Project no.	**SSPE-CT-2004-502397**
Project acronym:	**EEC 2092/91 (ORGANIC) Revision**
Project title:	**Research to support the revision of the EU Regulation on organic agriculture**

Instrument:	**Specific Targeted Research Project (STREP)**
Thematic Priority:	**Research for Policy Support**

Deliverable 4.3: **Guidance notes to operators including recommendations in relation to nutrient supply**

P. Nichols (UWA), A. Sundrum (UNKA) and S. Padel (UWA)

Due date of deliverable:	**31.12.2006**
Actual submission date:	**23.10.2007**

Starting date of project: **01.03.2004** Duration: **36 Months**

Organisation name of lead contractor for this deliverable:
University of Wales, Aberystwyth (UWA)

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)

Dissemination Level

P	**Public**	x

Research Institutions and Authors

The following research institutions and authors have contributed to this report

Dr. Phillipa Nicholas and Dr. Susanne Padel
Institute of Rural Sciences
University of Wales, Aberystwyth
Llanbadarn Campus

SY233AL

E-mail: pkn@aber.ac.uk and sxp@aber.ac.uk

Prof. Dr. Albert Sundrum
Department of Animal Nutrition and Animal Health
Faculty of Organic Agricultural Sciences
University of Kassel
Nordbahnhofstr. 1a
D-37213 Witzenhausen
Germany

E-mail: Sundrum@wiz.uni-kassel.de

Acknowledgements

Funding from the EU Commission for the Project EEC 2092/91 (Organic) Revision (Contract No. FP6-502397) is gratefully acknowledged. We would also like to thank the following individuals for their support: Gerhard Plakholm from Bundesanstalt für alpenländische Landwirtschaft (BAL) in Austria and Kim Holm Boesen from The Danish Plant Directorate.

Disclaimer

The views expressed in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission and in no way anticipate the Commission’s future policy in this area. The information contained herein, including any expression of opinion and any projection or forecast, has been obtained from sources believed by the authors to be reliable but is not guaranteed as to accuracy or completeness.

Should the publication of corrigenda becomes necessary, there will be posted at the project website **www.organic-revision.org**.

Table of Contents

1 Introduction 1
2 Principles and rules of organic livestock production 2
3 Balance of supply and demand 4
3.1 Shortages in the supply of organic feed in the EU 4
3.1.1 Increasing the availability of home-grown energy and protein from within the farm system 5
3.1.2 Addressing the reliance on external and non-organic feed inputs 5
3.2 Continuity and quality of supply of organically grown feeds is variable, creating problems with both processing and marketing 6
4 What are the dietary requirements of organically reared pigs and poultry? . 8
4.1 Dietary requirements of organic pigs 9
4.2 Dietary requirements of organic poultry 10
4.3 Is it possible to reduce the specification of rations in the different life stages? 12
4.4 Is there potential to increase the total intake of limiting amino acids by improving feed intake? 13
5 Can organic farming rely on breeds with lower feed requirements? 15
6 What protein sources can be used? 17
6.1 Grain Legumes 17
6.1.1 Lupins 17
6.1.2 Beans 17
6.1.3 Peas 18
6.1.4 Rapeseed 18
6.2 Fish meal 18
6.3 Milk by-products 19
6.4 Rice Protein 19
7 The future of derogations with respect to organic feeding 20
8 Challenges in using home-grown feed and suggestions for overcoming them 21
8.1 Considering and monitoring the availability of home-grown nutrients 21
8.2 Accuracy when formulating the feeding ration 21
8.3 Exact allocation of the feed and monitoring of feed intake 21
8.4 Integrating different farm management tools to manage nutrient supplementation 22
9 Conclusions 24
10 References 25

1 Introduction

Restriction in the use of inputs and therefore limited availability of certain nutrient resources is a key characteristic of organic farming. Making best use of resources available on the farm implies that diet formulation needs to consider the availability of home –grown feed materials and the nutrient requirements of the livestock, as well as taking into account factors outside the farm gate, such as market conditions and consumer expectations. It is therefore an on-going challenge for organic farmers to balance the different demands and the resources available.

In the move towards 100% organic diets organic pig and poultry producers are currently faced with a number of key issues in relation to the supply of energy and particularly protein that are addressed in this document. This guide is aimed at those involved with organic pig and poultry production, and summarises the main results of two Deliverables 4.1 and 4.2 of the project EC 2092/91 (Organic) Revision[1] on the possibilities and limitations of protein supply in organic poultry and pig production. It covers a range of issues that are relevant either to feed millers or to farmers or to both alike. These include:

- **Balance of supply and demand**
  - Continuity, batch size and quality of supply of organically grown cereals
  - Shortages in the supply of organic feed in several EU countries
- **Dietary requirements under conditions of organic farming**
  - Dietary requirements of organically reared pigs and poultry during the various life-stages (taking into account outdoor rearing systems)?
  - How far can the specification of fattening rations for pigs and poultry, and different breeds within these livestock categories, deviate from the optima?
  - Is there potential to reduce the energy content of the diet to increase intake and hence increase the total intake of limiting amino acids?
- **What is the organic livestock industry, particularly the poultry sector, doing to develop breeds and production systems that require less intensive feeding?**
- **What protein sources can be used?**
  - Grain legumes
  - Fish meal
  - Rape seed
- **Will further derogations be available?**
- **Challenges for producing home-grown feeds and suggestions for overcoming them**

[1] Sundrum et al., (2005); Sundrum and Padel, (2006); Padel, (2005)

2 Principles and rules of organic livestock production

To maintain consumer confidence during the development of organic food systems it is essential that organic production adheres to organic principles. This will allow the organic sector to offer a genuine alternative to conventional food production. A main principle of organic farming is to establish a balanced production system, and as far as possible, closed nutrient cycles (Table 1). To achieve this principle, non-organic and external inputs should be reduced to a minimum. For livestock this means that feed should be sourced preferentially from within the farm unit. These feeding principles are set out in the European Regulations (EEC) 2092/91 on Organic Production[2] (Table 1 and Annex 1).

Table 1: Summary of general principles on organic livestock production from Annex I B of the Regulations (EEC) 2092/91 on Organic Production (Annex B).

Integration of livestock, soil and plants	Livestock production forms an integral part of many agricultural holdings practising organic farming. Livestock production must contribute to the equilibrium of agricultural production systems by providing for the nutrient requirements of crops and by improving the soil's organic matter. It can thus help establish and maintain soil-plant, plant-animal and animal-soil interdependence. As part of this concept, landless production is not allowed. By utilising renewable natural resources (livestock manure, legumes and fodder crops), the cropping/stock farming system and the pasturage systems allow soil fertility to be maintained and improved in the long term and contributes to the development of sustainable agriculture.
Livestock production as a land related activity	Organic stock farming is a land-related activity, livestock must have access to a free-range area and the number of animals per unit of area must be limited to ensure integrated management of livestock and crop production on the production unit, so minimising any form of pollution, in particular of the soil and of surface and ground water. The number of livestock must be closely related to the area available in order to avoid problems of over-grazing and erosion and to allow for the spreading of livestock manure so that any adverse effect on the environment can be avoided.

The detailed rules (Table 2) specify which organic, in-conversion or non-organic feed can be used. Conventionally produced feedstuffs can only be used if organic or in-conversion feed (either grown within or outside the farm system) is not available in sufficient quantity and quality (Article 4.8). Even then, only a set percentage of non-organic components can be used, and these feedstuffs have to be listed in Annex II. For herbivores (though not monogastrics at present), there is an additional requirement that at least 50 % of the feed must come from the farm unit itself (except during the period each year when the animals are under transhumance), or if this is not feasible, has to be produced in cooperation with other organic farms.

[2] EC (1991) Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. Official Journal of the European Communities, L198 (22.7.91), 1-15.

However, livestock diets should also be formulated according to the specific requirements of each species and each life-stage. Home-grown feedstuffs alone do not always provide the nutrients needed to formulate a balanced diet. The difference between diet requirements and the availability of nutrients from home-grown feedstuffs varies between farms and regions, especially in pig and poultry production. Under certain circumstances, therefore, it is necessary to use some external feed materials, even though this conflicts with the principle of closed nutrient cycles. Taking these different and partly conflicting objectives of organic farming into account, the principle in relation to the use of external and non-organic inputs should be*: to use as few external inputs as possible and as many as necessary* (Sundrum and Padel, 2006).

Table 2: Summary of feed provisions in Regulation (EEC) 2092/91 on Organic Production

Organic feed (Article 4.2)	Livestock must be fed on organic produced feed stuffs
In-conversion feed (Article 4.4) amended March 2007, not implemented by all certification bodies	Until 31 December 2008, up to 50 % of the feed formula of rations on average may comprise in-conversion feed stuffs. When the in-conversion feed stuffs come from a unit of the holding itself, this percentage may be increased to 80 %. As from 1 January 2009, up to 30 % of the feed formula of rations on average may comprise in-conversion feed stuffs. When the in-conversion feed stuffs come from a unit of the holding itself, this percentage may be increased to 60 %. These figures shall be expressed as a percentage of the dry matter of feed stuffs of agricultural origin
Non-organic feed (Article 4.8 –as amended in August 2005)	The maximum percentage of conventional feed stuffs of agricultural origin authorised per period of 12 months is: (a) for herbivores: 5 % during the period from 25 August 2005 to 31 December 2007; (b) for other species: — 15 % during the period from 25 August 2005 to 31 December 2007, — 10 % during the period from 1 January 2008 to 31 December 2009, — 5 % during the period from 1 January 2010 to 31 December 2011. These percentages apply where the farmer can show that he/she is unable to obtain feed exclusively from organic origin. These figures shall be calculated annually as a percentage of the dry matter of feed stuffs from agricultural origin (Annex II). The maximum percentage authorised of conventional feed stuffs in the daily ration, except during the period each year when the animals are under transhumance, must be 25 % calculated as a percentage of the dry matter.
Home grown feed (Article 4.3)	Livestock must be reared using feed from the unit or, when this is not possible, using feed from other units or enterprises subject to the provisions of this Regulation. Moreover, in the case of herbivores, except during the period each year when the animals are under transhumance, at least 50 % of the feed shall come from the farm unit itself or in case this is not feasible, be produced in cooperation with other organic farms.

The Regulation (EEC) 2092/91 for organic production is under revision and a new regulation was adopted by the European Council in June 2007[3] coming into force January 2009. This new regulation clearly states practicing land-related crop cultivation and livestock production, and restricting the use of external inputs as principles of organic farming (see Annex II of this report).

[3] Council Regulation (EC) No 8620/1/2007 Rev 1 of June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91.

3 Balance of supply and demand

Farm animals are self-organizing organisms within the herd and within a complex of varying environmental conditions of the farm. It is essential that the farmer provides adequate livestock nutrition for maintenance, reproduction and performance. Each individual animal is characterised by a specific nutrient requirement, which is affected by factors including body mass, age, sex and in particular differences in the required level of performance.

A farm can also be considered as a self-organising system in a similar way to farm animals. There is considerable variation between individual farms across Europe concerning stocking density, husbandry and feeding practices, and the quantity and quality of nutrient flows. This is influenced by the specific soil and climatic conditions of the region, and also by the structure and organisation of the farm system itself. It is primarily the farm management acting within a certain economic framework that determines:

- the balance between supply and demand of feed nutrients in the system;
- whether there is need for external inputs, to make sure that any imbalances in the diet do not compromise animal health and welfare; or
- whether there is an oversupply of nutrients in the system, which is likely to have a negative impact on the environment.

The farm manager is the most important regulator of the system. He or she can set production goals, identify feed demands required to meet these goals, and calculate whether feed supply can meet these demands. If these demands are not met, the farmer can manipulate aspects of the system (production goals, feed demand and feed supply) to bring the system into balance. The following key measures could be used by organic farmers to regulate or balance the system (see also Sections 3 and 7):

- Increasing the availability of home-grown feedstuffs;
- Modifying the requirements of total livestock by adjusting stocking rates;
- Formulating the feeding ration in relation to different life stages;
- Improving feed intake;
- Reducing feed losses;
- Sourcing feed from outside the system when nutrient availability within the farm is insufficient.

Using external inputs adds an extra layer of complexity to the farming system, as the cost and availability of such feed impacts on the ecological and economic sustainability of the system. On the other hand, importing essential nutrients does allow the diet to be balanced relatively quickly. However, the viability of a farm system relying entirely or to a large extent on external feed sources may be at risk, if supplies become limited and/or costs rise.

3.1 Shortages in the supply of organic feed in the EU

Shortages of organically produced cereal and protein crops are a major problem facing several countries in the EU. The reasons for these shortages vary between countries: In the UK for instance, fewer crop-producing than livestock farms have converted to organic agriculture, resulting in an undersupply of organically grown crops and hence a reliance on imported feed. In 2007 shortages are being felt across the EU due to the dry summer of 2006 which reduced harvests. The EU has temporarily increased the proportion of in-conversion feed that can be used in livestock diets (see Section 6). A study by Padel and Sundrum (2006) indicates there could be sufficient organic cereal grown to feed all organic livestock, but that organic protein is currently in short supply. This has particular implications for organic pig and poultry producers who are reliant on adequate protein supply in the animals' diet to ensure good production and high levels of animal health and welfare. Outlined below are options for addressing these shortages.

3.1.1 Increasing the availability of home-grown energy and protein from within the farm system

The availability of nutrients on the farm depends firstly on whether suitable land for growing cereal crops and pulses is available to the farmer. Under organic farming conditions, it is much easier to meet the nutritional requirements of the ruminant than those of monogastric animals such as pigs and poultry. Ruminants can utilise home-grown forages, and only limited inputs of energy and protein concentrate feeds are required. The microbes in the rumen can synthesise all the essential amino acids from the diet required for milk and meat production.

In contrast, monogastric animals need certain quantities of essential amino acids in their diets for good production. They require feed materials with a relatively high concentration of energy and high biological quality of protein, and as such are directly competing with humans for feed sources. The best crop based sources of amino acids are soya, or from industrial by-products such as potato protein or maize gluten, but these are quite difficult to grow in many parts of the EU or source in sufficient quantity and quality. Farmers may therefore, need to consider other grain legume crops or source these amino acids from outside the farm. The availability and price of organic feed ingredients depends on various external economic and climatic conditions, but has significant impact on the long-term viability of monogastric livestock systems. The more an organic farm strives for self-sufficiency by increasing the availability of various home-grown feed stuffs, the more it becomes independent from feed market and price fluctuations, and able to balance the nutrient flow within the farm system.

3.1.2 Addressing the reliance on external and non-organic feed inputs

Several external feedstuffs can currently be used under the conditions of the Regulation (EEC) 2092/91 (see also Table 2):

- feed from organic origin (for ruminants, 50% of which must be sourced from the home farm or a linked farm);
- feed from farms in conversion (up to 50% until Dec 2008[4] and up to 30% thereafter); and
- feed from non-organic (conventional) origin (currently up to 15% of the total demand for non-herbivores). This category will be phased out by Dec 2011.

Currently, organic feed (particularly protein feeds) rely on approved conventional feeds in their compound diets. Appendix II (of Regulation (EEC) 2092/91) provides a list of conventional feed ingredients that millers can use in compounds feed within the specified non-organic proportions. There have been requests to extend this list (e.g. to include rice protein), due both to the shortage of many organic proteins and some conventionally produced protein feeds (e.g. potato protein)

[4] Not all certification bodies have accepted the temporary increase in in-conversion proportion

but this could only provide a short term solution as the conventional feed derogation will be phased out and organic systems have to move towards the use of 100% organic feed stuffs by December 2011.

Farmers and feed millers acknowledge that the removal of the conventional feed allowance is essential for the integrity and future development of the organic livestock industry. However, all realise that it will not be easy to do without this derogation, especially in the case of pig and poultry production. The problem of availability and supply of organic energy and protein feeds needs to be addressed by both feed millers and organic crop farmers. Organic protein sources are currently in short supply across the EU (Padel and Sundrum, 2006). Higher market prices would encourage more producers to grow such crops, but this would also mean higher prices for organic feed. Both the feed industry and organic farmers will need to make significant changes over the next four years to meet this challenge.

3.2 Continuity and quality of supply of organically grown feeds is variable, creating problems with both processing and marketing

Apart from a general shortage in the availability of organic feed across the EU in 2007 (see 2.1), some countries (e.g. the UK) are also experiencing long-term logistical problems with the supply of organic feeds. Continuity of supply and crop quality are very variable, and this can add to problems of undersupply and create problems for both the feed milling industry and for farmers trying to source feed. There appears to be a certain level of market failure, whereby even if demand and prices paid for organic livestock feed are high, the arable sector does not respond.

Available organic grain is often supplied to millers in small batches, requiring grain to be stored until there is sufficient quantity to process. Storage difficulties are further increased if the mill processes both conventional and organic feed, and essential storage is tied up by small batches of organic grain. Millers prefer to buy their organic grains and legumes on the spot market and are not prepared to commit to forward supply contracts with farmers. This is one of the key problems highlighted by cereal farmers when asked for the reasons for their reluctance to convert to organic production. Some organic farmers are known to hold on to organic feed cereals in the expectation that feed prices will rise further as demand continues to increase. Organic farmers also prefer to grow a range of cereals (including barley, oats and triticale) in their crop rotations to maintain soil fertility and reduce disease pressure. Millers, however, prefer to buy mainly feed wheat as this can be used in a wide range of rations for all types of farm animals. Finally, the premiums available to farmers for growing crops for bio-fuels are also dissuading farmers from converting to organic production. Conversion to organic is also seen as the much riskier diversification option.

A number of steps could be taken to improve the continuity and quality of supply of organic livestock feeds. Millers and farmers need to be prepared to enter forward supply contracts so that there is some degree of security for both parties. The farmer will know what price he/she will receive for the grain and the miller will be assured of both the quantity and quality of the grain supplied. Farmers need to work together to ensure that sufficient quantities of a suitable quality feed grain can be delivered to fulfil supply contracts with millers. Retailers also need to be prepared to enter supply contracts with organic farmers so that there is some degree of security for both parties in relation to the quantity and quality of organic products of animal origin.

Summary – Methods for balancing feed supply and demand and improving the consistency of supply

The different ways available for organic farmers to satisfy the feed demands of their livestock are:

- Increasing the availability of home-grown feedstuffs;
- Modifying total feed requirements by adjusting stocking rates;
- Formulating the feed ration in relation to the different life stages;
- Improving feed intake;
- Reducing feed losses;

Problems with feed shortages and inconsistency of supply can be addressed by:

- Estimating the land area used for the production of organic feedstuffs within a region and by calculating the possible demands for external feed ingredients (which could be met through trade with areas outside the region);
- Farmers and miller agreeing on supply contracts (quantities and quality) to add some degree of security of supply for both parties;
- Establishing co-operation between farmers in the purchase and storage of feedstuffs and in fulfilling supply contracts with millers.

4 What are the dietary requirements of organically reared pigs and poultry?

The implications of limited availability of feedstuffs in organic pig and poultry production on growth performance, traits of product quality, and animal health depend to a large extent on the capacities of livestock to adapt to and compensate for changes in nutrient supply in the various stages of their development.

For muscle growth, all the amino acids needed have to be available in synthesis compatible form. If one of the essential amino acids is missing, protein biosynthesis may be reduced or degradation of body protein may be increased. Protein synthesis or accretion is thus dependent on balanced protein provision via the feed, the Sulphur containing Amino Acids (SAA) are particularly important. In the case of poultry, methionine is regarded as the first limiting amino acid while with pigs, lysine is the first- and methionine or threonine are the second-limiting ones.

However, amino acid availability alone is not enough to ensure protein synthesis; adequate levels of energy in the diet are also necessary. In general, it can be assumed that a linear relationship between protein accretion and energy supply exists. However, this relationship is confined mostly to the early growth period. In the final fattening phase, muscle growth is primarily controlled by the animals' genetic capacity for protein accretion. Accordingly, this leads to individual animal differences in amino acid requirements, to which the amino acid to energy ratio must be adjusted. Furthermore, energy requirements are also dependent on the environmental temperature and locomotive activity of farm animals, and are thought to be significantly higher in outdoor conditions than indoors. Correspondingly, the requirements for energy, but not for amino acids, are up to 10% higher in the winter season under outdoor conditions.

The amino acid content of feedstuffs alone does not provide enough information to predict the nutritional value of the feedstuffs for protein biosynthesis. Firstly, there is limited information about livestock requirements for individual amino acids. Secondly, exact information about the availability of amino acids from the feedstuffs is necessary. The amino acid availability is related to both the digestibility and the availability in the intermediate metabolism. In the past various criteria were developed to assess protein quality; nitrogen retention, biological value or net protein utilization, but these criteria have not become established in practical nutrition.

Metabolic processes do not differ between organic and conventionally reared farm animals, and the recommendations for an adequate nutrient supply generally follow similar rules, but the outdoor access required in organic systems creates a higher energy requirement. There is a large variation in individual requirements, due to differences in live-weight, sex, body condition, and especially performance level. Additionally, living conditions are responsible for large differences in the performance level between farms even when the equal feed ration is offered. Differences in environmental temperature, stocking rate, group size and stress levels all contribute to high variability in protein accretion, particularly for poultry. Fattening animals exposed to a high pressure of infectious agents, increased stress, suboptimal living conditions and poor hygiene management cannot fulfil their genetic potential for protein accretion, even if they are offered an optimal feed ration *ad libitum*. In various studies, protein accretion under poor living conditions was only 50-70 % of that achieved under optimal conditions for the same ration (Schinkel et al. (2002)).

In summary, the high variation in genotypes and housing conditions in organic farming reduces the predictability of specific requirements and the rate of utilisation of nutrients. For practical purposes, general recommendations of the protein and energy supply of farm animals provide guidance for both conventional and organic agriculture. However, it is also necessary to carry out specific on-farm assessments, taking in to account the environment, feed intake and feed conversion in the various livestock life stages in order to provide optimal nutrition.

4.1 Dietary requirements of organic pigs

The protein supply for pigs is primarily based on grain legumes which are characterised by a low percentage of essential amino acids, especially with regard to methionine. Efficiencies in feed usage, particularly of the scarce protein component, can be improved by tailoring diets to particular life stages. Currently, organic pig farmers for example often use only two different diets, a lower specification ration for dry sows, boars and finishing animals and a higher specification feed for growers and lactating animals. However, by increasing the number of groupings, greater feed-use efficiencies may be possible.

In general young and growing animals have the greatest feed requirements. The specification of starter rations for these groups of animals should be met to prevent risks in relation to animal health and welfare. The main disadvantage of feeding for different life stages is the increased complexity of feed management and ration planning on farms. Different diets need to be mixed and stored separately, and the different groups of animals need to be fed separately. A balance needs to be achieved between the feed-use efficiency benefits of feeding a number of life stage groups, and the complexity of the process. The implementation of sexually divided stalling can help match the feed supply more closely to the different requirements of the sexes. Male animals have a genetically higher capacity for protein accretion than females (Chamruspollert et al., 2002), due primarily to the different hormone statuses of the sexes which results in a higher feed intake. The need for essential amino acids in male animals is also higher than for females. A compensatory growth effect has been shown for fattening pigs with limited protein diets in the initial fattening phase (Chiba et al., 1999). The authors, however, concluded that strains bred for high meat growth are less tolerant to restricted protein in this phase. Other studies have found that compensatory growth occurs regardless of whether fast or slow growing breeds were used (Fabian et al., 2002).

Piglets have the highest demand for limited amino acids. Their requirements should be covered in order to prevent predisposition of diseases. Discrepancy between nutrient requirements and supply, can cause diseases, such as diarrhoea in piglets, reproductive disorders in sows, and a suppression of the immune reaction. Furthermore, diarrhoea in piglets can be caused by ANF's from legumes.

Grain legumes can successfully be used in the feeding ration of sows and fattening pigs for which multi-phase feeding and sex segregation is recommended in all cases. We recommend the use of at least five diet specifications for pigs: for dry sows and boars, lactating sows, piglets (starter diet), fattening pigs (starting phase), and fattening pigs (finishing phase).

Furthermore, optimising the husbandry environment with related potential of a higher feed intake is an important option to make better use of the limited essential AA content in the available feed and to achieve a satisfactory performance and carcass yield.

Table 3 shows differences between feeding rations in relation to nutrient content, feed consumption, feed costs and gross margin for six German organic pig farms, during the fattening period (Marien and Sundrum, unpublished). Feed consumption and acceptable lean meat percentages may vary between countries (Denmark for example has more stringent requirements). The data show that differences in the proportion of high quality protein in the diet are only one of several factors explaining the large farm-variance in animal performance. Other important differences occurred in feed intake, total feed consumption, and feed conversion rate, with only small differences in feed prices. Farm systems that supplemented with both low and high levels of high quality protein could have both high and low gross margins. It can therefore be concluded, that there are different ways for optimisation on the farms. The focus should not solely be on the protein specification in the ration, but the whole farm situation needs to be considered.

Table 3: Differences in the feeding rations and in the mean values of feed consumption, feed costs, performance and production costs for the fattening period between 30-120 kg live-weight on 6 organic pig farms in Germany

	Farm A		Farm B		Farm C		Farm D		Farm E		Farm F	
Feedstuffs	kg/ pig	%	kg/ pig	%	kg/ pig	%	kg/ pig	%	kg/ pig	%	kg/ pig	%
Cereals	119	73	180	61	164	62	192	66	162	78	258	72
Grain legumes	63	21	59	24	64	21	64	17	42	12	39	13
High quality protein	9	3	7	14	37	14	44	14	34	5	17	10
Miscellaneous	9	3	8	1	8	3	8	3	7	5	17	5
MJ ME/ kg (88% DM)	13,3		12,6		13,5		12,7		12,4		12,6	
g CP/ kg (88% DM)	139		153		149		127		127		141	
Feed consumption (kg/pig)	**300**		**246**		**267**		**309**		**245**		**330**	
Feed price (€/100kg feed)	22,8		24,4		25,2		23,7		26,4		25,4	
Feed costs (€/ pig)	**68**		**60**		**67**		**73**		**65**		**84**	
Feed intake (kg/pig)	2,8		2,1		2,7		2,3		2,1		3,0	
Daily live-weight gain (g/ pig)	840		770		910		670		770		815	
Fattening period (days)	107		117		99		134		117		110	
Feed conversion rate (1: ..)	**3,3**		**2,7**		**3,0**		**3,4**		**2,7**		**3,7**	
Lean meat percentage (%)	49,0		54,0		58,0		51,5		51,5		55,0	
Receipt (€/ fattening pig)	**230**		**245**		**251**		**241**		**241**		**246**	
Receipt - feed costs (€/ pig)	**162**		**185**		**183**		**168**		**176**		**162**	

Source: Marien and Sundrum (unpublished)

Using roughage for pigs, especially in the case of dry sows and fattening pigs in the final phase is an appropriate instrument to reduce concentrate (protein and energy) inputs. At the same time this feeding strategy follows the EU Regulation which requires that pigs and poultry should be provided with roughage on a daily basis (Annex II, EEC/2092/91).

There is need for further studies concerning the use of breeds or genotypes that are more adapted to the organic framework conditions and at the same time do not provoke negative side effects on carcass quality such as obesity.

4.2 Dietary requirements of organic poultry

Broiler production

Growth performance, protein accretion, feed intake, and feed utilization are subject to considerable variation, depending to a large extent on genotype, sex and environmental conditions. A suboptimal level of limited amino acids in the feed ration can be partly compensated for by increased feed intake, especially when the energy content in the diet is reduced.

The implementation of sexually divided stalling can help match the feed supply more closely to the different requirements of the sexes. Male animals have a genetically higher capacity for protein accretion than females (Chamruspollert et al., 2002), due primarily to the different hormone statuses of the sexes which results in a higher feed intake. The need for essential amino acids in male animals is also higher than for females. We recommend using two diet specifications for table birds (growing and fattening).

When using slow-growing lines (slaughtered after 81 days) rations for lower performance can be formulated with lower amino acid content. Research showing that under the conditions of organic farming broiler production can be successful is limited to very few studies (e.g. Bellof et al., 2005; O'Brien et al., 2006).

Turkeys

Because it is possible to produce marketable products with a high slaughter weight, few attempts have been made by organic turkey producers to use slow growing strains. However, the use of strains with a high genetic capacity for protein accretion is not in accordance the principles of organic agriculture. It is difficult to ensure the supply of essential amino acids, especially in the initial fattening phase, due to the high protein accretion capacity in relation to the live weight and a low feed intake potential of these strains. In the starting phase, growth and protein accretion react very sensitively to a suboptimal supply with essential amino acids. With increasing age the demand on amino acids clearly declines and turkeys are more able to compensate partially for suboptimal contents of amino acids in feed by increased feed intake. Male animals can better compensate for the deficiency in amino acids than female ones, because their feed intake is higher. Because of the high initial demand, four to six diet specifications should be used, depending on the nutritional plan followed).

It has been shown that it is possible to make use of compensatory growth effects also in the case of turkeys and to reduce the demand for high quality protein feedstuffs in the starter ration. In a study in turkeys (Auckland and Morris, 1971) one group was fed a limited protein diet in weeks 0-10 and both groups were fed the same protein adequate diet in weeks 10-20. This showed that after week 20 both groups of birds were the same live weight and both consumed the same feed quantity, but the restricted birds used approximately 10% less crude protein. However, more research with slow growing strains under the conditions of organic farming is clearly needed.

Layers

The laying phase from the 22nd to the 34th week is very critical with respect to essential amino acid supply. In this phase laying performance is very high and at the same time body weight is still increasing. An inadequate supply with essential amino acids has a negative effect on the performance in strains with a high genetic performance capacity. At laest two diet specifications for (growing and for laying) should be fed.

The proportion of methionine to cystine is an important factor for the performance of layers. The methionine proportion should not be below 50% of the SAA. Energy and methionine both influence feed intake: low methionine content increases and a high energy content decreases feed intake. The laying performance increases most intensively with a high methionine and low energy content in the feed.

Laying hens are able to compensate partially for a suboptimal supply with limited amino acids by an increased feed intake, but rations with relatively high energy content will limit intake. There is need for further studies focussing on the possibilities for the use of specific strains that may be more adapted to a restricted availability of limiting AA.

Although some studies (e.g. Rose 2004) reveal that, in organic laying hen production, performances comparable with those of conventional husbandry can be achieved by using high-value protein sources; there is a need for further research work to investigate the possibilities on how to optimise the production of eggs under the organic framework conditions.

4.3 Is it possible to reduce the specification of rations in the different life stages?

The energy and essential amino acid requirements of animals are primarily a function of the performance levels expected from the animal by the farmer and/or the industry. In intensive production systems, expectations are focused on high growth rates consequently resulting in efforts to breed for higher performance, and high quality feedstuffs and the use of synthetic amino acids are essential production tools to meet the continually increasing demands. The restrictions in relation to external feedstuffs and the banning of synthetic amino acids in organic farming limit the potential for maximising the level of performance and protein accretion in comparison to conventional production. Problems arise when organic production relies on genetic strains bred for high performance in conventional production. The use of slow growing strains (see Section 4), has the potential to markedly reduce the level of nutrients required in the daily ration.

In general young and growing animals have the greatest feed requirements. The specification of starter rations for these groups of animals should be met to prevent risks in relation to animal health and welfare. A multiphase feeding strategy would allow reducing the overall demand by feeding lower diet specification in later stages. The main disadvantage of feeding for different life stages is the increased complexity of feed management and ration planning on farms. Different diets need to be mixed and stored separately, and the different groups of animals need to be fed separately. A balance needs to be achieved between the feed-use efficiency benefits of feeding a number of life stage groups, and the complexity of the process.

Feed mills have identified starter feeds as being the most difficult to produce to meet specifications under organic feeding regulations, because of high requirements and the lack of organically grown protein feeds of suitable quality. This is especially true for turkeys and layers where due to a combination of the fast growing breeds that are used in many organic systems and the lack of organically grown protein feeds of suitable quality. Most millers make full use of the derogation for conventional feeds in their starter diets, and many feel that there is absolutely no flexibility left in the starter feed specification.

Unless structural changes can be made in the organic livestock sector it will be very difficult to feed young organic birds when the conventional feed derogation is removed. One such change in the organic industry could be to reduce the use of organic soya to balance the diet of organic dairy cows and encourage ruminant farmers to rely more strongly on protein forages and home-grown grain legumes. This could result in increased availability of high quality organic protein for monogastric animal production. A further alternative would be to look into the possibilities of growing more soya in those parts of Europe where this is climatically possible.

As part of a range of farm management tools (see 7.4) producers faced with protein shortages and trying to reduce protein demands in organic pig and poultry diets should consider using slow growing strains and breeds, compensatory growth and substituting roughage for concentrate in the diets where possible. These should be supplemented by health planning considering the implication of these practices for animal health and welfare under the specific circumstances of the farm. Further research is needed to into the impact of reduced diet specification of starter feeds for pigs and poultry under the conditions of 100% organic diets, suitable organic protein sources and the short and longer term impacts on animal health and welfare.

4.4 Is there potential to increase the total intake of limiting amino acids by improving feed intake?

In general, nutrient supply for farm animals is a function of both the concentration of nutrients within the ration and the voluntary feed intake. Both variables can be modified, but current farm management focuses on the diet composition. This is because it is difficult to monitor the feed intake of farm animals in their various life-stages, and therefore farmers are unable to identify where farm specific improvements could be made. However, feed intake of farm animals (even when the same age) varies considerably within the herd and between farms, and the source of this variation is multi-factorial (various studies in Sundrum et al., 2005). Increasing feed intake by improving the living environment and management is an important option when there is a lack of high quality feedstuffs but other feedstuffs are available. An increase in feed intake from 1.0 to 1.1 kg feed/day of a diet with 13.0 MJ ME and 50 g methionine per kg effects an improvement of the energy provision by 1.3 MJ ME and an improvement of methionine provision by 5 g per animal and day. Under the restrictions of the Regulation (EEC) 2092/91 it seems to be easier to achieve a 10% better energy and methionine supply through a higher feed intake than by increasing the energy content and the concentration of methionine in the feed ration. In general, it is assumed that the feed intake is influenced primarily by live-weight, sex, stocking rate and the stall climate conditions (NRC, 1994; 1998).

For pigs, differences of approximately 30% have been determined between different genotypes with otherwise equal feed rations and living conditions. Crowding, group size and group mixing are factors that markedly influence feed intake, conversion efficiency and growth rates. Moreover, the feed intake is influenced by the condition of feed (particle size, crude fibre type and quantity, water binding capacity, anti-nutritive substances), the presence of pathogenic germs, and the physiological digestion capacity of the pigs. Pigs fed with voluminous, fibre-rich feed rations showed a higher stomach volume than pigs fed only on concentrate feeds and stomach volume is closely correlated with the long-term quantity of feed intake.

In the case of laying hens, there is an interaction between energy and methionine content. Low methionine content increases the feed intake, whilst a high energy supply reduces feed intake. Hence, laying hens are able to partially compensate for a suboptimal supply of limited amino acids by an increased feed intake. However, a feed ration with relatively high energy content limits feed intake.

In broiler production, both feed intake, and feed utilization are subject to considerable variation, which depends to a large extent on the genotype, sex and environmental conditions. Feed intake decreases as stocking rate increases and long-standing heat stress can also lead to a depression in feed intake (Bessei, 1993). A suboptimal level of limited amino acids in the feed ration can be partially compensated for by increased feed intake, especially when the energy content in the diet is reduced.

Summary – Better matching of pig and poultry feed demand and supply

When nutrients are in short supply, the specification of rations can be reduced in some cases by:

For pigs and birds: implementing multiphase feeding systems and adapting protein supply more closely to animal requirements at different stages of growth and production;

For birds (and to a lesser extent pigs): Improving feed intake of lower specification feeds through optimising feeding and housing systems and by reducing the energy content of the diet;

For pigs: making full use of the proportion of the diet that can come from roughage by introducing high quality forages into the diet of dry sows and fattening pigs in the finishing period.

For pigs, broilers and turkeys: in some instances, taking advantage of compensatory growth effects by restricting protein intake in the early stages of growth, However further research needs to be undertaken to ensure animal health and welfare and long term productivity are not compromised before this could be used as a standard practice.

For broilers: lowering the intensity of the system (change to slower growing strains) and increasing feed intake to meet total protein requirements;

5 Can organic farming rely on breeds with lower feed requirements?

Using appropriate breeds and strains and by developing production systems that are suitable for the nutrient production capacity of the farm are the ideal that organic farmers should be aiming for. The use of slow growing strains could reduce the nutrient requirements of farm animals in different stages of development. This is particularly relevant for organic broiler production, rather than pigs as most pig stock will be bred on the farm. Regulation (EEC) 2092/91 states that in choosing breeds or strains of livestock for organic systems, the farmer should consider the capacity of animals to adapt to local conditions, their vitality and their resistance to disease and health problems.

In practice, the majority of organic poultry producers are reliant on using conventionally bred broiler birds, as they meet the industry and consumer requirements in terms of conformation and growth. Consequently, the infrastructure does not yet exist where strains more suited for organic systems are available in commercial quantities. Fast growing strains are often difficult to manage under organic systems because they have been bred for rapid growth and increased processing yield, and as such require high levels of feed and tend to finish much earlier than the 12 weeks allowed under the Regulation (EEC) 2092/91. Studies on organic broiler husbandry and brand programmes using slow-growing lines (slaughtered after 81 days) show that with lower demands for performance, lower amino acid content in the feed is required (Bellof and Schmidt, 2005). However, so far the research investigating the implications of organic conditions on broiler production and on the capacity of broiler strains to adapt to changes in the nutrient supply has been very limited.

The poultry breeding sector is dominated by a small number of large companies for whom the organic broiler industry is only a very small proportion of their business. The exception to this has been in the French poultry sector, where the 'Label Rouge' programme was developed in the 1960's. The daily protein requirements for strains used in the Label Rouge programme are reduced as these birds take 12 weeks to mature compared with fast growing strains which take 5 to 7 weeks.

A fundamental discussion within the organic livestock sector as to which poultry production systems would actually fulfil the principles of organic farming is ongoing. The question of which breeds to use is fundamental to this. If slow growing broiler breeds are used, it may be possible to feed birds with a substantially higher proportion of home-grown feeds.

Summary – Different breeds for organic systems?

Organic systems would require slower growing breeds (broilers in particular) that have high vitality and disease resistance as opposed to the current conventional strains that have high growth rates and high nutrient demands. There are some examples where slow growing strains, more suited to organic broiler systems are widely used (e.g. Label Rouge programme in France). However, generally, poultry breeders are not at present developing breeds suited to organic farming due to the small size of the organic poultry sector.

In order to progress with the development of breeds suited to organic systems, further research into the suitability of breeds, strains and breeding programmes is essential. It may also be necessary for individual farmers, or groups of farmers acting co-operatively, to develop their own breeding stock and replacement programmes. This is already a common practice for organic pig producers, but rare for commercial poultry production.

6 What protein sources can be used?

6.1 Grain Legumes

Grain legumes are used worldwide both in human and animal nutrition as a major protein source. In temperate climates, such as those experienced by many in most European countries, it is possible to grow faba beans (*Vicia faba L.*), peas (*Pisum sativum L.*) and sweet lupins (*Lupinus spec.*). Some areas of southern Europe could also grow soybeans (*Glycine max*). These crops are the main sources of home-grown protein that is available in organic pig and poultry production. Although home-grown grain legumes are characterised by high crude protein content, the content of limited amino acids and their digestibility are low compared to soybean. Home-grown grain legumes contain anti-nutritional factors, which restrict the proportion to which they can be included in the diet. These factors can be destroyed by heat or other measures, but costs and logistics may prevent this on the individual farm scale. In recent years plant breeders have been successful at producing plant strains with reduced anti-nutritional factors (esp. in the case of lupins).

It is important that farmers are aware of the feeding characteristics of the grain legumes they use. There are several varieties of commonly used grain legumes, each with a distinct nutrient profile. The mean crude protein content can vary, according to species and variety, between 258 and 440 g/kg DM (Table 4). All grain legumes are relatively high in the essential amino acid lysine, but the concentration of methionine and tryptophan are relatively low. Feeding high levels of grain legumes to provide sufficient methionine usually leads to an excess in the other amino acids. Peas are among the poorest in sulphur containing essential amino acids and soya the richest, but there are other aspects that determine their suitability as livestock feeds, for example, soybean use is limited by its fat content.

6.1.1 Lupins

Yellow lupins have a higher crude protein content than either white or blue lupins. Lupins in general have similar crude protein content to that of full fat soya and yellow lupins have a higher crude protein content than white or blue varieties. The lysine content is high and the methionine and cystine contents are moderate. The amino acid profile of lupins is better suited to the dietary requirements of fattening pigs than either beans or peas. Some reports also suggest that moderate levels of sweet lupins (20 %) could replace soya in layer feeds, though differing nutrient profiles arising from different varieties and treatment of the raw product make it hard to make generalised recommendations. Blue lupins can be included in pig diets at relatively high levels without compromising feed intake and growth rates (max 20-25 % for growers and 30-35 % for finishers) (Van Barneveld, 1999).

Lupins, have not been widely used in the past as they contain alkaloids which have a bitter taste and can affect feed intake (this can, however, be substantially be reduced by swelling the grains and washing them). More recently, newer “sweet” varieties of lupin have been developed which have much lower levels of alkaloids and are therefore more palatable.

6.1.2 Beans

Faba beans and peas have a larger N-free extract fraction (primarily based on starch) than lupins. The lysine content of faba beans is high but they are low in methionine and linolenic acid, and the latter is especially important in egg production. Beans are not an ideal alternative protein source for poultry because of the low concentration of methionine and the presence of anti-nutritive factors, but they do play an important role in pig nutrition. However, approximately 10 % can be included in layer rations and up to 30 % in broiler rations (Sundrum et al., 2005).

6.1.3 Peas

Peas are a promising potential feed ingredient for organic poultry rations. They contain relatively high levels of lysine (but lower methionine and cystine) which complements the proteins found in cereal (lower lysine and higher methionine and cystine) (see Table 4 below) – they are nutritionally complementary. They can probably be incorporated in broiler diets at up to 25-30 % and in layer diets at up to 15-20 % (Sundrum et al., 2005).

Table: 4: Contents crude protein and essential amino acids of organic protein sources compared with soybean meal

	Crude protein (%) (88 % DM)	% amino acids of the crude protein content			
		Lysine (%)	Methionine/ Cystine (%)	Threonine (%)	Tryptophan (%)
Soybean meal, conventional	*41.8 – 51.8*	*6.4*	*2.9*	*4.0*	*1.3*
Soya beans	32.0 – 37.9	6.3	3.1	4.0	1.4
Rapeseed meal	32.8 – 35.0	5.3	4.7	4.5	1.4
Sunflower meal	31.5 – 35.5	3.6	3.9	3.6	1.2
Rice bran	15.6 – 18.5	4.6	4.2	4.0	1.1
Skimmed milk powder	33.8 – 39.3	7.7	3.3	4.4	1.4
Whey powder	22.3 – 26.0	7.5	3.4	5.6	1.5
Peas	18.0 – 23.5	7.2	2.5	3.8	0.9
Field beans	22.6 – 30.1	6.4	2.1	3.6	0.9
Sweet Lupins	30.5 - 42.7	4.6	2.3	3.56	0.76

Source: AminoDAT, Degussa, Feed Additives, 1996

6.1.4 Rapeseed

Full fat rapeseed is the complete oilseed rape grain, containing the original content of oil and is therefore an excellent source of protein and energy. It needs to be ground together with cereal to crack the seed coat and soak up the oil that is released. The seed does have poor palatability because of its mustard taste and also contains anti-nutritive factors which limit its inclusion in rations. Its high content of unsaturated oil may impact on the carcase quality (especially fat quality) of finishing animals. Rapeseed meal (a by-product of the oil extraction industry) is also a good source of protein and fibre. Inclusion rates are limited in poultry diets to 5 to 10%, but again inclusion rates are limited because of poor palatability and anti-nutritive factor content (Sundrum et al., 2005).

6.2 Fish meal

Many millers refer to fish meal as a potential solution for the lack of protein available in organic diets. Fish meal is a rich source of essential amino acids but there are a number of issues associated with its use. Firstly, fish meal, as an animal protein, is only permitted in monogastric and not ruminant diets. As such it is banned from use in mills that produce both ruminant and monogastric feeds. Secondly, fish and other marine animals and their by-products are permitted under Annex II of the Regulation (EEC) 2092/91 and their future use after the expiry of the derogation is uncertain. They are not ingredients from agricultural origin and it therefore likely that their continued use will be permitted. Some certification bodies (e.g. Soil Association in the UK) are certifying salmon farming as organic and this may result in small quantities of organic fish meal becoming available, though certainly not enough to meet the current demand for organic protein feeds. There is provision in the revised EU Regulation to certify organic fish farming.

6.3 Milk by-products

Another important protein source for monogastric animals are milk by-products such as non-fat milk powder and whey powder (de-sugared). These are available from both organic and non-organic origins. The high value of milk by-products is primarily due to their high digestibility, which is especially beneficial in the feeding of young stock, but also due to the relatively high portions of essential amino acids (Table 4). It is often argued that milk by-products are relatively expensive, although starter diets require only small amounts per animal per day. Higher prices for starter diets should be expected however, especially when taking into account that a good starter diet will induce enzyme activity in the gut of young animals and consequently increase feed intake. Improved feed intake can allow for increased use of home-grown feed stuffs in the grower diet.

6.4 Rice Protein

Due to the shortage of conventionally produced potato protein, which plays a major part in formulating organic poultry and pig rations in the UK and elsewhere, it has become increasingly common for feed millers to use rice protein as an alternative (rice protein is acceptable under the heading of rice germ expeller in Annex II C of Regulation (EEC) 2092/91). Rice feed meal (white or brown) contains about 11 to 16 % crude protein, with an amino acid pattern comparable to wheat. Rice protein, however, is only a short term solution for the current protein feed shortage as its use will not be permitted after 2011 unless a suitable organically produced source can be found.

Summary – Available protein sources

Alternative sources of protein are available that can either be grown on the farm (e.g. grain legumes such as peas, beans or lupins) or sourced from other agricultural systems (e.g. fish meal and milk by-products). The alternative protein sources reviewed here have various advantages and limitations: Lupins have a suitable amino acid profile for the diets of fattening pigs, and new more palatable varieties are available. Beans are a better alternative protein source for pigs than poultry. Peas are a promising feed alternative for poultry rations. Rapeseed also has a place but palatability and anti-nutritive factors limit the inclusion rates in diets. Fish meal is permitted for monogastric diets and presently only conventionally-produced fish meal is readily available. Milk by-products are expensive, but are particularly useful in starter diets. Rice protein is a short term protein solution only, as it is also only available conventionally.

7 The future of derogations with respect to organic feeding

It appears a consensus within all sectors of the organic industry, that organic livestock should be fed 100% organic diets, as this is one of the key principles of organic farming and contributes to the organic integrity of organic livestock products. Phasing out of the derogations to use non-organic feed as set out in the Regulation (EEC) 2092/91 is necessary to maintain consumer trust for the future development of organic farming and the organic market. Removal of the derogations means that the supply of organic livestock feed, especially feed of high quality protein, needs to grow to meet increasing demand from an expanding organic livestock sector.

The general conclusion, therefore, is that derogations are neither wanted nor needed in the long term. However, there are still significant advances to be made by both farmers and feed millers before the derogation allowing conventional feed expires at the end of 2011. To ease current shortages of organic feed because of the poor harvest of 2006 the EU Regulation has been amended allowing up to 50% of a ration, on average, to be comprised of in-conversion feedstuffs (this increases to 80% if from the same holding) up to 31 December 2008, reducing to 30 and 60%, respectively after that Regulation (EC) 394/2007 amending Annex I to Council Regulation (EEC) No 2092/91). Whilst in the short term this will help organic farmers, it is debatable whether there will be associated long term benefits of encouraging more producers to grow organic feed. Ultimately, the organic industry wants to achieve systems that are sustainable, comply with the EU Regulations on organic farming, and fulfil the broader principles of organic farming without compromising animal health and welfare.

Summary - Derogations

The impact of existing derogations for the use of non-organic feed material is ambivalent. Any derogations conflict with the concept of using local resources, closing nutrient cycles and land-related animal production systems. Derogations provide access to a wider range of feed ingredients and supplements that are not yet available organically and make the production of organic animal products cheaper and easier. At the same time, these derogations prevent the development of a more integrated, and input independent production system.

Given the relatively high consensus within organic farming that organic livestock should be fed 100% organic diets it is unlikely that derogations, other than time limited emergency-derogations, will be re-introduced.

8 Challenges in using home-grown feed and suggestions for overcoming them

8.1 *Considering and monitoring the availability of home-grown nutrients*

A broad estimate of the availability of home grown nutrients can be based on the area grown and typical yields for a particular crop, which can be set against an estimate of demand using stock numbers and typical ration requirements for the main components for each species. A more accurate estimate of the quantity of the home-grown feed ingredients available can be derived by carrying out a simple stock take of all feed materials that are stored in enclosed spaces, for example in feed silos.

On many farms the number of silos available for feed storage is a limiting factor. Farmers tend to store different cereals or grain legumes in the same feed silo rather than investing in additional silos. This can cause problems when it comes to estimating how much feed is available, and also when trying to calculate how much of the mixed feed should be put into the ration. Ideally, it would be best to have one silo per feed type, and therefore, one option may be to share feed storage facilities with neighbours. A recent initiative in the UK has encouraged the formation of farmer groups that share both the purchasing and storage of feed material in bulk. This type of co-operation could be extended to storing different types of home-grown feeds.

8.2 *Accuracy when formulating the feeding ration*

In order to be able to accurately formulate rations and make most efficient use of nutrients available, it is very important to analyse feed for crude nutrient content. Due to the large variation between different harvests of the same feed crops, the use of feed tables does not accurately enough describe the quality of the feed. Analysis is standard for purchased feeds, but should also be carried out for home-grown feeds. Many farmers, however, formulate their rations without any feed analysis of single ingredients or feed mixtures. Additionally, feed samples for analysis are not always drawn correctly, and hence do not accurately represent the feed stock. Whilst having home-grown feeds analysed is an additional cost for farmers, in the long term it will reduce feed costs by providing information required for more accurate formulation of rations, thereby improving feed conversion and increasing productivity.

In order to accurately formulate rations based on home-grown feed, the following steps should be taken:

- Where ever possible store different feed types and different harvests of the same feed type separately (see 7.1.)
- A nutrient analysis should be done for all batches of home-grown feed.
- Ensure correct sampling procedures are used when drawing samples for analysis from bulk feed silos. The laboratory testing the feed should be able to provide further advice on sampling procedures.

8.3 *Exact allocation of the feed and monitoring of feed intake*

The nutritional requirements of farm animals differ markedly between their different life-stages (see Section 3). Multiple phase feeding is required to efficiently meet the specific requirements of each phase (see Section 3.1). However, the number of feeding phases is often limited by the additional technical equipment required for the storage and distribution of multiple diets.

As the nutrient supply of the farm animals is a function of both diet composition and feed intake, it is important to know the feed consumption of animals during different life stages. On individual farms, it is difficult to assess the feed intake. Collecting accurate information of feed intake taking in to account multiple phase feeding would allow modifying the feeding ration to optimal levels (see Section 3.3).

8.4 Integrating different farm management tools to manage nutrient supplementation

A major challenge for managing an organic farm is the ability to establish a balance between availibility and demand of nutrients by utilising farm derived feed resources, whilst at the same time avoiding any detrimental effects on animal health and welfare. Apart from ration planning, the performance of sub-systems within the farm system should be monitored and regulated if necessary. Greater balance within the system can be achieved through imposing a number of control points, such as:

- Farm gate nutrient balance sheets to improve nutrient management and reduce nutrient losses;
- Farm specific feed balance sheets to improve the amount and the efficiency in the use of home-grown feedstuffs and to assess the necessity for supplementation (see 7.1);
- Animal health plans to strengthen the efficiency of a range of preventive measures and to reduce morbidity and mortality of farm animals.

The management tools suggested above are suited for managing the use of external inputs as they address the issues of necessity for external inputs, and the potential impact on both the environment and animal health and welfare. The implementation of these management tools is expected to clearly improve the efficiency of home-grown feedstuffs usage, the farm nutrient flow and animal health. The need for external inputs can be assessed and identified more clearly, and possible alternatives may be identified, although it will vary as to whether the amount of external inputs can be reduced. It can, however, be expected that the efficiency and the appropriateness of the external inputs used will be improved.

Summary – Improving efficiency of nutrient use through better feed management

Collecting accurate information about the quantity and nutrient content of home-grown feedstuffs and feed intake will ensure optimal use of home-grown feedstuffs.

Farm gate nutrient balances, feed balance sheets and animal health plans should improve the nutrient management, reduce losses, identify where supplementation is needed to ensure animal health and welfare and help in the early detection of arising problems.

It is necessary to develop farm-specific feeding strategies due to large variations in the availability of high quality feedstuffs, the digestibility and utilization of amino acids in feedstuffs, the capacity of protein accretion and feed intake between genotypes, and farm specific housing and feeding conditions.

It is important to remember that any decrease in the intensification of livestock systems to make better use of home-grown feedstuffs will be associated with decreased live weight gain and subsequently increased costs. Hence, it is essential that organic farmers continue to strive to produce the highest quality product they can, and as a result attract the highest possible economic returns.

9 Conclusions

Organic production of pigs and poultry aims for land based production systems and reduction in production intensity in terms of the use of external inputs. This is different from the production goal of intensified conventional production of improving live-weight gain, protein accretion and feed conversion rate while at the same time reducing production costs. Moving away from high production levels as a main aim of a farm system, and striving for balanced and land-related animal production has its associated costs. The reduction in the intensity implies fewer burdens on the environment but also decreases in livestock performance and increases in production costs. Consumers are willing to pay a premium for this increased quality, and this is necessary to compensate for the additional costs in production method. Hence, it is of high importance to minimise any of these production cost increases without compromising the product quality by using as few external inputs as possible and as many as necessary.

Discussions as to what types of organic pig and poultry production systems best represent the compromise between the different goals and principles of organic farming are likely to continue within the organic livestock sector. Due to the variation between farms and regions, there cannot be any general recommendations on how to deal with the limited availability of high quality protein feed stuffs in organic pig and poultry livestock production. There is variation in the availability of high quality feedstuffs, the digestibility and utilization of amino acids varies between the various feedstuffs, and there are differences in the capacity of protein accretion and feed intake between genotypes, and in the housing and feeding conditions on farms. The feeding strategies therefore need to be both farm and region specific. The variability of specific optimisation strategies of how to achieve 100% organic diets should correspond to the variability within organic livestock production.

This makes the farmer the most important regulator of the system who can change aspects of the system to achieve greater balance. In order to assess the requirement for supplementary feed within an organic farm system, it is necessary to monitor feed demand and the supply and quality of home-grown feedstuffs. Accuracy in the formulation of feed rations according to the individual requirements of livestock and precise allocation and monitoring of actual feed intake are essential tools in the management of organic pigs and poultry.

10 References

Auckland, J.N. and Morris, T.R. (1971): Compensatory growth in turkeys: effect of undernutrition on subsequent protein requirements. Brit. Poultry Sci. **12**, 41-48.

Bellof, E. and Schmidt, E. (2005): Broiler production with 100 % organic feed is possible. In Hess, J., Rahmann, G. (eds.). Proc. of the 8th Conference on Organic Farming, 2.-4.03.2005, University of Kassel, Germany, Kassel University Press GmbH, p. 321-324.

Bessei, W. (1993): Der Einfluss der Besatzdichte auf Leistung, Verhalten und Gesundheit von Broilern – Literaturübersicht. Arch. Geflügelk. **57**, 97-102.

Chamruspollert, M., Pesti, G.M., Bakalli, R.I. (2002): Determination of the methionine requirement of male and female broiler chickens using an indirect amino acid oxidation method. Poultry Sci. **81**, 1004-1013.

Chiba, L.I., Ivey, H.W., Cummins, K.A., Gamble, B.E. (1999): Growth performance and carcass traits of pigs subjected to marginal dietary restrictions during the grower phase. J. Anim. Sci. **77**, 1769-1776.

Fabian, J., Chiba, L.I., Kuhlers, D.L., Frobish, L.T., Nadarajah, K., Kerth, C.R., McElhenney, W.H., Lewis, A.J. (2002): Degree of amino acid restrictions during the grower phase and compensatory growth in pigs selected for lean growth efficiency. J. Anim. Sci. **80**, 2610-2618.

Marien and Sundrum, unpublished

NRC - National Research Council (1994): Nutrient requirements of poultry. Nutrient requirements of domestic animals. National academy press, Washington D.C. (USA).

NRC - National Research Council (1998): Nutrient requirements of swine. Nutrient requirements of domestic animals. National academy press, Washington D.C. (USA).

O'Brian, J; Aspray, C and Philips, L (2006) 7463: Research and development into the viability of a one hundred per cent organic ration for organic table birds within a silvo-poultry system. Paper presented at Joint Organic Congress, Odense, Denmark, May 30-31, 2006. http://orgprints.org/7463/

Padel, S. (2005). Overview of supply and demand for concentrated organic feed in the EU in 2002 and 2003 with a particular focus on protein sources for mono-gastric animals. D4.1 (2) EEC 2092/91 (Organic) Revision SSPE-CT-2004-502397. Institute of Rural Sciences, University of Wales, Aberystwyth.

Padel, S. and Sundrum, A. (2006). How can we achieve 100% organic diets for pigs and poultry. What will organic farming deliver? COR 2006. (C. Atkinson, et al. Eds) Aspects of Applied Biology 79, Association of Applied Biologists, Wellesborne,.

Schinkel, A.P., Smith, J.W., Tokach, M.D., Dritz, S.S., Einstein, M., Nelssen, J.L., Goodband, R.D. (2002): Two on-farm data collection method to determine dynamics of swine compositional growth and estimates of dietary lysine requirements. J. Anim. Sci. **80**, 1419-1432.

Sundrum, A., and Padel, S. (2006). Evaluation criteria for including feed materials in Annex II C and dietary supplements in Annex II D of the Regulation (EEC) 2092/91. D 4.2 EEC 2092/91 (Organic) Revision. SSPE-CT-2004-502397. University of Kassel.

Sundrum, A., Schneider, K., Richter, U. (2005). Possibilities and limitations of protein supply in organic poultry and pig production. D4.1 (1) EEC 2092/91 (Organic) RevisionSSPE-CT-2004-502397. University of Kassel.

Rose, S.P., Craig, L., Pritchard, S. (2004): A comparison of organic laying hen feed formulations. Brit. Poultry Sci. **45**, 63-64.

Van Barneveld, R.J. (1999): Understanding the nutritional chemestry of lupin (Lupinus spp.) seed to improve livestock production efficiency. Nutr. Res. Rev. **12**, 203-230.

Annex 1: Requirements of Regulation (EEC) 2092/91 on organic food in relation to feed

According to **Annex IB** of the European Council Regulation (EEC) 2092/91 organic farm animals must be:

- fed on organically produced feedstuffs (4.2),
- nourished primarily through home-grown feedstuffs (4.3), and
- feed stuffs from other organic farming systems, and
- feed ingredients that are processed by biological, mechanical, and physical means.

- Up to 31 December 2008, 50 % of the feed formula of rations on average may comprise in-conversion feedstuffs, if from the own holding: up to 80% in dry matter (4.4). From 1 January 2009 this will be reduced to 30% of the feed formula of rations on average may comprise in-conversion feedstuffs, if from the own holding: up to 60% in dry matter.
- Only if organic feed is not available in sufficient quantity and quality (4.8), a limited proportion of conventional feeding stuffs is authorised where farmers can show to the satisfaction of the inspection body or authority of the Member state that they are unable to obtain feed exclusively from organic production.
- The maximum percentage of conventional feed stuffs authorised per period of 12 months is:

  - for herbivores: 5 % during the period from 25 August 2005 to 31 December 2007;
  - for other species :

    - 15 % during the period from 25 August 2005 to 31 December 2007,
    - % during the period from 1 January 2008 to 31 December 2009,
    - 5 % during the period from 1 January 2010 to 31 December 2011.

- These figures shall be calculated annually as a percentage of the dry matter of feed stuffs from agricultural origin. The maximum percentage in the daily ration must is 25 % of the dry matter intake. '
- Roughage, fresh or dried fodder, or silage must be added to the daily ration for pigs and poultry (4.10)

Annex II C lists non-organic feed inputs that can be used within the specific percentages that are set out in Annex IB.

Annex II D further lists the products allowed for use as dietary supplements.

Annex II: Principles of organic production in Regulation (EC) 834/2007

The Council Regulation 2092/91 for organic production is currently under revision and a general approach has been agreed and has been adopted by the Council in June 2007[5]. The proposed new Article 4 will set out that organic farming shall be based on the following principles of organic farming:

(a) the appropriate design and management of biological processes based on ecological systems using system-internal natural resources by methods that:

(i) use living organisms and mechanical production methods;

(ii) practice land-related crop cultivation and livestock production or aquaculture which complies with the principle of sustainable exploitation of fisheries;

(iii) excludes the use of GMOs and products produced from or by GMOs with the exception of veterinary medicinal products;

(iv) are based on risk assessment, and use of precautionary and preventive measures, where appropriate;

(b) restricting the use of external inputs. Where they are required or the appropriate management practices and methods referred to in paragraph (a) do not exist, they are limited to:

(i) inputs from organic production ;

(ii) natural or naturally-derived substances;

(iii) low solubility mineral fertilizers;

(c) strictly limiting the use of chemically synthesized inputs to exceptional cases where:

(i) the appropriate management practices do not exist; and

(ii) where the external inputs referred to in paragraph (b) are not available on the market; or

(iii) the use of external inputs referred to in paragraph (b) contributes to unacceptable

environmental impacts;

[5] EC (2007) Council Regulation (EC) No 834/2007 Rev 1 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91.