Poultry Management

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1. Scope and Objectives of the Research Topic Review:

The scope of this review is to disseminate the recent research that has been conducted on poultry management. The main areas covered are breeding; rearing; housing; health and disease; medication and to a lesser extent nutrition. Nutrition will not be looked at in too much detail as work has already been carried out in this area; IOTA Research Review; Poultry nutrition and rations (http:/www.organicadvice.org.uk/papers/Res_review_8_dinnage.pdf).

This review covers all research commissioned by DEFRA and includes some other relevant European work. The results are analysed and practical implications summarised. A workshop relevant to the findings will take place.

The biggest current issue in the organic poultry sector is nutrition so most recent research has been done in this field; the following research has been done since 2000.

Due to the relatively small amount of research that has been carried out in the above mentioned areas, care should be taken when considering the results. Relatively few papers have investigated the same problem so it is hard to compare any work. All authors state that more research is required in their particular field.

2. Summary of Research Projects and the Results

Ferrante V. , Baroli D. , Lolli S. and Di Mauro F. (2008). Broilers welfare, health and production in organic and conventional systems. 16th IFOAM Organic World Congress, Modena, Italy, June 16-20, 2008. http://orgprints.org/12007/01/Ferrante.rtf

This trial compared organic and conventional management systems by evaluating production, health and bird behaviour. The author states that 'welfare is good when all needs associated with the maintenance of good health and …certain behaviours are met.' The research aimed to investigate the difference between the two rearing systems in terms of feather pecking and cannibalism reduction and of positive effect on birds skeletal and muscle development.

The organic system was characterised by lower bird density of 10 birds/m^2, natural ventilation and lighting with a mean temperature of 20^{o}C. Outside bird density was 4 birds/m^2. The conventional system was characterised by forced ventilation and a lighting programme that combined both natural and artificial light. Bird density was 15.4-17.6 birds/m^2 and mean temperature 23.2^{o}C.

Results from the two systems showed that conventional birds consumed less feed but were more efficient at converting it. Final weight, carcass weight and chest weight reached a higher value in the organic birds when slaughter weight is taken into consideration although this was probably due to the different growing periods (organic 91 d, conventional 56d). High levels of mortality due to Sudden Death Syndrome (SDS) in both groups demonstrate the importance of genetic factors in pathology, the slower growth in the

organic birds was not enough to delete genetic effects. The behavioural data showed the organic birds had a lower reactivity to humans, the author translated this to mean a better adaptation to environment and humans and therefore higher welfare.

Effect of breed suitability, system design and management on welfare and performance on traditional and organic birds. DEFRA (2002) project code OF0153 http://orgprints.org/8104/01/OF0153_2552_FRP.pdf

Over the past fifty years only broiler hybrids have been available to UK producers, as broiler production has accounted for almost all meat production in the UK. It is thought that these broiler hybrids are unsuitable for extensive systems (like organic) that became popular in the 1990s. This project aimed to characterise breed suitability for extensive production (free-range, traditional free-range and organic production) and to assess the contribution of management and system design on bird performance, range usage and animal welfare parameters.

Results:

- Breed differences were recorded in live weight, feed usage and food conversion efficiency (FCE). UK broiler hybrids were the heaviest and had best FCE. Traditional breeds were the lightest and had poorest FCEs. Broilers also had higher breast meat yields but were more susceptible to reduced methionine and lysine intakes.

- Traditional breeds were more active and showed more extreme escape responses than the broiler breeds. Gait was similar when live weight was accounted for. Some of the traditional breeds ground pecked in a stereotypical manner and aggressive feather pecking occurred.

- Early access to pasture increased range usage, natural shelter in the form of conifer wig-wams were attractive to birds and well used.

- Brooding in low-tech free-range facilities was found to be extremely labour intensive and sometimes resulted in a higher mortality rate than a controlled environment brooding facility. This high mortality was attributed to difficulties in achieving an appropriate thermal environment through day and night. Work showed however, that brooding can be done successfully even during the most difficult time of year (late autumn/winter) but labour requirements were significantly increased.

- Providing feed and drinker points beyond the recommended level within the free-range houses did not reduce brooding mortality. However in this part of the study chick mortality was high in the controlled environment, it was thought that chick quality may have been poor or that the chicks from slow growing hybrids need different hatching conditions than those of broiler strains.

- Early nutrient intake affected growth performance to 42 days but not to 81 days.

Implications of findings, future work and policy relevance.

- Producers can choose from a wide variety of hybrids available to meet their requirements for live weight at slaughter, meat conformation, behaviour and suitability to their production systems.

- Active and inquisitive breeds are needed for use in extensive production systems as they are likely to be better foragers and make better use of the range available. However their extreme response

to danger may not always be an advantage. Birds on the range need to escape predators but when they are in the house crowding and suffocation may occur during routine feeding and welfare inspections by humans, who will also be perceived as predators. It is recommended that pop holes remain open during such times to provide a means of escape.

- Centralised brooding in large automated housing is acceptable but care must be taken to minimise physiological stress and injury and trauma during handling and transport to range. Whilst low-tech brooding is more difficult and labour intensive, post brooding mortality is lower and predation not a problem. Enriched brooding increased mortality between 1-28 days; 9.4% (enriched pasture) and 3.6 % (pasture only) ($p<0.01$).

- Post brooding birds with access to enriched pasture roamed more widely. Usage tends to be better on warm, non-windy dry days.

- White feathering may increase risk of predation on the range.

- Pasture usage is encouraged by early access but parasite build-up may be higher. Control methods will be needed.

- Conifer wig-wams are attractive to chickens and they will follow them around a pasture. They can be moved and thus used to distribute droppings around the paddock.

- Slow growing hybrids may not be available locally, transportation is expensive and conditions affect mortality.

Desk study – optimising the synergism between organic poultry production and whole farm rotations including home grown protein sources. DEFRA (2002) Project code OF0163. http://orgprints.org/7982/01/OF0163_1131_FRP.pdf

Since poultry production became intensified in the 1950s it has been separated from other farm types. This meant there was little information on how to integrate it into a mixed organic system. This desk study aimed to bring together information and assess methods for integrating organic poultry into crop rotations whilst taking into account; the birds' nutritional and physiological requirements for health and performance, the recycling of nutrients between soil, plants and birds and the practical limitations of the system.

As home grown protein sources are less rich in protein than soya (particularly the amino acids lysine and methionine) and they contain antinutritive factors their inclusion in feed rations are limited. It is likely that a wider range of ingredients will be required to meet the same nutritional benefits as a non-organic ration. One difficulty in including home grown protein is that the cereal component occupies a lot of space in the ration, so other ingredients must be included on the basis of their nutrient density. This may increase the cost of the feed. For health and performance it is important that the essential amino acid (AA) balance is correct, performance should not necessarily mean maximum growth or egg production but performance at a level that is financially and biologically sustainable. Further more, crude protein levels should not be allowed to rise too high as this increases manure moisture and nitrogen content, this means wet litter and potential risk of nitrogen pollution.

Fish meal, which is allowed to be certified organic under EU Regulation 889/2008, is likely to be an important 'balancer' of nutrients in organic rations. Care must be taken that taint does not occur and customer attitude should be assessed.

Implications of findings, future work and policy relevance.

- Organic poultry production will not be as nutrient efficient as intensive conventional systems.
- Wider rotations will be needed to better integrate birds and to provide more of the birds' nutrients from home grown sources. Grass/clover leys are not well used by birds in terms of nutrient supply and a high protein forage crop may be better used. This will require further research.
- As organic feed is the largest variable cost in poultry production, a means of reducing feed costs may be to use high protein forages for grazing, rather than poorly utilised and low nutrient value rye grass swards.
- The approach of using a dual purpose hybrid may eliminate the 'waste' of male chicks in egg lines; female chicks are reared for egg production whilst males are used for meat.

Horsted, K. (2006) Increased foraging in organic layers. Ph.D., Department of Agroecology, University of Aarhus, Faculty of Agricultural Sciences.* http://orgprints.org/10463/01/10463.pdf

This is a thesis that hypothesised that *'hens are capable of finding and utilising a considerable amount of feed items from a forage range area.'* If increased foraging of suitable vegetation is utilised better use of local resources can take place. This could increase the cycling of nutrients within the system, ease the transition to 100% organic rations, benefit the economy of egg production, lead to greater dispersion of poultry in the field reducing the risk of nutrient leaching and increasing welfare.

Results.

- It was found that hens on a normal and restricted nutrient diet consumed a considerable amount of herbage. Those on the restricted diet were found to have an approximately 50% higher intake. Non-restricted hens may consume between 10-30g of grass/clover per hen per day and nutrient-restricted hens may consume between 20-40g per hen per day.
- Hens foraging chicory plots consumed twice as much as those on grass/clover lays.
- Wheat fed birds were found to have more plant material, grit, soil and oyster shells in their crop than non-wheat fed birds. They also gave higher priority to earthworms and larvae even though the amount in the forage vegetation decreased after a few days.
- Hens favoured quinoa seeds over lupin seeds and pea/vetch/oats.
- It was found that irrespective of type of supplementary feed hens may consume up to 0.25 MJ of their Metabolisable Energy (ME) requirements from forage. This would be greater for nutrient restricted hens due to higher foraging rates.

- It was estimated that forage area, on average, supplied the nutrient-restricted hens with approximately 70% of their requirements of lysine and methionine and approximately 25% of their requirements of calcium.

- After an adaptation period nutrient restricted hens were found to perform well in a crop rotation, laying rates were comparable to non-restricted hens.

- Welfare of hens was found to be excellent on both nutrient-restricted and non-restricted diets.

- Chicory, quinoa and earthworms have promise for providing nutrients.

- It seems possible to lower the standards of important nutrients in the supplementary feed, provided that good forage is available and that the production system supports good welfare of the poultry. A crop rotation system is suggested.

Castellini, C. (2005). Organic poultry production system and meat characteristics. Paper presented at XVII th European Symposium on the Quality of Poultry Meat, Doorwerth. http://orgprints.org/9330/01/wageningen.pdf

This Italian paper looked at the qualitative effect of organic poultry production systems on meat quality. Any effect is due to the greater age and activity of the bird but is also affected by management decisions i.e. pasture availability or genetic strain used. Due to economic reasons and chick availability fast or intermediate growing strains, that are not adapted to organic systems, are usually used[1]. Owing to this widespread use of genetically inadequate birds health and welfare problems caused by leg disorders and lameness are recurrent.

Compared to conventional chickens, organic carcasses have higher breast and drumstick percentages and a lower level of abdominal fat. Slow strains reach commercial maturity later than fast strains, 75 days as opposed to 50 days to meet 50% maturity. Slower growing strains, due to increased kinetic behaviour and higher intakes of forage have an increased oxidative stability of both fresh and stored meat than faster growing strains.

Faster growing strains have a greater growth rate but are strongly affected by an organic production system; growth performance is reduced by approximately 25% of that obtained in a conventional system. Conversely, slow growing genotype birds show almost the same performance in organic systems as conventional systems. When conventional management strategies selected for high production rates, behaviour modifications took place[2]; reducing all activities involving high energy use, allowing birds to reallocate the saved energy to production traits. When these birds are reared in free-range systems they make little use of pasture[3], probably due to excessive weight and leg weakness. Fast growing strains of birds have numbers of welfare problems and high culling and mortality rates when organically reared[4]. Slow growing strains show more active behaviours such as more walking, less lying, spend more time outdoors than in and have a reduced period of tonic immobility. As slow growing strains forage more effectively they have high levels of free radicals and therefore enhanced antioxidant ability to cope with high amounts of carotenoids, α-tocopherol and polyphenols consumed with pasture[5].

In this trial sensorial analysis showed a clear preference for slow growing birds and that fast growing strains grown in an organic system could not be differentiated from conventionally reared birds.

The author believes that the role of slow growing breeds as an organic product could be strengthened if further research confirmed their ability to perform with lower quality feeds whilst producing high quality meat. As slow growing strains take 120 days to fatten, resulting in increasing production costs, it would be advisable to cross slow growing strains with heavier genotypes. Furthermore, slow growing strains are in danger of extinction and organic farming should be considered as an important chance to assure their preservation.

Castellini, C., Mugnai, C. and Dal Bosco, A. (2002). Meat Quality of three chicken genotypes reared according to the organic system. Italian Journal of Food Science 14(4); 411-412. http://orgprints.org/9319/01/IJFSpollo.pdf

According to European guidelines more rustic strains of bird are preferred in organic poultry systems due to their slower growth rate and better adaptation to poorer living conditions. It is also thought that animals selected for high production efficiency are more at risk for behavioural, physio-biological and immunological responses. In response to these problems some geneticists have been selecting strains with the desired traits. One such strain is a Kabir hybrid whose positive traits include resistance to environmental stress and disease and good adaptation to poor diets[6]. Another such breed, Robusta maculate is a Buff Orpington White American Cross, was obtained in an Italian experimental station in the 1950's. It has dual qualities; 140-160 eggs laid per year and about 4kg of adult body weight. These two slower growing breeds were compared to a commercial hybrid – Ross.

Results

- The Kabir and Robusta maculate hybrids both expressed natural behaviour patterns in the extensive system. They showed good motor activity and good adaptation to poor environmental conditions.

- Their antioxidant capacity was higher and the oxidative processes of the meat were lower when compared with the Ross.

- Sensorial quality of the slow growing meat was rated higher during the panel test than that of the Ross, which was nutritionally sound except for low iron content and low oxidative stability.

- The Kabir birds took 81 days to reach a marketable weight whereas the Robusta maculate took 120 days. It is advisable to cross a female of this breed with a heavier male to improve growth rate and ensure maturity is reached at slaughter so that moisture and protein content are not negatively affected.

- Results showed that the environment-genotype interaction is also very important for the qualitative characteristics of the meat.

- Slow growing breeds are in danger of extinction and should be considered for extensive production to assure their preservation.

Development of nutritional regimens for rearing organic laying stock (2008). DEFRA LINK project LK0664.

These trials looked at trying to solve the problems posed by the exclusion of synthetic amino acids in organic poultry diets. It looked at replacing these with betaine, fructo-oligosacharides and saponins , individually or in combination in the diet.

Results

- The project concluded that it was not possible to compensate for the lack of synthetic sulphur amino acids (lysine and methionine) in organic pullet rearing diets with the additives used in this trial. Birds on the novel diets grew more slowly and produced fewer eggs than those fed added methionine.

- More informed attention needs to be given to basic husbandry procedures if the welfare potential of organic systems is to be uniformly recognised across the sector.

- There was no evidence that betaine was able to compensate for suboptimal levels of methionine.

- When there are marginal nutritional deficiencies birds, particularly those in smaller flocks, can over come them by scavenging from the range

- The inclusion of fishmeal (which is permitted under EU Organic Rules – EU Regulation 889/2008) in the diet formulation can significantly reduce the negative impact of an organic pullet diet.

- The inclusion of exogenous enzymes such as beta-glucanases has potential to improve the utilisation of nutrients from an organic diet.

- Commercially reared organic pullets did not, and are unlikely to, achieve breed standard body weights or egg output.

- The author states that welfare is not necessarily reduced just because diets do not meet nutritional requirements for maximum output. Providing that organic producers can accept lower productivity from their birds then organic rearing diets can be used successfully.

- The author believes though that if a 100% organic diet (as planned for by 31st December 2011) is demanded then not only productivity but welfare of the pullet and particularly the laying hen would be considered to be at risk.

Workshop and desk study to appraise technical difficulties associated with organic breeder flocks and organic hatching. (2003). DEFRA project OF0336. http://orgprints.org/6774/01/OF0336_2174_FRP.pdf

The workshop identified factors likely to limit the success of organic breeder production and therefore organic table bird production. The priority issues were energy balance of breeders on the range, supplying

protein and amino acids, meeting energy and protein requirements from a 100% organic diet, impact of diet on manure nutrient content and health and disease.

The main findings of the literature review;

- Energy usage is difficult to estimate in varying free-range temperature and estimates are for laying hens not breeders but equations were reviewed for ad-libitum feed intake;. Values ranging from 155-190g/day/bird were tabulated. Seasonal variation may change this and members at the workshop expressed doubts of the ability of birds to consume the higher level of feed.

- 700mg/day for methionine and cystine, 765 mg/day for lysine and 190 mg/day for tryptophan were recommended by the literature, although the author warns this data is often inconsistent and dated.

- It was predicted that the cost for ingredients for a 100% organic diet would be expensive, especially protein and oil. There may be consumer resistance to increased prices for the final product.

- Excretion rates ranging from 984-1095g N/female/year were estimated, for feed protein contents ranging from 155-170g/kg.

- To avoid foot problems caused by wet litter, adequate ventilation, modest stocking density and regular foot and site inspections must take place.

- Helminths are more common in outdoor birds, paddock rotation, keeping grass short, avoiding reused litter, housing ages separately, and pasture harrowing are essential.

- There may be breed differences in ascarid resistance.

- Coccidiosis is potentially a major problem for free-range systems although partial immunity may be developed latter in life.

- Mites are likely to be a problem.

- Wild birds carry fowl cholera, and Newcastle disease so outdoor flocks are at risk.

- Monitoring for pullorum disease is essential because it can be vertically passed to chicks.

- Feed, wild birds, rodents and possibly ascarid eggs enhance the risk of salmonella in out door reared birds, control measures include vaccination and competitive exclusion by promoting gut *Lactobacilli* concentration.

- Organic birds may be vulnerable to *Campylobacter* infection from wild birds and possibly ruminant livestock acting as carriers.

Animal Welfare and genetics in organic farming of layers; the example of cannibalism. 4th NAHWOA Workshop, Wageningen, 24-27th March 2001. pp62-85. http://www.veeru.reading.ac.uk/organic/FINALProceedingsEdited.pdf

As intensive systems of poultry production have prevailed for the last 40 years, birds have been genetically selected to do well in these conditions. Has the potential to adapt to an extensive system been removed or should birds now be selected anew for extensive organic systems?

The study found that although cannibalism occurs frequently in organic systems it was not known whether ontogenetical, environmental or genetic factors played the largest role in its' development.

- A survey conducted in the Netherlands suggests that having a cockerel on the farm could play a role in reducing incidence.
- Changes in breed showed a high level of significance especially on mortality due to cannibalism. Thus one of the most promising ways to reduce cannibalism may to be to adapt the animal to its ecological environment by genetic selection.
- There has only been one study conducted into the heritability of cannibalism but it showed a strong correlation. Based on this estimate genetic selection appears feasible.
- Genotype-environment interactions seem important. This would have to be put into practise adapting the environment to the animal and the animal to the environment.
- Molecular genetic analysis together with ethological analysis can show markers or even genes that are responsible for the cannibalism. Using natural selection using genetic information could be used to breed good egg layers and those that survive cannibalism.

Hovi, M. and Sundrum, A Discussion report Feeding for health and welfare. Poultry Production. The 4th NAHWOA Workshop, Wageningen, 24-27th March 2001.
http://orgprints.org/876/01/hovi-2001-4thNAHWOA-proceedings.pdf

Problem areas identified.

- Control of internal parasites, in particular coccidiosis, is a possible problem in free-range systems that do not have feed rations containing prophylactic medications.
- Home grown and mixed rations are likely to be of low nutritional density, this could lead to thin intestinal density and poor absorption of nutrients.
- Farmers may not have a good understanding of ration formulation which may lead to deficiencies in home mixed rations.
- EU Regulation banning artificial amino acids was considered to cause a potential problem in the provision of essential amino acids.

Potential solutions

- In layer systems serious coccidiosis problems were thought to be an unlikely problem in adult birds that have acquired immunity, as long as hygiene standards are good, stocking densities are not too high and site rotation is practised. The acceptability of coccidial water administered vaccines in organic hatcheries should be clarified.

- Training and advisory materials on poultry ration formulation for home mixing should be developed.

- Poultry should be allowed to practise choice feeding.

- The need to adjust production levels to available diet should be considered, rather than a change of feeding standard.

- Germans have used potato protein in broiler diets, Scandinavian countries use soured milk powder in broiler and layer diets to replace artificial amino acids.

Organic egg production – a sustainable method for meeting the organic hen's protein requirements. DEFRA project OF0357 http://randd.defra.gov.uk/Document.aspx?Document=OF0357_5352_FRP.doc

A desk study was carried out to assess the potential of novel proteins in the laying hen's diet. As plant protein sources are deficient in methionine and synthetic replacements are not allowed in organic diets, new sources must be found to ensure the bird's requirements are met. If these requirements are not met egg outputs are reduced, there can be immunocompetence and feather pecking problems. To date it has not been possible to solve the problem using typical organic crops. Novel sources were reviewed, these included insects, earthworms, microalgae, aquatic plants and herbs. It is also important to establish whether these proteins can be produced in the UK without harm to the environment at a competitive price.

Results

- None of the novel proteins had optimal methionine concentrations but when included in a diet, whether singularly or as a combination, targets could be met without over supplying crude protein. (see appendix for graph on crude protein content of each novel source).

- No adverse effects of feeding earthworm meal, house fly larvae or microalgae on bird health or welfare. Some microalgae fed at low concentrations are thought to be beneficial to bird health and reduce mortality. Aquatic plants rich in ash were thought to constitute a health risk but this could be reduced by washing to remove calcium deposits.

- Microalgae are a rich source of xanthophyll pigments which give the egg yolk a deep orange colour depending on concentrations included.

- Earthworms, microalgae and aquatic plants accumulate heavy metals and dioxins at concentrations greater than in their environment, which if eaten by the hen would readily transfer to the egg.

- Although the novel proteins affected the crude protein levels (both positively and negatively) it is thought that the implications in terms of potential effects on the scale of N emissions from organic hens are negligible due to the small size of the UK flock.

- If livestock manures are to be used as feed for the novel proteins (i.e. earthworms) then there are risks of N emissions during production, manure needs to be managed according to 'best available practices'.

- Outdoor vermiculture is thought to be possible in the UK all year round. This is not the case for house fly larvae production – indoor production would be required to reduce odour and fly nuisance.

- The UK climate does not provide optimal growing conditions for *Spirulina*, *Chlorella* or duckweed. They could be grown indoors with reduced production during the winter months.

- In all cases livestock manure would be suitable to grow the novel proteins on but chicken manure would have to be composted to reduce ammonia content.

- Estimates for prices in 2006 ruled out the use of these novel proteins even when produced organically. The cost of drying them in the UK is likely to be significant.

- It needs to be determined whether diverting manure from other land based applications to organic novel protein production will affect soil surface nutrient balance . If managed correctly there should be minimal environmental impacts although N and greenhouse gases would need to be quantified. In addition any 'wastes' subsequently applied to the land should be monitored.

Validation of the HEN biological model for laying hens and an assessment of nutritional issues in organic poultry production. DEFRA code OF0327
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=11046&FromSearch=Y&Publisher=1&SearchText=OF0327&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

The researcher found that due to hens in outdoor systems not displaying a consistent significant relationship between feed metabolisable energy intake and temperature, the HEN model can not be applied to organic systems.

Again the issue of methionine deficiencies is discussed; the implications of a deficiency are reduced performance, negative affects on the immune system and behavioural modifications such as injurious feather pecking. Attempts to maximise dietary methionine could result in an over supply of crude protein which will impact on the rate of nitrogen excretion and the risk of pollution.

This research found that the published values for crude protein and amino acid content of organic wheat to be too high. Organic peas were found to have similar levels of crude protein, lysine and threonine as conventional peas but the methionine levels were lower.

It was thought that the contribution of range to nutrition is low, less than 5% during the summer months.

It has been estimated that to maintain 2004 sector sizes for organic eggs and table production;
2,800 t/annum organic full-fat soya
400 t/annum sunflower meal
850 t/annum 'replacement protein'
370 t/annum fish meal would be required.

3. Analysis and Conclusions

Breeding.

- Over the past fifty years only broiler hybrids have been available for use by UK producers as broiler production has accounted for almost all meat production in the UK. It is thought that these broiler hybrids are unsuitable for the extensive systems that became popular in the 1990's. Slow growing strains of birds not only taste better but are more suited to extensive systems, they can make better use of a good range, they range further and forage more effectively, they are less susceptible to environmental stresses, can cope very well with poor diets as opposed to broiler strains that perform 25% less well in extensive systems, they are less susceptible to predation as they tend not to be a conspicuous white colour.

- Different studies had opposing results in relation to escape behaviours and tonic immobility. OF0153 recommends that pop hole remain open during routine welfare inspections and feeding as traditional birds have a more extreme response to danger and are likely to crowd and suffocate. It also found that some traditional breeds pecked in a stereotypical manner and suffered aggressive feather pecking. Castellini reports that slow growing strains of bird have a reduced period of tonic immobility. This suggests a less extreme response to danger. Castellini also found in a later paper that animals selected for high production efficiency are more at risk for behavioural, physio-biological and immunological problems.

- Many authors suggest crossing fast and slow growing strains to produce a commercially viable bird that is suited to an extensive system. An example is the Kabir hybrid. Cobb® are currently crossing this breed with a Sasso type and it is thought they will be in a strong position to supply the extensive market in the future.

Rearing.

- Brooding in low-tech free-range facilities was found to be extremely labour intensive and sometimes resulted in a higher mortality rate than a controlled environment brooding facility, due to the difficulty experienced in maintaining temperature between day and night. Work showed however, that brooding can be done successfully, even during the most difficult time of year (late autumn/winter) but labour requirements were significantly increased. It may be possible that chicks from slow growing hybrids need different hatching conditions than those of broiler strains.

- Centralised brooding in large automated housing is acceptable but care must be taken to minimise physiological stress and injury and trauma during handling and transport to range. Whilst low-tech brooding is more difficult and labour intensive, post brooding mortality is lower and predation not a problem. Enriched brooding increased mortality between 1-28 days; 9.4% (enriched pasture) and 3.6 % (pasture only) ($p<0.01$) (OF0153).

Management Systems.

- Hens are capable of finding and utilising a considerable amount of feed items from a forage range area. If increased foraging of suitable vegetation is utilised better use of local resources can take place. This could increase the cycling of nutrients within the system, ease the transition to 100% organic rations, benefit the economy of egg production, lead to greater dispersion of poultry in the field reducing the risk of nutrient leaching and increasing welfare.

  - Non-restricted hens may consume between 10-30g of grass/clover per hen per day and nutrient-restricted hens may consume between 20-40g per hen per day.
  - Hens favoured quinoa seeds over lupin seeds and pea/vetch/oats.
  - Nutrient-restricted hens can acquire approximately 70% of their lysine and methionine requirements from the range and approximately 25% of their calcium requirements.
  - It was found that irrespective of type of supplementary feed hens may consume up to 0.25 MJ ME of their requirements of ME from forage; and probably higher for nutrient restricted hens due to higher foraging rates.

- It seems possible to lower the standards of important nutrients in the supplementary feed, provided that good forage is available and that the production system supports good welfare of the poultry. A crop rotation system is suggested.
  - This could make bought in feeds cheaper if it was formulated to contain less nutrients. There is the potential for a bought in feed to supply the energy component of a feed if farm can not produce a high quantity of cereals which presents the possibility for linked holding potential.
  - To put this in context with the Pullet LINK report this suggests that the range needs to be expansive, diverse and contain both nutritious flora and fauna.

Housing.

- Early access to pasture increased range usage, natural shelter in the form of conifer wig-wams were attractive to birds and well used. Providing feed and drinker points beyond the recommended level within the free-range houses did not reduce brooding mortality.
- In layer systems serious coccidiosis problems were thought to be an unlikely problem in adult birds that have acquired immunity as long as hygiene standards are good, stocking densities are not too high and site rotation is practised.
- To avoid foot problems caused by wet litter, adequate ventilation, modest stocking density and regular foot and site inspections must take place.
- More informed attention needs to be given to basic husbandry procedures if the welfare potential of organic systems is to be uniformly recognised across the sector.

Health and Disease.

- Outdoor and extensive production systems have specific health and disease implications. Animals selected for high production efficiency are more at risk for behavioural, physio-biological and immunological responses.

- Pasture usage is encouraged by early access but parasite build-up may be higher; control methods will be needed.
    - Conifer wig-wams are attractive to chickens and they will follow them around a pasture; they can be used to distribute droppings within the paddock.
- Control of internal parasites, in particular coccidiosis, is a possible problem in free-range systems that do not have feed rations containing prophylactic medications. It is thought not to be a likely problem in adult birds that have acquired immunity as long as hygiene standards are good, stocking densities are not too high and site rotation is practised.
- Helminths are more common in outdoor birds. Paddock rotation, keeping grass short, avoiding reused litter, housing ages separately, and pasture harrowing are essential.
- Mites are likely to be a problem.
- Wild birds carry fowl cholera, and Newcastle disease so outdoor flocks are at risk.
- Monitoring for pullorum disease is essential because it can be vertically passed to chicks.
- Feed, wild birds, rodents and possibly ascarid eggs enhance the risk of salmonella in out door reared birds, control measures include vaccination and competitive exclusion by promoting gut *Lactobacilli* concentration.
- Organic birds may be vulnerable to *Campylobacter* infection from wild birds and possibly ruminant livestock acting as carriers.
- Breeding for general disease resistance is possible, though complicated. Possibilities in the field of developing the general immune system by bringing young chicks into well-controlled contact with micro organisms (hygiene theory) should be further researched.
- Examples hygiene theory include administering gut flora to one-day-chicks, keeping young hens in contact with (healthy) older hens, providing compost, access to a free-range area at young age, feeding microbial fermented feeds, etc.[7]

4. References

[1] Network for Animal Health and Welfare in Organic Agriculture, 2002 Final Recommendation and comments. http://www.veeru.reading.ac.uk/organic/
[2] Schütz, K.E., and Jensen, P. 2001 Effects of resource allocation on behavioural strategies: a comparison of red jungle fowl (*gallus gallus*) and two domesticated breeds. *Poultry Ethology*, **107**; 753
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5. Appendix

Organic egg production – a sustainable method for meeting the organic hen's protein requirements. DEFRA project code OF0357. Table to show crude protein content of novel protein sources.

Diet	Dietary crude protein content (g/kg)	Calculated rate of N excretion (kg/hen housed/year)	Total UK NH_3 emission (kt/yr)	Total UK N_2O –N emission (kt/yr)
85% organic diet	199.3	1.02	0.68	0.007
House fly larvae meal 1	157.5	0.73	0.49	0.005
House fly larvae meal 2	190.1	0.95	0.64	0.006
Earthworm meal 1	200.9	1.03	0.69	0.007
Earthworm meal 2	225.8	1.19	0.80	0.008
Chlorella meal 1	184.2	0.91	0.61	0.006
Chlorella meal 2	201.1	1.03	0.69	0.007
Chlorella meal plus house fly larvae meal	190.9	0.96	0.64	0.006
Chlorella meal plus earthworm meal	191.1	0.96	0.64	0.006
Spirulina meal 1	224.3	1.18	0.79	0.008
Spirulina meal 2	250.1	1.36	0.91	0.009
Spirulina meal 3	220.3	1.16	0.78	0.008
Lemna meal 1	188.3	0.94	0.63	0.006
Lemna meal 2	200.1	1.02	0.68	0.007