SM3

NUTRITION
MANAGEMENT HANDBOOK

Revised 19.01.15

Cherry Valley®

This Handbook

Cherry Valley has invested for many years in a research and development resource covering all aspects of duck production. This handbook is based on that research, along with more than 50 years' experience of integrated duck production and the benefit of working with customers in all of the World's important duck markets.

The modern duck industry is an international business, with production in many countries and varying climatic and environmental conditions. This handbook is not designed to provide definitive information on all aspects of duck management in every scenario. It is a guide to best practice, aimed at helping customers produce the maximum number of best quality day-old duckling, as efficiently as possible, from their **Super M3 (SM3)** parent stock, whilst maintaining flock health, vigour and wellbeing.

Much of this technology is unique. It is important not to rely on previous experience of other ducks, but to apply **Cherry Valley** management to **Cherry Valley** ducks. Users must be aware of local legislation, which may influence the management practice that they choose to adopt. **Cherry Valley Farms** cannot accept any liability for the consequences of using this information as it does not control the detail of its application.

Performance Objectives

For a hatchery to achieve optimum levels of hatchability, of good quality day-olds, it is important that it receives good quality hatching eggs with high levels of fertility. The flocks supplying the hatchery with hatching eggs should be maintained at the highest possible level to achieve high levels of fertility. A high standard of management and husbandry is required to maintain breeding ducks in good condition. Feeding, bodyweight control, lighting and mating ratios all require special attention to ensure the flocks reach their potential output of day-old ducklings.

The performance of actual flocks, grown and managed in UK conditions, is used to set the objectives given in the technical data sheet. Comparative data from around the world shows that the same objectives can be achieved in other climates, with different feed and husbandry systems, providing the basic principles are accurately applied.

Technical Support

Additional information on specific issues is available from the Livestock Division Technical Department. The Technical Desk is maintained to provide a technical service to **Cherry Valley** customers worldwide and can be contacted as follows:

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Contents

Cherry Valley ducks are grown around the world in hot, temperate and cold conditions, and in a wide range of agricultural systems, to produce a variety of duck products. It is therefore important that the ducks are fed an appropriate diet correctly balanced for energy, protein, essential amino acids, minerals, vitamins and trace minerals if the birds genetic potential is to be achieved and its welfare not compromised.

The formulation and manufacture of rations for ducks follows the same general rules as apply to the preparation of wholesome feeds for any type of stock. To obtain suitable feeds it is necessary either to have a feed mill available or to buy feed from a reliable commercial supplier.

Raw Material Quality

If poor quality ingredients or incorrect nutritional values are used in feed manufacture then poor quality feeds must result. It follows that the actual analysis of the ingredients used must match the values assumed at the time of diet formulation. Some ingredients will be very consistent in composition if bought from reliable sources but blended materials, such as fish meals and meat/bone meals for example, can be very variable if not bought to a fixed specification. By-product materials, for example fractions of whole grain such as wheat middlings or rice bran, are another source of variation if average nutrient values from textbooks are assumed without checking the real quality.

As well as varying in nutrient content ingredients can also vary in other aspects of quality.

The proportion of saturated to unsaturated fatty acids in fats should be checked for starter diets because of the limited ability of young ducks to digest saturated fatty acids. The levels of anti-nutritional factors such as histamines (biogenic amines) in fish meals, or trypsin inhibitor in soya beans and field beans, should be monitored. Test kits are available to give a check on soya heat treatment for example.

Toxins, particularly mycotoxins, produced in the field (ergot and fusarium in wheat) or in storage (aflatoxin), should be controlled and monitored. Ducks are particularly susceptible to mycotoxins; they cause liver damage and reduce feed intake, growth rate and egg production. Every care should be taken to ensure that maize in particular is free of mycotoxins if possible. This can be achieved by a screening procedure that segregates grain arriving at the mill according to whether it is free of toxins or not.

Grain with moderate toxin contamination may be safe for other species of stock, allowing the clean material to be reserved for ducks. This rule may limit the sources of maize that can be used but that is preferable to the problems caused by high levels of aflatoxin and other mycotoxins.

Health Control and Feed Hygiene

It is widely recognised that feed plays a very important role in the spread of disease organisms. Salmonella and campylobacter are of particular concern because of their public health implications. To achieve the objective of minimally contaminated duck feed, a number of important steps must be taken.

Raw materials should be selected on the basis of routine bacteriological monitoring. The level of individual raw material monitoring should be dependent on the volume and frequency with which a material is purchased.

Storage areas should be periodically checked for adequate vermin controls. The mill should be designed and operated to ensure no possibility of cross contamination from untreated raw materials to finished product. The mill facilities should be kept clean.

The bacterial contamination of a raw material can be reduced by exposure to high temperatures by using specialised milling equipment such as expanders, extruders and conditioners. The degree of bacterial kill is dependent on a combination of

temperature, moisture and time. Total bacterial elimination is achievable, but at the expense of important macro and micro nutrient availabilities.
Recontamination of heat treated feed must be prevented. The hot pellets should be cooled as rapidly as possible by blowing only clean, filtered, cold air through the stream of product.

Organic acids can be successfully used to control the growth of bacteria and moulds in finished product and raw materials.
It is an advantage to use a delivery vehicle that is dedicated to feed delivery, rather than a general haulage vehicle that could be handling raw materials and other possibly contaminated products. This vehicle should be regularly cleaned, both inside and outside, with particular attention paid to the discharge system.

Diet Formulation

This service will usually be provided by the feed or supplement supplier, using his knowledge of local ingredients, to provide diets that meet Cherry Valley specification at optimum cost to the duck producer. The feeds will typically consist of one or more cereals such as wheat or maize, protein sources such as soyabean meal or fish meal, and sources of vitamins and minerals. The use of more than one cereal source and more than one protein source helps to reduce the effects of raw material variation. Sometimes a feed compounder will already be manufacturing poultry rations which meet Cherry Valley specifications and these can be used. NOTE however that chicken and turkey feeds may incorporate medications such as coccidiostats. Coccidiostats can be extremely harmful to ducks and medicated feeds should not be used with ducks without veterinary advice.

As ingredient prices change relative to each other the formulations will also need to change to minimise cost. However, large fluctuations in ingredient content should be avoided or duck performance may be upset. As already mentioned, it is also good practice to have 5-10 main ingredients so that variations in the nutritional value of any one ingredient have less effect on the nutrient content of the final feed.

Diet Form and Quality of Final Rations

For ducks it is particularly important that feed is formed into pellets, which should be no more than 3mm diameter for ducks up to 2-3 weeks of age but can be 4mm diameter for older birds.

The quality of the final ration offered to the stock depends on the quality of the ingredients and then on the quality of the manufacturing process and the subsequent storage of the feed before and during use.
Wheat based diets are more easily pelleted than maize (corn) diets but the 'fines', or dust particles, of wheat diets are far less palatable than maize fines. Dust and fines should be kept to a minimum by using the correct combination of moisture, added fat and pellet binders (commonly lignosulphonates). If pellet quality is poor then ducks will still grow, or lay eggs reasonably well but they will be very wasteful. The dust will be spilled on the floor and will also be carried on the beaks to the drinkers where contamination of the water supply will result. A mill which is accustomed to producing chicken and turkey feeds, where pellet quality is less critical, will need to be told strongly how important it is to take extra care with duck feeds.

The other aspect of quality in the final product is storage. Feed should be used as soon as possible after delivery and not stored in large quantities if it can be avoided. This is especially important in hot/humid conditions.

Good feed quality will be maintained for longer if feed is stored in a dry shaded place. Use up stocks in rotation.

Feed in bags should be stored off the ground and under cover to avoid losses and contamination by rodents and weather. If bulk bins are used for storage they should be completely emptied and cleaned out every three months and the clean bin treated inside with a mould inhibitor.

Heat and humidity will both increase the rate of decline in vitamin levels and other aspects of quality and will encourage mould growth and possible toxin production. The addition of a mould inhibitor and an

antioxidant to the feed will help to prolong its life but, in general, feed should be used within four weeks of manufacture in temperate climates and within seven days in less favourable conditions where temperature and humidity are high.

Fat Quality

Neo-natal ducklings are not capable of digesting saturated fats properly so the fat in the starter feed should be largely unsaturated (e.g. soya oil). The ability of ducklings to metabolise fats improves as they develop, so the grower and finisher feeds can include increasing amounts of saturated fat (e.g. palm oil and tallow). The higher the proportion of saturated fatty acids within a fat the higher the relative melting point. This allows the manufacture of a good quality pellet. NOTE that the fat within the final carcass will tend to reflect the fatty acid composition, hardness and other characteristics of the dietary fat. The use of a more saturated fat in grower and finisher diets will therefore help prevent the final carcass becoming too greasy.

If the feed includes an unsuitable or poor quality fat, the undigested fat will be excreted causing a greasy surface on the litter, which may lead to burnt hocks, feather damage and breast blisters.

Fats, particularly long chain unsaturated fatty acids, are damaged by heating and oxidation. Fat blends often include waste products from commercial frying operations and the by-products from chemical processes, such as distillation residues from oil refining. These will need to be protected by ant i - oxidant s such as B.H.T (butyatedhydroxytoluene), B.H.A.(butylatedhydroxyanisole) and ethoxyquin.

The use of anti-oxidants in the feed, e.g. vitamin E, can have an important mitigating effect on fat quality and quantity. The use of increased levels of vitamin E may be beneficial when fat quality is marginal, or fat additions are higher than normal (e.g. hot weather feed specifications).

A suitable fat blend for use in duck feed should be based on the following:-

Free Fatty Acids	Max 50%
Non elutables	Max 10%
Moisture and Impurities	Max 1%
Unsaponifiables	Max 3%
Oxidised Fatty Acids	Max 3%
Antioxidant	200 ppm synergistic blend of BHA and BHT
Pesticide Residues:	Should be tested for and certification should be available.

Taking Samples

A good feed sampling technique is as important as good laboratory practice if the result of the analysis is to reflect the real content of the feed. The sample must be representative of the feed from which it was taken, and this cannot be achieved by 'grabbing' a sample of feed from the feed trough.

A 20 tonne bulk load of finished feed will be made up from a number of different mixed batches of raw materials; for example, it may consist of 10 batches from a 2 tonne mixer or 5 batches from a 4 tonne mixer. It is unlikely that these batches will be identical in composition. So to get a representative sample of feed it is necessary to take a number of sub-samples and combine then to make a composite sample. Take at least 5 sub-samples from any size of load.

Every feed delivery should be sampled in this way and the samples should be stored in a refrigerator. The samples should be retained until the birds have been slaughtered, and need be analysed only if a production problem has arisen. Always record details of the date, the location and the feed type of the sample. It is often beneficial to discuss with the feed analyst the situation that has arisen and they will be able to advise on the most appropriate tests and give you an insight as to what the results show. Share the results of any analyses with your feed supplier so that they know you are checking.

Aflatoxins

Mycotoxins are toxins produced by fungus development. So far some 200 different toxins have been identified. Aflatoxins are mycotoxins produced by particular strains of fungus; the Aspergillus species. They were first identified in 1960 following the large losses due to 'Turkey X' disease.

Toxins arise when particular moulds grow in suitable conditions of moisture and temperature. Note that moulds may proliferate without producing toxins, so mouldiness does not itself indicate toxicity.

Aspergillus flavus is ubiquitous and able to grow on any product of high carbohydrate content in a wide range of environments.

TABLE 1 - Table of Typical Analysis Reason

Analysis	Reason
Crude Protein	Indication of quantity but not quality
Manganese	Inexpensive method of assessing vitamin and trace mineral supplement inclusion
Calcium	Separation may occur if pellet quality is poor so high or low results may indicate poor mixing
Total Phosphorus	Availability is approximately 60-65% of total phosphorus
Salt	Indicator of sodium level, but assumes all chloride in the diet is in the form of NaCl.
Vitamins	Vitamin analysis is expensive. Vitamin A is easiest to assess and may be used to indicate correct supplement levels.

Agricultural products world-wide are therefore vulnerable. In fact, the USDA at one point failed to find a single aflatoxin-free control sample of grain when planning trials.

Aflatoxins were first found naturally in peanut meal in supplies from Brazil and then from elsewhere. Aflatoxins are found in many other ingredients, notably maize. Discoloured maize may have a high aflatoxin content, but this is not an invariable rule.

There are considerable annual and regional differences in maize aflatoxin content. In a striking survey in France some years ago, out of 380 batches of ingredients or compounded feed 167 were toxin-contaminated. Note that in a contaminated batch, less than 1% of the grains may account for all of the toxin, so sampling needs to be thorough and precise if a true picture of a bulk commodity is to be established.

Assay of Aflatoxin

The early work on chemical characterisation was carried out at the Tropical Products Institute in London. It was shown in 1962 that the first aflatoxin isolates contained 4 main components called B1 and B2 (shows blue under ultraviolet light) and G1 and G2 (turquoise under U/V light). B2 and G2 are metabolites of B1 and G1, respectively.

Agricultural products vary widely in chemical composition and a range of extraction procedures has been developed to deal with excess fat, etc. Natural lipid components, primary aflatoxin extracts and other products may be present, especially in cereals, which have similar fluorescent properties to aflatoxins.

Various tests for mycotoxins are available. Cottonseed or corn (and perhaps other grains) may show a bright green/yellow fluorescence under an ultraviolet light. This is not directly due to aflatoxin, but there is sufficient correlation between the two to use this as a presumptive test. However, aflatoxin may be present in up to about 20% of non-fluorescing samples and false positives also occur. Test kits are also available for field use and can be used for initial screening purposes. Again false positives and negatives may occur.

At a laboratory level there is a mini-column method of qualitative assay, which takes 20 minutes to complete and with thin-layer chromatography, the quantitative assay is possible with 98% recovery.

Whatever assay procedure is used, the main problem is in the initial sampling as all of the toxin may be found in a few grains. A single kernel may have a toxin concentration of 1000 ppm.

Biological assay commonly uses ducklings because of their sensitivity to aflatoxins. 0.8mg. of crude toxin will kill a day-old duckling. At 7 days of age the LD(50) for oral doses are toxin B1 18.2µg; B2 84.8µg; G1 39.2µg; G2 175.5µg per 50g. body weight.

Toxin Effects

1. Poor growth and egg production - mortality.
2. Reduced resistance to infection due to reduced globulin levels
3. Liver damage, bile duct proliferation, tumours, inhibition of protein synthesis and of vitamin/mineral absorption.

The effects appear to be worse at low protein intakes. Different strains of duck seem to be equally sensitive. Mortality is often higher at the onset of egg production.

Control

Effective control requires:

a. control of field infection
b. avoidance of damage at harvest
c. control of mould spread in store

Storage Conditions

Avoid damaged grain or dirty samples. Control insect infestation.

Avoid dust build-up in feed stores and in feeders. Low temperature, moisture or oxygen level in storage will reduce toxin production. The optimum temperature for toxin production by Aflatoxin Flavus is 25°C. The incubation period for maximum toxin production is 7 to 15 days. A change in temperature may change the B1/G1 ratio (more B1 at higher temperature). The optimum RH for toxin production is 85% or greater. Fungi will not invade grain at a relative humidity of 70% or less. At that level, the moisture content of cereals would be about 13% and of high oil seeds about 7 to 10%. Avoid supplies with moisture levels higher than those values in warm, humid climates.

At all costs avoid remoisturing of dry crops as toxin production may then be high. Wet spots are especially dangerous. Note that moisture is a by-product of mould growth so that the cycle is self-perpetuating once started. Use of anti-fungal agents gives good control of mould production in store but will do nothing about toxin contamination already present in storage.

If aflatoxin is found during sampling it is recommended that substitution of ingredients takes place. The most likely sources of aflatoxin in duck feed are maize, groundnut and cotton seed.

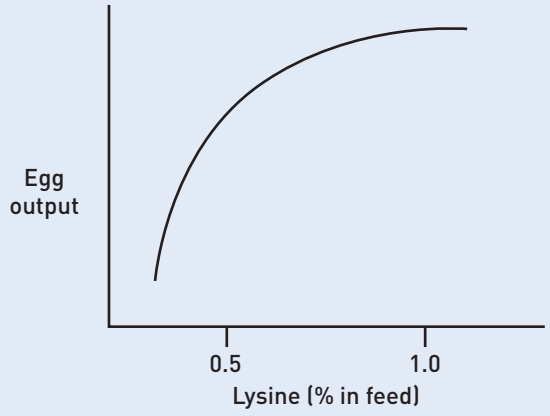
Avoid groundnut and cottonseed in duck formulations if at all possible. As far as maize is concerned try to ensure that all supplies are tested on arrival at the mill and segregated on the basis of toxin content. There is no safe minimum level of mycotoxin for ducks but levels of below 10ppb should be the target at all times.

Deciding Feed Specifications

Ducks require energy and nutrients for two purposes. First of all they must maintain themselves; that is, they must make provision for activity, keeping warm and replacing body tissues on a continual basis. Secondly they must consume sufficient additional nutrients to be profitably productive in terms of growth or egg and day-old production. Energy and nutrients for maintenance and production will usually be provided by offering a complete feed designed to satisfy the requirements of the duck.

A Cherry Valley feed specification is provided with the stock, detailing energy and nutrient concentrations in appropriate units; for example, metabolisable energy (kilocalories/kilogram) or lysine (%). These feed specifications are arrived at after extensive research work at Cherry Valley. There have been many hundred of trials over the years and the results of a typical trial, showing the response of egg output to different lysine levels (Fig. 1).

FIGURE 1: Response to diet lysine level



Duck nutrition, in common with all biology, includes many examples of the 'law of diminishing returns'. Fig. 1 is an example of this 'law'. It can be seen that, if we start at low levels of lysine inclusion, additional lysine causes significant Fig. 1 Response to diet lysine increase in output. As lysine concentration is increased further, however, there is less and less additional response until a plateau of output is reached. In this case the plateau is at a lysine concentration in the feed of about 1.1%. Further increases in lysine concentration have no effect. As a result of such trials with lysine Cherry Valley have concluded that the lysine specification in a duck breeder feed should be 1.1% in temperate conditions, with adjustments for other environments when necessary (see later) due to reduced intake. Similar trials on the wide range of other nutrients have resulted in the full specification tables supplied with the stock.

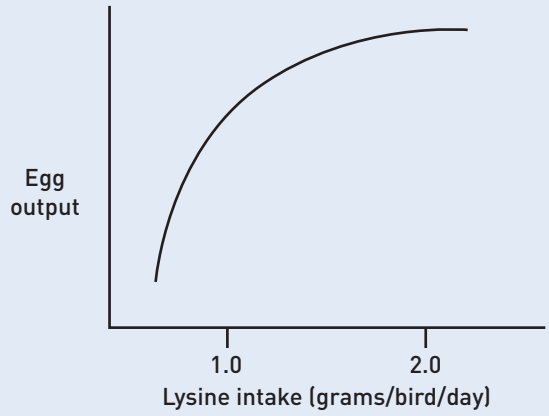
These specification tables are expressed as nutrient concentrations in the final feed. Feed manufacturers will know the nutrient concentrations in their raw materials and can thus prepare feeds which meet the required specification.

Note, however, that satisfactory performance will only result if the INTAKE of the final feeds is similar to the intake of the original trial birds. All tables offered specification ASSUME a particular level of feed intake. If feed intake is reduced below this level for any reason then the specifications must be altered.

The Importance of Feed Intake

In Fig. 1 we saw the relationship between lysine concentration (%) and egg output. However, the birds in such trials are not responding to lysine percent. They are responding to daily lysine INTAKE. An example of this response is shown in Fig. 2.

FIGURE 2: Response to diet lysine intake

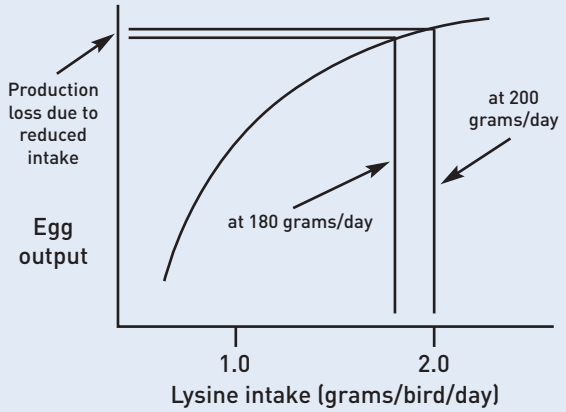


The shape of the graph is the same as before but now the optimum lysine intake is seen to be about 2.2 grams/bird/day. This lysine intake is achieved by birds eating 200 grams/day of a feed containing 1.1% total lysine. A lysine SPECIFICATION of 1.1% is thus very appropriate when birds are eating about 200 grams of feed per day.

Feed intake is not a fixed characteristic, however, and is altered by many factors which will be dealt with later. Suppose for a moment that the feed intake each day was only 180 grams/bird.

This loss of 20 grams/day of feed intake means that after meeting its maintenance needs the bird now has significantly less nutrients available for productive purposes. The loss of performance that will result with an unaltered feed specification is shown in Fig. 3.

FIGURE 3: Effect of different intakes of the same feed on egg output



Clearly if the feed still contains 1.1% total lysine then the daily lysine intake will now be only 1.98 grams/day and egg output will fall as shown. Effect of different intakes of the same feed on egg output.

In these circumstances we need therefore either to increase feed intake back to 200 grams/day to match the feed specification or we need to increase the specification so that we get the required NUTRIENT intakes at an intake of 180 grams of feed/day. The action to take depends on the reason for intake being reduced.

Reasons for Reduced Feed Intake

Assuming that feed is freely available, the main causes of reduced feed intake are poor feed quality or climate.

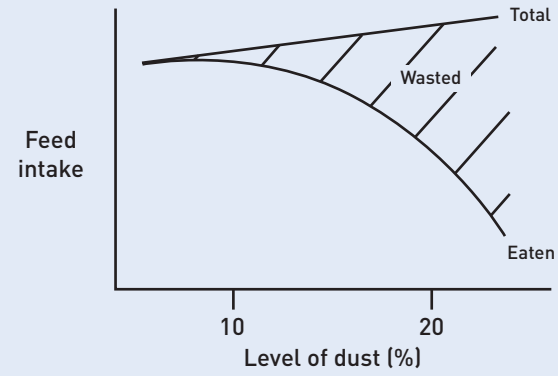
Poor feed quality may consist of poor pellets with too much dust or the presence of toxins or rancid ingredients. Any of these problems will make feed unattractive to the duck and feed intake, and therefore production, will fall. Toxins and rancidity in ingredients can only be overcome by putting more emphasis on the quality of raw materials.

Emphasis on feed quality will involve close co-operation with the feed mill and its ingredient suppliers. In the case of toxins, other stock may be much more tolerant, and so the ingredients with lowest toxin levels can be reserved for ducks without creating a problem for other species.

Moulds, toxins or rancidity in the final feed may be caused by poor storage on the farm or by keeping feeds for prolonged periods in conditions of high temperature and humidity. Feed should be consumed if possible within a week of manufacture in these conditions. The formulations should also include antioxidant protection and a mould inhibitor at the manufacturer's stated levels to protect the feed against rapid deterioration.

Dusty feed, especially if the dust is fine, will also reduce feed intake. An example of this effect is shown in Fig. 4. Increased wastage can also mean that actual levels of consumption are in fact much lower than recorded intakes.

FIGURE 4: Effect of dusty feed on feed intake



If facilities for adding molasses to the feed (up to 5%) or for spraying fats on the outside of the pellets are available then these measures will help to improve feed physical quality.

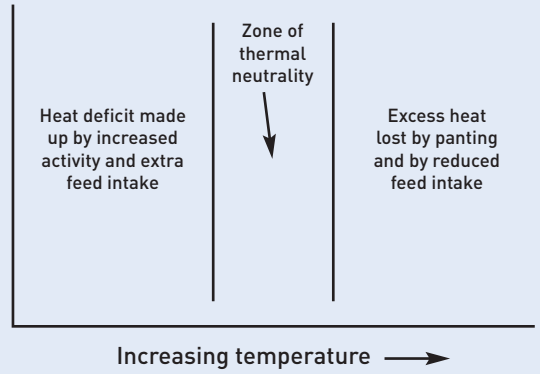
Fig. 4 Effect of dusty feed intake In the case of all feed quality problems the birds will eat more as soon as the problem is removed. Therefore, in those circumstances the feed specification may not need to be changed.

However, where the climate is responsible for the reduction in intake, the specification of feed MUST be changed unless the environment in which the birds are housed can be changed.

The Effect of Climate on Feed Intake

When the duck uses its feed for maintenance and production it is involved in the physical activity of eating and drinking as well as the chemical activity of digestion and absorption. All of these activities produce heat. The effect of this heat production on the bird is shown in Fig. 5.

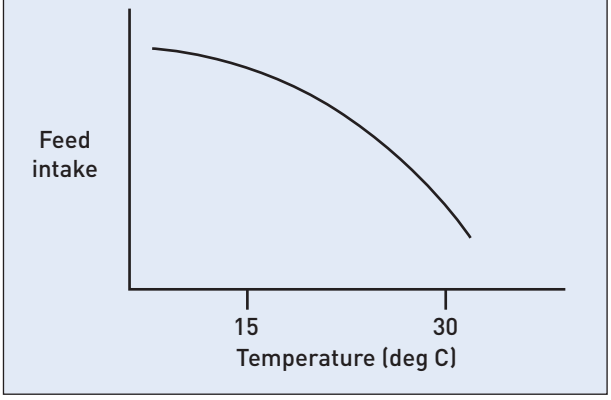
FIGURE 5: Heat output at different temperatures



If the climate is very cold this heat output will be insufficient to maintain a stable body temperature and the bird will tend to eat more feed to use as fuel to keep warm.

When the climate becomes progressively hotter the bird is first of all in a stable heat balance with the environment but then reaches the point where it can no longer get rid of the excess heat by stretching out its limbs or by panting. The only mechanism left is to reduce the heat production of eating by eating less. The bird is suffering from temperature stress and this stress is greatest when high temperatures are combined with high humidity. The typical effect of temperature on feed intake is shown in Fig. 6.

FIGURE 6: Effect of temperature on feed intake



Modifying Feed Specifications to Deal with Hot Climates

The bird reduces its intake in hot climates because it is suffering from heat stress. With ducks this stress does not usually result in significant loss of stock, simply a costly loss of performance. This loss of performance is mainly a response to the reduced feed intake shown above and also to some alteration of metabolism due, for example, to panting. The actions followed, therefore, have to tackle these two problems. As far as loss of intake is concerned, we are faced with a bird which does not want to eat any more because to do so will raise its heat output.

We therefore need to define feed specifications which will allow a greater nutrient intake for the heat output that the bird indicates it can deal with. In other words we have to reduce the heat increment of the feed and a number of actions may be helpful in doing this.

Use the maximum level of fat inclusion to increase the proportion of energy from that source. Increase amino acid levels in proportion to feed intake reduction but keep protein level to the minimum at a cost in order to minimise the non-essential amino acids the birds has to deaminate. For example, if breeders lose 20% intake we would increase the lysine and other amino acid specifications by 20% but try to stop protein content moving at all.

This will in turn call for more use of synthetic amino acids and better quality proteins.

As well as amino acids, also increase the major nutrients, other than protein, in proportion to the intake loss. In the case of phosphorus it may be beneficial to place less reliance on animal by-product as a phosphorus source if they are unreliable in analysis.

Instead, use either a mono or a dicalcium phosphate of good quality.

Increase the level of vitamin/mineral supplement by MORE than the estimated intake loss as it will not cost much to err on the safe side where these micro-nutrients are concerned.

Finally, to deal with altered ion balance, we can consider using in the feed, or the water, a mineral source such as potassium chloride, or potassium sulphate, or sodium bicarbonate. This will help to compensate for the effects of panting and will avoid dehydration.

A Practical Example

Earlier, breeder ducks with feed intakes of 180 grams/day were discussed. If that reduced intake was caused by climate rather than poor feed quality it would be necessary to adjust feed specification.

For this particular case the original specification and the adjusted version are shown in Table 2.

Other nutrients not mentioned below should be increased as well, in proportion to the intake reduction. In addition every effort must be made by good management to ensure best use is made of any cool part in the day.

It is impractical to quote tables of specifications for all circumstances. Instead it is Cherry Valley policy to publish a table of basic specifications and modify these according to feed intakes found under local customer conditions. Close observation by the customer, and close co-operation with our technical team ensure that the best solution is found in each case.

TABLE 2 An example of specification adjustment to deal with reduced feed intake caused by climate Nutrient Diet level at a feed intake of 200 gram/day Required level when feed intake is only 180 grams/day.

Nutrient	Diet level at a feed intake of 200 gram/day	Required level when feed intake is only 180 grams/day
Energy	2700 kcal/kg	3000 kcal/kg (using as much fat/oil as possible)
Protein	19.5%	Less than 19.5% if possible
Total Lysine	1.2%	1.33%
Methionine + Cystine	0.68%	0.76%
Calcium	3.75%	4.2%
Available Phosphorus	0.4%	0.44%
Vitamin/mineral	See specification	25% extra

The following diet specifications are intended to provide the minimum nutrient levels to achieve good performance from both commercial and parent SM3 stock.

All these specifications are for ducks reared in temperate climate conditions with a mean diurnal temperature of 12°C-24°C. When the mean diurnal temperature exceeds this range the duck's nutrient requirement changes and the dietary specifications should be modified as described in the 'Temperature Response' section.

Recommended supplement levels of key vitamins and trace minerals are given.

Commercial Diets

A four-stage feeding programme is described, based on two starters, one grower and one finisher type feeds. Feed changes occur at defined ages. Typical cumulative feed intakes for the SM3 heavy are given below:

9 days	450 grams/bird
16 days	1170 grams/bird
42 days	6540 grams/bird
46 days	7700 grams/bird
49 days	8630 grams/bird
54 days	10,210 grams/bird

If rearing only a relatively small number of ducks and it is not practical to implement all four stages, we would recommend that Starter 1 is used from 0 to 16 days and then the Grower feed used from 17 days to kill.

Footnotes to Diet Specification Tables

1. Protein, oil and fibre values are given for general guidance only. What is important is that ME and individual amino acid specifications are met.
2. Metabolisable energy (ME) values are suggested minimum levels. It may be economic to feed higher density diets, in which case other nutrient levels should be increased in proportion to ME changes. It will be necessary to use higher density diets if feed intake is constrained by high temperatures. In those circumstances heat stress may be reduced by use of fats, synthetic amino acids and well-balanced protein, as described in a previous section of the manual.
3. Apart from choline, no reliance is placed on the vitamin contribution of the main ingredients.
4. Choline specifications INCLUDE the contribution from the main ingredients in the feed. To avoid deterioration it is recommended that choline is not included in the vitamin/mineral premix but is added separately.

Footnotes to Vitamin and Mineral Recommendations

5. Higher levels of vitamin E may be required in the presence of fats with a significant poly-unsaturated fatty acid (PUFA) content.
6. The acid form is assumed.
7. All trace mineral sources should be of high availability and free of toxic elements. Sources of poor availability may require much higher levels of supplementation and should be avoided.

NOTE:

It is advisable to ensure that a vitamin/mineral supplement is protected by inclusion of an antioxidant, such as Ethoxyquin, at the manufacturer's recommended rate.

Breeder Diets - Minimum Recommended Ration Specification for Good Performance

Notes	Nutrient		Starter 0-6 wks	Developer 7-20 wks	Breeder 21 wks to end of lay
2	ME	(kcal/kg)	2900	2850	2700
		(MJ/kg)	12.13	11.92	11.30
	Energy: Protein ratio	kcal ME / g CP	13.18	17.27	14.59
		MJ / g CP	0.055	0.072	0.061
1	Crude Protein	(%)	22.00	16.50	18.50
	Total Lysine	(%)	1.30	0.90	1.20
	Total Methionine	(%)	0.50	0.35	0.55
	Total Methionine + Cystine	(%)	0.85	0.65	0.90
	Total Threonine	(%)	0.90	0.55	0.75
	Total Tryptophan	(%)	0.21	0.14	0.21
	Digestible Protein (Dig P)	(%)	19.05	14.27	16.00
	Digestible Lysine	(%)	1.17	0.82	1.07
	Digestible Methionine	(%)	0.47	0.33	0.51
	Digestible Methionine + Cystine	(%)	0.82	0.62	0.87
	Digestible Threonine	(%)	0.76	0.52	0.71
	Energy: Digestible Protein ratio	MJ / g Dig P	0.064	0.084	0.071
1	Oil (Fat)	(%)	4.00	4.00	4.00
	Linoleic Acid	(%)	1.00	0.75	1.50
1	Fibre	(%)	4.00	4.50	4.00
	Calcium	(min %)	1.00	0.90	3.75
	Available Phosphorus	(min %)	0.50	0.40	0.40
	Calium: Av Phosphorus ratio		2.00	2.25	9.38
	Sodium	(min %)	0.18	0.18	0.18
	Potassium	(min %)	0.60	0.40	0.60
	Chloride	(min %)	0.18	0.14	0.18
3/4	Chlorine	(g/tonne)	1500	1500	1500
	Vitamin and Mineral Supplement		1	1	3

Commercial Diets - Minimum Recommended Ration Specification for Good Performance

Notes	Nutrient Approximate feed quantities (per bird)		Starter 1 0-9 days 0.5kg	Starter 2 10-16 days 0.75kg	Grower 17-42 days 4kg	Finisher 43 to Kill balance to kill
2	ME Energy: Protein ratio	(kcal/kg) (MJ/kg) kcal ME / g CP MJ / g CP	2850 11.92 12.95 0.054	2900 12.13 14.50 0.061	2900 12.13 15.68 0.066	2950 12.34 17.35 0.073
1	Crude Protein Total Lysine Total Methionine Total Methionine + Cystine Total Threonine Total Tryptophan	(%) (%) (%) (%) (%) (%)	22.00 1.35 0.60 0.95 0.90 0.23	20.00 1.17 0.50 0.88 0.85 0.21	18.50 1.00 0.42 0.75 0.75 0.20	17.00 0.88 0.42 0.70 0.75 0.19
	Digestible Protein (Dig P) Digestible Lysine Digestible Methionine Digestible Methionine + Cystine Digestible Threonine Energy: Digestible Protein ratio	(%) (%) (%) (%) (%) MJ / g Dig P	19.05 1.20 0.54 0.90 0.75 0.063	17.30 1.10 0.48 0.83 0.67 0.070	16.00 0.90 0.40 0.68 0.55 0.076	14.70 0.80 0.40 0.62 0.50 0.084
1 1	Oil (Fat) Linoleic Acid Fibre	(%) (%) (%)	4.00 1.00 4.00	4.00 1.00 4.00	5.00 0.75 4.00	4.00 0.75 4.00
	Calcium Available Phosphorus Calium: Av Phosphorus ratio Sodium Potassium Chloride	(min %) (min %) (min %) (min %) (min %)	1.00 0.50 2.00 0.20 0.60 0.20	1.00 0.50 2.00 0.18 0.60 0.18	1.00 0.35 2.86 0.18 0.60 0.17	1.00 0.32 3.13 0.18 0.60 0.16
3/4	Chlorine Vitamin and Mineral Supplement	(g/tonne)	1500 1	1500 1	1500 2	1500 2

Vitamin and Mineral Recommendations

	Supplement		1	2	3
Notes	**Vitamin** /tonne of finished feed	**Units**			
	A	mIU	14	10	15
	D3	mIU	3	3	4
5	E	grams	100	100	100
	B1	grams	3	3	5
	B2	grams	12	10	16
	B6	grams	4	3	4
	B12	mg	25	15	25
	K	grams	10	10	5
	Folic acid	grams	2	2	2.5
	Biotin	mg	250	150	200
6	Nicotinic acid	grams	75	45	50
6	Pantothenic acid	grams	16	12	20
7	**Trace Minerals** /tonne of finished feed	**Units**			
	Maganese	grams	100	80	100
	Zinc	grams	100	80	100
	Copper	grams	15	15	15
	Iron	grams	50	50	50
	Colbalt	grams	1	1	1
	Iodine	grams	2	2	3
	Molybdenum	grams	0.5	0.5	0.5
	Selenium	grams	250	250	250

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