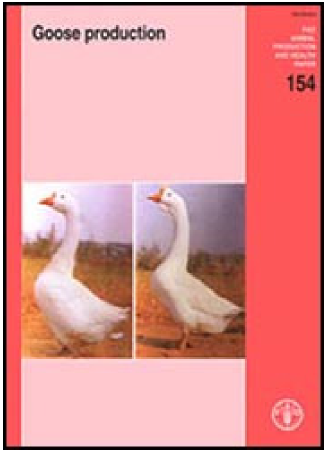
Goose Production



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NOTE TO READERS

The authors wish to point out that readers will find some repetition in the first part of this publication and the chapters that deal specifically with goose production in Asia, Eastern Europe and South America. They will also notice that production methods differ from region to region, sometimes considerably. Conditions of goose production can change for a variety of reasons but the most common are climatic conditions and local customs.

Readers are advised to analyse all the possibilities presented here before choosing the solution most appropriate for their personal situation. Successful goose production depends, above all, on the producer's ability to observe and to adapt. As in any enterprise, success does not come automatically - it is necessary to dedicate time and patience to the task. Only in this way can the recommendations contained in this publication lead to successful goose production.

PART I - GOOSE PRODUCTION SYSTEMS

by

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and

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INTRODUCTION

The objective of this publication is to provide the reader with a guide to sustainable goose production systems that are based on the natural physiological and behavioural advantages of the goose.

The goose is ideally suited to sustainable animal production practices because:

- it can consume and digest large amounts of high fibre feedstuffs;
- its behavioural patterns make it easy to manage;
- it has a rapid growth rate, the fastest of avian species used for meat;
- its feathers and fatty liver are valuable additional products.

Since geese are selective with respect to what plants they eat, they can be used to weed a large variety of crops. In addition, their patterns of behaviour make them not only easy to manage as a flock but also mean that they can be very effective guard animals.

Chapter 1. ORIGINS AND BREEDS OF DOMESTIC GEESE

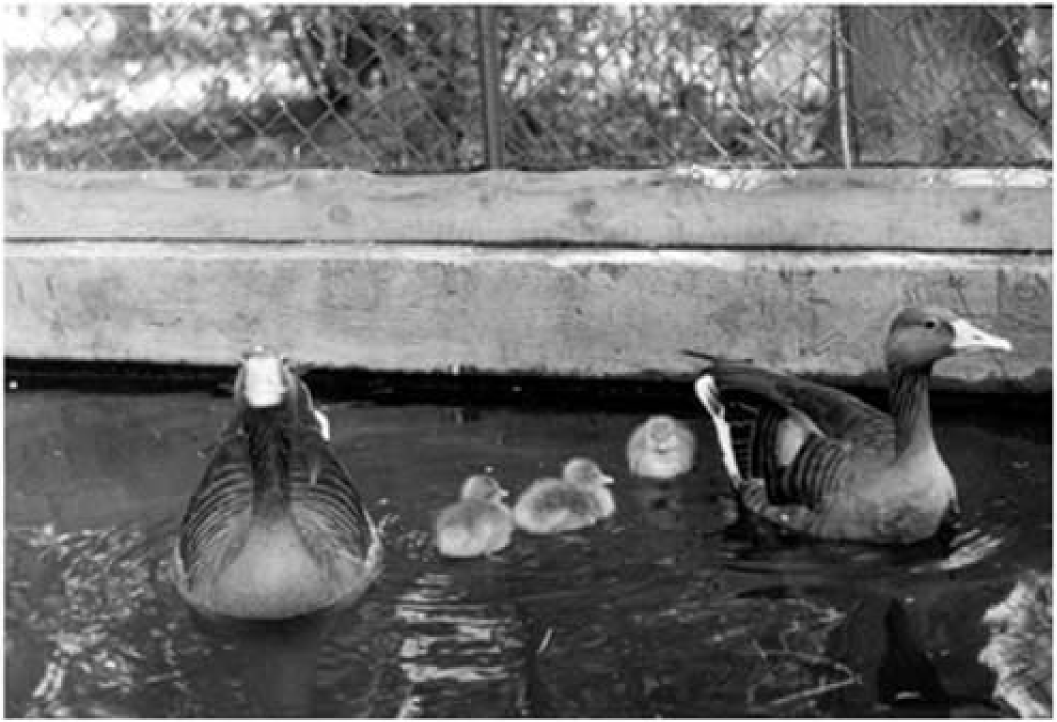
It is generally accepted that geese, which are of the Family *Anatidae* and the Genus *Anser,* were one of the first animals to be domesticated. Their domestication probably took place in Egypt about 3 000 years ago, although some research suggests that it may have been even earlier. Despite this, geese have never been exploited commercially as much as chickens or even ducks have been.

Geese are found worldwide. They can adapt equally well to hot climates (as long as shade is provided) as to cold climates - as seen in their ability to withstand northern winters out of doors with the minimum of shelter. In spite of this broad adaptability, commercial goose production is only important in relatively few countries in Asia and Europe.

Domestic geese come in a wide range of colours, sizes and shapes. In general, domestic breeds are much larger than their wild ancestors although they have in many cases retained their ability to fly.

There are two main types of domestic geese. The first are thought to have their origins in Europe, descendants of the wild Greylag goose (*Anser anser*) and the second are thought to have their origins in Asia, descendants of the wild Swan goose (*Anser cygnoides*). Crosses between the domestic breeds which have originated from these two species of wild geese are fertile and in fact have resulted in a number of recognised breeds.

FIGURE 1. Wild Greylag (*Anser anser*) geese (Poland)



(*Source:* Chelmonska, 1995)

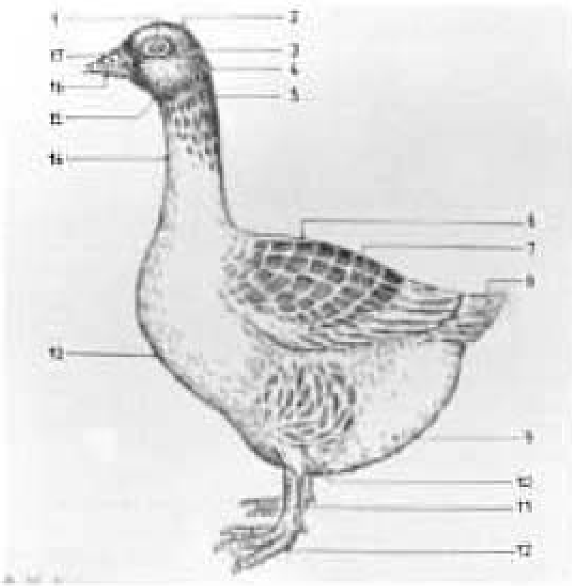
Over the centuries many countries, and even regions within countries, have developed their own breeds and types of geese. But although there is a large pool of genetic material available for the genetic improvement of the domestic goose, it appears to have been relatively under-utilised. In addition, there are also species of wild geese which could be domesticated or could at least contribute to the commercial goose germplasm. For example, from temperate climates, there is the Canada goose (*Branta canadansis*) of North America and the American Swan goose (*Coscoroba coscoroba*) of southern South America. From the tropics, there is the Egyptian goose (*Alopochen aegyptiacus*) from Africa, the Nene goose (*Branta sandvicensis*) from the Hawaiian Islands, the Bar-headed goose (*Anser Indicus*) from India and central Asia, the Northern Spur-winged goose (*Plectropectus gambensis*) from Africa and the Semipalmated (magpie) goose (*Anseranas semipalmata*) from Australia and New Guinea.

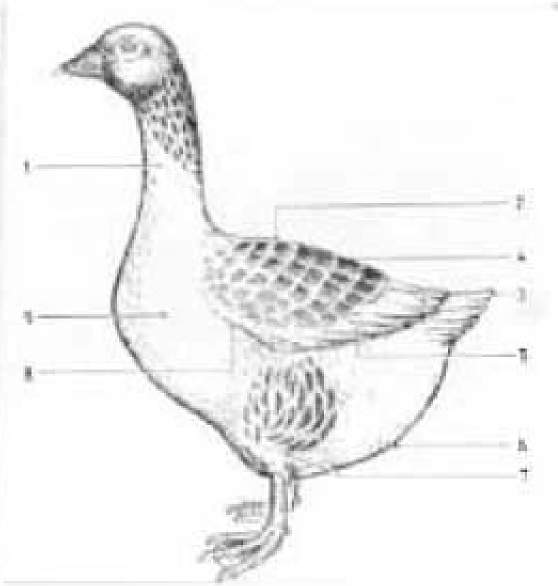
This book will deal only with domestic geese that descended from either the Greylag goose (*Anser anser*) or the Swan goose (*Anser cygnoides*).

From the research for this book and a search of its Animal Genetic Resources Data-base, The Food and Agriculture Organization of the United Nations (FAO) have identified 96 breeds or genetic groups of geese, although there are probably more. Many of these breeds, although important world germplasm resources, are of little direct economic importance today because of their relatively low performance level and/or their low numbers and limited geographic distribution. In addition to these breeds, both old and new, there are a number of commercial cross-breeds made available by companies specialising in goose breeding.

In this section on breeds of geese, detailed information is provided on a number of representative breeds from around the world. In Appendix I all the breeds which FAO has been able to identify are listed, along with their performance characteristics.

FIGURE 2. The external parts and feathers of the goose





1. Eye
2. Crown
3. Ear
4. Back of head
5. Neck
6. Back
7. Wing
8. Tail
9. Abdomen
10. Thigh
11. Shank
12. Foot with web and toes
13. Breast
14. Throat
15. Dewlap
16. Lower beak
17. Upper beak with nostril

1. Neck feathers
2. Back feathers
3. Tail feathers
4. Wing coverts
5. Flight feathers
6. Fluff
7. Thigh feathers
8. Wing secondaries
9. Breast feathers

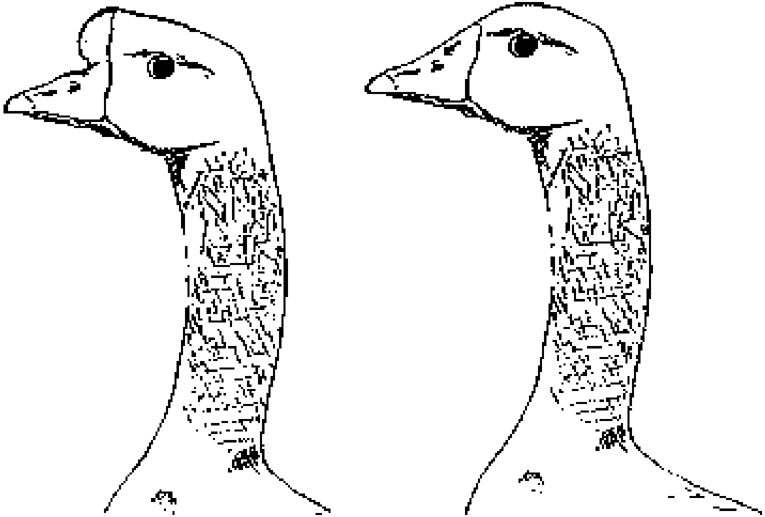
(*Source*: Schneider, 1995)

CHINESE (*Anser cygnoides*)

There are over 20 breeds of *Anser cygnoides* geese in China. The breed described here is the one commonly known throughout Europe and North America as the Chinese goose and readily identified by the knob at the base of its beak (Figure 3).

There are white and brown varieties but the white variety is by far the more popular. The declining popularity of the brown variety is probably due to the fact that when the birds are killed, the coloured pin-feathers produce a less attractive carcass than the white feathered variety.

FIGURE 3. Head of *Anser cygnoides* (left), and *Anser anser* (right)



(*Source*: Guy, 1996)

The white Chinese geese have orange shanks, beaks and knobs while the brown variety has orange shanks but its beaks and knobs are black or very dark green. One feature of the knob is that it can be used for sexing at 6-8 weeks of age, if not before. The knob of the male is larger and more pronounced than that of the female. The Chinese goose is relatively small in body size with mature males averaging 5.0 kg and females 4.0 kg. However, the breed is known for its high egg production and there are reports of Chinese geese laying up to 100 eggs in a breeding season of approximately five months (February to the end of June) although 50-60 eggs is the average. Egg weight, at 120 g, is lighter than for most other breeds.

Because the body conformation and meat yield of the Chinese goose is not as good as that of other breeds, it has not been widely used for meat production, either as a pure breed or in breeding programmes as a female line to produce a crossbred commercial goose. However, a number of breeds of geese have been developed by combining *Anser anser* type with *Anser cygnoides* type, using the Chinese goose as described here.

The Chinese goose is reported to be very effective as a guard animal. In addition it has strong legs and when required, can range over large distances to forage. This may explain in part why the distribution of this bird extends beyond the borders of China and why they are commonly found in countries like Siberia and India.

CZECHOSLOVAKIAN WHITE (*Anser anser*)

This goose is a white goose with orange shanks and an orange beak. It is also known as the Bohemian goose. It has a relatively small body size, with the males weighing 5.0 kg and the females 4.0 kg but its egg production, averaging 45 eggs with an egg weight of 140 g, is fairly good for *Anser anser* type geese. This means it can be useful as a female line in the production of a crossbred commercial goose.

EMBDEN (*Anser anser*)

The Embden is a white goose with relatively tight feathering, an erect stand, orange shanks and an orange beak. Most strains of Embden can be sexed on the down colour of the goslings, as males are a lighter grey than females. This difference is evident until the goslings are two to three weeks of age. The breed has been relatively popular for many years in both Europe and North America. It is one of the larger breeds with males weighing up to 10.0 kg and females up to 9.0 kg. It has a moderate egg production producing 40 eggs per year with an egg size of 170 g. The Embden is suitable for heavy type meat production but is probably of more value when used as a male line in the production of a crossbred commercial goose.

FIGURE 4. A flock of embden prior to lay (Hungary)

(*Source*: Buckland, 1995)

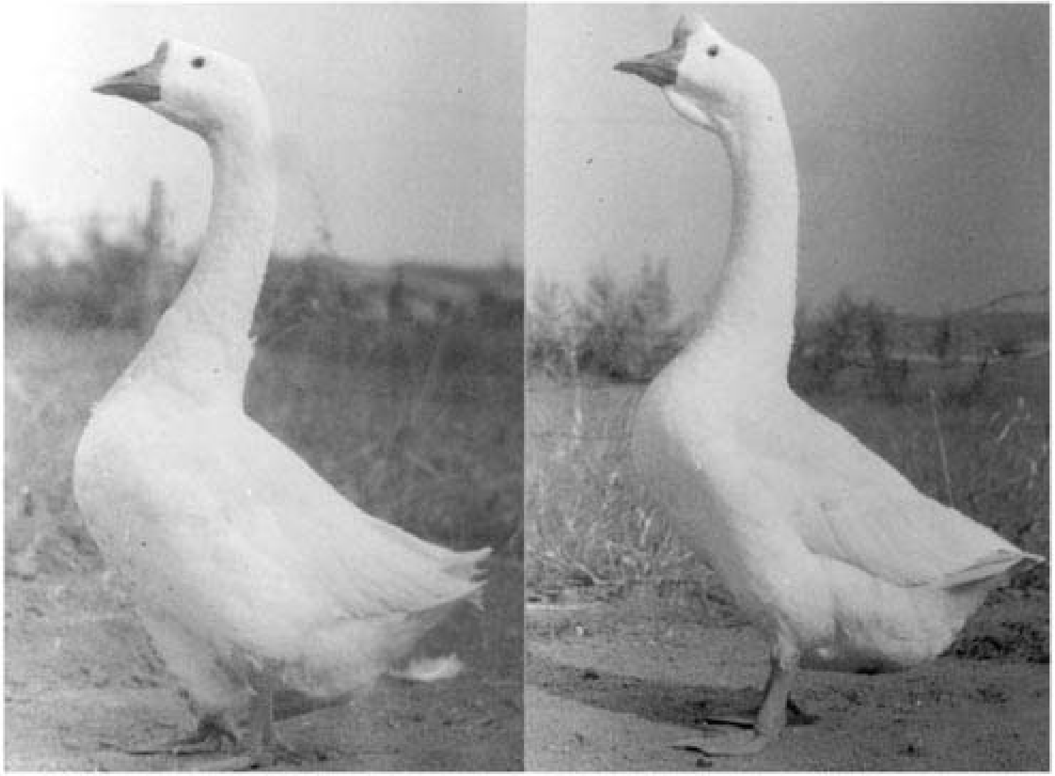
HUOYAN GOOSE (*Anser cygnoides*)

The Huoyan breed of geese originates from Changtu country in Liaoning province of China. It differs from the Chinese goose described previously in that it has a lighter body weight, and a very high rate of lay (Huoyan geese can lay more than 200 eggs per year). Huoyan geese have orange shanks and orange beaks, but there is considerable variation in feather colour.

In 1981 the Animal and Veterinary Research Institute of Tie Ling in China obtained 500 Huoyan geese and began a genetic selection programme focusing on egg production. In addition to selecting for egg production, birds which were not white and which did not have openings in their eyelids were culled. The results presented here gives performance data for these Huoyan goose after four generations of selection.

These selected Huoyan geese begin to lay at approximately 240 days of age and produce between 90-210 eggs per laying period with 10 percent of the geese producing 210 eggs per laying period. Egg weight ranges from 120-210 g. The adult body weight of the males ranges from 4.0-4.5 kg and that of the females from 3.0-3.5 kg. The Huoyan goose is noted for its ability to make good use of rough fodder and for its resistance to cold.

FIGURE 5. Male and female Huoyan geese

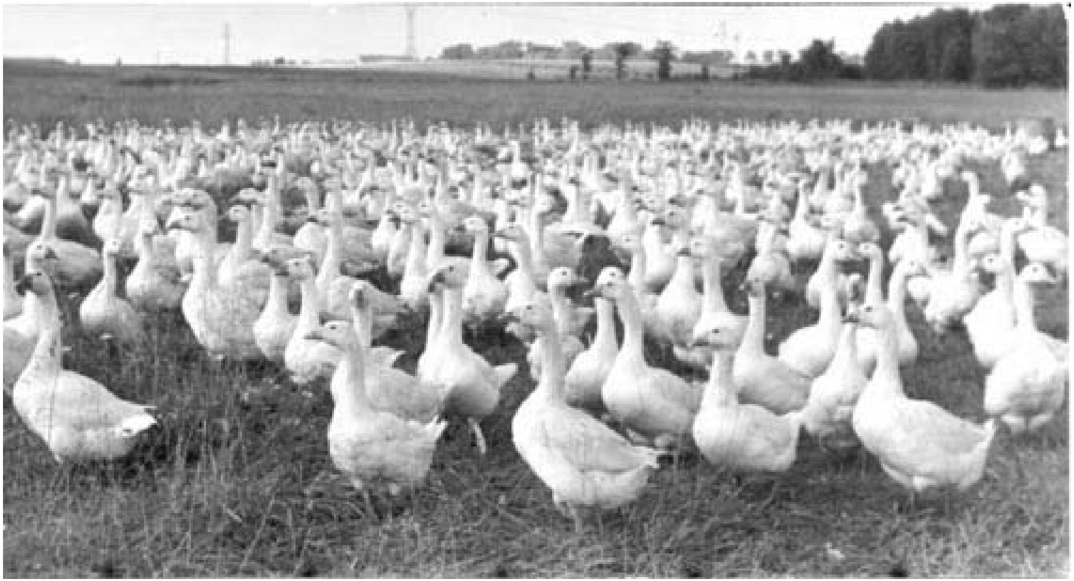


(*Source*: Chinese Academy of Agricultural Sciences, 1988)

KUBAN (*Anser cygnoides)*

This breed was developed at the Kuban Agricultural Institute (southern Russia) by crossing Gorki and Chinese geese. The feather colour is brown which results in relatively dark pin-feathers and thus an unattractive carcass. These birds have orange shanks while their beaks and knobs are black to dark green. The adult body weight for the male is 5.2 kg and 4.8 kg for the female. The advantage of this breed is that they have a relatively high egg production of between 50-60 eggs with an average egg weight of 150 g. This makes the Kuban suitable for use as a female line in a crossbreeding programme provided it is used in such a way that the resulting commercial crossbreeds are essentially white and that the poor body conformation associated with the Kuban can be overcome.

FIGURE 6. Flock of Kuban geese (Democratic People's Republic of Korea)



(*Source*: Buckland, 1995)

LANDES (*Anser anser*)

Both the males and females of this breed are grey and their shanks and beaks are orange to yellow. This breed originated in France but has been widely used in a number of other countries, notably Hungary, for the production of fatty livers (Foie Gras). Today there are a number of lines of the Landes that have been selected for their ability to produce fatty livers. They originate from the grey Toulouse geese, but today their feather phenotype is similar to the wild Greylag goose although they are much larger in body size. The adult body weight of the male is 6.0 kg while that of the female is 5.0 kg. The annual egg production is 40 eggs per female per year with an egg weight of 170 g.

FIGURE 7. Landes geese under the trees (France)

(*Source*: Buckland, 1995)

PILGRIM (*Anser anser*)

The Pilgrim is a breed of geese which was popular in North America and was recognised as a breed in 1939 but its popularity is declining. A unique feature of the Pilgrim goose is the sexual dimorphism of its adult plumage colour with the males being white and the females grey. The Pilgrim is a medium weight goose with males weighing 6.0 kg and females 5.2 kg. The annual egg production is 30 eggs per female with an average egg weight of 165 g.

POMERANIAN (*Anser anser*)

Pomeranian geese originated from the north-western part of Poland but they are also present in north-eastern Germany and the south of Sweden. They come in three colours: white, grey or white and grey. In all cases, they have orange shanks and beaks. The Pomeranian as been described as a solidly built goose with the adult body weight of the male being 6.0 kg and that of the female being 5.0 kg. The average egg production is 40 eggs per female with an average weight of 170 g.

SYNTHETIC UKRAINIAN (*Anser anser*)

The Synthetic Ukrainian is an example of a relatively new synthetic line that has been developed at the Ukrainian Poultry Research Station, Borki, Ukraine. It is autosexing at eight weeks of age because the females have grey primaries while the males are white. It is a medium sized breed with the males weighing 6.0 kg and the females 5.4 kg. It has fairly good egg production with females averaging between 47 and 53 eggs per year.

WHITE HUNGARIAN (*Anser anser*)

As the name denotes, the plumage of this breed is white and it has orange shanks and beaks. The physical characteristics of this goose are very close to the White Italian, but its body weight and egg production is lower. An improved line of this breed has been selected for feather production. It can also be used in crosses both for the production of fatty liver (Foie

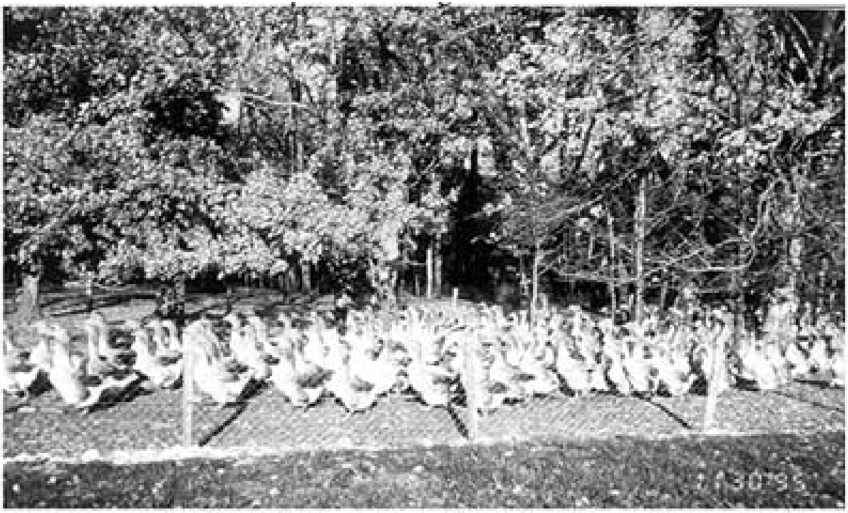
Gras) and meat. The males weigh 5.5 kg and the females 4.7 kg. The level of egg production is fairly good at 48 eggs per female with an average egg weight of 160 g.

WHITE ITALIAN (*Anser anser*)

The White Italian is a very popular breed in Europe and one often finds reference to it in the formation of local stocks. It is also a breed that has been well researched. The White Italians reported on in this publication are those kept at the Koluda Wielka Experimental Station in Poland where they have been under genetic selection since the 1960s and where separate male and female lines have been developed. Goslings of both lines can be sexed during the first ten days of life on down colour, as males are lighter in colour than females. As the name indicates, the adult plumage is white while the shanks and beaks are orange. In the male line, the average body weight of males is 7.0 kg and of females is 6.5 kg, while in the female line the average is 6.5 kg for the males and 6.2 kg for the females.

Annual egg production for the male line is 55-65 eggs while for the female line it is 60-70 eggs and egg weight for both is 160-180 g. The White Italian, at least for these strains, has the highest egg production of any of the *Anser anser* type breeds. Thus these lines can be used directly as male and female lines respectively to produce two-way commercial crosses or the female line can be used to produce a crossbred female parent line. The White Italian and particularly these lines, is therefore one of the breeds of choice for anyone wanting to produce geese for meat production.

FIGURE 8. White Italian geese on pasture (Poland)



(*Source*: Wezyk, 1995)

Chapter 2. BEHAVIOUR

The early domestication of the goose was probably as much due to its behaviour as to the products that could be obtained from it. The goose is one of the most intelligent birds. It has a good memory and does not forget people, animals or situations easily which is what makes it such a good watch animal against intruders whether human or animal.

Geese do not normally exhibit pecking or cannibalism and usually live harmoniously among themselves and with other creatures. They have very strong flocking instincts and can easily be herded from one area to another. It is because of the combination of their memory and flocking instincts that geese will return home as a flock of their own accord in the evening, even after being permitted to range over distances of 5 km or more. This allows the birds to make long trips every day, if necessary, to find their food.

Furthermore, geese are not very demanding with regard to their environmental conditions. The area in which they can be bred is very large, ranging from hot (Africa) to cold (Scandinavia) countries. The most important precaution is that the young goslings are protected from the cold during the first weeks of their life.

The goose, of all poultry species, is a bird used for multipurpose production. Raising geese provides an opportunity to produce meat at a low cost in unfavourable areas while fatty liver production requires considerable input but leads to a very high value product for an affluent market.

FIGURE 9. A flock of geese on the move (Poland)

(*Source*: Wezyk, 1995)

In the wild, the bond between a breeding pair of geese is very strong and carries over from year to year. A similar but weaker bond exists with domestic geese in small mating groups of one gander and four to six geese. In flocks larger than twenty this bond does not exist as both geese and ganders are promiscuous.

By nature, geese are independent and intelligent creatures. If you recognise and work with their unique attributes, you will find that geese can be one of the easiest and most enjoyable birds to work with.

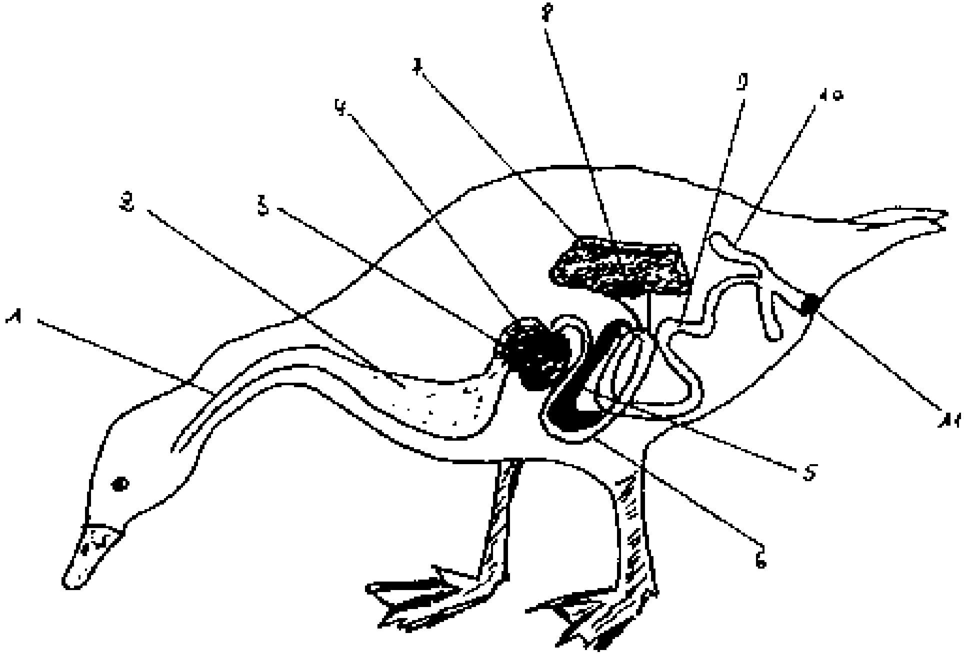
Chapter 3. DIGESTIVE PHYSIOLOGY

It is the structure and function of the digestive system of the goose which allows it to consume and digest large amounts of high-fibre feedstuffs and that sets it apart from other classes of poultry. This ability to utilise high-fibre feedstuffs, when combined with its foraging and scavenging ability and its aquatic nature, readily lends the goose to a number of sustainable agricultural systems.

At first glance, the digestive tract of the goose does not appear dissimilar to that of other poultry species. Its oesophagus is relatively long, with mucous glands to lubricate the passage of food and extends into the spindle shaped crop that serves as a reservoir for food storage. The food passes quickly into the proventriculus (stomach), the primary function of which is gastric secretion (acid and pepsin). The food then moves to the gizzard the function of which is firstly mechanical (grinding and crushing the food) and secondly to initiate protein digestion. The small intestine is the principal site of digestion involving bile, and intestinal and pancreatic enzymes. Microbiological fermentation of dietary fibre occurs in the caeca after which the digesta passes into the large intestine (there is also microbial digestion here) and then to the cloaca which is the site for both urinary and faeces excretion for all birds.

Rates of digestion of acid digestive fibre for the goose are from 15-30 percent depending on the material. The digestive system of the goose is able to digest this high level of fibre primarily for two reasons. The first is its large and muscular proventriculus and its extremely well-muscled gizzard that can develop pressures of up to 275 mm Hg as opposed to values of 180 and 125 mm Hg for the duck and the hen respectively. The action of these organs results in the release of cell sap and the crushing of the cells so that they can be subject to further digestion. The second is the microbial breakdown of fibre in the extremely well developed caeca and large intestine of the goose. This efficiency in fibre utilisation exists despite the fact that feedstuffs pass through the digestive tract of the goose relatively rapidly.

FIGURE 10. Digestive tract of the geese



1. Oesophagus

2. Crop
3. Proventriculus
4. Gizzard
5. Pancreas
6. Duodenum
7. Liver
8. Gallbladder
9. Ileum
10. Caecum
11. Cloaca

(*Source*: Guy, 1996)

Chapter 4. GEESE IDENTIFICATION

At hatching, all goslings destined for a breeder flock must be tagged so that they can be identified throughout their growing and reproductive life. The best method is to wing band each gosling after hatching, preferably using duplicate wing bands with one in each wing. At 4-6 weeks of age geese should be identified again by putting on a leg band since the wing bands will probably come off before the end of their life as adult breeders.

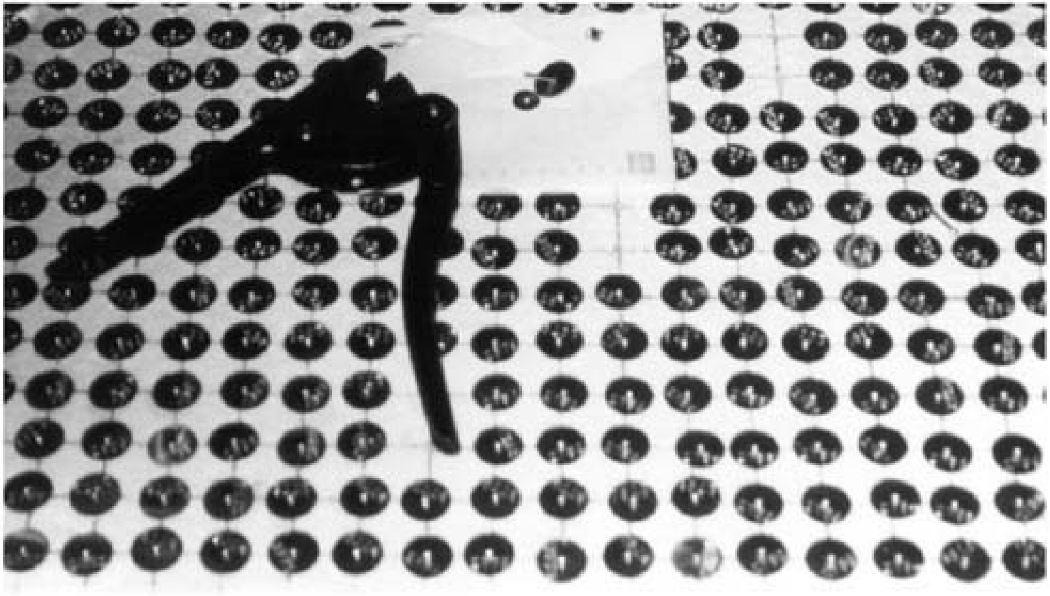
One of the most important aspects of gosling identification is that it allows for the ready identification of males and females. Goose identification is also helpful in managing the breeder flock for such things as the following:

- keeping track of geese of different ages;

- determining egg production on an individual goose basis;
- keeping records of which geese are broody and for how long;
- assisting in the culling of non-productive geese.

In addition, under free-range conditions where geese belonging to a number of people are on the same range, identification is important to determine ownership of individual geese.

FIGURE 11. Goose wing bands with crimping pliers (France)



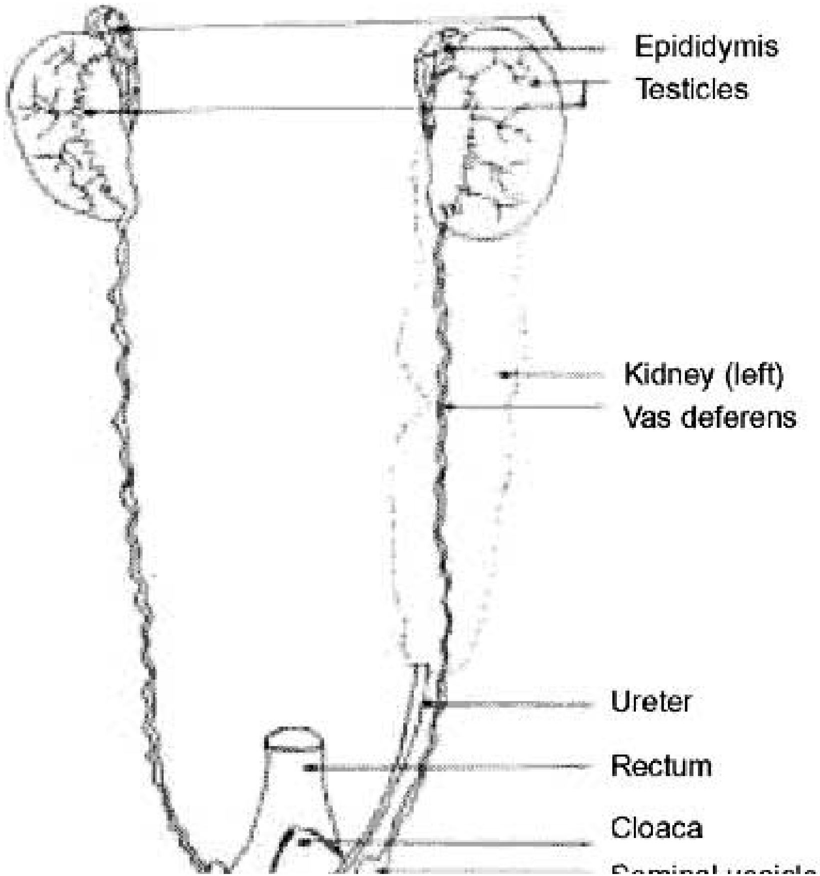
(*Source*: Buckland, 1995)

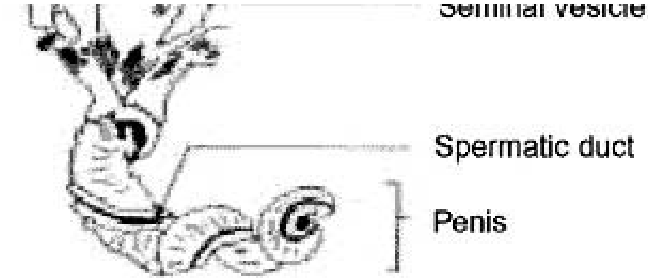
Chapter 5. MALE AND FEMALE REPRODUCTIVE SYSTEMS

This chapter begins with a description of the male and female reproductive systems followed by a section on sex determination. A good knowledge of the anatomy of these systems has allowed the development of a unique technique for semen collection and insemination adapted specifically to geese (see section on Artificial Insemination). This is slightly different from the technique used for most other avian species, e.g. *Gallus gallus*.

MALE REPRODUCTIVE SYSTEM

FIGURE 12. Reproductive organs of the gander





(*Source*: Pénichon, 1990)

The reproductive system of the gander consists of three distinct parts:

The testicles

There are two bean-shaped testicles inside the body cavity which produce both spermatozoa and male hormones. They are highly vascularized and change in size and position according to whether the gander is sexually active or not. The age of sexual maturity for ganders is directly related to their lighting programme. However, spermatozoa production does not usually begin until the ganders are at least 30 weeks of age. From the testicles the spermatozoa move to the epididymis.

The vas deferens

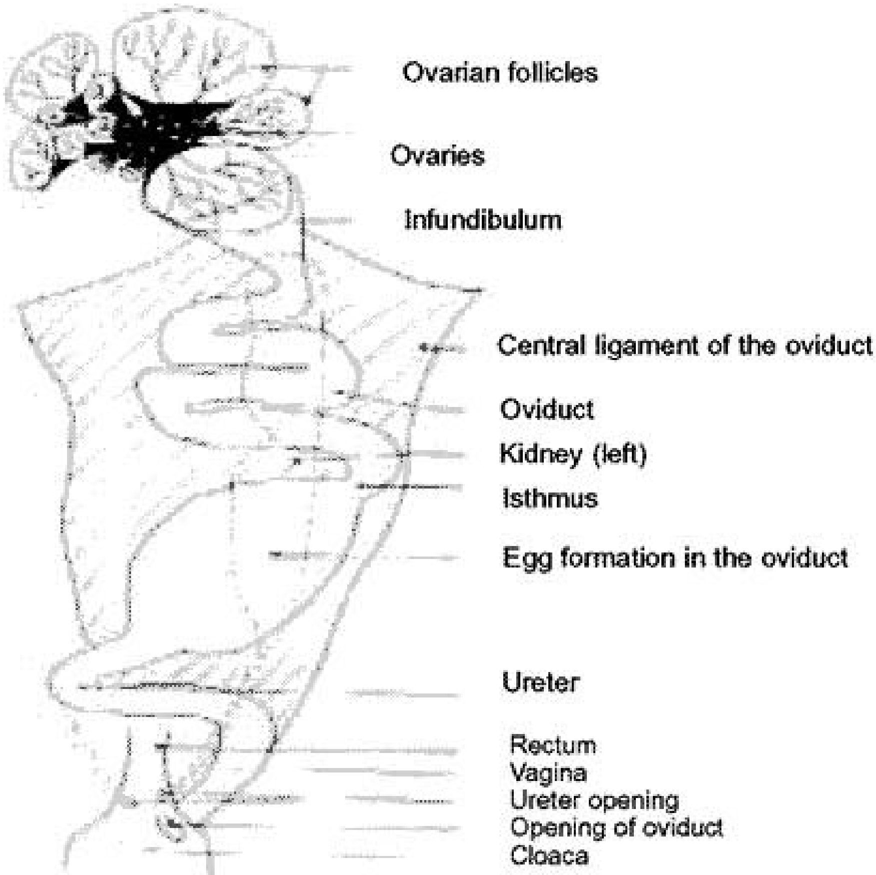
These (there are two) follow the urethras and transport the spermatozoa from the testicles and the epididymis to the copulatory organ. Their apparent length is 15 cm, but they have numerous bends and twists and in fact measure more than 30 cm. The vas deferenes are the location of spermatozoa maturation and storage. They terminate at the seminal vesicles located in the cloaca wall.

The copulative organ

Contrary to the rooster, Gallus gallus, the copulatory organ of the gander is very well developed. It is invaginated, spiral-like and is about 15 cm in length. A spermatic furrow runs along the entire length of the organ and transports the semen after ejaculation.

FEMALE REPRODUCTIVE SYSTEM

FIGURE 13. Reproductive organs of the goose



(*Source*: Pénichon, 1990)

Like most other birds, the female goose possesses a unique reproductive system located on the left side of its abdomen. The functions of the reproductive system are to produce, fertilise and mature the oocyte.

Once copulation or insemination has taken place, the oviduct plays a role in spermatozoa storage. When a mature oocyte is released on an ovulated yolk, it is picked up by the infundibulum where fertilisation occurs. The egg white or albumen is then secreted primarily in the magnum. The egg then moves to the isthmus where the shell membranes are formed. In the uterus or shell gland, water and the thin albumen are added and the shell is formed. The vagina has a muscular component that helps to expel the egg through the cloaca.

SEX DETERMINATION

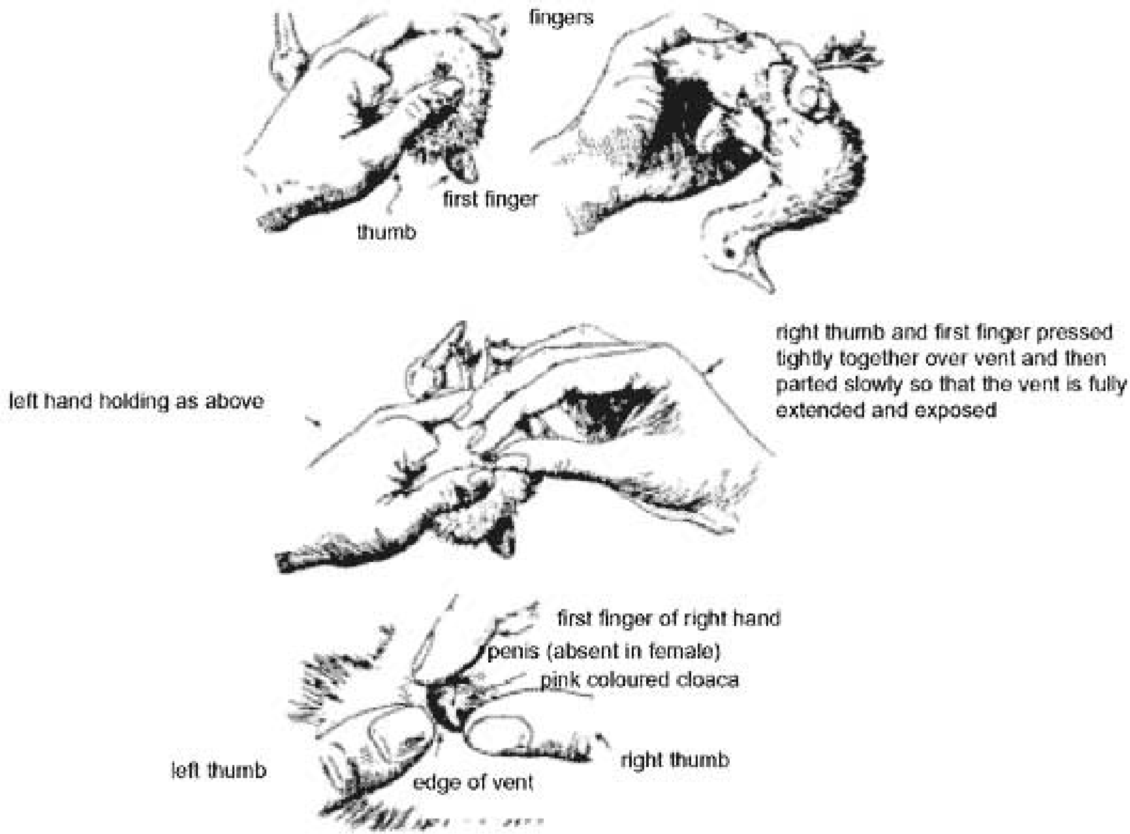
When selecting geese for breeding, the sex of each goose must be determined. With breeds such as the Pilgrim which are autosexing by feather colour (adult males are white and adult females are grey), this is simple. For Chinese breeds of geese, the sexes are readily identifiable by the size of their knob, with those of mature males being larger, more prominent and associated with a larger head. Most strains of Embden and some strains of White Italian can be sexed by down colour as goslings, since the males are lighter in colour than the females. After a few weeks of age, these sex differences in down colour disappear, so sex identification of individual goslings must be done at hatching.

Most other breeds of geese lack distinctive secondary sex characteristics and therefore to sex geese of these breeds it is necessary to examine their sex organs. However, even though geese can be sexed by examination of their sex organs, either as gosling or as adults, it is recommended that they be sexed as goslings at hatching. When this is done, a good system of identification is required (see Geese

Identification) to ensure that individual geese can be identified throughout their life. The sexing of goslings at hatching also allows for the disposal of surplus males, not required for breeding, at market age. It is recommended that one male be kept for every three females to ensure there are enough males to make up breeder groups with a ratio of one male to four or five females.

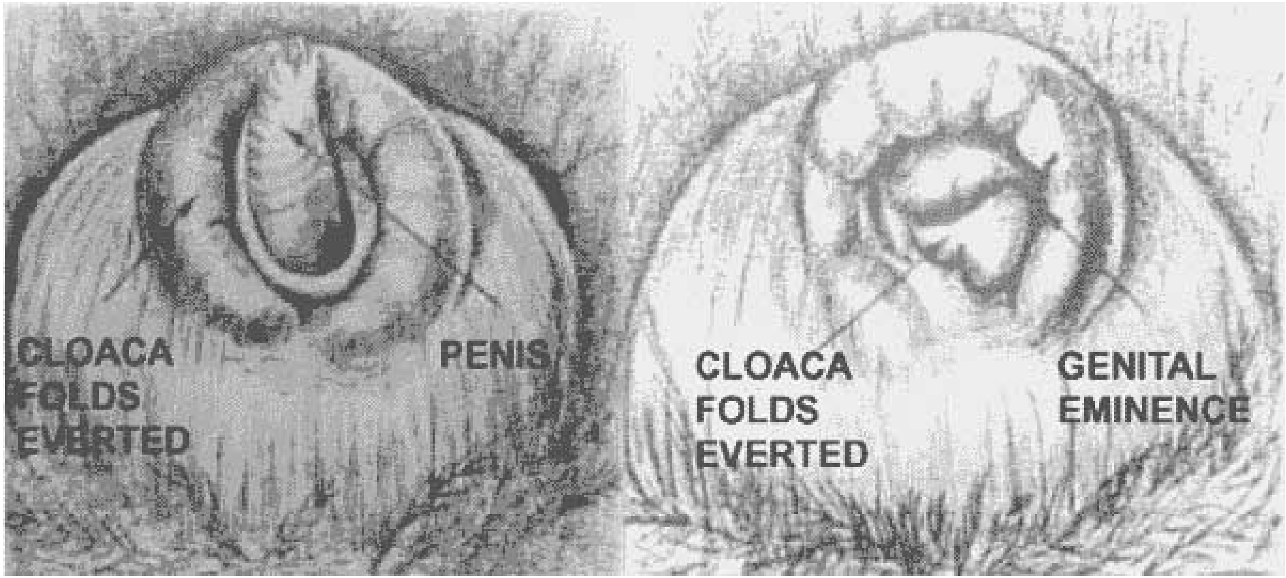
Vent sexing of day old goslings is not difficult and a little practice will make the sexing of day-old goslings a fairly easy task. Figure 14 shows how to hold a gosling, which is the same way to hold a duckling, so as to expose its reproductive organs. This process of exposing reproductive organs should take place under a strong light in order to better identify the sex organ. Figure 15 shows the male and female reproductive organs of goslings much enlarged.

FIGURE 14. Method of holding day-old goslings to expose their reproductive organs


fingers
first finger
thumb
left hand holding as above
right thumb and first finger pressed tightly together over vent and then parted slowly so that the vent is fully extended and exposed
first finger of right hand
penis (absent in female)
pink coloured cloaca
left thumb
edge of vent
right thumb

(*Source*: Hunter & Scholes)

FIGURE 15. Male (left) and female (right) reproductive organs of day-old goslings (much enlarged)



(*Source*: Ontario Ministry of Agriculture and Food)

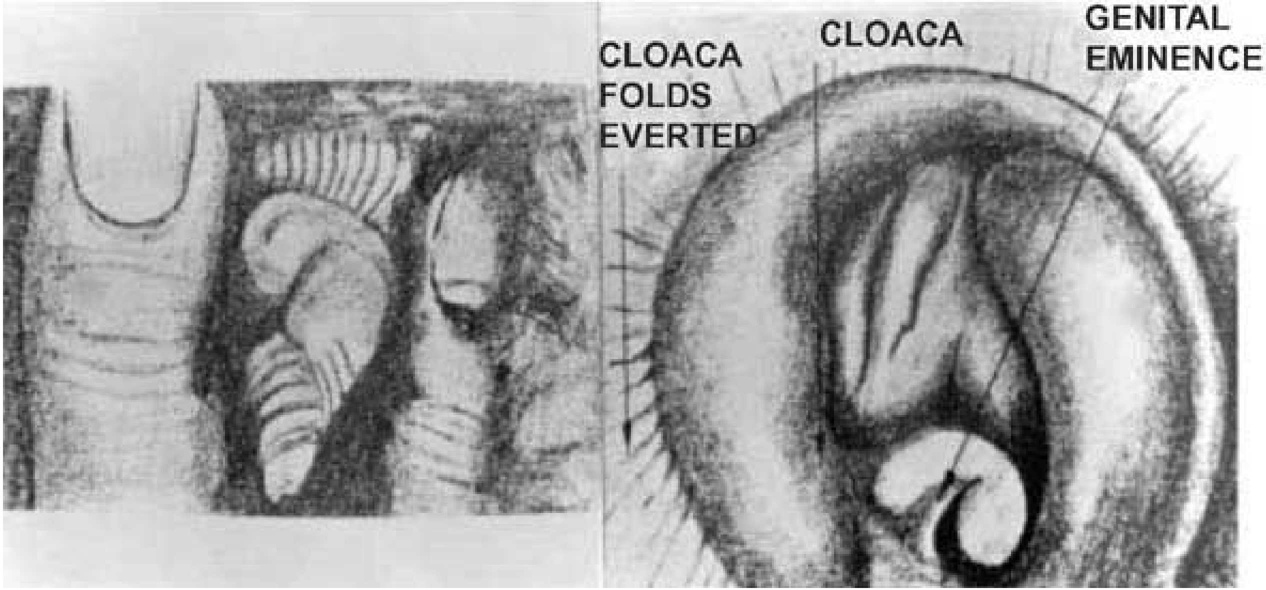
If geese are to be sexed as adults, the recommended procedure is that each goose be caught, lifted by its neck and laid on its back, either on a table or over the operator's bent knee, with the tail pointed away from the operator as shown in Figure 16.

FIGURE 16. Method of holding adult geese for sexing

(*Source*: Ontario Ministry of Agriculture and Food)

The tail portion of the bird should be out over the edge of the table or over the operator's knee so it can be bent downwards easily. The operator then inserts his/her index finger (sometimes it helps to have a little Vaseline on it) into the cloaca about 1.0 to 1.5 cm and moves it around in a circular manner several times to enlarge and relax the sphincter muscle which closes the opening. Next, pressure is applied both directly below and to the side of the vent in order to expose the sex organ as shown in Figure 17. In some birds the male organ is somewhat difficult to unsheathe, particularly if the birds are either immature or not in semen production. For this reason an inexperienced sexer can easily mistake a male for a female if, after slight pressure, the phallus is not exposed. Only the presence of a female genital eminence will positively identify a female.

FIGURE 17. Exposed reproductive organs of mature male (left) and female (right)



(*Source*: Ontario Ministry of Agriculture and Food)

Chapter 6. BREEDER FLOCK MANAGEMENT

The most important aspects of goose production are the management and feeding of the breeder flock as these can have a major impact on the reproductive rate, including the number of eggs produced, percent fertility, percent hatch, and subsequently the number of goslings produced per goose.

The total number of eggs laid per year by geese is very low compared with most other poultry species. *Anser cygnoides* geese generally have higher egg production than *Anser anser* geese. But for most breeds, the total number of eggs per year does not exceed 30-50, and sometimes less, even if the birds are under good management conditions.

Furthermore, contrary to many other poultry species, the laying period is highly seasonal which is why producers should use artificial lighting programmes to prolong or change the natural laying period.

The selection of the males and females for the breeder flock is particularly important and is normally done 2-3 months before the birds begin to lay. For spring-hatched goslings in the northern hemisphere, under natural lighting, this means that the selection takes place in November or December. Egg production in the flock will begin the following February. The following guidelines will assist in the selection of birds for the breeder flock:

- the sex of each goose selected must be known;
- select one male for every four females;

- ensure that each goose selected is identified;

- select only geese with a sound body and conformation which will enable them to remain in the breeder flock for 4-5 years;

- cull all geese that have any defects such as crooked keelbones, bad legs, crooked toes, deformed beaks or deformed eyes.

In some cases, it may also be desirable to select geese for the breeder flock based on body weight and/or egg production. If body weight is being considered, then all females selected should have a body weight of at least the average female body weight for the flock and the males selected should be 10-20 percent heavier than the average male body weight for the flock.

If egg production is being considered, the individual mothers of the geese being selected for the breeder flock must be identified and the geese (males and females) selected should only come from mothers with a high egg production. To do this means that the geese being considered for inclusion in breeder flocks can only come from flocks that are in their second or subsequent year of lay so that production records of the mothers will be available.

PRE-LAYING PERIOD

After the breeders have been selected, they may be kept with other geese until about two months before the start of lay, when they should be moved to a separate flock.

FIGURE 18

Geese being kept under four (A, B, C, D) management systems during the holding period

FIGURE 18 (A). Geese on slatted floors (France)

FIGURE 18 (B). Geese on a deep litter inside the barn and a concrete yard outside (Hungary)

FIGURE 18 (C). Geese on a pasture with deep litter inside the barn (Poland)

FIGURE 18 (D). Geese in an open yard with no shelter (France)

(*Source*: Buckland, 1995)

Putting the breeders into a separate flock before the breeding season is usually important if a high level of fertility is to be achieved. Sometimes, however, a breeder flock formed immediately before the laying period will produce a high number of goslings. It seems that most problems occur in flocks used to produce crossbreed offspring, especially when the physical characteristics of the parents are very different eg. birds with white and grey plumage. Setting up the breeder flock just before lay begins can result in fighting, a decrease in breeder performance and increased mortality. Such cases would justify establishing the flock two or three months before the beginning of lay.

In all cases it is necessary to check the behaviour of the birds carefully during the first few weeks that they are together as a flock. It must be remembered that although wild geese are naturally monogamous, with domestication the objective is to have promiscuous geese and thus a ratio of approximately one gander to four geese must be maintained to ensure a high level of fertility. In forming a breeder flock the objective is to establish a social structure in the flock, so that all geese are mated regularly, and for this reason the breeder groups are put together well in advance of the breeding season.

Once a breeder flock has been established, they should stay together as a flock for their entire reproductive life.

If the number of geese permit, it is recommended that breeder flocks be made up of four sub-flocks with one sub-flock in each of their first, second, third and fourth year of lay (assuming they are kept for four years of lay). This will permit the replacement of 25 percent of the breeder flock each year. This is also a good way to balance the total number of goslings produced each year, as geese are much more productive in the second and third years of their life.

Small village breeder flocks may consist of no more than one or two ganders and 4-10 geese. The standard recommendation for introducing new breeders is to establish a new flock to replace the old. However, this may not be possible with small breeder flocks and instead new females can be introduced as the old ones die or are culled. In this case, it is important to identify the eggs from these newly introduced geese so that the fertility of their eggs can be tested to see whether the gander is mating with them. When replacing ganders in an existing flock, it is necessary to change all ganders at the same time and to do this at least two months before the breeding season. If necessary, a flock of geese may be divided into two flocks with one flock staying with the old gander(s) and the other receiving the new gander(s).

The management of geese destined for breeder flocks is the same as that for market geese in intensive and extensive management systems, including the feeding management for the brooding and growing periods although sometimes geese for breeder flocks need a higher level of feed restriction to ensure that they do not put on excess fat during the growing period.

Recent research from a number of sources has shown that the feeding programme for a breeder flock during the 2-3 months prior to the laying period can have an important effect on the number of goslings produced per female. The results appear to apply equally to breeder flocks coming into lay for both their first and subsequent lays.

The basic principle of feeding breeder flocks during this pre-lay period is to control body weight. The general recommendation is that at two months before the beginning of lay, geese in the breeder flock should have an average body weight of 80-85 percent of their adult weight. This reduced body weight is achieved by restricting feed intake during the holding period. The amount of feed fed to the flock will then be increased two months before lay so that by a month and a half and one month before lay, the birds will be at 90 percent and 100 percent of adult body weight respectively. This increase in body weight can be achieved by increasing the amount of holding ration fed and/or by changing over to a breeder ration.

When putting geese on reduced feed for the holding period, two points should be noted: geese approaching their first laying period are normally transferred to a holding ration at between 9-12 weeks of age while geese completing a lay cycle are transferred from the breeder ration to the holding ration at the end of the laying period.

There are a number of ways to provide geese with an appropriate level of nutrient intake during this holding period, but in all cases body weight must be monitored closely.

The first is to give the geese a holding ration as a complete feed. Such rations normally have a crude protein level of 12-14 percent and an energy level of 2300-2600 kcal/ME/kg. This can be fed in conjunction with pasture or as the sole ration for geese in confinement. In both cases feed restriction must be practised to prevent the geese from overeating. The normal approach to feed restriction would be to feed between 100-200 g of the holding ration per bird per day.

The objective is to avoid any sudden change in body weight and to gradually bring the birds to 80-85 percent of adult body weight by two months before the beginning of the laying season.

A second approach is to replace the holding ration with either mixed grains or a single grain that is readily available. In this case, it is strongly recommended that the geese also have access to pasture since a diet of limited grains may be deficient in some essential amino acids, vitamins and/or minerals. The forage consumed on pasture will normally help provide these. Again, the guide for the amount of grain to feed is based on body weight. If the growth of forage slows or stops in either autumn, winter or the dry period, the geese can be provided with good quality preserved roughage such as hay, silage or root crops.

A third approach possible with good quality forage is to meet the entire nutrient needs of geese during this holding period from pasture alone. However, again, the body weight of the birds must be monitored. If they start to lose so much weight that they might fall below the target of 80-85 percent of adult body weight two months prior to the laying period, they must receive a feed supplement of either grain, kitchen waste or whatever other source of energy is available. *Note*: it is generally energy that is the limiting factor under these conditions.

In Table 1 the results of using various levels of a breeder ration for feed restriction for the two month period up to the point of 20 percent lay are presented. Restricting feed during this pre-lay period to a moderate level of 700 kcal ME per day per bird (320 g per daybird of a 2200 kcal/Kg ME diet) resulted in a slight, but non-significant drop in subsequent egg production. However, it did give a significant increase in percent fertility, which resulted in an increase of four goslings per female during the laying period. The authors also concluded that a body weight gain of 1.0-1.2 kg per bird during this period of two months is optimal. These results are valid for geese in their first year of production as well as for subsequent lays.

Another experiment that examined feed restriction during the lay period to a level of 750 kcal ME per day per bird led to a slight decrease in egg production, but an increase in fertility. On balance, the number of goslings produced was higher with the restrictive feeding system suggesting that the nutrient requirement may be different for male and female breeders, as it is with most other poultry species. However, the very small sexual dimorphism of geese does not allow different feeding programmes for ganders and geese in the same flock. This means that an important field of research in the future could be to examine the effects of different feeding systems for males and females prior to the laying period.

TABLE 1. Effect of feed restriction prior to laying on the reproductive performance of geese

	Level of Feed Restriction			
TRAIT	No restriction	Mild restriction	Moderate restriction	Severe restriction
Egg number/goose	43.6	43.7	42.5	30.5
Percent fertility	63.1	65.1	75.2	64.1
Goslings/goose	22.6	23.3	26.7	16.4
Percent mortality	2.9	0.5	3.2	3.8
Body wt. (kg)	6.7	6.4	6.2	6.0
Body wt. (kg)	7.2	6.6	6.6	6.2

(Source: Sellier et al., 1994)

The breeder ration fed contained: ME (kcal/kg) = 2216, c rude protein = 17.0%, Lysine = 0.73%, sulphur amino acids = 0.71%, calcium = 3.36% and available phosphorous = 0.68%.

Under no restriction the ration was fed ad libitum, *mild restriction was 1000 then 750 kcal ME/day/bird; moderate restriction was 700 kcal ME/day/bird; and severe restriction was 520 then 600 kcal ME/day/bird.*

The values from the two trials have been combined for all traits.

LAYING PERIOD

Feeding

The feeding of geese during the egg laying period is perhaps the most important feeding period in the entire cycle of goose production. Poor nutrition during this period will adversely affect egg production and the low rate of lay of geese is already one of the major constraints in its production. It must be remembered that the geese must ingest adequate nutrients both for body maintenance and egg production.

In recent years, research from a number of sources indicates that the energy requirements per day for the laying goose is between 800-850 kcal ME per bird per day. Unlike most other species of domestic fowl, geese are unable to regulate their feed intake according to energy needs. Therefore, taking into account the energy level of the ration, the body weight of the birds and the ambient temperature, care must be taken to ensure that:

- breeding geese do not consume too much energy;
- the daily crude protein intake during the laying period should be between 45-50 g per day depending on rate of lay and egg size. Of this 25-30 g are required solely for egg production;
- the goose must also consume between 10-12 g of calcium a day, depending on egg size and rate of lay, to meet the needs of egg shell formation which constitutes

about 12 percent of the weight of the egg;

- the intake of essential amino acids, vitamins and minerals is important and must be sufficient to support both egg production and subsequent embryo growth.

Specific breeder rations have been developed which normally contain 2200-2500 kcal ME/kg, 13-15 percent crude protein and 2.60-3.00 percent calcium as shown in Table 2.

There is, however, another school of thought which recommends more concentrated rations for breeders during the laying period with energy levels of 2700-2800 kcal ME/kg, 18-19 percent crude protein levels and calcium levels of 3.6-3.8 percent. It may depend to some extent on the concentration of other nutrients in the ration, the ambient temperature and the rate of lay, but, as stated above, breeder geese (6.5-7.0 kg) including the gander, should normally consume between 800-850 kcal ME per bird per day irrespective of the ration.

TABLE 2. Recommended dietary levels of energy, crude protein, amino acids and minerals for breeder geese during the laying period

	Ration 7	Ration 8
Energy (kcal ME/kg)	2200	2500
Crude protein	13.0	14.8
Amino acids (%):		
Lysine	0.58	0.66
Methionine	0.23	0.26
Sulphur amino acids	0.42	0.47
Tryptophan	0.13	0.14
Threonine	0.40	0.45

Minerals (%):		
Calcium	2.60	3.00
Total phosphorus	0.56	0.60
Available phosphorus	0.32	0.36
Sodium	0.12	0.14
Chloride	0.12	0.14

(Source: Leclercq et al., 1987)

In most cases, rations also be fed to laying geese with access to good quality pasture. The pasture will usually provide adequate levels of protein and vitamins, but care must be taken to ensure that the energy intake does not drop below 800-850 kcal ME per bird per day. Free access to limestone or oyster shell must be provided to breeder geese on pasture to supplement their calcium intake.

In situations where complete goose breeder rations are not available, chicken or turkey breeder ration can be used as these will have sufficient vitamins and minerals to support egg production, embryo development and hatching. If such rations are not available, the next best choice is a ration for laying chickens. Such laying rations would normally have a metabolizable energy level of 2 800-2 900 kcal ME/kg, a crude protein level of 15-17 percent and a calcium level 3.0-3.5 percent. However, they may not be sufficiently fortified with amino acids, vitamins and minerals to support embryo development and hatching.

If no such complete rations are available, then a combination of available grains, kitchen scraps and forages can be used to try to meet the nutrient requirements of the laying goose. It is of prime importance to ensure that the geese have access to an adequate source of calcium. The level of egg production that can be expected under such a system will depend on the quality and quantity of feedstuffs available (i.e. energy intake). It is important to note that the goose exhibits a great deal of flexibility with regard to its level of production under sub-optimal plans of nutrition. That is, it will readily adjust its level of growth and productivity (egg production) to its level of nutrient intake. Therefore when using an *ad hoc* ration, egg production can be expected to be between 25-75 percent of the normal rate of lay.

In Table 3 the effect of feeding five levels of protein to laying White Italian geese on daily nutrient intake and reproductive performance is presented. This experiment shows that breeder flock geese are not very demanding with respect to the protein level of their diet. At a level of 12 percent the number of eggs decreases slightly with a higher egg weight but on average, the number of goslings produced with the diets ranging from 12-16 percent of crude protein is not significantly different.

TABLE 3. Effect of feeding five levels of protein on nutrient intake per day and the level of reproductive

performance of White Italian geese

	CRUDE PROTEIN %				
	16	15	14	13	12
Feed intake (g/bird)	313	315	314	321	324
Energy intake (kcal ME/bird)	860	870	870	900	910
Protein Intake (g/bird)	51	47	44	42	39
Eggs per goose	58.3	58.8	58.0	57.5	54.2
Eggs incubated per goose	56.4	56.7	55.2	55.8	52.9
Egg weight (g)	176	178	175	173	185

Fertility (%)	85.4	91.1	88.5	88.8	89.9
Hatchability of fertile egg (%)	74.6	72.4	74.2	76.9	77.5
Number of goslings per goose	36.0	37.4	36.2	38.2	36.8

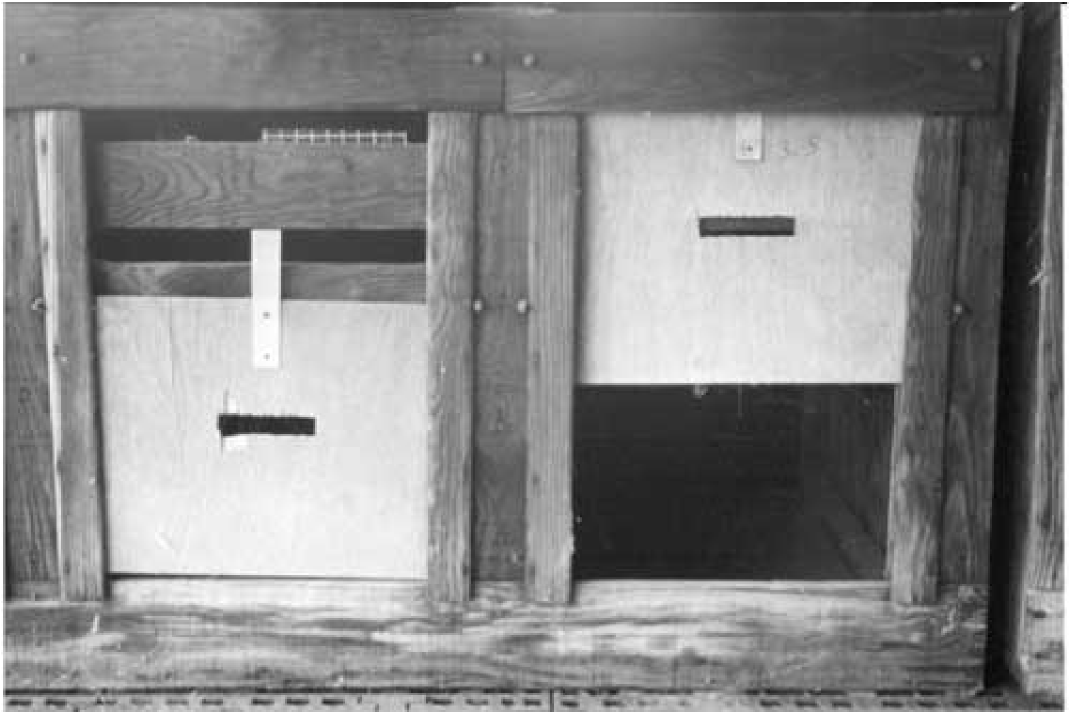
(Source: Bielinski et al., 1985)

Housing

As with all geese, the breeder flock can be kept under a variety of systems from intensive to extensive. Mating pools with water are not required for geese. The primary objective for housing the breeder flock is to maximise the number of goslings produced per goose and it is important to have well designed, clean nests in order to get clean eggs. The recommended nest size for geese is 50 cm wide, 70 cm deep and 70 cm high. Nests should be installed at ground level for easy access and have a retainer of 3-6 cm in height across the front of the nest to hold in the nesting material. There should be at least one nest per five or six geese. Eggs should be collected at least every two hours to ensure that the eggs are neither broken nor soiled by other geese entering the nest.

Trap nesting, which allows for the identification of individual eggs laid by specific geese, is also possible. It is normally used as part of a genetic selection programme but may be used to help identify the best layers to assist in choosing the next year's breeders or to cull unproductive females. Trap nesting can be done in two ways. The first is to have a door on the standard nest which closes when the goose enters so that she cannot escape until released by an attendant. Such trap nests are shown in Figure 19. Some birds will enter the nests voluntarily, while other females may prefer to lay their eggs elsewhere in the pen which results in unidentified eggs. This problem is greater for geese kept on deep litter than for those on slatted floors. The second method is to catch all the geese late in the day and then to palpate each one for the presence of an egg in the oviduct and, if an egg is present, to put the goose in an individual nest with closed doors. When the eggs have been laid, the geese are released. Both methods can be practised from 4-7 days a week, but five days per week is usual with egg production calculated on *pro-rata* basis.

FIGURE 19. Trap-Nest (France)



(*Source*: Million, 1996)

The most intensive method of housing breeding geese is on a raised floor. Floor types that have been used include:

wooden slats (30 × 30 mm) spaced at 30 mm (Figure 18A), expanded metal or plastic (Figure 20). Under these conditions geese need about 0.5 m^2 per bird. The advantages of this type of housing are that it allows a high bird density, no litter is required and both droppings and spilt water pass directly either to a pit or to the ground below.

FIGURE 20. Plastic flooring suitable for both young and adult geese (France)

(*Source*: Buckland, 1995)

A more traditional type of intensive housing is the deep litter system. For this system it is recommended that each bird be given approximately 1.0 m^2 of floor space. It is important that the drinkers are designed and placed in such a way that the litter does not get wet. Wet litter can contribute to a substantial increase in the number of dirty eggs.

Perhaps the most popular system of housing is deep litter combined with access to an outside yard and/or pasture (Figure 18C). Typically under such a system the geese would need 0.5 m^2 per bird inside on the deep litter and a minimum of 1.0 m^2 per bird in a yard or run. Yards covered in sand, gravel (Figure 21) or concrete (Figure 18B) permit a substantial reduction in building space yet keep the geese confined. Again, it is desirable to place the feeders and particularly the drinkers in the yard in a way that the litter is kept clean to ensure cleaner eggs. When this system is operated in conjunction with a pasture, a stocking rate of 150 birds per hectare of pasture is recommended, depending upon the quality of forage.

In warm climates, the provision of a simple roof over part of a fenced area to provide shade, protection from the rain and a slightly darker and quieter area for the nests may be adequate. The major disadvantage with such a low-cost system is to keep the geese from dirtying the nests, and often there is no opportunity to use artificial lighting to increase egg production. This, however, would be the system of choice for an extensive scavenging-based systems.

FIGURE 21. Well-drained gravel goose yards with access to pastures (France)

(*Source*: Buckland, 1995)

Lighting programmes

The lighting regime under which the breeder flock is maintained is very important. Geese are seasonal breeders with males and females becoming sexually active under increasing hours of daylight. The subsequent laying season will last approximately four months with egg production being quite low during the later part of the laying season.

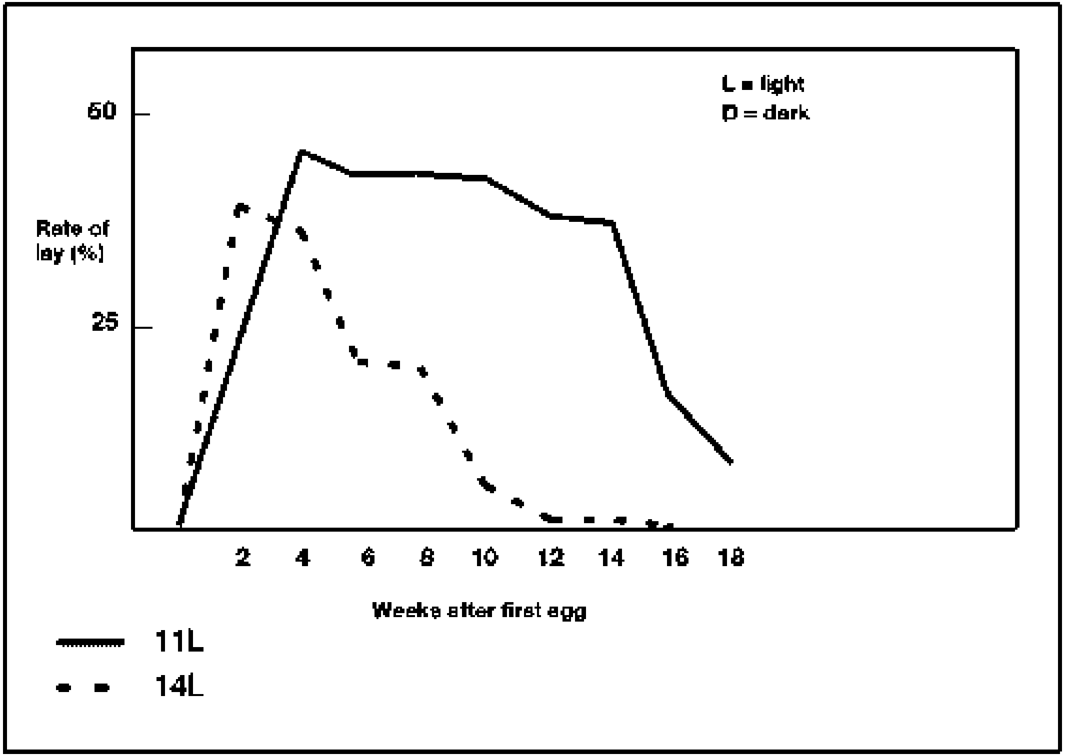
In the northern hemisphere, under natural light, geese begin to lay about mid-February and continue until early or mid-June, while in the southern hemisphere, laying starts in July or August. In the tropical or subtropical parts of both hemispheres, where there is less difference between the longest and the shortest daylight periods, these subtle differences in daylight may still influence the laying period. In equatorial areas where there is little variation in the length of the daylight period, it has been reported that geese may breed in natural conditions, twice a year.

In developed countries, many producers now use sophisticated artificial lighting programmes to enhance the productivity of all poultry species, including geese. However such lighting programmes are not always possible for the goose breeder because of the high capital cost of buildings, and/or the erratic supply of electricity. This does not mean that nothing can be done to improve egg and gosling production. In the temperate areas of the northern hemisphere, after the natural start of the lay, it is possible to increase the total number of eggs by prolonging the laying period.

To do this, it is necessary to restrict daylight to nine hours per day up to a 25 weeks after the beginning of lay. A simple way to achieve this is to shut the birds in a dark building every evening, and to release them the following morning (the geese must be kept inside in the dark for a total of 15 hours).

This is not practised in tropical countries where daylight averages 10-12 hours, although it would be useful to determine if such a lighting programme would increase egg production in this area.

FIGURE 22. Egg production by geese exposed to: 1) 11 hours of light with 13 hours of darkness (solid line); 2) 14 hours of light with 10 hours of darkness (broken line)



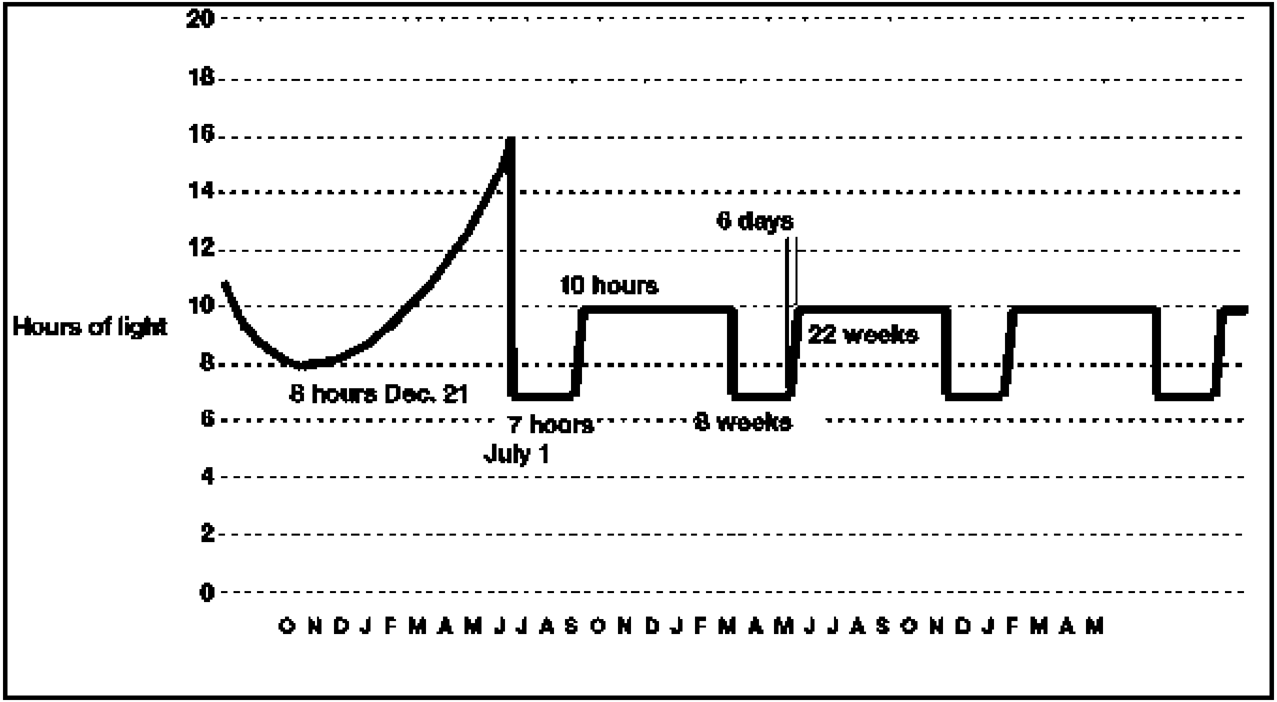
(*Source*: Rousselot-Pailley & Sellier, 1990)

Figure 22 shows the effect of exposing breeding geese to two lighting programmes as described. Geese under the first treatment laid 40.6 eggs whereas those exposed to the second treatment laid 17.3 eggs.

Other research has shown that ten hours of light is better than 11 hours of light and that 8-9 hours of light may be sufficient for egg production.

In conclusion, a recommended lighting regime for laying geese would be to expose them to a short day of seven hours of light 12 weeks before the desired onset of lay. After eight weeks, the light should be increased half an hour per day until ten hours of light is reached. The geese will then begin to lay in approximately four weeks. Under confinement, this lighting programme can be regulated by a time clock. Where birds have outside access, the hours of light can be controlled by letting them out only for the required hours of light and keeping them inside for the period of darkness.

FIGURE 23. Lighting programme for geese to have six laying periods in four years



(*Source*: Buckland, 1995)

To increase the level of egg production per goose per year and to have a continuous supply of hatching eggs all year, artificial lighting programmes can be used to have a breeder flock come into lay more than once a year. Lighting programmes to achieve this are based on the principles underlying the programme as described above and as shown in Figure 21.

The lighting programme shown in Figure 23 assumes that the geese were hatched in the spring in the northern hemisphere and that their first laying period was from February 15 to June 15 under natural light. Their second laying period will begin on approximately the first day of October. This is after a period of eight weeks of seven hours of light per day, a period of six days to increase the light to ten hours per day and then four weeks of ten hours of light per day after which they will begin to lay. This lay period will continue for 16-18 weeks giving a total programme of 28-30 weeks from the beginning of one seven hour lighting period until the beginning of the next.

Some producers let their geese rest for 2-4 weeks before beginning the next cycle. The standard, however is to be able to complete six full laying cycles in four years which will result in 30-40 percent more eggs than if the flock had only four laying periods in four years.

To conclude this section on breeder flock management, Table 4 presents some reproductive data for two breeder flocks over annual lay periods that extended for 12 years. Though most commercial flocks of geese that have one laying cycle per year are not kept for more than 4-5 years, these data show that even with mortality increases and reproductive rate declines, some geese can maintain their reproductive ability for a considerably longer period of time. In practice there are two approaches: the first consists of keeping the breeding geese for four laying periods to ensure maximum production performance per goose. The second is to keep the breeders for six years or more and although the number of goslings per goose is generally lower after the fifth and subsequent lays, the additional production will help offset the relatively high cost of breeders.

TABLE 4. Reproductive traits in 12 successive laying seasons of White Italian geese (WD-1 strain); 1&2: first and second flock

CRITERION	FLOCK	SUCCESSIVE LAYING SEASONS											
		1	2	3	4	5	6	7	8	9	10	11	12
Number of females	1 2	60 59	56 57	54 55	52 51	49 48	45 42	41 38	37 34	32 29	26 21	21 14	14 8
Females per gander	1 2	4.0 3.9	4.3 3.8	4.2 3.7	4.3 3.5	4.3 3.4	4.8 3.0	5.1 2.7	4.1 2.8	6.0 2.4	7.2 2.0	6.9 1.5	11.2 0.8
Eggs from laying geese	1 2	47 49	45 48	46 47	45 43	46 49	39 46	34 38	34 38	30 37	25 25	20 13	17 10
Egg weight (g)	1+2	153	166	167	177	174	181	178	168	191	193	186	187
Fertility (%)	1 2	81 79	91 94	84 92	89 90	79 88	74 86	75 88	61 86	48 85	57 83	44 69	7 63
Hatchability from set eggs (%)	1 2	71 70	70 67	73 70	63 64	70 71	64 67	68 70	41 50	29 49	54 61	29 37	5 12

(Source: Rosinski et al., 1995)

Chapter 7. ARTIFICIAL INSEMINATION

Fertile goose eggs can be produced by artificial insemination and, if done properly, the level of fertility can be as high or higher than those obtained with natural mating. However, this technique is not usually used for the commercial production of goslings for the following reasons:

- the high labour requirement: both semen collection and insemination require two people;
- the semen production of ganders varies: on average, a Landes gander gives 0.3ml and 150 million spermatozoa per ejaculate but ganders vary as do different ejaculates

from the same gander;

- the geese must be inseminated twice a week to maintain an acceptable level of fertility.

However, in cases such as pedigree matings or when there is a shortage of ganders during a breeding season, artificial insemination can be useful.

The technique of artificial insemination begins with the collection of the semen. To maximise the percentage of ganders producing semen and the volume of semen produced, ganders should be housed individually. Pens of approximately 2 m^2 have been shown to be satisfactory. To obtain clean semen, the ganders should have their feed removed 12 hours before the semen is to be collected.

Ganders should also be practised once or twice a few days before starting semen collection. The person collecting the semen sits on a stool and holds the gander on his lap as shown in Figure 24. He or she stimulates the gander by stroking his back from the middle towards the tail, while at the same time stroking the abdomen towards the vent with the other hand. After doing this several times, the thumb and the index finger of the right hand massage the pubic bones lightly. This causes the gander to extrude the phallus and, if the bird is producing semen, results in ejaculation. A second person is required to collect the semen with a suitable receptacle. The semen is released at the base of the phallus but it may run along the canal which extends the length of the phallus and be collected anywhere along its length, either through aspiration from the canal, or by collection in a centrifuge tube or other suitable receptacle.

FIGURE 24. Procedure for collecting semen from a gander

(*Source*: Johnson, 1954)

It should be noted that males in their second or subsequent breeding season are more likely to produce semen than young males in the first breeding season.

When preparing to inseminate the female, it must be noted that the oviduct does not become exposed as it does in the chicken and turkey. To inseminate the female, one person holds the bird by both legs in a horizontal position with its head toward him and under his right arm. The second person inserts the index finger of his left hand into the vent and, by palpation, locates the opening of the oviduct. The syringe, with or without an attachment, containing the semen is inserted into the vent and then into the oviduct by using the finger as a guide, and the semen is deposited.

Geese should be inseminated twice a week with 20 million spermatozoa per insemination. Ganders exhibit a lot of variation in both ejaculate volume and the number of spermatozoa per ejaculate. Average figures however would be a volume of 0.3 ml of semen and a total of 150 million spermatozoa per ejaculate. Therefore a rule of thumb would be to use 0.05 ml of pooled, undiluted semen per insemination (5-10 ganders). However, if equipment is available, it is recommended that the concentration of spermatozoa be determined for each pooled semen sample before insemination. Semen can be collected from ganders 2-3 times per week.

There are no specific diluents for gander semen but it can be readily diluted with a number of poultry semen diluents without any deleterious effect on fertility. One is the Beltsville Poultry Semen Extender as described by Sexton in his 1977 publication. In addition, if required, gander semen can be held up to six hours at 4°C if diluted in a standard poultry semen diluent. Some research has been carried out on freezing gander semen, but the results are not yet good enough to make use of this technique.

Chapter 8. INCUBATION

A great deal of expense and effort goes into the production of fertile goose eggs, so they must be handled with care and it must be assumed that each egg is fertile and will produce a healthy gosling. Successful incubation begins with the collection of sound, clean eggs from the nests.

After collecting and drying the eggs, any dirty eggs should be individually cleaned with a brush or with sandpaper. Although washing of hatching eggs is not recommended, eggs which do not come clean by dry cleaning can be scrubbed individually in water at 40°C (note that the water temperature must always be warmer than the temperature of the egg). A disinfectant such as sodium hypochlorite (Na OCl) can be added to the water. Eggs should be collected in plastic trays, or any non-porous, easy-to-clean collector so that any bacterial contamination is not passed from egg collection to egg collection.

Immediately after the eggs have been cleaned, they should be fumigated on the farm before being transported to the hatchery. This immediate fumigation is very important. The greater the delay in fumigation, the less effective it will be because both Aspergillus and Salmonella can penetrate the shell.

Fumigation is normally done using formaldehyde CH2O which is a gas sold commercially in a 40 percent water solution (37 percent by weight) under the name of formalin. It can also be purchased in powder form when it is known as paraformaldehyde. The eggs are fumigated by putting them in a small room or chamber that can be tightly sealed as formaldehyde is very toxic, and the formaldehyde is then released into the room or chamber.

To release formaldehyde gas from paraformaldehyde, a thermostatically controlled heating device is used. The manufactures' instructions regarding the amount and temperature must be followed.

To release the formaldehyde gas from the formalin, potassium permanganate ($KMnO_4$) is added to the formalin, at a ratio of 1 g potassium permanganate to 2 ml of formalin. This must be done in an earthenware crock or metal container as the heat generated by the reaction could break a glass container. The recommended amounts for 2.8 m^3 (100ft3) of cabinet space are 60 g potassium permanganate and 120 ml formalin. If the eggs are densely packed in trays, these amounts should be increased to 75 g and 150 ml respectively.

Where neither formaldehyde nor any other fumigant is available, solar radiation can be used as it has good disinfecting properties. The eggs must be placed in single layers so that they are well exposed to the sun and care must be taken not to use a dirty place where the eggs could pick up more bacteria than the solar radiation destroys. Care must also be taken to not overheat the eggs.

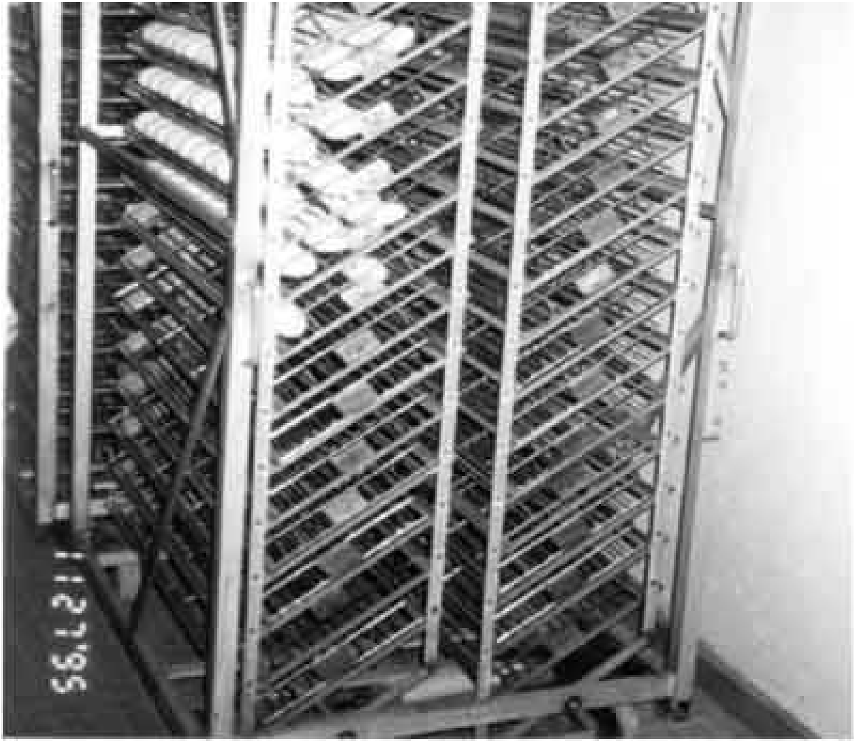
The hatchery building should be isolated from the goose flock, constructed in such a way as to protect the incubators from sudden temperature changes and should provide good ventilation for the incubators as the oxygen requirement of the growing embryo is high.

The hatchery should have separate rooms for:

- egg reception and storage;
- pre-warming of the eggs;

- incubators for setting (setters) - days 1-27 of incubation;
- incubators for hatching (hatchers) - days 27-30 of incubation;
- an area to which to take the goslings from the hatching trays and to use for gosling identification, sexing, vaccination, etc..

FIGURE 25. Goose eggs being turned during storage (France)



(*Source*: Buckland, 1995)

After the eggs have been fumigated they can be stored prior to incubation. The recommendation is to store them at 10-15°C with a relative humidity of 70-75 percent. The eggs should be turned (90 degrees) six times per day during storage. If at all possible, goose eggs should be set twice a week and not stored for more than four days before incubation. Recent work on periodic warming of goose eggs during storage (Table 5) indicates that periodic warming will improve the percent hatch of stored eggs. In the work shown in Table 5 the eggs were stored at 10-15° C up to day 14 and for the remaining ten days at 18-22°C. The relative humidity was about 75 percent. For eggs that received no treatment and remained under these conditions throughout the experiment, the decline in percent hatch was from 83.46 to 20.67 percent over the 24 days. The eggs that received periodic warming were warmed for five hours on the first day of storage and five additional hours every fifth day thereafter. Thus eggs stored for ten days received ten hours of warming; those stored 17 days received 20 hours of warming and those stored 24 days received 25 hours of warming. These results clearly show that periodic warming of goose eggs during long term storage can increase the percent hatch and reduce the incubation time.

There are two fundamental types of incubators that can be used for goose eggs. These are the larger forced-air type found in commercial hatcheries and the much smaller still-air type used for incubating small numbers of eggs. The incubation period for goose eggs is 30 days and, as with other waterfowl eggs, they have unique requirements during their artificial incubation which are not needed by other poultry species. From the fourth day to the 27th day it is a good practice to cool and humidify the eggs daily. It has been demonstrated many times that this has a positive effect on the total number of goslings hatched. This is probably related to the fact that in natural conditions, waterfowl leave the nest each day to bath and come back with moisture in their feathers.

TABLE 5. The effect of periodic warming on percent hatch and length of incubation period of long term stored goose eggs

Length of storage (days)	No warming (control)		Periodic warming		
	Average	Difference compared with fresh eggs	Average	Difference compared with fresh eggs	
	Hatch (%)				
3	83.46	-	-	-	-
10	79.73	- 3.73	85.69	+ 2.23	+ 5.96
17	64.46	-18.98	80.54	- 2.92	+10.06
24	20.67	-62.79	61.34	- 22.35	+40.67
	Length of incubation (hours)				
3	702.0	-	-	-	-
10	706.0	+ 4.0	702.0	-	-4.0
17	711.0	+ 9.0	704.5	+2.5	-6.5
24	715.0	+13.0	707.0	+5.0	-8.0

(Source: Bogenfürst, 1995)

FORCED-AIR INCUBATION

Most forced-air incubators come with specific recommendations for hatching goose eggs and the manufacturer's recommendations should be followed. However, the general recommendation for hatching goose eggs is that for the first 27 days, until the eggs are transferred to the hatcher, the incubator (setter) temperature should be maintained at 37.7°C with a relative humidity of 50-55 percent. The eggs must be placed in a horizontal position in the incubator tray and turned 90 degrees every two hours. If the eggs are in a vertical position in the incubator tray, they must be turned 180 degrees every two hours.

FIGURE 26. Goose eggs in a forced-air incubator (Hungary)

(*Source*: Buckland, 1995)

The eggs should be cooled each day during incubation by opening the doors of the setters for 15 minutes from days 4-27 and at the end of the cooling period the eggs should be sprayed with water or preferably with a bactericide solution.

The temperature of the water should be 20-25°C. On the seventh day of incubation, the eggs should be candled with a bright light source to check, by transparency, that the embryos are developing normally. Any infertile eggs and dead embryos should be removed. On the 27th day of incubation the eggs must be transferred from the setter to the hatcher. Dead embryos should again be removed at this time.

While in the hatcher the eggs are neither cooled nor sprayed with water and the temperature should be maintained at 37.5°C with the relative humidity at 75 percent. Hatching will begin on day 30 and the ventilation openings on the hatcher should normally be fully opened to allow the goslings to dry before being removed on day 31. Just prior to hatching the goslings will absorb the remaining yolk sac and this enables them to survive for over 24 hours without food or water if they are to be transported. However, in spite of this, it is strongly recommended that goslings be given feed and water as soon after hatching as possible.

FIGURE 27. Goslings hatching (Democratic People's Republic of Korea)

(*Source*: Buckland, 1995)

STILL-AIR INCUBATION

Still-air incubators can be very useful for hatching small numbers of goose eggs under a variety of conditions. These incubators are generally much smaller than the forced-air type and normally hold 10-100 goose eggs on a single level. Usually the humidity is provided by a pan(s) of water located below the eggs. It is important that the pan(s) be kept full of fresh, preheated clean water to keep the relative humidity at the right level. The water and the pan(s) must be kept clean because a layer of dirt or dust on the surface of the water will reduce the rate of evaporation and thus lower the relative humidity level in the incubator which will result in a poorer percent hatch.

Unlike the forced-air incubators that must operate with electricity because of their fans and egg turning devices, many models of still-air incubators do not require electricity. Instead they can operate with a variety of heat sources since they have no fans or egg turning mechanism. Heat sources for still-air incubators can be straw or rice hulls, the traditional brick and clay incubator still found in some Egyptian villages, kerosene, natural gas or, of course, electricity. Almost any heat can be used provided there is some mechanism to monitor and/or control the temperature.

Again, as with forced-air incubators it is vital to follow the manufacturer's recommendations for incubating and hatching goose eggs. Generally, the recommended temperature for setting and hatching is 39.4°C in still-air incubators. This is higher than that recommended for forced-air machines as there is no air movement. Since there is no automatic turning device in still-air incubators, the eggs must be marked on one side to show when they have been turned. They should be turned 180 degrees 4-6 times a day with the first and last turning being done first thing in the morning and the last thing at night. All eggs should be candled at seven days of incubation and the infertile eggs and dead embryos removed.

Since most still-air incubators have only one tray due to smaller egg numbers and reduced air movement, this can mean that the eggs are set once a week in the same incubator. For this reason, the date that the eggs are set should be written on each egg with a lead pencil. Also, since eggs are generally set weekly and so the goslings will be hatching weekly, it is recommended to use a second incubator for hatching. In this way the incubator being used as a setter can be kept clean, and free from down, broken eggshells, etc. If the eggs are set weekly, the space required in the hatcher is only about 25 percent of the space required in the setter.

FIGURE 28. Still-air incubator (Poland)

(*Source*: Buckland, 1995)

With either type of incubator, a slight drop in temperature due to a power failure or an interruption in the supply of heat, although not ideal, need not harm either embryo development or percent hatch since regular cooling has in fact been shown to improve percent hatch. On the other hand, overheating can cause severe problems and must be avoided at all costs by opening the incubators to expose the eggs to cooler air if, for some reason, the cooling mechanism is not functioning or the ambient temperature gets too hot.

If kept clean and there are no broken eggs etc., the incubators used as setters can be used throughout the laying season without being cleaned. It is only necessary to clean and fumigate the eggs before they are set. On the other hand, the hatcher must be washed and disinfected after each hatch. If disinfectant is not available, the hatcher should be washed well and put in the sun, as the ultraviolet rays will help with the sterilisation.

NATURAL INCUBATION

Most female geese, if given the opportunity, will become broody and sit on and hatch the clutch of eggs (generally 10-12) they have just laid. This is not recommended. The reason is that while the goose is sitting on her eggs she is not laying.

However, if natural incubation is the only method available it should be used but the goose eggs should be set under a broody hen, duck, or turkey for incubating. If it is known in advance that natural incubation will be used, sufficient broody birds must be identified in order to incubate all the expected goose eggs except for the last 10-12 eggs of the laying season which the goose can incubate. Normally a hen can incubate between 4-6 goose eggs, a duck 8-10 and a turkey 10-14. At one time, it was recommended that goose eggs being incubated by a broody hen have additional water applied to them during incubation to increase the humidity, however, it is now generally accepted that this is not required.

The nest for the broody female should be clean and in a relatively dark area where she will not be disturbed. Food and water should be available. Eggs for incubation under broody females should be collected and stored as previously recommended. The eggs can then be placed under the hen, the duck or the turkey when she is broody. It should be noted that because of the size of the eggs, some hens could have trouble turning them. For this reason the eggs should be marked on one side as previously described and if it is noted that the eggs are not being completely turned, they should be turned manually, to 180 degrees, two or three times a day in addition to the turning that the hen can achieve.

A broody bird may be able to care for newly hatched goslings for a few days. However, the recommendation is to remove them from the female at hatching and transfer them to the gosling brooding facility.

Chapter 9. GEESE FOR MEAT PRODUCTION

This section describes the different management and feeding requirements of goose production for meat. It should be noted that, with very little variation, the same management and feeding recommendations apply to all types of goose production.

BROODING

Brooding is the management practice to which young poultry are subjected immediately after hatching and for geese this is considered to be the first three weeks of life. The most important aspect of brooding is to provide extra heat so that there will be no temperature shock when the newly hatched goslings are moved from the incubator to the area where they will be brooded and grown. To ensure that the temperature in the brooding area is stable, it is important that the heat sources be turned on at least 24 hours before the goslings arrive.

Success in raising geese depends to a large extent on the care and attention the young birds receive during the brooding period. Frequent management checks to make sure that the goslings are comfortable and have enough feed and water is one of the surest ways of raising healthy goslings.

Almost any building can be used for brooding geese providing it is dry, clean and free of draughts and vermin. It is important to remember that the colder the ambient temperature of the room or building where the goslings are being brooded, the more heat will be required from the localized brooder heat source to maintain the temperature where the birds are located. Any brooder heat source that can be used for chickens can be used for goslings with the recommendation, depending on ambient temperature, that the number of goslings does not exceed one-third to half the number of chicks recommended by the manufacture.

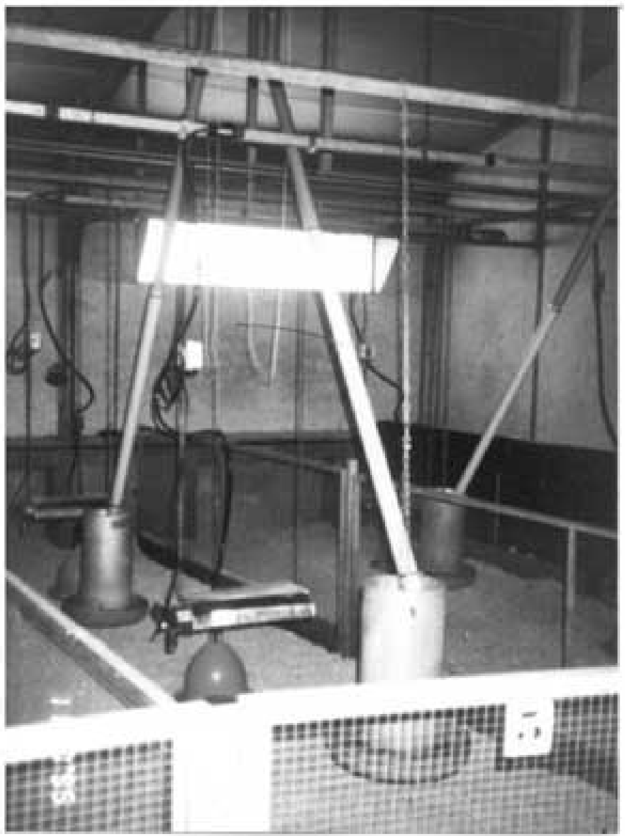
Energy sources may include electricity, oil, coal, natural gas, propane or other organic fuel. Normally the areas where the brooder heat sources are located will have a protective guard placed around them to reduce draughts and to ensure that the goslings will not stray from the heat source. This guard need only be in place for the first 2-3 days of the brooding period. A circular area is preferable for this purpose as it prevents the goslings from crowding into a corner.

FIGURE 29. Newly hatched goslings with feed, water and a protective guard (Democratic People's Republic of

Korea)

(*Source*: Buckland, 1995)

FIGURE 30. A pen with automatic feeders, drinkers and an electric heat source ready to receive goslings (France)



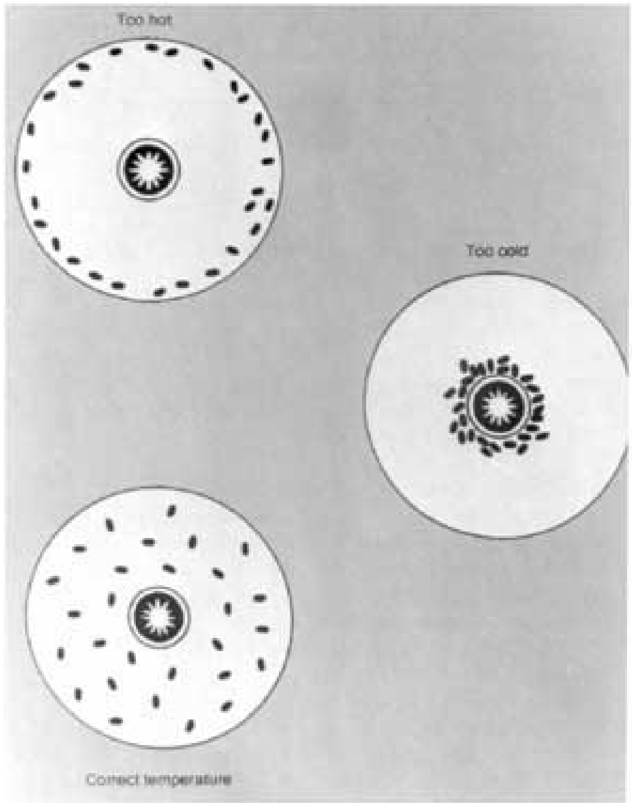
(*Source*: Buckland, 1995)

In areas where electrical interruptions are frequent, an alternative energy source should be used for brooding, although research in Canada has shown that goslings are resistant to temperature drops during the brooding period as long as they do not crowd and smother each other.

When goslings arrive, the temperature at bird level directly under the heat source should be 36-37°C which can be reduced to 32-33°C at the end of the first week and to 23-25°C by the end of the second week. After the third week, no further additional heat source should be required unless the ambient temperature in the building is below 20°C.

The best guide to deciding when to reduce the temperature and when to remove the brooding heat source is the behaviour of the goslings. If they are too cold, they will be huddled together close to the heat source and if they are too warm they will be far away from the heat source as shown in Figure 31.

FIGURE 31. Diagrammatic representation of gosling behaviour under a brooder



(*Source*: Shanawany, 1994)

The goose has the fastest initial growth rate of birds kept for meat production. Table 6 presents an example of the increase in body weight of geese (the breed is the Hungavi Combi resulting from a three-way cross) during the brooding period. This rapid growth rate, combined with the fact that they are susceptible to overcrowding, means that it is very important that geese have adequate space during the brooding period. On average, maximum density per square metre should not exceed 14-20 birds during the first week, 7-14 birds during the second week and 4-5 birds during the third week.

Even during the brooding period when the goslings are two weeks of age, they can be let out to graze, provided the weather is warm and it is not raining. This can reduce the building space requirements per gosling. Goslings should not be permitted out in heavy, cold rain until about five weeks of age, since before that they do not have sufficient feather cover to protect them.

Almost any material can be used as a source of bedding for goslings e.g. straw, wood shavings, rice hulls etc. provided the material is dry, highly absorbent and that it is not easily compacted. These points are important for goslings as their droppings are moist and they tend to spill water onto the litter. For these reasons, it is recommended that the water be placed on wire mesh or on plastic or wooden slats which are supported by a frame to prevent spilled water from wetting the litter (Figures 18A, 20, 33).

TABLE 6. Growth rate of Hungavi Combi goslings from hatching to 3 weeks of age

	MALE	FEMALE
Egg wt (g)	170.1	170.1
Hatching wt (g)	104.9	104.3
1 week wt (g)	307.9	295.9
2 week wt (g)	800.0	755.8
3 week wt (g)	1513.0	1365.5

(Source: Willin, 1995)

The watering space recommended during the brooding period is a minimum of 2 cm per bird and this can be provided by either a circular drinker or a linear drinking trough. Goslings require 1.5 cm of feeder space per bird which can be provided either with a double-sided linear feeder or with a circular feeder. For the first 24 hours after hatching, it is advisable to provide additional, more accessible feed to ensure that all goslings start to eat immediately. This feed can be put in egg trays which are placed on the litter in the brooding area for easy access.

During the brooding period, a waterfowl starter ration in the form of either crumbles or small pellets is recommended and should be fed *ad libitum*. These starter rations normally have a crude protein level of between 16.0-18.0 percent and a metabolizable energy level of between 2 600-2 900 kcal ME/kg (Table 7). If a goose starter ration is not available then a chicken starter ration of similar protein and energy levels can be used. Mash feed can also be used if neither crumbles nor pellets are available. In many low income and food deficient countries, where feed mills do not exist, farmers must use the local sources of nutrients to provide essential nutrients such as ground cereals and chopped fresh grass. Such feeding systems, however, are usually protein deficient and can lead to very slow growth. If it is possible, the diet should be balanced with a supplement high in protein content such as soybeans, cotton seed or peanuts.

The total feed consumption for goslings, depending on breed, for this initial three week period will be between 2.5-2.7 kg of starter ration. Goslings will consume between 7-8 litres of water during this period. If the goslings have access to high quality forage (ryegrass, white clover, cabbage, or even nettles) during the three week brooding period, this could reduce their intake of the complete ration by as much as 20 percent.

When the goslings are three weeks old, it is possible to restrict their feed intake up to 75 percent of *ad libitum*. However, where a higher level of restriction must be exercised because of a shortage of either a starter ration or mixed grains, then every effort must be made to provide the goslings with young tender forage either through direct grazing or by cutting and carrying the forage to them. Fresh kitchen and/or garden waste may also be used during this period. If the goslings are required to graze, then any starter ration or mixed grains should be fed at night so that during the day the goslings will be hungry. This will increase their forage intake. If feed restriction is practised at this young age, it is very important to keep a close watch on the goslings to see that they remain in good health.

TABLE 7. Recommended dietary energy, crude protein, amino acid and mineral levels for goslings during the brooding period of three weeks

	Ration 1	Ration 2
Energy (kcal ME/kg)	2600	2800
Crude Protein (%)	15.8	17.0
Amino Acids (%):		
Lysine	0.89	0.95
Methionine	0.40	0.42
Sulphur Amino Acids	0.79	0.85
Tryptophan	0.17	0.18

Threonine	0.58	0.62
Minerals (%):		
Calcium	0.75	0.80
Total Phosphorous	0.67	0.70
Available Phosphorous	0.42	0.45
Sodium	0.14	0.15
Chloride	0.13	0.14

(Source: Leclercq et al., 1987)

GROWING

After the brooding period geese can be grown to market weight under either intensive confinement conditions, extensive range-type conditions or a mixture of the two. The growing facility need not be sophisticated since these birds are not demanding - a simple shelter should be adequate.

The most important factor is to ensure that the goslings are warm during the brooding period and protected from sun, heavy rain and predators, especially during the night. In hot countries, a wooden shelter is sufficient for this purpose.

The growing of geese in confinement permits greater control of the environment. Although this has a number of advantages, it does not, however, capitalise on the goose's natural capacity to consume and utilise large volumes of forage. When they are grazing, geese consume not only grass, but also insects, snails, worms, etc. which can provide about 10 percent of their total protein intake. Furthermore, the strong legs of the goose combined with its aquatic tendencies means it can travel long distances if required to consume forage both on land and in the water. Finally, the production of geese on extensive pasture type conditions eliminates the need for expensive housing and equipment and requires only drinkers, feeders, fencing and shelters for shade.

Because of the relatively high cost of the buildings and equipment needed when raising geese under confined conditions, geese are normally brought to market weight as quickly as possible. Broiler type geese can go to market at 8-9 weeks of age at a body weight of 4.0 kg and heavy type geese can go to market at 12-14 weeks of age at a body weight of 6.0 kg. This means that geese produced under these systems are generally not plucked during the growing period (see Feather and Down Production).

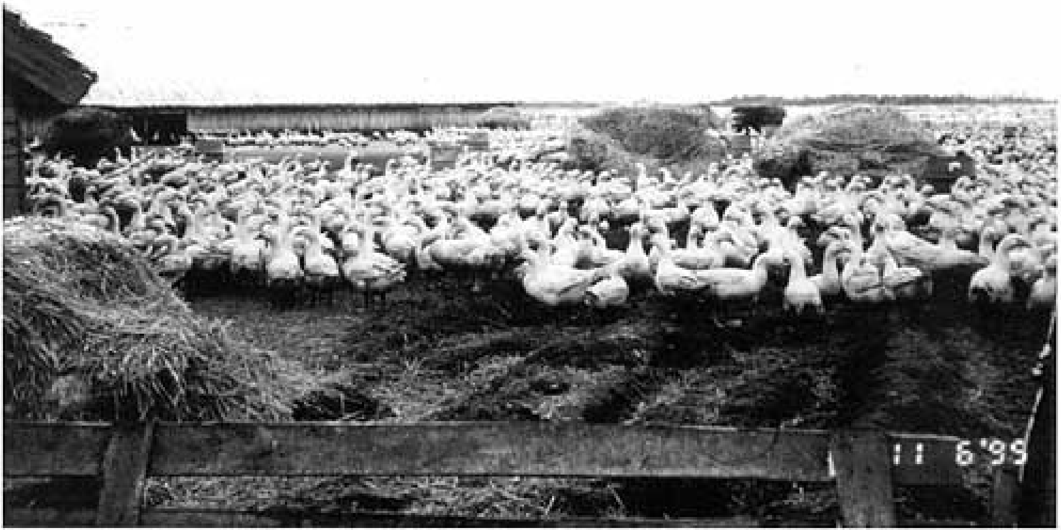
FIGURE 32. Geese in elevated pens being fattened for market (Poland)

(*Source*: Buckland, 1995)

FIGURE 33. Geese in floor pens being fattened for market (Poland)

(*Source*: Buckland, 1995)

FIGURE 34. Geese under an extensive management system being fattened for market (Hungary)



(*Source*: Buckland, 1995)

Geese grown in confinement are generally raised on deep litter which is considered the classical system of poultry production. However, they may also be grown on a raised floor of wooden slates (Figure 18A), plastic slats (Figure 20), heavy wire mesh (Figure 33) or expanded metal without exhibiting any of the problems of breast blisters etc. so common with chicken broilers grown under these systems. The advantages of the raised floor systems are that:

- approximately twice as many birds can be housed per square metre;

- the droppings pass through the floor to a pit or the ground below;

- any water spilled from the drinkers passes through the floor and does not cause any problem;

- the risk of parasite infection is reduced.

With the deep litter system, the drinkers should be located on a wire or slatted area so that spilled water does not wet the litter. One practice is to have one third of the floor space elevated with wire mesh or wooden or plastic slats to accommodate the drinkers.

TABLE 8. Recommended dietary energy, crude protein, amino acid and mineral levels for goslings during the growing period

	Age (weeks)			
	4-6		7-12	
	Ration 3	Ration 4	Ration 5	Ration 6
Energy (kcal ME/kg)	2700	2900	2700	2900
Crude protein (%)	11.6	12.5	10.2	11.0
Amino acids (%):				
Lysine	0.56	0.60	0.47	0.50
Methionine	0.29	0.31	0.25	0.27
Sulphur	0.56	0.60	0.48	0.52
Amino acids				

Tryptophan	0.13	0.14	0.12	0.13
Threonine	0.46	0.49	0.43	0.46
Minerals (%):				
Calcium	0.75	0.80	0.65	0.70
Total Phosphorous	0.62	0.65	0.57	0.60
Available Phosphorous	0.37	0.40	0.32	0.35
Sodium	0.14	0.15	0.14	0.15
Chloride	0.13	0.14	0.13	0.14

(*Source:* Leclercq et al., 1987)

Note: Insoluble grit should be offered to geese at all times. The amount required is about 1 kg per 100 geese per week.

At six weeks of age, the density of geese raised on deep litter should not exceed four geese per square metre, and only three after 13 weeks. For those raised on a slatted floor system, the respective values are seven and five birds per square metre. It must be noted that large geese in hot weather may require more space.

Under intensive confined conditions, geese should receive 15 cm of feeding space per bird. If at any time restricted feeding is practised, irrespective of the system used, it is vital that sufficient feeder space is provided so that all birds can eat at the same time. If this is not done, the more timid birds will simply not get any feed as it will be all gone by the time they get to the feeder.

The watering space per bird should be about 5 cm per bird. Drinkers must be of a durable nature and should not be large. A drinker 20 cm square and 10 cm deep to contain about 3 cm of water is recommended by some producers, while both commercial hog and cattle drinkers have been reported to work very well with geese. It is important that the drinker does not spill a lot of water. When automatic drinkers are not available, it is possible to use any ordinary container, but it must be filled often to provide abundant fresh water. It is useful to adapt the containers so that the birds cannot bath in them.

The type of feed generally fed during the growing period is a pelted waterfowl growing ration ranging from 10-13 percent crude protein with a metabolizable energy level of 2 700-2 900 kcal ME/kg (Table 8). If such rations are not be available then a chicken broiler or a chicken roaster ration of similar nutrient density can be used. While the recommendation is to use a pelted or crumbled feed for growing geese, in many parts of the world these are not available and, in such cases, the rations can be fed as a mash.

The main advantage of growing of geese for meat under extensive conditions is the goose's unique ability to utilise high-fibre feeds and thus use a variety of types of forage. This ability holds true whether the geese are kept under well-managed pasture systems or under less structured scavenging systems.

Under extensive management conditions geese will generally reach market weight at an age older than under confinement. In fact, the age at which geese go to market may not depend on their ability to grow, but rather on whether:

- the birds are to be plucked before they go to market (see Feather and Down Production);
- the birds are to meet a particular market demand at a particular time.

It is the relatively low cost of the extensive production systems that allows for this flexibility.

Providing geese with access to good quality pasture during the growing period, even without any form of feed restriction, can result in substantial savings with respect to grain consumption. Table 9 gives an example where geese with access to pasture consumed 34 percent less of the grain-based ration, yet their body weight was only 17 percent less than those grown solely in confinement. For the period from 12-14 weeks of age the geese with access to pasture consumed 48 percent less grain-based ration than the geese grown in confinement. These results also demonstrate the capacity of the goose to consume large quantities of good quality forage.

Restricting the feeding of grain in any form while geese are on pasture is a very popular practice and one that is recommended. Depending on the level of restriction, it is a practice that can ensure the maximum use of available forage or any other feedstuffs. Almost all kinds of grain can be used in combination with pasture feeding. In Europe barley, oats, wheat, and maize are commonly used. In low income, food deficient countries it is necessary to test all local sources of grain for anti-nutritional factors before use.

TABLE 9. Growth rate and feed consumption of White Chinese and Embden geese (sexes combined)

	Confined Intensive			Extensive Range		
	Average weight	Cumulative feed consumption	Food intake/ body weight gain	Average weight	Cumulative feed consumption	Food intake/ body weight gain
Age weeks	(kg)	(kg)		(kg)	(kg)	
3	1.68	2.65	1.55	1.59	2.64	1.66
6	4.20	8.40	2.00	3.80	6.08	1.60
9	5.74	17.16	2.99	4.98	9.61	1.93
12	6.71	23.89	3.56	5.80	16.23	2.75
14	7.10	28.61	4.03	5.95	18.68	3.14

(Source: Leeson and Summers, 1991)

The greater the level of feed restriction, the more forage the geese will consume and the less selective they will be in what they eat. If necessary, geese will travel considerable distances to obtain forage. The level of feed restriction that is practised will depend on a number of factors. For example, if there are no alternative energy-protein sources available, then the level of restriction will be severe and the dependency on foraging and/or scavenging will be high. Under these conditions, the geese should be monitored closely, particularly if severe restriction is begun prior to three weeks of age. If the quality of the local forage is low and there are no other supplementary feeds, then there may be a need to cut and carry forage to the geese.

This forage should be of the highest possible quality. If good forage is available, then even with small amounts of grain, high quality geese can be produced. The only difference is that they will be ready for market at an older age and the carcass will be leaner than that produced by a high grain (energy) ration. Even when available grain is not a constraint, it may be desirable to restrict grain intake to maximise the use of any available forage, and a restriction of between 0.5-1.0 kg of grain per goose per week is recommended. However, to achieve the desired market weight and have adequate fleshing, it is recommended that the geese be fed a complete ration for the last 2-3 weeks before killing. Depending on the body weight and condition of the geese at the beginning of this finishing period of 2-3 weeks, and the market for which the geese are intended, they may be fed either a complete ration similar to that in Table 8 or grain only.

In Hungary and Poland, the practice of finishing geese in the autumn on oats only is very popular (Figures 32, 33 and 34). If the birds are too light, a mixture of oats and a complete ration similar to that shown in Table 8 is fed during this period of three weeks.

When planting a pasture specifically for geese, it should be noted that they will eat almost any grass or clover species although they do not like alfalfa as much as other clovers. One pasture mixture that has been recommended in Great Britain consists of Perenial Ryegrass (*Lolium perenne L.),* Timothy (*Phleum pratense L*.) and White Clover (*Trifolium repens L*.). Stocking densities for geese on pasture are around 150 geese per hectare depending on the quality of the forage and how fast it is growing. Geese like new growth, so pasture management should be practised and it should include rotation and clipping.

To summarize, the management of geese under extensive conditions both in managed pastures and under extensive scavenger situations is, in many respects, similar:

- the behavioural characteristics of geese lend themselves to extensive management systems because they have a natural tendency to flock and at the end of a day will return home on their own accord;

- it is very important that geese are provided with a natural or man-made shelter to provide protection from the sun;
- they must have water available at all times and feeders must be built so that the feed remains dry in case of rain;
- if predators are a problem, fences and secure housing at night must be provided.

Chapter 10. FEATHER AND DOWN PRODUCTION

This section deals with the production and harvesting of fine feathers and down for use in the garment and household linen industries as opposed to the processing of coarse feathers for feather meal.

The most valuable product is the down, which is obtained from the breast area of the goose, followed by the fine feathers. Most commercial products contain a blend of both down and feathers; the higher the proportion of down, the higher the value of the product. The difference between down and feathers is shown in Figure 35.

FIGURE 35. Feathers and down from geese

(*Source*: Guy, 1996)

To obtain feathers and down at the time of slaughter, the normal process is to first scald the geese in hot water (60-

68°C) for 1-3 minutes. The coarse feathers of the wing and tail are then removed by hand with the remainder of the feathers and down removed either by a plucking machine or by hand. The feathers are then dried and this is normally done in large commercial tumble dryers. For small amounts, the feathers are spread and stirred frequently to facilitate their drying.

FIGURE 36. Plucking feathers from live adult geese (Poland)

(*Source*: Buckland, 1995)

FIGURE 37. Sorting feathers in air currents (France)

(*Source*: Buckland, 1995)

On a small scale, geese can be plucked dry without scalding and, although it takes longer, it does yield dry down and feathers. Irrespective of the plucking process, the sorting of the down and feathers can be done by weight in air currents as shown in Figure 37.

The harvesting of feathers from live geese can be an important source of income from geese being bred for the production of either meat or fatty liver and from those in breeder flocks. The harvesting of feathers and down from the breast of live geese is possible because between 9-10 weeks of age their mature down feathers, together with the other soft feathers, moult naturally. By timing the plucking process to coincide with the natural moult, the breast feathers and down can be harvested as shown in Figure 36. Growing geese can then be plucked approximately every six weeks as this will coincide with each successive moult. The yield of feathers and down from the first plucking is approximately 80 g and for each subsequent plucking between 100-120 g. The percentage of down will normally be between 15-20 percent of the total weight. The actual number of pluckings for market geese generally depends on the market conditions for the meat or fatty liver and the current market value of the feathers and down. All breeds can be plucked, but white plumage is more valuable. Whether plucking live geese or harvesting feathers at slaughter, the feathers must be mature.

Breeding geese may be plucked during the non-laying period on a similar schedule of every six weeks with the general recommendation being that the last plucking should be two and a half months or more before the onset of lay. Normally these recommendations result in three pluckings per season. However, recent work in Poland has shown that for birds which stop laying at the beginning of June and whose next laying season begins about mid-January, it is possible to pluck four times (last plucking in early November) with no harmful effect on subsequent egg production or fertility.

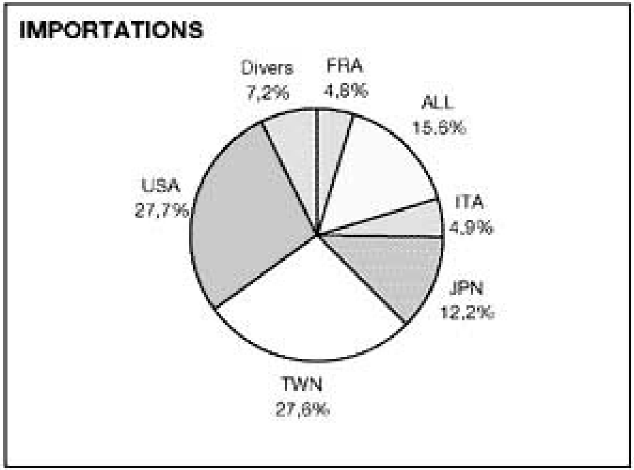
Feathers and down are a valuable product of goose production. This is particularly true for feathers plucked dry, as no equipment is needed to dry or sort them. Feathers and down can either be stored and marketed on the international market or used in local cottage industries for the production of high value retail products such as duvets (Figure 38).

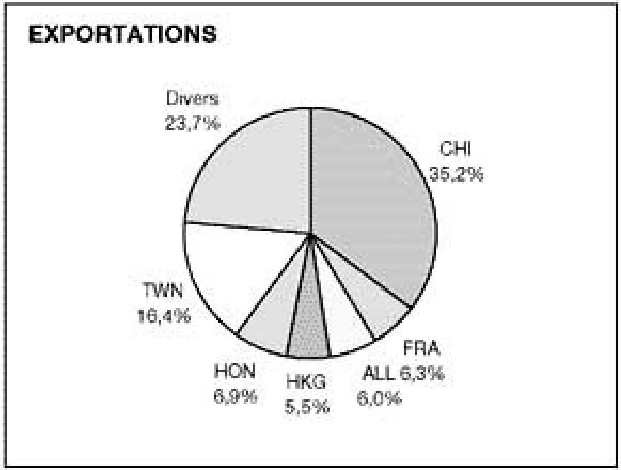
FIGURE 38. Duvets filled with goose feathers (Poland)

(*Source*: Buckland, 1995)

The international trade in feathers and down is shown in Figure 39. In 1994 the international trade reached more than 67 000 tons of raw feathers and down with a total value estimated at approximately US$650 million. These data cover feathers from all waterfowl species, with geese accounting for about 30 percent of the total tonnage and about 40 percent of the total dollar value. The international demand for feathers and down is determined primarily by six countries that import 93 percent of the world's production for further processing to supply both their domestic and export markets. There are, however, more than 25 countries that have a significant production of feathers and down. These are located mainly in Europe, Asia, and North America. However, the demand is strong so new producers can access the market, especially for down and feathers plucked by hand as these have the highest value.

FIGURE 39. International trade of down and feathers





(*Source*: Guy, 1996)

Chapter 11. FATTY LIVER OR FOIE GRAS PRODUCTION

Fatty liver production is the process of force-feeding (cramming) geese, which are normally between 9-25 weeks of age, for a period of 14-21 days. During this period the weight of the liver will increase from an initial weight of about 80g to a final weight of between 600-1 000g. Geese, along with mule ducks, and to a lesser degree Muscovy ducks, are the most popular birds used for fatty liver production. As is the case for both mule and Muscovy ducks, corn is the nutrient of choice for the force-feeding period for geese because of its high starch content and relatively low cost. Fatty liver production is very specialised and to be successful both skill and sensitivity are required of the person force-feeding the geese.

FIGURE 40. Fatty livers with goose carcasses in the background (Poland)

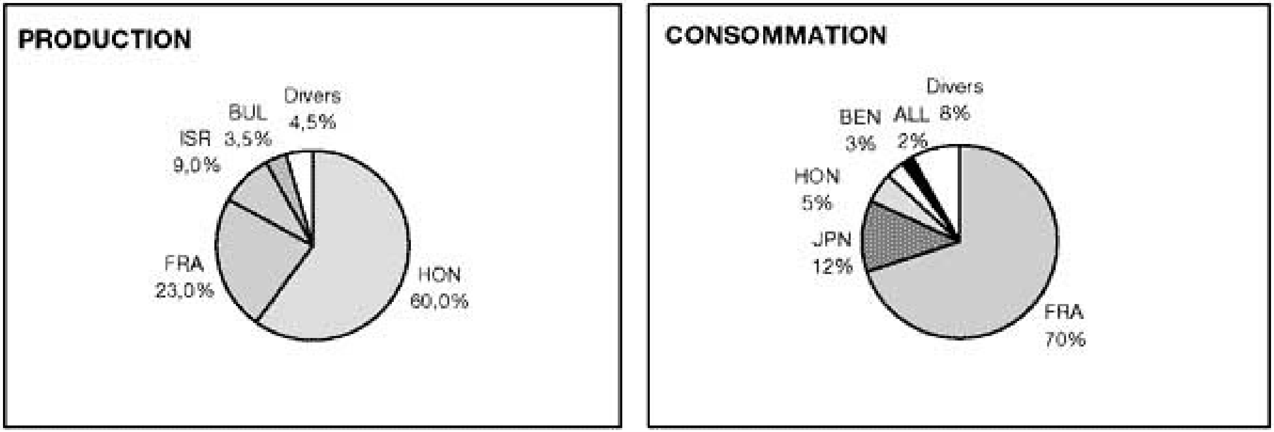
(*Source*: Buckland, 1995)

There are large differences between breeds and crosses of geese in their suitability for the production of fatty liver. Most important is that the breed responds to the force-feeding process by producing an enlarged liver of the desired size and within the 14-21 day period. Secondly, the temperament of the goose is important since the geese are handled up to 5-6 times per day and thus a quiet non-aggressive breed is required. Two breeds that meet these requirements are the Landes and Toulouse, with a genetically improved strain of the Landes being the most popular. A third desirable but not essential trait is that the breed be white since white down and feathers are more valuable than coloured down and feathers. On the other hand, the presence of dark pinfeathers on the carcasses of geese for fatty liver production is not as serious a problem as for geese produced for regular meat production since the carcasses from geese for fatty livers are generally cut up and sold as parts.

The structure of a fatty liver production system is often focused on the slaughter house which is usually responsible for both the processing and marketing of the livers. With this system the slaughter house will purchase the goslings, brood and grow them in fairly large flocks and then, as the market dictates, deliver the geese to farmers who specialise in the force-feeding for the production of fatty livers. In some regions, the production of fatty livers is carried out more as a cottage industry with the production and processing of the fatty livers taking place on the farm.

The international marketing of goose Foie Gras is mainly concentrated in Hungary and France which represent three-quarters of both the world production and consumption (Figure 41). Market demand is one reason for geese not being of uniform age when they are used for fatty liver production. A second reason is that the age at which geese are to be used for fatty liver production depends on whether the geese are to be live plucked for their down and breast feathers before they are used for fatty liver production and, if so, how many times. If the geese have been plucked, force-feeding would not generally start until three weeks before the down and feathers are mature again so that mature down and feathers can be obtained at slaughter.

FIGURE 41. The production and consumption of goose Foie Gras by country



(*Source*: Guy, 1996)

FIGURE 42. A cooker to cook the corn for force-feeding geese (Poland)

(*Source*: Buckland, 1995)

The feed normally used for force-feeding geese during the fatty liver production period is, as previously mentioned, whole grain corn. Before feeding, the corn is cooked slightly in hot water until the kernels are just soft to a firm squeeze. Fat (often from birds that were previously used for fatty liver production) can be added up to a level of 2 percent of the feed mixture. This is to lubricate the corn and to facilitate its flow to the crop of the bird. Geese are usually force-fed three times a day (morning, noon, and evening) and with the force-feeding period lasting approximately three weeks. It is possible to reduce the duration of the force-feeding period by cramming twice on three occasions each day. In this case, when the last bird of the flock is force-fed, the farmer begins again with the first bird, but with a minimum of 90 minutes between the two force-feedings. Under these conditions, the total number of meals is six per day and the total duration of the force-feeding period does not exceed 13-14 days. This intensive method saves corn, with 12-14 kg of corn producing a fatty liver instead of 17-20 kg needed with the traditional method.

FIGURE 43. An electric screw dispenser for force-feeding (France)

(*Source*: Buckland, 1995)

FIGURE 44. A manual screw dispenser for force-feeding

(France)

(*Source*: Million, 1996)

FIGURE 45. Force-feeding geese with corn while they are in their pen (Hungary)

(*Source*: Buckland, 1995)

A new method of force-feeding is now becoming popular. This uses an uncooked mixture of 35 percent ground corn, 30 percent whole grain corn and 35 percent water which is fed using recently designed equipment. With this method it is recommended that the geese are force-fed four times (twice a day on two occasions as described above) for 18-21 days. The total amount of corn required is about 17-20 kg. The popularity of this technique is due to the large number of geese that can be force-fed by one producer in one day. This method is, however, confined to large commercial units because of the relatively high cost of the equipment. Various factors influence the number of geese that can be force-fed by one person: the method, the material, the skill of the producer and the available facilities. With the new method, using a wet mix as described above, a specialist can force-feed over 300 geese a day. A maximum of 80-100 birds can be force-fed by an experienced producer if an electrical automatic dispenser for whole grain is used (Figure 43). Using a manual screw dispenser, as shown in Figure 44, it is possible to force-feed only about 30 birds per day.

Because of the specialised and intensive nature of fatty liver production, the production units are generally small in size and usually not more than 200-250 geese are force-fed in a flock at any one time. The geese are housed in traditional pens for growing geese, either on slats or wire at 0.3 to 0.5 m^2 per bird, or on litter at 0.5 to 0.75 m^2 per bird. The geese must not have access to a run or range during the force-feeding period.

As mentioned, fatty liver production is a highly specialised aspect of goose production, and to be viable all aspects of a successful production and marketing system must be in place. These include: a reliable source of appropriate geese, a source of good quality corn, availability of specialised slaughter facilities and a market to which the chilled fatty liver can be shipped within 4-5 days or facilities for further processing (see Killing and Processing).

The production of fatty liver for foie gras however raises serious animal welfare issues and it is not a practice that is condoned by FAO. Currently European Union legislation allows force feeding to continue only in traditional areas of production. This situation could easily change and more restrictive legislation introduced. Elsewhere, a number of European states have already decided to ban altogether foie gras production including Poland.

Chapter 12. GEESE AS WEEDERS

Geese are effective weeders because they like grasses but do not like many broadleaf plants. At least in modern times, the use of geese as weeders began in the United States in the 1950s when geese were used to weed cotton fields. Since then geese have been used to weed a wide range of crops including asparagus, potatoes, fruit shrubs, nursery stock, tobacco, nut trees, grapes, fruit trees, beets, sugar beets, beans, hops, various ornamental flowers, onions and strawberries. In addition, geese can provide a second source of income in plantations by making use of the forage that grows under the principal plantation crop.

The number of geese needed per hectare for weeding depends on the level of weed growth and the crop. For a hectare of cotton, 5-6 geese are adequate while for a hectare of strawberries 6-8 geese are recommended. In addition to weeding traditional crops, geese can also be used to clean up the forage on dikes and in ditches that are difficult to access with equipment. In fact, it has been shown that white Chinese geese, if properly managed, will readily consume and control floating water hyacinth in drainage ditches.

The management of geese as weeders is simple because young growing geese are used. Generally, any reluctance by geese to eat the weeds is an avoidable problem. First, farmers should not provide palatable or lush grass to young geese before putting them in a weeding programme otherwise the birds will reject the low quality weeds. Also, geese kept for weeding are normally kept on a programme of restricted feed with any grain being given in the evening. The level of feed restriction will depend on the amount of forage material available in the area to be weeded. Birds must, however, be watched because very hungry geese will eat whatever is available and, under extreme conditions, they could damage the crop they are supposed to weed. Some crops, like beets, are more susceptible to such damage than others, for example, trees. As with any extensive management system, shade and water must be provided. The geese can be kept within the area to be weeded either through direct supervision or by enclosing the area with a relatively low (70-90 cm) traditional fence or an electric fence.

After the strong interest in the 1950s to use geese to weed various crops, the enthusiasm declined during the 1970s with the advent of a wider selection of effective herbicides. However, there is still a place today for the goose as a weeder, especially for the farmer or plantation owner who does not want to use herbicides. In addition, using geese for weeding has a positive effect on the environment due to the reduced use of chemical weed-killers and because their droppings provide a nitrogen fertiliser.

Although the objective is different from weeding, another low-cost goose production system is to utilise harvest waste. In some European countries it is a popular practice as a complementary feeding programme since it uses material which is both low-cost and which would otherwise be wasted. After being harvested, the by-products of many crops can be used for this purpose. These include cereals, vegetables (especially carrots) and salad crops where the waste portion of the crops is particularly palatable to geese.

Chapter 13. KILLING AND PROCESSING

In many parts of the world, there are no slaughtering facilities with the proper equipment to kill and process geese. Where such facilities are available, they are the method of choice for killing and processing, particularly if the number of geese to be killed and processed is fairly large. If such facilities are not available, geese can easily be killed and processed by hand. Geese which are to be killed should have their feed removed at least eight hours beforehand to reduce the likelihood of contamination from either faecal matter or material from the digestive tract should it be ruptured during processing. The geese should continue to get water during this eight hour period.

FIGURE 46. Goose in killing funnel being bled

(*Source*: Ontario Ministry of Agriculture and Food)

For killing and processing a modest number of geese, the method of choice is to use a killing funnel (average length 35-40 cm, entry diameter 25-30 cm, exit diameter 10-12 cm). The procedure is to suspend the goose head down in the funnel (Figure 44). This holds the body and allows the neck and head to protrude. The underside of the neck is turned towards the operator who, holding the back of the goose's head in one hand, severs the jugular vein by cutting on the left side of the neck. The head is not cut off. The funnel prevents the wings from flapping and the goose bleeds freely.

Before the bleeding, it is necessary to anaesthetise the bird. Electrical stunning is the best method. Two types of stunning apparatus are available. One is manual and has a grip with electrodes at the end which are set on the eyes of the bird. The second is used in industrial processing plants. Here the geese move on a slaughter line and receive an electric shock when their heads go into a bath filled with an electrolyte. There are two electrodes: one in the solution, and the second in contact with the legs of the geese. However, if an electrical stunning apparatus is not available, a sharp knife (with a blade no more than 1 cm wide and sharpened on both sides) can be used to penetrate the brain through the end of the beak groove in the back of the mouth before cutting the jugular.

The blood may be caught in a blood cup. Blood cups are normally made of metal and are approximately 10 cm in diameter and 20 cm deep with a hook to attach it to the beak and a weight in the bottom to hold the head steady during the bleeding process.

After the bleeding is complete, geese can be manually dry plucked which gives both a good quality carcass and good quality feathers although it is generally considered to be too labour intensive. The alternative is to scald the carcass by immersing it in water at 60-68°C for 1-3 minutes to loosen the feathers. The precise time and temperature depend upon the feather condition of the birds and may vary considerably between groups of geese. It is necessary to scald the birds only enough to ensure easy plucking. Agitating the carcass in the scalding water and adding a little detergent helps wet the feathers thoroughly.

After scalding, the birds are ready for plucking. Normally the large wing and tail feathers are removed by hand and the rest are either plucked by hand or by machine. Either way it is not easy to remove all of the down and pin feathers. To do this a wax dip is used.

FIGURE 47. Plucked geese on a processing line coming out of the first wax bath (Hungary)

(*Source*: Buckland, 1995)

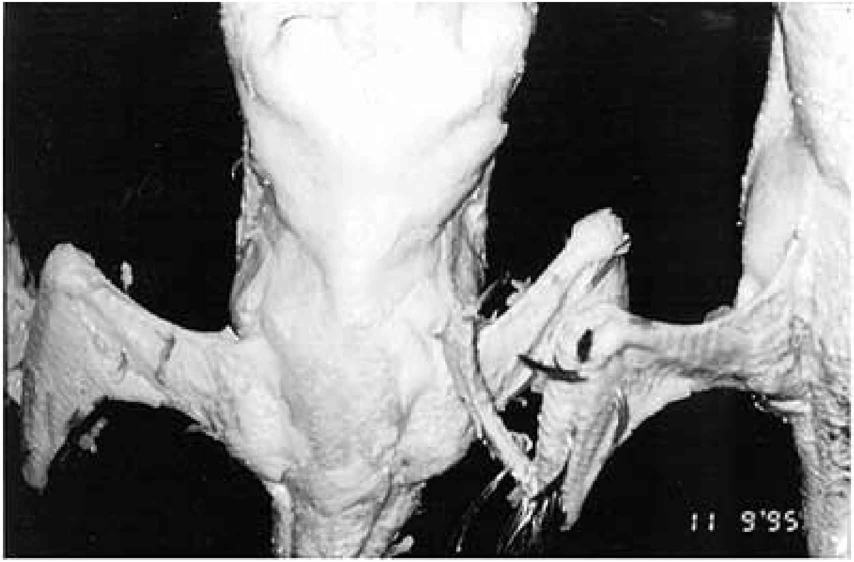
To make a wax bath, solid poultry wax is melted at a temperature of 65-70°C. The plucked goose carcass is then dipped into the wax and agitated slightly for 1-2 minutes. The goose carcass is then removed from the hot wax and dipped into cold water to harden the wax. The carcass is put back in the hot wax to add a second layer of wax and then into the cold water again. The wax is stripped off the carcass either by hand or with a dewaxing machine and takes with it the remaining down and pin feathers. Note that the used wax can be melted, cleaned and re-used.

After the removal of any feathers that may have been missed through either the plucking or wax dipping process, the carcasses are ready for eviscerating. The dressing percentage for geese is approximately 70 percent with giblets and 63 percent without. After evisceration, the carcass is ready for immediate consumption or storage, which may mean further processing. If the carcass is to be stored, it must first be cooled.

There are some differences in the slaughtering of force-fed geese for their fatty livers. Given the high value of the fatty liver, which represents the main commercial part of the goose in this case, it is necessary to take extra care during plucking. Small feathers and down on the abdominal section of the bird are not taken off with a classical rubber finger plucking machine as it can damage the liver. A special piece of equipment, with two plastic rollers turning in opposite directions giving a softer action, has been developed (Figure 49). The feathers are pinched between the rollers and removed without any damage to the liver. If this kind of equipment is not available, manual plucking of this area is recommended.

After the force-fed geese are plucked, there are two schools of thought as to the next step. The classical one is to cool the whole bird and eviscerate it after at least 12 hours of cooling. The second approach is to extract the fatty liver immediately after slaughtering, and to cool it as fast as possible. The latter process provides a product of better quality as it reduces fat loss during cooking.

FIGURE 48. Geese after the second wax bath and the second chilling (Hungary)



(*Source*: Buckland, 1995)

FIGURE 49. A plucker for force-fed geese that prevents damage to the fatty livers (France)

(*Source*: Million, 1996)

Where freezing facilities are available, the long term storage of frozen goose carcasses is both easy and convenient. The carcasses should be packed in plastic bags, with as much air removed as possible, preferably by vacuum pump. The bags should be made to adhere as tightly as possible to the surface of the carcass to avoid freezer burn. This is accomplished by submerging the bag into hot (80-90°C) water after sealing, which causes it to contract tightly around the carcass in it. To keep the carcasses for up to 12 months, a temperature of -30°C is required. If the carcasses are to be kept for only six months, a temperature of -18°C is adequate.

Curing and smoking of goose carcass parts is also effective in preserving carcasses for limited periods of time. The normal process is to first cure the goose carcass in a brine solution and then to smoke it. A curing solution of 14 percent salt (NaCl plus Nitrite) is suitable. Sugar and various spices may be added for flavour and in accordance with tradition. The goose carcasses should remain in the solution for 48 hours at a temperature between 2-5°C. After removal, the carcasses can be rinsed in water for one hour and then smoked. If no further cooking is required after smoking, then a smokehouse temperature of 85-90°C is required and the internal temperature of the carcasses should reach 63-65°C. Otherwise, a smokehouse temperature of 40-50°C is adequate. The smoking time required will depend on the density of the smoke and can vary from 3-5 hours.

Preserving meat from forced-fed geese by first cooking the meat and then preserving it in jars or cans is popular, not only as a method of preserving goose meat but also because of the variety of products it can yield. The first step in preserving goose meat in this way is to cut the carcass into parts. This means removing the breast meat and cutting off the legs, thighs and wings. These parts are then cooked and put into jars or cans for heat preservation (one hour at 100°C is suitable for meat which has been previously cooked). Adding liquid goose fat to each container before heat preservation and sealing, not only adds flavour but helps to preserve colour and provides a protective layer of fat on top of the meat. To obtain clean liquid goose fat, the fat removed from the carcasses should be heated to 100°C to remove the water and then poured through a sieve to remove the non-fat particles.

Goose meat can also be stored by first removing it from the carcass and then using it alone or in combination with other meats and spices to make a variety of sausage and other meat products that can be preserved by heating, smoking or drying.

In Eastern Turkey, where the external winter temperature is generally below freezing, the storage of goose meat is achieved through a combination of salting, dehydration and natural refrigeration. After killing in late November, the goose carcasses are salted and then packed tightly in a box for one week. They are then hung in the air to dry. After drying, the carcasses are stored under natural temperature conditions until eaten.

Table 10 shows the weight and size of a number of carcass components of geese slaughtered at 11-17 weeks of age.

TABLE 10. Weight and size of carcass components of geese

	11 weeks of age		17 weeks of age	
	weight (g) or size (cm)	Percentage of bled plucked weight	weight (g) or size (cm)	Percentage of bled plucked weight
Live body weight	5350 g	117.32	6150 g	116.04
Bled plucked weight	4560 g	100.00	5300 g	100.00
Thigh + shank bones	100 g	2.19	99 g	1.87
Feet	137 g	3.00	138 g	2.60
Wings	515 g	11.29	530 g	10.00
Thigh + shank muscles	549 g	12.04	575 g	10.85
Gizzard	168 g	3.68	178 g	3.36
Chest girth	414 cm	--	440 cm	--
Breast bone length	166 cm	--	181 cm	--
Liver	96 g	2.10	105 g	1.98

Neck	193 g	4.23	216 g	4.08
Head	163 g	3.57	183 g	3.45
Heart	34 g	0.75	40 g	0.76
Pectorals minor	65 g	1.42	78 g	1.47
Pectorals major	476 g	10.44	588 g	11.09
Thigh + shank, skin + fat	126 g	2.76	165 g	3.11
Breast skin + fat	214 g	4.69	310 g	5.85
Abdominal fat	195 g	4.28	301 g	5.68

(*Source*: Rouvier *et al.*, 1993)

Chapter 14. GOOSE DISEASES

In this chapter the most common goose diseases are listed, described, and the appropriate treatments proposed. A well-managed production system which includes cleanliness, know-how, and disease prophylactic practices can greatly reduce the incidence of many diseases. A list of 16 recommendations to contribute to the control and prevention of disease is provided.

RECOMMENDATIONS FOR THE CONTROL AND PREVENTION OF DISEASE

- examine the geese before buying them. Buy geese only from a reliable breeder;
- before the arrival of new geese, make sure that there is adequate good quality feed and water;

- keep feed troughs and drinkers clean;
- provide a stress-free environment for the geese (away from noise and other disturbing elements);
- do not add birds from an outside source to your own flock; if you must have additional geese, it is better to establish a second flock;
- keep breeders away from growing geese;
- the younger the geese, the more susceptible they are to diseases so never mix geese of different ages;
- give timely vaccines and medications. Always use the correct vaccine or medication at the recommended dose;
- when inspecting the geese, always go from the youngest to the oldest;

- isolate any sick geese immediately. Removing sick geese from a flock reduces the number of infectious organisms available to pen mates;

- safely destroy dead geese immediately by either incinerating or burying them. Get an early diagnostic report by sending sample carcasses to a veterinary laboratory for a diagnosis of the cause of death;

- discourage visitors to the farm and do not allow visitors without protective clothing onto the farm. Make sure that they have not been near other geese for at least 14 days prior to their visit;

- when selling geese, do not allow a buyer to bring unclean crates and/or boxes onto the farm for transporting the geese;

- thoroughly clean and disinfect the building and equipment between flocks of geese. This may not render the building sterile but it can reduce the number of infectious organisms to such a low level that they cannot initiate a flock infection;

- as much as possible, keep wild birds out of your pens;
- maintain complete records at all times.

In the following pages a list of goose diseases classified alphabetically is provided. An alternative classification could be according to infectious agent i.e. bacteria, fungi, protozoa or viruses.

ASPERGILLOSIS

Aspergillosis is defined as any disease condition caused by a member of the fungal genus *Aspergillus*. In the goose, as in most other classes of poultry, the organs most affected are the lungs, hence the term Pulmonary Aspergillosis. The disease can be quite severe in young goslings as they may become infected during hatching and even embryos may become infected. The source of infection can be either dirty incubator equipment and/or dirty eggs. Dirty eggs can contaminate both the setter and hatcher. In addition, it is possible for *Aspergillus* to penetrate the egg which is how embryos can become infected. Young growing goslings are also susceptible to Aspergillosis but usually not as severely although they can be infected from contaminated litter.

Symptoms. The symptoms are difficult and accelerated breathing (gasping) with rattling or gurgling noises. The birds might be very depressed and mortality can be high. Nervous symptoms may appear in a small percentage of the birds and can be accompanied by increased thirst and diarrhoea.

Treatment. The first step is to clean the hatching facilities, organize a good sanitation programme and ensure that all hatching eggs are cleaned and fumigated as soon as possible after laying. Mouldy feed and litter must be removed and destroyed and the building cleaned and disinfected with 1:2000 copper sulphate. The treatment of Aspergillosis is not always effective. Nystatin and Amphoteciricine-B have proven to be the most effective medications for geese. If these are not available, a recommended low cost treatment consists of 5 percent potassium iodine in the drinking water for three days, followed by two days of no treatment and then a second treatment for three days.

AVIAN ADENOVIRUS

The Avian Adenovirus Group 1 has been isolated from geese but the role of these pathogens is not clear. The disease is not a problem in geese, and no vaccine is available.

CHLAMYDIOSIS

Chlamydiosis is a general term which refers to infections caused by a bacterium of the genus *Chlamydophila*. In birds, the disease is caused by *Chlamydophila psittaci* and, although reported in geese, is very rare. It is however a disease of public health significance in that it is transmissible to other animals as well as to humans.

Symptoms. The disease has been reported to affect a wide range of organs with symptoms including mild respiratory difficulties, conjunctivitis, inflammation of the sinuses, rhinitis, diarrhoea and atrophy of the breast muscle.

Treatment. The antibiotics of choice to treat this disease are the tetracyclines. In some cases salmonellosis may be a complicating factor and it may be necessary to use a combination of antibiotics.

COCCIDIOSIS

Geese can get two distinct types of coccidiosis. The most prevalent form is renal coccidiosis caused by *Eimeria truncata.* While intestinal coccidiosis is less prevalent, it is caused primarily by *Eimeria anseris*. At least five additional species of *Eimeria* have been isolated from the intestine of the goose. The level of infection and degree of economic loss associated with coccidiosis in the goose is generally low and it is not regarded as a major problem.

Symptoms. Renal coccidiosis can affect geese from 3-12 weeks of age, although the younger birds are much more susceptible. In an exceptional acute form, renal coccidiosis can result in mortality as high as 80 percent. Other indicators of the disease include depression, weakness, diarrhoea, whiteish faeces, anorexia, dull, sunken eyes and drooped wings. Diagnosis of renal coccidiosis can be confirmed by locating the distinctive oocysts in the kidneys and in the cloaca near the urethras. Birds quickly develop immunity to re-infection by *Eimeria truncata*.

Intestinal coccidiosis also mostly affects young birds but does not always result in mortality. Rather, the infection produces anorexia, a tottering gait, debility, diarrhoea and morbidity. The small intestine becomes enlarged and filled with reddish brown fluid. Lesions are primarily in the middle and lower portion of the small intestine.

Treatment. Various sulphonamide drugs and coccidiostats have been used in the treatment of renal and intestinal coccidiosis of geese. If the geese are to be fed rations which were formulated for other types of poultry, it should be noted that in spite of popular belief to the contrary, waterfowl can be fed rations containing most of the coccidiostats used for chickens. The Veterinary University of Hanover, Germany have specifically reported that the following coccidiostats found in chicken rations are tolerated by waterfowl: amprolium, amprolium-ethopabate, clopidol, clopidolmethylbenzoquate, DOT (zoalene), lasalocid monensin-sodium, narasin, nicarbazin, robenidin, salinomycin and sulfaquinoxaline. They also reported that neither halofuginone nor arprinocid are tolerated by waterfowl and that they could find no information on the effect of giving waterfowl feed containing either decoquinate or maduramicin ammonium.

CRYPTOSPORIDIOSIS

This is a protozoan disease caused by parasites of the genus *Cryptosporidium* which infects both the lungs and intestine of geese.

It is found worldwide wherever commercial poultry are raised and, as poultry health specialists develop appropriate tools to identify it, it is expected that more cases will be reported. This probably explains why reports from the goose industry are that its incidence seems to be on the increase.

Symptoms. One form of Cryptosporidiosis infects the respiratory tract and the symptoms include depression, sneezing and respiratory distress with moderate mortality. The other form infects the digestive tract and the symptoms include diarrhoea and, if the geese are young, can result in a relatively high mortality rate. Because a number of diseases can produce the same symptoms, fluids obtained from respiratory tract and the faeces should be examined for oocysts.

Treatment. There are no effective drugs for the prevention or treatment of *Cryptosporidium*. There is evidence that once infected birds recover, they are immune, but to date no vaccine has been developed. Good sanitation is recommended as a preventative measure, together with steam cleaning of infected premises. The oocysts of Cryptosporidium are extremely hardy.

DERZY'S DISEASE

Derzy's disease is a viral disease also known as Parvovirus disease because of the causative agent. Other names include Goose Plague, Goose Hepatitis, Goose Enteritis, Goose Influenza, Infectious Myocarditis and Ascetic Hepatonephritis. It is a highly contagious disease that affects young geese. The disease has been reported to exist in any part of the world where geese or Muscovy ducks are raised since they are also susceptible to it and can transmit the disease to geese. In its acute form, the disease can result in up to 100 percent mortality rate or it can occur in a more chronic form. If birds are infected during the first week of age, very high losses can occur but if the goslings are 4-5 weeks old or older the mortality rate will be negligible.

Symptoms. For goslings under one week of age the clinical signs are morbidity (anorexia and prostration) and mortality, with deaths occurring in 2-5 days. Older birds, depending on their level of maternal immunity, will exhibit anorexia, polydipsia, weakness with a reluctance to move, nasal and ocular discharge, swollen and red uropygial glands and eyelids and a profuse white diarrhoea.

Treatment. There is no treatment for Derzy's infection. Adult breeding geese that have been naturally infected with the parvovirus become immune and transfer this passive immunity to their progeny. This passive immunity will persist in the newly hatched goslings for 2-3 weeks. It is the phenomena of passive immunity being transmitted to the offspring that has led to the development of a recommended vaccination programme. In its simplest form, all goslings should be vaccinated at about two weeks of age. This assumes that the goslings' parent flock had been vaccinated which would mean that the goslings' natural passive immunity would protect them until 2-3 weeks of age. For birds not designated to be breeders, this single vaccination is sufficient. Birds designated to be breeders should be vaccinated again three weeks before the beginning of lay and three weeks before the beginning of each subsequent lay. In addition, some practitioners recommend a booster vaccination at peak egg production.

If the parent flock had not been vaccinated which would mean that no passive immunity was passed on to the goslings, the recommendation would be to give serum to the goslings on day one and on day ten to give them passive immunity and to then vaccinate them on day 21.

DUCK VIRUS ENTERITIS

Duck Virus Enteritis (DVE) is an acute, contagious disease caused by a herpes virus that can infect ducks, geese and swans although the incidence of the disease in geese is very low. DVE can be transmitted directly, by contact between infected and susceptible birds, or indirectly, by contact with a contaminated environment. Birds that have recovered from DVE are immune to re-infection by the DVE herpes virus. It should be noted that in Australia a herpes virus has been isolated from a flock of infected geese (with a mortality rate of 97 percent) which was anti-genically distinct from the duck viral enteritis herpes virus.

Symptoms. The symptoms depend on the age and sex of the geese, the stage of infection and the virulence and intensity of the virus exposure. Lesions of DVE are associated with vascular damage (tissue haemorrhages and free blood in the body cavities), vascular eruptions at various locations on the mucosa surface of the gastrointestinal tract, as well as lesions of lymphoid and other tissues.

Treatment. There is no treatment for DVE but vaccines that are effective have been developed.

ERYSIPELAS

Erysipelas is generally an acute, sudden infection of individual geese within the flock. In both young and adult birds it is caused by the bacterium *Erysipelothrix rhusiopathiae*. Outbreaks of this disease which are economically significant are uncommon in avian species, with the exception of turkeys, but some cases have been reported for geese. *Erysipelothrix rhusiopathiae* is somewhat unique in that it can infect over 50 animal species and can also infect humans. In the latter case, the infection usually enters through scratches or puncture wounds and is considered a safety issue for people working with infected animals. Human infections can be treated with antibiotics.

Symptoms. Infected geese will appear depressed, have diarrhoea and die suddenly. Lesions are suggestive of generalised septicaemia.

Treatment. The antibiotics of choice are rapid-acting forms of penicillin that can be administrated together with an erysipelas bacterin. Since the presence of the disease in geese is sporadic, routine immunisation is not generally recommended. However, in areas where the disease is prevalent, and particularly for breeder flocks, vaccination is recommended. Birds that have recovered from acute infections have a high degree of resistance to re-infection.

FLUKES

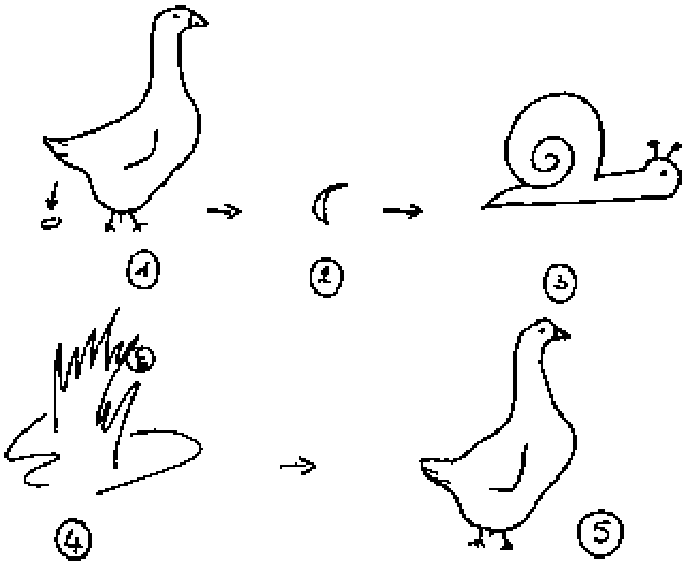
Flukes (trematodes) are flat, leaf-like parasitic organisms. Over 500 species belonging to 125 genera and 27 families are known to occur in birds. Generally, flukes are not a problem for geese, however, geese with access to natural lake or pond water may become infected. This is because most flukes have an aquatic snail (genus *Limnaea*) as an intermediate host. The dragonfly (genus *Odonata*) is the second intermediate host in many cases.

Symptoms. Flukes may invade almost every cavity and all tissue of birds and can show up unexpectedly at a post-mortem. One species of fluke known as the oviduct fluke

(*Prosthogonimus ovatus*), can infect the oviduct which results in flukes appearing in the geese's eggs.

Treatment. The only practical solution is to remove the birds from the source of infection. This can be done if the intermediate host(s) is/are known.

FIGURE 50. A sample life cycle of flukes



(*Source*: Guy, 1996)

(1) Infected geese excrete fluke eggs in their dropping.
(2) When the conditions are favourable, the eggs hatch, producing a primary larvae.
(3) The larvae mature in an intermediate host (a

snail of genus *Limnaea*).

(4) The intermediate host lays the mature larvae on grass.

(5) After ingesting the larvae by grassing, the geese become re-infected.

FOWL CHOLERA

Fowl Cholera, also known as Pasteurellosis, is a contagious disease affecting all domestic and wild birds. *Pasteurella multocida* is the causative agent, to which geese are highly susceptible and mortality can be high.

Symptoms. Fowl Cholera usually appears as a septicaemic disease, associated with high morbidity and mortality. Perhaps the most characteristic aspect of the acute form is the sudden death of birds with the symptoms appearing only a few hours before death. The chronic form, which can follow the acute form, normally shows as localised infections. The lesions associated with this disease can take several forms, but in most cases the heart, pericardium and air sacs are damaged.

Treatment. Fowl Cholera is not a disease of the hatchery nor is it one transmitted through the egg. Rather, infection occurs when the geese are on the farm. The first step in the control of Fowl Cholera is therefore good sanitary management practices and keeping the geese separate from other birds.

In areas where Fowl Cholera is present either in geese or other species of birds, vaccination of all birds is recommended. In the case of an outbreak, it is possible to treat the birds to stop the spread of the disease, but this must be done quickly. A number of sulphonamides, such as sulphamethazine, sulphamerazine, sulphaquinoxaline and sulphathoxypyridazine have been shown to be effective when administered in the feed or water. In addition, a number of antibiotics when given intramuscularly have been shown to give good results. These include chlortetracycline, oxytetracycline, chloramphenicol and penicillin. Erythromycin in the water and both oxytetracycline and chlortetracycline in the feed have also been seen to be effective.

LEUCOCYTOZOONOSIS

This is a parasitic disease of birds which affects the blood cells (especially the white blood cells) and the tissues of various internal organs (parasite multiplication occurs in the macrophages of brain, liver, heart, lungs, and spleen). It is a very uncommon disease in geese but outbreaks of economic significance have been reported. *Leucocytozoon simondi* is the causative agent in waterfowl and has been reported in 27 species of ducks and geese in North America, Europe and Vietnam.

Symptoms. Leucocytozoon infections are diagnosed by direct microscopic observation and by identification of either the gametocytes (sexual stage of the parasite) in stained blood samples or of the schizonts (stage of massive multiplication) in tissue sections.

Treatment Treatment of leucocytozoonosis with drugs has, in general, had limited success and no effective treatment has been found for *Leucocytozoon simondi*. Control methods require the elimination of the insect carriers that include various species of diptera (simuliid flies and culicoid midges) that live near streams.

LISTERIOSIS

Listeriosis is not a common disease of geese but some instances have been reported in temperate areas of the world. This is probably due to the fact that, in temperate climates, *Listeria monocytogenus* (the causative agent) is found in both faeces and soil. Also, it is in these areas that many geese are kept on pasture and therefore are exposed to the organism.

Symptoms. The symptoms are septicaemia with necrotic areas in the liver and heart. Encephalitis has been reported in young geese. Infected birds appear emaciated with diarrhoea.

Treatment. Prevention depends on eliminating the source of infection. As the organism is resistant to most commonly used antibiotics, high levels of tetracyclines are usually recommended for treatment.

MYCOPLASMA INFECTIONS

Mycoplasma infections, also know as Pleuro-Pneumonia Like Organisms or PPLO, can cause relatively serious problems in geese. These organisms have an intermediary structure between that of bacteria and viruses. At least three species of Mycoplasma (*Mycoplasma anseris*, *Mycoplasma claucale* and Strain 1220) have been isolated in geese. In recent years the prevalence of Mycoplasma infections in geese in a number of areas appears to have increased. This is most notable when birds are managed under intensive conditions.

Symptoms. The main problem of Mycoplasma infections is that in breeder flocks it results in reduced egg production and lower fertility. There is necrosis of the phallus (Venereal Disease) which can cause a severe drop in fertility. In young goslings Mycoplasma infection results in reduced growth, and respiratory and air sac infections. For young geese the common source of Mycoplasma infection is from the hatching egg.

Treatment. The most important aspect of a Mycoplasma control programme is to ensure that the grandparent and parent stocks are Mycoplasma-free so that goslings from these flocks are not infected. Treatment of eggs from an infected flock is achieved by dipping the eggs in a tylosin solution before the eggs are incubated. Infected goslings can be treated by adding either tetracycline or tylosin to their drinking water.

MYCOSIS OF THE DIGESTIVE TRACT

Mycosis of the digestive tract, caused by *Candida albicans*, can occur frequently in some classes of poultry but not in geese. An exception is force-fed birds, where inflammation of the oesophagus may be caused by the insertion of the corn dispenser. This inflammation can then provide a port of entry for *Candida albicans.*

Symptoms. The symptoms are not particularly characteristic but infected birds show unsatisfactory growth, are stunted, listless and have ruffled feathers. Lesions occur most frequently in the crop and are characterised by a whiteish deposit.

Treatment. Since unhygienic and overcrowded conditions are conducive to *Candida albicans* infections, the first step is to eliminate these. The addition of copper sulphate to the drinking water has had variable results in treating chickens and geese. Sodium bicarbonate in the drinking water increases the pH in the crop and creates an unfavourable condition for the organism as it likes an acid environment. Addition of either Nystatin or Amphotericin to the feed has been reported to be effective.

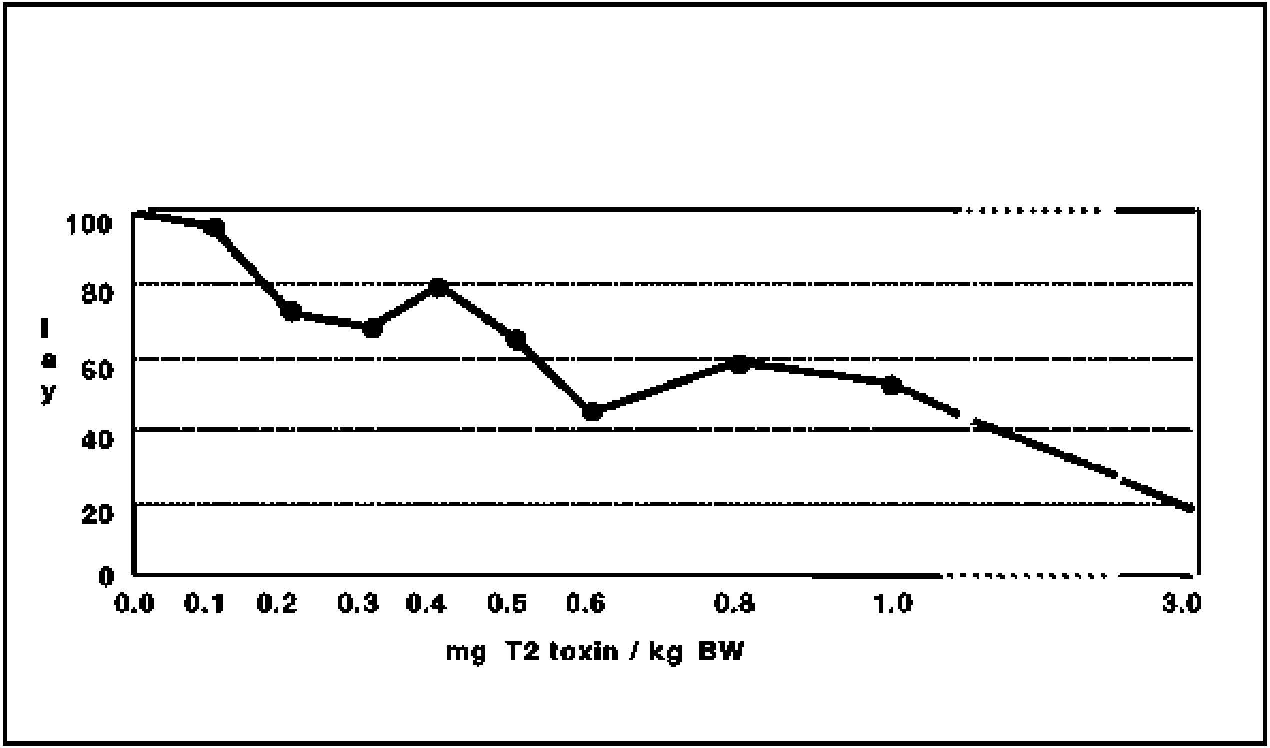
MYCOTOXICOSES

Mycotoxicoses is a disease caused by exposure to mycotoxins, and the most prevalent source of mycotoxin contamination for geese is mouldy feedstuffs. Diagnosis of Mycotoxicoses can be very complex since hundreds of mycotoxins have been identified. However, knowing what the geese are being fed, the source, the symptoms the geese are exhibiting and whether or not other livestock or poultry being fed the same feedstuffs are showing similar symptoms, will allow diagnosis of the problem and identification of the source(s) of the mycotoxin. In tropical countries where aflatoxins are very common, their origin is connected with the development of genus *Aspergillus flavus* and *Aspergillus parasiticus* growing mainly on peanuts but also on soybeans, copra, rice bran and corn. According to the literature, alflatoxins may cause slow growth, a drop in egg production and feather loss for all species of waterfowl, although geese are among the less sensitive. The genus *Fusarium* produces numerous toxins injurious to geese, and these have been found in corn, sorghum, barley, sunflower seed, oats, mixed feed and brewers' grains. *Fusarium* mycotoxin production thrives in conditions of high humidity and a temperature of 6-24°C. In temperate climates it is therefore essential that grains be harvested early before the cool-humid conditions of fall arrive as these are conducive to mycotoxin production.

Symptoms. T-2 toxin is one of the most common *Fusarium* toxins and, depending on the level of contamination, will cause feed refusal, reduced activity, increased water consumption, reduced egg production and reduced hatch (Figure 51 and 52). There are reports that exposure of young geese to T-2 toxin has resulted in the geese dying within two days. Another *Fusarium* toxin to which geese are very sensitive is zearalenone which can not only result in an immediate drop in fertility but can also permanently damage the testes of the gander.

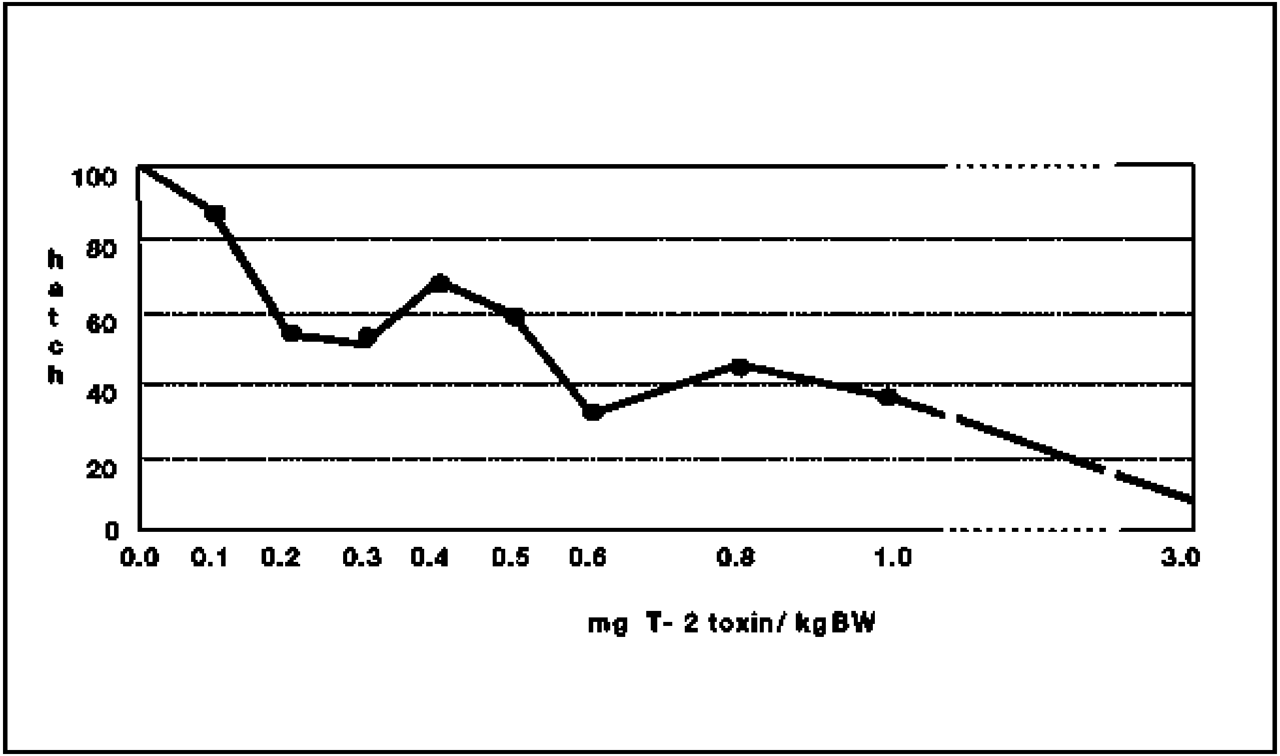
Treatment. Treatment is to remove the contaminated feedstuff immediately and provide the geese with fresh, uncontaminated feed. The best prevention is to ensure that all purchased feedstuffs are mycotoxin-free.

FIGURE 51. Relative effect of T-2 toxin intake levels on egg production (relative rate of lay of controls is set at 100)



(*Source*: Vanyi *et al*., 1992)

FIGURE 52. Relative effect of T-2 toxin intake levels on hatch of fertile eggs (relative rate of hatch of controls is set at 100)



(*Source*: Vanyi *et al*., 1992)

NECROTIC ENTERITIS

Necrotic enteritis is caused by *Clostridium perfringens* and has been reported to occur in geese although the incidence of the disease does not appear to be high. *Clostridium perfringens* can be found in soil, faeces, dust, litter and contaminated feed.

Symptoms. The clinical signs of Necrotic enteritis are severe depression, decreased appetite, reluctance to move, diarrhoea and ruffled feathers. Sick birds may die quickly due to enterotoxemia and necrosis of the small intestine.

Treatment. Prevention is the rule. Many birds have natural populations of *Clostridium perfringens* in their caeca, but rarely in the small intestine. Stress or any irritant to the digestive tract can provide the stimulus for this genus to appear and multiply in the small intestine and should be avoided. If the disease appears, a number of antibiotics have been found to be effective which include lincomycin, bacitracin, oxytetracycline, penicillin, tylosin, virginiamycin, avoparcin and nitrovin.

NEMATODES

It has been said that nematodes, or roundworms as they are commonly called, constitute the most important group of helminth parasites of poultry. With geese, *Ascaridia* are generally not a problem but various species of *Capillaria* and *Heterakis* can cause problems. The most common nematode in geese is *Amidostomum anseris*.

Symptoms. The usual symptom of worm infection in geese is lethargy. The presence of eggs or worms in either the faeces or in any organ, as revealed upon autopsy, will confirm a worm infection. *Amidostomum anseris* infects the horny lining of the gizzard and sometimes the proventriculus. It causes dark discoloration of the gizzard and a sloughing off of the lining.

Treatment. The first principle in controlling nematode infections is to practice good management. For geese on range, it is essential to rotate pastures 3-4 times a year and to change the pastures every year so as to break the cycle of nematode re-infection. For geese in confinement, the litter should be changed regularly and the building washed and disinfected with insecticide after each flock of geese. It is important not to mix young and old geese together, nor to follow old geese with young geese who are much more susceptible to nematode infections.

A number of anthelmintic drugs are available to treat nematode infections. For the control of *Amidostomum anseris* in geese cambendazole, pyrantel, mebendazole and fenbendazole have each been shown to be effective.

Hygromycin B and coumaphos, when included in the feed, are both effective against *Ascaridia*, *Capillaria* and *Heterakis*. Phenothiazin is effective against *Heterakis* and Thiabendazole is effective against *Syngamus*.

The following nematodes have been isolated from the small intestine of the goose: *Echinura uncinata*, *Epomidiostomum uncinatum*, *Ascaridia galli*, *Capillaria anatis*, *Capillaria bursata*, *Capillaria annulata*, *Capillaria anseris*, *Capillaria caundinflata*, *Capillaria obsignata*, *Heterakis dispar*, *Heterakis gallinarum*, *Strongyloides avium* and *Trichostronglus tenuis*. The nematode *Syngamus trachea* has been isolated from the respiratory tract of the goose.

NEPHRITIC HEMORRHAGIC ENTERITIS

Nephritic hemorrhagic enteritis is a disease that is currently quite prevalent in the south western region of France and is often referred to simply as NEHO. It can infect geese from 4-

20 weeks of age and causes mortality rates from 30-100 percent. The causes of this disease are not well understood but it seems to be primarily poor management. An excess of protein in the feed or any sudden change in the diet of the birds can also bring it on, as can poor quality drinking water and parasite infections.

Symptoms. When suffering from this disease, geese are often unsteady on their feet, have difficulty getting up and have erratic movements. These symptoms are accompanied by diarrhoea and trembling and death usually follows shortly afterwards. The characteristic lesions are urates and haemorrhaging in the kidneys, an exaggerated sub-cutaneous swelling and the presence of intestinal parasites.

Treatment. The first measures to take are good management prevention practices such as controlling parasites and ensuring that the geese have a balanced ration. For outbreaks of the disease, good results can be obtained by injecting homologous serum. Also available are renal tonics and liver detoxicants, both of which can help relieve the symptoms. Due to a lack of knowledge of the disease, no vaccine has yet been developed.

NEWCASTLE DISEASE

The Newcastle Disease Virus is of the genus *Paramyxoviruses* which has been isolated from geese. Clinical signs are the exception rather than the rule, but when present, consist of greenish diarrhoea and, occasionally, disorders of the central nervous system. In many cases, geese may be infected without showing any clinical symptoms, yet they can be carriers for a prolonged period. Usually geese are not vaccinated since Newcastle disease is not generally a problem for them.

PARATYPHOID

Paratyphoid, or salmonellosis, is an important disease in geese with young birds, generally under six weeks of age, being the most susceptible. In addition, the concern regarding salmonella infection in humans and the demand for salmonella-free poultry products has increased the awareness of this disease and resulted in various monitoring programmes being undertaken in many countries. Over 2 000 types of salmonella organisms have been isolated from various species of fowl worldwide. Generally, the salmonella serotypes isolated from poultry are more characteristic of the region than the species of poultry. Paratyphoid is easily spread through contact with either infected birds, their faeces or through infected equipment, particularly that used for hatching and brooding. It now appears that salmonella is spread by salmonella entering the egg both *in vivo* before it is laid and by penetrating the egg after it is laid. In both cases it can multiply in the egg. For this reason, the importance of collecting eggs frequently before they get dirty, and cleaning and fumigating them as soon as possible, cannot be over emphasised.

Symptoms. Geese with Paratyphoid will usually be less than six weeks of age, tend to stand in one position, with their heads lowered, eyes closed, wings dropping and feathers ruffled. Sick birds will also exhibit marked anorexia, increased water consumption, watery diarrhoea, pasty vent and a tendency to huddle close to the heat.

Treatment. The first step in the control of Paratyphoid is to remove all the possible sources of salmonella. This requires excellent management and sanitation of the breeders, the hatching process and the rearing of the goslings. The cleanliness of the hatching eggs is perhaps the most important single aspect in the control of Paratyphoid, especially the fumigation of eggs immediately after laying. Rodent control is also very important.

A number of sulphonamides, antibiotics and nitrofurans have been recommended in the treatment of paratyphoid. In addition, furazolidone and injectable gentamicin and spectinomycin can be used. The final diagnosis of Paratyphoid depends on isolation and identification of the causative organism. This will help determine which drugs are best suited to treat a particular outbreak.

RIEMERELLA ANATIPESTIFER INFECTION

Riemerella anatipestifer infection is a contagious disease affecting domestic geese, ducks and various other birds which means that infections in geese can originate from other species.

Symptoms. The common symptoms are ocular and nasal discharges, mild coughing and sneezing, greenish diarrhoea, uncoordinated movement, tremor of the neck and head and coma. Geese that recover from the disease are resistant to subsequent infection.

Treatment. The sulphonamides and antibiotics as listed under Fowl Cholera for the control of *Pasteurella multocida* are usually effective against *Riemerella anatipestifer*. Vaccines have been developed but they have been used primarily with ducks although they can be expected to prevent the disease in geese as well.

PSEUDOTUBERCULOSIS

Pseudotuberculosis caused by *Yersinia pseudotuberculosis* has been reported in a large number of avian species, including geese. It is not, however, a common disease in geese.

Symptoms. The disease is characterised by an acute septicaemia and infected birds have difficulty breathing and are weak, with dull and ruffled feathers and diarrhoea. A definite diagnosis requires isolation and identification of the causative agent.

Treatment. Due to the low incidence of the disease, there is very little information available but chloramphenicol, streptomycin and tetracycline have been effectively used in some species.

RETICULOENDOTHELIOSIS

Reticuloendotheliosis refers to a group of syndromes caused by the retroviruses of the REV group. The disease occurs in a wide variety of domestic poultry but is rare in geese. It is sometime called the Runting Disease because it is characterised by poor growth and abnormal feathering. In geese, viruses have been isolated from tumours of the spleen, liver, pancreas and intestines. No vaccine has been developed for this disease because the incidence and economic importance of the disease is very low.

SPIROCHETOSIS

Spirochetosis in avian species is caused by *Borrelia anserina* and is tick-borne. Spirochetosis was first described in 1891 as a severe septicaemic disease of geese in Russia but it is now found worldwide, especially in the tropical and subtropical areas where fowl ticks (genus *Argas*) are common. However, even in these areas the incidence of the disease is low.

Symptoms. Morbidity and mortality are highly variable, ranging from 1-2 percent up to 100 percent. Lowest rates occur when the birds have previously been exposed to *Borrelia anserina* and have developed immunity. Larval ticks or puncture haemorrhages from tick bites on the birds, or ticks in the birds' environment are indicative of the disease.

Treatment. In areas where Spirochetosis is prevalent, vaccination is the control method of choice. Female geese that have acquired immunity, either through natural exposure or through vaccination, are capable of passing on passive immunity to their offspring which will protect them for 5-6 weeks post hatching.

When an outbreak occurs, the treatment of choice is usually antibiotics. *Borrelia anserina* is sensitive to most antibiotics including penicillin, chloramphenicol, kanamycin, streptomycin, tylosin and tetracyclines.

STAPHYLOCOCCOSIS

All avian species are susceptible to staphylococcal infections though geese do not appear to be affected to any great degree. If and when they are infected, it is generally as a secondary infection but even this is rare in geese. *Staphylococcus aureus* is the most common infection in birds. One of the major concerns is that staphylococcus infections can be transmitted from birds to humans. This has been observed among both slaughterhouse workers and people performing autopsies.

Symptoms. The most frequent sites of infection in poultry are bones, tendon sheaths and leg joints but infections may occur elsewhere.

Treatment. Staphylococcus infections can be treated with antibiotics. Penicillin, streptomycin, tetracycline, erythromycin, novobiocin, sulphonamides, linomycin and spectinomycin have been used successfully.

STREPTOCOCCOSIS

There are a number of species of streptococcus that infect birds. However, to date, streptococcus infections in geese are very rare although *Streptococcus mutans*, a common bacterium of the human oral cavity, has been identified as a cause of septicaemia and mortality in geese.

Symptoms. In its acute form, the clinical signs of Streptococcosis are related to septicaemia, depression, lethargy, diarrhoea and head tremors, although often the birds are just found dead. In the chronic form, depression, loss of weight, lameness and head tremors may be observed.

Treatment. Prevention and control require reducing stress and following proper sanitation practices. Treatment includes the use of either antibiotics such as penicillin, erythromycin, tetracycline or nitrofurans.

TAPEWORMS

Over 1 400 species of cestodes or tapeworms have been noted in wild and domestic birds and for many an intermediate host has been identified. Control of the intermediate host has proven to be the best way of controlling the tapeworm. Even though geese have been reported infected with numerous species of tapeworms introduced by wild waterfowl, tapeworms are generally not a problem in goose production. This is particularly so if geese are denied access to natural waterways where they can ingest an intermediate host (most of the time a fresh water crustacean). At least four tapeworms have, however, been isolated from the intestinal lumen of geese: *Fimbriara fasciolaris*, *Hymenolepis megalops*, *Hymenolepis compressa*, *Hymenolepis lanceolata*.

Symptoms. Normally geese infested with tapeworms will not perform well, but isolation and identification of the worm is required for an accurate diagnosis.

Treatment. As with many other poultry species, it is not easy for geese to contract a tapeworm infection because of the trend towards confinement poultry production systems. This trend has resulted in a marked decline in tapeworm infections simply because poultry species are now more separated from the intermediate host. For this reason the first step to control tapeworm infestations in geese is to separate the geese from the intermediate host by confining them or by developing an effective pasture rotation system. The geese must also be isolated from natural waterways. Using only drugs to expel the worm will have a very short-term effect if the intermediate host is not controlled. Drugs that have been effective in controlling tapeworms in chickens are butynorate, either on its own or in conjunction with piperazine and phenothiazine under the trade name Wormal. Experimentally, hexachlorophene and niclosamine have also been shown to be effective.

TRICHOMONIASIS

This is a protozoan disease that infects mostly mature geese in breeder flocks. The causative agent in geese is *Trichomonas anseris* while for other classes of poultry it is *Trichomonas gallinae*. These organisms are transmitted from bird to bird through the water and, to a lesser degree, through the feed.

Symptoms. The infection in geese is mainly in the lower digestive tract and the first symptoms are reduced reproductive performance and weight loss. The droppings can be monitored for the protozoan although an autopsy (with heavy infections mortality can be high) will generally not yield the protozoa as they disappear quickly.

Treatment. If the disease has not spread throughout the flock, any sick birds that can be identified should be isolated. Nitrofurazon, metronidazole and dimetridazole are effective in treating the disease.

VENEREAL DISEASES

Bacteria, especially *Neisseria*, *Mycoplasma*, and *Candida albicans* have been associated with a venereal disease in ganders although it now seems that *Mycoplasma* are the primary infective agents.

Symptoms. Initially, the base of the phallus becomes swollen and inflamed with the infection extending to the cloaca. Later, there is necrosis, ulceration and eventually considerable scarring, making reproduction impossible. The disease spreads throughout the flock very rapidly.

Treatment. The onset of the disease has, in some cases, been associated with a high density of ganders that has led to fighting, resulting in the phallus of some ganders being injured and becoming infected. The infection then spreads through the flock via the females. When infected, the females exhibit symptoms such as airsaculitis, peritonitis, and salpingitis. The first control measure to take is good management of the breeder flock. Because of the principle involvement of *Mycoplasma*, some veterinarians view the disease as a component of Mycoplasma infections rather than as a separate disease. Treatment is therefore with antibiotics effective against *mycoplasma* such as tylosin, tetracycline, chlortetracycline, linomycin, oxytetracycline, spectinomycin, spinomycin and tiamulin. Sensitivity tests should be conducted to select the appropriate antibiotic.

GOOSE DISEASES - CONCLUSIONS

To conclude this chapter, we can say that for a sustainable production of geese, it is essential to ensure sanitary conditions for the flock. Some diseases, such as Derzy's disease, can cause severe losses of up to 100 percent of the geese but generally many of the diseases are not as serious a problem for geese as they are for other poultry species. Every effort must still be made, however, to keep the geese healthy and good flock management will greatly contribute to the prevention of most diseases.

Listed below are the summarized guidelines with regard to disease management for both growing and breeding geese:

GROWING GEESE

General

- Put goslings in a clean, disinfected poultry house and ensure that the temperature is correct and that the air circulation is adequate.

- Provide adequate fresh food and water.

- Practice pasture rotation and treat with 5-6 g of ferric sulphate per square metre.

- Respect the stocking density recommended for the type of housing being used.

- Observe the behaviour and general health of the flock regularly.

Medical prophylactics

Derzy's disease: goslings from protected breeders should be vaccinated before they are four weeks of age. Goslings from unprotected flocks should be injected with a serum twice: at one and 18 days of age and then vaccinated.

Cholera: three vaccinations are required at six, ten and 20 weeks of age.

Parasites: birds on deep litter and pasture should be treated for worms every six weeks. It is also recommended to check the faeces every month for worms and/or oocysts.

When available, and depending on the composition of the diet being fed, a vitamin and mineral supplement is recommended every two weeks up to ten weeks of age and at any time that the birds are stressed.

BREEDING GEESE

It is necessary to perform all the medical treatments before the first egg is laid. These include treatments for Parasites (worms, coccidioses, tricomoniasis), Mycoplasma, Salmonella, and further vaccination for Cholera and Derzy's disease. During the lay period, it is important to monitor egg production, percent fertility and percent hatch on a weekly basis. Any decrease in these or any other parameters could mean the onset of a disease even if the birds still appear healthy. To maintain the reproductive performance of the flock, any disease must be identified and treated immediately.

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PART II - INVITED PAPERS

GOOSE PRODUCTION IN CHILE AND SOUTH AMERICA
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INTRODUCTION

Geese were the earliest bird to be domesticated. Their domestication started during the Neolithic period approximately 20 000 years ago so man has been using geese for thousands of years and their use has increased over time.

The goose is a unique bird with very special characteristics, very different from other domestic birds. One of these differences is due to its digestive system which allows it to eat and survive exclusively on grass. Unlike other domestic birds but similar to sheep, geese have been used from the start as a multi-purpose animal: for their meat as food and for their high quality feathers as insulation against the cold. Geese can also be used to produce another very high quality product, fatty liver or Foie Gras. However, the production of this product requires a specialised feeding technique called force feeding or cramming.

In spite of the above, geese have not been commercially developed as a domestic bird of worldwide importance as, for instance, chickens have been. This is due to three main considerations:

- historical and cultural factors;
- the multi-purpose nature of geese which requires the processing of a number of products;
- local economic and agrarian conditions.

As will be discussed later in this paper, these factors played a decisive role in the introduction of geese to North and South America.

With the colonization of North America came English, French and Dutch settlers, who in addition to bringing genetically superior animals, also brought geese who participated significantly in the establishment of the settlements. Keeping geese became a tradition on farms and it is still maintained today in Canada and the northern parts of the United States of America.

However, geese were not introduced into South America during its colonization. At first glance, this would appear to be due to the climatic difference between North and South America but this is not the case. South America is a vast continent and it includes a wide variety of climatic conditions, from the very hot tropical, humid jungle to the ice fields of Patagonia. With this great variety of climatic conditions, the Spanish conquerors had no lack of appropriate environments for goose production. It was only after the South American countries achieved their independence and other European immigrants, mainly German, English and French settlers arrived, that the goose was brought to the South American continent.

Contrary to popular opinion, these new settlers did not encounter any difficulty in introducing geese to South America. In Chile today it is possible to find small flocks of geese, raised under family farm conditions, extending over the vast area from the Aconcagua valley (32-33 latitude south) to the plains of Magallanes (53-56 latitude south).

It was in this way and basically due to personal preferences, that geese began to arrive in Chile during the second half of the nineteenth century. The Emden geese came from the city of the same name in Germany (in Holland they were known as Embden geese and both spellings are used for the breed today), the Toulouse geese from Toulouse in France and the small Pilgrim geese came from England and Ireland. German settlers, invited by the Chilean government to colonize parts of the south of the country, brought the Emden goose in 1845. Toulouse geese apparently arrived in 1891 in larger numbers and became very popular because it was a favourite of the French, the French-Basques and the French-Belgians settlers who established themselves in Chile in the south-central region during this time. Today, descendants of the Toulouse goose are present in the majority of the flocks in the Chilean countryside.

Pilgrim geese arrived in Chile in smaller numbers, probably from Ireland. Pilgrim geese have a more rounded and refined body conformation and, since their meat has a milder flavour, they were probably more suitable for the culinary traditions of the Anglo-Saxon and Irish settlers in the southern parts of Chile and Argentina and so more appreciated by them.

Unfortunately, these original settlers did not pass on their knowledge of goose breeding and management to their descendants and subsequently information on many important aspects of goose production, such as feeding and breeding, was lost. In addition, they allowed the various breeds to interbreed freely and it is from this interbreeding that the rustic "Chilean goose" originated. Furthermore, keeping small flocks over a long period of time without the introduction of new genetic material and the continual mating of closely-related individuals, led to inbreeding which resulted in low egg production and poor reproductive performance.

During the years 1989-1993, the Catholic University of Chile developed a project that had two main objectives:

- to study the management requirements of the Chilean goose and to transfer this knowledge to the farmers;
- to incorporate better genetic material into the local population of Chilian geese with the introduction of French breeds superior in meat and fatty liver production.

As a result, these new importations were made but to date they have been of little commercial importance.

As in Chile, goose production in other Latin American countries has not reached a level of commercial importance. The few exceptions have resulted in medium size enterprises. Nevertheless, the need for creating new production initiatives in animal husbandry may help in the future to generate new goose production ventures with clear commercial objectives, perhaps in combination with other agricultural activities.

The objective of this paper is to provide information on the management of geese in Chile including data compiled in Chile on their reproductive performance, meat production and feather production. The specialized production of fatty liver will not be included here because of the level of sophistication required to produce this product and the difficulty of adapting it to the farming sector, to whom this report is aimed.

GENERAL CONSIDERATIONS

The goose is characterized by its unique ability to use food with a high fibre content and this is particularly important as the goose is able to use forages and weeds not utilized by other species. In addition, the goose lives harmoniously with humans as both a productive animal and a good watch animal which immediately gives warning of any intruders.

There has been great interest in geese during recent years perhaps because the unique products that they produce can provide a good income when exported. But although goose produce is greatly appreciated in various countries, production costs must be kept reasonable if the producer is to make a profit. Primary products such as meat, fatty livers and feathers do not generate a very good income. From an economic and social point of view, the processed products such as pillows, duvets, parkas, smoked meat and any other typical or regional products are much more profitable.

In Chile, improved breeds of geese have not been introduced except for isolated cases, most of which has been done by the Research and Reproduction Centre of the Catholic

University. Since its creation in 1989, this Centre has imported about 4 000 day-old goslings of improved breeds. This represents one percent of the total geese existing in the country. It has been estimated that in Chile approximately 16 000 farmers raise geese, on average 20-30 geese each, giving a total population of about 400 000 geese. The high demand for day-old goslings reported by the Reproduction Centre indicates a growing interest in producing these birds and in learning about their management.

REPRODUCTION

Reproductive parameters and general management

In general, the reproductive processes of all domestic animals are very important in defining their management requirements. Geese have a reasonable egg production which takes place over a prolonged period of many years and is very seasonal, unlike chickens which produce at a higher rate but are generally only kept for one laying year. In other words, geese lay fewer eggs in a season but their production can be maintained at a good level for three to four years, after which egg production begins to decline. Because of this, with the most prolific strains it is posssible to develop programmes in which the geese produce 20-35 eggs in their first year of lay, 40-50 eggs in their second and third years, 50 eggs in their fourth, after which egg production starts to decline and at which time it is recommended that, if intensive production is being practiced, the breeders be replaced. In extensive production systems, with lower input costs, it may be possible to keep the breeders for one or two more years.

The poorest reproductive parameter is percent hatch which, with artificial incubation, generally does not exceed 70 percent. Consequently, it is possible to produce an average of 25-28 goslings per reproductive female per year, over four years of production. Under natural incubation it is difficult to achieve more than 8-9 goslings per female per year.

With respect to sexual maturity, the females are more precocious than males and generally start producing eggs at six months of age. The sexual activity of the males generally starts 2-3 weeks later and the percent fertility tends to be better the second year.

Breeders must be selected and managed according to their future use, i.e. to serve as reproductive flock. The following are some practical management rules:

- a general rule for the management of breeders of any strain is to avoid the mating of related individuals because this will result in inbreeding which can have very damaging effects, especially on percent egg production and percent hatch;

- in order to achieve a good percent hatch, a male to female ratio of 1|3 is recommended. The breeding group should be established about two months before the begining of egg production. If the birds are young, it is advisable to raise the males and females together, in the same groupings that they will be kept as adults;

- whenever possible, eggs should be collected twice a day, especially if they are to be incubated artificially which is the recommended practice;

- breeders should not have their feathers plucked during egg production (August to December in the southern hemisphere). If they are plucked at this time both percent egg production and the number of goslings produced per female will be severely reduced. They can be plucked at all other times of the year;

- if the main objective is to produce feathers of good quality, white breeds or strains should be used. In Chile, as in Europe, coloured feathers are downgraded up to 30 percent of their value, although the quality of the feathers is the same;

- for meat production it is also recommended that white breeds or strains are used because the coloured feathers leave dark spots on the skin as a result of the dark pin feathers which are impossible to remove. This gives a poor appearance to the carcass. White feathers do not present this problem. If the meat is going to be used for processed products such as sausages and hams or if it is to be cut up into parts, coloured breeds can be used because in these cases the skin is not used;

- for the production of fatty livers only specialized breeds or strains which have been genetically selected for this purpose should be used. If other breeds are used, the liver will not reach an adequate size and fat level no matter how well the force-feeding is done;

- the presence of water in the form of a pond, stream or other similar source is not essential for mating but it will provide a natural stimulant. When the breeder flock is kept in confinement, the use of water baths is recommended. A total lack of water could result in necrosis of the male copulatory organ and subsequently, infertility.

Facilities for Breeders

In intensive production systems, breeders can be kept confined in pens at a stocking rate of 2.5 birds per m^2 in groups of 25-30 breeders, and to ensure a good fertility rate, a female to male ratio of 3:1 is recommended.

The yard or pen must have sloping floors because they are continuously washed by rain. A slatted floor must cover about one third of the area (wood or bamboo are adequate). This floor must be easily removable to clean underneath on a weekly base since this is where the geese droppings and any spilt feed fall because feeders are placed in this area (Figure 1). A thorough cleaning must be done regularly (e.g. every six months) and the feeders must be removed, and well-washed using a 10 percent solution of copper sulphate as a disinfectant. Care must be taken to avoid the geese coming into direct contact with the copper sulphate because of its toxicity.

FIGURE 1 - A) Pens for Breeders

FIGURE 1 - B) Slatted floor made of wood or bamboo

As mentioned before, water baths are recommended for birds in confinement, not for mating to take place under water but so that the birds can get wet to prevent necrosis of the male copulatory organ.

Pens should be provided with enough feeders and drinkers, especially when feed restriction is practised, to avoid excessive competition for access to the feed. Round, semi-automatic feeders are recommended because they do not obstruct the movement of the birds and they are more space-efficient than linear ones. For adult geese the feeding space requirements are about 16 cm per bird using round feeders and 20 cm per bird using linear feeders. However, these values should be adjusted after observing the behaviour of the birds.

For the drinkers (Figure 3), a similar or a slightly larger space per bird is required than for the feeders and the drinkers should be at least 15 cm deep to allow the birds to wet their head and eyes. This will help prevent conjunctivitis and other eye irritations, particularly if the birds are fed a concentrate that produces dust. Drinking water should always be available.

FIGURE 2. Semi-automatic round feeder

FIGURE 3. Hanging linear drinker

Nests 70 cm long, 50 cm wide and 25 cm high (Figure 4) should be installed at a ratio of one nest for every four females. Clean litter should be used inside the nests. Straw works well and it should be changed and/or added often enough to ensure that the eggs are clean. This is the first step to good sanitation during incubation and a subsequent high yield of healthy goslings.

FIGURE 4. Nests

If an extensive production system is used, small yards or pastures can be used which provide the birds 8-10 m^2 per bird. In this case, some shade should be provided to protect the birds from the sun. In addition, there must be another isolated facility to provide an area for the nests. The floor of this nesting facility must be kept dry by using wood shavings or straw as litter. It can also be used to provide a good place for the birds during the night to protect them from attack by dogs or other predators. If artificial incubation is being used it is important to keep the nests supplied with clean, fresh straw and to collect the eggs frequently. This practice helps to keep the eggs clean and prevents the females from staying in the nest too long, which can decrease egg production. If the breeders are to be supplemented with a concentrate feed, it is recommended that the nesting facility is supplied with feeders, as well as drinkers for the night. Geese normally drink large amounts of water during the night.

ARTIFICIAL INCUBATION

The incubation of goose eggs takes about 30 days and is regarded as difficult due to the large size of the eggs, the hardness of their shells, and the need to cool them regularly. All these factors make the artificial incubation of goose eggs a much more complicated task than the incubation of chicken eggs. However, incubation equipment especially adapted for goose eggs is available and will produce good results.

Forced air incubators have a larger capacity and although they cost more, they give better results than simple still air incubators. The higher cost of the forced air incubators is due to the advantage of their greater automation. Hygiene during incubation is a determining factor in obtaining a high percent hatch.

Management of the eggs

The success of an artificial incubation programme depends not only on keeping the eggs under optimal environmental conditions but also on how they are handled from the moment they are laid.

Egg collection. This should be done as often as possible to avoid damage to the eggs caused by changes in temperature, dirty nests and trampling on the eggs which causes cracking etc. Collecting the eggs at least twice a day can prevent these problems. The collection and transport of the eggs must also be practised with care to avoid shell damages. Cracked eggs have no chance of hatching. Before going to the hatchery, the eggs should be stored in a cool and clean place.

*Egg disinfecting***.** Hygiene of the eggs starts with clean nests and frequent egg collection. It is not recommended that dirty eggs be washed because if preventive measures are not taken, they can become more contaminated than they originally were. This is because if the water temperature is lower than that of the egg, as the egg cools due to the cooler washwater, a suction occurs and the washwater is pulled into the eggs through the pores in the shell carrying dirt from the washwater and micro-organisms from the faeces on the egg surface. It is better that any dirt adhering to the shell surface is carefully removed by using a dry soft brush.

The purpose of disinfecting the eggs is to kill any micro-organisms that exist on the surface of the shell. The most popular method is to fumigate the eggs with formaldehyde. This is a gas with a wide anti-microbial action that is effective for bacteria, fungi and even some viruses. The fumigation is performed in sealed chambers where eggs are exposed on trays. The formaldehyde gas is produced by mixing formalin (a 30 percent solution of formaldehyde) with potassium permanganate. This is done in a rust-proof container (enamelware is often recommended) with a capacity 5-10 times larger than the volume of formalin being used because when the chemicals react, a foam is produced and the volume increases. A good mixture for disinfecting eggs is 40 ml of formalin and 20 g of potassium permanganate per cubic meter of the fumigation chamber for a half an hour. Care must be taken to avoid inhaling the formaldehyde gas because it is a strong irritant. The disinfecting should be done twice: once at the breeder facilities and again just before the eggs are put into the incubators.

Egg storage. Before putting the eggs in the incubators, it is usually necessary to store the eggs until there are enough ready to be incubated together. This storage should take place in an enclosed, cool, slightly humid and clean facility. During storage the eggs should be kept in a horizontal position (laying down) or upright with the wider end up. If the eggs are stored for more than three days, it is advisable to turn them once a day. They can be stored up to ten days but only if the temperature is not higher than 20° C and the relative humidity is 75-80 percent. In many cases it is not recommended that the eggs be incubated before six days after being laid. This allows for the albumen to become a little more watery and has no detrimental effect on the embryo development.

Incubation procedures

If the eggs have been stored prior to incubation at a low temperature, i.e. 15-20°C, it is recommended that they are pre-warmed to room temperature (approximately 25°C) before putting them into the incubator. In this way, contamination of the interior of the egg through dirt dissolving in the condensation water on the shell surface and entering the egg, can be avoided.

In order to obtain a good percent hatch, it is important to set the eggs in a horizontal position or with the air cell slightly up. If the air cell is placed downwards, there is no possibility of the egg hatching. It is not recommended to put the eggs one on top of the other or to leave spaces between the eggs as this can cause cracking when the eggs are turned.

In general, conditions for the incubation of goose eggs are similar to those for chicken eggs. As with chickens, one incubator is used as a setting unit at the beginning and another as a hatching unit for the last three days. However, goose eggs must be regularly cooled during incubation to avoid damage to the embryo. This practice is one that makes the hatching of goose eggs more complicated.

Temperature. The recommended incubation temperature is 37.7°C. It is important to have a good internal system for air circulation in the incubator to maintain a uniform temperature for all the eggs. In most cases one should use the temperature recommended by the manufacturer of the incubator, which would usually not be very different from the 37.7°C indicated here.

Humidity. This is another very important environmental factor that must be controlled. Usually, a relative humidity of 65 percent is recommended. It should be kept in mind that the high incubator temperature tends to result in dehydration of the eggs and it is necessary to maintain a high level of humidity to counteract this. Low humidity in the incubator can result in weak embryos that will have difficulty hatching. Humidity in the incubator is measured by means of two thermometers, a dry one, to measure the direct air temperature in the incubator, and a wet one, to measure the rate of evaporation. It is from the relationship between these two temperatures that the relative humidity can be calculated (charts with relative humidity values are available). For example, if the dry thermometer shows 37.5°C and the wet one shows 30.7°C, the relative humidity is 60 percent.

*Cooling the eggs***.** The best percent hatch is obtained when the eggs are cooled daily from the seventh day of incubation to day 27. Although there are several recommendations for this, the most practical one is to remove the eggs from the incubator daily from the seventh day and to thoroughly shower them with water for a couple of minutes. Once the eggs have dried, they are returned to the incubator. This cooling of the eggs strengthens the embryos and facilitates the hatching of the goslings.

During hatching, i.e. during the last three days of incubation, the egg cooling should be stopped but it is advisable to raise the humidity inside the hatching unit up to 75 percent to help with the hatching process.

Turning the eggs. During the setting period or the first 27 days of incubation, the position of the eggs should be changed frequently but this should be done with care. The turning is to prevent the embryo from remaining in a static position and to keep it from moving too close to the shell as this can result in dehydration and embryo death. French researchers have shown that if the eggs are set in a horizontal position, turning them to 90° gives very good results. This avoids the turning of the eggs to 180°, like others have proposed, and makes the turning less complicated since, if the eggs are turned to 180°, the egg trays must be closed to support the eggs during turning. Turning the eggs 1-2 times per hour is sufficient. The eggs should not be turned during the last three days of incubation.

Hatching. Goslings usually start pecking at the shell two days before they hatch. This takes a lot of energy and makes them weak when they hatch. To ensure that they have sufficient energy, it is important to follow the incubation management practices described above. In addition, high humidity in the hatching unit facilitates the hatching of the goslings by preventing the down from sticking to the shell.

Once the goslings have hatched, they must be kept in the incubator for a few hours until they are completely dry and have recovered their strength. Removing the goslings from the hatching units prematurely, when they are still wet, may result in chilling and death. A good practice to facilitate hatching, especially for slow or late-hatching goslings, is to remove the surrounding empty shells that may restrict their free movement while they are trying to hatch.

ALTERNATIVE TYPES OF GOOSE PRODUCTION

Among the alternative types of production that are possible with this species are: meat, fatty livers and feathers. In addition, geese can be used to weed a number of crops. As indicated at the beginning of this paper, the production of fatty liver will not be discussed.

Meat production

In South America in general and in Chile in particular, there is no tradition of goose meat consumption, except in a few small villages where there are still some descendants of the

European immigrants. However, the goose is of course well-known.

As with other meat-producing avian species, goose meat can be sold as whole carcasses, in parts or processed. For this last use, preservation by smoking of either the whole bird or various parts is the most common. It is also possible to use the meat for the preparation of sausages, hams and other processed meats. Because goose meat is red in colour, it can be processed very easily with salts (nitrites) to yield an attractive product. In addition, goose fat is of a high quality and provides processed products with the special flavour that is unique to this avian species.

For commercial objectives, meat production is the easiest form of goose production to implement. However, in order to obtain good quality carcasses and/or a good yield of smaller cuts, it is necessary to have good breeding stock, ideally of a specialised meat breed or strain. In addition, there must be an economical feeding programme.

Birds with white feathers are preferred for meat production because the carcasses have a better appearance. As explained before, this is due to the fact that the dark pin feathers of coloured birds remain in the feather follicles after plucking, while in the case of white birds these pin feathers are not visible.

For meat production the use of a good quality feed is necessary to obtain both a good growth rate and meat with a good flavour. If only grass is fed to geese being grown for meat production, the meat will not have a good flavour therefore good quality concentrates are needed, especially during the final fattening period. On the other hand, the use of forage is a good and economical resource, especially for breeders not in egg production.

It is a well-known fact that goslings, especially during the first four weeks of their life, must receive a nutritionally balanced diet based on cereals, wheat by-products, protein sources (oilseed meals and fish-meal) and vitamin and mineral supplements including calcium and phosphorous. For modern strains with a high growth rate, an adequate feeding programme during the peak of the growth period is critical in order to achieve maximum growth. To save on concentrates, the use of forage is possible when the birds are five weeks old but the growth of the geese will be slower than for birds fed with concentrates only.

Similar to other domestic avian species, the production period for geese is defined primarily by their nutritional and physiological needs. When producing geese for meat, two production phases can be distinguished by the age of the birds: the growing phase and the fattening phase.

Growing phase

Within the growing phase it is usually possible to distinguish two sub-phases: the first is characterised by the high growth rate and consequently the high nutritional requirements from day one to the fourth week of age and the second is from the fifth to the eighth week of age.

During their first four weeks, geese have their highest nutrient requirements because at this time they achieve their highest growth rate. It is a very critical period for geese and special care must be taken in providing supplemental heat, appropriate space per bird (density) and good hygiene. Heating can be provided with gas brooders that perform with high efficiency and are easy to manage. Some of the general management guidelines are presented in Table 1.

TABLE 1. Density and temperature recommendations for goslings during the growing period

Age (weeks)	Density (birds/m^2)	Temperature (° C)	
		Under brooder	Ambient
1 -2	10	32 - 35	20 - 22
3 - 4	5	25 - 30	18 - 20 *
5 - 6	2,5	---	16 – 18

* If the natural external temperature reaches approximately 20°C, additional heating is not necessary.

During the growing phase goslings can be placed on the floor with a litter of straw or wood shavings, on a raised floor of wooden slates or in battery cages. The most economic alternative is to put the birds on litter. However, special care must be taken to ensure that the litter is dry to prevent the possibility of aspergillosis infection that can result in high mortality. Good ventilation of the building can help to maintain good litter conditions and a satisfactory interior environment but draughts at the level of the birds must be avoided at all times. The alternatives of either slatted floors or batteries represent a major investment but allow a greater number of birds to be maintained per square metre of building space, as well as a better use of the building space. When the birds are five weeks old they do not need supplemental heating and can either be transferred to a productive pasture with a good yield of grass or stay in the barn on litter. In this latter case, it is advisable to provide fresh grass or hay to prevent feather pecking that can result in high mortality.

During this period it is very important to provide abundant water to the goslings with drinker and feeder spaces similar to those recommended for the breeders.

The nutrient requirements of goslings during this growing phase are shown in Table 2, based on information compiled from both published material and the author's personal experience. Nutrient requirements of geese are not as well established as they are for chickens, but experience has shown that chicken data can be used as a good approximation of the requirements of geese for meat production.

It is important to provide the geese with feed of good quality, free of fungi and/or toxins (*aflatoxins*) because geese are very susceptible to a number of toxins. A good feeding practice, especially with birds in confinement, is to make sure that the birds have enough feeders with enough space to prevent competition and the resultant uneven growth among the birds.

TABLE 2.Nutritional requirements of geese for meat production during the growing period

Nutrient		Nutrient Requirement Age in Weeks	
		0 - 4	5 – 8
Metabolisable energy	(Kcal/kg)	2 800	2 850
Crude protein	(%)	20.0	15.0
Crude fibre	(%)	5.0	5.0
Calcium	(%)	1.14	1.13
Available phosphorus	(%)	0.42	0.41
Lysine	(%)	1.03	0.68
Methionine	(%)	0.54	0.45
Methionine+Cystine	(%)	0.88	0.77

TABLE 3. Performance during the growing period of Native X Embden crossbred goslings

Parameter	Age weeks 1 - 5	5 - 8
Average weight gain (grams per day)	76.1	46.8
Food intake (grams per day)	164.1	242.5
Feed conversion ratio	2.07	5.35

It can be observed in Table 3 that the average daily body weight gain from weeks 1-5 was higher than from weeks 5-8. This emphasises the importance of providing a good and well-balanced diet during the first four weeks.

Table 4 shows the results of another feeding trial in which Rhine and Guinea geese were compared. Both breeds were imported from France.

TABLE 4. Performance of White Rhine and Guinea goslings during the growing period

Parameters	White Rhine geese Weeks		Guinea geese Weeks	
	1-5	6-10	1-5	6-10
Initial body weight (kg)	0.18	2.25	0.18	2.88
Final body weight (kg)	2.25	3.71	2.88	3.37
Average daily weight gain (g)	73.0	42.0	38.0	18.0
Daily food intake (g)	175.0	277.0	-	-
Feed conversion ratio	2.20	3.90	-	-

The significant reduction in the average daily weight gain of both breeds after the fifth week of age seems to be more related to the change in diet that took place at the fifth week than to an age response. Indeed, it has been observed that goslings fed diets with 18-21 percent crude protein (CP) after the fifth week had a faster growth rate than birds receiving only 14 percent CP. In other words, this decline in growth rate could be due more to the problem of adjusting the diet to meet the true requirements of the birds than to their age.

Fattening Phase

This phase represents the finishing period of geese raised for meat production. Usually, the duration of this period is long because after the growing phrase the geese are often placed on a pasture where they consume only grass. However, it is recommended to confine them before slaughtering and to feed them a complete ration to increase their body weight and to induce a moderate degree of fatness. When the geese are on pasture, they require minimum attention and if the grass is sufficient and of good quality, the terminal fattening period can be postponed. In addition, this period on grass promotes a subsequent greater capacity for feed consumption, because their digestive tracts have been distended from the large volume of high-fibre forage that they have consumed.

The nutritional requirements for meat-type geese during the fattening period are shown in Table 5. Two feeding programmes are proposed: the first is an intensive fattening programme using a complete feed, and the second is an alternative maintenance diet which includes forage.

TABLE 5. Nutritional requirement of geese during the fattening period

		Age (weeks)	
		9-11*	9 plus**
Metabolizable energy (Kcal/kg)		3 100	2 600
Crude protein	(%)	19.5	13.6
Crude fibre	(%)	3.0	7.5
Calcium	(%)	1.10	1.20
Available Phosphorus	(%)	0.41	0.38
Lysine	(%)	0.65	0.55
Methionine	(%)	0.37	0.30
Methionine + Cystine	(%)	0.70	0.59

* Fattening diet
** Maintenance diet (values include forage)

It has been shown that under intensive fattening conditions, geese should not be slaughtered after 10-12 weeks of age. Beyond this age their growth rate is slow, and although their feed consumption remains high, their feed efficiency is very poor and consequently the cost per unit of weight gain is high.

Table 6 shows the results obtained fattening three strains of geese under intensive conditions according to the nutritional requirements as indicated in Table 5.

TABLE 6. Performance of three commercial goose breeds fattened under an intensive feeding programme

Breed	Slaughtering Age (weeks)	Final Weight (kg)	Starved Weight (kg)	Carcass* Yield (%)
Creole	8	3.38	3.22	56.7
	9	4.02	3.79	59.9
	10	3.83	3.61	60.1
	11	4.75	4.38	64.6
	12	4.30	3.94	61.4
	14	4.67	4.30	61.8
Rhine	10	3.71	3.44	59.6
Guinea	14	3.37	3.27	62.7

* Carcass not cooled in water, ready to cook without giblets
(liver, gizzard, heart) or neck

Commercial meat production alternatives

In Chile it is not usual to find goose meat on the market, but when it is available, it is sold as whole carcasses only. However, there are other attractive alternatives to offer the consumers, such as smaller and de-boned pieces of carcass, and smoked or processed meat products.

As mentioned, goose meat has particular properties that allow for the production of very attractive and tasty products. The subcutaneous fat on the breast gives the meat its characteristic flavour and also prevents the breast from having a "dry look". In France, the markets offer a special cut of goose breast (and duck): the meat is cut into very thin slices which include the subcutaneous fat. This high quality product is known as "*magret*" and has a high market value.

On the other hand, the dark red colour of goose meat - quite different from turkey and other poultry, which have white breast meat - allows for the combining of meat from different parts of the carcass into one product. In addition, because the dark colour of the meat is ideal for salting with nitrite, meat with a very good colour and appearance, similar to pork, can be produced. It is for this reason that smoked goose meat, either in pieces or as whole carcasses, also has such a good appearance, colour and flavour. It is important to point out that processing these cuts or products, by whatever procedure, brings a significant increase in profitability to any goose meat producing operation.

FEATHER PRODUCTION

Whatever the primary commercial objective of the goose production operation, goose feathers are a significant commercial product. The small feathers of geese, better known as "down", are regarded as the ideal natural insulating fibre and are used for manufacturing a number of products which insulate against the cold. These include feather bedding products and clothes for winter, mountaineering and skiing. The larger or covert feathers are of a lower quality and are used to make sleeping bags, furniture and other similar products (Figure 5).

FIGURE 5. Goose down and covert feathers - Down

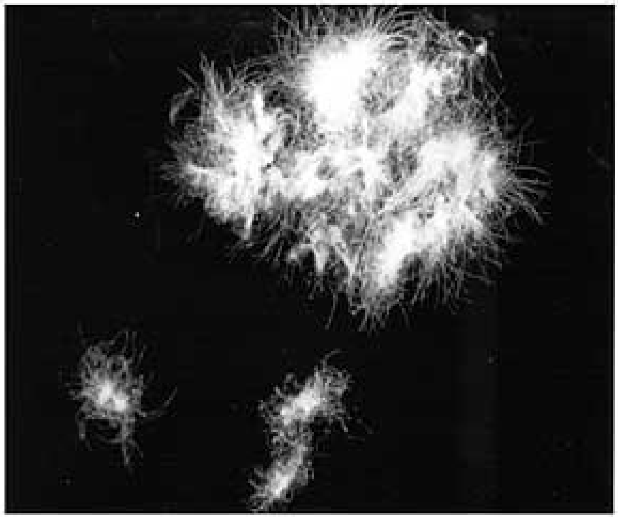


FIGURE 5. Goose down and covert feathers - Covert feathers

Another characteristic of goose feathers is their smoothness, and the way they move together easily. This is due to the light film of natural fat that covers them. When the feathers are washed, it is important to use soft detergents and specially selected concentrates in order to avoid removing this fatty layer.

The lightness of goose feathers and their unique ability to trap air (which gives them their high insulating property), makes them ideal for the manufacture of clothing. White feathers are again more valuable than coloured ones because they are not visible under light fabrics. This can be a problem with the coloured feathers, particularly when the fabric gets wet.

The goose, like other waterfowl, has two very different kinds of feathers. The majority are covert feathers which have a central rachis or shaft from which the barbs and barbules grow. These are the most common feathers and are found in several sizes. Unlike those of chicken, covert feathers in the goose are curved and behave like "springs", i.e. they easily go back to their initial shape after being folded or compressed. The second type of feather, very different from the coverts, are the down feathers which do not have a central shaft. They consist of thin branches, are spherical in shape and have a diameter of 2-2.5cm when mature. Down from ducks is very similar to that of geese except that their diameter is less. Down feathers have the highest commercial value because of their smoothness, lightness and their unique insulating properties. Down feathers grow under the bird's wings and at the base of the neck but the majority are found on the chest and abdomen under the covert feathers.

Feather Production and Plucking

As shown in Table 7, an adult goose of a medium to heavy breed produces a total of 150-230 grams of valuable feathers (the large feathers of the wings and the tail are not included). There are various criteria for classifying feathers, one of which is length. For covert feathers two commercial classes have been established: smaller than 4 cm and from 4-8 cm.

For down the only criterion is colour, with white down bringing a price up to 30 percent higher than coloured down.

TABLE 7. Goose feather production of White Rhine geese at slaughter

Type of Feather	(g/head)	(%)
Down	19,6	15
Coverts feathers <4 cm	46,2	35
Coverts feathers <8 cm	66,0	50
Total	132,0	100

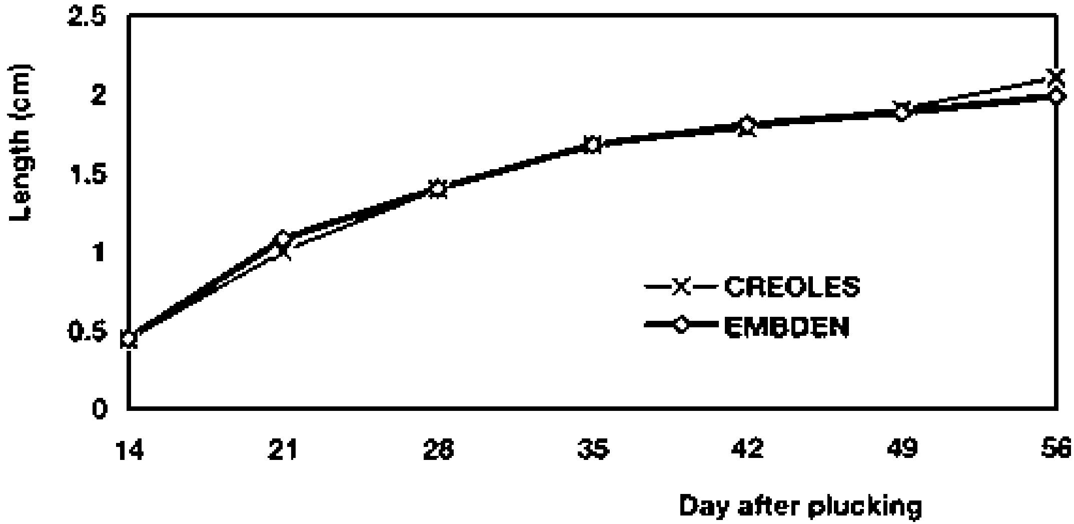
Feathers can also be harvested by plucking the geese while they are alive. Although this practice is sometimes criticized because of its apparent cruelty, this is not the case since almost all birds have a natural cycle of growth, maturation, and moulting. When the feathers are plucked, they are being removed at the time that they would naturally be lost by moulting. A good way to determine the appropriate time for plucking is to test the bird by pulling out a few feathers. If there are no blood marks, it is the natural moulting period and the right time to pluck.

The plucking of live birds can be done with different degrees of completeness - from a partial plucking, done in some areas of the body, to a total plucking. The total plucking excludes the feathers of the tail, the wings and the back. A common practice is to remove only the breast area. The frequency of plucking varies but an interval of two months between pluckings is regarded as the minimum.

With regard to plucking frequency, Figure 6 shows the results of one trial conducted in order to measure the growth rate of the feathers on various parts of the body in two breeds of geese: the White Native and the Embden. All geese were plucked initially and thereafter the length of their feathers was recorded weekly. The results indicate that the growth rate of feathers is similar or almost identical for the two breeds. It is noticeable that the growth from 49-56 days was negligible and this may be an indication that this is the right time for plucking. This was confirmed by the absence of blood after pulling some feathers at this age. Another observation from this trial was that the feather growth rate in different parts of the body is similar, an important consideration when plucking.

FIGURE 6

Feather growth of geese Creoles and Embden.



Another important aspect of feather production is the fact that it apparently does not depend on the feeding level of the birds. To examine this point, a study was carried out with three feeding treatments consisting of three levels:

1) Pasture only (maintenance)
2) Pasture plus 50 percent of maintenance requirements as concentrate
3) Pasture plus 100 percent of maintenance requirements as concentrate

Feather production was monitored over three plucking periods done at two month intervals. The results are shown in Table 8.

TABLE 8. Effect of the feeding level of geese on weight gain and down production.

Feeding Treatments	Initial Weight (kg)	Weight Gain (g)	Feathers (grams/goose) 1	2	3	Total
1)	4.04	60	20.0	22.7	25.6	68.3
2)	4.09	340	18.2	21.9	28.4	68.5
3)	- 4.39	950	19.2	22.1	27.0	68.3

It can be seen from the results presented in Table 8 that, in spite of the difference in body weight gain observed in the three levels of feeding, the total production of feathers at each plucking was similar and the total accumulated yields were identical.

These results suggest that sustainable feather production is possible with birds placed on pasture without additional feed, as long as body weight is maintained. In fact, the production of feathers can be compared to wool production by sheep. Accordingly, geese can be kept on various types of land with the dual objective of:

- controlling weeds and scrub plants;
- producing feathers without any additional input costs.

On this basis, a study was conducted in Chile to assess the implementation of an Agroindustry producing and processing goose feathers under semi-extensive conditions. This study used forage as the main feed and Pannon geese of the White Kolos strain, specifically selected in Hungary for down production. Initial results have been promising but he capital investment in these geese is high.

Feather treatment

As mentioned before, goose feathers are covered by a thin layer of fat which makes their plumage waterproof. However, this does not prevent some moisture from remaining on the feathers if the geese get wet before plucking. For this reason, it is recommended that the geese are kept in a clean and dry area before the harvesting of the feathers. It is very important to collect feathers that are clean and dry to avoid any fungi and moulds developing in the feathers before marketing. Under humid conditions, feathers, being organic, can be damaged by moulds and fungi and the resulting changes in colour and odour cannot be washed out. Feathers must be packed in special containers which will prevent condensation, keep moisture out and to which the feathers, especially the down, will not stick. Polyethylene bags cannot be used as they create condensation, and neither can canvas bags because the feathers tend to stick to them. Paper bags seem the best choice because they do not have the problems.

It is also advisable to carry out the plucking and harvesting of the feathers in an enclosed building because feathers, especially down feathers, are so light that they tend to be easily blown about in the air.

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GOOSE PRODUCTION IN INDONESIA AND ASIA by T. Yuwanta

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INTRODUCTION

Geese are an important livestock commodity for Asian villagers since most of them are small farmers. The purpose of raising geese in Asian countries is not only to produce eggs and meat but also to use them as guard animals and to help control the growth of wild grass and weeds. For

Indonesian farmers, for example, keeping geese is more than just a way of increasing family income.

The genetic capacity of Asian geese as either meat or egg producers is generally accepted as less than that of most modern breeds found in Europe. In addition, since most farmers cannot afford to buy commercial complete rations for their geese, goose raising is frequently done as a backyard farming activity using cheap and locally available feedstuffs, including grass. Traditionally, geese in Asia are fed rice bran, or mixture of rice bran and sago which is produced from the rumbia tree (a kind of palm tree) which grows around the homes.

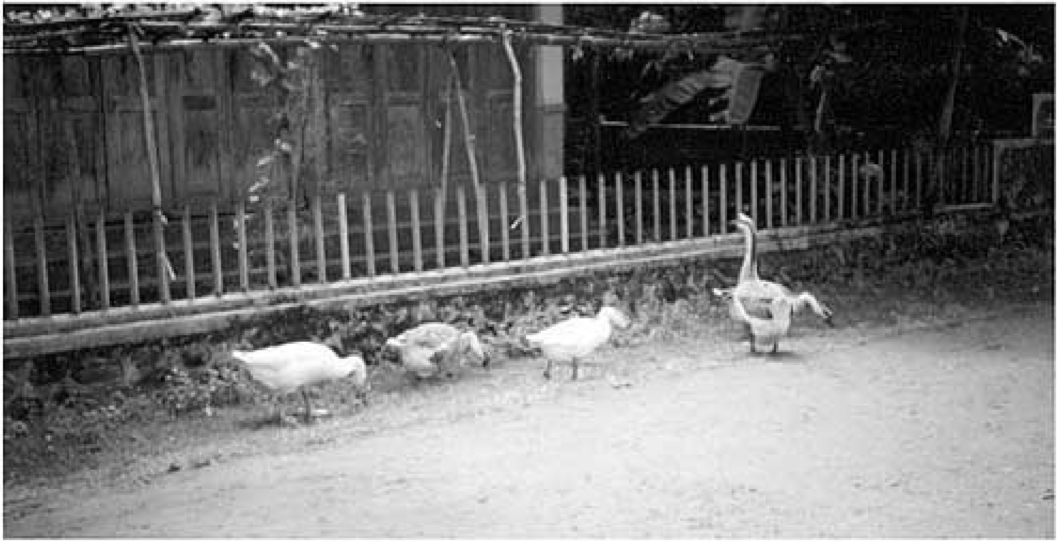
Even though Asian goose production technology is not well developed, goose production in Asia is increasingly popular and has become accepted as a recognized type of livestock production.

BIOLOGICAL CHARACTERISTICS

Asian geese came from central Asia, Japan and China. The term 'Asian geese', or 'Swan geese', including the geese in Indonesia, originated from *Anser cygnoides ferus domestica* but the size of goose populations in Asia have not been accurately determined because of the difficulty of collecting data. This is largely due to the goose production systems utilized and the problems created by the distances involved. There are, however, two main varieties of Asian geese (*Anser Cygenoides*): a brown-gray variety and the white variety. Each type of goose has specific characteristics.

Asian geese have a lighter body weight than European geese (*Anser anser*) and they require wet areas for feeding as they often find their food at the base of water plants or in their roots (Figure 1). They also have a characteristic knob at the base of their bill. Male Asian geese have a larger knob (Figure 2) than females (Figure 3) and older males have a larger knob than younger males. This distinctive knob starts to develop at 4-6 months of age. In addition, the cry of the Asian goose is loud and resembles a trumpet, with the female having a harder and hoarser cry than the male. They like to swim and dive for insects in the water. Asian geese are also temperamental and will attack their enemies, a characteristic that sometimes makes them difficult to raise together with European geese.

FIGURE 1. Asian geese grazing on weeds



(*Source*: Yuwanta, 1999)

FIGURE 2. A male Asian goose (*Anser cygenoides*)

(*Source*: Yuwanta, 1999)

FIGURE 3. A female Asian goose (*Anser cygenoide*)

(*Source*: Yuwanta, 1999)

In most of the developing countries in Asia, goose raising technology is not very well-developed and only a few farmers in Taiwan, Japan and China are raising geese intensively.

Developing geese husbandry is advantageous because geese have:

- a fast growth rate during the starting and growing periods;
- a high feed efficiency during the fattening period;
- a low feed conversion ratio;
- the capacity to effectively utilize rations with low levels of crude protein;
- an ability to digest forages and to obtain them by grazing

on pasture;

- a strong flocking tendency;
- minimum shelter requirements and only at night;
- a high resistance to disease.

The disadvantages of raising geese are:

- their low reproductive rate;
- their season-dependent reproduction;
- the fact that breeding couples are not stable within a group;
- their tendency to form groups within a flock.

PHYSICAL CHARACTERISTICS

The Asian goose is a prolific species but with a relatively small body size. Its main characteristics are its plump, compact body and its active behaviour. Its back is reasonably short, broad, flat and sloping to give its characteristic upright carriage with a well-rounded and plump breast, which is carried high. The wings are large, strong, held high, and carried closely to the body. Its stern is well-rounded, with a well-developed paunch and the tail is closely feathered and carried well out.

Its medium sized head is well-proportioned and the bill, stout at its base, is symmetrical and also of medium size. The knob is large, rounded and prominent and the eyes are bold. It has a long neck, carried upright and gracefully arched. Its legs are relatively short, the shanks are strong and of medium length, and the toes are straight, well spread and webbed.

The white Asian goose has blue eyes with orange-yellow bill, knob, legs, and feet. The Asian brown-gray goose has a dark russet brown head with a fawn face up to the demarcation line above the eyes. The face has a well-defined white band or line from the top of the head down to the face. The neck is fawn with a prominent dark russet brown stripe running down the middle of back of the neck for its entire length. The back is russet brown. The breast is grayish fawn except for the lower abdomen where it becomes lighter. The thigh is russet in colour and each feather is edged with a lighter shade of grayish fawn, almost white. The wing bow and coverts are a medium russet brown, and each feather is laced with a lighter grayish fawn edging, approaching white. The flight feathers are a russet brown. The stern, paunch and tail are a lighter shade of grayish fawn, almost white while the tail feathers have a broad band of russet brown and a light edging. In both sexes the bill is black or dark slate, the knob is dark slate, the eyes are brown and the legs and feet are orange.

Body weight of the Asian goose varies between 5.5 kg for males and 4.5 kg for females. Egg production varies from 15-

87 eggs per female per year. Percent fertility and percent hatch are approximately 86 percent and 72 percent respectively. A female Asian goose produces on average 28 goslings per year. For breeding a sex ratio of one male to 5-8 females is recommended.

MANAGEMENT OF ASIAN GEESE

Asian geese are usually raised under poor management conditions using a backyard scavenging system with a basin or pool for swimming. Little care is given to either their feed or their feeding system. Consequently, stress related problems such as low levels of production and reproduction are often encountered, especially since birds are more easily stressed in tropical countries. Good management and husbandry are therefore very important.

Housing design plays an important role not only in the reduction of stress but also in improving both the level of production and reproduction. Traditional housing for geese is very simple and is often built in a fenced back yard. Such housing can be built using bamboo and other inexpensive materials. It normally consists of a roof with ridge ventilation and a narrow timber framed construction with low side walls. This design, used by many farmers, allows for the practice of naturally integrated waterfowl-fish production systems. Borders of irises are sometimes planted and these grow into permanent fences. The fenced backyards are divided into several compartments so that the young growing geese can be separated from the adults. Each compartment is provided with feeders, drinkers, shelter and an open space in which the geese can scavenge.

The raising of Asian geese can be divided into three phases:

- starter (one day old to 4 weeks of age);
- grower (from 4-36 weeks of age);

- layer (from 36 weeks to 4 years of age).

During the brooding or starter phase the young goslings need artificial heating until four weeks of age. With natural brooding one female is able to raise 20 goslings.

Under the traditional management system, the type of housing and its construction determines the ease with which the geese can be managed, especially when raising goslings. They must be grown with a heat source for brooding and provided with the essential requirements for growing goslings. They can be raised either in pens with litter floors, pens with slatted floors or in battery cages. In Asia, the heat supply for the brooding period is provided from a variety of sources such as kerosene lamps, kerosene heaters or electric bulbs. Other fuel sources can include wood, coal and rice hulls.

After the brooding stage, the goslings are transferred to a larger area with more floor space per bird without an additional heat source. In general, Asian farmers use the same poultry house for both brooding and growing.

Geese can be grown in a wide variety of houses. When geese are grown in a system using both a poultry house and a yard, they need more land and a water basin or pool. For good results with this system, the poultry house must provide at least one square metre for every eight geese. It must also be remembered that under tropical conditions the litter floor can become very warm during certain seasons of the year.

Like the growing house, a laying house for geese can have either litter floors, slatted floors or a combination of both. In addition, the geese should be able to scavenge in a yard or pasture and have access to a pool or river. The recommended interior floor space is 0.5 m^2 per goose, 1 m^2 for the pool, 10 m^2 for the yard and 250 m^2 of pasture per goose. The type of feeders provided will depend on the feeding system. The feeder space requirement is 3 cm per head when the geese are fed *ad libitum* and 10cm per head when the geese are on a restricted feeding system. The provision of nests is very important for laying geese in the litter floor system, the slatted floor system or when a combination of the two is used. Four to seven geese can share one nest which should be 60 cm deep, 60 cm wide and 75 cm high. Trapnests are generally required for genetic selection programmes.

EGG COMPOSITION AND CARCASS QUALITY

In Asian countries goose eggs are used as a source of animal protein for human consumption but this is limited by the goose's low level of egg production. Egg weight varies from 140-170 g, depending on the variety and the age of the geese.

TABLE 1. Physical composition of Asian geese egg

Properties	Absolute	Relative (%)
Egg weight (g)	146.6 ± 18.1 g	100
Albumen weight	70.5 ± 14.4 g	49.2 ± 5.4
Yolk weight	53.8 ± 8 g	38.1 ± 5.4
Egg shell	18.3 ± 3 g	12.5 ± 1.4
Egg shell thickness (mm)	0.47 ± 0.08	---
Egg index	---	66.6 ± 3.6

(*Source*: Sasongko, 1990)

The proportion of yolk in goose eggs is much higher than that of chicken eggs: approximately 39 percent versus 30 percent. This characteristic of goose eggs means that they are higher in energy and that the feed requirements for the production of goose eggs are also higher than those for chicken eggs in terms of both protein and energy.

TABLE 2. Carcass composition and nutrient value for goose meat and eggs

Body weight at 16 weeks	4.50kg	Egg weight	170 g
Carcass composition	**Percentage**	**Egg Composition**	**Percentage**
Carcass weight:	73.2	Yolk	39.5
Liver	1.7	Moisture	56.9
Neck	4.4	Protein	15.5
Gizzard	3.8	Fat	25.5
Heart	0.7	Albumen	47.3
Abdominal fat	2.2	Moisture	90.4
Eviscerated weight	60.4	Protein	7.9
Without neck & wings	54.0	Fat	0.1
Breast	18.0	Shell	13.2
Thigh	26.0	Moisture	1.2
Skin and fat	23.0	Protein	6.8
Bone	23.0	Triglycerydes	100
Nutrient value of goose meat:		Saturated	33.0
Dry matter	47.3	Monounsaturated	52.0
Crude Protein	15.7	Polyunsaturated	9.1
Extract Ether	29.4	Phospholipides	100
Ash	0.8	Saturated	42.6
Fatty acids	100	Monounsaturated	30.9
Saturated	50.4	Polyunsaturated	20.8
Monounsaturated	33.3		
Polyunsaturated	16.3		
Total fat (g/100g)	7.1		

(*Source*: Leskanich and Noble, 1997 and Peterson, 1998 cit. Sidadolog, 1999)

As can be seen from Table 2, the carcass represents 73-74 percent of live body weight. When compared with chicken carcasses, the carcasses of geese have a higher content of saturated fatty acids but a lower content of unsaturated fatty acids.

THE FEEDING AND NUTRITION OF GEESE

Like chickens, geese have complex nutritional needs. There are at least 40 essential compounds that must be present in their diet. These must be present in adequate amounts, optimal proportions and in a form that is readily available if the geese are to realize a rapid growth rate, optimal egg production, a high reproductive performance and, at the same time, achieve maximum feed efficiency.

The essential nutrients for geese are energy, protein, minerals and vitamins. Energy for geese is generally expressed as kilocalories of metabolizable energy per kilogram of feed. Proper energy levels are important. Too much or too little can make a difference in the performance of geese. Protein is also an important factor in poultry feeding. The quality of the protein is determined by the balance of its amino acids. In formulating goose rations, the first nutrient to be considered is the protein level in order to be sure that the bird's requirements are met. The levels of energy, vitamins and minerals in the ration are then adjusted by modifying the proportion of the other ingredients and adding various nutrients in a synthetic form. Vitamins are usually added to the diet in excess of the minimum requirements. For proper nutrition, the practical mineral requirements include at least 12 inorganic minerals.

Various factors determine which ingredients are used in goose rations. Cost and availability, as well as the presence of toxic substances, limit the use of some ingredients. In Asian countries, rice and corn, and especially their byproducts, are often the main ingredients used as energy sources in goose rations. Sometimes in specific regions, farmers use sago and cassava meal (manihot) as the main energy source and, as a protein source, they use copra meal (coconut meal), soybean meal or fishmeal, either singly or as a mixture. In Asia grass is fed as a supplement as it is seen as a necessary food for geese. The amount fed varies, depending on the age of the geese, their stage of production and the level of the other nutrients being fed. In traditional goose raising, kitchen byproducts are also sometimes used to formulate goose rations (Figure 5).

The scavenging management system is the main type of goose husbandry practiced in Asia. Under this system a flock of geese will consist of 4-20 birds and they will be allowed to range freely over part of the village area. The geese are kept in backyards around the farmers' homes but are allowed access to canals, lakes and rice fields. They are fed mainly kitchen waste and other feed found in the farmyard. Their average egg production varies from 20-45 percent. Goose eggs are sold unwashed, directly from the nests by the individual farmers in traditional markets (Figure 5). This system is typical of that used by small producers. It is based on family tradition and there is usually insufficient practical and technical knowledge of nutrition with the geese being fed mainly rice grain. Such a nutritionally limited rice-based diet, together with the practice of using female geese and Muscovy ducks to hatch the eggs, invariably results in a very low reproductive rate.

Goslings are usually raised for the first 2-3 weeks in a closed building with heat provided by hurricane lamps or electric light bulbs at night. Feed and water are available at all times. The goslings are fed either a duck or broiler chicken starter diet, as a mash or as crumbles. After this brooding period, the goslings are allowed outdoors and will usually be fed diets mixed by the owners. Such diets usually consist of cooked trash fish, rice bran, broken rice, corn, soybean meal or soy sauce waste. In some areas, dry trash fish and sago meal are also used. The crude protein of such a feed is 16-18 percent.

The ingredients for layer geese rations are similar to those described above except that seashell powder is added to supply calcium during the egg laying period. In most of Asia, modern reproductive practices for the breeder flocks have not yet been developed and genetic selection programmes are needed to improve all egg production traits, percent fertility, percent hatch, feed efficiency and percent livability if maximum profitability is to be reached. In reproduction flocks, farmers usually keep one male for every 5-8 females in order to obtain the optimal number of day old geese. For genetic selection, pedigree breeding is done by using pen matings as it needs a minimum of extra labour.

FIGURE 4. A ration based on kitchen waste and bran

(*Source*: Yuwanta, 1999)

FIGURE 5. Goose eggs destined for market

(*Source*: Yuwanta, 1999)

INCUBATION OF GOOSE EGGS

Goose eggs are known to be more difficult to incubate than chicken eggs, partly because goose eggs take 30-34 days to hatch and chicken eggs only take 21 days and so there is more time for things to go wrong. But there is more to the problem than just the length of the incubation period. Incubation of waterfowl eggs, including goose eggs, require a higher percent humidity than chicken eggs need. Also, the pores of goose eggs are much larger than the pores of chicken eggs. This, combined with the fact that geese dirty their eggs more easily because of their large webbed, often wet, feet, can result in increased bacterial contamination on the outside of the egg which, because of the egg's large pores, also enters the egg more easily. This is particularly a problem when there is a high concentration of birds that can contaminate the surrounding area.

In Asian countries the incubation practices for goose eggs are also much less developed than for chicken eggs. Two traditional incubation practices are still used by many farmers to produce goslings. The first is natural incubation by a female goose where one female usually produces only 5-7 goslings since the percent fertility and percent hatch are relatively low. The second system is artificial incubation which has two methods: traditional artificial incubation and modern artificial incubation.

Traditional artificial incubation (or the parched rice incubation technique) was developed in south China more than 2 000 years ago and spread to Laos, Vietnam and Indonesia where it is still used today. For modern artificial incubation, Asian farmers use a simple modern incubator. Farmers modify these artificial incubators to meet the requirements of each type of poultry production. There are several different makes of modern incubators and each differs in design, size, type of fuel used, humidity and temperature controls as well as various other features. They range from simple box-like incubators of cheap design and construction to large, room-sized incubators with the latest design and control features. Petroleum is frequently used to heat the small incubators since, for the traditional Asian farmer, electricity and coal are more expensive. Modern incubators are primarily used for intensive goose raising in countries such as Taiwan and Japan.

GEESE FEATHER PRODUCTION

Another important reason for raising geese and ducks in Asian countries, especially in China, Taiwan, Thailand and Indonesia, is to make badminton shuttlecocks from selected goose feathers and to use the down feathers to produce duvets and insulated clothing for export.

Good quality feathers are obtained from geese 100-110 days of age. These geese produce good, mature, strong down and nicely curved body feathers which can both be processed without damage. Both the age of the geese and the production method used influence the quality of feathers, especially those used to make shuttlecocks. Slaughtering at an older age markedly influences the quality of the feathers as well as the cleaning and processing required. To obtain feathers for shuttlecocks, the goose carcasses are dipped into hot water prior to hand plucking and then the selected feathers are dried on a concrete pad. Some varieties of geese produce good feathers at 50 days of age. At this age, however, the down feathers are not mature and both their filling power and their resilience (the ability of the down to retain its original shape) is reduced and consequently their insulating value. Feathers from the rapid-growing meat varieties lose their insulating value much more quickly than those from the older, slower-growing traditional varieties.

Feather production is an important aspect of the goose industry in Asia and more attention should be given to this commodity. Table 3 shows that feather production depends on the age of the geese and the frequency of plucking.

TABLE 3. Geese feather production (g/head)

Age and harvesting	Total feathers	Down
One year of age		
-3 pluckings/year	242.7	43.9
-at slaughter	183.7	24.3
Two years of age		
-3 pluckings/year	272.2	54.5
-at slaughter	205.0	39.9

DISEASE CONTROL AND PREVENTION

There are four classes of goose disease found in Asia: those that have a genetic base, those caused by stress, those caused by infectious organisms and those due to poor management and/or malnutrition. Poor management diseases include ailments caused by physical injuries, trauma, chemicals/poisons, nutritional deficiencies and some metabolic disorders

Infectious diseases and leg inflammations are currently a problem with Asian geese. Under either intensive or extensive management systems, the high production costs and the small profit margins make it essential that profit conscious poultry producers carry out routine health and sanitation programmes geared for the prevention and control of disease. A goose producer can lose about five percent of his young stock during the brooding and growing period and up to one percent of his mature stock can die monthly in the first year of production. This can severely affect the producers' profit. Apart from obvious outright losses due to death, the effects of morbidity such as decreased egg production, stunting of growth, delayed sexual maturity, low percent fertility and poor percent hatch, can also cause severe economic losses.

Another problem associated with livestock production in many Asian countries is that rainy weather, flooding, high temperatures and high humidity can cause diseases to spread very rapidly.

Infectious diseases (contagious) as opposed to non-infectious diseases (non-contagious) are those diseases caused by micro-organisms such as bacteria, fungi, viruses, protozoa and metazoan parasites. To prevent and control infectious diseases, goose farmers should take two main precautions: the first is to prevent the entry and re-entry of pathogens onto the farm. This is best accomplished by strict quarantine and isolation, together with the use of both disinfectants and prophylactic medications. The second method is to increase resistance to disease by selecting the geese carefully, providing adequate nutrition, ensuring that they have clean and comfortable housing and by following a recommended vaccination programme.

Hepatic and enteritic viruses cause the most common viral diseases in Asian geese. They are most often found in areas of high goose populations and intensive goose production. Outbreaks of bacterial diseases have become both more frequent and more serious due to the increased use of confinement housing for goose production with a decline in the use of yards and pasture. *Pasturella* or Avian Cholera is the most difficult bacterial disease to control and presents the biggest problem in Asia.

In Asian countries feed ingredients are often badly stored and this can contribute to mycotoxin contamination as fungi then grow in the feed ingredients and produce mycotoxins. It is difficult to prevent this as the production of mycotoxins is not only due to the handling and storage of the grains but also to agronomic practices, the composition of the ration and condition and stage of harvesting the grains. Fungi, especially the genus *Aspergillus flavus* and *Aspergillus paracitus,* produce aflatoxins that can affect the liver and the heart. Goslings are highly sensitive to aflatoxin B1 and mortality can reach 95 percent.

In general, good management practices can greatly help to reduce disease problems but where there is a risk of the birds contracting an infectious disease, the farmer should not hesitate to follow a recommended vaccination programme.

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GOOSE PRODUCTION IN POLAND AND EASTERN EUROPE by A. Rosinski

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INTRODUCTION

Although goose production is particularly popular in the Eastern European countries, it does not comprise more than 4-7 percent of the total production of live poultry. The largest producers of geese in Eastern Europe are Hungary, Poland and Romania. Geese are also produced on a commercial scale in the Czech and Slovakian Republics. Depending on the country and the production system, geese are produced for meat, fine feathers and down, as well as for fatty livers (Foie Gras).

Geese are produced primarily on commercial specialised farms that deliver the birds at slaughter age to poultry processing plants. For large producers, the relationships between the goose production farms and the slaughterhouses are based on long-term contracts. Geese are also kept on a small scale as backyard farm flocks for the farmers' own needs and for sale, mainly as live birds at nearby markets.

These smaller scale farm flocks deliver good quality meat, fat, feathers and down at a relatively low cost. They demonstrate that geese are highly adaptable to various environmental conditions, resistant to climatic changes and efficient in their feed utilisation since they can utilise green feeds from both pasture and non-cultivated land. Depending on the size of the production unit and various other factors, geese can be produced under both a relatively semi-intensive management system or an extensive management system.

Fatty liver production in Hungary is approximately 920 tons per year while in Bulgaria it is about 65 tons per year and recently Lithuania has produced about eight tons per year. In the 1990s, approximately 30 tons of fatty liver was also produced in Poland using Landes geese imported from France for this purpose. About 2 000 parent flock geese were maintained to produce 50-60 thousand goslings annually for this purpose. Since the beginning of 1999, however, force feeding (cramming) of geese has been prohibited by law in Poland.

Poland and Hungary are the largest exporters of goose meat from Eastern Europe. Goose meat from both countries is exported primarily to western European countries, mainly to Germany. These exports meet nearly 100 percent of the demand for goose meat in Germany. Export sales to Germany are of a seasonal nature and take place primarily from October to the beginning of December. The highest demand for goose meat in Germany is during the Christmas and New Year holiday periods.

For decades, goose production for export has been considered one of the main activities of the Polish agriculture. Between 5.5 and 6.0 million day-old goslings are hatched each year for this purpose and the country's live goose production amounts to 27-28 thousand tons per year.

During the years 1995-1998 a substantial increase (47 percent) in goose meat production was observed. During this same period exports of goose meat (mainly of whole carcasses, breasts and legs) increased by 44 percent, from

11.5 thousand to 16.6 thousand tons. In 1998 the ratio, based on weight, of whole carcasses to breast and legs being exported from Poland was 60:40.

The economic importance of Polish goose meat export is confirmed by the fact that it accounts for 50-52 percent of the total poultry products exported from Poland although, at the present time, geese production is only 5-6 percent of the total amount of live poultry produced in Poland.

Goose production has a long tradition in Poland and was developed in the nineteenth century when, at the Warsaw Livestock Exchange, approximately three million geese were sold annually to Germany. At that time Russia was the largest producer of geese in Europe. Because the birds had to walk to get to market, before the journey they were herded through melted pitch and then through fine sand. In this way a fine layer of pitch and sand protected their feet during the long journey.

Both the intensification of farming and the World Wars reduced the goose population in Poland and in other Eastern European countries. The number of the goose varieties and breeds has also diminished.

BREEDS

Today the main goose breed being grown on a commercial scale in Poland is the White Italian goose which was imported from Denmark in 1962. The birds adapted well to Polish management conditions and with their good egg production, meat yield and carcass quality, they soon superseded the popular Pomeranian and other indigenous breeds of geese.

Among the native breeds found in southern Poland are the Lubelska, Kielecka, Podkarpacka, Garbonosa, Bilgorajska and Zatorska; whereas in northern Poland the Kartuzka, Rypinska, Suwalska and Pomorska are found. Even though at one time they were popular throughout Poland, these breeds are now only kept in small backyard flocks as they are of marginal importance to commercial goose meat production. However, for the purposes of genetic conservation and cultural reasons they are also kept at three research stations in Poland as it is recognised that they could, in the future, be a source of certain genes that may have been removed from existing commercial populations due to intensive genetic selection. The performance traits of the regional goose breeds demonstrate great variability although their performance level is, in general, lower than the White Italian goose. They lay from 15-41 eggs per layer per year, with an average egg production intensity from 12-31 percent, an egg weight of 145-156 g and a percent fertility of 61-72 percent. Percent hatch of fertile eggs has been found to be between 32-53 percent. Body weight at 12 weeks of age varies from 4.2-4.9 kg for males and from 3.6-4.3 kg for females. The indigenous breeds demonstrate numerous valuable characteristics such as resistance to diseases, good egg shell quality, docility, adaptability to poor environmental conditions and an ability to utilise low quality feeds. These indigenous varieties and breeds are also seen by the inhabitants of certain regions of Poland as important elements of culture and tradition.

At the present time, the semi-intensive system of goose management predominates in Poland. Only in the small backyard flocks, primarily for the needs of the farm owners, are geese being kept under predominantly extensive production systems.

GENETICS AND BREEDING

Over the past 35 years the Polish selection and breeding programme has developed two valuable strains of White Italian geese. Management, nutrition and disease control programmes have been designed for both the parent and commercial stocks and incubation procedures have also been improved. Development of goose production in Poland has been stimulated by the introduction into commercial practice of research findings and technological developments. Research programmes on goose production are being conducted by the Research Institute of Animal Production under the Ministry of Agriculture and Food, the Institute of Animal Physiology and Nutrition and five agricultural universities.

The genetic improvement of the goose in Poland is being conducted by the Research Institute of Animal Production on a pedigree farm at Koluda Wielka called the Koluda Wielka Experimental Station. Two pedigree strains of the White Koluda goose, the W33, a male line, and the W11, a female line, are being selected. In the male line (Figure 1), among the primary selection objectives are increased body weight and meat yield, combined with a lower fat content in the carcass. In the female line, selection criteria relate to higher reproduction performance. Egg production per female for the

W11 strain ranges from 65-73 eggs, percent fertility from 85-90 percent and percent hatch of fertile eggs from 81-84 percent. Feed consumption for the W11 strain is 990 g per egg, lower than that for the W33 strain which is 1130g per egg. Body weight for birds of the W33 strain (6 800 g) is 400-500 g higher than that of the birds of the W11 strain (6 300 g) and their breast muscle weight at 17 weeks of age is also greater (750 g and 650 g respectively), but their fertility and hatch percent is up to ten percent lower. The yield of breast and leg muscles is similar in both strains and ranges from 35.1-36.2 percent.

FIGURE 1. The strong body conformation of a goose of the W33 line

(*Source*: Rosinski, 1999)

REPRODUCTION

The majority of commercial hatching eggs are produced from a crossing programme using males of the W33 strain as the male parent and females of the W11 strain as the female parent. The pure strain mating of a W11 male with a W11 female is only used to a limited extent to produce commercial hatching eggs (goslings) i.e. 16-18 percent of reproduction flocks in Poland.

In 1998 the parent stock population of breeder geese in Poland was about 230 000 layers. The average size of the parent stock farms ranged from 450-500 layers; however, there are also some parent stock farms that have from 3-4 thousand layers each. The smallest parent stock farms have from 100-150 layers although these are rare. The breeding geese in parent stock flocks are kept for four years i.e. four reproductive seasons.

The lay season is from the end of January or beginning of February until June and lasting on average about 20 weeks.

Its duration depends on the number of hours of light the birds receive per day and whether the lighting programme is natural daylight or an artificial lighting programme that can be applied in windowless poultry houses. Only natural mating is used and one gander is required for every 4-5 geese. After four reproductive seasons the geese are sent to a slaughterhouse and a new parent flock is established.

In Poland goose hatching eggs are incubated in about 50 commercial hatcheries equipped with walk-in incubators which are either produced in Poland on PAS REFORM (NL) licence, or of foreign manufacture. In a few small hatcheries the old type of incubators (holding 100-150 eggs) are still in use. Goslings are produced by artificial incubation only. Even goslings for backyard flocks are purchased from hatcheries. Before the Second World War natural incubation was popular for Polish backyard flocks and either older female geese or turkeys were used, with each covering 13-15 or 11-13 goose eggs respectively.

Rearing

Goslings to be used as parent stock for the following year need to be hatched between March and the end of May because the birds should start laying eggs in their first season at the age of 8-9 months. The greatest demand for goslings in Poland is in the spring (April to May) since rearing birds is easier at this time when temperatures can reach 20-250C, lessening the need to heat poultry houses. Also, the goslings can have access to yards and pasture when they are younger and have new grass available for grazing. Up to six weeks of age the goslings are kept in a poultry house with access to a yard.

Either poultry houses specifically designed for this purpose are used or, more frequently, buildings which housed adult parent stock already marketed. Before re-use, the used deep litter must be removed from the poultry house, and the house thoroughly washed and disinfected, and a treatment applied to get rid of rats and other vermin. To reduce heating costs when a poultry house is too large, it can be divided into sections with plastic film curtains. The goslings are housed on deep-litter in lots of between 100-200 birds. Stocking density during the first week of age is 8-10 birds per m^2 of floor area and the density of birds is then reduced gradually with age and reaches 2-3 birds per m^2 of floor area by 11 weeks of age.

During the initial rearing period the poultry house can be heated with oil, gas or electric heaters, or with central heating. Air temperature must be maintained at 24-260C during the goslings' first week and can gradually be reduced to 180C by the fourth or fifth week. During the first three weeks when additional heat sources are often needed, electric or gas brooders can be used (infrared lamps are the most popular). One infrared lamp is sufficient to produce heat for 25-30 goslings. Usually three infrared lamps are installed on a single wooden triangle frame hung from the ceiling. Air temperature under the additional heat source is initially 6-100C higher than the room temperature but, after the first week, can be changed to 4-60C higher than the room temperature. During the first days, the infrared lamps are hung about 40-50 cm above the litter and are lifted to 60-70 cm or higher as the birds get older. If infrared lamps are used, they are also a light source and provide a 24 hour lighting programme in the poultry house until the goslings are approximately three weeks of age. If normal electric, gas or oil brooders are used, the rearing room should have a lighting programme of 24 hours of light until the goslings are two or three days of age and then 14-16 hours of light per 24 hours. From the fourth week, the goslings are generally under natural daylight. When lighting programmes are changed, it is important that the birds are introduced to darkness gradually since they can react to darkness by crowding and this can lead to suffocation.

The deep litter must be kept dry, in good condition and free from fungi. High moisture content in the litter at a high air temperature can stimulate the growth of fungi, causing Aspergillosis which can kill as many as 80 percent of the goslings. For deep litter, rye, wheat or barley straw cut into 5-8 cm pieces is recommended.

In small rearing houses natural ventilation via an exhaust chimney is used. In large houses, however, mechanical ventilation must be employed. When outside temperatures are about 200C and until the goslings are three to four days old, ventilation of the rearing house can be achieved by opening the windows.

Various types of feeders and drinkers are used for goslings. Large goose rearing houses have automatic feeding and drinking installations, whereas smaller ones have simple non-automated feeders and drinkers. Their size is in accordance with the age of the birds. Very popular are bell shaped plastic drinkers that are used during the first two weeks of the rearing period (one drinker for 30 goslings). Trough drinkers made of sheet aluminium are also used and are of the following dimensions: 100 × 4 × 6 cm (for birds up to two weeks of age), 100 × 15 × 12 cm (for birds from 2-4 weeks of age) and 100 × 20 × 25 cm (for birds older than four weeks). The number of drinkers and their length is adjusted to provide the following linear drinking space per bird: 2 cm per bird up to two weeks of age; 3-4 cm from 2-4 weeks of age and 5 cm for birds over four weeks of age.

Feeders are also made of sheet aluminium or dry wood and have the following dimensions: 100 × 15 × 7 cm for birds up to two weeks of age; 150 × 30 × 15 cm for birds from 2-4 weeks and 170 × 30 × 25 cm for older birds. The linear feeder space per bird is as follows: 4 cm up to two weeks of age; 8 cm from 3-4 weeks of age; 10-15 cm from 5-7 weeks of age and 20-25 cm for older birds.

Goslings of 7-10 days of age are given access to a yard during mild weather, but only for 20-30 minutes per day. This time is extended gradually as the birds get older. From 0.5 to 2.0 m^2 of yard area is required per gosling, depending on age. The grass or solid surface yard is located near the rearing house. The yard can be equipped with feeders and drinkers and a shelter is required to protect birds from excessive sunshine if there are no trees.

Up to 5-6 weeks of age or until the oil glands of the birds have developed, the goslings are not allowed to graze on wet grass or during a rainfall. From six weeks of age onwards the birds are put on the nearby yard or pasture for the whole daylight period, but come back to the poultry house at night. From 12 weeks of age onwards geese may be on pasture for 24 hours a day.

In such cases the birds are generally maintained on a distant pasture and are kept there in a pen overnight. Goslings in open yards and on pastures are susceptible to attack by predators, including predatory birds like the goshawk; whereas older birds are subject to attack by predators such as foxes and martens.

Goslings to be used in parent flocks are fed intensively until four weeks of age on a complete ration of 19-20 percent crude protein, 2.60-2.75 Mcal metabolizable energy per kg and 4-5 percent crude fibre. Birds are fed *ad libitum* up to three weeks of age.

From the fourth week they are fed 210 g per bird per day. The complete ration contains ground wheat, barley, triticale or maize and a protein supplement such as soybean meal or canola (rapeseed) meal. Other ingredients are also used, e.g. dried grass, feed grade yeast and sometimes the seeds of lupins, peas, faba beans or field peas. The complete ration is supplemented by adding a mineral-vitamin premix. These complete rations are manufactured by commercial feed mills and sold to goose producers. Currently the feeds provided to the goslings during this initial rearing period are seldom prepared by the farmers themselves.

From days 3-4 onwards the goslings are introduced to small amounts of green forage on a regular basis and the quantity is increased as they get older. Birds are given finely-cut, young fresh green forages like nettles, dandelions or grass. Early hatched goslings, i.e. in March or April, are given carrot puree if no green forage is available. From the fourth week of age, when the amount of complete ration is reduced, the green forage is given *ad libitum*. Up to the end of the fourth week of age the total consumption of the complete ration per bird is 3.7-4.0 kg and of green forage about 3.5 kg. At this time the average body weight is about 2.1 kg.

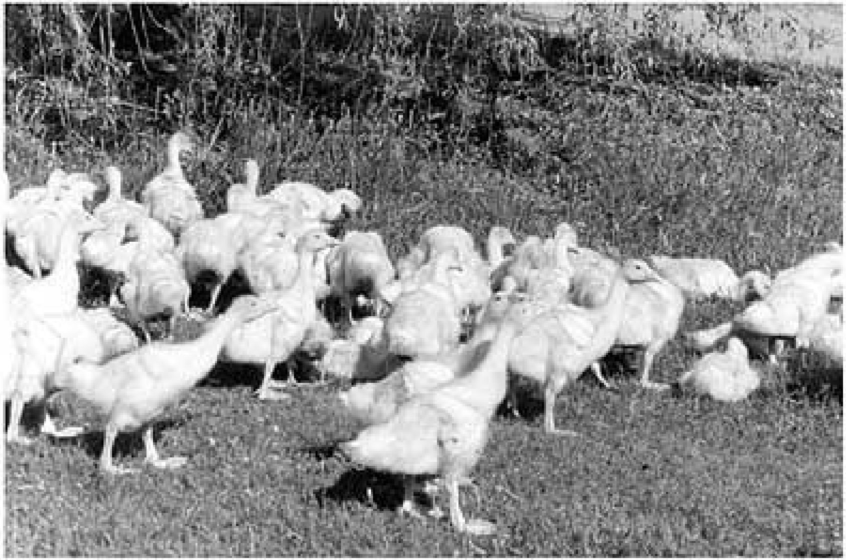
FIGURE 2. Young goslings ready for their first trip outside

(*Source*: Rosinski, 1999)

FIGURE 3. Young goslings during their first trip outside

(*Source:* Rosinski, 1999)

FIGURE 4. Goslings which have not yet been plucked on pasture



(*Source*: Rosinski, 1999)

From the fifth week of age onwards the amount of complete ration is reduced to 200-230 g per bird per day depending on the quality of the green forage and pasture. The initial nutritive value of the complete ration is: 17-18 percent crude protein, 2.6-2.7 Mcal of metabolizable energy per kg and 5-6 percent crude fibre. From the eighth or ninth week to the twelfth or fourteenth week of age the birds are fed mainly on ground grain (90 percent) with added canola meal as a protein supplement. The nutritive value of this mixture is as follows: 13-13.5 percent crude protein, 2.68-2.75 Mcal of metabolizable energy per kg and 6-7 percent crude fibre. During this period the birds are given green forage *ad libitum*. Apart from pasture, geese are often given cut grass and consumption of it increases from 600 g per day at six weeks of age to around 1 500 g per day at 12 weeks of age. Consumption of the complete ration over the period from 5-12 weeks of age amounts to 11-13 kg per bird and about 50-60 kg of green forage per bird. Average body weight at 12 weeks is about 4.5 kg for males and 4.0 kg for females.

From 13 weeks of age until autumn, the main feed source for young geese is pasture. About 100-120 birds may be kept on one hectare of pasture. During that time geese are given 100-170 g per bird per day of ground grain (oats, barley and wheat) depending on pasture quality.

The best goose pasture contains a mixture of grasses, leguminous plants and herbs. The following grass species are used for goose pasture:

- short grass species - *Lollium perenne L., Festuca ovina L., Festuca rubra L.,* and *Poa pratensis L.;*
- grass species resistant to both overgrazing and trampling: *Phleum pratense L, Festuca pratensis Huds.* and *Lolium italicum A.Por..*

Fine stemmed palatable legumes account for 10-20 percent of the pasture mix. If there is shortage of natural pasture, geese can be kept in orchards, stubble fields and green wastelands of various types but in such cases they are also given freshly cut forage. In spring the earliest fresh forage is obtained from nettles, winter rape, and rye together with leguminous plants e.g. *Vicia villosa* Roth and then later from winter wheat and spring cereals (oats and barley). In summer, green forage from the second grass cutting is given to the birds. From mid-August, maize, sunflowers, third grass cuttings and sugar beet leaves are good sources of green forage for geese. The birds are often kept on stubble fields after the harvest of cereals and leguminous plants. In October geese are given fodder kale or root crops, e.g. red fodder carrots or sugar beets cut in half. Fresh beet pulp, steam-cooked potatoes or mixed silage are also used.

Laying period

In November young ganders and geese destined for the breeder flock are kept indoors and prepared for their first season of reproduction. Usually the breeder flock comprises birds of the same age. Age differences of no more than two weeks are tolerated but the males must be older than the females. In the reproduction flock no changes are required except for the culling for health defects. The birds are kept indoors but have access to a yard during daytime. Only during the very cold winter (December-March) are the birds kept indoors 24 hours a day.

Poultry houses for breeder flocks and the resulting management conditions depend on the scale of production. There are both specialised buildings and those adapted as poultry houses for breeders. There are houses with and without windows, with and without heat, mechanical ventilation or with natural ventilation but all houses have an adjacent poultry yard. A few large farms have poultry houses built in the 1990s which have a controlled microclimate but on the majority of smaller farms the poultry houses have been adapted from barns, covered shelters or old piggeries. Adaptations can be made relatively easily and at a low cost. The walls must be sealed to eliminate draughts, the ceiling must be insulated to keep the heat in, a new floor installed and wall openings to the yard provided. Additional air inlets are also required to ensure proper ventilation, as well as additional windows, if necessary. Unheated buildings are not harmful to birds despite the cold Polish winters although the water supply sometimes freezes. The optimum temperature for a goose-house during the reproductive season in Poland is 5-8°C.

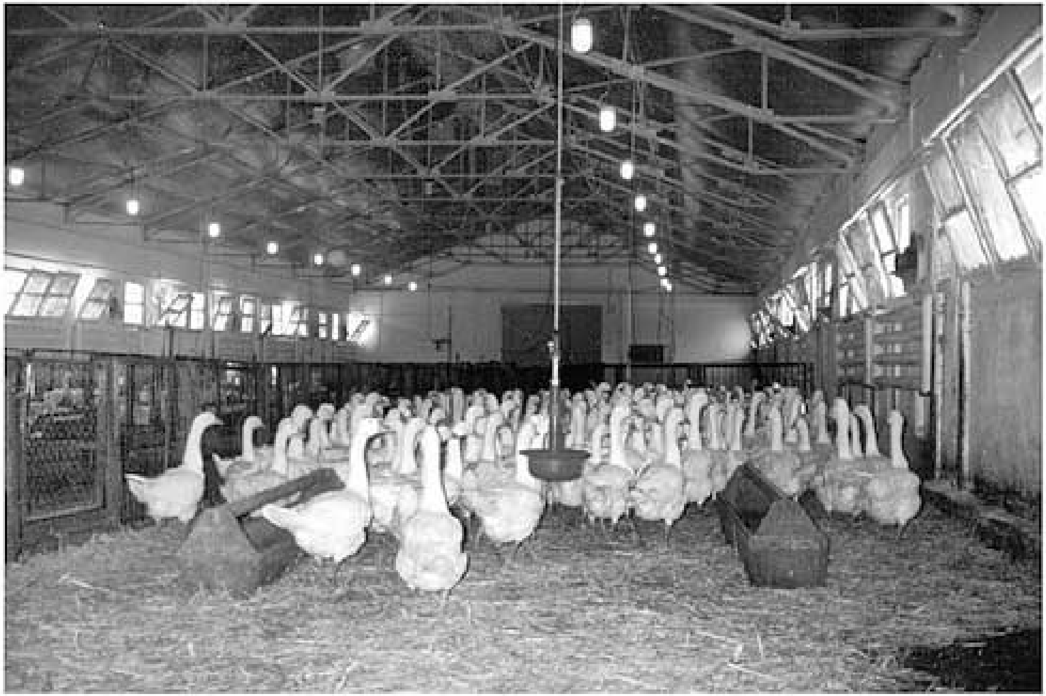
FIGURE 5. Building for the reproduction flock with darkened windows and trap-doors leading to the yard

(*Source:* Rosinski, 1999)

Parent stock geese are kept on deep litter made up of cereal grain straw (mainly rye) either whole or cut. New litter is added daily or every second day and it is all removed after the lay period, prior to cleaning and disinfecting the poultry house. The initial layer of deep-litter is 5-7 cm thick and this is gradually increased up to a thickness of 30-40 cm.

Stocking densities are 1.4 bird per m^2 of floor area in the house and 0.7 bird per m^2 in the yard. On the majority of goose farms the yard is adjacent to the goose house and is fenced. Most frequently these are grass or soil yards and rarely covered with concrete or asphalt. Soil yards of frozen ground are waterproof and are sometimes covered with whole or cut straw to which peat has been added. On some farms, yards with a hard surface have a pool that is used by the geese after the winter period but in general, the reproduction flock does not have access to water reservoirs or ponds during the laying period.

FIGURE 6. A reproductive flock on straw litter



(*Source*: Rosinski, 1999)

FIGURE 7. A reproductive flock of geese during their first year of lay in a fenced yard with pool

(*Source:* Rosinski, 1999)

The feeding and drinking equipment in the poultry houses for geese varies from simple wooden or sheet metal feeders and drinkers filled manually to semi-automatic and automatic installations made by established manufacturers. On small farms, the feeders are generally made with dry, smooth wood or sheet aluminium, with a bar on top to prevent wastage. Feeders are usually 150-200 cm long, 30 cm wide and 25 cm deep. The number of feeders is dependent on flock size with each goose given 20-25 cm of linear feeder space. The complete ration is generally fed indoors but the green forage is given outdoors.

Trough drinkers 100 cm long, 20 cm wide and 25 cm deep are also made of sheet aluminium and each goose requires 5 cm of linear drinking space. In the poultry houses there are open nests made of wood that are 50-70 cm in width and depth. One nest is sufficient for 2-3 geese. The nests are situated in one row against a building wall and have neither floor nor back wall. At the front of each nest there is a wooden bar of 10-15 cm in height to prevent the loss of litter from the nest. The sides are 70 cm high.

The more intensive feeding of the geese for reproduction starts in December to prepare them for the laying season. The birds are given the same complete ration that they will receive during the lay period, beginning at 200 g per bird per day and then increased to 250 g per bird per day. At the beginning of January and during reproductive period the geese are fed *ad libitum* on a complete ration of 14-15 percent crude protein, 2.5-2.6 Mcal of ME per kg and approximately 3 percent calcium. The following feed ingredients are used: a ground cereal grain (wheat, barley and oats) up to 67 percent, ground peas up to 5 percent, ground maize up to 10 percent, either soybean or canola meal up to 16 percent, dried grass up to 10 percent and a mineral-vitamin premix. During feeding *ad libitum* the consumption of this complete ration is initially increased up to more than 500 g per bird per day and then gradually decreased to around 350 g per bird per day. For the entire lay period the consumption of complete ration is about 60-65 kg per goose on average.

Another method for feeding geese during the reproductive period is to use a combined system using a limited quantity of a complete ration (about 300 g per bird per day) together with a bulky feed (about 200-300 g per bird per day or more). The birds are usually given either red carrots, fodder beets (up to 200 g per bird per day), kale (up to 500 g per bird per day), hay (up to 50 g per day) and steam-cooked potatoes as the bulky food.

On smaller farms the birds are maintained under natural daylight. In such cases the lay season begins in mid February and continues until early June. The highest intensity of lay is observed in March and April. The number of eggs per layer produced over the season under these conditions is not usually more than 40. On many farms various lighting programmes are used but the most popular programmes provide the geese with 10-12 hours of light. The lighting programme starts about 30 days before the beginning of the laying season. At the end of December, when the natural daylight is about nine hours per day, the period of light is extended by using electric lights for 10-15 minutes every second day. In this way the required duration of 10-12 hours of light can be reached and maintained at the same level until the end of reproductive season. During the daylight period the birds are in the poultry house or in the yard. For the standard 12 hour lighting programme, the lighting period is from 7.00 a.m. to 7.00 p.m. For the ten hour lighting programme, it extends from 7.00 a.m. to 5. 00 p.m. For the dark period the birds are then kept in the house and the lights are switched on and off automatically according to the lighting programme. The use of artificial lighting programmes, particularly with the reduced hours of light, requires windowless houses with good ventilation. These programmes are also used in poultry houses with windows that have been painted dark or covered.

With 12 hours of light per day, the laying season begins in mid-January and ends in June, with an average laying intensity of 40 percent. The average egg production for this period is 54-57 eggs per female.

With ten hours of light per day, the laying period is 20 days longer than with the programme of 12 hours of light per day and the number of hatching eggs is increased by 15-20 percent, but the average laying intensity, at 38 percent, is slightly lower. Because of the longer laying period, however, the average number of eggs is greater, i.e. 63-68.

To increase laying intensity, at the beginning of the laying season under the programme of ten hours of light per day, a "light stimulus" is applied. This consists of lighting the poultry house for 24 hours for one day only. This stimulus is applied on about the fifteenth of January and thereafter the hour programme is continued. Ten days after application of the stimulus, the laying performance of the flock is about ten percent and during the next 4-6 days it will increase to 40 percent.

Very good results have been reported during the reproductive period with lighting programmes that provide only eight hours of light per day. With this programme a greater number of eggs can be obtained from each female because the lay period is extended until July and higher fertility can be maintained until the end of reproductive season. Values of up to 80 percent have been reported. However, this lighting programme is seldom utilised by goose breeders.

Hatching eggs are collected 3-5 times a day. The nests must be maintained at a high level of hygiene and their litter replaced frequently. After collection the eggs are disinfected on the farm by UV light or formaldehyde gas and delivered to the hatchery once a week. The price of goose hatching eggs accounts for 40 percent of the price of day-old commercial goslings.

Egg production of White Koluda geese kept under local conditions and in various management situations, is between 44-55 eggs per bird in the winter-spring reproductive season. The percent fertility ranges from 84-92 percent and the percent hatch of eggs set ranges from 66-70 percent.

From the end of the laying period until November, the breeder flock is kept in yards or on pasture where the birds are fed on green forage and other bulky feeds, supplemented with ground cereal grain.

MEAT PRODUCTION

As mentioned, both the White Koluda W31 (from the cross of a W33 male with a W11 female) and the W11 pure strain birds are used as commercial stock for meat production. On completion of the fattening period at 17 weeks of age, the W11 geese have a bodyweight about 0.5kg lower than the W31. The W31 hybrids currently account for 80-85 percent of the total market goose production in Poland while the W11 pure strain birds account for 15-20 percent.

The most popular production system consists of growing the geese until 17 weeks of age (the second cycle of feather maturity) although some flocks are grown until 24 weeks of age (the third cycle of feather maturity). In both cases the production system is semi-intensive and the goslings are fed intensively on a complete ration until four weeks of age. During their first week of age fresh green forage is introduced into their diet. From the fourth or fifth week until 12 weeks of age the goslings are given green forage *ad libitum* and a complete ration limited to 210-240 g per bird per day. In week 11 the birds are partially plucked and the amount of complete ration is increased by 20-30 g per day. From weeks 13-14 the birds are given 150-170 grams of complete ration per day and green forage *ad libitum*.

The type and quality of complete ration and green forage is similar to that used for rearing goslings for the reproduction flock. The management system of the birds is also the same, that is, rearing them under a system using both a house and yard up to the sixth week of age and thereafter using either a yard or pasture system. However stocking density may be higher by 1-2 birds per m^2, e.g. in the first week of age which means 10-12 goslings per m^2. The fattening period is three weeks prior to slaughter i.e. from 15-17 weeks of age inclusive. During this time the birds are kept indoors or in yards. They are often kept in fenced pens, each holding 250-300 geese. The geese are kept at 0.33-0.50 m^2 per bird. At week 14 oats is gradually introduced into their diet. No bulky feed is given to the birds during the fattening period and the consumption of oats amounts to 10-11 kg per bird for this period. During the fattening period the birds gain between 1.2-1.4 kg and by the end of the fattening period at 17 weeks of age, their final body weight is between 6.0-6.7 kg.

Total consumption of the complete ration and oats is approximately 28-30 kg per bird and that of green forage between 60-65 kg per bird. Fattening birds in autumn is easier because of their genetic and physiologic tendency to have a greater appetite during this period as well as a tendency for increased fat accumulation. To prevent the birds from becoming excessively fat, the daily ration of oats is limited to 600-700 g per bird per day. In the summer months from June to August goose fattening is less effective as the high temperatures reduce their appetite. This decreased appetite can, in part, be overcome by adding either red carrots or fresh succulent green forage to the oat ration at the rate of 100 g per bird per day.

When the geese are to be slaughtered at the age of 24 weeks, they are given less complete ration per day (100-150 g per bird per day) for a longer time, i.e. until 21 weeks of age. During this time green forage (either as cut grass or pasture) is the main feed, and the second plucking is performed at 17 weeks of age. The geese are fattened with oats for the three week period from 22-24 weeks of age inclusive. The body weight of these geese is usually 0.4-0.6 kg higher than birds marketed at 17 weeks of age.

The carcass of a goose fattened with oats is called "oat goose", and is one of the specialities of Polish agriculture. "Oat goose" meat is considered a high quality product on the German market. The high quality is a result of both the genetic traits of the goose and of the feeding system used. At 17 weeks of age, the slaughter yield (carcass without giblets) is about 65-66 percent; the breast muscle yield from the carcass (with neck) is about 18-19 percent and the leg muscle yield is 16-17 percent. The carcass has an optimal subcutaneous fat layer and the peritoneal fat content is 3-5 percent.

On large goose growing farms the number of birds is from 3-4 thousand birds. On the smallest farms around 500 birds are grown and fattened. In all cases the number of birds and their marketing is synchronised with the capacity of the slaughterhouse to which they are taken. Some very large farms grow up to 50-60 thousand "oat geese" annually. The increasing demand for young commercial geese in the 1990s has resulted in the construction of large farms where geese are grown in poultry houses under controlled microclimatic conditions and with automatic feeding and watering equipment.

Apart from growing geese on commercial farms, the traditional system of keeping them in backyard flocks of various sizes ranging from 10-40 birds is still popular. Geese are initially reared in one of the farm buildings or even in the farmer's house (up to ten goslings) with an infrared lamp or a common light bulb used as a supplemental heat source. Goslings are fed a commercial complete ration for the first two weeks which, from week three, is mixed with ground wheat. From 6-8 weeks of age the birds are given ground cereal grain (wheat, oats or barley). Green fodder is given from the beginning of the rearing period. Geese are kept together with other farm animals and are allowed to range freely where they can graze for grass and weeds. In nearby ponds or other water reservoirs they can find duck weed and other water plants. For feeding geese in backyard farm flocks kitchen waste and by-products including vegetables, fruit (mainly apples and plums) can be used. The geese are also given such things as red beets, steam-cooked potatoes, carrots and cabbage. During the growing period the soft feathers and down are partially plucked and the feathers and down used as pillow and duvet filling. The geese are usually kept until December when they are slaughtered, and the meat and fat used by the family for their own needs.

FEATHER AND DOWN PRODUCTION

Soft feathers and down from the breast and abdomen of geese are valuable raw materials and can be sold at a relatively high price. They are obtained by partial manual plucking of live birds. This operation has to be done when the feathers are fully mature and the foot of the calamus is closed and free of blood, and can be easily removed without skin damage. Done properly, the plucking of live birds is not harmful and has no detrimental effect on productivity. On the contrary, it results in a more uniform growth of new feathers and can improve the appearance of the carcass. In Poland plucking of live geese is performed on young and adult birds.

The first period of soft feather and down maturity is between 10-11 weeks of age when 60-70 g of white soft feathers and down can be obtained from one goose, of which about 16 percent is down. The subsequent pluckings are done at 6-7 week intervals, as this is the period required for the soft feathers and down to mature. Commercially produced birds that are to be fattened are plucked alive either once (if slaughtered at 17 weeks of age), or twice (if slaughtered at 24 weeks of age). Young breeding stock birds are usually plucked alive three times: at 10-11 weeks, 17-18 weeks and at 24-25 weeks. The second and third pluckings each yield between 100-120 g per bird of soft feathers containing 19-22 percent down. Adult geese in the reproduction flock are plucked three times after the reproductive season. The first plucking after the end of the laying period delivers 70-90 g of soft feather with a down content of 15-17 percent. The two successive pluckings yield 110-130 g of feathers with a down content of 28-32 percent. Adult birds sometimes have a fourth plucking which is done in the first ten days of December. This last plucking is the most efficient and up to 150 g of feather and down can be obtained per bird.

Before plucking the birds are bathed and allowed to dry overnight on clean, dry straw to give the feathers and down a better colour. They have their shanks bound with a soft textile tape and are put on their backs on the knee of the person doing the plucking. The bird's neck is slightly pressed down with the left hand and the lower part of neck, breast and abdomen, as well as the sides of the body, are plucked. The flank feathers are not removed and the back of the body is not plucked. Feather and down are used both for the manufacture of high quality bedding and clothing articles in Poland and exported as raw materials, mainly to Germany, Switzerland and Japan.

PREVENTION

In large-scale production of breeding and market geese, great attention is paid to hygiene and disease control. On the farms, the rearing houses are properly prepared prior to the introduction of goslings. The rooms and equipment are cleaned, washed with hot water containing detergents and sanitizers. The rooms and the production equipment are disinfected mainly with formaldehyde gas. The yards are also disinfected. Hard surface yards are disinfected with a 2-3 percent iron or copper sulphate solution or with other disinfectant preparations. Soil yards are disinfected by spreading chlorinated or burnt lime in the quantity of 1-4 kg of lime per m^2, after which they are rinsed with water and a few days later ploughed to a depth of 15-20 cm. Geese that were kept on pasture are treated for parasites, mainly against *Amidostomum anseris* prior to introduction into the poultry houses. The reproductive flocks and goslings are vaccinated against Derzsy disease.

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APPENDICES

Appendix 1. Breeds of Geese

Appendix 2. Abbreviations

cal	Calorie
cm	Centimetre
c	Centigrade
g	Grams
h	Hours
Hg	Mercury
kcal	Kilocalorie
kg	Kilogram
km	Kilometre
l	Litre
m	Metres
ME	Metabolizable Energy
mm	Millimetres
min	Minutes
%	Percent

wt Weight

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BACK COVER

This publication is a guide to sustainable domestic goose production. Geese have a number of inherent advantages: they can consume and digest large amounts of high-fibre and low-quality feed; they are easy to manage; and their rapid growth renders them one of the most efficient sources for meat production. In addition, feathers/down and fatty liver are valuable by-products, while their strong territorial Instinct makes them very effective guards. As selective feeders, geese have been used for weed control in a wide range of crops. All aspects of goose production are discussed in this book, including feeding and nutrition, housing, general husbandry, flock heath and breeding. Regional differences in production practices are also described. The book will be of practical value to those planning to

keep geese and those who already keep geese, as well as students and development agencies wishing to promote goose production.
