while weight gain decreased significantly in some cases using other roughages. In another project in 2007, the various processing methods for soybean cake and feed produced therefrom were tested on broiler chickens, laying hens and pigs. The aim was to develop a suitable technology to inactivate the anti-nutritive components in soy and thus to increase the protein digestibility and the nutritional value. At the same time, as part of a broad collaborative project, the use of five different roughages (straw, hay, clover silage, maize silage and Jerusalem artichokes) were compared in organic piglet production. It could be demonstrated that the feeding of various roughages resulted in a stabilisation of the intestinal flora in comparison to the control group. In particular, by feeding various roughages, the *Clostridium perfringens* population can be significantly reduced. A review of the compensatory protein uptake of organic pigs has found that it cannot be concluded that an economically relevant compensation takes place, and that under the specific feeding restrictions of organic farming GfE recommendations for lysine supply for the initial fattening period are estimated too high. In studies of different genotypes, management and feeding strategies it was also found that turkey diets with reduced ME (metabolisable energy) and amino acid levels, in combination with free-range management, result in a lower animal loss and high growth and carcass performance. In a review of the use of the microalga *Spirulina platensis* in a feeding trial with fattening broilers a positive dose-response effect was observed. The higher the amount of *Spirulina* absorbed, the better the carcass weights. Due to the high cost of the *Spirulina* product (despite improved fattening and carcass performance) the economics of its use in broiler production are unfavourable. Thus the application of this product is only recommended in the first phase of the rearing (1-14 days). The aim of another project was the development of NIRS calibration which allows a more timely determination of the constituents, especially the protein and amino acid contents (AS), of organically produced grain legumes immediately after harvest, in order to create optimal, demand-based rations. In 2007, a database for feed was created to assist in ration design. In 2011 a number of projects started in which various locally available protein feeding stuffs will be tested in different feeding trials with pigs. The supply of essential amino acids within the available protein feed, especially for poultry, is often insufficient, and another research project

is testing approaches to produce high-quality protein feed in the form of clover silage and use this feed in feeding trials with laying hens and broilers. The first results of these projects are expected in 2015.

### 3. The individual projects

#### 100% organic feed for monogastric animals (05OE008) 01-01-2006 to 30-11-2007

As part of this project a feed database was developed to assist in ensuring 100% organic feed rations for monogastric animals (pigs and poultry). For this purpose a total of 86 researchers, consultants and agricultural practitioners in Germany, Austria and Switzerland were asked to contribute to this study by providing and documenting protocols related to organically produced feed. A total of 751 samples from five research institutes and two farms were collected and documented in the DLG database on feed. The largest samples were collected for single feeds such as wheat, peas, lupins, barley and triticale. The willingness to provide examination protocols was generally low. In some cases, the decision not to collaborate was explained on the grounds that the tabular values were counterproductive, because they indicate a statement which is not guaranteed. Overall collaboration was only possible where steps towards creating a feed database had already been made. In addition, in some cases it was not possible to create documentation from the examination protocols submitted, because no information on dry matter and water content was available. In older research reports the challenge was to identify the methods of analysis for each parameter, as the methodology of the analysis was not always documented.

#### Roughages in the growing season (03OE407) 01-01-2006 to 30-09-2008 <http://orgprints.org/16341/>

The aim of the project was to clarify the feed intake of pigs depending on forage supply and utilisation. The project investigated the intake of different crops by pigs in the field, using titanium dioxide as a marker, and quantified the intake based on *in vitro* digestion tests. In four fattening cycles the animals had free access to the crops, while the supply of concentrated feed pellets was reduced by 15% (initial fattening) or 30% (finishing period) compared with the control. The daily weight gain varied considerably between and within feeding systems. With Jerusalem artichoke as a crop significantly higher weight gains were achieved compared to the control, while weight gains decreased significantly in systems using other roughage components (silage, ryegrass or fodder beet). The carcasses showed generally high lean meat portions. Because of the high amount of mineral uptake through ingestion of soil and its interference with titanium dioxide, it is concluded that the titanium dioxide concentrations in faeces do not permit reliable conclusions to be drawn about roughage intake and that the use of titanium dioxide as a marker under field conditions is not appropriate. Possible risks of rearing pigs in potentially contaminated soils, related to consumer protection, require further assessment.

#### Network animal nutrition (03OE475/F) 01-01-2006 to 30-04-2008 <http://orgprints.org/5902/> and <http://orgprints.org/13621/>

The aim of this project was to establish a network on forage production and animal nutrition in organic farming. It was used to connect professionals from agricultural practice, consulting and research to enable knowledge sharing and develop new perspectives through inter- and trans-disciplinary discussions. Working groups were formed that covered the areas of cattle, pig and poultry feeding for a detailed analysis and evaluation of the problems. They developed approaches for the adequate feed supply for these animals, in particular with regard to the implementation of the 100% organic feed legislation. In addition, an extensive literature review and vulnerability analysis was performed. At a workshop in March 2007, the results of this work were presented, and discussed and evaluated by a network of experts from research, consulting and practice. Recommendations for forage production and animal nutrition in organic farming were formulated, differentiated by their implementation and research needs. In addition, the results were published in the journal *Ökologie und Landbau* (Ecology & Agriculture) as a special issue, and made available to a broad agricultural specialist group. The network has proven to be an efficient method of transferring and condensing existing knowledge between and within the various disciplines and institutions. It should be continued, in the interest of all stakeholders, in order to develop the scientific exchange and to be used for cooperation within research, but also between research and practice.

#### Quality assurance for protein feed (soybean) (06OE233) 01-11-2007 to 31-07-2009 <http://orgprints.org/16490/>

The EU organic regulation imposes a rule of 100% organic feed for monogastrics from 2012. This requires the use of organic protein feed to adequately supply monogastrics with essential amino acids. This project aimed to identify the appropriate heat treatment to use for soybeans and soybean cake. Organically grown soybeans (variety 'PR91M10', Fa. Pioneer) were processed into soybean cake, and sub-lots were subjected to four different heat treatments (A, dry heat; B, hydrothermal treatment in steam; C, hydrothermal treatment in a hydrothermal reactor; D, hydrothermal



treatment with an expander). The success of the four treatments was tested in feeding trials, under conditions of 100% organic feeding. In a feeding experiment with broilers (720 males, genotype J ISA 957) soybean cake mix was fed in a percentage of 20% (rearing) and 15% (fattening). At the end of the finishing phase (56 days), significant differences between the four feeding groups were observed. Group A reached the highest final weight (2435 g), followed by D (2347 g), C (2253 g) and B (2124 g). This order was also reflected in the feed intake. In a feeding trial with laying hens (508 pullets, Lohmann Brown) four feeding groups were compared (15% soybean cake of variants A, B, C, D). The egg production in group A was significantly lower than in the other three groups. The egg weight of groups A and D were significantly lower than those of groups B and C. In a trial with weaned piglets (96 male castrates) the four soybean cake variants (mixing ratio of 20%) were tested, and for treatments A and D an increase test was performed (15%, 20% and 25% soybean cake portion in the rearing mixture). The groups with a mixture of 25% soybean cake reached a significantly lower weight gain than the groups with 15% and 20% soybean cake.

#### [Organic pig farming \(07OE026 from 07OE023-07OE029\) 01-09-2007 to 31-10-2010](http://orgprints.org/19322/)

The aim of the project was to assess food intakes for different roughages and their effects on the stability of the intestinal microflora of pregnant sows. The labour time required for the production of roughage was also quantified. Under standardised conditions, five different roughages (straw, hay, clover silage, maize silage, Jerusalem artichoke tubers) ad libitum combined with reduced feeding of concentrate were used. To study the possible effects on the gastrointestinal flora when compared to a control group without roughage, animal health parameters for the sow and piglets at birth were investigated, as were the constitution of the sow in the carrying and suckling period and reproductive performance. In addition, the intake of roughages was quantified and the labour recorded for providing roughage in all variants. In a second step, the 'effective' roughage variety was implemented on four commercial farms and evaluated with regard to the above-mentioned parameters. The feeding of various roughages resulted in a stabilisation of the intestinal flora in comparison to the control group. In particular, by feeding the various roughages, the content of *Clostridium perfringens* can be significantly reduced. The pregnant sows were able to compensate for the reduced feed supply from concentrated feed through ad libitum roughage uptake without any adverse effects on reproductive performance. Determining the feed intake showed that forage is consumed in large quantities, and is particularly suitable for the supplementation of a reduced concentrate pellet feeding.

#### [Compensatory approach to protein in pig feed \(06OE060\) 01-07-2008 to 30-09-2009](http://orgprints.org/16377/)

The project aimed to test possible growth compensation, where feed-related deficits in protein deposition in the initial phase can be compensated for by corresponding rations in the finishing period. The lack of organic feed sources with a high-quality amino acid pattern poses a risk of low lysine content in the initial fattening ration, compared to the GfE-required standards, and may therefore generate excessive fattening of the carcass. 96 pigs of modern genetics (48 castrates, 48 sows) were studied in four groups with different lysine-ME (metabolisable energy)-ratios in the start/finishing phase of growth performance: protein retention, carcass characteristics, meat quality and profitability were studied. All four groups were similar in growth performance (e.g. weight gain, feed conversion) and meat quality (e.g. pH, conductivity value). The N balance of feed-faeces-urine showed a compensation for protein in the experimental groups as well as in the negative control. The lean meat content (carcass quality) was comparable in the test groups and the negative control, but tended to decrease compared to the positive control and the general control group. It was concluded that no economically relevant compensation capacity of fattening pigs occurs, and that under the specific constraints of organic agriculture, the GfE recommendations for lysine supply in the initial fattening phase are considered too high.

#### [Fluctuations of ingredients in organic feed \(06OE110\) 01-08-2008 to 31-12-2010](http://orgprints.org/18703/)

The aim of this project was the development of NIRS calibration which allows a more timely determination of the ingredients, especially the protein and the amino acid contents (AS), in organically produced grain legumes immediately after harvest, in order to create demand rations. 225 samples of each protein feed crop (peas and beans) were collected nationwide and analysed. The goal was a quick detection of protein feed ingredients for farmers to enable them to deal with the fluctuations of the ingredients in organic feed and therefore provide customised diets adapted to the animals' needs. These NIR calibrations were developed to enable the timely provision of crude nutrients including starch, sugars and amino acids in field beans and peas immediately after harvest. The results of this project show that it is possible to make a quick, easy and cost-effective estimate of the nutrients, starch, sugars and amino acids in dried, milled peas and broad beans using the NIRS calibration method. The development and expansion of the calibrations to other feed components (e.g. lupine, maize) and to estimate the levels of valuable ingredients in all feed components would simplify optimised rationing.

### Organic turkey production (06OE234) 01-12-2008 to 31-12-2010 <http://orgprints.org/18771/>

The need to feed turkeys exclusively with organic feed in the future complicates ration design significantly. This study investigated whether in organic turkey production the growth performance and carcass value vary between genotype [fast (BIG 6) vs. slowly growing origin (Kelly BBB)], management (free-range vs. indoor) and feeding regime (variant M, medium feeding intensity vs. variant L, low feeding intensity). In two successive rounds, each with 192 animals (male chicks), a four-phase fattening was performed (rearing phase, three fattening periods, slaughter in the 21<sup>st</sup> week). The rearing phase took place in an air-conditioned barn. The fattening phases were in mobile houses (with or without free-range option). The feeding groups were graded for ME (metabolisable energy) and amino acid levels set in the feed mixtures. Losses occurred more frequently in the rearing phase and at the end of the fattening (21% on average). In the animals almost ready for slaughter, cardiovascular problems were frequent reasons for culling and primarily animals which were not free-range were affected. Carcass value of the BIG 6-cocks showed significantly higher weights compared to the Kelly BBB-cocks. At the end of the fattening period the free-range turkeys showed a significantly increased final body weight and therefore increased carcass weight and value. Turkeys supplied with ME-reduced diets showed a compensation under free-range conditions by taking up increased amounts of feed, and reached nearly the same final weights. It was found that organic turkey production using diets with reduced ME and amino acid levels, in combination with a free-range option, leads to lower losses, and high animal growth and carcass performance. For the traits studied in this experiment, no genotype-environment interactions were detected.

### Microalgae (*Spirulina platensis*) in broiler fattening (08OE098) 01-01-2010 to 31-10-2010 <http://orgprints.org/18501/>

This feeding trial determined the cost-effectiveness of *Spirulina platensis* as a protein feed for organic broiler production. The spirulina mixtures used in this trial were consumed without problems. No differences in the general health status between the groups were observed. The growth and carcass performance results showed a dose-response effect: the higher the spirulina amount absorbed, the better the carcass weights and yields. Associated with this were increased portion weights (breast and legs). However, the colour of the muscle showed a visible influence of the spirulina feed. Due to the high cost of the *Spirulina platensis* product, despite improved fattening and carcass performance, the economics of its use in broiler production is unfavourable. Therefore the use of this product is only recommended in the first phase of rearing (1<sup>st</sup>-14<sup>th</sup> day of life).

### Feeding strategies to feed 100% organic sources (11OE021) 01-10-2011 to 31-01-2015

The aim of this project is to test different regionally available protein feeds for their suitability in organic pig and poultry production. Feeding trials will show whether a single-phase feed for piglets based on 100% organic feed materials can produce healthy and strong piglets. In addition, straw and clover-grass silage were compared in combination with the single-phase feed. Since the tested piglet feed is similar to the feed for lactating sows, this feeding strategy would entail a significant reduction of the logistical effort involved in fodder storage. For organically managed farms producing piglets this strategy is of particular relevance, because these often have small-scale farm structures with limited mechanisation and automation potential.

### Clover silage in organic poultry feed (11OE022) 01-10-2011 to 31-01-2015

This project is part of the project 'Improved contribution of local feed to support 100% organic feed supply to pigs and poultry' planned under CORE Organic II. In this joint project, feeding studies will be performed with clover silage for laying hens and broilers. The nutrition of monogastric animals in organic agriculture is subject to special restrictions. The supply of essential amino acids is, in particular in poultry, often not sufficiently achieved because the available protein feeds do not contain these amino acids in sufficient concentration. Roughage availability is very often used ineffectively by poultry, because it lacks sensory appeal to them. Thus, the contribution of roughage for the supply of nutrients and minerals is often marginal due to poor quality of the roughage. The proposed research project aims to demonstrate new approaches to the use of high-quality protein feed in the form of clover silage and use this feed in diets for laying hens and broilers. Since clover-grass silage can be produced by the farmers themselves, the closed cycle and system approach of organic farming would be met by this approach.