Chapter 8: Guidelines for Poultry Husbandry

The husbandry guidelines in this chapter are for the three major poultry species in the United States: chickens (both egg-type and meat-type), turkeys, and ducks.

FACILITIES AND ENVIRONMENT

The physical environment afforded by a poultry facility should not put birds at undue risk of injury or expose them to conditions that would be likely to cause unnecessary distress or disease (Davis and Dean, 1968; Berg and Halverson, 1985; Tauson, 1985; North and Bell, 1990). The facility should prevent bird escape and entrapment, maintain air quality by ventilation, allow the birds to keep themselves clean, minimize extremes of environmental temperature consistent with the housing system (less control is possible with open-type houses), avoid unnecessary accumulation of waste, and protect birds from unusual deleterious environmental factors (e.g., predators).

Design of the housing system should facilitate cleaning and inspection of birds on all decks without handling them, yet the birds should be easily accessible. Adequate lighting should be available for examination of all birds, and a mechanical platform or other system should be provided for examination of higher level decks, if those cannot be readily seen by attendants standing on the floor. Feeding and watering equipment also should be accessible for easy maintenance.

Chickens, turkeys, and ducks are likely to panic when sudden changes occur in their environment (e.g., a wild bird flying through the house or loud noises to which the birds are not habituated). When kept in group housing, they may trample each other and pile up against barriers or in corners with resulting injury and mortality. Therefore, such sudden changes should be prevented to the extent possible. Alternatively, young birds, which are less susceptible to such stimuli, can be habituated to conditions that are likely to be encountered and cause hysterical responses later in life.

FEED AND WATER

General recommendations for feeding and watering are covered in Chapter 2. Requirements for feeder and watering space are outlined in the text and tables in the section on Husbandry.

Feeding Programs Throughout Life

Because meat-type chickens have been bred for rapid growth to market age, obesity of breeder stocks is a problem unless energy intake is controlled beginning early in life. Feed should be allocated to maintain a recommended body weight for the particular stock and age. Rations may be either a fixed amount of feed allotted either daily or under various alternate-day feeding schemes. Procedures that require restricted feeding should have enough feeder space so that all birds can eat concurrently.

Ducks experience difficulty consuming mash because, as it becomes moist, the mash tends to cake on their mouth parts. Therefore, it is recommended that all feeds for ducks be provided in pelleted form. Pellets no larger than .40 cm (5/32 in) in diameter and approximately .80 cm (5/16 in) in length should be fed to ducklings under 2 wk of age. Pellets .48 cm (3/16 in) in diameter are suitable for ducks over 2 wk of age.

Water

Newly hatched birds may have difficulty obtaining water unless they can find waterers easily. Similar difficulties may occur when older birds are moved to strange surroundings, especially if the type of watering device differs from that used previously by the birds.

Watering cups that require birds to press a lever or other releasing mechanism involve operant conditioning. Because individuals may fail to operate the releasing mechanism by spontaneous trial and error, shaping of the behavior may be required. Thus, watering cups may need to be filled manually for several days (or weeks in some cases) until the birds have learned the process. Water pressure must be regulated carefully with some automatic devices and watering cups. In such cases, pressure regulators and pressure meters should be located close to the levels at which water is being delivered. Manufacturer recommendations should be used initially and adjusted if necessary to obtain optimal results. Automatic watering devices may require frequent inspection to avoid malfunctions that can result in flooding or stoppage. Recommendations for watering devices are given in Table 8-1.

Poultry ordinarily should have continuous access to clean drinking water. However, with some restricted feeding programs, overconsumption of water may occur, leading to production of overly wet droppings. This situation can be controlled by restricting excessive water intake, usually by limiting water availability to certain times of the day, in accordance with accepted management programs that consider the amount of time that feed is available and also environmental temperature conditions. Water may also be shut off temporarily in preparation for the administration of vaccines or medications in the water. Recommendations

TABLE 8-1. Minimum Watering Space Recommendations for Poultry in Multiple-bird Pens and Cages Recommended for Use in Agricultural Research and Teaching.

Bird type and age	Linear space[a,b]						Cups or nipples[a]	
	Females				Males		Females	Males
	(cm)	(in)			(cm)	(in)	(maximum no. birds/device)	
Chickens (all types, floor or cage)								
wk 1 (provide one 3.78-L [1-gal] or four .95-L [1-qt] chick waterers/100 chicks								
Layer-type[c] (floor or cage)								
0 to 6 wk	1.5	(.6)			2.0	(.8)	20	15
6 to 18 wk	2.0	(.8)			2.5	(1.0)	15	11
>18 wk	2.5	(1.0)			3.3	(1.3)	12	9
Breeder flocks (mixed sex, floor)								
Broiler-type[d,e]								
Turkeys[f] (floor)								
Females (three-stage rearing)								
0 to 5.5 wk	1.3	(.5)						
5.5 to 11.0 wk	1.3	(.5)						
11 to 16.5 wk	1.3	(.5)						
Males (five-stage rearing)								
0 to 4 wk					1.3	(.5)		
4 to 8 wk					1.3	(.5)		
8 to 12 wk					1.9	(.75)		
12 to 16 wk					1.9	(.75)		
16 to 20 wk					2.5	(1.0)		
Breeder females[g]								
8 to 16 wk	1.9	(.75)						
16 to 30 wk	1.9	(.75)						
>30 wk (breeder pen)	1.9	(.75 ad libitum)						
Breeder males	2.5	(1.00 restricted)						
8 to 16 wk			1.9	(.75)				
16 to 25 wk			1.9	(.75)				
>25 wk (breeder pen)			1.9	(.75 ad libitum)				
			2.5	(1.00 restricted)				
Ducks			(cm)	(in)			Cups[h]	Nipples
Brooding or growing							(no./100 birds)[h]	
0 to 7 wk			1.9	(.75)			10	15
Developing breeders								
7 to 28 wk			2.5	(1.00)			12	18
Laying breeders								
28 wk			2.5	(1.00)			12	18

[a]Assumes moderate temperatures and that males require approximately 30% more space than females.

[b]Perimeter space for round waterers is obtained by multiplying linear trough space by .8.

[c]Recommended values are for Leghorn-type chickens. To obtain values for Mini-Leghorns, multiply by .9 before 6 wk and by .75 after 6 wk; for medium weight breeds, multiply by 1.1 before 6 wk and by 1.15 after 6 wk.

[d]Because various watering systems are available, investigators should follow the manufacturer's recommendations as to the maximum numbers of birds placed per waterer.

[e]If breeder growing flocks are being restricted in water time, they must be provided full access to water for at least 3 hr in the morning, starting just before their normal feeding time. Laying flocks should be given a minimum of 8 hr of access to water, also starting just before their normal feeding time. All flocks must have continuous access to water when environmental temperature exceeds 90°F.

[f]Modified from Berg and Halvorson (1985).

[g]Space during earlier ages is the same as for market turkeys.

[h]Cups approximately 7.6 cm (3 in) in diameter and 2.5 cm (1 in) deep of the "Swish" type.

for watering space vary widely, depending on species, type, bird density, and whether water intake is restricted (Table 8-1). Waterers should be examined frequently to ensure their proper operation.

Ducks. Most conventional poultry drinkers may be used for ducks, except for cup drinkers that are smaller in diameter than the width of the duck's bill. Nipple drinkers support slightly poorer duck performance during hot weather than do trough waterers.

Ducks can grow, feather, and reproduce normally without access to water for swimming or wading, but weight gain may be improved slightly during summer months if such water is provided (Dean, 1967). If ducks are provided water for swimming or some other wet environment, they should also have access to a clean and dry place; otherwise, they are unable to preen their feathers and down properly, and the protection normally provided by this waterproof, insulated layer is lost.

SOCIAL ENVIRONMENT

Certain common social environments are particularly stressful to poultry and should be avoided as indicated in this section.

Chickens. Excessive fighting and sexual abuse of individuals showing extremely submissive behavior may occur in groups of mature males residing in floor pens. If such abuse is likely to be encountered, as when aggressive stocks are used, late adolescent or mature males should be placed in environments where those behaviors are not possible or are less troublesome: in individual cages, in multiple-bird cages with moderate density (Craig and Polley, 1977), or in heterosexual flocks with appropriate sex ratios. The proportion of mature males in sexually mature flocks should be low enough to avoid injury to females from excessive mounting. The optimal ratio in most breeder flocks is 1 male to 12 to 15 females for egg-type strains and 1 male to 9 to 11 females for meat-type chickens.

There is sufficient evidence to recommend that the number of hens per cage should not exceed 8. When group size increases to 12 or more in relatively high density hen cages, adult hen hysteria may occur in some stocks; moreover, productivity declines, and feather loss may be excessive (Hansen, 1976; Craig and Adams, 1984; Craig and Muir, 1996). Also, fearfulness and feather loss are greater in 8-hen cages than in 4-hen cages when comparisons are made at the same densities (Craig and Milliken, 1989). Significant differences in productivity and mortality with group sizes greater than 4 to 8 (density held constant) may (Al-Rawi et al., 1976) or may not be detected (North Carolina State University, 1992; Carey et al., 1995).

Repeated movement of individuals from one socially organized flock to another tends to induce stress in those individuals that are moved (Gross and Siegel, 1985). Human interactions with chickens can also contribute, either favorably or unfavorably, to the social environment of the animal (Gross and Siegel, 1982; Jones, 1994).

Turkeys. Tom turkeys are prone to excessive aggression as they become older. Early beak-trimming reduces the likelihood of injuries from fighting among toms.

Ducks. For sexually mature breeder ducks, injury to females resulting from excessive mounting by drakes may be exacerbated in the presence of other stressful conditions, such as lameness associated with foot pad trauma caused by improper flooring (discussed later in this chapter). For Pekin breeders, the ratio of males to females should not exceed 1:5 and may require periodic adjustment throughout the breeding cycle because of higher mortality rates for females than for males.

HUSBANDRY

Area and Feeder Recommendations

Use of floor area by individual birds within groups follows a diurnal pattern and is influenced by the dimensions and other aspects of the accommodation. Birds may huddle together for shared warmth or spread out for heat dissipation. They generally use less area during resting and grooming than during more active periods. When competition for feed is substantial because of limited feeder space, inhibition of feeding in subordinate birds is likely (Cunningham and van Tienhoven, 1984).

Recommendations for minimum floor area and feeder space for multiple-bird pens and cages are presented for layer-type chickens, broiler-type chickens, turkeys, and ducks in Tables 8-2, 8-3, 8-4, and 8-5, respectively. Allowances for layer-type chickens are based on extensive research. In a survey of experiments involving density effects (mostly with White Leghorn hens), Adams and Craig (1985) made multiple comparisons within specific categories for several production traits and for livability. Their survey indicated that livability and hen-housed egg production were reduced significantly when areas of 387 and 310 cm^2 were compared with 516 cm^2, amounting to reductions of 2.8 and 5.3% in livability and 7.8 and 15.8 eggs per hen housed, respectively.

Decreases in livability and other measures of well-being were also associated with high density in subsequent studies. Thus, Craig et al. (1986a,b) found that livability and egg mass were significantly lower with 310 cm^2 than with 464 cm^2; Okpokho et al. (1987) and Craig and Milliken (1989) found livability was lower at 348 cm^2 than at 464 and 580 cm^2; and Craig and Milliken (1989) found lower hen-day rate of lay and egg mass per hen at the highest density. In the same studies, however, no differences in survival and egg production measures were detected between the two lower densities. From data on plasma corticosteroid concentrations, Mashaly et al. (1984) concluded that more than 387 cm^2 of space per hen should be provided; Craig et al. (1986a,b) found that plasma corticosteroid concentrations were higher at 310 than at 464 cm^2. Similarly, feather condition was worse (Craig et al., 1986a,b), and fearfulness was greater when estimated at 40 wk of age

Table 8-2. Minimum Floor Area and Feeder Space for Layer-type Chickens in Multiple-bird Pens and Cages Recommended for Use in Agricultural Research and Teaching.

			Floor area per bird[b]				Feeder space per bird[b,c]			
Age	Kind of house	Floor[a]	Female		Male		Female		Male	
(wk)			(cm²)	(in²)	(cm²)	(in²)	(cm)	(in)	(cm)	(in)
0–6	Pen	Litter	464	(72)	606	(94)	2.5	(1.0)	3.3	(1.3)
6–18		Litter	929	(144)	1206	(187)	5.1	(2.0)	6.6	(2.6)
>18		Litter	1625	(252)	2116	(328)	10.2	(4.0)	13.2	(5.2)
		S&L, W&L	1393	(216)	1812	(281)	10.2	(4.0)	13.2	(5.2)
		All-S, All-W	1161	(180)	1509	(234)	10.2	(4.0)	13.2	(5.2)
0–3	Caged	Wire	97	(15)	129	(20)	1.0	(.4)	1.3	(.5)
3–6		Wire	155	(24)	200	(31)	2.0	(8)	2.5	(1.0)
6–12		Wire	232	(36)	303	(47)	3.0	(1.2)	4.1	(1.6)
12–18		Wire	310	(48)	400	(62)	5.1	(2.0)	6.6	(2.6)
18–22		Wire	387	(60)	503	(78)	7.6	(3.0)	9.9	(3.9)
>22		Wire	464	(72)	606	(94)	10.2	(4.0)	13.2	(5.2)
			Breeder flocks							
				(cm²)	(in²)			(cm)	(in)	
Mature	Pen	Litter		1858	(288)			10.7	(4.2)	
		S&L, W&L		1625	(252)			10.7	(4.2)	

[a]Kind of flooring: S&L, W&L = >50% slats (S) or wire (W) and <50% litter (L); All-S, All-W = all slats or all wire.

[b]Recommended values are for Leghorn-type chickens. To obtain values for Mini-Leghorns, multiply by .9 before 6 wk and by .75 after 6 wk; for medium weight breeds, multiply by 1.1 before 6 wk and by 1.15 after 6 wk.

[c]Perimeter space for round feeders is obtained by multiplying linear trough space by .8.

[d]Cages should allow birds to stand erect.

Note: During the first week, supplementary feed should be placed on some type of temporary feeders (such as egg flats) on the floor.

or older (Okpokho et al., 1987; Craig and Milliken, 1989). Using data on egg production, mortality, and serum corticosterone concentrations, Roush et al. (1989) concluded that 3 hens, rather than 4, should be kept in cages of 1549 cm² area; that is, within the goals and constraints employed, hens should have 516 rather than 387 cm² area.

Because of a relative absence of research on well-being indicators for broiler chickens, turkeys, and ducks, recommendations are based on professional judgment, experience, and the opinions of recognized authorities. Generally, area allowances are assumed to be adequate when productivity of the individual birds is optimal and conditions that are likely to produce injury and disease are minimal.

For cage housing, unless otherwise stated, it is assumed that the cages have wire, plastic-coated wire, or plastic floors, which allow the waste produced to drop through the cage. Recommended floor space excludes the space that is taken up by feeders and waterers if those are located within the cage and take up floor space. Waterers should be readily available to all birds in each cage.

Caged hens may cease egg production temporarily or birds may even undergo a molt (suggesting that they are stressed) if removed from the cages to which they have become accustomed, for example, for cage cleaning. To minimize such stress, hens and roosters may be kept in their cages for 18 mo or longer, as long as air cleanliness is maintained and excreta are disposed of regularly from under the cages. However, the incidence of ostopenia and weak bones is higher in hens caged for prolonged periods than in hens housed in systems where greater freedom of movement is possible (Knowles and Broom, 1990).

Singly caged birds are frequently used in agricultural research and teaching to establish or demonstrate fundamental principles and techniques. Because within-cage competition for feed and water is absent, feeding and watering spaces are not critical; however, individually caged birds must have ready access to sources of feed and water. Table 8-6 presents recommended floor area allowances for adult chickens, turkeys, and ducks that are kept in single cages. The recommended minimum dimensions given allow birds to turn around within their cages.

Minimum watering space recommendations for use in multiple-bird cages and pens are presented in Table 8-1. These recommendations assume moderate ambient temperatures.

Flooring

Poultry may be kept equally well on either solid floors with litter or in cages or pens with raised wire floors of appropriate gauge and mesh dimension. When poultry reside on solid floors, litter provides a cushion during motor activity and resting and absorbs water from droppings. The ideal litter can absorb large quantities of water and also release it quickly to promote rapid drying. The poultry

TABLE 8-3. Minimum Floor Area and Feeder Space for Broiler-type Chickens in Multiple-bird Pens and Cages Recommended for Use in Agricultural Research and Teaching.

Average weight range		Approximate age	Type of housing and floor	Foor area/bird		Feeder space/bird[a]	
Broiler breeders							
(g)	(lb)	(d)		(cm^2)	(in^2)	(cm)	(in)[a]
Hatch to 23 wk of age (females or mixed ratio, 1:10, of males to females)							
<300	(<.7)	0–21	Litter	320	(50)	3.8	(1.5)
300–600	(.7–1.3)	22–42	Litter	690	(107)	5.1	(2.0)
600–900	(1.3–2.0)	43–63	Litter	870	(135)	6.4	(2.5)
900–1200	(2.0–2.6)	64–84	Litter	1058	(164)	7.6	(3.0)
1200–1500	(2.6–3.3)	85–105	Litter	1238	(192)	8.9	(3.5)
1500–1800	(3.3–4.0)	106–126	Litter	1426	(221)	10.2	(4.0)
1800–2100	(4.0–4.6)	127–140	Litter	1612	(250)	11.4	(4.5)
2100–2400	(4.6–5.3)	141–150	Litter	1740	(270)	12.7	(5.0)
2400–2700	(5.3–6.0)	151–160	Litter	1860	(288)	12.7	(5.0)
Hatch to 23 wk of age (males only)							
<300	(<.7)	0–14	Litter	320	(50)	3.8	(1.5)
300–600	<.7–1.3)	15–28	Litter	690	(107)	5.1	(2.0)
600–900	(1.3–2.0)	29–43	Litter	870	(135)	6.4	(2.5)
900–1200	(2.0–2.6)	44–61	Litter	1058	(164)	7.6	(3.0)
1200–1500	(2.6–3.3)	62–77	Litter	1238	(192)	8.9	(3.5)
1500–1800	(3.3–4.0)	78–92	Litter	1426	(221)	10.2	(4.0)
1800–2100	(4.0–4.6)	93–104	Litter	1612	(250)	11.4	(4.5)
2100–2400	(4.6–5.3)	105–120	Litter	1740	(270)	12.7	(5.0)
2400–2700	(5.3–6.0)	121–138	Litter	1860	(288)	14.0	(5.5)
2700–3000	(6.0–7.2)	139–149	Litter	1974	(306)	15.3	(6.0)
3000–3300	(6.1–7.2)	150–161	Litter	2090	(324)	16.5	(6.5)
>3300	(>7.2)	>162	Litter	2195	(340)	17.9	(7.0)
Lay period (>20 wk of age, males and females)							
Males and females or females only							
>2100	(>4.6)	>140	2/3 slat, 1/3 litter	1860	(288)	12.7	(5.0)
>2100	(>4.6)	>140	Litter	2787	(432)	12.7	(5.0)
>2100	(>4.6)	>140	Multiple-bird mating cages[b]	1860	(288)	12.7	(5.0)
Females only							
>2100	(>4.6)	>140	Single cages[c]	1160	(180)		
Males only							
>2400	(>5.3)	>120	Single cages[d]	1390	(216)		
Commercial broilers							
Hatch to final market weight							
<300	(<.7)		Litter or cages[e]	248	(38)	3.8	(1.5)
300–600	(.7–1.3)		Litter or cages	342	(53)	3.8	(1.5)
600–900	(1.3–2.0)		Litter or cages	432	(67)	3.8	(1.5)
900–1200	(2.0–2.6)		Litter or cages	516	(80)	3.8	(1.5)
1200–1500	(2.6–3.3)		Litter or cages	606	(94)	3.8	(1.5)
1500–1800	(3.3–4.0)		Litter or cages	703	(109)	5.0	(2.0)
1800–2100	(4.0–4.0)		Litter or cages	780	(121)	5.0	(2.0)
2100–2400	(4.6–5.3)		Litter or cages	871	(135)	5.0	(2.0)
2400–2700	(5.3–6.0)		Litter or cages	948	(147)	5.0	(2.0)
2700–3300	(6.0–7.2)		Litter or cages	1019	(158)	5.0	(2.0)
>3300	(>7.2)		Litter or cages	1097	(170)	6.4	(2.5)

[a]Feeder space for broiler breeders is greater than for commercial broilers because they are feed restricted. Therefore, broiler breeders must be given enough feeder space so that all of the birds can consume their feed at the same time.

[b]Cages must have a minimum of 103 cm (16 in) of head height.

[c]Cages must be a minimum of 25 cm (10 in) wide with a head height of at least 48 cm (18-19 in).

[d] Cages must be a minimum of 30 cm (12 in) wide with a head height of at least 48 cm (18-19 in).

[e]The limiting factors for broilers in cages are generally the feeder capacity, water capacity, and cage height. All birds must be able to stand erect without hitting their heads on the top of the cage. Enough feeder capacity should be available for once a day feeding.

TABLE 8-4. Minimum Floor Area and Feeder Space for Turkeys in Multiple-bird Pens and Cages Recommended for Use in Agricultural Research and Teaching.

	Weight		Type of housing and floor	Floor area/bird		Feeder space/bird	
	(kg)	(lb)		(cm^2)	(in^2)	(cm)	(in)
Growing turkeys	<.3	(<.7)	Litter or wire	257	(40)	3.8	(1.5[a])
	.3–2	(.7–4.4)	Litter or wire	580	(90)	3.8	(1.5)
	2–3	(4.4–6.6)	Litter or wire	807	(125)	3.8	(1.5)
	3–6	(6.6–13.2)	Litter	1419	(220)	5.1	(2.0)
	6–8	(13.2–17.6)	Litter	1871	(290)	5.1	(2.0)
	8–12	(17.6–26.5)	Litter	2741	(425)	5.1	(2.0)
	12–16	(26.5–35.3)	Litter	3548	(550)	5.1	(2.0)
Breeder turkeys				(cm^2)	(in^2)		
Hens	<8	(<17.6)	Floor pen[b]	2786	(3)		
	8–12	(17.6–26.5)		3715	(4)		
	>12	(>26.5)		4644	(5)		
Toms	<12	(<26.5)		3715	(4)		
	12–17	(26.5–37.5)		4644	(5)		
	>17	(>37.5)		5573	(6)		
Hens	<12	(<26.5)	Cage[c]	2694	(2.9[d])		
Toms	<20	(<44.1)		4644	(5[d])		
	>20	(>44.1)		8359	(9[d])		

[a]Supplemental feeder lids should be used for starting.

[b]Does not include space for nests or broody pens.

[c]Cage design must allow the birds to stand erect.

[d]Minimum dimensions 46 cm (18 in) for hens <12 kg (26.5 lb), 61 cm (24 in) for toms <20 kg (44.1 lb), and 91 cm (36 in) for toms >20 kg (44.1 lb).

[e]Floors should be litter.

house should be ventilated to maintain litter in a slightly moist condition.

Some of the materials used for litter, depending on local availability, include rice hulls, straw, wood sawdust or shavings, and cane bagasse. Because litter materials differ in their ability to absorb and release water, husbandry practices should be varied to maintain proper litter conditions. Litter being stored for future use should be kept dry to retard mold growth.

When poultry are kept in cages or on raised floors, accumulated droppings should not be permitted to reach the birds. Droppings should be removed at intervals reflecting industry practice, and the basis for frequency of removal of droppings should be justified in the protocol or husbandry written operating procedures.

Ducks. Particular attention should be paid to the type of floor provided in pens or cages for the common duck because the epidermis of the relatively smooth skin on the feet and legs of this species is less cornified than that of domesticated land fowl (Koch, 1973) and therefore is more susceptible to injury. Properly designed, nonirritating floor surfaces minimize or prevent injury to the foot pad and hock and subsequent joint infection.

Dry litter floors are least irritating to the feet and hock joints of ducks and should be used whenever possible, particularly if ducks are going to be kept for extended periods. Litter floors that are not kept dry present a serious threat to the health of the flock.

Wire floors and cage bottoms of proper design may be used without serious adverse effect if the ducks are not kept on wire for more than 2 or 3 mo. Younger ducks and smaller egg-type breeds (e.g., Khaki Campbell) are less susceptible to irritation from wire than are older and larger meat-type breeds (e.g., Pekin). Properly constructed wire floors and cage bottoms should provide a smooth, rigid surface that is free of sags and abrasive spots. The 2.5-cm (1-in) mesh, 12-gauge welded wire is usually satisfactory for ducks of all ages over 3 wk. Mesh size should be reduced to 1.9 cm (3/4 in) for ducklings under 3 wk of age. Vinyl-coated wire is preferable, but stainless steel or smooth, galvanized wire is satisfactory. Slats are not recommended for ducks because leg abnormalities have developed in many ducks kept in research pens with slatted floors.

Irritation to the feet and legs of ducks is reduced greatly if hard flooring such as wire occupies only a portion of the total floor area of a pen. In large floor pens, one-third wire and two-thirds litter is a satisfactory combination, provided that drinking devices are located on the wire-covered section of the pen, which greatly reduces the transport of water from the drinking area to the litter.

Maintenance of litter in a satisfactorily dry condition is considerably more difficult in housing for ducks than in that for chickens and turkeys. Ducklings drink approximately 20% more water than they need for normal growth (Veltmann and Sharlin, 1981), and, as a result, the moisture content of their droppings is relatively high—approxi-

TABLE 8-5. Minimum Floor Area and Feeder Space for Ducks[a] in Multiple-bird Pens and Cages Recommended for Use in Agricultural Research and Teaching.

Type and developmental stage	Type of housing and floor	Per bird: Floor area/bird		Feeder space/bird[b]	
	Floor pen housing[c]				
	Total and semi-				
Meat/egg type	confinement	(cm^2)	(in^2)	(cm)	(in)
Brooding/growing, wk					
1	Litter[d]	232	(36)	.9	(.35)
2	Litter	464	(72)	1.0	(.4)
3	Litter	839	(130)	1.3	(.5)
4	Litter	1116	(173)	1.5	(.6)
5	Litter	1393	(216)	1.7	(.65)
6	Litter	1671	(259)	1.8	(.7)
7	Litter	1858	(288)	1.9	(.75)
1	Wire	232	(36)	.9	(.35)
2	Wire	439	(68)	1.0	(.4)
3	Wire	651	(101)	1.3	(.5)
4	Wire	974	(151)	1.5	(.6)
5	Wire	1187	(184)	1.7	(.65)
6	Wire	1413	(219)	1.8	(.7)
7	Wire	1625	(252)	1.9	(.75)
Developing breeders, wk 7–28	Litter[e]	2322	(360)	10.2[f]	(4.0[f])
Laying breeders, all stages	Litter	3251	(504)	2	(.8)

[a]Space recommendations for ducks were determined with Pekin ducks. The allocations given should be adequate for all domesticated breeds, but they may be slightly excessive for some of the smaller breeds.

[b]Space on one side. When access is available from both sides, the amount of space available is doubled.

[c]If ducks are under semiconfinement, allow indoor space equal to the amount recommended for total confinement.

[d]Waterers located on wire-covered section with cement drain underneath.

[e]Developing breeders may be raised outdoors on well-drained soil (preferably sand) with open shelter. A minimum of 1290 cm^2 (200 in^2) of shelter area/bird should be provided.

[f]Additional space is allowed for restricted feeding.

TABLE 8-6. Minimum Floor Area and Dimensions for Single-bird Cages for Mature Chickens, Turkeys, and Ducks Recommended for Use in Agricultural Research and Teaching.[a]

Species and type	Floor	Floor area per bird: Female		Male		Minimum dimension: Female		Male	
		(cm^2)	(in^2)	(cm^2)	(in^2)	(cm)	(in)	(cm)	(in)
Chicken									
Layer-type[b]	Wire	826	(128)	929	(144)	20.3	(8)	20.3	(8)
Broiler-type	Wire	1161	(180)	1393	(216)	25.4	(10)	30.5	(12)
Turkey									
<12-kg (26.4-lb) hens	Wire	2696	(418)			45.7	(18)		
<20-kg (44.1-lb) toms	Solid[c]			4644	(720)			61.0	(24)
>20-kg toms	Solid[c]			8359	(1296)			91.4	(36)
Duck									
Pekin	Wire	1625	(252)	1625	(252)	30.5	(12)	30.5	(12)

[a]Cages for all species should allow birds to stand erect.

[b]Recommended values are for Leghorn-type chickens. To obtain values for Mini-Leghorns, multiply by .75; for medium weight breeds, multiply by 1.15.

[c]Litter.

mately 90% (Dean, 1984). To offset this extra water input in duck houses, extra litter and removal of excess water vapor by the ventilation system are essential. Supplemental heat is often necessary to aid in moisture control.

Brooding Temperatures and Ventilation

Because thermoregulatory mechanisms are poorly developed in young chicks, poults, and ducklings, higher environmental temperatures are required during the brooding period. Requirements of young birds may be met by a variety of brooding environments (e.g., floor pen housing with hovers or radiant heaters distributed in localized areas, battery brooders, and cage or pen units in heated rooms).

Ventilation is ordinarily gradually increased over the first few weeks of the brooding period. Whether ventilation is by a mechanical system or involves natural airflow, drafts should be avoided, and streams of air should be minimized that impinge upon portions of pens or groups of cages. In relatively open brooding facilities, as with houses having windows for ventilation and with chicks kept in floor pens, draft shields may prove beneficial during the 7 to 10 days after hatching.

Young birds may huddle together or cluster when sleeping but are likely to disperse when awake. Within limits, birds can maintain appropriate body temperatures by moving away from or toward sources of heat when that is possible and by seeking or avoiding contact with other individuals. Extreme huddling of young birds, especially during waking hours, usually indicates a need for more supplemental heat; dispersal, associated with panting, indicates that the environment is too warm.

With brooding systems that allow birds to move toward or away from heat sources, the temperature surrounding the brooding area should be at least 20 to 25°C during the first few weeks but not be so high as to cause the young birds to pant or show other signs of hyperthermy. When the entire room is heated and chicks are not free to move to cooler areas, the minimum temperatures that are recommended below may be too high. Thus, during the first week after hatching, a lower temperature, for example, a few degrees below 32°C (90°F), may reduce the lethargy and nonresponsiveness that is otherwise likely to be seen. As indicated in the preceding paragraph, chick behavior should be monitored to be sure that temperatures are within acceptable ranges.

Areas with minimum temperatures that are adequate for comfort and prevent chilling should be available to young birds. The following minimum temperatures and weekly decreases are suggested until supplementary heat is no longer needed:

- for chicks, a 32 to 35°C ambient temperature (90 to 95°F) initially, decreasing by 2.5°C (4.5°F) weekly to 20°C (68°F) [however, for some well-feathered strains, supplemental heat may be discontinued at 3 wk if room temperature is 22 to 24°C (72 to 75°F)];
- for poults, 35 to 38°C (95 to 100°F), decreasing by 3°C (5°F) weekly to 24°C (75°F);
- for ducklings, 26.5 to 29.5°C (80 to 85°F), decreasing by 3.3°C (6°F) weekly to 13°C (54°F). After the brooding period, ducklings are comfortable at environmental temperatures of 18 to 20°C (64 to 68°F).

Ducks. The recommended ventilation rates for chickens and turkeys have also given good results with ducks (Davis and Dean, 1968). Generally, however, lower relative humidity is desirable in duck houses to help offset the higher water content of duck droppings. Proper screening underneath watering equipment in houses with litter floors and the addition of generous amounts of litter are necessary features of the moisture control program. When outside temperature allows, supplemental heat may be used to help to control moisture build-up in duck houses.

STANDARD AGRICULTURAL PRACTICES

For handling birds and for all practices under this heading, experienced and skilled persons should carry out or train and supervise those who carry out these procedures.

Beak-Trimming

Egg-Strain Chickens. Although Eskeland (1981) and Struwe et al. (1992) reported that, in the absence of cannibalism, moderately beak-trimmed hens appeared to experience less stress than did those with intact beaks, the majority of evidence indicates that beak-trimming to control cannibalism causes pain and heightened beak sensitivity that persists for several weeks or even months (Breward and Gentle, 1985; Duncan et al., 1989; Craig and Lee, 1990; Gentle et al., 1990; Lee and Craig, 1990, 1991). Also, evidence exists that available stocks differ in their beak-trimming requirements (Craig and Lee, 1990) and that genetic selection is effective in reducing or even eliminating most feather-pecking and beak-inflicted injuries (Craig and Muir, 1993, 1996; Muir, 1996).

Therefore, when feasible, stocks should be used that require either minimal or no beak-trimming. Nevertheless, beak-trimming is justified in stocks that otherwise are likely to suffer extensive feather-pecking and cannibalistic losses. Management guides, available from most breeders, indicate appropriate ages, methods, and amount of beak to be removed to reduce these vices. In the absence of such information, other sources of information should be used (e.g., consultation with poultry faculty specialists; North and Bell, 1990). Beak-trimming should be carried out when birds are as young as possible to minimize pain (Hughes and Gentle, 1995).

Broiler-Type Chickens. Beak-trimming has long been an accepted practice to reduce feather-pecking and cannibalism in breeder stocks.

Turkeys. Beak-trimming of turkeys is a standard management practice. As with chickens, evidence exists that strains (Noble et al., 1994) and sexes (Denbow et al., 1984;

Cunningham et al., 1992) differ in their requirement for and response to beak-trimming. In strains of turkeys that exhibit a high incidence of beak-inflicted injuries, arc-type beak-trimming at hatching is effective in reducing such injuries (Noble et al., 1994). Severe arc-type beak trimming (1.0 mm anterior to the nostrils) increases mortality relative to hot-blade trimming of the upper beak at 11 days of age (Renner et al., 1989). There is no evidence that arc-type beak-trimming 1.5 mm from the nostrils at hatching or hot-blade trimming of the upper beak at 11 days of age increases mortality relative to leaving beaks intact (Renner et al., 1989; Noble et al., 1994). Arc-type beak trimming 1.5 mm anterior to the nostrils or hot-blade trimming of the upper beak at 11 days of age is recommended to prevent cannibalism in strains of turkeys that exhibit a high incidence of beak-inflicted injuries.

Ducks. Feather-pecking is a vice that sometimes occurs in ducks and may be controlled by either partial removal of the nail of the upper bill or inhibition of the growth of the nail by heat treatment (Dean, 1982). If not controlled, feather-pecking injures the feather follicles of the tail, wings, and back, and the protective feather and down covering breaks down.

Toe-Trimming

Because of the size and weight of the birds involved and the sharpness of their toenails, broiler breeder males and market turkeys generally have certain toes trimmed in order to prevent them from inflicting serious injuries to the hens during natural matings or to their penmates. Toe-trimming should be done at 1 day of age using an electrical device that removes and cauterizes the third phalanx of the toes involved.

Broiler Breeder Males. When meat-type males are to be used in natural matings, the practice of trimming certain toes at 1 day of age should be considered; toe-trimming of breeding males prevents scratching and mutilation of females during mating. However, there is also evidence that toe-trimming may impair the mating ability of males (Ouart, 1986). The removal of one nail does not appear to cause chronic pain (Gentle and Hunter, 1988).

Turkeys. Toe-trimming is a widespread management practice in turkey production. The number of toes trimmed per foot varies from 1 to 3 plus the dewclaw. Carcass grade of turkeys may or may not be improved by toe-trimming (Owings et al., 1972; Proudfoot et al., 1979; Moran, 1985), although rate of early mortality may be increased (Owings et al., 1972; Newberry, 1992). Toe-trimming may be justified when excessive injuries are likely to occur, but alternative methods should be developed to prevent bird injury.

Comb Removal (Dubbing)

Comb removal (dubbing) of chickens may be desirable if birds are to be kept in cages where combs rub or frequently get caught in wire openings after significant comb growth has occurred. Dubbing of cockerels is more likely to be needed because of greater comb growth by the male. To perform successful comb removal with minimal bleeding and excellent long-term results, cuticle or small surgical scissors should be used to remove the comb during the first few days after hatching.

Induced Molting

In birds, plumage is normally replaced before sexual maturity. This process, termed molting, also occurs after sexual maturity and is associated with a pause in egg production, which can be lengthy and take place out of synchrony with others in the flock if the birds are permitted to molt naturally. Inducing synchronized, rapid molt in order to extend the productive life of a flock has become a common procedure for commercial table-egg layers and sometimes for broiler breeders and turkey breeders.

There is a considerable amount of literature available on induced molting (Wolford, 1984). Procedures used include feed or feed and water restriction; manipulation of dietary ingredients such as calcium, iodine, sodium, or zinc; and administration of pharmaceutical compounds that influence the neuroendocrine system, sometimes coupled with a reduction in photoperiod. These procedures cause an abrupt cessation of egg production, coupled with body weight and feather loss. Restoration is accomplished by feeding a diet designed to meet the nutritional requirements for a non-ovulating feather-growing hen.

The most common procedure used to induce molt is feed withdrawal. Data do not suggest that water withdrawal is beneficial, and considerable field experience has shown it to be detrimental, especially during hot weather; thus, water should not be withdrawn during the molt. Unfortunately, there are few data on the well-being of hens during the withdrawal and postwithdrawal periods. However, feed deprivation in general is known to be a significant stressor for birds and results in both increased stress hormones and behavioral changes (Mench, 1992). Until more information is available, programs that minimize the length of the feed withdrawal period should be used whenever possible.

Mortality that occurs during the feed withdrawal period is generally associated with birds that were sick or emaciated going into the molt. It is, therefore, strongly suggested that such birds be removed and euthanatized before the start of feed withdrawal. It is further recommended that feed be abruptly removed at the beginning of the feed withdrawal period and immediately returned to ad libitum intake at the end. This procedure prevents small birds from having less than full access to the feed when it is available.

HANDLING

Human-Poultry Relationships

Socialization of poultry with humans can be carried out with relative ease by frequent exposure to kind, gentle care. Even brief periods of handling, beginning at the youngest possible age, confer advantages for ease of later handling of birds and increase feed efficiency, body weights, and antibody responses to red blood cell antigens (Gross and Siegel, 1993). In addition, Gross and Siegel (1982) found that positively socialized chickens had reduced responses to stressors and that resistance to most diseases tested was better than that of birds that had not been socialized. Therefore, gentle handling of birds should be done when feasible or unless the protocol or the use of large numbers dictates otherwise.

Routine Handling

In many experimental and teaching situations, newly hatched birds or relatively small numbers of older birds need to be handled. In those cases, individuals can be easily caught, manipulated, and moved about. Examples include wing- or leg-banding; immunization by intranasal or intraocular application of drops and wing-web puncture; and removing or placing birds in different groups, cages, and holding crates. Trained and experienced scientists and caretakers know that birds struggle less if they have been socialized, if the environment is relatively quiet, and if the body is fully supported in an upright position (Gross and Siegel, 1993). More complex procedures—for example, obtaining blood samples, intraperitoneal and venous puncture, and artificial insemination—often require at least two experienced persons. Skilled operators should adequately train personnel in such handling procedures so that stress to birds is minimal. Particular care should be exercised in handling caged layers to minimize the risk of bone fractures (Gregory and Wilkins, 1989a).

When large numbers of birds are to be moved or treated, handling methods need to be compatible with the housing systems involved (Nicol and Saville-Weeks, 1993). A source of major concern should be the manner in which individual birds are caught, carried, and placed in new quarters or crates. In many situations, birds are at risk of injury because they are caught and moved by grasping a single leg or wing with subsequent exertion of excessive force in moving the bird. Thus, Gregory and Wilkins (1989a) found that, when hens were caught by one leg and removed from cages at the end of lay, the incidence of broken bones was 12.7%; the incidence was only 4.6% when both legs were used in removing hens from the cages. Broilers carried even briefly in the inverted position by the legs show a larger corticosterone response than do birds carried in an upright position, and the response lasts for about 3 hr (Kannan and Mench, 1996). Therefore, birds should be carried upright whenever possible. Poultry harvesting machines are currently under development that appear to cause less stress in depopulating floor pens than does typical commercial manual catching (Nicol and Saville-Weeks, 1993). Recommendations regarding space, ventilation, and thermal control during transportation are discussed in Chapter 2.

EUTHANASIA

Appropriate methods of euthanasia and slaughter for poultry are covered in Chapter 3 and by the AVMA Panel on Euthanasia (1993). Briefly stated, acceptable euthanasia initially depresses the central nervous system to ensure insensitivity to pain. Anesthetic agents are generally acceptable, and most avian species can be quickly and humanely subjected to euthanasia by injection of an overdose of a barbiturate. Where relatively large numbers are involved, as in disposal of excess baby chicks, exposure to gas euthanasia agents such as carbon dioxide in enclosed containers may be used. Argon anoxia (less than 2% oxygen) or low concentrations of carbon dioxide (less than 35%) in argon with 2% residual oxygen have been found to be effective and to produce minimal distress (Mohan Raj, 1993) for market weight meat birds and laying hens. If the experimental protocol requires that poultry be killed using the commercial method of exsanguination, it is strongly recommended that birds first be stunned using a gas or electrical stunning method if possible. Although exsanguination does result in a relatively rapid loss of consciousness if both carotid arteries are completely severed (Gregory and Wotton, 1986, 1988), exsanguination may be incomplete if blood clots form (European Commission, 1997). Considerations involved in electrical stunning are discussed by Gregory and Wilkins (1989b) and Bilgili (1992). Cervical dislocation is also acceptable with birds small enough that the procedure may be carried out quickly and completely. Electrocution is acceptable if the current travels through the brain and through the heart. Embryonated eggs can be destroyed by chilling or freezing at a temperature of <4°C for 4 hr (European Commission, 1995). Decapitation or anesthetic overdose are also suitable methods for embryos that have been exposed for experimental purposes. Maceration in a purpose-designed macerator is also considered a humane method for killing embryos and surplus baby chicks (Bandow, 1987). Methods selected should take into account any special requirements of experimental protocols so that useful data are not lost.

SPECIAL CONSIDERATIONS

Alternative Housing Systems

European research into alternative housing systems to replace cage housing for egg-strain hens, such as strawyards, aviaries, and free-range systems, has been extensive in recent years (Appleby et al., 1992a). It appears that no housing or management system is likely to be optimal in all respects, and the concept of a welfare plateau (Duncan, 1978) is useful; that is, ethically acceptable levels of welfare can exist in a variety of housing systems. Welfare of the caretaker, in addition to bird well-being, deserves consideration in evaluation of alternative housing systems (Craig and Swanson, 1994). Evaluation of alternative housing systems may require temporary easing of the guidelines during the evaluation process.

Research during the last two decades indicates that modification of commercial cages from those currently in wide usage for chickens may improve the health and welfare of birds (Tauson, 1995). Thus, cage height of at least 40 cm (15.7 in) over 65% of the cage area and not less than 35 cm (13.8 in) at any point seems desirable (Harner and Wilson, 1985; Nicol, 1987). Taller cages may be necessary for larger breeds. Cage floors with a slope of no more than 9º in shallow, reversed cages may result in better foot health (Tauson, 1981). However, such low slopes may not be desirable in deeper cages, because difficulties are encountered in getting eggs to roll out efficiently (Elson and Overfield, 1976). Horizontal bars across the front of the cage appear to allow birds to feed easily and with reduced probability of entrapment (Tauson, 1985), and wide cage doors allow easier removal of birds. If existing or new cages are high enough, the addition of a perch results in extensive use by hens and has been shown to improve bone strength and foot health (Appleby et al., 1992b; Duncan et al., 1992). Perches may be either round or square depending on diameter, and birds readily use perches of either wood or wire mesh; smooth plastic perches are less preferred (Faure and Jones, 1982; Muiruri et al., 1990; Appleby et al., 1992b). Provision of an abrasive strip on the baffle plate of the feeder results in hens having claws that are not excessive in length (Tauson, 1986).

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