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FEEDING ORGANIC PIGS

A HANDBOOK OF RAW MATERIALS AND RECOMMENDATIONS FOR FEEDING PRACTICE

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Introduction

In the feeding of pigs, the main objective is to produce piglets from breeding animals, and subsequently meat from those piglets, with the maximum efficiency and profitability. Since feed accounts for 70-80% of the cost of pigmeat production, the correct formulation and rationing of feed is critical to this process. In conventional production, there has been a great deal of research into the nutrient requirements of pigs and the feeding value of the commonly available raw materials, and diet formulation and feeding strategies have become extremely sophisticated.

In organic pig production, considerations other than simple economic efficiency of production come into play. Organic farming requires an integrated, whole-farm approach to food production which takes due account of sustainability, environmental and animal welfare considerations. Thus, whilst much of the knowledge gained from conventional pig production can be applied in the organic context, the feeding of organic pigs will differ from that of conventional pigs in a number of significant ways.

This handbook is designed to assist the organic pig producer in selecting appropriate diets and feeding strategies by summarising the relevant knowledge from conventional pig nutrition, discussing the ways in which organic systems may differ, presenting simple rules for diet formulation and providing information on the nutritional value and feeding characteristics of different raw materials for organic pig diets. This information will not be comprehensive, since good data specifically collected on organic pig nutrition are still very sparse, but should provide an adequate grounding for the feeding of pigs of all classes under organic conditions within the United Kingdom.

Organic Standards for feeding of pigs

For any farm to sell organic produce, it must (according to EC Regulation 2092/91) be registered with a recognised Certification Body and adhere to the standards specified by that body. Within the UK, a number of such Certification Bodies are accredited and approved by the UK government authority, the United Kingdom Register of Organic Food Standards (UKROFS). These Certification Bodies currently include:

Soil Association Certification Ltd.
Organic Farmers and Growers Ltd
Scottish Organic Producers Association
Bio-Dynamic Agricultural Association
Organic Food Federation
Irish Organic Farmers and Growers Association
Organic Trust Ltd
CMi Certification

Each Certification Body can formulate and inspect to it's own standards, and there are minor differences between the different bodies. It is therefore essential to check the detailed standards of the body with which the farm is certified before finalising the feeding strategies for pigs produced on that farm. However, in 1999, the European Union produced harmonised standards for organic livestock production, which provide the baseline to which all member states must conform (EC Regulation 1804/99 supplementing the basic Regulation 2092/91). It is these standards, subsequently adopted by UKROFS, which are outlined in the following section. It is important to be aware that whilst these standards must always be adhered to, more stringent rules with additional requirements regarding feedstuffs and feeding may be applied by individual certification bodies. In all cases, organic pigs can only be fed on food predominantly produced under certified organic conditions.

General livestock production standards affecting feeding strategy

- Feed is intended to ensure quality production rather than maximising production.
- Preference is to be given to indigenous breeds and strains of pig
- All pigs must have access to pasturage or an open-air exercise area or an open-air run which may be partially covered, and they must be able to use those areas whenever the physiological condition of the animal, the weather conditions and the state of the ground permit. The final fattening phase of pigs for meat production may take place indoors, provided that this indoors period does not exceed one-fifth of their lifetime and in any case for a maximum period of three months. Exercise areas must permit dunging and rooting by the pigs. For the purposes of rooting, different substrates can be used.
- All pigs must be fed on natural milk for a minimum period of 40 days.
- Roughage, fresh or dried fodder, or silage must be added to the daily ration for pigs.

Sources of feedstuffs

- Livestock must be reared preferably using feed from the unit or, when this is not possible, using feed from other units subject to the provisions of the EU Regulation.

- Up to 30% of the feed formula of rations on average may comprise 'in conversion' feedingstuffs. When the 'in conversion' feedingstuffs come from a unit of the own holding, this percentage can be increased to 60%.

- For a transitional period expiring on 24 August 2005, the use of a limited proportion of conventional feedingstuffs is authorised when the farmer is unable to obtain food exclusively of organic origin. The maximum percentage of conventional feedingstuffs authorised per year for pigs is 20%, calculated annually as a percentage of the dry matter of feedingstuffs from agricultural origin. The maximum percentage in the daily ration must be 25%, calculated as a percentage of the dry matter.

- By 24 August 2003, the list of permitted feedingstuffs will be reviewed with the aim of removing, in particular, conventional feed materials of agricultural origin produced organically in sufficient quantity in the community.

Limitations on raw materials

- Feedingstuffs, feed materials, compound feedingstuffs, feed additives, processing aids for feedingstuffs and certain products used in animal nutrition must not have been produced with the aid of genetically modified organisms or products derived therefrom.

- Conventional feed materials of plant origin can be used only if listed in the Regulation (Annex II C1), subject to the quantitative restrictions imposed in this Annex, and only if they are produced or prepared without the use of chemical solvents.

- Feed materials of animal origin, whether conventionally or organically produced, can only be used if listed in the Regulation (Annex II C2) and subject to the quantitative restrictions imposed in this Annex.

- Feed materials of mineral origin, trace elements and vitamins can only be used if listed in the Regulation (Annex II C3 and D).

- Additives such as enzymes, micro-organisms, binders, processing aids can only be used if listed in the Regulation (Annex II D). Antibiotics, coccidiostatics, medicinal substances, growth promoters or any substance intended to stimulate growth or production may not be used in animal feeding.

A full listing of the raw materials in Appendix II of the Regulation is given in Appendix A of this handbook.

Formulating pig diets

The essential components of a pig's daily nutrient requirements fall into the following categories:

Energy

This is needed for maintaining all the vital processes, exercise, thermoregulation (keeping warm), growth and reproduction and lactation. Within the UK, it is usually expressed as MegaJoules of Digestible Energy (MJ DE), although different measurement systems are used in other countries. Whilst this system works well in conventional production, it can give some problems in organic production where the use of forages and roughages is more common (and indeed a requirement of the standards). Forages contain a higher content of dietary fibre than conventional cereal or oilseed crops. Because the pig does not have enzymes to digest this fibre, but relies on the micro-organisms in its gut to break them down, the digestible energy in fibre is less well used by the pig than the DE in starch, sugar or fat. Allowance must be made for this when formulating rations with high fibre diets.

Protein

This is needed to repair and replace body tissues, grow lean tissue (meat), reproduce and lactate. Although the crude (total) protein level in a feedstuff can be relevant, what is really important for the pig are the component amino acids, which must be supplied in correct balance for the function for which they are needed. In most situations, the limiting amino acid in pig diets is lysine and, if the level of this is inadequate, excesses of other amino acids cannot be used and are wasted. Other amino acids which might be limiting with UK feedstuffs are Methionine+Cysteine (especially in high legume diets) and Threonine. Excess protein is excreted by the pig and can be an important source of nutrient (nitrogen) return to the soil, but also a potential source of pollution.

Minerals

These are needed for the growth of different tissues, especially bone, and also for reproduction and lactation. Some of them also play an important role in other physiological processes in the body. The most important are calcium, phosphorus and sodium.

Vitamins and trace elements

These are essential for a multitude of different processes in the functioning of the body. There are many different categories of these, and it is common for a specially prepared supplement, formulated by an expert nutritionist, to be added to the diet to meet all the requirements.

Organically grown feedstuffs may contain higher levels of some minerals and trace elements. However, variability is high and data are still relatively scarce. Pigs at pasture can also consume significant amounts of soil, which provides minerals and trace elements. However, because of variability in both the amount of soil ingested and its chemical composition, it is difficult at the present time to make any scientific allowance for this in the calculation of mineral requirements.

Calculating the daily nutrient needs of pigs

It is possible to calculate the daily needs of a pig for each of the above categories of nutrient if the appropriate information is available. This is done by adding together the needs for all the different functions performed by that nutrient.

Maintenance

The requirements for maintenance, the daily processes involved in keeping alive and moving around, depend on the weight of the pig, its level of activity and the environment in which it is kept. Because the pig must maintain a stable body temperature, in cold conditions it will burn up food to produce extra heat to keep warm. Since organic pigs are generally kept on pasture or with outdoor runs, they are more exposed to the variations in climate than conventional pigs. This means that, under UK weather conditions, they are likely to require extra energy in relation to standard recommendations. This extra feed requirement can be minimised by providing a suitably sized, draught proof, well-bedded shelter.

Growth (meat production)

The liveweight gain (growth) of a pig is made up primarily of lean tissue (containing protein and water), fat and bone. These are deposited in different proportions depending on the age of the pig, its genetic type and its growth rate. Traditional breeds (whose use is recommended in organic standards) such as Saddleback, Tamworth, Gloucester Old Spot, grow a higher proportion of fat to lean tissue than pigs of more improved modern genotypes such as Landrace, Large White, Duroc. This means that they require less protein in their diet, but need more energy for each kg of growth because growth of fat has a higher energy demand than lean. Pigs for meat production have a high nutrient requirement for growth. However, young breeding pigs also require an allowance for growth in their ration because they can continue to grow, albeit at a slowing rate, for up to three years until they reach their final adult size.

Reproduction

The precise requirements for reproduction will depend on the number of piglets and stage of pregnancy. The production of piglets has a relatively low nutrient demand until the last month of pregnancy, when most of the growth of the unborn piglets and development of the udder takes place. Boars require relatively little extra food for breeding, unless they are mating with a lot of sows in a short period and are therefore very active.

Lactation

This is a time of very high nutrient demand for the sow, who can produce more than 10kg of milk each day. The precise nutrient requirements will depend on the number of piglets being suckled and on the stage of lactation, with milk yield reaching a peak at about three weeks after farrowing.

General considerations in feeding different categories of pig

Dry sows and boars

The most important objective in feeding breeding animals is to maintain the ideal body condition (neither too thin nor too fat). Animals which are too thin will be more susceptible to cold and disease, will not breed regularly and will produce small and less viable offspring. Animals which are too fat will be more likely to become lame and to have problems with prolonged farrowing and stillborn piglets. Fat sows will also be clumsy mothers, more likely to crush their piglets, and have a poor appetite in lactation which can reduce milk production.
The ideal body condition for breeding animals is Condition Score (CS) 3 on a 0-5 scale assessed as outlined below. All sows should be between CS 3 and 3½ at the time of farrowing, and not less than CS 2 at weaning. They should be regularly assessed, every 2-4 weeks, and feed allowances adjusted accordingly.

Condition Score	Definition
1 (emaciated)	Bones clearly visible
2 (thin)	Bones can be felt without pressure when the palm of the hand is laid flat on the skin
3 (ideal)	Bones can be felt only with firm pressure when the palm of the hand is laid flat on the skin
4 (fat)	Bones can only be felt when fingertips are pressed into the skin
5 (obese)	No bones can be felt

The assessment is made by feeling the bones of the spinal vertebrae (along the backbone), over the ribcage, over the loin, and the pin bones at the base of the tail. The combination of these different regions gives an overall impression, but more importance should be placed on the results from the backbone and ribs. In animals of very lean breeds, and in young animals, it is important not to confuse fatness with muscularity. The body condition of these categories of animals is easily overestimated, and advice on the technique should be sought if you are unsure in the first instance.

The amount of feed needed to achieve and maintain the recommended condition will depend on the breed (and size) of animal, its age and need for growth, how cold the weather is and whether the pig must regain body condition after earlier losses. For cereal–based diets of typical energy and protein content, maintaining condition will require an allowance of 2-2½ kg of meal per day in summer and 3-3½ kg per day in winter. Because this is less than the appetite of the animals (who must usually be rationed to avoid obesity), and because animals are housed in groups, it is important to minimise bullying and unequal acquisition of food within the group. This is ideally achieved by providing individual feeding stalls, but otherwise by ensuring that the food is well spread out on the ground or in a long trough so that all animals, including timid ones, can feed at the same time. Timid animals who are losing body condition may need to be fed separately. Sows and boars can be given their complete allowance in a single feed each day. Unless the sow is already at CS 4 or above, food allowance should be increased in the last 3 weeks of pregnancy to 3-3½ kg/day to ensure that viable piglets of a good size are born.

Sows in lactation

The nutrient demands for milk production are very high and the appetite of the sow is often insufficient to allow these needs to be met. Milk yield gradually increases over the first two weeks after farrowing, reaches a peak at about 3 weeks and declines gradually thereafter. The amount of feed sows need will depend on the stage of lactation, the number of piglets they are suckling and the weather conditions. The quality of feed is normally higher than for dry sows, and feed allowance should be increased gradually from the day of farrowing. Too rapid an increase in feed in the first days can cause health problems and poor milk yield. For cereal-based diets (of typical energy and protein content), a typical feeding regime might be to feed 2-3 kg feed on the day of farrowing and increase the allowance by ½kg each day until appetite level is reached. Sows should be fed at least twice daily during lactation, and it can be beneficial to feed them *ad libitum* from a specially designed trough once lactation is established. Large losses in condition should be avoided at all costs because this can compromise the ability of the sow to conceive again after weaning and size of the next

litter. To promote a good feed intake, it is essential that a plentiful supply of clean water is available close to the farrowing hut. In summer, lactating sows can drink as much as 50 litres (10 gallons) of water each day.

Sows after weaning

After weaning, neither food nor water should be withheld – contrary to traditional opinion, this does not help in 'drying off' the sow. A high quality diet, such as used in lactation, should continue to be fed generously (not less than 3kg/day) until the sow has been rebred, as this can help increase the size of the next litter. After mating, the food allowance should be reduced to the typical pregnancy level, but not more than 3kg/day for the first three weeks of pregnancy unless the sow is in very poor condition. Giving too much food in the period immediately after mating can reduce the size of the next litter.

Suckling and newly weaned piglets

Under organic standards, piglets cannot be weaned at less than 6 weeks of age. For the first 2-3 weeks of life, the mother's milk will be adequate to supply all the needs of the piglets. However, after this time, the needs of the piglets continue to increase while the milk production of the sow gradually declines, and extra food is needed by the piglets. Whilst the piglets will often start to share the food of the sow, because they still have an immature digestion they will benefit by being given access to a better quality and highly palatable diet (often referred to as a creep feed). This can be supplied *ad libitum* in a special feed hopper, replenished each day to ensure the feed stays fresh, which cannot be accessed by the sow but to which the piglets have access through a barrier. Their intake of this creep feed will gradually increase according to their needs, so that they are fully adapted to eating solid food by the time of weaning. In the period immediately after weaning, while their digestion adapts to the fact that they no longer receive sow's milk, they should continue to receive this easily digested diet *ad libitum*. Once they have all made the weaning transition, and provided that they remain in good health, they can then be changed to a cheaper diet of less critical quality.

Young growing pigs

It is normal to allow young growing pigs to feed *ad libitum* from a specially designed feed hopper. This allows each pig to eat according to its own requirements, and minimises aggression arising from competition for food. With *ad libitum* feeding, enough trough space should be provided for 25% of the pigs to eat at the same time. If preferred, pigs can be fed once or twice daily to appetite, but in this case the trough must be long enough for all pigs, including timid ones, to eat happily at the same time. General recommendations are given in the following table:

Liveweight (kg)	Trough space (mm/pig) Restricted feeding	Trough space (mm/pig) *Ad libitum* feeding
10	140	35
30	200	50
50	235	59
70	265	66
90	285	71

Finishing (fattening) pigs

As the pigs get older and their appetite increases, the quality of the diet given can be further reduced. Older pigs require diets with a lower protein:energy ratio than younger pigs, because an increasing proportion of the food is used for maintenance and fat deposition, and a decreasing proportion for lean meat deposition. Beyond a certain age and weight, which differs for each genetic strain of pig, the intake of the animal becomes so high that, unless the feed is restricted, it will deposit too much fat and the quality of the carcass will be reduced. For modern, improved genotypes, which have been bred for greater capacity for lean growth and lower appetite, this stage is not reached until after the time when they are normally slaughtered (90 kg liveweight), and they can be fed *ad libitum* throughout their life. For less improved genotypes, feed may need to be restricted from as early as 50-60kg liveweight. This will reduce the growth rate but maintain carcass quality. Since these pigs will be hungry and compete for feed when it is given, provision of adequate feeding space is essential. The degree of restriction necessary will depend on the breed of pig. As a general rule, restriction of feed of typical energy and protein content by about 0.3 kg/day (10-12% of *ad libitum* intake) for a period of 5-6 weeks is required to reduce backfat thickness at slaughter by 1mm, and will be associated with a reduction in growth rate of about 100 g/day.

Replacement breeding stock

Young breeding stock should be selected as early as possible in the growing phase. They should be allowed to grow steadily (500-700 g/day depending on genetic type), which can be achieved by feeding them *ad libitum* up to 60-70kg liveweight and restricting them in amount or energy content of diet thereafter. Animals which grow poorly will be slower to breed and may have poor litter size, whilst animals which grow too fast will be more likely to have problems of lameness and leg weakness. The correct level of minerals, vitamins and trace elements in the diet is important for good bone strength and reproductive development. For one cycle (three weeks) before planned mating, gilts should be fed *ad libitum* or to appetite, since this increases ovulation rate and litter size. Once they have been mated, feed level should be reduced to about 2 kg/day of a cereal-based diet of typical energy and protein content, since overfeeding in the first month of pregnancy can reduce litter size. After this, they should be fed to achieve the correct condition score at farrowing, as for all other breeding animals.

The use of forage and voluntary feed intake of pigs

Organic standards require that pigs receive forage in their diet. This can be achieved by allowing animals to graze at pasture, by incorporating dried forage in their compound diet, by allowing them *ad libitum* or restricted daily access to products such as silage or root crops with supplementary concentrate, or by feeding a complete mixed diet of forage and concentrate in long troughs. In the latter case, significant problems with differential selection of diet components and high feed wastage can occur if the complete diet is fed close to appetite.

Pregnant sows, which need to have their concentrate feed restricted to prevent obesity, have a high intake capacity and can eat and utilise large amounts of low energy forages as substitutes for concentrate diet. However, in lactation, when metabolic demands on the sow are high, expecting her to obtain a significant part of her diet from low value forages will result in excessive condition loss, poor milk yield and subsequent breeding problems. In this stage, forages are better used as a supplement rather than replacement of concentrate diets. The same is true for young piglets, whose digestive tract is small and poorly developed. However, as pigs get older and their intake capacity increases, the amount of forage in the diet can be increased. When forage replaces concentrate in the diet, the daily nutrient intake of the pig is decreased and growth will be slower. Whilst this may be disadvantageous in the early stages of rearing, in the later stages it can help to improve carcass quality by preventing over-fatness.
When growing pigs are offered both concentrate and forage *ad libitum*, the intakes of forage are low, typically only 2-5% of daily dry matter intake. If concentrate intake is restricted by 20-25%, intakes of forage can be increased to 5-10% of dry matter, but growth rate will be reduced by 10-15% and a leaner carcass will be produced.

Diet specifications for pigs

The diet composition which is most appropriate for a pig will depend on the combination of its nutrient needs and feed intake. At each stage of its life, the ideal diet composition for most efficient use of feed will therefore be different. Since it is impractical to feed a different diet each week, a compromise is usually made between efficiency and convenience. Most units use 2-6 different diets depending on the scale of operation and feedstuff availability. The stages normally differentiated are:

Dry sows and boars
Lactating sows
Suckling and newly weaned piglets
Growing pigs
Finishing pigs

Replacement breeding stock would normally be fed a growing pig diet in the early stages (until 60-70 kg) followed by a dry sow diet with its higher levels of minerals, trace elements and vitamins. On some units, feeding is simplified by using the same diet for dry sows and finishing pigs, and for lactating sows and growing pigs. However, this will usually involve some loss in efficiency of feed use.

Compound diets and supplements formulated from organically produced raw materials can be purchased from specialist feed compounders, who source their raw materials from organic farms which have excess to their own requirements. It is often possible to arrange for such compounders to take crops grown on the farm and use as part of the diets which are finally purchased, with the difference made up from the compounder's raw material pool. Diets can also be home-mixed on the farm if equipment is available. In this case, raw materials which cannot be grown within the rotation on that farm and the necessary minerals, vitamins and trace elements will need to be purchased from a specialist supplier of organically grown feedstuffs.

The example nutrient specifications given below for each production stage apply to compound diets (~86% dry matter) designed to be fed as described in the preceding section to supply the complete daily needs of the animals. These specifications can be fine-tuned where more information is available on the genetic growth and intake characteristics of the animals. Where large amounts of separate forages are fed, the compound diets will need to be modified to complement the composition of these forages on a case-by-case basis.

More sophisticated diet formulation criteria take into account more precise descriptors of nutrient value than are given in the table, such as net energy, and availability of individual amino acids and minerals. Whilst such information is available for the commonly used conventional feedstuffs, it is still lacking for the wider range of raw materials likely to be used in organic diets with more use of forage.

Recommended minimum nutrient levels in compound diets (expressed on a meal equivalent basis of 86% DM)

	Dry sows and boars	Lactating sows	Suckling & newly weaned piglets	Growing pigs	Finishing pigs
Digestible energy (MJ/kg)	12.0-13.0	13.5-14.0	14.0	13.5	12.5-13.0
Crude protein (%)	13-14	17-18	20	18	16-17
Lysine (%)	0.5-0.6	0.9-1.0	1.2	1.1	0.8-1.0
Methionine +Cysteine (%)	0.3	0.5	0.7	0.65	0.4-0.6
Threonine (%)	0.4	0.6	0.8	0.75	0.5-0.7
Calcium (%)	0.8	0.9	0.8	0.8	0.7
Phosphorus (%)	0.6	0.7	0.6	0.6	0.5
Sodium (%)	0.15	0.15	0.15	0.15	0.15

Diet formulations for pigs

Specialist feed compounders use sophisticated least cost formulation computer programmes to determine the most cost-effective combination of available raw materials to provide the desired diet specification. The diets given in the following table are examples suitable for simple home mixing situations. At present, it is seldom possible to meet the protein needs of all the animals from crops grown on the farm, or even crops grown in the UK. Organically grown cereals tend to have a lower protein content than conventional cereals. Potential UK protein crops such as peas, beans, rapeseed and lupins all contain anti-nutritive substances which impair digestion and can cause digestive upset, especially in young pigs. These substances limit their inclusion level in the diet if good health and performance are to be maintained. The purchase of (non GMO) soya bean meal, either organically produced in other countries or within the permitted non-organic allowance, is the usual remedy for this situation. The difficulty in meeting protein requirements has been increased by the prohibition on use of synthetic amino acids. As a result, it is generally necessary to oversupply crude protein in order to meet the requirement for the first limiting amino acid, usually lysine. The oversupply of crude protein is often detrimental in young pigs, where it can cause digestive upset. Oversupply of crude protein will also result in inefficient use of energy to break down and excrete the excess of non-limiting amino acids, which then increase nitrogen loading on the occupied land. However, the alternative of feeding diets lower in total protein will restrict growth rate and result in production of fatter carcasses if this protein has a poor balance of amino acids.

Examples of simple home mixed diets for different stages of pigs (ingredient inclusion in kg/tonne)

	Dry sows and boars	Lactating sows	Suckling & newly weaned piglets	Growing pigs	Finishing pigs

Ingredients:					
Wheat		472	547	475	
Barley	556				456
Wheatfeed	250	200	100	100	250
Peas	150	150	100	150	150
Expeller soya meal (non GMO)[‡]				250	125
Full fat soya (non GMO) [‡]	20	150	150		
Fishmeal			90		
Calcium carbonate	15	11	10	11	14
Dicalcium phosphate	4	12		9	
Salt	3	3	1	3	3
Vitamin & trace element supplement[§]	2	2	2	2	2
Composition:					
Digestible energy (MJ/kg)	12.3	13.6	14.0	13.5	12.5
Crude protein (%)	13	17	20	20	16
Lysine (%)	0.6	0.9	1.2	1.1	0.9
Methionine +Cysteine (%)	0.4	0.5	0.7	0.6	0.5
Threonine (%)	0.4	0.6	0.7	0.7	0.6
Calcium (%)	0.8	0.9	0.8	0.8	0.7
Phosphorus (%)	0.6	0.7	0.6	0.6	0.5
Sodium (%)	0.15	0.15	0.15	0.15	0.15

[‡] Bought-in non-organic GM risk materials will require a GM declaration, and this should be made available to the Certification body.

[§] This supplement must be from an organically approved supplier and should be included at the manufacturers recommended rate.

Feedstuffs compendium

This compendium contains information of the different raw materials likely to be of interest in the feeding of organic pigs under UK conditions. This includes information on typical nutrient composition, likely intake of pigs of different classes, restrictions on use and general comments from practical experience where no scientific information is available.

Remember that whilst any feedstuffs which are produced under organic conditions can be included in the diet, feedstuffs produced in conventional agriculture can only be used as part of the non-organic allowance if listed in the Regulations (see Appendix). If in doubt, check with your Sector Body. The organic component of any purchased feedstuffs must be certified as organic and records must be kept on farm.

It is important to bear in mind that individual raw materials can differ widely from batch to batch in nutrient composition as a result of season, growing conditions, variety, crop husbandry and, in the case of by-products, the processing procedures which they have undergone. In particular, the dry matter content of silages and by-products can be highly variable. **The information which follows should therefore be used only as a general guideline and chemical analysis of any raw material, particularly if used at a high inclusion rate, is strongly recommended.**

General Comments

The best all round cereal for pig feeding. It is suitable for any stage of growth, although it has a lower energy value than wheat which makes it less attractive in stages where more energy dense diets are desirable. To improve digestibility, it should be ground before feeding. For small-scale enterprises, if grinding facilities are not available, soaking in water for at least 24h is an alternative. High moisture barley (>15% water content) which has been preserved by addition of propionic acid can be used, but this process destroys some vitamins and special attention to the supplementation of such diets with Vitamin E is needed. New crop barley should be introduced gradually by mixing with old crop barley for a period, as digestive upsets can otherwise occur.

Organic barley will usually be of lower protein content than conventionally grown barley. This difference is typically 1-2% but may be more, depending on the crop rotation, location and crop husbandry factors.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	13.0
Crude fibre (%)	4.4
Crude protein (%)	9.0
Lysine (%)	0.32
Methionine +Cysteine (%)	0.33
Threonine (%)	0.31
Calcium (%)	0.08
Phosphorus (%)	0.34
Sodium (%)	0.02

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	No limit
Lactating sows	No limit
Suckling and newly weaned piglets	No limit
Growing pigs	No limit
Finishing pigs	No limit

General Comments

One of the most commonly grown organic cereals in the UK. It is higher in energy than barley and therefore useful in diets for young pigs and lactating sows. However, if used in diets for finishing pigs of less improved genotype, carcass grading can suffer. To improve digestibility, it should be ground before feeding. However, avoid very fine grinding (<3mm screen) which can give problems with gastric ulceration. The gluten in wheat can form a sticky dough when chewed, and this can reduce palatability in some instances. High moisture wheat preserved by addition of propionic acid can be used, but this process destroys some vitamins and special attention to the supplementation of such diets with Vitamin E is needed. When included at high levels (>40%) some varieties of wheat can cause digestive upset and diarrhoea under some farm circumstances. If this occurs, a 50:50 mix of wheat and barley is recommended as the cereal base.

Organic wheat will usually be of lower protein content than conventionally grown wheat. This difference is typically 1-2% but may be more, depending on the crop rotation, location and crop husbandry factors.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	14.0
Crude fibre (%)	2.6
Crude protein (%)	10.0
Lysine (%)	0.30
Methionine +Cysteine (%)	0.35
Threonine (%)	0.30
Calcium (%)	0.05
Phosphorus (%)	0.30
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	50
Lactating sows	50
Suckling and newly weaned piglets	50
Growing pigs	50
Finishing pigs	30

General Comments

Oats have a poorer energy value than wheat and barley, but contains more unsaturated oil and digestible fibre. This makes its use at low inclusion rates (5-10%) beneficial for gut health. To improve digestibility, it should be ground or flaked before feeding. When included at high levels in finishing pig diets, the high unsaturated oil content can cause soft carcass fat.

Organic cereals will usually be of lower protein content than conventionally grown cereals. This difference is typically 1-2% but may be more, depending on the crop rotation, location and crop husbandry factors.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	11.5
Crude fibre (%)	9.0
Crude protein (%)	9.0
Lysine (%)	0.36
Methionine +Cysteine (%)	0.36
Threonine (%)	0.32
Calcium (%)	0.10
Phosphorus (%)	0.30
Sodium (%)	0.04

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	No limit
Lactating sows	20
Suckling and newly weaned piglets	10
Growing pigs	20
Finishing pigs	30

General Comments

A less common feed for livestock, grown usually for the human market. It is relatively unpalatable compared to other cereals. To improve digestibility, it should be ground before feeding. Ensure seeds are free from ergot, a fungus to which it is very susceptible and which causes serious health problems in pigs.

Organic cereals will usually be of lower protein content than conventionally grown cereals. This difference is typically 1-2% but may be more, depending on the crop rotation, location and crop husbandry factors.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	13.5
Crude fibre (%)	1.8
Crude protein (%)	10.0
Lysine (%)	0.33
Methionine +Cysteine (%)	0.31
Threonine (%)	0.28
Calcium (%)	0.04
Phosphorus (%)	0.45
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	50
Lactating sows	20
Suckling and newly weaned piglets	0
Growing pigs	20
Finishing pigs	30

General Comments

A hybrid of wheat and rye which grows well on poor soils. It has similar characteristics to wheat, but is usually slightly higher in essential amino acids. To improve digestibility, it should be ground before feeding. Ensure seeds are free from ergot, to which triticale is more susceptible than other cereals.

Organic cereals will usually be of lower protein content than conventionally grown cereals. This difference is typically 1-2% but may be more, depending on the crop rotation, location and crop husbandry factors.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	13.8
Crude fibre (%)	2.1
Crude protein (%)	10.0
Lysine (%)	0.33
Methionine +Cysteine (%)	0.43
Threonine (%)	0.33
Calcium (%)	0.04
Phosphorus (%)	0.40
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	50
Lactating sows	40
Suckling and newly weaned piglets	30
Growing pigs	50
Finishing pigs	30

General Comments

This has the highest energy content of any of the cereals but is a relatively expensive import and not widely used in the UK. It will need to be checked for non-GMO status. To improve digestibility, it should be ground or flaked before feeding. It is palatable and a good energy feed for young piglets, but contains low levels of protein and minerals. If used at high inclusion levels in finishing pig diets, its high energy content can cause overfat carcasses and poor grading. If contaminated by fungi during growth or in storage, it can contain mycotoxins which cause serious problems for pig health.

Typical Nutrient Composition

Dry matter (%)	88
Digestible energy (MJ/kg)	14.5
Crude fibre (%)	2.2
Crude protein (%)	8.5
Lysine (%)	0.30
Methionine +Cysteine (%)	0.40
Threonine (%)	0.33
Calcium (%)	0.08
Phosphorus (%)	0.25
Sodium (%)	0.08

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	No limit
Lactating sows	No limit
Suckling and newly weaned piglets	No limit
Growing pigs	30
Finishing pigs	20

General Comments

Full fat soya is the complete soya grain after dehulling, containing the original content of oil. It is therefore an excellent source of both energy and protein. Because the UK climate is generally unsuitable for growing soya, it is usually imported and checks for non-GMO status will be necessary. The raw bean contains anti-nutritive factors which impair protein digestion and can cause gut irritation in young piglets. These factors are inactivated by heat treatment (steaming, toasting or extruding). However, if overheated during this process, protein quality will be damaged. Because of its high content of unsaturated oil, a high inclusion level in the diet for finishing pigs can give problems of carcass grading and of soft fat.

Typical Nutrient Composition

Dry matter (%)	88
Digestible energy (MJ/kg)	17.0
Crude fibre (%)	5.3
Crude protein (%)	35.0
Lysine (%)	2.5
Methionine +Cysteine (%)	1.0
Threonine (%)	1.4
Calcium (%)	0.26
Phosphorus (%)	0.50
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	10
Lactating sows	20
Suckling and newly weaned piglets	20
Growing pigs	20
Finishing pigs	5

General Comments

A by-product from the oil extraction industry, comprising the protein and fibre component of the grain after dehulling. Only meal produced by physical expeller processes is permitted, and any meal produced by solvent extraction (the most common process) is prohibited in organic rations. The meal is an excellent source of protein, but it is usually imported and checks for non-GMO status will be necessary. The raw bean contains anti-nutritive factors which impair protein digestion and can cause gut irritation in young piglets. These factors are inactivated by heat treatment (steaming, toasting or extruding). However, if overheated during this process, protein quality will be damaged.

Typical Nutrient Composition

Dry matter (%)	88
Digestible energy (MJ/kg)	15.0
Crude fibre (%)	6.5
Crude protein (%)	42.0
Lysine (%)	3.0
Methionine +Cysteine (%)	1.3
Threonine (%)	1.7
Calcium (%)	0.26
Phosphorus (%)	0.55
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	25
Lactating sows	25
Suckling and newly weaned piglets	10
Growing pigs	25
Finishing pigs	25

General Comments

The complete oilseed rape grain, containing the original content of oil. It is therefore an excellent source of both energy and protein. It should be ground together with the cereal to fracture the seed coat and soak up the oil which is released. The seed has poor palatability because of its mustard taste, and contains anti-nutritive factors which can cause metabolic and health problems in pigs. These factors limit its inclusion rate in all pig diets. Because of its high content of unsaturated oil, a high inclusion level in the diet for finishing pigs can give problems of carcass grading and of soft fat. If purchased rapeseed is used, checks for non-GMO status will be necessary.

Typical Nutrient Composition

Dry matter (%)	90
Digestible energy (MJ/kg)	17.0
Crude fibre (%)	6.5
Crude protein (%)	19.0
Lysine (%)	1.3
Methionine +Cysteine (%)	0.6
Threonine (%)	0.8
Calcium (%)	0.36
Phosphorus (%)	0.76
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	5
Lactating sows	10
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	5

General Comments

The by-product from the oil extraction industry, comprising the protein and fibre component of the seed. Only meal produced by physical expeller processes is permitted, and any meal produced by solvent extraction (the most common process) is prohibited in organic rations. If purchased rapeseed meal is used, checks for non-GMO status will be necessary. The meal is a good source of protein and phosphorus, but the seed has poor palatability because of its mustard taste, and contains anti-nutritive factors which can cause metabolic and health problems in pigs. These factors limit its inclusion rate in all pig diets.

Typical Nutrient Composition

Dry matter (%)	88
Digestible energy (MJ/kg)	10.6
Crude fibre (%)	10.0
Crude protein (%)	34.0
Lysine (%)	1.8
Methionine +Cysteine (%)	1.0
Threonine (%)	1.4
Calcium (%)	0.70
Phosphorus (%)	1.0
Sodium (%)	0.06

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	10
Lactating sows	5
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	15

General Comments

These provide a good source of protein but, like other legumes, are low in the sulphur containing amino acids (methionine and cysteine). Spring beans are higher in protein than winter varieties. They contain a number of anti-nutritive factors which impair protein digestion and can cause gut irritation in young piglets. Some of these factors can be inactivated by heat treatment. They should be ground before feeding to improve digestibility, but if the released oil is then allowed to go rancid they will become more unpalatable. Their higher content of anti-nutritive factors means that peas are generally a better home-grown source of protein for pigs than beans.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	13.4
Crude fibre (%)	7.7
Crude protein (%)	25.0
Lysine (%)	1.7
Methionine +Cysteine (%)	0.5
Threonine (%)	0.9
Calcium (%)	0.12
Phosphorus (%)	0.70
Sodium (%)	0.02

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	20
Lactating sows	10
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	20

General Comments

These are the best source of home-grown protein but, like other legumes, are low in the sulphur containing amino acids (methionine and cysteine). They contain a number of anti-nutritive factors which impair protein digestion and can cause gut irritation in young piglets. Some of these factors can be inactivated by heat treatment. The nutrient composition and the extent of anti-nutritive factors can vary between varieties. They should be ground before feeding to improve digestibility.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	13.5
Crude fibre (%)	6.0
Crude protein (%)	22.5
Lysine (%)	1.5
Methionine +Cysteine (%)	0.5
Threonine (%)	0.8
Calcium (%)	0.08
Phosphorus (%)	0.55
Sodium (%)	0.04

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	20
Lactating sows	15
Suckling and newly weaned piglets	10
Growing pigs	15
Finishing pigs	20

General Comments

Lupins are a possible source of home-grown protein in the UK. Until recently, they have been relatively little exploited because of lack of suitable varieties, but this situation is changing. Bitter varieties contain toxic alkaloids, but newer 'sweet' varieties have much lower levels of these antinutritive factors. Their high fibre level makes them unsuitable for young pigs and they should be processed before feeding to remove the fibrous seed coat. The energy content depends on the oil level in the variety used, and is generally higher in the broad leaf 'white' lupin (L.albus) than in the narrow leaf lupin (L.angustifolius). Like other legumes, they tend to be low in the sulphur containing amino acids (methionine and cysteine). They should be ground before feeding to improve digestibility, but should be used as soon as possible after grinding because the oil can go rancid.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	14.4
Crude fibre (%)	13.1
Crude protein (%)	29.0
Lysine (%)	1.36
Methionine +Cysteine (%)	0.60
Threonine (%)	1.01
Calcium (%)	0.20
Phosphorus (%)	0.28
Sodium (%)	0.03

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	20
Lactating sows	15
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	20

General Comments

This is one of the highest quality protein sources for pigs. For use in organic production, it must be derived from sustainable fish stocks and may be used only in the diet of young piglets. The meal can be produced from the whole fish or from trimmings which are a by-product from human food production. The composition will vary according to the type of fish and the processing. If the meal has been overheated during the drying process, protein quality will be impaired. Fishmeal is a rich source of essential amino acids, vitamins and minerals, but can be unpalatable at high levels in the diet.

Typical Nutrient Composition

Dry matter (%)	90
Digestible energy (MJ/kg)	15.0
Crude fibre (%)	0
Crude protein (%)	65.5
Lysine (%)	4.3
Methionine +Cysteine (%)	2.4
Threonine (%)	2.3
Calcium (%)	2.7
Phosphorus (%)	2.5
Sodium (%)	1.0

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	0
Lactating sows	0
Suckling and newly weaned piglets	10
Growing pigs	0
Finishing pigs	0

WHEAT FEED
(also called wheatings and middlings)

General Comments

A by-product from the manufacture of flour, it contains the husks and particles of grain. It can be quite variable in quality, depending on the processing mill. It is very palatable and beneficial in all pig diets. It is a particularly useful source of phosphorus.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	10.5
Crude fibre (%)	7.7
Crude protein (%)	15.0
Lysine (%)	0.60
Methionine +Cysteine (%)	0.50
Threonine (%)	0.50
Calcium (%)	0.13
Phosphorus (%)	1.0
Sodium (%)	0.04

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	No limit
Lactating sows	20
Suckling and newly weaned piglets	10
Growing pigs	20
Finishing pigs	No limit

General Comments

A by-product from the manufacture of flour, containing mainly the grain husks. It therefore has a high fibre and low energy value, but is a useful source of phosphorus. It can also be a useful remedy for constipation in farrowing sows.

Typical Nutrient Composition

Dry matter (%)	86
Digestible energy (MJ/kg)	9.0
Crude fibre (%)	10.5
Crude protein (%)	15.0
Lysine (%)	0.55
Methionine +Cysteine (%)	0.45
Threonine (%)	0.50
Calcium (%)	0.12
Phosphorus (%)	1.2
Sodium (%)	0.04

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	50
Lactating sows	10
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	20

MAIZE GLUTEN FEED
(also called corn gluten feed)

General Comments

A by-product of the manufacture of maize starch, composed of the bran and gluten components of the seed. It is mainly imported and checks for non-GMO status will be necessary. Composition can vary depending on the source. Despite a reasonable content of energy and protein, the quality of the protein is relatively poor for pigs. If black rather than golden in colour, it has been overheated during drying and should be avoided as the protein will be badly damaged and indigestible. If contaminated with fungi during growth or storage, it can also contain mycotoxins which cause serious health problems in pigs. A high inclusion level in the diet for finishing pigs can give problems of soft and yellow fat.

Typical Nutrient Composition

Dry matter (%)	88
Digestible energy (MJ/kg)	11.5
Crude fibre (%)	7.0
Crude protein (%)	19.0
Lysine (%)	0.60
Methionine +Cysteine (%)	0.80
Threonine (%)	0.75
Calcium (%)	0.30
Phosphorus (%)	0.88
Sodium (%)	0.20

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	20
Lactating sows	10
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	10

DRIED SUGAR BEET PULP
(for wet pulp see later in section)

General Comments

A by-product of the sugar industry, comprising the fibre component of the sugar beet root which may be dried alone (unmolassed sugar beet pulp) or have some of the sugars added back in the form of molasses (molassed sugar beet pulp). The fibre is highly digestible and at low inclusion levels can promote good gut health. However, it readily absorbs water and swells, reducing voluntary food intake at high levels. This can be a problem in young piglets, but can reduce hunger in restrict-fed dry sows and assist in the improvement of carcass grading in finishing pigs. At high levels, it also has a marked laxative effect.

Typical Nutrient Composition

	Molassed	Unmolassed
Dry matter (%)	90	86
Digestible energy (MJ/kg)	11.8	11.8
Crude fibre (%)	13.5	17.0
Crude protein (%)	9.9	9.0
Lysine (%)	0.45	0.36
Methionine +Cysteine (%)	0.18	0.20
Threonine (%)	0.29	0.27
Calcium (%)	0.85	0.72
Phosphorus (%)	0.14	0.09
Sodium (%)	0.45	0.36

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)	
	Molassed	Unmolassed
Dry sows and boars	20	20
Lactating sows	10	10
Suckling and newly weaned piglets	5	5
Growing pigs	10	10
Finishing pigs	20	20

General Comments

A by-product from the sugar refining industry, comprising predominantly non-sucrose sugars and non-protein nitrogen. It can either be added back to the pulp, or sold separately as a thick liquid product. It is highly palatable and can be added to meal diets to reduce dustiness. Due to its high content of potassium, salt and sugars, it is also highly laxative. It can be stored in a tank and removed by gravity, but becomes very thick and viscous in cold weather and flows only slowly.

Typical Nutrient Composition

Dry matter (%)	75
Digestible energy (MJ/kg)	10.0
Crude fibre (%)	0
Crude protein (%)	5.0
Lysine (%)	0.05
Methionine +Cysteine (%)	0.01
Threonine (%)	0.02
Calcium (%)	0.50
Phosphorus (%)	0.07
Sodium (%)	0.50

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	5
Lactating sows	5
Suckling and newly weaned piglets	3
Growing pigs	5
Finishing pigs	5

General Comments

A by-product of the sugar industry, comprising the fibre component of the sugar beet root. The fibre is highly digestible and at low inclusion levels can promote good gut health. The wet pulp is normally pressed to remove some of the water, but not dried. Because of its high bulk and high fibre content, it is not a good feed for young piglets, but can be a valuable product for pregnant sows and finishing pigs of poorer genotype, where its appetite restricting properties can aid satiation and help reduce grading problems. It can be fed alone or as a complete diet mix with compound feed. It can be fed fresh (within 2-3 days) or can be ensiled. When exposed to air, it can mould very quickly and good feeding hygiene is essential. It is important to ensure that the balancer feed contains adequate phosphorus.

Typical Nutrient Composition

Dry matter (%)	20.0
Digestible energy (MJ/kg)	3.0
Crude fibre (%)	4.0
Crude protein (%)	1.9
Lysine (%)	0.08
Methionine +Cysteine (%)	0.04
Threonine (%)	0.06
Calcium (%)	0.20
Phosphorus (%)	0.04
Sodium (%)	0.10

Voluntary intake and limits on inclusion

Dry sows have been reported to eat up to 5kg of pressed pulp per day and 2kg of ensiled pulp. However, great variation between different farms and different individual sows is reported. Old sows eat more than younger ones, and intakes will increase over time as the sows become accustomed to the feedstuff.. The pulp can be fed to finishing pigs at up to 20% of the diet DM equivalent per day (up to 2.5 kg pulp/day in the final stages). This is likely to reduce both growth rate and fatness, and inclusion rates should be modified according to genotype and grading profile.

General Comments

A by-product of the brewing industry, composed of the residues of malted cereals (mainly fibre and protein). It is usually sold as a moist product, but can be dried. The composition will depend on the cereal used, usually barley, and the source. Dry matter can vary considerably and should be checked. Moist product can be fed fresh or ensiled, but beware of moulding and production of toxins if poorly stored.

Typical Nutrient Composition

Dry matter (%)	23
Digestible energy (MJ/kg)	2.2
Crude fibre (%)	3.0
Crude protein (%)	5.5
Lysine (%)	0.19
Methionine +Cysteine (%)	0.20
Threonine (%)	0.18
Calcium (%)	0.09
Phosphorus (%)	0.11
Sodium (%)	0.01

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	20
Lactating sows	0
Suckling and newly weaned piglets	0
Growing pigs	10
Finishing pigs	20

General Comments

Whole milk may be available as a by-product from the dairy on occasions. It is an excellent and highly digestible feed for pigs of all ages, but careful attention to feed hygiene is necessary when it is used. Because of its high fat content, it can give rise to carcass grading problems if fed at high levels to finishing pigs.

Typical Nutrient Composition

Dry matter (%)	13.0
Digestible energy (MJ/kg)	3.0
Crude fibre (%)	0
Crude protein (%)	3.4
Lysine (%)	0.27
Methionine +Cysteine (%)	0.10
Threonine (%)	0.10
Calcium (%)	0.89
Phosphorus (%)	0.67
Sodium (%)	0.40

Voluntary intake and limits on inclusion

The only limitation on the amount which can be given will relate to grading in finishing pigs. 4.5 kg whole milk can replace 1 kg compound feed.

General Comments

A by-product from the cream or butter making process, comprising the milk following removal of a large part of the cream. It is therefore lower in fat and energy than whole milk. Buttermilk contains slightly more fat and less protein than skim milk. It is an excellent and highly digestible feed for pigs of all ages, but careful attention to feed hygiene is necessary when it is used. Stainless steel or plastic storage containers should be used as corrosive activity can result in zinc toxicity if galvanised tanks are used. The milk should be fed consistently either fresh (within 2 days) or sour to avoid digestive upsets. The milk can be fed as a liquid, with a suitable balancer meal trough fed separately. The balancer meal requires less protein than the normal compound diet, but must include adequate minerals, vitamins and trace elements. If too much milk is fed to finishing pigs, grading problems can result.

Typical Nutrient Composition

Dry matter (%)	9.0
Digestible energy (MJ/kg)	1.5
Crude fibre (%)	0
Crude protein (%)	3.4
Lysine (%)	0.23
Methionine +Cysteine (%)	0.11
Threonine (%)	0.14
Calcium (%)	0.11
Phosphorus (%)	0.09
Sodium (%)	0.05

Voluntary intake and limits on inclusion

For weaned pigs, start with up to 1.5 litres/head/day, increasing gradually to a maximum of 4.5 litres. Whilst best used for young pigs because of its high quality, skim milk can be fed to older pigs at up to 5 litres/head/day or to sows. The balancer meal can be fed *ad libitum* to weaned and growing pigs, unless poor genetics gives grading risk when some restriction after 60-70kg liveweight may be necessary. For sows, 3 litres of skim milk can replace 0.4 kg of compound feed.

General Comments

Liquid whey is a by-product from cheese making, comprising the milk following removal of the fat and casein protein. It is an excellent and highly digestible feed for pigs of all ages, but careful attention to feed hygiene is necessary when it is used. The whey should be fed consistently either fresh (within 2 days) or sour to avoid digestive upsets. The whey can be fed as a liquid, with a suitable balancer meal trough fed separately. The balancer meal must include adequate protein, minerals, vitamins and trace elements. Because of the high salt content of whey, it is essential to ensure that a plentiful supply of additional fresh water is available. Liquid whey can be quite corrosive to metal, and storage tanks, pipework and troughs therefore need special attention. They should be of stainless steel or plastic, and galvanised tanks and fittings should be avoided because of risk of zinc toxicity.

Typical Nutrient Composition

Dry matter (%)	6.0
Digestible energy (MJ/kg)	1.0
Crude fibre (%)	0
Crude protein (%)	0.9
Lysine (%)	0.06
Methionine +Cysteine (%)	0.03
Threonine (%)	0.04
Calcium (%)	0.06
Phosphorus (%)	0.05
Sodium (%)	0.06

Voluntary intake and limits on inclusion

When offered *ad libitum*, dry sows will drink up to 60 litres per day. 15 litres of whey can replace 1kg of compound feed. Weaned pigs can be introduced gradually to 2-3 kg liquid whey/head/day. The allowance can be increased gradually up to 10 litres/day for finishing pigs and sows. This will replace about 0.8kg compound feed.

General Comments

Surplus potatoes or those graded unsuitable for the human market can be utilised as pig feed. The fleshy tuber provides an excellent source of energy, protein, essential vitamins and minerals. The precise nutritional value will depend on many factors including variety, season, tuber size and yield level. The starch in the raw potato is resistant to the digestive enzymes of the pig, and much of it is fermented by the gut microflora, resulting in reduced energy availability. Cooking the potato improves its energy value by 40%, but is not always economic because of the fuel costs involved. The cooking process has a second major benefit, because it inactivates the anti-nutritive factors contained in raw potato which impair protein digestion. Ensiling the potatoes with addition of 1% molasses can also reduce activity of these antinutritive factors, but involves loss of about 5% of the energy content. Cooking improves the palatability of potatoes, which can be low for the raw and ensiled product in young pigs. Green potato tubers and sprouts contain the toxin 'solanine' which causes digestive upset and should not be fed to pigs.

Typical Nutrient Composition

Dry matter (%)	20.0
Digestible energy (MJ/kg)	2.2
Crude fibre (%)	0.5
Crude protein (%)	2.2
Lysine (%)	0.12
Methionine +Cysteine (%)	0.06
Threonine (%)	0.07
Calcium (%)	0.20
Phosphorus (%)	0.50
Sodium (%)	0.02

Voluntary intake and limits on inclusion

Approximately 6kg of raw or 6.5kg ensiled potato are needed to replace 1kg barley, with additional protein supplementation required. Dry sows can easily meet their daily energy requirements from raw potato fed *ad libitum* with a small amount of protein supplement. To avoid overfatness, it will generally be necessary to restrict potatoes to 6-8 kg/ sow/day fed with 1kg concentrate supplement providing the necessary additional protein, vitamins and minerals. For finishing pigs, about 25% of the diet DM can be provided from raw potato, but performance is likely to be reduced relative to cereal diets. Including raw potato in the diet will reduce the killing out percentage because of greater gut weight. Feeding the potato and the concentrate separately at different daily meals may reduce the adverse effects of the raw potato on the protein digestion of the supplement. For weaned pigs, potato will not be a useful significant feedstuff unless cooked because of its relatively low palatability and high bulk. When used, 1kg of cooked potato can totally replace 0.25kg barley.

General Comments

Fodder beet has one of the highest yields of nutrients per hectare of all forage crops. The root is rich in sugars and energy, and should be introduced gradually to avoid digestive upset. It should be minced or chopped for feeding to growing pigs, but can be fed whole to sows or even strip grazed. The tops can also be fed but contain oxalic acid and should be used with caution and wilted first. Fodder beet can be stored over winter in clamps, provided they are protected adequately from frost, but start to regrow and lose nutritive value when weather becomes warmer. As an alternative, they can be minced and ensiled with addition of 3 litres of formic acid /tonne fresh beet to aid preservation. However, this treatment is only permitted under adverse conditions and with approval from the Sector Body.

Typical Nutrient Composition

Dry matter (%)	18.0
Digestible energy (MJ/kg)	2.4
Crude fibre (%)	1.0
Crude protein (%)	1.0
Lysine (%)	0.05
Methionine +Cysteine (%)	0.04
Threonine (%)	0.03
Calcium (%)	0.05
Phosphorus (%)	0.04
Sodium (%)	0.10

Voluntary intake and limits on inclusion

Dry sows have been reported to eat up to 30kg day of fodder beet, which is well in excess of their requirements. Information on intakes of growing and finishing pigs is less available, but it has been reported that they can eat up to 50% of their diet DM in the form of fodder beet. However, when concentrate is offered *ad libitum*, fodder beet intakes of only 100g day have been recorded in trials with growing pigs. Approximately 6kg fresh fodder beet are required to replace 1kg barley. The intake and utilisation of ensiled beet is similar to that of fresh roots.

General Comments

Surplus carrots and those graded unsuitable for human food can be utilised by pigs. They have a good energy value but are relatively lower in protein than cereals. They contain a yellow pigment which can colour carcass fat in finishing pigs.

Typical Nutrient Composition

Dry matter (%)	15.0
Digestible energy (MJ/kg)	1.4
Crude fibre (%)	1.0
Crude protein (%)	0.8
Lysine (%)	0.03
Methionine +Cysteine (%)	0.02
Threonine (%)	0.02
Calcium (%)	0.04
Phosphorus (%)	0.02
Sodium (%)	0.01

Voluntary intake and limits on inclusion

No detailed information is available, but intakes similar or slightly lower than those of other root crops might be expected.

General Comments

These can be obtained as surplus from crops for human consumption or grown specially as a forage crop. The roots contain sugars and soluble fibres yielding energy, and they are only slightly lower in protein than cereals on a DM basis. Their high pectin content can impair nutrient utilisation and they should be introduced gradually to avoid digestive upset. Swedes should be minced or chopped for feeding to growing pigs, but can be fed whole to sows or even strip grazed.

Typical Nutrient Composition

Dry matter (%)	12.0
Digestible energy (MJ/kg)	1.4
Crude fibre (%)	1.0
Crude protein (%)	1.2
Lysine (%)	0.03
Methionine +Cysteine (%)	0.02
Threonine (%)	0.02
Calcium (%)	0.04
Phosphorus (%)	0.03
Sodium (%)	0.02

Voluntary intake and limits on inclusion

Precise data are lacking. Dry sows might be expected to eat in excess of their requirements if fed *ad libitum*. Growing pigs can eat up to 40% of their DM intake in the form of swedes, although performance and killing out percentage will be significantly reduced at this level and a maximum of 20% is recommended. About 10 kg of swedes are needed to replace 1kg of barley.

General Comments

These may be available for pig feeding as a by-product of crops grown for human food. They have a slightly better energy level than carrots. There is no detailed information available on their use for pigs.

Typical Nutrient Composition

Dry matter (%)	15.0
Digestible energy (MJ/kg)	1.0
Crude fibre (%)	0.5
Crude protein (%)	1.3
Lysine (%)	0.03
Methionine +Cysteine (%)	0.02
Threonine (%)	0.02
Calcium (%)	0.01
Phosphorus (%)	0.04
Sodium (%)	0.01

Voluntary intake and limits on inclusion

No information on feeding to pigs is available. It is anticipated that 6kg parsnips could replace 1kg cereals for dry sows or finishing pigs, with some additional protein supplementation needed in the case of finishing pigs.

General Comments

Turnips can be grown as a catch crop in summer or autumn. They have a root providing energy from sugar and fermentable fibre, and should be introduced gradually to avoid digestive upset. They should be minced or chopped for feeding to growing pigs, but can be fed whole to sows or even strip grazed.

Typical Nutrient Composition

Dry matter (%)	11.0
Digestible energy (MJ/kg)	1.2
Crude fibre (%)	1.0
Crude protein (%)	1.3
Lysine (%)	0.03
Methionine +Cysteine (%)	0.02
Threonine (%)	0.02
Calcium (%)	0.06
Phosphorus (%)	0.03
Sodium (%)	0.05

Voluntary intake and limits on inclusion

No specific information is available, but intakes comparable to those of swedes might be predicted.

General Comments

Sugar beet give a high dry matter yield per hectare, and are high in energy because of their content of soluble sugars. The exact composition will vary with variety, agronomy and climate. They are very palatable to pigs and should be introduced gradually to avoid digestive upset. The green tops of the sugar beet plant contain oxalate, which can reduce calcium availability to the pig. They must therefore be introduced gradually and in limited amounts. Beet should be chopped or minced if given to younger pigs to improve efficiency of utilisation, but they can be given whole to sows. They have been reported to give better performance than fodder beet or swedes, and similar performance to potatoes.

Typical Nutrient Composition

Dry matter (%)	24.0
Digestible energy (MJ/kg)	3.5
Crude fibre (%)	1.2
Crude protein (%)	1.4
Lysine (%)	0.06
Methionine +Cysteine (%)	0.03
Threonine (%)	0.04
Calcium (%)	0.04
Phosphorus (%)	0.03
Sodium (%)	0.03

Voluntary intake and limits on inclusion

Sows have been reported to eat up to 12kg of roots daily. For sows, 5kg of sugar beet could replace 1.2 kg of compound feed daily. Sugar beet can replace up to 50% of the cereal (on a DM basis) in diets of finishing pigs (3kg roots could replace 0.7kg cereals). If high levels are given, additional protein supplement will be necessary to avoid grading problems. Danish data suggest that an allowance of beet increases from 2kg/day at 30kg up to 5kg/day at 90 kg.

General Comments

Since organic pigs are generally kept at pasture, they have the possibility of obtaining nutrients from grazing. Grass/clover swards are likely to predominate, since these both provide forage and are beneficial to soil fertility. The precise nutrient value of the forage will depend on the species mixture, location and season. Early in the growing season the forage will be high in water and soluble sugars, whereas later it will have a higher dry matter and fibre content, making it less digestible. Forage availability will also depend on ground conditions and the extent of sward destruction by the pigs. For much of the year, in late summer and the non-growing season, it must be assumed to make no significant contribution to the nutrition of the animals.

Typical Nutrient Composition

Dry matter (%)	23.0 (spring) 26.0 (summer)
Digestible energy (MJ/kg)	2.9 (spring) 1.9 (summer)
Crude fibre (%)	4.9
Crude protein (%)	5.5
Lysine (%)	0.20
Methionine +Cysteine (%)	0.10
Threonine (%)	0.19
Calcium (%)	0.25
Phosphorus (%)	0.09
Sodium (%)	0.06

Voluntary intake and limits on inclusion

The daily grazing intake of sows on a plentiful organic grass/clover sward has recently been measured. Intake of individual sows ranged from 2 to 10 kg of fresh herbage per day, averaging 6-7kg and providing on average 50% of their maintenance energy needs in both early and late summer. This indicates that good grazing can replace 1 kg of compound feed in the growing season, but that condition of individual sows must be watched carefully and the level of compound adjusted as necessary. There is limited information on the grazing intake of growing pigs, but in one experiment growing pigs fed *ad libitum* concentrate consumed only 4% of their organic matter intake from early summer grazing on a grass/clover pasture. It should be assumed that grazing will make a negligible contribution to their nutritional needs for much of the year. When cut fresh grass/clover was offered *ad libitum* to finishing pigs, they consumed this at about 5% of their total daily energy intake. When the concentrate offered was reduced by 30%, grass intake increased to 6-7% of daily energy intake, but growth rate was reduced by ~15%.

General Comments

Grass/clover swards are likely to predominate in organic farms, since these both provide forage and are beneficial to soil fertility. The ensiled forage can be used as a fodder for pigs. However, because of its bulky nature and high fibre content, it is more suited to dry sows and finishing pigs than to younger animals. The precise nutrient value of the silage will depend on the species mixture, season and quality of fermentation. In particular, the dry matter content will depend on whether or not the silage has been wilted. A relatively early cut and short chop length is beneficial to both voluntary intake and nutritive value for pigs. Silage can be fed *ad libitum* with concentrate given separately in troughs, or can be mixed with the other feedstuffs to form a complete diet given daily. In the latter case, it is important to maintain trough hygiene and avoid moulding and fermentation of uneaten food.

Typical Nutrient Composition

Dry matter (%)	35.0
Digestible energy (MJ/kg)	3.2
Crude fibre (%)	10.0
Crude protein (%)	6.0
Lysine (%)	0.28
Methionine +Cysteine (%)	0.14
Threonine (%)	0.27
Calcium (%)	0.35
Phosphorus (%)	0.13
Sodium (%)	0.09

Voluntary intake and limits on inclusion

Recorded intakes of pregnant sows offered grass silage *ad libitum* vary between 2.5 and 9.2 kg per day. Intakes decrease in late pregnancy, probably due to more restricted gut space as the foetuses grow. On average, this can replace 0.5-1.0 kg of the daily compound feed. However, there can be wide variation between individual animals. The condition of individual sows must be watched carefully and the level of compound adjusted as necessary. There is currently little information on the intake of growing pigs. When offered in conjunction with *ad libitum* concentrate, silage intake of growing pigs has averaged only 100g/day. In Danish studies, where concentrate feed has been restricted, intakes of ~1kg fresh silage per day have been recorded for finishing pigs (5-10% of total DM intake). However, in both this and other German studies, feeding of grass/clover silage with restricted concentrate in the growing and finishing phases reduced liveweight gain by 10-15% and also resulted in poorer killing out percentage of pigs.

General Comments

Lucerne is often grown as a legume crop to both provide forage and improve soil fertility. The ensiled forage can be used as a fodder for pigs and has a higher protein content than grass silage. The precise nutrient value of the silage will depend on the species mixture, season and quality of fermentation. Silage can be fed *ad libitum* with concentrate given separately in troughs, or can be mixed with the other feedstuffs to form a complete diet given daily. In the latter case, it is important to maintain trough hygiene and avoid moulding and fermentation of uneaten food.

Typical Nutrient Composition

Dry matter (%)	35.0
Digestible energy (MJ/kg)	3.0
Crude fibre (%)	1.05
Crude protein (%)	6.8
Lysine (%)	0.28
Methionine +Cysteine (%)	0.16
Threonine (%)	0.25
Calcium (%)	0.52
Phosphorus (%)	0.10
Sodium (%)	0.01

Voluntary intake and limits on inclusion

There is no precise information regarding feeding of lucerne silage to pigs. However, intakes and performance responses similar to those for grass/clover silage might be expected.

General Comments

The whole cereal plant (wheat or barley) can be cut before ripening and ensiled to give a forage feed with a higher energy value than grass/clover silage. This makes it a much more valuable forage for growing pigs. It can also be made using a cereal/legume mixture (e.g. barley/peas) to give it a higher crude protein content. The precise nutrient value of the silage will depend on the species mixture, season and quality of fermentation. The silage can be fed *ad libitum* with concentrate given separately in troughs, or can be mixed with the other feedstuffs to form a complete diet given daily. In the latter case, it is important to keep troughs clean and avoid moulding and fermentation of uneaten food.

Typical Nutrient Composition

Dry matter (%)	40.0
Digestible energy (MJ/kg)	5.8
Crude fibre (%)	9.3
Crude protein (%)	3.9
Lysine (%)	0.14
Methionine +Cysteine (%)	0.15
Threonine (%)	0.13
Calcium (%)	0.08
Phosphorus (%)	0.10
Sodium (%)	0.01

Voluntary intake and limits on inclusion

Pregnant sows have been reported to eat 6.5 kg whole crop silage per day. Trials in Denmark indicate that pregnant sows can maintain body condition when given up to 75% of the daily energy intake from whole crop silage. Lactating sows can consume 1-2 kg whole crop silage per day, but will only do so if concentrate is restricted and show large variation between animals. They cannot totally compensate for reduced concentrate intake and milk production will suffer. Finishing pigs receiving 30% whole crop silage in a Total Mixed Ration (complete diet) showed a 10% reduction in growth rate and poorer feed conversion ratio. Feed selection and wastage of the TMR diet was a significant problem.

General Comments

Whole crop maize gives a high dry matter and energy yield per hectare, and can be ensiled to give a high energy feed for growing pigs and sows. The silage is high in starch, but low in protein, minerals and trace elements. The nutritive value of the silage can vary widely with variety, harvest condition and fermentation quality. The silage can be fed *ad libitum* with concentrate given separately in troughs, or can be mixed with the other feedstuffs to form a complete diet given daily. In the latter case, it is important to maintain trough hygiene and avoid moulding and fermentation of uneaten food.

Typical Nutrient Composition

Dry matter (%)	30.0
Digestible energy (MJ/kg)	3.4
Crude fibre (%)	5.4
Crude protein (%)	2.4
Lysine (%)	0.06
Methionine +Cysteine (%)	0.07
Threonine (%)	0.06
Calcium (%)	0.06
Phosphorus (%)	0.06
Sodium (%)	0.06

Voluntary intake and limits on inclusion

In trials with pregnant sows, 10 kg maize silage replaced 1.4 kg compound feed with no loss in performance and additional gain in fatness, suggesting this substitution rate to be overgenerous. There is little good data on the use of maize silage for growing pigs, but ‘corn-cob-mix’ comprising the moist grain heads has been very widely used. This product has a DM content of about 50%, and a nutrient value of about 8MJ DE and 5% crude protein per kg fresh weight, and can replace up to 50% of the cereal in compound feed for finishing pigs.

General Comments

Waste forage from green vegetable crops (e.g. cabbage, brussel sprouts) grown for human food may be available as a forage for pigs. The precise nutrient value of such waste will depend on the vegetable(s), season and mix of stem and leaf in the by product. For example, brussel sprout waste is likely to be higher in dry matter, fibre and protein than cabbage waste. Such waste can be fed *ad libitum* with concentrate given separately in troughs, or can be mixed with the other feedstuffs to form a complete diet given daily. In the latter case, it is important to maintain trough hygiene and avoid moulding and fermentation of uneaten food. Some brassicas can contain antinutritive factors with adverse effects on metabolism of pigs. No problems should be experienced at low feeding levels (<10% of diet DM intake). The material can be ensiled, with losses of about 5% of the energy content, and this improves digestibility. Cooking gives even better results but is unlikely to be economic.

Typical Nutrient Composition

Dry matter (%)	12.0
Digestible energy (MJ/kg)	1.4
Crude fibre (%)	1.4
Crude protein (%)	2.8
Lysine (%)	0.05
Methionine +Cysteine (%)	0.03
Threonine (%)	0.04
Calcium (%)	0.10
Phosphorus (%)	0.04
Sodium (%)	0.02

Voluntary intake and limits on inclusion

The intake of ensiled cabbage by sows has been reported to average 11 kg/day (1.46 kg DM). Chopped raw cabbage has been used to replace up to 30% of the DM of finishing pigs, but liveweight gain and killing out percentage were significantly reduced at this level. 2.6 kg DM of cabbage were required to give equal performance to 1kg of DM from compound feed.

General Comments

Although it is unlikely that this will be produced on farm because of the high energy cost of production, it may be purchased and used as a forage component in compound diets. It is a useful source of protein, but high in fibre. The precise nutrient value will depend on the grass mix and stage of cutting. Dried clover meal has a higher crude protein content (~21%) and lower fibre content (~15%).

Typical Nutrient Composition

Dry matter (%)	90.0
Digestible energy (MJ/kg)	7.7
Crude fibre (%)	20.0
Crude protein (%)	15.3
Lysine (%)	0.8
Methionine +Cysteine (%)	0.4
Threonine (%)	0.7
Calcium (%)	0.90
Phosphorus (%)	0.45
Sodium (%)	0.27

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	20
Lactating sows	10
Suckling and newly weaned piglets	0
Growing pigs	5
Finishing pigs	10

General Comments

Although it is unlikely that this will be produced on farm because of the high energy cost of production, it may be purchased and used as a forage component in compound diets. It is a better source of protein than dried grass, but still relatively high in fibre and low in energy. The precise nutrient value will depend on the variety and stage of cutting. Palatability of the diet can be reduced if high levels of dried lucerne are included. It is a good source of vitamin E and selenium, and can be beneficially used in diets for breeding sows.

Typical Nutrient Composition

Dry matter (%)	90.0
Digestible energy (MJ/kg)	7.8
Crude fibre (%)	30.0
Crude protein (%)	17.4
Lysine (%)	0.80
Methionine +Cysteine (%)	0.45
Threonine (%)	0.71
Calcium (%)	1.40
Phosphorus (%)	0.23
Sodium (%)	0.10

Voluntary intake and limits on inclusion

	Maximum inclusion (% DM)
Dry sows and boars	50
Lactating sows	5
Suckling and newly weaned piglets	0
Growing pigs	5
Finishing pigs	10

APPENDIX A:
PERMITTED RAW MATERIALS FOR FEEDING OF ORGANIC PIGS ACCORDING TO EC REGULATION 1804/99 AMENDING REGULATION 2092/91

Annex II: Permitted feeds in organic pig production [feedstuffs of conventional origin which can be used within the permitted non-organic allowance]

C1. Feed materials from plant origin

Cereal grains and their products and by-products

Oat grains, flakes, middlings, hulls, bran
Barley grains, protein, middlings
Rice grains, bran, germ expeller
Millet grains
Rye grains, middlings, feed, bran
Sorghum grains
Wheat grains, middlings, bran, gluten feed, gluten, germ
Spelt grains
Triticale grains
Maize grains, bran, middlings, bran, germ expeller, gluten
Malt culms
Brewers grains

Oil seeds and fruits and their products and by-products

Rape seed, expeller, hulls
Soya bean, toasted, expeller, hulls
Sunflower seed, expeller
Cotton seed, expeller
Linseed seed, expeller
Sesame seed, expeller
Palm kernal expeller
Turnip rape seed expeller, hulls
Pumpkin seed expeller
Olive pulp

Legume seeds and their products and by-products

Chick pea seeds
Vetch seeds submitted to appropriate heat treatment
Pea seeds, middlings, bran
Broad bean seeds, middlings, bran
Horse bean seeds
Vetch seeds
Lupin seeds

Tuber roots and their products and by-products

Sugar beet pulp, dried beet
Potato tuber, pulp, starch, protein
Sweet potato tuber
Manioc roots
Tapioca

Other seeds and fruits, their products and by-products

Carob pods
Citrus pulp
Apple pommace
Tomato pulp
Grape pulp

Forages and roughages

Lucerne, meal
Clover, meal
Grass, meal, hay, silage
Cereal straw
Root vegetables

Other plants, their products and by-products

Molasses
Seaweed meal
Plant protein extracts
Herbs and spices

C2 Feed Materials from animal origin

Milk and milk products

Raw milk, powder
Skim milk, powder
Buttermilk, powder
Whey, powder, protein extract
Casein powder
Lactose powder

Fish, other marine animals, their products and by-products

Fish, fishmeal, fishoil, cod-liver oil not refined
Fish moluscan or crustacean autolysates, hydrolysate and proteolysates obtained by enzyme action, whether or not in soluble form, solely provided to young animals

Sodium:	unrefined sea salt coarse rock salt sodium sulphate sodium carbonate sodium bicarbonate sodium chloride
Calcium:	lithothamnion and maerl shells of aquatic animals calcium carbonate calcium lactate calcium gluconate
Phosphorus:	bone dicalcium phosphate precipitate defluorinated dicalcium phosphate defluorinated monocalcium phosphate
Magnesium:	anhydrous magnesia magnesium sulphate magnesium chloride magnesium carbonate
Sulphur:	sodium sulphate

D Feed additives

Trace elements

Iron:	ferrous (II) carbonate ferrous (II) sulphate monohydrate ferric oxide
Iodine:	calcium iodate, anhydrous calcium iodate, hexahydrate potassium iodide
Cobalt:	cobaltous (II) sulphate monohydrate and/or heptahydrate basic cobaltous (II) carbonate, monohydrate
Copper:	copper (II) oxide basic copper (II) carbonate, monohydrate copper (II) sulphate pentahydrate
Manganese:	manganese (II) carbonate manganous oxide and manganic oxide manganous (II) sulphate, mono- and/or tetrahydrate
Zinc:	zinc carbonate zinc oxide zinc sulphate mono- and/or hepta-hydrate

Molybdenum:	ammonium molybdate natrium molybdate
Selenium:	sodium selenate sodium selenite

Vitamins and provitamins

Vitamins authorised under Directive 70/524/EEC preferably derived from raw materials occurring naturally in feedingstuffs, or synthetic vitamins identical to natural vitamins (permitted for monogastrics only)

Enzymes

Enzymes authorised under Directive 70/524/EEC

Microorganisms

Microorganisms authorised under Directive 70/524/EEC

Preservatives

For silage only:	formic acid acetic acid lactic acid propionic acid

Binding agents

colloidal silica
kieselgur
sepiolite
bentonite
kaolinitic clays
vermiculite
perlite

Processing aids

For silage:	sea salt coarse rock salt enzymes yeasts whey sugar sugar beet pulp cereal flour molasses lactic, formic, propionic bacteria