Raising chicken and turkey broilers in Canada

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Contents

Click on a subject to view its content

Foreword

The present publication results from the integration of two prior publications dedicated to chicken and turkey broiler industries in Canada. Although there are distinct production guidelines for each segment of the poultry industry, clearly there are many aspects that are common to the broiler trade. It is our hope that those associated with these industries will find this new compilation to be an even more useful source of information. Authorship of the revised publication is principally that of F.G. Proudfoot, Principal Research Scientist (retired), building on the original contributions of research and extension staff collaborating within the framework of the Poultry Subcommittee of the Atlantic Provinces Agricultural Services Coordinating Committee.

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Checklist

- Obtain good-quality chicks or poults of known parentage and of one age only.
- Practice isolation brooding, particularly from 1 to 10 days of age.
- Regulate brooding temperature 24 h before chicks or poults are expected to arrive.
- Check your thermometers in water registering 38°C on a medical thermometer, to ensure that they are accurate.
- Expose birds to water as soon as possible and feed within 1 h of being placed under brooders.
- Ensure that all birds have found water during the first 24 h.
- Spread waterers and feeders evenly throughout the brooding area.
- Ensure that water and feed are available at different temperatures when a centred source of heat is being used.
- Keep feed waste to a minimum by maintaining feeders one-third full and by adjusting the level of feeders to the back height of the birds.
- Prevent water spillage by adjusting water level equal to the level of the birds backs; keep litter dry around waterers.
- Reduce water spillage by maintaining a low but adequate water level in the waterers.
- Wash and disinfect waterers two or three times a week.
- Check water pressure frequently, particularly if nipple waterers are being used.
- Follow a medication and vaccination program for protection against diseases that may be prevalent in your area.
- Debeak birds only if necessary.
- Watch for sick birds and get a prompt diagnosis.
- Have alarm system set to warn staff in the event of power failure or occurrence of unusual temperatures.
- Check for fire hazards and ensure that the caretaker has an escape route.
- Check and operate auxiliary power unit weekly. Have a container of extra fuel available.
- Provide for emergency ventilation in the event of a power failure.
- Check with your poultry processing plant regarding the feed withdrawal time that is required.
- Take special precautions to prevent bruising, when catching broilers for shipment to the processing plant.
- Use a sanitary method for the disposal of dead birds.
- Use special care with fumigant chemicals and disinfectants, because they can be extremely hazardous to birds and personnel.
- Follow the *Recommended code of practice for the care and handling of poultry from hatchery to processing plant* (Publication 1757/E, Agriculture Canada).

Introduction

The production of poultry and eggs is an important source of farm income in Canada. In 1989, cash income from the sale of poultry meat and eggs exceeded 1.3 billion dollars, which amounted to 8% of the total farm cash receipts. About two-thirds of the cash income of poultry farmers came from the sale of poultry meat. Turkey meat now represents about 17% of the poultry meat produced in Canada.

The growth of the chicken broiler industry has been phenomenal. In 1989, some 395 million chicks were hatched in Canada for the production of either broiler or roaster chickens. Only 242 million chicks were hatched for this purpose in 1977 (Fig. 1).

In 1989, some 21 million turkey poults were hatched for broiler and heavy, roaster-type production in Canada (Fig. 2). Increased turkey production has responded to an expanding market (Table 1) based on a steady increase in the human population. Technological development of this specialized industry has been accompanied by a remarkable increase in chicken broiler meat consumption in Canada. However, over the past 20 years the per-capita consumption of turkey meat has not increased as rapidly as the consumption of chicken meat (Fig. 3).

During the last three decades producers and processors of broiler meat have developed highly efficient methods of production and marketing and are providing consumers with a highly competitive, wholesome meat. Increasing efficiency in the production of poultry meat is shown by the decreasing amounts of time and feed needed to grow chicken broilers (Table 2). The feed conversion ratios and liveweight gains that have been achieved for both chicken and turkey broilers have continued to improve (Table 3).

Table 1 The eviscerated weight equivalent of turkey broilers slaughtered in registered grading stations (metric tonnes)

Year	Classes			Total
	≤ 5 kg	5 - 8 kg	≥ 8 kg	
1978	27 679	23 545	38 355	89 579
1979	34 222	26 278	41 849	102 349
1980	31 167	25 029	39 198	95 394
1981	30 687	24 298	34 349	89 334
1982	34 544	23 192	34 214	91 950
1983	32 925	24 774	34 778	92 477
1984	30 660	24 156	37 671	92 487
1985	33 040	25 733	38 725	97 498
1986	31 966	27 396	41 315	100 677
1987	33 933	28 962	47 615	110 510
1988	34 598	29 905	48 923	113 426
1989	36 588	33 520	45 200	115 308

Source: Poultry Market Review (1978-1989), Agriculture Canada

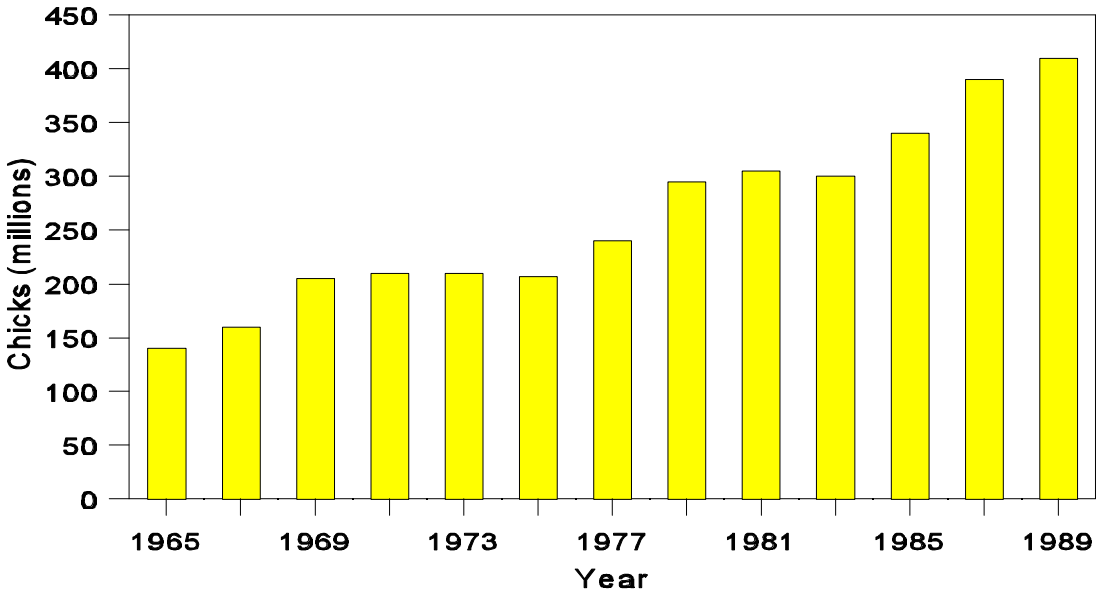

Fig. 1 Chicks hatched for broiler and roaster production in Canada, 1965-1989.

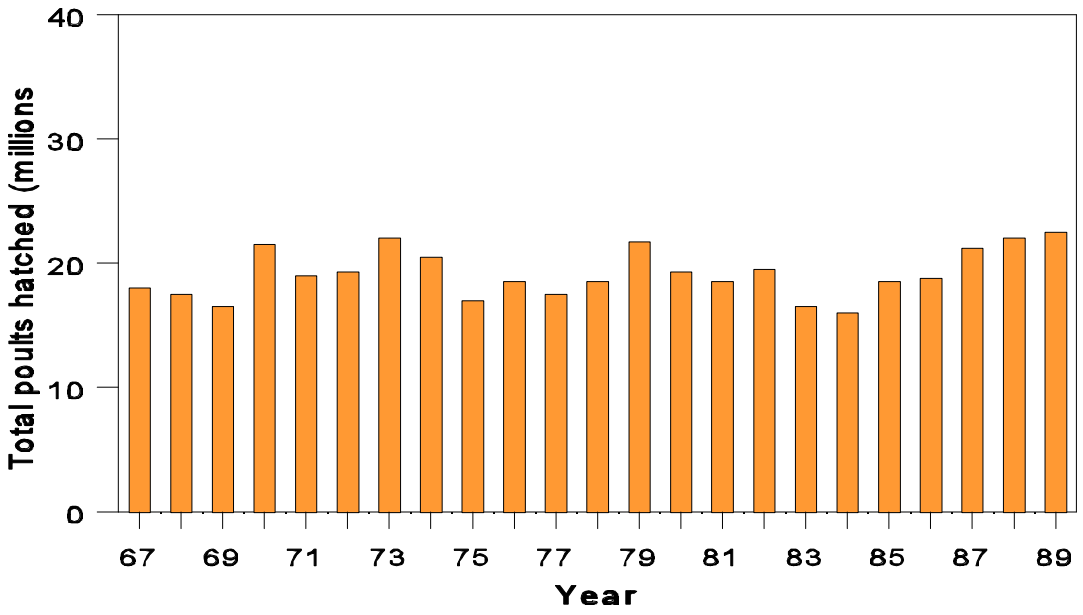

Fig. 2 Turkey poults hatched for meat production in Canada, 1967-1989.

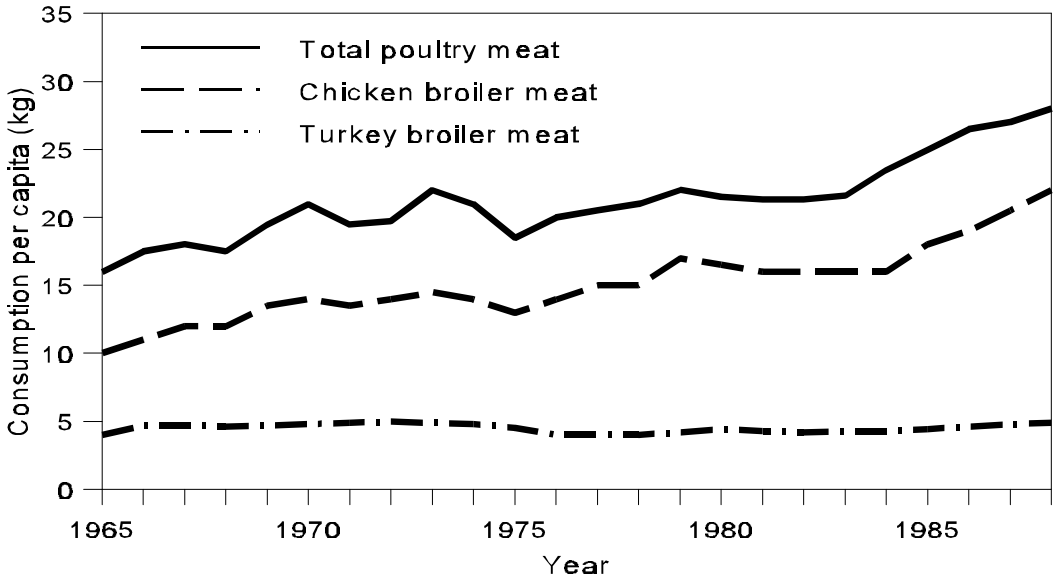

Fig. 3 Per capita poultry meat consumption in Canada, 1965-1989.

Table 2 Change in time and feed required to grow chicken broilers, 1950-1988

Year	Age at slaughter (days)	Broiler weight (kg)	Feed conversion ratio (kg)
1950	84	1.36	3.40
1965	63	1.59	2.25
1975	49	1.73	2.00
1977	47	1.90	1.95
1988	42	2.00	1.85

Table 3 Performance data for flocks of chicken and turkey broilers grown at the Kentville Research Station, 1989

	Sex		Sexes combined
	Male	Female	
Chicken broilers			
Mortality to 42 days (%)	4.00	2.80	3.40
Feed conversion ratio to 21 days[1]	1.43	1.42	1.42
Feed conversion ratio to 42 days	1.82	1.84	1.83
Av. liveweight at 21 days (kg)	0.65	0.64	0.65
Av. liveweight at 42 days (kg)	2.31	1.98	2.14
Av. monetary index ($)[2]	0.91	0.74	0.83
Turkey broilers			
Mortality to 84 days (%)	4.90	2.00	3.50
Feed conversion ratio to 28 days	1.30	1.31	1.30
Feed conversion ratio to 56 days	1.57	1.60	1.59
Feed conversion ratio to 84 days	1.96	2.01	1.99
Av. body weight at 28 days (kg)	0.90	0.77	0.84
Av. body weight at 56 days (kg)	3.31	2.70	3.01
Av. body weight at 84 days (kg)	5.59	4.56	5.07
Av. monetary index ($)	2.18	1.73	1.96

[1] Feed conversion ratio is the amount of feed consumed divided by the liveweight of the birds.

[2] Monetary index is the money received for the sale of poultry meat reduced by the cost of day-old birds and feed consumed per bird started.

Both chicken and turkey broilers can adapt to, and thrive in, a wide variety of climatic conditions. They can be raised almost anywhere that proper housing and nutrition are provided and appropriate management procedures are followed.

Besides improving the production and marketing of poultry meat, broiler producers and processors have helped to create many new supporting enterprises. These include feed mills that prepare special poultry diets, plants that manufacture special processing equipment and packaging materials, specialty chicken shops and restaurants, food processing plants, and plants that make useful products such as fertilizers from broiler by-products.

The Broiler Production Enterprise

With the establishment of marketing boards in Canada, the resulting quota system avoids a surplus of poultry meat on the market. Marketing boards require that a person must obtain a license or a quota to produce and sell broilers through the normal market channels. These boards can adjust market prices within certain limits.

Most broilers now raised commercially are grown under contract as part of an integrated production operation, usually planned by poultry processors and feed manufacturers. The feed manufacturer supplies feed to the grower, who in turn ships broilers to the poultry processor. Naturally a broiler hatchery coupled with parent breeder flocks are essential components of the operation of providing day-old chicks or poults to the broiler producer. This type of operation requires long-range planning to achieve the most efficient use of labour, capital, and management at all levels of production and marketing.

A broiler producer grows a relatively large number of broilers per year and expects a reasonable profit for each bird started. The costs of feed and chicks or poults represent up to 75% for chicken and 70% for turkey broilers of the total operational expenses; other costs are comparatively low (Table 4). Large-scale operations respond favourably to good management. For example, a chicken broiler grower with a 20 000-bird operation, who experiences 5% mortality and 3% condemnations, who produces birds having an average liveweight of 1.9 kg at 6 weeks (slaughter age), and who sells the flock for $1.08 per kilogram, can increase returns by $1000.00 for the flock by reducing mortality to 3.5% and condemnations to 1.8%.

Table 4 Calculated percentages of cost items involved in the production of chicken and turkey broilers in provinces having supply management programs as of December, 1989

Cost item	B.C.[1]	Alta.[2]	Sask.	Man.	Ont.	Que.	N.B.	N.S.	PEI	Nfld.
Chicken broilers										
Feed	50.4	-	47.8	47.0	40.2	53.4	49.1	47.8	48.5	48.6
Chicks	18.4	-	21.1	22.6	22.3	20.2	18.9	20.3	20.9	23.4
Labour	8.4	-	8.1	9.1	9.8	9.4	10.5	11.4	10.2	8.8
Energy	3.4	-	3.5	4.5	3.8	3.6	3.4	3.0	3.4	3.7
Other costs	19.4	-	19.5	16.8	23.9	13.4	18.1	17.5	17.0	15.5
Turkey broilers										
Feed	48.6	47.5	49.6	49.3	43.3	48.6	50.8	45.8	-	-
Poults	20.4	21.7	20.4	19.6	20.8	16.9	17.3	20.7	-	-
Labour	11.0	10.9	11.6	11.3	12.8	12.1	9.0	8.9	-	-
Energy	2.3	2.2	3.0	3.4	3.5	4.1	5.5	5.0	-	-
Other costs	17.7	17.7	15.4	16.4	19.6	18.3	17.4	19.5	-	-

[1] British Columbia provincial marketing board has recently withdrawn from the Canadian Chicken Marketing Agency (1990).

[2] Alberta has recently joined the Canadian Chicken Marketing Agency (1990).

Source of Birds

Chickens

In the early years of the chicken broiler industry, after selecting the female stock for egg production, males of the dual-purpose crosses were used for broiler production rather than being discarded. Although these male day-old chicks were obtainable at a low price, it was soon recognized that birds specially bred for broiler meat production were much superior in performance.

Today several commercial stocks are available for broiler production. Parental flocks consist of a female line and a male line. The female lines usually have been developed from birds with a White Rock background and the male lines from birds of Cornish ancestry (Fig. 4). Thus, most commercial broiler chicks are the result of crossing different strains that have been selected over many generations for combining ability resulting in improved body weight gain, livability, and feed conversion in their progeny at 6-10 weeks of age as a result of heterosis.

Parental broiler stocks are usually purchased from breeders located in Canada, the United States of America, and some European countries. Special precautions taken by federal and provincial departments of agriculture have been effective in controlling egg-borne diseases. These parental flocks are received as day-old chicks consisting of females of the female line and males of the male line and are reared and mated by "multiplier" flock owners. At 24-26 weeks of age these birds commence producing eggs for hatching. Eggs are set by hatcheries, which supply broiler chicks continuously to growers.

Fig. 4 Mated group of broiler parent birds.

Although the genetic makeup of parental stocks is of primary importance, other factors can markedly influence performance. Nutrition of the parent flock, size of the egg from which the broiler chick was hatched, and the lighting program used on the parent flock can each affect performance of the progeny. Also, storage time and method of storing hatching eggs can have an important effect on the growth rate of broilers hatched from stored eggs.

Therefore, it is important not only to use stock of good breeding, but also to ensure that parental stocks are properly managed. We emphasize particularly that special attention is needed in feeding and lighting programs and in the handling of hatching eggs.

Turkeys

Several standard varieties of turkeys recognized by the American Poultry Association are described in the American Standard of Perfection. Among the most prominent are Beltsville Small White, Narragansett, Slate, White Holland, Bourbon Red, and Bronze. Nonstandard varieties, such as the Broad Breasted Bronze and the Broad Breasted Large White, are also commercially significant.

The Bronze variety originated in North America. The Broad Breasted Bronze resembles the standard Bronze variety, although it usually has buffy white instead of pure white feather tips. The basic plumage of this variety is black.

The Broad Breasted Large White was developed in the early 1950s, through pedigree breeding and selection at Cornell University from crosses of Broad Breasted Bronze and White Holland. Private breeders soon began to develop other strains through crossbreeding.

Most breeders named their own strains. Selection of Large White and Broad Breasted conformation has been intensive because of the important commercial value of this trait. Most strains of Broad Breasted Large White are now equal to Broad Breasted Bronze in this respect. The white pin feathers on the carcass of an immature bird of this variety are less noticeable than the coloured pin feathers of coloured varieties. This characteristic gives the Broad Breasted Large White variety a definite market advantage. The genetic factor responsible for its white plumage is a recessive gene with no significant adverse effects on other characters.

The Beltsville Small White variety was developed by the U.S. Department of Agriculture at the Agricultural Research Centre in Beltsville, Md., between 1941 and 1962. This stock has been distributed throughout the world. It is smaller in size and is generally better in egg production, fertility, and hatchability; it is usually less broody than larger-sized varieties. When marketed as broilers, these birds are usually slaughtered at 10-11 weeks of age.

From these basic stocks, Canadian turkey breeders have successfully developed specialty varieties suited to broiler and heavy turkey production.

Hatchery practices

The operation of a hatchery requires a high degree of managerial control to arrange for a supply of hatchery eggs and to schedule hatches for meeting preplanned requirements of consumers.

Two types of incubators are used: the small incubator with a capacity of 50-200 eggs and the larger type with a capacity of 2 500-100 000 eggs (Fig. 5). The five factors that affect incubation are temperature, humidity, ventilation, position, and turning of eggs.

Small, still-air incubators are usually operated at 38-39ºC. Large incubators with forced-air circulation are usually kept at 37-38ºC, with the hatcher operated at a slightly lower temperature. Incubator temperature for turkey eggs is slightly lower (0.1ºC) than for chicken eggs. As temperature requirements vary slightly among different types of incubators and hatchers, follow the manufacturers directions.

Controlling the humidity in an incubator is important for two reasons. First, too much loss of moisture from the egg kills the embryo because it adheres to the shell. Second, insufficient evaporation from the egg causes death because of a lack of oxygen in the air cell. Relative humidity is usually maintained at 68-70%.

Ventilation requirements are affected by such factors as room temperature and humidity, number of eggs set, period of incubation, and the air movement in the incubator.

Eggs are set horizontally in small incubators and vertically with large end up in large incubators (Fig. 6). Turn eggs at least twice daily in small incubators. In large incubators they are incubated at a 45º angle and turned automatically every hour to prevent the egg contents from adhering to the shell. Eggs are positioned horizontally when placed in the hatching trays during the last 3-4 days of incubation prior to hatching (Figs. 7,8, and 9).

Hatchability varies depending on fertility and other factors, but should be at least in the 80-85% range for chickens and in the 75-80% range for poults (Fig. 10).

Special sanitation measures must be used to control the development of infectious agents in incubators and hatchers. It is essential to wash and disinfect equipment thoroughly (Fig. 11). In addition fumigation methods are frequently used to control harmful pathogens.

Fig. 5 Incubators used for the production of broiler chicks.

Fig. 6 Setting turkey eggs in a commercial-type incubator.

Fig. 7 Hatcher tray of turkey broiler poults.

Fig. 8 Removing a tray of broiler chickens from the hatcher.

Fig. 9 Counting turkey poults as they are being placed in shipping cases.

Fig. 10 Injecting turkey poults prior to shipment from hatchery to the grower.

Fig. 11 Washing and disinfecting hatcher equipment.

Physical Facilities

Location of Houses

Locate broiler houses on well-drained land with an adequate water supply. Provide easy access to truck transportation for delivery of feed and day-old birds and pick-up of those ready-for-market. Before construction begins, contact the appropriate authorities regarding zoning and environmental and health regulations.

Construction

Broiler houses vary considerably in design. Most new buildings are windowless and have metal sheeting on the outside walls and roof (Fig. 12). They are usually about 92 m long and 12 m wide. Studs of 2 x 6 material accommodate insulation and add extra strength for supporting the truss-type roof.

If using rigid-type insulation, enclose it with aluminum foil and seal cut edges by using foil tape to prevent larvae of the mealy beetle from invading and destroying the insulation. Most rigid insulation material must be covered to prevent birds from picking it. Recommended RSI values are as follows:

- ceiling -- 5.3 RSI[1]
- walls -- 3.5 RSI
- wall-floor perimeter -- 1.8 RSI

A separate furnace building reduces fire hazards and helps to prevent the spread of disease by service personnel. Arrange to have access to an incinerator or other approved means for the disposal of dead birds.

Make special provisions for the removal of the flock at slaughter time. Use feeding and watering systems suspended from the ceiling so that they can be removed. Provide side doors to facilitate the removal of birds.

Further information on the construction of broiler houses may be obtained from provincial agricultural engineering offices.

Heating Systems

Different types of brooders have been used to provide heat for broilers. Early in the development of the industry, heat lamps and brooders fired by oil, gas, wood, and coal were used. Individual brooder units have largely been replaced by the use of a centrally located, oil-fired furnace with a hot-water system conveying heat to the birds (Fig. 13).

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[1] RSI (Resistance System International) is an insulation index.

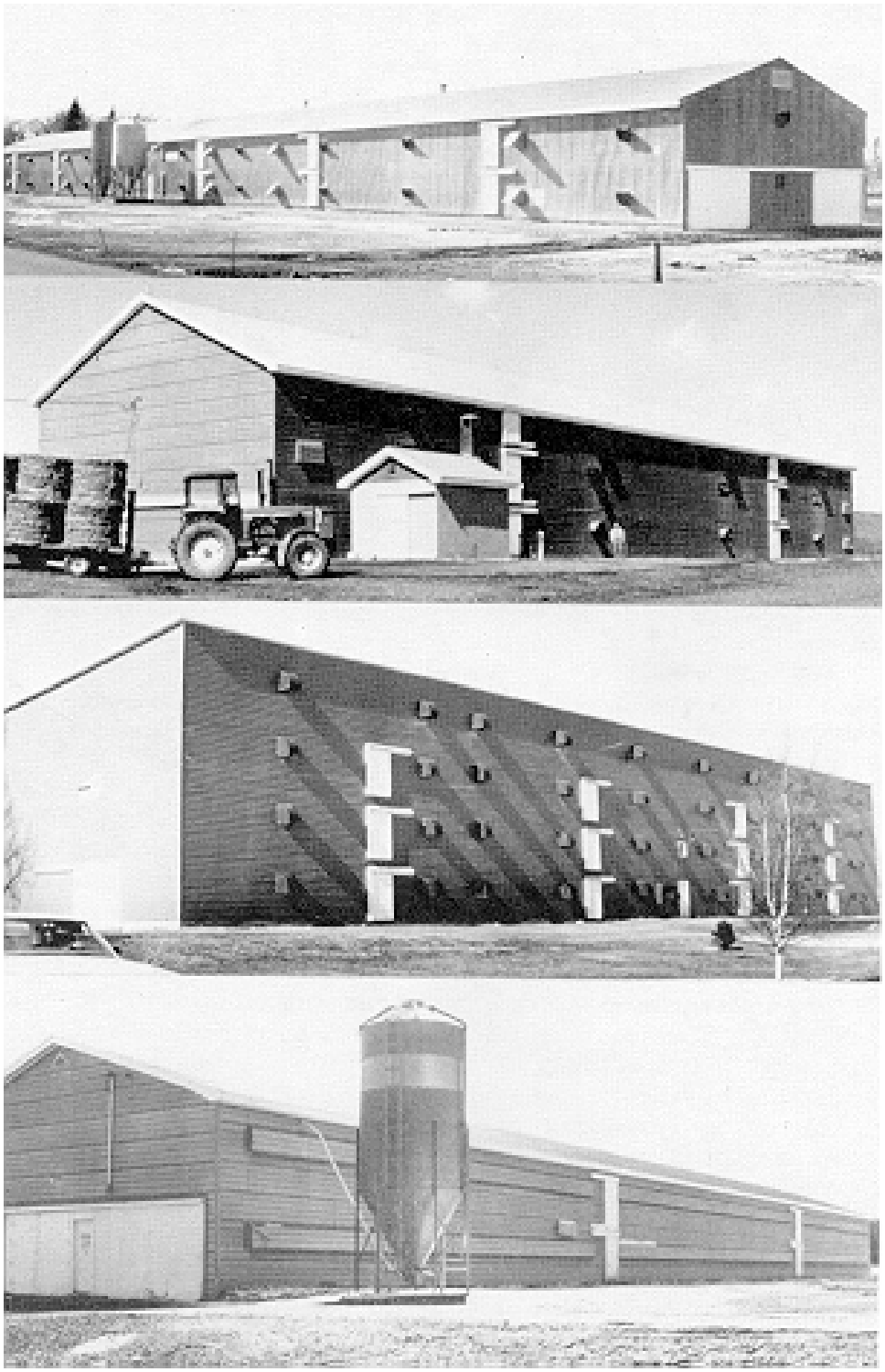

Fig. 12 Poultry barns used for growing either chicken or turkey broilers.

Fig. 13 Oil-fired, hot-water furnace used as a source of heat for brooding either chicken or turkey broilers.

A hot-water system may entail the permanent installation of several rows of black iron pipes spaced several centimetres apart (Fig. 14a and b) and used to heat all or part of the building. Birds may be restricted to a limited pen area during the first few days by using a cardboard guard (Fig. 14c). After several days they may be released to the entire pen.

With the development of warm-room brooding, the use of hot-water heating units equipped with fans has largely replaced black iron pipe as a heat source. These units are connected to the hot-water furnace and are suspended from the ceiling, which makes it easier not only to locate the feeders and waterers but also to remove the litter from the pens.

More recently radiant tube heating systems fueled by either propane gas or oil have become more popular as an integral part of a warm-room brooding system (Fig. 15). Oil-fired radiant tube heaters must be vented to the outside of the building whereas propane gas tube heaters require less venting.

Disadvantages of the warm-room brooding system are that it may dehydrate the birds; birds have little opportunity to adjust their environmental temperature by moving toward or away from the heat source. It can also be uncomfortable for the caretaker to work in these hot surroundings.

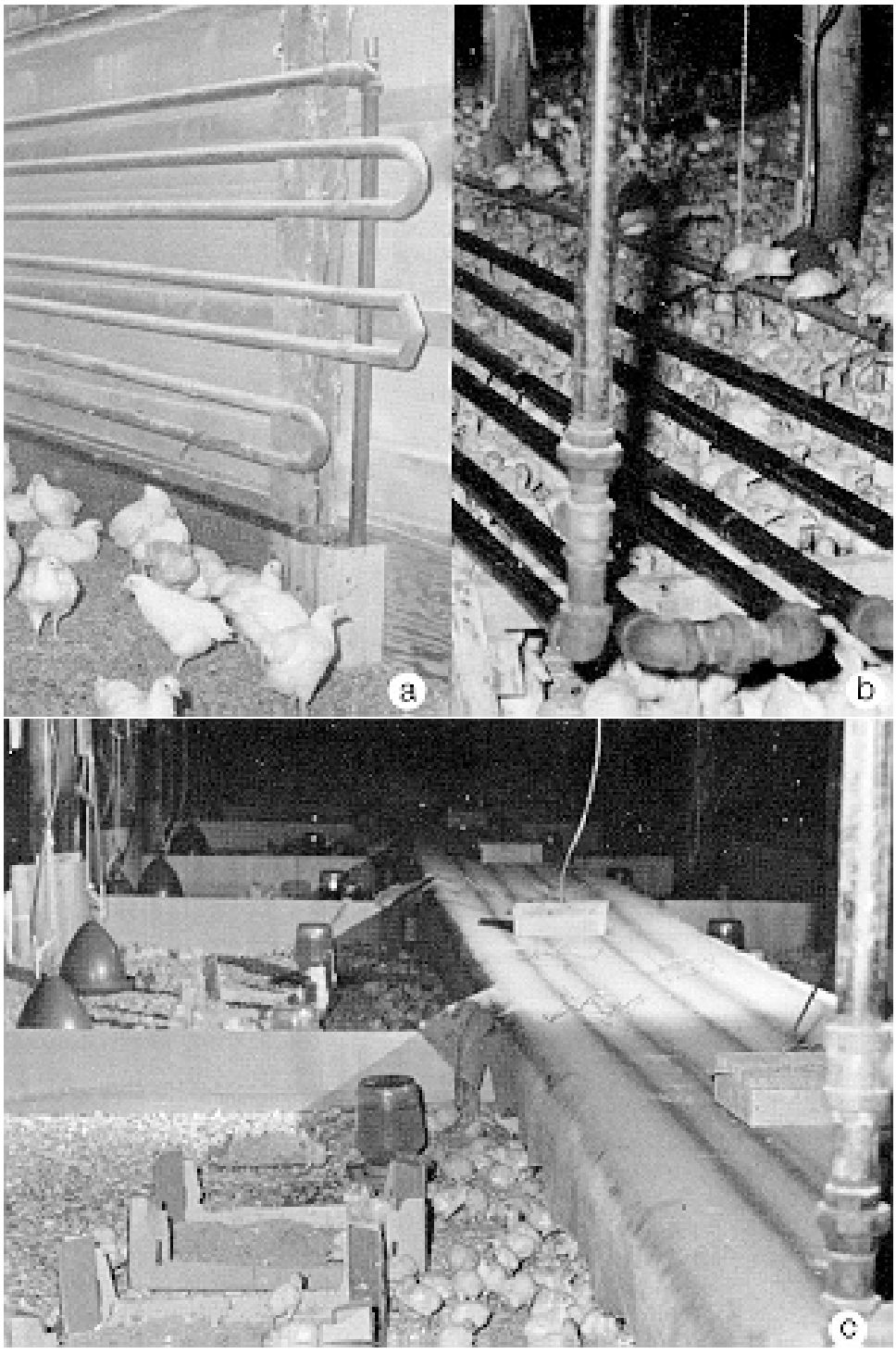

Fig. 14 Hot water circulates through pipes to provide heat for either chicken or turkey broilers.

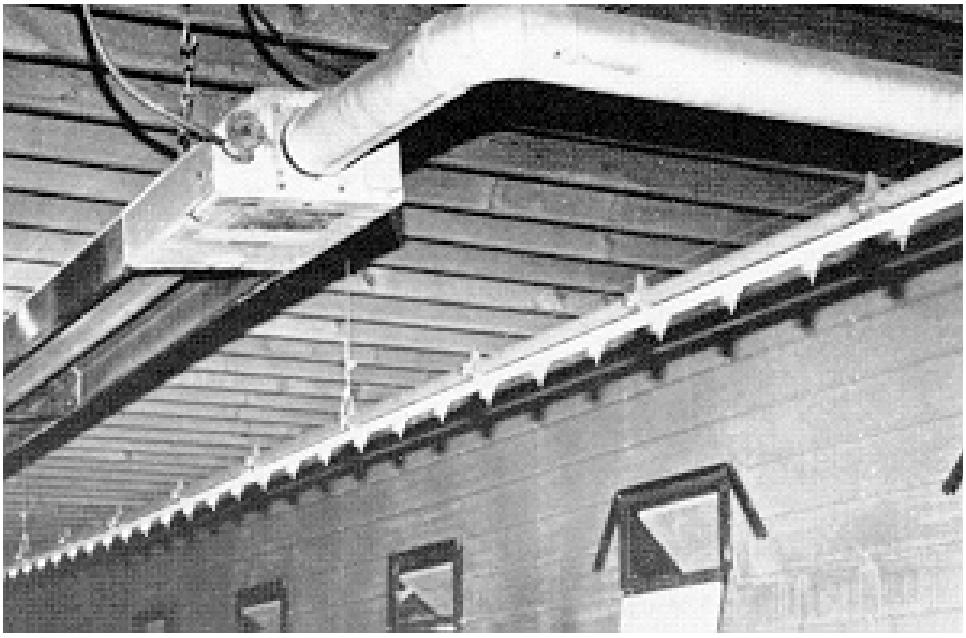

Fig. 15 Propane gas-fueled radiant-heating unit for brooding either chicken or turkey broilers.

Limited experimentation has been undertaken to estimate the effects of using heated concrete floors for brooding both chicken and turkey broilers. The floors are heated by embedding plastic pipe in the concrete floor and circulating warm water through the pipe. Hot water from an oil-fired furnace is passed through a heat exchanger from which lower-temperature water is circulated through the floor pipes. Because only a light scattering of planer shavings are used for litter with the warm-floor brooding system, this system may be considered feasible under conditions where shavings are excessively expensive or difficult to obtain. The few wood chips on the floor help to distribute chicks evenly on the floor (1 chip per 0.05 m^2), which reduces the hazards associated with chicks crowding together and being smothered. Care must be taken to ensure that watering systems are operating properly because water spills can result in much mess because there is little or no litter to absorb excess moisture.

Auxiliary Power

A generator is required to provide auxiliary electric power to maintain essential services, such as heating, lighting, and ventilation, during power failures. A generator may be operated either by a stationary engine or from a tractor power take-off (Figs. 16 and 17). Install in the broiler house and wire to the operator's residence a battery-operated alarm system, which would be activated by a power failure or when extreme temperatures occur. Reduced line voltage (brown-outs) can seriously damage electric motors.

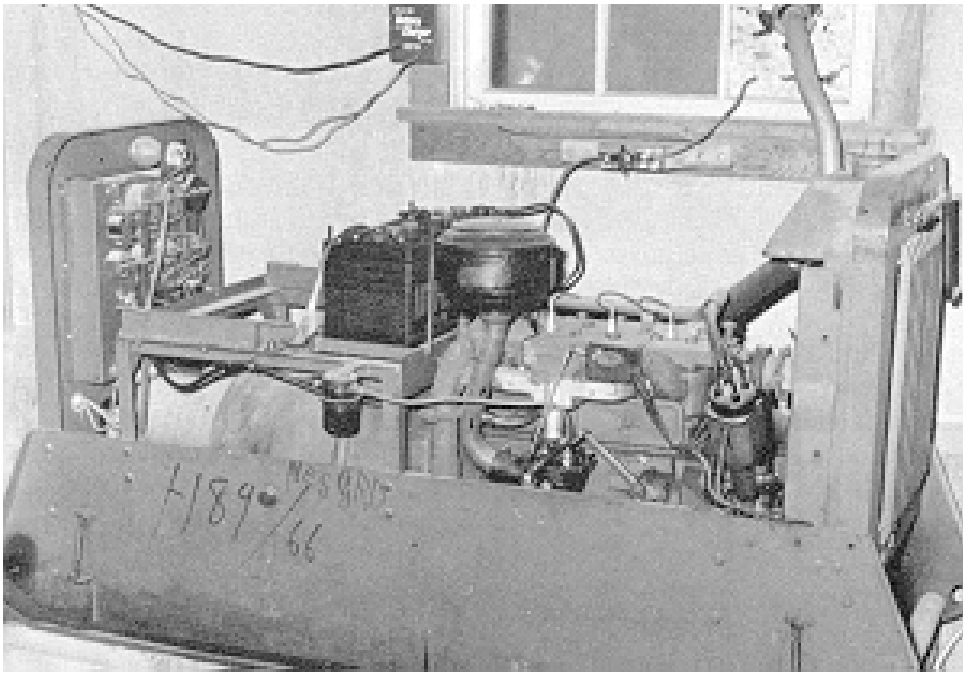

Fig. 16 Auxiliary power unit used to provide essential electricity during power failures.

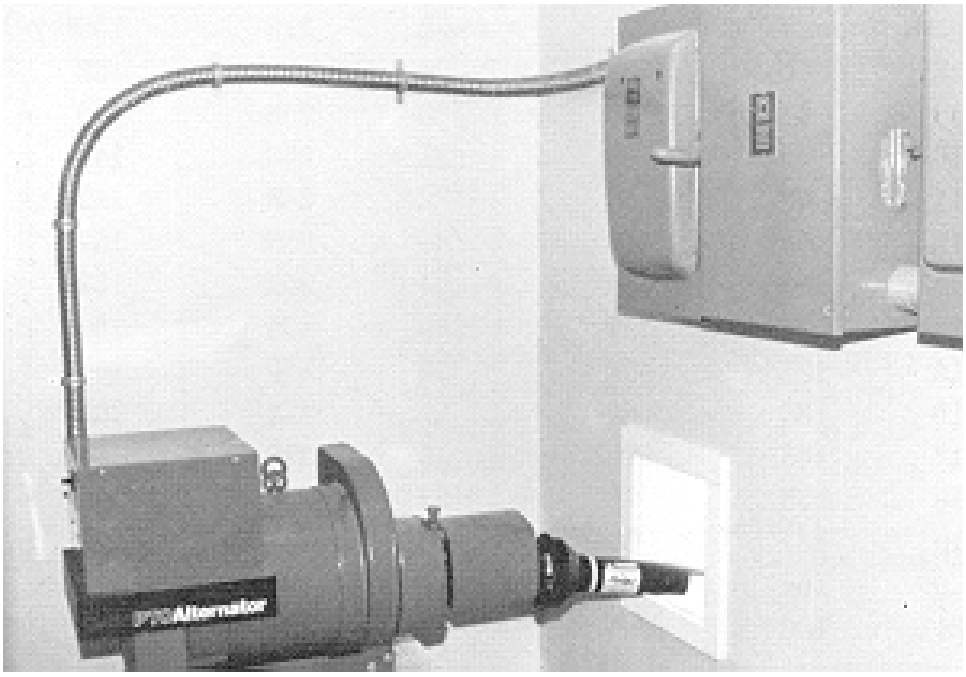

Fig. 17 Stand-by electrical generator, which can be powered by hooking it up to a farm tractor in the event of a power failure.

Feeder Space

Chickens

During the brooding period, it is important that feed and water be available at varying distance from the source of heat, so that the chicks can adjust their eating and drinking to the environmental conditions (Table 5). Several kinds of mechanical feeders are used by the industry. The amount of space to allot depends to some extent on the type of feeder used. As a general guide allow 2.0 cm per bird from 1 to 14 days, 2.5 cm per bird from 15 to 49 days, and 3.0 cm per bird from 49 to 70 days. When determining the amount of space, measure both sides of the trough-type feeder. When circular feeders are used, the linear space may be reduced by 20% because a circular feeder can accommodate more chicks at any given age than a longitudinal feeder (Figs. 18 and 19). Inadequate feeder space may contribute to an increase in the incidence of "scabby hip" syndrome.

Table 5 Daily feed and water consumption among male broiler chickens[1]

Age (days)	Water consumed per bird (mL)	Feed consumed per bird (g)	Age (days)	Water consumed per bird (mL)	Feed consumed per bird (g)
1	24	9	22	176	107
2	29	11	23	185	108
3	38	17	24	196	116
4	45	20	25	204	119
5	52	22	26	210	125
6	60	25	27	214	128
7	67	29	28	218	130
8	73	32	29	225	138
9	81	36	30	232	140
10	89	40	31	236	142
11	98	43	32	248	149
12	104	46	33	255	152
13	110	50	34	262	154
14	121	55	35	265	159
15	131	61	36	270	161
16	136	65	37	274	163
17	148	70	38	276	164
18	155	75	39	289	169
19	161	80	40	292	170
20	164	83	41	294	173
21	166	87	42	296	183

[1] Feed and water consumption are less for females and vary with environmental temperature and other factors.

Turkeys

To maintain optimum feed consumption, poults must have easy access to the feeders (Table 6). A bird should not have to walk more than 3 m to a feeder. During the first few days, place the feed on new cardboard trays. Provide two feed trays for each 100 poults. The box in which the poults were shipped may be cut down and used as a feeder. Introduce regular feeding equipment by the end of the 3rd day, or it may be used along with feed trays from the start. Remove the feed trays after the poults are eating from the regular feeding equipment. The recommended linear feeder space for poults is 3.5-5 cm of trough space from brooding to 6 weeks and 5-6.5 cm thereafter. As a guide, adjust the lip of the trough to the level of a bird's back. Many kinds of mechanical feeders are available.

Table 6 Approximate feed consumed[1] by 1000 turkey broilers with sexes intermingled, 1987

	Feed (kg)	
Age (weeks)	**Weekly**	**Accumulated**
1	99.5	99.5
2	191.5	291.0
3	323.5	614.5
4	431.8	1046.3
5	557.4	1603.7
6	694.5	2298.2
7	847.1	3145.3
8	939.4	4084.7
9	1199.4	5284.1
10	1395.6	6679.7
11	1551.2	8230.9
12	1570.0	9800.9
13	1710.2	11511.1

[1] Quantity of feed will vary with environmental temperature, strain of turkeys, and dietary program.

Fig. 18 The cylinder-type feeder is satisfactory for hand feeding.

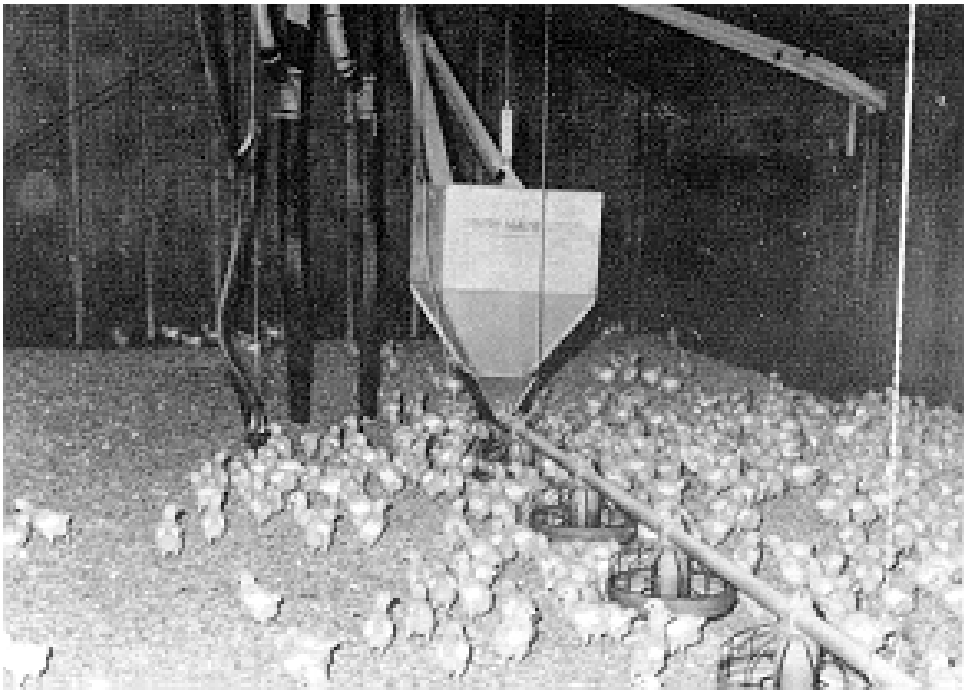

Fig. 19 Mechanical feeder used for feeding either chicken or turkey broilers.

Watering Equipment

Chickens

Hand-type waterers (4.5 L) are used for watering chicks during the first few days; to improve labour efficiency “satellite plate-type” waterers have been used. These waterers are laid out in series connected to each other and the main water source by flexible hoses. This system provides flexibility to adjust the position of waterers relative to the heat source when using cool-room brooding. Under warm-room brooding it is not unusual to start the chicks directly on the bell-type waterers. If nipple-type waterers are used it is considered advisable to use either hand-type waterers or satellite waterers prior to, and during, the introductory phase when chicks are learning to drink from the nipple waterers.

Several kinds of automatic watering systems are available. If a trough-type waterer is used, allow 1.0 cm per bird counting both sides. With circular waterers the drinking space may be reduced to about 0.5 cm per bird (Fig. 20). Recently introduced nipple-type waterers allow 10-12 broiler chickens per nipple (Fig. 21). Remember to run a broom over the nipples to activate water flow just before day-old birds arrive.

Birds need an adequate supply of clean water, as free as possible from minerals. Install a water filter of sufficient capacity and fitted with a replaceable core. The frequency of replacement will depend on the mineral and organic content of the water.

Some operators use solenoid valves on the waterlines, which are controlled by the time clocks that also regulate the lights. This system may be used with intermittent lighting so that the water is shut off when the lights are turned off, thus preventing pen flooding during periods of darkness.

Turkeys

To prevent the birds from dying of thirst when they are first placed under brooders, dip the beaks of some of the poults to familiarize them with the water and its location.

Two 4.5-L water founts for each 100 birds are recommended for starting poults. Of the automatic waterers available, the bell-shaped ones are most often used to complement the founts. The founts should remain in the pen until the poults are accustomed to the automatic waterers. Make sure that all poults find the waterers when the founts are removed. Use enough waterers to provide 1.5 m of linear water space for each 100 poults.

Disinfect the waterers two or three times a week with an iodine-, chloride-, or quarternary ammonium-based disinfectant. As a guide, adjust the level of the waterer frequently to ensure that it is level with a bird's back. This adjustment should minimize spillage and the wetting of litter around the waterers. The water should be deep enough to allow easy access by the birds, but shallow enough to minimize spillage.

Fig. 20 Bell-type, gravity-fed waterer for use by either chicken or turkey broilers.

Fig. 21 Nipple-type waterers used for providing drinking water to turkey broilers.

Environmental Needs

Brooding Temperature

The correct temperature must be used when starting broiler chickens and turkeys. Conventional (cool-room) brooding conditions for broiler chickens call for an under-hover temperature of 35°C at the level of the bird's back for the 1st week, after which the temperature is decreased by 3.5°C per week until 20°C is reached.

For turkey poults a brooding temperature of 35-37°C is considered necessary; this temperature may be advantageous also for chicken broilers when producers have less than ideal control over temperature conditions. Although the correct brooding temperature is indicated by the behaviour of the birds, thermometers should be used to guide the caretaker. If temperatures are too low, the birds will crowd together, stand up, and peep shrilly; during dark periods they may crowd together and suffocate. If the temperature is correct, the birds are active or when resting they will settle down in a uniform well-distributed pattern. Comfortable birds are quiet and uncomplaining.

If a warm-room brooding system is being used, maintaining a uniform temperature of 33-35°C during the first week is important. It is also useful to have sensitive controls, because birds have little opportunity to adjust their environmental temperature. They cannot escape from excessive heat or, when it is cold, their only means of obtaining additional warming is to crowd together, which can lead to suffocation. Environmental temperatures of less than 20°C may result in poor feed conversion. During periods of stress, such as disease, it may be advisable to alter the environmental temperature. Often brooder thermometers read incorrectly, so check the accuracy of each thermometer.

It may be advantageous to use a water-cooling device during periods of extremely warm weather, to prevent losses and maintain maximum growth, which may be critical, particularly during the later stages of the rearing period.

Birds should be protected from direct drafts from the ventilation system and from openings around windows or doors, particularly during the initial 2 weeks of the brooding period.

An important factor is the background room temperature, which is linked closely with ventilation. For cool-room brooding a room temperature of 30°C is recommended for the 1st week. It can gradually be lowered to 20°C by the 5th week and maintained at that level for the remainder of the growing period.

Ventilation

The main functions of ventilation are to remove moisture, dust, and ammonia from the building; to maintain oxygen; to keep carbon dioxide levels low; and to maintain optimum temperatures.

Proper ventilation requires careful management, because of large variations in outside temperatures from time to time and increasing requirements of broiler flocks as they age.

During the 1st week, avoid excessive ventilation. A rapid rate of air change at this time is neither necessary nor desirable, as there is a danger of chilling the young birds before they have developed enough to achieve good physiological control over their body temperature.

Generally, broiler houses are constructed so that ventilation is controlled by the use of high-speed or multi-speed fans operated continuously and thermostatically (Fig. 22). The ventilation system must let air into the building in a way that avoids drafts on the birds and yet promotes air mixing, air exchange, and dust removal (Fig. 23).

The ventilation system should have the capacity to remove from 0.54 to 3.8 m^3 of air per hour per kilogram of bird housed. The system should be able to reduce the rate of air exchange during periods of low temperature that occur in winter and maintain a minimum ventilation rate (Fig. 24).

Many different ventilation systems are available. Most may be classified into one of two types: negative or positive pressure. In a negative pressure system, exhaust fans expel air that has been drawn in through passive intakes, usually located in the opposite wall with a minimum 0.33 m^2 of inlet area per 3608 m^3/h of air exhausted capacity. The ventilation rate will vary depending largely on exterior temperatures, age of birds, and density of the flock. The hourly rate will range from 0.02 to 7.6 m^3 per broiler. With most systems it is necessary to adjust intake openings to accommodate variable conditions. Negative pressure systems are generally used in broiler buildings, although positive pressure systems are used occasionally. The positive pressure system uses fans to force air into the pen area, and air escapes or is exhausted out through ventilation openings. This method makes it easy to filter the incoming air, a decided advantage from the standpoint of disease control; it provides uniform air change without drafts.

Make some provision for emergency ventilation in the event of an electric power failure. Either provide sufficient auxiliary electric power to operate fans or install kick-out doors in the side of the building, which can be opened to allow natural airflow to prevent birds suffocating. However, take care when opening kick-out doors, because sudden exposure to high-intensity natural light may make birds extremely nervous.

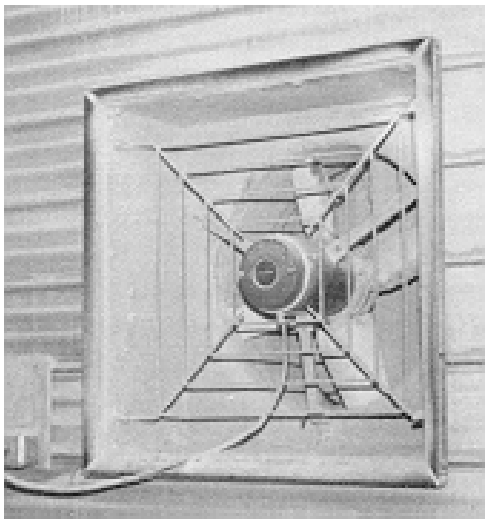

Fig. 22 Fan used for exhausting air from broiler barn.

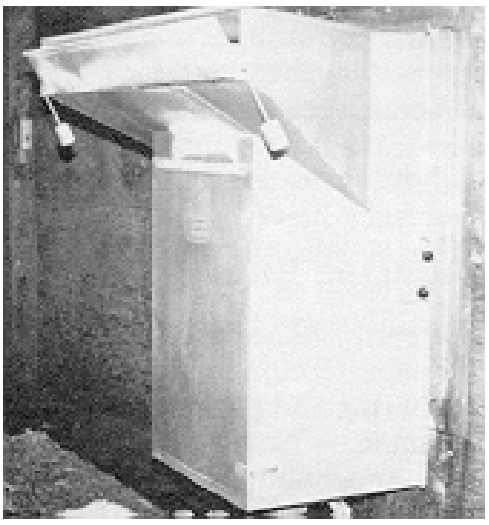

Fig. 23 Air-intake, light-trapped, Ventilation plenum used in chicken and turkey broiler barns.

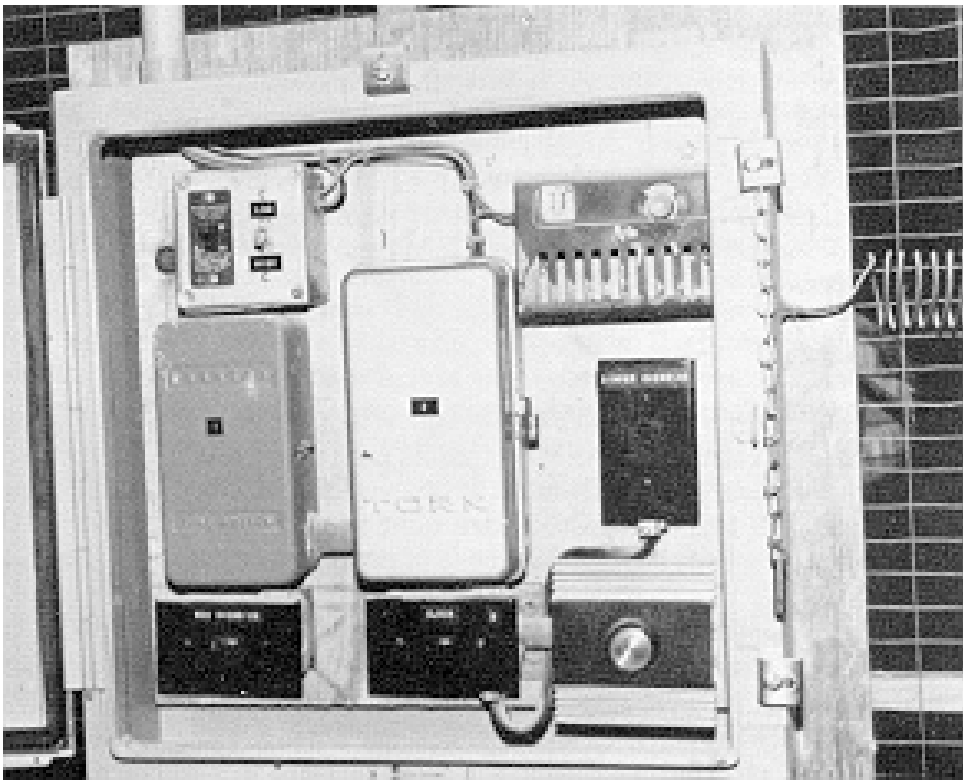

Fig. 24 Ventilation and light control panel used in a brooder house.

Relative Humidity

The performance of a broiler flock can be affected by the humidity level in the pen. Optimum humidity levels reduce dust and may promote better feathering and growth. A relative humidity of 60-70% appears to be the optimum. When dry, dusty conditions prevail, it may be useful to spray the walls and ceiling with a fine mist, using fogging nozzles, to increase the relative humidity to acceptable levels.

Floor Space

Chickens

Floor space requirements vary depending on the age of birds at time of slaughter. Flocks slaughtered at 7 weeks may be housed at 16 to 18 birds per square metre. Although it is well established that growth rate is reduced as density increases, it may pay to sacrifice some growth to obtain maximum return per square metre of floor area. A portion of a flock may be removed for slaughter as "Cornish broilers" to provide extra floor space for the remainder of the flock if the operator wishes to grow them to an older age. Inadequate floor space may contribute to the occurrence of "scabby hip" syndrome.

Turkeys

Start no more than 250 poults per group. When poults are 10 days of age, groups may be combined. Allow 50 poults per square metre the 1st week; 10 poults per square metre from 1st to 6th weeks; and 5.0 poults per square metre from 6th to 12th weeks. Extra floor space would be needed if the flock were to be kept beyond 12 weeks of age.

Litter

When using litter, cover the floor with 5 cm of high-quality, planer-wood shavings before the birds arrive. Increase the amount later to between 7.5 and 10 cm. Shavings should be large, dry curls free from wood preservative. Be sure to use fresh litter that contains no dust, molds, or foreign material such as nails. It is recommended that birds be started inside a brooder guard on planer shavings rather than on straw, particularly during the first 10 days. During the first several days ingesting the straw can cause compaction of the digestive system and death. This problem is associated more with turkey poults than with chickens. At an older age and after removal of the brooder guard, the danger of straw ingestion is greatly reduced and they could have access to straw litter providing they have easy access to adequate waterer and feeder space and uniform low light intensity.

During the growing period the condition of the litter is affected by temperature, ventilation, and type of waterers used. Avoid too much moisture in the litter, although dusty conditions are also detrimental. Skilled management is required to maintain a proper environmental balance. A cushion of reasonably dry litter helps to reduce breast blisters. It is best not to reuse old litter, because disease organisms can be carried over to the next flock.

Managerial Considerations

General

Start the brooder heating system at least 48 h before the birds are scheduled to arrive. Ensure that the system is operating properly and allow the building to become warm.

Place the birds under the brooders as soon as possible after their delivery from the hatchery. Keep disturbances to a minimum during the next 24 h to permit the birds to adjust to their new environment. Provide easy access to water as soon as possible and feed within 1 h: severe losses can result if the birds fail to find the water founts and feeders. Install cardboard guards 30 cm and 46 cm in height for chickens and turkeys, respectively, to reduce floor drafts and to prevent the birds from wandering too far from the source of heat (Fig. 25). The guards also reduce the risk of crowding. An area with no corners helps to prevent the birds from piling on and smothering. In a large pen, it is advantageous to use only part of the pen area during the first 10 days. A double-layered plastic curtain with air space between layers can be used as a partition which will reduce fuel costs with some brooding systems (Fig. 26).

Lighting Requirements

The different lighting programs used for growing broilers range from continuous light to intermittent light as day-old birds grow to slaughter age. Continuous lighting maybe hazardous, because if a power failure were to occur the flock might panic when confronted with total darkness for the first time. Therefore, managers should provide at least 1 h of darkness each day from 2 days of age to the end of the growing period (Fig. 27).

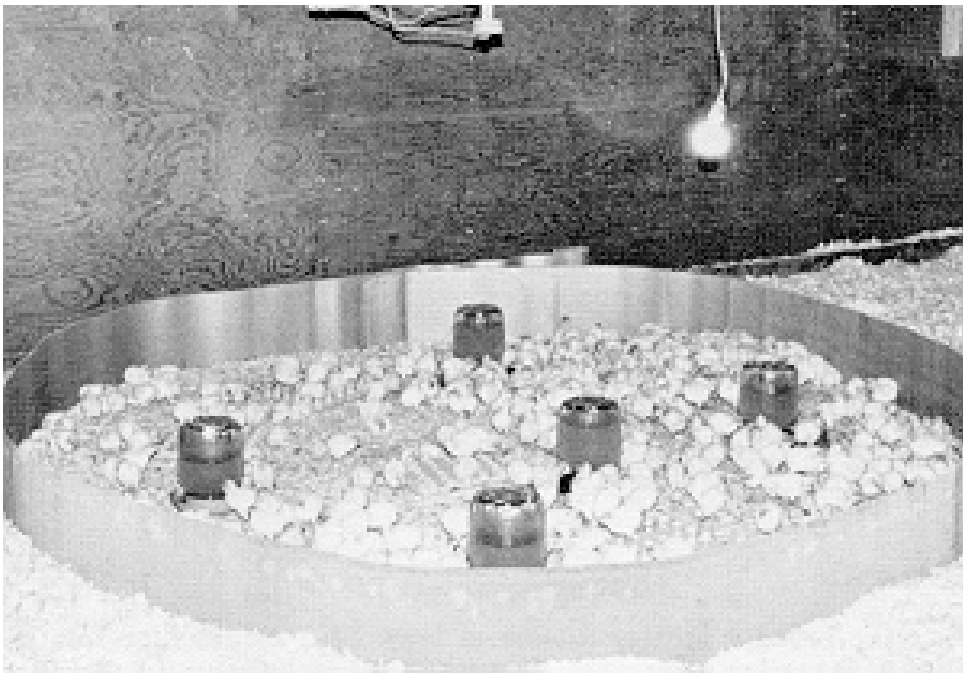

Fig. 25 Brooder unit raised to show layout of waterers and feed trays for turkey broilers.

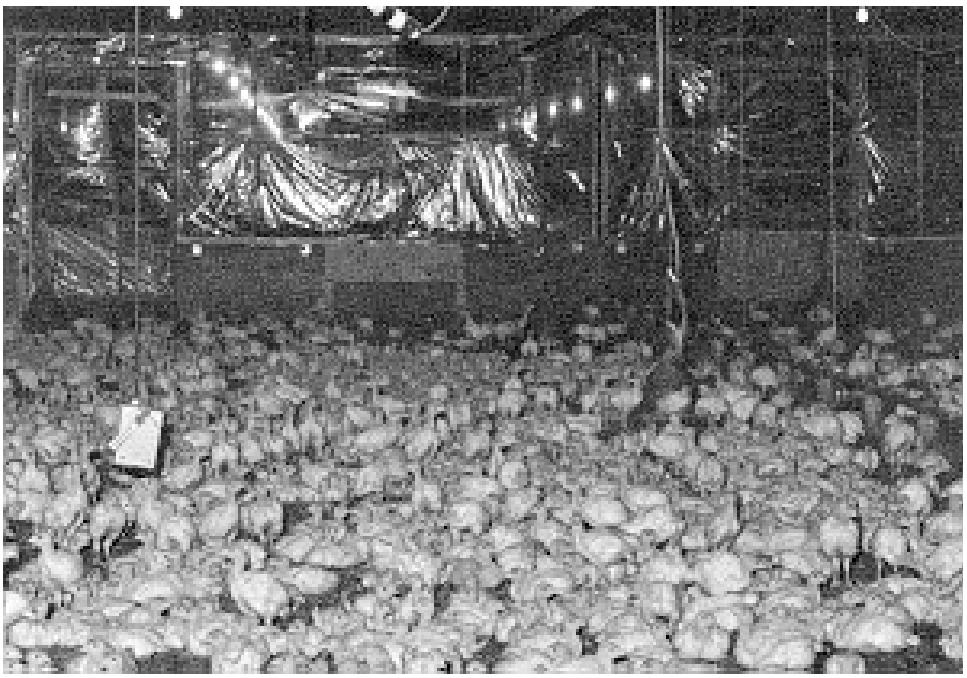

Fig. 26 Plastic curtain used to restrict the floor area during the early stages of brooding either chicken or turkey broilers.

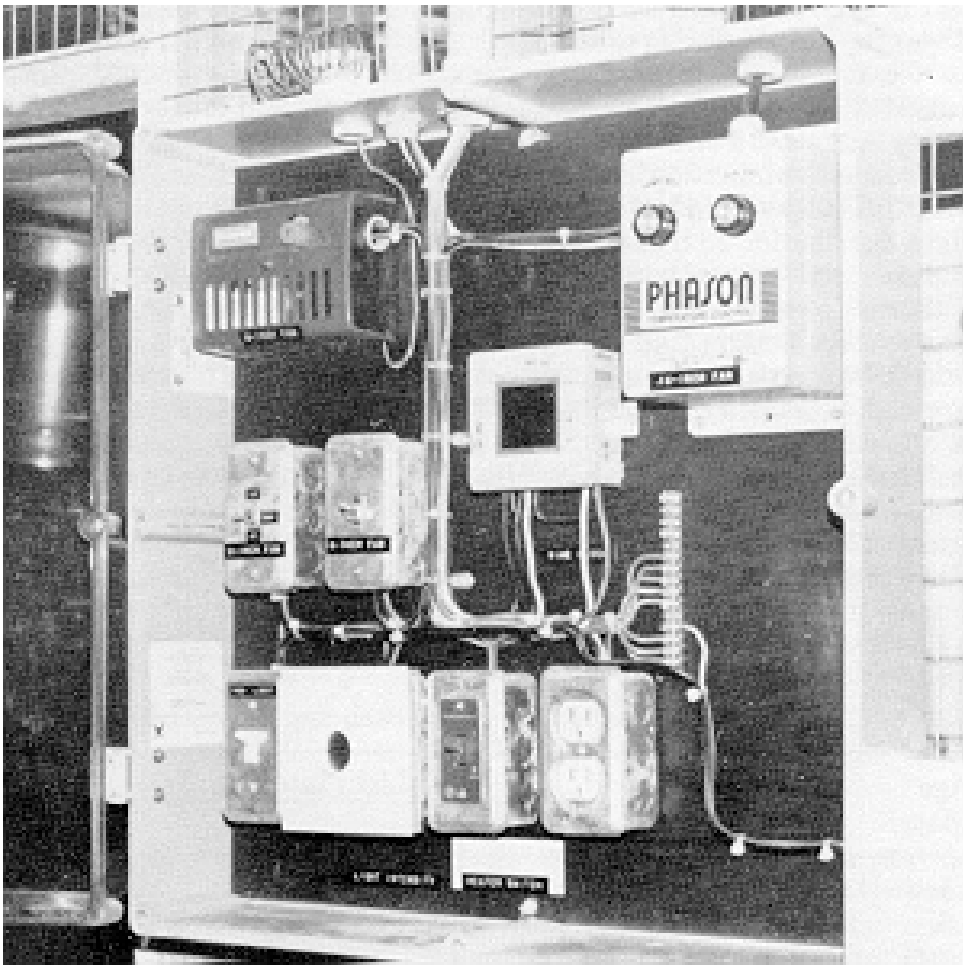

Fig. 27 Panel for controlling photoperiods, light intensity, and air change. Containing metal box is equipped with a Plexiglass cover for dust- and water-proofing during wash-up.

By excluding natural light through the use of proper light trapping at all entrances and ventilation openings, intermittent lighting may be used to advantage. The use of continuous light for the first 48 to 72 h may be followed by cycles of 4 h of light and 2 h of darkness (4L:2D) for the rest of the growing period. Recently an innovative lighting program has been used, which involves introducing a 6-h light period (6L:18D) on the 4th day with weekly increments in light of 4 h until an 18-22-h light period is achieved. A 1-h light period may be used half way into the dark period as a snack period. This program appears to support normal body weight with the advantage of significantly reducing deaths from sudden death syndrome. It is important to increase feeder space by about 10% when intermittent rather than conventional continuous lighting is used. If you are already using a continuous lighting program with good results, do not change to a new program without first consulting a poultry specialist.

Keep broilers on a fairly high light intensity of 20 lux for chickens and 35 lux for turkeys during the first 48 h. Then gradually reduce the intensity to 0.5 lux as the birds age to reduce cost of power and to control cannibalism (Table 7). Low light intensity is important for turkey broilers being reared on a straw litter, as high light intensity has been associated with excessive ingestion of straw. (At 0.5 lux a person can read a newspaper with difficulty within 1 m of the light source.) It is important to have good light distribution so that feeders and waterers are adequately lighted. To reduce electric power costs, use low-intensity lighting, provided by the use either of lower wattage lights or electronic dimmers. Rheostat dimmers are usually designed to produce heat rather than light and may not conserve electricity. Take care to ensure that electrical fittings and wiring are kept dry when the building is being washed and disinfected.

Incandescent bulbs may be used, although recently more interest is being shown in different types of fluorescent tube lighting equipped with light intensity controls. It is important to be able to dim lights to control cannibalism yet provide sufficient light for birds to locate feed and water. Fluorescent electronic dimmer controls can be used to adjust light intensity when tubes are equipped with special ballasts.

Table 7 Light-intensity schedule[1] for chicken and turkey broilers

Age (days)	Light intensity (lux)	
	Chickens	Turkeys
1-2	20	35
6	15	25
8	10	10
10	5	5
12	3	2.5
14	1	2
16+	0.5	2

[1] For use in a windowless, light-trapped barn.

Feeds and Feeding

Feed constitutes about 50% of the cost of producing broilers (Table 4). It is important, therefore, to give special attention to feeding. Since the rate of feed consumed increases rapidly with advancing age (Tables 5 and 6), it is therefore important that adequate quantities of feed are available at all times. Care must be taken to ensure that, to prevent spillage and subsequent wastage, feeders are properly adjusted as birds grow. Although a great deal is known concerning the formulation of broiler diets, there are still areas where further information would be beneficial.

The importance of protein quality and of the protein-to-energy ratio has been recognized for some time. Dietary demands of rapidly growing birds require that all nutrients must be accurately balanced for optimum performance. Unfortunately, feed ingredients vary considerably in nutrient value, thus introducing an undesirable variable into the problems of feed formulation. As a

safeguard against nutritional deficiencies, feed manufacturers select a fairly wide range of cereal grains and protein supplements as nutrient sources.

Research has shown that feed conversion is superior for broiler chickens on crumbles and pellets compared with mash. Feed texture, however, is less important for turkey broilers. The feeding of crumbles and pellets reduces the amount of feed lost in the litter compared with feeding mash. Feed wastage may be associated with having feeders too full.

Crumbled and pelleted feeds are usually purchased in bulk and stored in upright metal tanks (Figs. 28, 29, and 30). The feed is moved by auger from the storage tank to the automatic feeder or feeders. Ensure that bulk-feed tanks and augers are watertight, to prevent water leakage and development of moldy feeds (Fig. 31). If possible, locate feed tanks on the shady side of the building.

Water additives are used occasionally as "boosters" during the first 4 or 5 days, but they should only be necessary when birds have been subjected to extraordinary stress.

Chickens

Recent research conducted at the Kentville Research Station provides evidence that chicken broilers maybe grown successfully without the use of subtherapeutic dietary levels of antibiotics as growth promoters provided that chickens are fed properly balanced diets and are grown in a low-stress environment under well-managed conditions. There is probably no one best dietary formula or dietary system for the efficient feeding of chicken broilers. It has been found that the protein level of finisher diets (22 days to slaughter) may be reduced considerably without an adverse effect on weight gain as indicated in Table 8.

Turkeys

To meet the dietary demands of rapidly growing poults, all nutrients must be balanced accurately. Thus special attention must be given, particularly to the protein quality and the protein-to-energy ratio. Several different dietary regimens can probably support optimum performance. Formerly six dietary regimens were used, which were initially developed when turkey broilers were grown to older ages (15 weeks). Currently turkey broilers are slaughtered at younger ages (12 weeks or less), and thus the relatively short growing period makes it almost impractical to use more than four different diets in the dietary regimen. Recent research at Kentville provides evidence that the feeding system may be simplified by using only three different diets (Table 9).

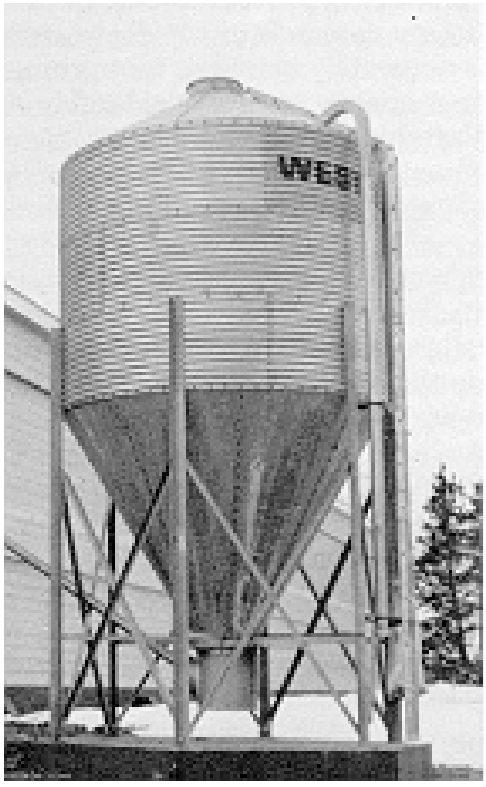

Fig. 28 Corrugated metal, bulk feed tank with centre draw.

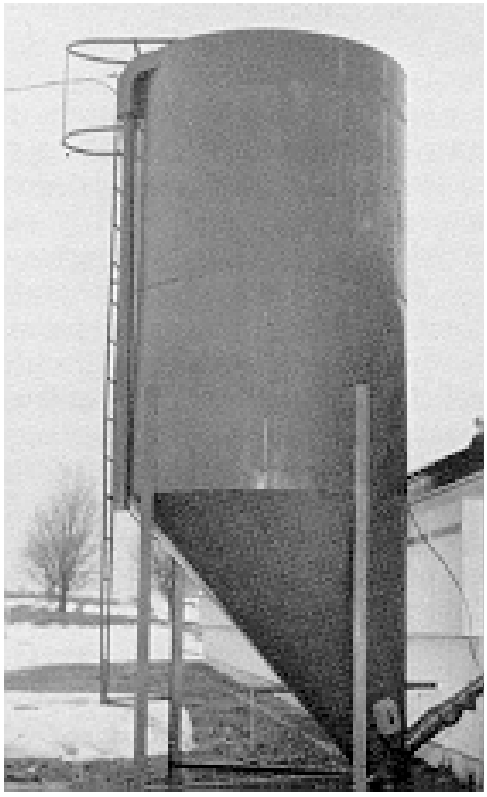

Fig. 29 Welded steel, bulk feed tank with side draw.

Fig. 30 Electromagnetic vibrator attached to all-metal feed tank prevents bridging of feed.

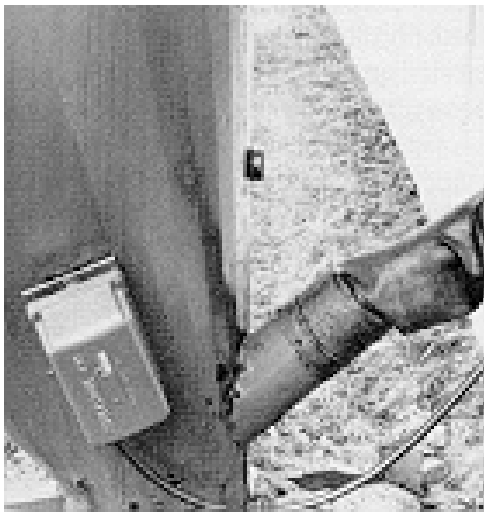

Fig. 31 Tire tube or oversized plastic pipe may be used to ensure a watertight connection between the feed auger and feed tank.

Table 8 Composition of basal diets for chicken broilers

Ingredient	Starter,[1] 1-21 days (kg/1000 kg)	Finisher,[2] 22-42 days (kg/1000 kg)
Ground corn	464.0	656.0
Ground wheat	100.0	100.0
Soybean meal (49%)	325.3	122.9
Fishmeal (63%)	50.0	50.0
Fat (poultry grease)	28.4	33.6
Salt (NaCI)	3.5	4.9
Ground limestone	11.7	12.2
Dibasic calcium phosphate	5.0	6.4
Vitamin mineral premix[3]	10.0	10.0
DL-methionine	2.1	1.9
L-lysine	-	2.1
Calculated analysis		
Protein (%)	24.0	16.0
ME (Mj kg^{-1})	12.55	13.39

1 Fed as crumbles.

2 Fed as pellets until slaughter, coccidiostat omitted from finisher during last week before slaughter.

3 Supplied per kilogram of diet: 10 000 IU Vitamin A; 2000 ICU Vitamin D_3; 8 mg riboflavin; 12 mg d-calcium pantothenate; 12 g Vitamin B_{12}; 3 mg Vitamin K; 30 mg niacin; 1 mg folic acid; 200 g biotin; 400 mg choline chloride; 15 IU Vitamin E; 5 mg pyridoxine; 3 mg thiamine; 120 mg manganese oxide (60% Mn), 90 mg zinc oxide (80% Zn); 25 mg copper sulfate (25% Cu); 500 mg calcium iodate (65% I); 220 mg sodium selenite (45% Se); 200 mg ferrous carbonate (36% Fe); 100 mg ethoxyquin; coccidiostat.

Table 9 Composition of basal diets for turkey broilers

Ingredient	Starter, 1-28 days (kg/1000 kg)	Grower, 29-56 days (kg/1000 kg)	Finisher,[1] 57-84 days (kg/1000 kg)
Ground corn	201.3	137.2	362.2
Ground wheat	228.0	398.0	351.0
Soybean meal (49%)	420.0	295.0	143.0
Fishmeal (63%)	56.0	75.0	50.0
Fat (poultry grease)	55.1	60.0	50.0
Salt (NaCI)	2.67	3.30	4.60
Ground limestone	8.13	6.20	9.50
Dibasic calcium phosphate	7.07	4.50	9.70
Vitamin mineral premix	10.00[2]	10.00[3]	10.00[3]
DL-methionine	1.73	0.80	-
Lignosol FG	10.00	10.00	10.00
Calculated analysis			
Protein (%)	29	24	17
ME (Mj kg^{-1})	11.92	12.55	12.97

1 Coccidiostat drug omitted from the finisher diets the last week before slaughter.

2 Supplied per kilogram of starter diets: 11. 000 IU Vitamin A; 2 000 ICU Vitamin D_3; 6 mg riboflavin; 12 mg calcium pantothenate; 20 g vitamin B_{12}; 40 mg niacin; 2 mg Vitamin K; 20 IU Vitamin E; 800 g folic acid, 250 g biotin; 2 mg thiamine; 4 mg pyridoxine; 300 mg choline chloride; 500 mg ethoxyquin; 117 mg manganous oxide (60%); 106 mg zinc oxide (72%); 30 mg copper sulfate (25%); 400 mg sodium selenite (45%); coccidiostat.

3 Supplied per kilogram of grower and finisher diets: 8000 IU Vitamin A; 1500 ICU Vitamin D_3; 5 mg riboflavin; 9 mg d-calcium pantothenate; 15 g vitamin B_{12}; 35 mg niacin; 2 mg Vitamin K, 15 IU Vitamin E; 600 g folic acid; 200 g biotin; 1.5 mg thiamine; 3 mg pyridoxine; 300 mg choline chloride; 500 mg ethoxyquin; 117 mg manganous oxide (60%); 106 mg zinc oxide (72%); 30 mg copper sulfate (25%); 400 mg sodium selenite (45%), coccidiostat.

Further information on feeds and feeding is available from agricultural colleges, provincial extension services, research stations of Agriculture Canada, and feed manufacturers.

Separation of Sexes

Day-old sexing of birds has become a popular practice. Broilers are often sorted into male and female lots at hatching time. Chicken broilers may be sexed by vent, colour, or rate of feathering (Fig. 32). The last two methods are possible only if parental stocks were specially selected and mated.

Turkey poults may be sexed by vent. When sexes are housed separately it enables the producer to feed diets that have been especially formulated for each sex and to market the two sexes at different ages to provide birds of specific weights required by the market. Furthermore, it is much easier to control the height of feeders and waterers when the sexes are raised separately. Research shows that intermingling the sexes appears to have no detrimental effect on growth if adequate floor space is provided per bird. If the floor space is reduced, the growth. rate of females may be adversely affected.

Fig. 32 Separating males and female chicks at hatching for an examination of the rate of feathering.

It is not considered practical to remove males from an intermingled flock at an earlier age than the females. On the other hand, if the two sexes are separated by a partition, the males may be removed first and the females may be given the extra floor space and retained longer for heavier weights.

Cage Rearing of Broiler Chickens

A limited number of chicken broilers are being grown commercially in cages in an attempt to increase the number of birds being housed per square metre of building space, to eliminate litter material, and to increase labour efficiency. As far as the authors are aware no attempt has been made to grow turkey broilers in cages on a commercial basis.

Research is being conducted with chickens in an attempt to solve problems associated with rearing broilers in cages. These problems include breast blisters, leg weakness, brittle bones resulting in broken wings, enlarged feather follicles, and cannibalism. Most of these conditions have been experienced with floor-reared broilers but to a lesser degree.

Most cages, house 10 or 12 chicken broilers allowing about 450 cm^2 per bird. By stacking the cages three or four high, bird density can be increased considerably.

Researchers have reported that the incidence of breast blisters can be reduced by the use of a plastic fabric floor. It is hoped that problems associated with skeletal weaknesses (primarily leg weaknesses) can be solved by the use of a diet specially formulated for raising broilers in cages. It is quite possible that poultry breeders could develop a bird that is specially adapted to a cage environment. As discussed previously, debeaking can be used to control cannibalism.

Some trials have been conducted with a specially fabricated cage that can be shipped to the processing plant; thus broilers are grown in the same cage in which they are shipped for slaughter. To date, results from these trials are inconclusive.

Controlling Cannibalism

Cannibalism can become a serious problem in a broiler flock. It usually begins by birds picking tail feathers, toes, and vents and eventually progressing to other parts of the body.

Cannibalism is caused by a combination of stress conditions. Among the most common of these are overcrowding, excessive light intensity, insufficient ventilation, overheating, inadequate feeder and waterer space, nutritional deficiencies, or being without feed or water for too long.

When they can be identified, it is relatively simple to alleviate these causes of cannibalism. Unfortunately, once cannibalism has started in a flock it is hard to control. It is easier to prevent in a windowless house where light intensity can be reduced to a low level or red lights can be used. In windowed houses, debeaking may sometimes be necessary.

Debeaking, when properly done, has no detrimental effect on bird performance. Actually, some evidence indicates that general bird performance is improved by debeaking. Birds may be debeaked after 14 days of age by cutting off one-third of the beak using a commercial hot-blade-type debeaker (Fig. 33). Follow directions supplied by the manufacturer of the debeaker.

A conventional electric debeaker is still generally used. However, a laser-type debeaker has recently become available that enables poults to be debeaked at day-old by making a laser mark on the upper mandible, which sloughs off after a couple of days. This method appears to reduce the degree of stress associated with the use of the electric debeaker. Medication may be administered to the birds, under the direction of a veterinarian or poultry specialist, to counteract the stress associated with the operation and its aftereffects.

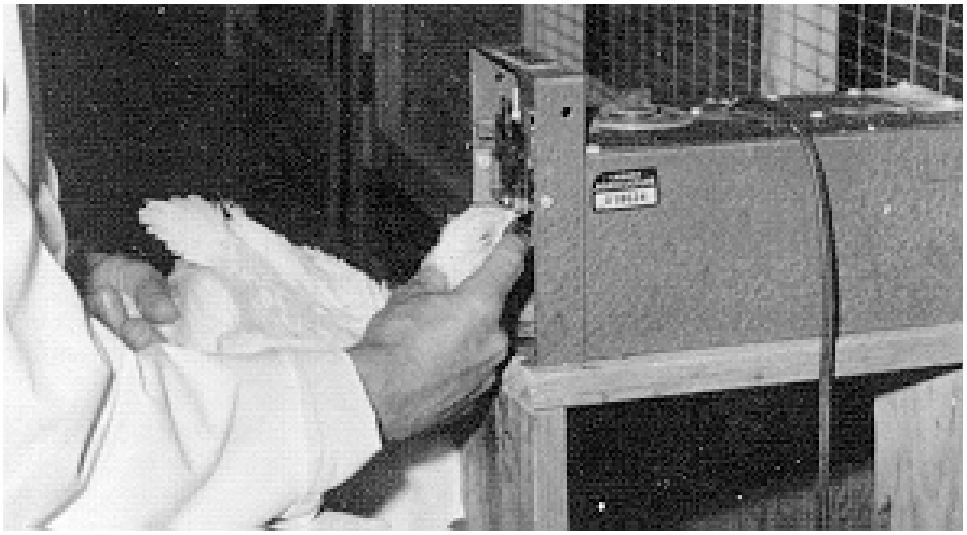

Fig. 33 Debeaker used to control cannibalism.

Maintenance of healthy flocks

Checklist for Prevention of Disease

1. Following the removal of the broiler flock for slaughter, remove all litter material; wash the building and equipment with a high-pressure sprayer, and disinfect the building and equipment.

2. Use fresh clean litter, preferably planer shavings from wood that has not been treated with wood preservatives.

3. House only birds of the same age in each building, because disease can spread from older to younger birds quite readily.

4. Isolate broiler flocks away from other birds, rodents, and human visitors to prevent introducing diseases to the premises.

5. Ensure that drinking water is fresh and free of undesirable minerals or other contaminants. If quality of water is suspect, have it tested in a laboratory. Consult your poultry specialist or veterinarian.

6. Follow a conventional feeding program. Ensure that feed storage tanks and conveyors are kept clean and free of caked and or moldy feed. Make sure that there are no water leaks from rain into feed tanks or storage bins. Store feed for no more than 4 weeks on the farm because nutrients especially vitamins can deteriorate.

7. Examine the flock carefully each day and remove any sick or dead birds.

8. Manage ventilation carefully to ensure that the air change system is adjusted to accommodate the age of the flock as well as prevailing weather conditions.

9. Contact your veterinarian or poultry pathology laboratory if a disease problem is suspected.

Disease Control

General Considerations

It is important to obtain broiler stocks from reputable sources where strict control measures are used to ensure that stock is free from disease. Broilers should be grown separately from other poultry in a clean, disinfected environment.

Treat the broiler flock as if it were quarantined, restricting visiting to personnel, whose job requires them to enter the building. Place a shallow pan with disinfectant at the entrance of the building to sanitize footwear. It is advisable to keep the building locked at all times. For the same reasons, the caretaker should not enter other poultry buildings.

Keep the area around the barn clean, neat, and free from manure and debris that can harbor disease organisms and rodents. Exclude rodents and wild birds by screening ventilation openings and drains, keep doors tightly fitted and closed, to prevent these pests from entering the building. Rodenticides (Poisons) may be used in areas away from the birds if rats and mice are a problem. Cats may be used to control rodents in poultry houses.

Check the flock daily for sick or dead birds. Have dead birds examined promptly by your veterinarian or sent to a pathology laboratory. Along with specimens, provide a written, detailed flock history. Dispose of dead birds by incineration or place in a disposal pit.

Diseases of chickens

Omphalitis This bacterial infection of the yolk sac is caused by contaminated hatching eggs, unsanitary hatchery conditions, or both. It occurs during the 1st week of life and is characterized by chicks with an enlarged abdomen (mushy chick) and high mortality. Postmortem may reveal an unhealed navel and a distended, discoloured yolk sac with foul-smelling contents. Microbiological culture will reveal the contaminating organisms (such as *Escherichia coli*, *Pseudomonas*, or *Streptococcus*). Treatment with antibiotics may be helpful in preventing the spread of infection in the flock (Fig. 34).

Starve-out Insufficient intake of water or feed is characterized by small, weak, dehydrated chicks. Crop and intestinal tract are empty, the liver is yellow, and the gall bladder is distended. Mortality rises in the first 7 days. Provide the correct brooding temperature, lighting, and satisfactory supplies of feed and water.

Fig. 34 Pump and tank used for injecting medicated solution into the drinking water system

Sudden death syndrome ("flip-over") This disease, which strikes as early as 2-4 days of age and peaks at about 3 weeks, is characterized by the sudden death of large, fast-growing birds, especially males. The birds are usually found lying on their backs and, aside from the association with fast growth, the cause has yet to be proven. Lowering the light intensity and reducing growth rate may be effective in reducing mortality.

Necrotic enteritis This disease is caused by *Clostridium perfringens* and is associated with high-energy feeds. It is characterized by a rising rate of mortality, which increases over 2-3 days. The distended small intestine contains brown, granular debris. Treat by adding antibiotics to the water. The condition may be prevented by adding antibiotics to the feed.

Enteritis (intestinal infection) This infection is caused by bacteria other than *C. perfringens*. Symptoms are weak, depressed birds and diarrhea in any of the first 3 weeks of life. After identifying the causal agent, treat preferably by adding antibiotics to the water.

Leg weakness Leg problems resulting in loss of broilers from lameness may be caused by infectious agents, nutritional imbalances, or environmental stress. Some stocks may be genetically predisposed to leg weakness. Characteristic lameness is associated with the vertebral column, leg bones, joints, and tendons. Infectious problems may be controlled by chick maternal antibodies to viruses and antibiotic treatment for bacterial pathogens. Nutritional imbalances involving calcium or phosphorus, or both, may result in leg problems.

Ascites This problem is increasing in broiler chickens; commencing at 3 weeks of age, birds fail to grow, appear weak, or simply are found dead. The condition. is caused by right-sided heart failure with a subsequent accumulation of fluid in the abdomen. To help control this condition, reduce growth rate, improve ventilation, and provide a satisfactory environmental temperature.

Coccidiosis This intestinal infection is caused by protozoan organisms, which can attack different sections of the intestine. The intestine and ceca are swollen and may contain bloody material. The rate of mortality increases after the 1st week and any time thereafter throughout the growing period. Treat by adding anticoccidial drugs to the water. Broiler rations should contain preventative coccidiostats. Check the feed label to ensure that correct withdrawal procedures are followed, before slaughter.

Fungus infection or brooder pneumonia This disease, usually caused by an *Aspergillus* species, is characterized by gasping and possibly nervous signs, such as circling, trembling, and twisting of the neck. It can occur within the first 2 weeks of housing and usually originates from the use of moist, moldy litter. Yellow plaques and nodules may be found on the air sacs and lungs. Brain involvement may be detected by culture and microscopic examination. There is no effective treatment, but this problem may be prevented by using mold-free litter.

Infectious bronchitis This respiratory disease, caused by a virus, usually appears after 3 weeks of age. It is characterized by swollen eyes, slight coughing, and noisy respiration. The condition is worsened by poor ventilation and adverse environmental conditions; secondary infection by *E. coli* may lead to a generalized infection (septicaernia.) and Airsacculitis. Airsacculitis, a general term used to denote infection of the air sacs, may be bacterial in origin or secondary to viral

infection. Fibrino-purulent (pus) material may be present on the heart, air sacs, and liver. Use antibiotics in the water or feed to treat the secondary bacterial invasion. Vaccines may be used to prevent the condition.

Infectious laryngotracheitis This disease is characterized by sudden coughing, swollen eyes, gasping, and elevated mortality. Death usually results from asphyxiation caused by a trachea occluded with clotted blood. There is no effective treatment. Prevention consists of isolation and avoidance of multi-age or backyard flocks. It is advisable to use a vaccine in heavily contaminated areas.

Newcastle disease This disease can cause respiratory symptoms similar to *infectious bronchitis* but with nervous signs, and high condemnations because of secondary infection with *E. coli*. It may be prevented by strict isolation and sanitation. Vaccines are advised in heavily contaminated areas.

Infectious bursal disease (IBD) IBD caused by a virus, can damage the immune system and increase subsequent susceptibility to disease. This syndrome of immune suppression occurs if birds are without an effective antibody level against this condition and are exposed early in the growing period. A second classical condition produces listless, depressed birds, watery diarrhea after 3 weeks of age. An enlarged, wet bursa occurs during the first 24 h of infection. Later the bursa shrinks and is smaller than normal for bird of a given age. The vaccination of parental stocks for the IBD virus enables them to transmit protection to their progeny.

Marek's disease This tumorous disease is caused by a virus. It can result in high mortality, as well as a high rate of condemnations among older broilers and roasters at the time of slaughter. It is characterized by tumours in the skin and internal organs. Although broiler chicks are vaccinated (Fig. 35) in the hatchery at 1 day of age, they must still be raised with a low exposure to the virus to prevent the problem. It is important to clean and disinfect broiler buildings and equipment prior to the arrival of chicks from a hatchery.

Malabsorption and stunting By 2-3 weeks of age birds are characteristically small, lame, weak, and poorly feathered. Viruses, bacteria, and toxic agents are implicated. There is no effective treatment, stringent sanitation is the primary means of control, coupled with vaccination of the parent flock.

Fig. 35 Using an automated vaccinator for inoculating chickens with vaccine for the prevention of Marek's disease.

Diseases of turkeys

Fungus infection Usually originating from damp, contaminated litter, this disease infects the lungs and air sacs. This condition, referred to as brooder pneumonia, attacks the young poults and causes high mortality. Postmortem reveals yellow nodular plaques on the lungs and air sacs. Remove the offending litter material to control the condition. Use clean, fresh planer wood shavings as a litter material rather than straw.

Mycoplasma meleagridis (MM) MM originates via the egg from parent breeders (most breeder flocks are now free from this infection). Small, yellow-to-white, circular areas are found on the air sacs. Crooked necks and leg weakness may also occur. This disease does not cause high mortality but can reduce flock growth and feed efficiency.

Airsacculitis (Septicaemia/toxemia) *Escherichia coli* infects the air sacs, the heart sac, and the abdominal cavity. This organism is opportunistic and usually secondary to other organisms or

environmental stress factors. The air sacs, heart, and liver may be covered with a yellow fibrinous material. Unclean drinking waterers are frequently a source of the infectious bacteria.

Alcaligenes/Rhinotracheitis This acute, persistent, contagious, upper-respiratory disease is characterized by eye and nasal discharge. It is caused by a bacteria on which antibiotics have little effect. Provide good ventilation and ensure that premises are properly cleaned and disinfected. This disease has only been identified in a few locations in Canada.

Arizonosis (arizona hinshawii) This egg-transmitted disease is characterized by listlessness, pasted diarrhea, trembling, occasional blindness, and nervous symptoms. Treatment with antibiotics may be beneficial, but mortality can be high.

Transmissible enteritis A virus causes this highly infectious disease of poults, characterized by failure to eat, diarrhea, and dehydration. There is no effective treatment; mortality can be high.

Hemorrhagic enteritis This virus disease of young turkeys (6-12 weeks of age) produces the sudden onset of bloody diarrhea and depression. There is no effective treatment for this disease. Mortality can be high. Vaccinations may be used on farms where this condition is a problem.

Coccidiosis A protozoan disease occurring in all poultry, with the turkey having its own species. Control is similar to the program used for chicken broilers.

Histomoniasis (blackhead) This protozoan disease, which attacks the intestinal tract and the liver, requires vectors (cecal worms and earthworms) to spread. Initial signs are yellow (sulfur) droppings, listlessness, head dark (cyanotic), hence the name blackhead. This disease can be prevented by adding drugs to the feed or water. Birds reared on soil or dirt floors may be exposed to this infection.

Fowl cholera This disease is caused by a bacteria, *Pasteurella. multocida*, which usually attacks birds over 10 weeks of age. Sudden death may be the first indication of infection. Sick birds fail to eat, are depressed, breathe noisily, and may have swollen heads as well as green diarrhea. Treatment with a sensitive antibiotic may be beneficial. Infection may be prevented by vaccination.

Field rickets This condition may be caused by a deficiency of vitamin D_3, calcium, or phosphorus, possibly related to a malabsorption problem of these nutrients. It is characterized by weakness and rubbery bones of young, fast-growing turkeys. Recovery can be rapid following treatment for nutritional deficiencies.

Dissecting aneurysm Occurs between 8 and 24 weeks of age, primarily among male turkeys. The carcass is pale with abdomen containing blood from the rupture of the aorta.

Angiopathy This condition is characterized by normal, healthy, fast-growing birds suddenly dying. Hemorrhage is found around the kidneys and beneath the capsule of the spleen. The cause is unknown.

Erysipelas This disease is caused by the bacteria *Erysipelothrix insidiosa*, a septicemic (generalized infection) disease, characterized by sudden death. Hemorrhages occur in the muscles; the bird also has a dark, congested liver and an enlarged spleen. This condition is transmissible to humans particularly during the slaughter of turkeys or handling infected carcasses. Infected flocks may be treated with antibiotics. A reliable vaccine is available for prevention.

Round heart This condition, involving 2-4 week old poults, is characterized by an enlarged, flabby, round heart. Earlier reports indicated an association with high levels of nitrofurans and salt; however, in most field cases there have been no associations with these agents.

Cleaning and sanitation

After the broiler flock has been taken from the building, remove the litter and use a broom and vacuum to remove the dust from walls, ventilation openings, and service rooms. If mealy beetles are a problem, spray insecticide over a 25-cm strip, starting at the top of the foundation, around the inside walls and posts, and increase the temperature to >30° C for 24 h. Later remove the litter. Turn off all nonessential electrical circuits and enclose all electrical controls in waterproof plastic, before washing the interior of the building and equipment thoroughly using a detergent sanitiser. Use a high-pressure sprayer and stiff broom and scraper to remove as much organic matter as possible from cracks and crevices in the pen areas and service rooms. Be sure to use plenty of water to wash away all debris.

Disinfection

After washing the building and equipment thoroughly, disinfect all interior surfaces of the building and all equipment with a high-pressure sprayer (Figs. 36 and 37). Iodophors, phenols, and quarternary ammonium compounds are effective disinfectants on surfaces that are relatively free from organic matter. Coal-tar disinfectants offer more residual activity. When mixed with oil they are a potential fire hazard. Shut off all electric power before spraying these disinfectants inside a building. As some chemicals may flavour the meat of subsequent flocks, care must be taken to air the building after disinfecting. Follow the recommendations of the manufacturer. Because chemical disinfectants are hazardous, obtain advice from a poultry specialist before using them.

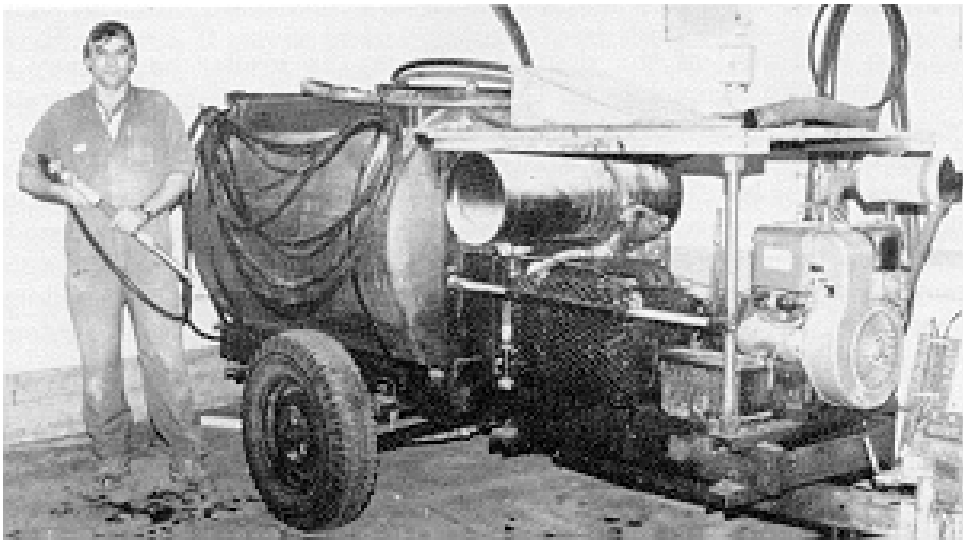

Fig. 36 A high-pressure sprayer used for washing and disinfecting broiler buildings.

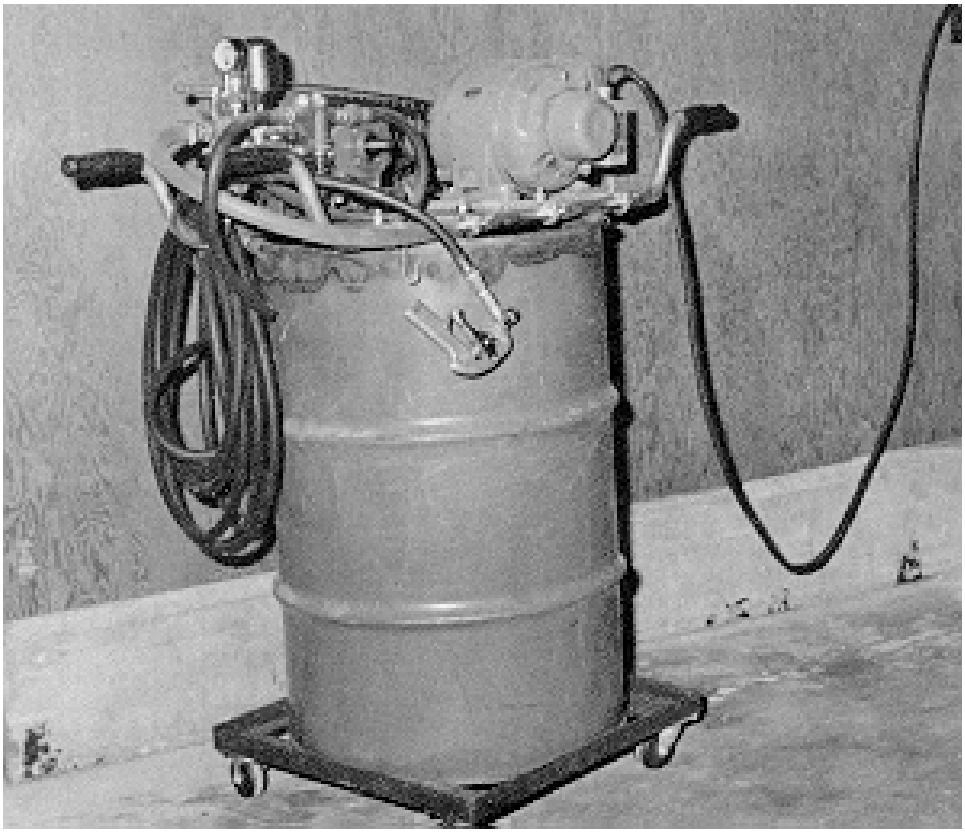

Fig. 37 A high-pressure sprayer used for washing and disinfecting poultry equipment.

Fumigation

As the final step of the cleaning process, the broiler house may be fumigated with formaldehyde. Use safety glasses, gloves, and a respirator when conducting this procedure.

If the building can be sealed reasonably well, fumigation for the control of disease may be effective. Before fumigation, tightly seal all ventilation openings and doors to delay the escape of the fumigant. Fumigation can be achieved by using 525 mL of formalin with 240 g of potassium permanganate per 100 m^3 of air space. Following fumigation the building should be closed for 24 h. Because fumigants are extremely hazardous, obtain advice from a poultry specialist before using them.

Use all fumigants and insecticides according to directions provided by the manufacturer.

Disposal of dead birds

Dispose of dead birds by burying them in a disposal pit or by incineration to prevent insects, dogs, cats, and wild birds from spreading disease to other farms or to other flocks on the same farm. Check with your provincial department of agriculture for regulations on the disposal of dead birds.

Marketing broilers

Most broilers are marketed when chickens are between 5 and 6 weeks of age and when turkeys are about 10-11 weeks of age. Broilers grown to an older age require more floor space, the incidence of breast blisters usually increases, and mortality and condemnations are generally higher. Age at slaughter depends to some extent on market demand.

Although broilers are marketed throughout the year, consumer demand for chicken broilers is greatest during June, July and August and for turkey during Thanksgiving and Christmas holiday periods. Production is adjusted to accommodate seasonal demand. Occasionally broilers are frozen and stored during the fall and winter for the summer trade. The sale of frozen broilers has not become a general practice in certain regions of Canada apparently because of consumer resistance. Consumers have become accustomed to buying chilled (unfrozen) broilers and resist the purchase of frozen birds, even though they often freeze them once they get home.

Shipping

Feed is usually withdrawn from broilers 8-10 h prior to crating; however, in some circumstances it may be necessary to lengthen the feed withdrawal period, particularly for turkeys.

Because broilers bruise easily they must be handled gently when being removed from the broiler house for shipment to the processing plant. Make sure that the handling crews are familiar with the best methods of handling birds. It may be advantageous to catch the flock under a blue light because the birds cannot see well in this light. The birds may have to be crated at night if the house has windows. Remove or elevate feeding and watering equipment before catching the birds to keep them from being bruised during the exercise. Corral the birds in small groups to prevent smothering and injury. Do not force the birds into a crate or drag them over crates. Handle the crates carefully after they are filled and do not drop them. It is a good practice to have crates loaded on pallets so that they can be moved gently with a pallet hoist.

Make sure that live birds are well protected from extreme temperatures while they are being trucked to the processing plant. In cold weather, provide shelter to prevent chilling, which can result in poor bleeding and downgrading of carcasses after slaughter. During warm weather, protect the birds against overheating during shipment by using open crates and by trucking them directly to the processing plant without stops en route. At the plant, keep them under cover away from direct sunlight in an adequately ventilated area.

Processing

The slaughter and preparation of broilers for marketing is an assembly-line operation conducted under sanitary conditions. Usually, the processing procedure follows this sequence of events:

1. After unloading and weighing (Fig. 38), each bird is shackled to a conveying chain.
2. The birds are usually rendered unconscious by an electric shock and bled by severing the jugular vein.

3. After bleeding, the birds are conveyed for about 1 min through a hot-water tank operated at about 61°C.
4. Birds are then conveyed through a rougher, which. removes the feathers.
5. The carcasses then go through a special machine to remove remaining pinfeathers and cuticles, which can also be done by hand.

On the eviscerating line, the carcasses and exposed viscera are inspected by a health inspector (Fig. 39), and kidneys, lungs, head, and feet are removed. After being graded, the carcasses are eviscerated (Fig. 40) then pass through a cooling tank containing iced water[2]. Some carcasses are cut into parts (Figs. 41 and 42). Other carcasses are sorted by weight and prepared for delivery to the consumer market (Figs. 43 and 44).

Not all broilers in a flock are Canada A birds (Table 10). Some are downgraded into Canada B (Table 10), Utility (Table 11), and C (Table 11). Females usually grade higher than males. A reasonable goal is to have 75% of the birds of Canada A quality. If a flock fails to meet these standards, review the entire production program and take corrective measures.

One of the main concerns of broiler growers is the number of birds condemned for human consumption at the processing plant.

[2] Air chilling provides an alternative method for cooling the carcasses.

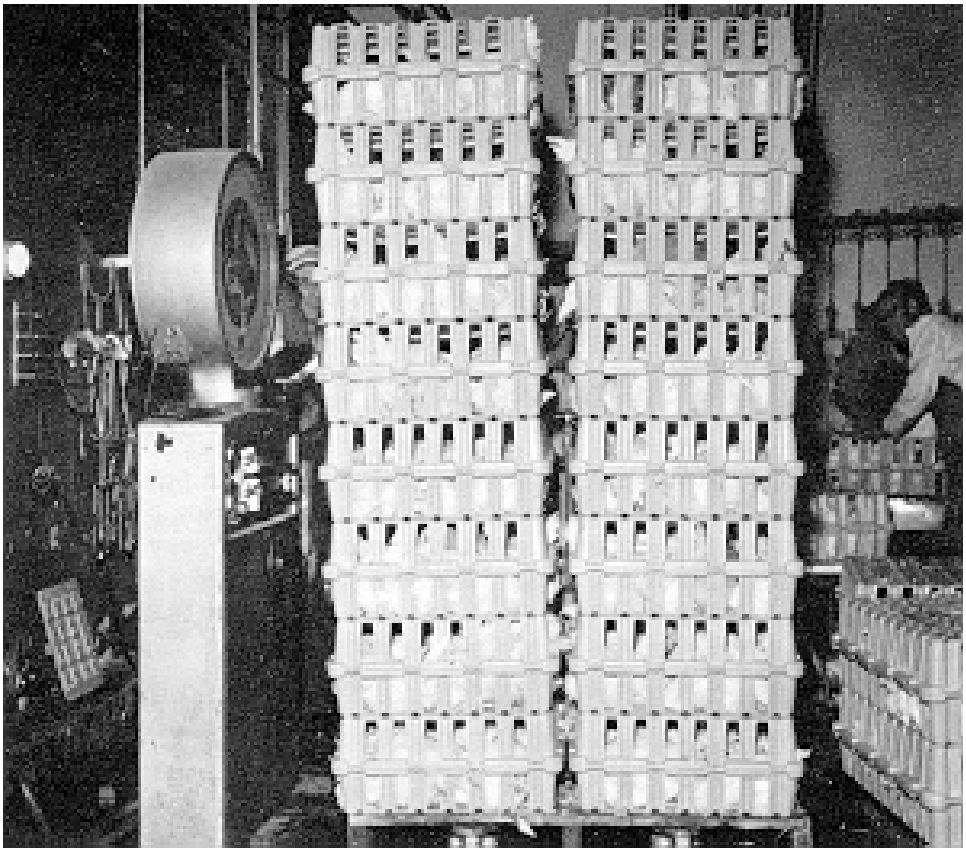

Fig. 38 Weighing broilers at the processing plant.

Condemnations may result from mismanagement, respiratory ailment, and other disorders. Frequently, downgrading and condemnations are the result of bruising through mishandling of birds during catching, loading, and transporting to the processing plant. Improper bleeding, overscalding, and intestinal rupture during processing also result in condemnation. Broiler growers and processors must strive to minimize condemnations, which represent a direct monetary loss to all concerned.

Carcass composition, quality, and flavour can be affected adversely by dietary and environmental factors. Decreased tenderness may result if growing birds are allowed too much floor space, or if carcasses are cut up while still warm. Meat may become rancid if stored too long or kept at improper freezing temperatures.

The grade standards apply to poultry sold at the retail level and are subject to change from time to time. In addition, processed poultry maybe graded Canada Canner if the carcass meets the requirements of processed poultry graded Canada A, B, Utility, or C, except that (a) both legs including the thighs, (b) area of skin including one-half the area of the breast, and © an amount of flesh not exceeding one-half the flesh from the breast, may have been removed.

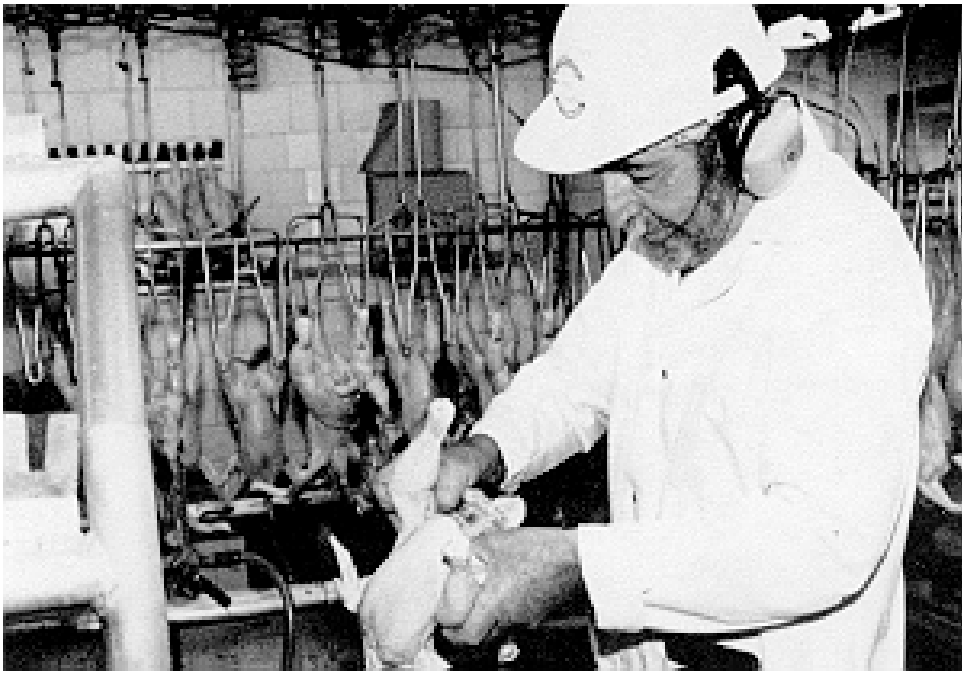

Fig. 39 Veterinarian performing a health inspection on broilers during processing.

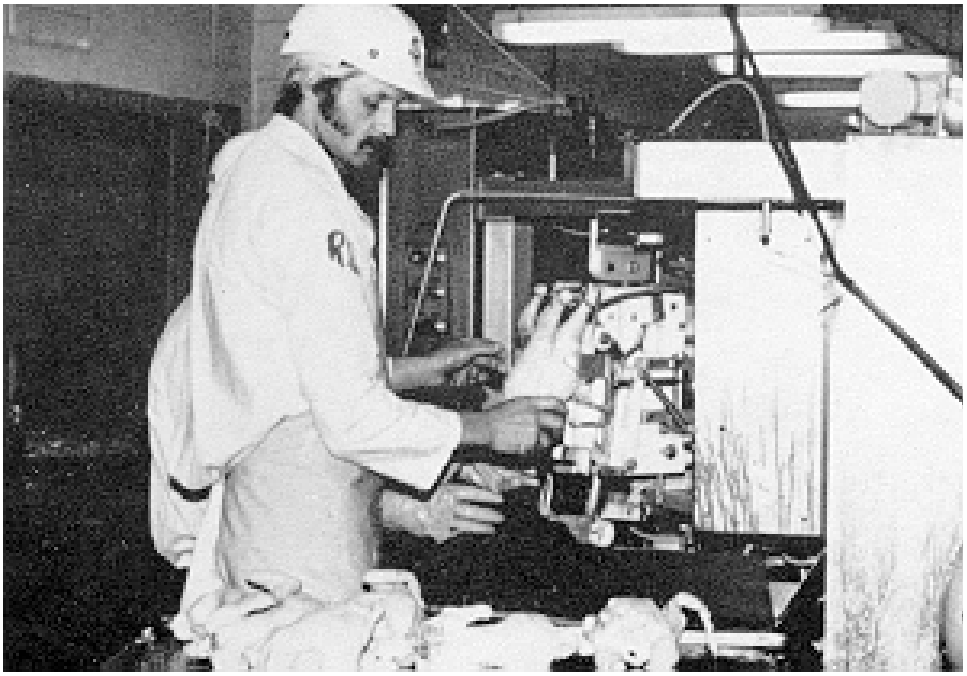

Fig. 40 Poultry carcass being eviscerated.

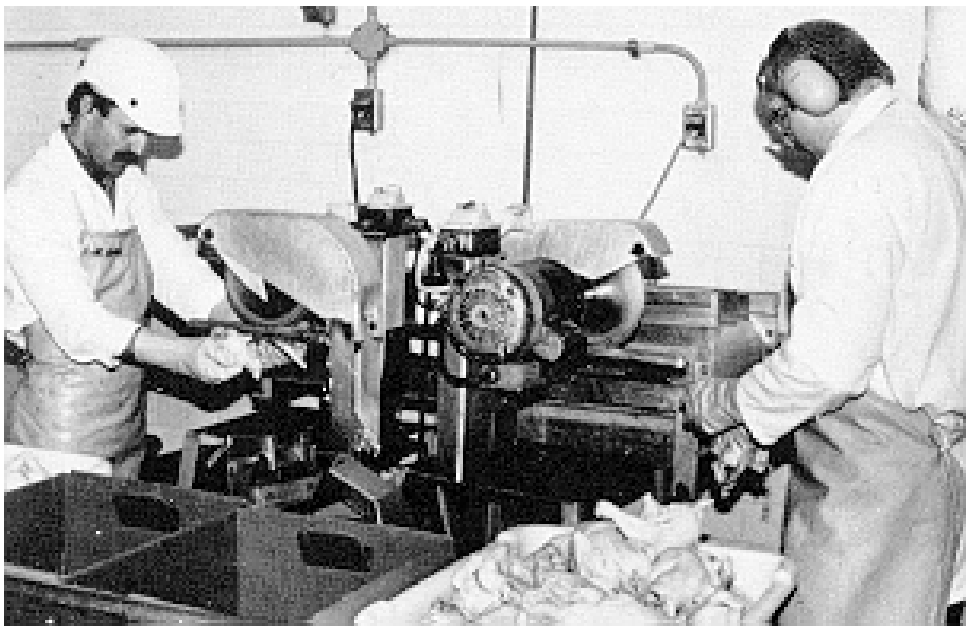

Fig. 41 Cutting up poultry for the chicken parts trade.

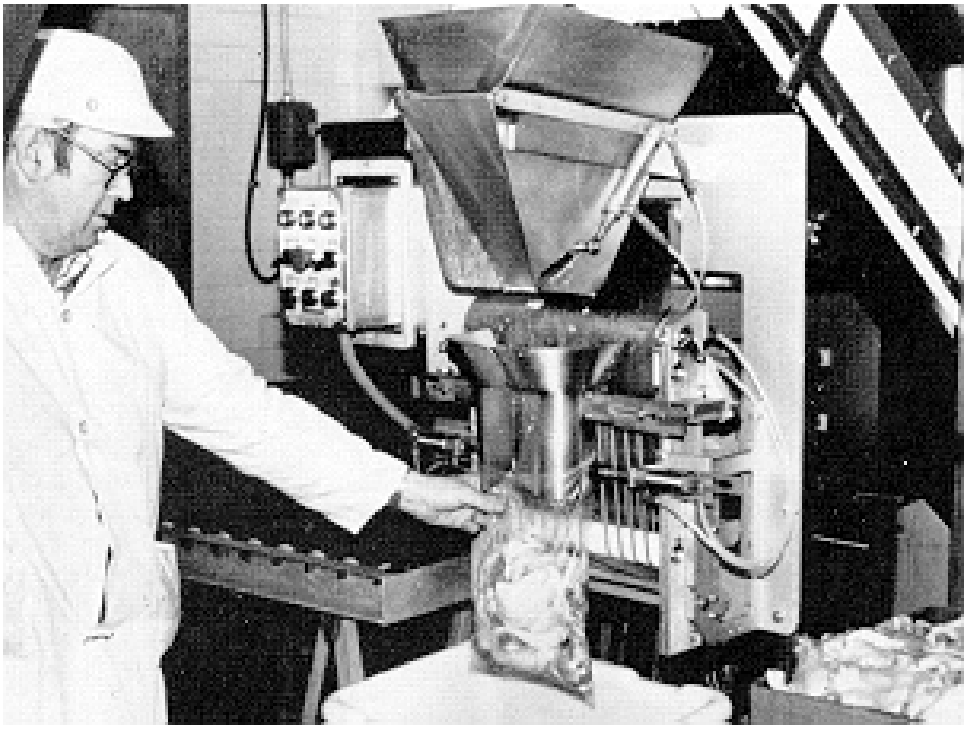

Fig. 42 Packaging cut-up poultry for market.

Fig. 43 Grading poultry for market.

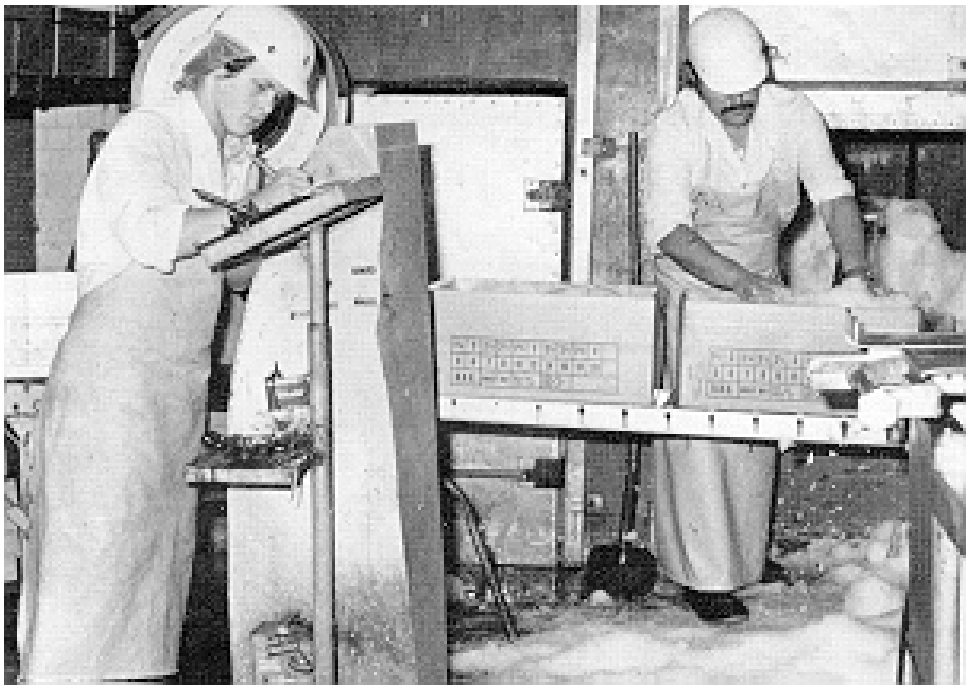

Fig. 44 Boxing dressed poultry for the retail trade.

Table 10 Excerpts from poultry grade standards for Canada A and Canada B

FACTORS **Subfactors**		**CANADA A**		**CANADA B**
CONFORMATION				
Skeletal structure		Normal Slightly crooked keel but no meat interference		Slightly crooked keel May have meat interference but no lower than A for fleshing
Curvature of backs		Moderate		Allowed
Knobby keels		Slight to moderate		Allowed
Cysts		Nil		1 small, loose and clear
Deformed backs		Nil		Nil
Blisters		Max. length 2.5 cm		Max. length 2.5 cm
FLESH				
Breast		Moderately plump Moderate taper		Sufficient to prevent sharp falling away from keel
Keel		Maximum projection anterior end 3.0 mm		Maximum projection 3.0 mm beyond flesh
FAT				
Chickens		Definite deposit base of neck Unbroken in "V" Evidence on breast and thighs		
Turkeys		Deposits main feather tract on breast Evidence by pronounced thickening at centre		Sufficient to prevent flesh from appearing prominently through skin
FLABBINESS				
Breast		Slight		Allowed
DRESSING				
Tears		*Breast*	*Elsewhere*	*Elsewhere*
Chickens	<5.5 kg	Aggreg.	Aggreg.	Aggreg.
Turkeys		length	length	length
		6 mm	2.5 cm	3.8 cm
	>5.5 kg	1.2 cm	3.5 cm	7.0 cm
Pins (Dressed)				
Breast		5		8
Elsewhere		10		16

(Continued)

Table 10 (concluded)

FACTORS Subfactors	CANADA A	CANADA B
DRESSING (continued) Discolouration		
Breast	Total area 1.6 cm^2	Total area 6.5 cm^2
Elsewhere	Total area 6.5 cm^2	Total area 8.0 cm^2
Parts-missing		
Wing tips	May be removed	
Breast bone	May be removed for poultry weighing <850 gm	
Flesh exposure	Maximum 3.0 cm exposed at posterior end of keel	Same as Canada A
Freezer burn	No deep-pitted dessication	Area of deep, pitted dessication not exceeding 14.5 cm^2
Dried-out areas	Not allowed	Not allowed
Broken and dislocated bones	None	None
Free liquid (frozen)	1.5 x allowable aggregate discolouration	1.5 x allowable aggregate discolouration

Table 11 Excerpts from poultry grade standards for Canada Utility, Canada C and Canada Canner

FACTORS Subfactors	CANADA UTILITY	CANADA C	CANADA CANNER
CONFORMATION Skeletal structure	Slightly crooked keel May have meat interference but no lower than B	Abnormal Crooked keel May have meat interference	Meets requirements for Canada A, B, Utility and C
Curvature of backs	Allowed	Allowed	
Knobby keels	Allowed	Allowed	
Cysts	1 small, loose and clear	Allowed, no max., clear	
Deformed backs	Nil	Allowed	
Blisters	Max. length 2.5 cm	Allowed	

(Continued)

Table 11 (continued)

FACTORS Subfactors	CANADA UTILITY	CANADA C	CANADA CANNER
FLESH			
Breast	Sufficient to prevent sharp falling away from keel	Sufficient to prevent extreme sharp falling away from keel	
Keel	Maximum projection 3.0 mm beyond flesh	Maximum projection 5.0 mm beyond flesh	
FAT	Sufficient to prevent flesh from appearing prominently through skin	None	
FLABBINESS			
Breast	Allowed	Allowed	
DRESSING			
Tears	Areas of skin removed not more than half area of breast Tears and cuts half the length of keel	Allowed	Areas of skin exceeding half area of the breast may be removed
Pins (Dressed)			
Breast	8	May have pin feathers	Nil
Elsewhere	16		
Discolouration	Weight		
Breast	Total area <5.5 kg 6.5 cm^2	Not exceeding 14.5 cm^2	
Elsewhere	Total area >5.5 kg 8.0 cm^2	Not exceeding 19.5 cm^2	
Parts-missing			
Wings	May be removed		
Legs	One leg including thigh or both drumstick removed		Both legs including the thighs
Tail	May be removed	Same as Canada A & Canada B (see Table 10)	
Limbs	Severed joint only		
Flesh	Small areas of flesh		An amount not exceeding half of the breast

(Continued)

Table 11 (concluded)

FACTORS Subfactors	CANADA UTILITY	CANADA C	CANADA CANNER
DRESSING Parts-missing (continued)			
Skin	Not exceeding half area of the breast		Areas exceeding half area of the breast may be removed
Back portion	Young and mature turkeys >7 kg - 6 cm max. <7 kg - 4 cm max.		
Freezer burn	Same as Canada B (see Table 10)	Allowed	Meets requirements for all grades
Dried-out areas	Not allowed		Meets requirements for all grades
Broken and dislocated bones	Wing and leg bones may be dislocated but not broken	Allowed	Meets requirements for all grades
Free liquid (frozen)	1.5 x allowable aggregate discolouration	N/A	N/A

Selected references

The authors have prepared a comprehensive list of references divided into those applicable to chickens and those applicable to turkeys. These lists are available on written request to the following: Director, Research Station, Research Branch, Agriculture Canada, 132 Main Street, Kentville, Nova Scotia B4N 1J5.

CONVERSION FACTORS FOR METRIC SYSTEM			
Imperial units	**Approximate conversion factor**	**Results in**	
Length			
inch	X 25	millimetre	(mm)
foot	X 30	centimetre	(cm)
yard	X 0.9	metre	(m)
mile	X 1.6	kilometre	(km)
Area			
square inch	X 6.5	square centimetre	(cm^2)
square foot	X 0.09	square metre	(m^2)
square yard	X 0.836	square metre	(m^2)
square mile	X 259	hectare	(ha)
acre	X 0.40	hectare	(ha)
Volume			
cubic inch	X 16	cubic centimetre	(cm^3, mL,cc)
cubic foot	X 28	cubic decimetre	(dm^3)
cubic yard	X 0.8	cubic metre	(m^3)
cubic ounce	X 28	millilitre	(mL)
pint	X 0.57	litre	(L)
quart	X 1.1	litre	(L)
gallon (Imp.)	X 4.5	litre	(L)
gallon (U.S.)	X 3.8	litre	(L)
Weight			
ounce	X 28	gram	(g)
pound	X 0.45	kilogram	(kg)
short ton (2000 lb)	X 0.9	tonne	(t)
Temperature			
degrees Fahrenheit	(^{o}F-32) X 0.56 or (^{o}F-32) X 5/9	degrees Celsius	(^{o}C)
Pressure			
pounds per square inch	X 6.9	kilopascal	(kPa)
Power			
horsepower	X 746	watt	(W)
	X 0.75	kilowatt	(kW)
Speed			
feet per second	X 0.30	metres per second	(m/s)
miles per hour	X 1.6	kilometres per hour	(km/h)
Agriculture			
gallons per acre	X 11.23	litres per hectare	(L/ha)
quarts per acre	X 2.8	litres per hectare	(L/ha)
pints per acre	X 1.4	litres per hectare	(L/ha)
fluid ounces per acre	X 70	millilitres per	(mL/ha)
tons per acre	X 2.24	hectare	(t/ha)
pounds per acre	X 1.12	tonnes per hectare	(kg/ha)
ounces per acre	X 70	kilograms per	(g/ha)
plants per acre	X 2.47	hectare	(plants/ha)
		grams per hectare	
		plants per hectare	