Factors Affecting Floor Laying By Domestic Hens: A Review

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Introduction

All intensive systems of management for domestic hens, except battery cages, involve the collection of eggs from nest boxes. Eggs laid on the floor, instead of in the nest boxes provided, are a major economic problem in breeding flocks housed on deep litter, and in laying flocks in alternatives to batteries. Many floor eggs are broken, and this may encourage egg eating. Those collected are often dirty, which reduces hatchability (Hodgetts, 1981) or saleability. Furthermore, control of floor laying and collection of floor eggs are labour intensive.

The problem of floor laying is not just a product of modern intensive husbandry methods: it was described early in this century by Pearl (Pearl, 1909; Pearl and Surface, 1909) and Turpin (1918). However, the proportion of floor eggs seems to be particularly unpredictable in intensive systems. Several studies have been prompted by increased floor laying occurring on a farm, with no obviously relevant differences in conditions from other farms (Perry *et al.*, 1971a, b; McGibbon, 1976; Hearn, 1981). Perry *et al.* reported 30% floor eggs, which is not unusual. Similarly, variation may occur between pens within a single experiment. Dorminey *et al.* (1970) found 3.5 to 22.9% floor eggs in pens differing only in light intensity, and floor laying was not systematically related to light. This variability suggests that important causal factors of floor laying are being widely overlooked. In this paper, studies of factors affecting the proportion of eggs laid on the floor by domestic hens will be reviewed. It must be emphasized, however, that there have been few properly conducted, statistically acceptable experiments on this subject.

Floor Laying Behaviour

The percentage of eggs laid on the floor by a flock of hens is usually highest at the beginning of lay, and then declines (Pearl, 1909; Hurnik *et al.*, 1973b; Dorminey, 1974). If initial levels are high, it is occasionally possible to accelerate this decline by active management. However, floor laying rarely ceases competely, and in many cases no significant reduction can be achieved, even with a major effort (Ministry of Agriculture, Fisheries and Food (MAFF), 1982; Hill, 1983), or no decline at all occurs (Hearn, 1982). These characteristics of floor laying may be interpreted in terms of the behaviour of individual birds. Each hen has to learn to lay in nests (Pearl, 1909; Hurnik *et al.*, 1973b). A common pattern is for a hen to lay several eggs on the floor, then all subsequent eggs in nests (Appleby *et al.*, 1983a). After their first few eggs, however, most hens are consistent in laying either in nests or on the floor (small groups: Wood-Gush, 1954; Kite *et al.*, 1980; Appleby *et al.*, 1983a; large flocks: Pearl and Surface, 1909; Appleby and McRae, 1983). Once the laying behaviour of individuals is established, it is difficult to change (Perry *et al.*, 1971a; Kite *et al.*, 1980), but some individuals may learn to use nests later (Pearl, 1909). This may partly account for the decline in floor laying within flocks.

Behaviour of individual animals is often influenced by that of others. This suggests one possible explanation for the variability in floor laying discussed above. If laying behaviour of hens is extensively influenced by that of flockmates, then floor laying or nest laying by the first few birds to come into lay could lead to high or low levels of floor eggs, respectively. This chance variation would be very difficult to control. However, there is no evidence for such strong social effects. The first few eggs laid in a flock are almost invariably floor eggs, and it is not possible to predict at this stage whether floor laying will be a major or a negligible problem (Appleby *et al.*, 1983a).

Other factors contributing to the initiation of floor laying or nest use by individual hens are potentially more controllable. They may be categorized as follows:

- Genetic factors
- Rearing conditions
- Housing conditions
- Nest boxes
- Training

Genetic Factors

The main evidence for genetic effects on floor laying is from differences between strains. Among breeding stock, broiler breeders lay more floor eggs than layer breeders (Brocklehurst, 1975; there have been no surveys of the problem in dwarf strains). In laying strains, medium hybrids lay on the floor more than light hybrids (Thornber and Hale, 1954; McGibbon, 1976; Hill, 1981), while bantam hens readily use next boxes (Kite *et al.*, 1980). Similar strain differences also exist among turkeys (Kosin and Mun, 1960). It is not clear what aspects of genetic variation give rise to these differences. Strains are known to vary in nest-site selection (Appleby *et al.*, 1983b) and in other aspects of pre-laying behaviour (Wood-Gush, 1972; Kite *et al.*, 1980), but this variation is not clearly related to floor laying. Other factors may have indirect effects on nesting. Strains differ in body weight, and an influence of weight on use of nests has been suggested. However, this is not supported by analysis within strains (Appleby *et al.*, 1983a). By contrast, an effect of variation in perching behaviour on floor laying is consistent between and within strains. Perching is important for access to raised nest boxes (see below), and failure to perch is more common in medium hybrids than in light hybrids (Faure and Jones, 1982a, b). Similarly, floor laying by individuals is related to failure to perch within medium hybrids (Appleby *et al.*, 1983a), and may have a genetic basis.

There has been one report of increased floor laying in inbred lines of hens (McGibbon, 1976). That result may have been affected by rearing conditions (see below), but McGibbon concluded that floor laying was heritable and selected for and against the trait. Results differed between two experimental sites. At one site, selection for floor laying increased the proportion of floor layers present. At the other site no effect of selection was observed.

Rearing conditions

The conditions in which hens have been kept before introduction to laying houses are rarely considered in relation to laying behaviour, but may have important effects. When groups of mature hens are moved from cages to pens with nest boxes, they lay a high percentage of eggs on the floor (Morgan and Bonzer, 1959; Craig, 1980). Similarly, McGibbon (1976) found that 'confinement reared' birds laid more floor eggs than others 'range reared'. In addition, McGibbon's inbred lines, which

had a high incidence of floor laying, had been reared in individual cages. These results may be explained by an effect of rearing on learning to perch, and on use of raised nests. Hens that have not had the opportunity to perch during rearing often fail to perch as adults (Faure and Jones, 1982b). Similarly, in an experiment with medium hybrids, birds reared in pens with perches readily gained access to nest boxes as adults, and laid few floor eggs. By contrast, many individuals reared without perches failed to perch and laid on the floor (Appleby *et al.*, 1983a).

In some rearing houses, birds are prevented from perching on food tracks by electric wiring. This practice is often associated with severe subsequent floor laying (personal observation; A. McDonald, personal communication), possible because hens have been trained not to perch during rearing.

Rearing houses are not usually provided with nest boxes, so birds coming into lay before being moved must lay on the floor. The importance of avoiding this situation, with hens learning to lay on the floor, has been stressed (Murphy, 1969). Dorminey (1974) compared floor laying in flocks housed with nest boxes at 18 or 23 weeks of age. More floor eggs were produced by flocks which had started production before moving.

Housing conditions: Design and Management of Laying Houses

The commonest intensive system of management for breeding flocks of hens, and for the small number of laying flocks not kept in batteries, is the deep litter house. Among alternative systems, all-slatted floors for layers were often associated with severe floor laying (Sainsbury, 1980), but sometimes gave satisfactory results (Armour, 1962). In new alternatives being developed, floor laying has been a major problem initially in both the aviary system (Hill, 1981, 1983) and the perchery (Anon., 1983). However, it is difficult to make valid comparisons between systems that differ in many varied aspects of management.

Several aspects of the design of deep litter houses were considered in a survey of floor laying carried out by Brocklehurst (1975). The clearest effect was associated with droppings pits. Floor laying averaged 16% in houses without droppings pits, but only 7% in houses where a droppings pit was present. It is likely that this effect is also related to the involvement of perching in the use of nests, mentioned above. Use of a droppings pit for drinking or roosting is often encouraged by training, and birds jumping up to a droppings pit should also be able to gain access to raised nests. Brocklehurst also found that floor laying varied with group size. In houses divided into pens with less than 900 birds in each, less floor eggs were laid than in larger groups. No clear explanation for this effect is available, but details of husbandry may also have varied with group size.

Some studies have reported that use of nests is affected by lighting or ventilation. Dorminey (1974) found less floor eggs in pens with some natural light and ventilation than in completely controlled conditions. Floor laying was also reduced in one experiment by increased intensity of overhead lighting (Dorminey, 1974), but there is no general relationship between incidence of floor eggs and light intensity (Dorminey *et al.*, 1970). In the extreme case of complete darkness, however, hens tend to lay on the floor. As a result, very short daylength increases floor laying (Walther and Newell, 1962; Siegel *et al.*, 1963).

Conditions on the floor itself are widely believed to affect the likelihood of hens laying there. For example, Thornber and Hale (1954, p 26) state that "quite a few birds will not use the nests at all. The floor is favoured because it is warm and comfortable and they prefer this to any nest they may be given". If this is true,

making the floor less comfortable should discourage floor laying. For this reason Pitt (1983) suggests using dry sand rather than litter during early production. However, there is little evidence that condition of the floor is actually important, except in determining the particular floor sites used. Perry *et al.* (1971a) cast doubt on the influence of temperature, air movements or light intensity on floor laying. They found that sites favoured by floor layers were slightly warmer than other parts of the floor, but they were still cooler, more draughty and brighter than the nests provided. Brocklehurst (1975) suggested that more eggs were laid on the floor when the temperature near the litter was above 16°C, but measurements were made at sites where most eggs were laid and may not have been representative. Similarly, it is possible that protected floor sites encourage floor laying (Dorminey, 1974). Blocking off corners may therefore be recommended (Murphy, 1969), but this is not necessarily effective (Hearn, 1982). Pitt (1983) reports use of electric wiring alongside walls in Dutch houses to prevent hens reaching favoured sites.

It is sometimes suggested that feeding birds during peak laying time may suppress nesting behaviour without delaying oviposition, so that eggs are laid on the floor while birds feed. Hearn (1981) varied feeding times for broiler breeders, but found no effect on floor laying.

Nest Boxes: Design and Management

Type of Nest Box. Nest boxes may be either communal or individual. Communal nests were once widely used in deep litter houses (Dun, 1964), but there was some evidence that floor laying was worse than with individual nests (Parnell and Quisenberry, 1951; Armour, 1962). Communal nests have since declined in popularity (Smith and Dun, 1983) and are now not generally recommended (MAFF, 1982).

Individual nest boxes include traditional, rollaway and tube nests. Traditional nests usually contain litter, and need manual egg collection. Rollaways have no litter: eggs are allowed to roll into a collection channel, which may contain a conveyor belt for automatic collection. In tube nests, collection is achieved by moving litter and eggs together on a belt, then separating them and recycling the litter. Traditional and rollaway nests have been compared in several studies. Floor laying is generally worse with rollaways (Bressler, 1961; Armour, 1962; Anon., 1983), but these results are difficult to interpret, since the nests compared often also differ in other aspects. By contrast, successful results have been reported with some designs of rollaways (Pitt, 1983). Similarly, satisfactory performance of tube nests has been described (Anon., 1982), although no comparisons with other types have been published.

It is often suggested that automatic nests cause more floor laying than nests with manual collection (cf. Anon., 1982), or at least require more training for birds (cf. Smith and Dun, 1983). However, both these categories include a wide variety of nest boxes and comparisons on this basis are difficult.

Details of Design. There have been many suggestions about the detailed design of nest boxes. General texts on the management of poultry usually state that hens prefer to lay in dark, secluded places (e.g. Winter and Funk, 1948; Robinson, 1948; Card and Nesheim, 1966). This idea may be based on a tendency for hens to avoid nests near windows or doors (Woods and Laurent, 1958; Hurnik *et al.*, 1973a). However, it is not supported by experimental tests of hens preferences (Appleby *et al.*, 1983b, 1984b). Choices by hens between nests varying in enclosure (Appleby *et al.*, 1984a) and entrance design (Kite *et al.*, 1980) have also been equivocal. Nests

with curtains were preferred by bantams to nests without (Kite *et al.*, 1980), but addition of curtains to nests in a flock of broiler breeders with severe floor laying did not reduce the problem (Hearn, 1982). In fact, there is little evidence that details of the design of nest boxes have any effect on the proportion of hens that use them. One recent study that did report an effect found that floor laying was worse with a commercial type of rollaway than with a home made rollaway, and worse with both than with traditional nests (Anon., 1983), but nests also differed in design of alighting rail (see below). Smith and Dun (1983) point out that there have been many successful designs of nests, and conclude that the important features of a nest are quite simple.

Individual variation in nest-site selection was thought important by Murphy (1969), who suggested providing varied nests. The introduction of heterogeneity to nest boxes may also help hens to distinguish between them, which could be important if each hen attempts to lay a clutch in one place (cf. Wood-Gush, 1954). Hurnik *et al.* (1973b) reported lower percentages of floor eggs in pens with nests painted in five colours than in pens with plain nests.

Accessibility. Accessibility of nest boxes is largely independent of other aspects of design. It has been stressed as important in nest use (Kite *et al.*, 1980; MAFF, 1982), and there is evidence to support this position. On one farm with a bad record for floor laying, Hearn (1982) found that least floor eggs were laid in pens with ground level or low nests. Where both ground level and raised nests are available, those on the ground are often heavily used, while raising low nests usually increases floor laying (Hearn, 1982; Appleby *et al.*, 1983a). This is probably because perching is necessary for access to raised nests, and some birds have difficulty perching (Faure and Jones, 1982a; Appleby *et al.*, 1983a). This explanation is supported by variation between strains, and by effects of rearing and housing conditions. Similarly, if access to nests is obstructed by other house furniture, floor laying is increased (Anon., 1983). In addition, design of the alighting rail is important for nest access. In a survey of 53 flocks of broiler breeders, floor eggs varied from an average of 9% when the rail was within 12.5cm of the nest front to an average of 19% when it was more than 25cm away (Brocklehurst, 1975). A system of raised nests with no need for an alighting rail has recently been reported as successful (Anon., 1982). Birds gained access to nests directly from a droppings pit, and less than 2% floor eggs were recorded.

Nesting Material and Eggs. A number of studies have reported preferences of hens for nest boxes with or without nesting material (Wood-Gush and Murphy, 1970; Kite *et al.*, 1980) or for different sorts of material (Hansen *et al.*, 1948; Siegel and Howes, 1959; Fölsch, in press). Effects of nesting material on production of floor eggs are not clear, however. Daly *et al.* (1964) reported variation in floor laying between pens with different nesting materials, but did not give any statistics, and Baker (1962) found no significant variation with a similar range of materials. With rollaway nests, one study recorded more floor eggs with wire linings than with matting (Armour, 1962). Covering wire floors with nest pads during early lay has been suggested (Ensminger, 1980), and wire floor rollaways are not now generally recommended on deep litter (MAFF, 1982). Armour (1962) considered that nests must provide more 'comfort' than the floor of the house.

Hens prefer nests containing eggs to others (Kite *et al.*, 1980), and it is often suggested that leaving some eggs in nests at point of lay should encourage their use (e.g. Pitt, 1983). Similarly, use of artificial decoy eggs is somethimes advocated in

training birds to use nests (e.g. Bressler, 1961). There is no published evidence which shows the effectiveness of these measures.

Number and Arrangement. A ratio of one nest for every four or five hens is usually recommended (e.g. MAFF, 1979, 1982). These recommendations are supported by a survey of breeding flocks, which found that floor laying was least with a ratio of 1 : 4 (Brocklehurst, 1975). In practice, ratios of from 1 : 6 to 1 : 8 are common (Pitt, 1983; Smith and Dun, 1983). These may give satisfactory results: for example, Woods and Laurent (1958) reported less than 1% floor eggs with a nest ratio of 1 : 6.25. However, very high ratios probably contribute to floor laying problems. A proportion of 30% floor eggs in one flock was attributed to the nest ration of 1 : 12.5 by Perry *et al.* (1971a). The shortage of nests in this flock was made worse by dominance interactions between birds (Perry *et al.*, 1971a, b). For tube nests, the only recommendation made by MAFF (1982) is that nesting space should not be reduced on the grounds of cost. In the survey by Smith and Dun (1983), one farm provided a metre length of nest for each 16 hens, while another provided one metre per 38 hens. The latter farm had a higher percentage of floor eggs.

Poultry farmers included in Smith and Dun's (1983) survey considered that hens should not have to move more than 5m to find a nest. There is no experimental evidence to support this view, and in one commercial flock marked birds were seen to move up to 26m to nest (M. C. Appleby and S. N. Maguire, unpublished). Hearn (1981) tried varied arrangements of nest boxes in six pens of broiler breeders and found no effects on floor laying. Arrangement in relation to overhead lights was investigated by Dorminey (1974). In small pens with a light at one side, he found that floor laying was worse when nest boxes were against the wall opposite the light than when they were underneath it.

If floor laying becomes a problem in a flock, it is common practice to place nests in the most-used floor sites (Bress.er, 1961; MAFF, 1982; Hiull, 1983). These nests are usually heavily used, perhaps because they are at ground level and more accessible than raised nests. As a result, reduced percentages of floor eggs are often reported. There is no indication that this practice increases use of other nest boxes, although Bressler (1961) removed the additional nests several months later with no resurgence of the problem.

Training

Most farms carry out some training of hens when they are first housed, in an attempt to prevent floor laying becoming established. Measures taken to discourage hens laying on the floor include regular disturbance of sitting birds, frequent collection of floor eggs and destruction of floor nests (Ensminger, 1980; Pitt, 1983). It is not clear how effective these measures are. Hens are also actively encouraged to use nests, by lifting them in (Pearl, 1909; Pearl and Surface, 1909; Kite *et al.*, 1980). Pearl and Surface worked with relatively small flocks of marked birds. Floor layers were identified individually, and trained by placing them in trap nests. In fact, Pearl stated (1909) that "a hen was never allowed to continue the floor-laying habit". More recently, Craig (1980) achieved similar success with mature hens, by confining birds in nests for short periods. Floor eggs in experimental pens declined to 1%, compared to 24% in control pens. By contrast, training in large, commercial flocks is usually less systematic, and is probably less successful. Trap nests are uncommon, so hens cannot be shut in nests, and individuals may by chance be lifted several times, only once or not at all. Kite *et al.*

(1980) showed that a single exposure to nests can sometimes be sufficient training, but is not always so.

Reduced attention to individual hens in large flocks is a possible explanation for Brocklehurst's (1975) finding that floor laying is worse in pens of more than 900 birds then in smaller pens.

Negative training with nest boxes is also possible, if hens learn to associate them with aversive stimuli. This may contribute to floor laying. Wood-Gush (1954) described a pullet about to lay her first egg, frightened by the action of a trap nest. She then laid on the floor for several days. Some farms avoid collecting eggs in the morning during the first period of egg production to prevent disturbance to birds in nests.

Conclusions

It was suggested in the introduction that important causal factors of floor laying by domestic hens were being widely overlooked. When possible factors are divided into the categories used above, it appears that there has been extensive consideration of each of these, with the possible exception of rearing conditions. It is clear that factors in all the categories, including rearing conditions, contribute to the problem of floor laying, and they must all be taken into account in attempts to alleviate it.

Within these categories, however, some factors have been given more emphasis than others. These are generally factors concerned with hens' *preferences* for certain nest sites. For example, many studies have concentrated on floor conditions, nest box type or structure, or nesting material. They have demonstrated that such factors affect hens' choices between floor sites or between nest boxes. Nevertheless, there is little evidence that most of these factors actually affect whether hens lay in nest boxes or on the floor. By contrast, less attention has usually been given to factors affecting the *ability* of hens to use nest boxes. Most nest boxes are raised off the ground, so that birds must perch to gain access to them. Their ability to do so is affected by genetic factors, rearing conditions, housing conditions, nest box accessibility and training. Greater concentration on these aspects of management may help to reduce commercial problems of floor laying by domestic hens.

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Summary

The proportion of eggs laid on the floor by hens kept in non-cage systems is unpredictable under intensive husbandry. This suggests that important causal factors of floor laying are being overlooked. Studies of such factors are reviewed. These range from selection of birds on a genetic basis, through rearing and housing of stock, to providing nest boxes and training hens to use them. There has been extensive consideration of most of these categories, but rearing conditions have received little attention. Rearing conditions have important effects on laying behaviour, by affecting hens' ability to perch, and so to gain access to raised next boxes. Ability to use nest boxes is also affected by other aspects of management. However, more emphasis has been placed on hens' preferences for certain nest sites than on their ability to reach those nest sites. There is little evidence that variation in preferences affects the proportion of eggs laid on the floor by hens in commercial conditions.

Résumé

FACTEURS AFFECTANT LA PONTE AU SOL PAR LA POULE DOMESTIQUE
(M. C. Appleby)

La proportion d'oeufs pondus au sol par les poules logées en bâtiments sans cage est imprévisible en élevage intensif. Ceci suggère que des facteurs importants de la ponte au sol ne sont pas identifiés. L'étude de tels facteurs est passée en revue ici. Ils vont de la sélection génétique des oiseaux, élevés et mis en poulaillers, à la fourniture de nids et á l'entraînement des poules à les utiliser. La plupart de ces facteurs ont été étudiés en détail, mais les conditions d'élevage des jeunes ont reçu peu d'attention. Ces conditions ont des effets importants sur le comportement de ponte, en affectant l'aptitude des poules à se percher, et ainsi à avoir accès aux nids. La faculté d'utiliser les nids est aussi affectée par d'autres aspects de l'élevage. Cependant, l'accent a davantage été mis sur les préférences des poules pour certains nids plutôt que sur leur aptitude à atteindre ces nids. Il y a peu de preuves que la variation dans les préférences affecte la proportion des oeuf pondus au sol par les poules dans les conditions commerciales.

Zusammenfassung

EINFLUßFAKTOREN AUF DAS VERLEGEN AUF DEN BODEN BEIM HAUSGEFLÜGEL—EINE ÜBERSICHT
(M. C. Appleby)

Der Anteil von Eiern, die in Bodenhaltungssystemen von den Hennen auf den Stallboden gelegt werden, ist in der Intensivhaltung besonders schwer vorherzusagen. Dies deutet daraufhin, daß wichtige Einflußfaktoren des Verlegens übersehen werden. Hier soll ein Überblick über Untersuchungen derartiger Faktoren gegeben werden. Diese reichen von der züchterischen Selektion des Geflügels, über die Bedingungen während der Aufzucht und Legeperiode, bis zur Verfügungstellung von Nestboxen und dem Trainieren der Hennen, sie zu benutzen. Die meisten Einflußgrößen sind intensiv untersucht worden, nur die Aufzuchtbedingungen haben bisher wenig Aufmerksamkeit erfahren. Die Aufzuchtbedingungen haben einen bedeutenden Einfluß auf das Legeverhalten, weil sie die Neigung der Hennen zur Benutzung der Sitzstangen beeinflussen, die dadurch leichter Zugang zu den erhöht angebrachten Nestboxen haben. Die Fähigkeit zur Benutzung von Nestboxen ist auch beeinflußT durch andere Gesichtspunkte des Managements. Bisher ist jedoch der Bevorzugung bestimmter Nestplätze durch die Hennen eine größere Bedeutung beigemessen worden als ihrer Fähigkeit, diese Nestplätze zu erreichen. Es gibt wenig Hinweise, daß durch die Variation in der Bevorzugung von Nestplätzen der Anteil von Bodeneiern unter kommerziellen Bedingungen beeinflußt wird.

РЕЗЮМЕ

ФАКТОРЫ, ВЛИЯЮЩИЕ НА НАПОЛЬНУЮ ЯЙЦЕКЛАДКУ ДОМАШНИХ КУР - ОБЗОР
/М.С.ЭПЛБАЙ/

В условиях интенсивного содержания кур вне клеток количество яиц,откладываемых напольно, непредсказуемо. Это говорит о недооценке важных причинных факторов напольной яйцекладки. В данной работе рассматриваются эти факторы,которые включают как селекцию птицы на генетической основе, выращивание и размещение поголовья, так и оснащение птичников ящиками-гнездами, а также обучение птицы, как ими пользоваться. Большинство этих факторов было широко исследовано, и лишь условия выращивания птицы получили мало внимания. Условия выращивания оказывают значительное влияние на поведение птицы во время яйцекладки, воздействуя на способность кур нестись и, таким образом, добираться до поднятых ящиков-гнезд. Другие аспекты содержания также влияют на их способность достигать участки гнездования. Однако, в бóльшей мере акцентировалась приверженность курнесушек к определенным участкам гнездования, чем их способность добираться до них. Имеется недостаточно доказательств того, что изменчивость в предпочтении тех или иных участков гнездования влияет на количество откладываемых яиц напольно в условиях промышленного содержания кур.

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