Funnel nest box: a system for automatic recording of individual performance and behaviour of laying hens in floor management

S. THURNER[1]*, G. WENDL[1] and R. PREISINGER[2]

[1]Institute for Agricultural Engineering, Farm Buildings and Environmental Technology, Bavarian State Research Centre for Agriculture, Vöttinger Straße 36, 85354 Freising, Germany,
[2]Lohmann Tierzucht, Am Seedeich 9-11, 27454 Cuxhaven, Germany.
***Corresponding author: Stefan.Thurner@LfL.bayern.de**

Changes in legislation promote alternative group housing systems for laying hens. To evaluate actual hybrid layers and to improve breeding programmes, individual data about laying performance and behaviour are necessary. Therefore a Funnel Nest Box (FNB) and an Electronic Pop Hole (EPH) were developed. This paper presents the FNB and results regarding the reliability of the FNB and analysis of data from a flock over the entire laying period. The FNB is designed as a single nest box. Each hen carries a passive transponder that is registered by an antenna in the nest box. The assignment "egg to hen" is obtained by combining the transponder ID, the egg sensor signal and the position of the egg in the egg collecting tube. Data from an initial flock of 337 Lohmann Silver hens (LS, brown layers) and 29 Lohmann Selected Leghorn hens (LSL, white layers) were collected and evaluated. To assess the reliability of the assignment „egg to hen", the position of all white eggs was recorded and subsequently checked, weather one of the 29 LSL hens was assigned to these eggs. Video recording was used to evaluate the reliability of the nest occupancy times. In total 6,521 white eggs were collected and 95.8 % of these eggs could be correctly assigned to the individual hen. Failures occurred due to double nest occupation (0.6%), incorrect egg identification (2.0 %), plausibility problems (0.5 %) and non-specific errors (1.1 %). In 97.8 % of the evaluated entrances and exits (n= 770) the hens could be identified within 5 seconds in the FNB. 277 LS hens were used for analyses about the laying performance and behaviour. All hens visited the FNB at least three times but 8 hens (2.9 %) had never laid an egg in the FNB. Another 27 hens (9.7 %) laid only between 1 and 200 eggs in the FNB, 242 hens (87.4 %) laid between 201 and 325 eggs. Clear preferences for some nest boxes could not be observed. For hens with more than 200 eggs, the minimum number of FNB's used to lay all eggs was 18. Further evaluations about the duration of nest visits, the average amount of eggs per laying sequence and about the average time delay between eggs of the same laying sequence were done from the fifth laying period to the end of the observation time. All hens visited the nest box and for the majority of the hens visits without a laid egg lasted on average 5 to 10 minutes and visits where an egg was laid 15 to 30 minutes. Half of the hens with an average amount of 2 to 17 eggs per laying sequence, showed a greater variety for the average time delay between the eggs of the same laying sequence (11 to 76 minutes) and a lower laying performance (47 to 229 eggs) than the other half of the hens with an average amount of 18 to 80 eggs per laying sequence (average time delay between the eggs: 10 to 29 minutes; laying performance: 172 to 240 eggs). The FNB can be regarded as a reliable system for the recording of the laying performance and behaviour of hens. In combination with the EPH the behaviour of the hens can be better analysed and breeding programmes as well as the management and the housing systems can be improved.

Keywords: laying hens; funnel nest box; laying performance; automatic recording; RFID

Introduction

Changes in legislation and consumer demand promote alternative group housing systems for laying hens. Since most of the actual hybrid layers were bred for a cage environment, some have problems to adapt to the conditions in group housing environments, resulting e.g. in poor performance or aggression (LANGE, 1996; PREISINGER, 1997). To enhance the situation, the existing breeds need to be evaluated and new selection criteria for future breeding programs need to be developed (PREISINGER et al., 1999). These requests can only be achieved on the basis of individual data about laying performance and behaviour of hens housed in alternative group housing systems (PREISINGER, 1998). Therefore a Funnel Nest Box (FNB) and an Electronic Pop Hole (EPH) were developed on the basis of RFID technology. This paper concentrates on the FNB. The aim was to evaluate the system by testing the reliability of the assignment „egg to hen" and the recording of the nest occupancy times. Furthermore, the laying performance and behaviour of a whole flock over the entire laying period was analysed.

Materials and methods

Each hen carried a passive transponder (Texas Instruments, HDX - ISO transponder, 23.10 * 3.85 mm) with a unique ID that was tightened to the leg of the hen using a LegBand (RoxanID, modified). The FNB (Figure 1), which was developed on the basis of the "Auto-Nest" of MARX et al. (2002), is designed as a single nest box with a trap device at the entrance. The trap device assures that the hens are separated when entering the nest box and prevents further hens to enter when the single nest box is occupied. The funnel nest floor, which locks the trap device during an occupancy, has a specially designed shape that helps to orientate the hens with their head towards the nest entrance and allows the egg to roll away immediately after laying. Furthermore a trapezoid-shaped antenna is positioned underneath the funnel nest floor to register the transponder ID of the hen inside the nest box. When the egg rolls out of the nest box it is registered by the seesaw egg sensor which is positioned immediately after the nest box. All eggs that are laid in a nest box during a day are collected in the order of lay in the egg collecting tube behind the nest box. The assignment of each egg to the individual hen is carried out by combining the transponder ID, the signal from the egg sensor and the position of the egg in the egg collecting tube.

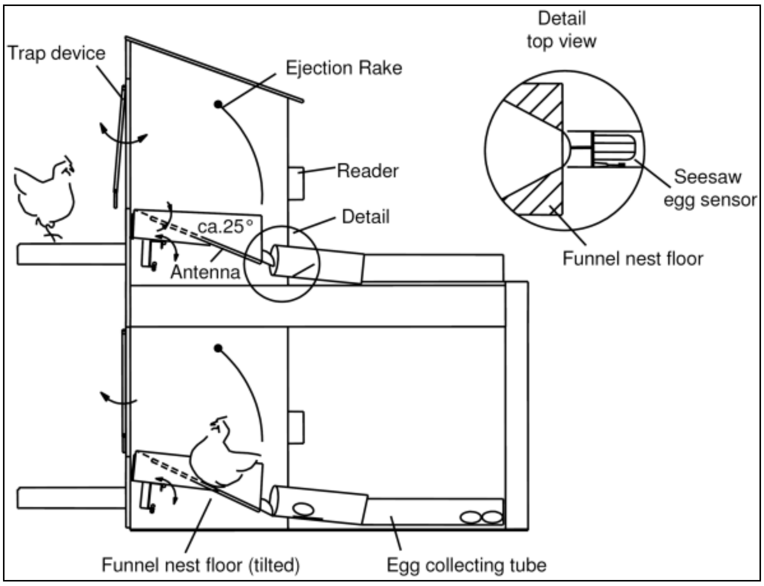

Figure 1 Sketch of the Funnel Nest Box (FNB)

Data from an initial flock of 337 Lohmann Silver hens (LS, brown layers) and 29 Lohmann Selected Leghorn hens (LSL, white layers) were collected and evaluated by a specially developed software package from 48 FNB's (arranged in two rows of 24 FNB's, one above the other) over one year (20.12.2004 to 20.12.2005). The LS chickens hatched at a farm of Lohmann Tierzucht (09.08.2004) and at the same day they, were brought to the experimental station Thalhausen (Technical University of Munich). There they were reared in accordance with the Lohmann Silver management programme (N.N., 2004) in an aviary system until the age of 17 weeks and then transferred to the section with the FNB's (09.12.2004). The first laying period started with the first egg that was laid in the nest boxes at the 31.12.2004. Due to the experimental design the 29 LSL hens were placed in the LS flock later (17.02.2005), which is in contradiction to normal flock management. Unfortunately, this caused an infection with *M. haemolytica* in the LS flock. Therefore, some results were evaluated using the whole observation time (366 days, Figure 2) and others with a part of the observation time, starting with laying period five (22.04.2005 – 20.12.2005, 243 days, Figure 3 and 4). The mixed flock was housed in a section (surface area approximately 55 m^2) with an aviary (Volito, three tiers) and a littered area on both sides of the aviary. Furthermore, a littered winter garden with a surface area of approximately 40 m^2 was available to the hens. The length of the artificial light day altered during the observation time between 14 hours (20.12.2004 – 26.12.2004: 3 a.m. to 5 p.m. and 04.04.2005 – 13.11.2005: 6 a.m. to 8 p.m.), 14.5 hours (27.12.2004 – 01.02.2005: 3 a.m. to 5:30 p.m.) and 15 hours (02.02.2005 – 03.04.2005: 3 a.m. to 6 p.m. and 14.11.2006 – 20.12.2005: 5 a.m. to 8 p.m.). The FNB was accessible for the hens from 3 a.m. to 3 p.m. during the whole experimental period. To assess the reliability of the assignment „egg to hen", the position of all white eggs from the LSL hens in the egg collecting tubes was manually recorded during the daily collection of the eggs between 3:30 p.m. and 8 p.m.. Subsequently it was checked in the data base, weather one of the 29 white layers was assigned to these eggs. Video recordings from the interior of the nest boxes, taken with four digital CCD cameras (Panasonic, type WV-BP550 and WV-BP510) and a digital long-term recorder (Dallmeier, type DLS 6 S1-edition), were used to evaluate the reliability of the nest occupancy times.

Results and discussion

In total 6,521 white eggs were collected. Thereof 95.8 % could be correctly assigned to a white layer. Failures occurred due to double nest occupation (0.6 %, e.g. an egg was laid while two hens were in the nest box and therefore a correct assignment was not possible), incorrect egg identification (2.0 %, e.g. a soft shell egg blocked the seesaw egg sensor and therefore the following eggs piled up and were not registered), plausibility problems (0.5 %, e.g. two eggs were assigned to one hen at the same day) and non-specific errors (1.1 %, e.g. the position of a white egg was not written down correctly). To test the recording of the nest occupancy times 770 entrances and exits where evaluated. In 97.8 % of the evaluated nest entrances and exits, the hens could be identified within 5 seconds in the FNB. In 0.5 % of the cases the time span for the identification overran 5 seconds, in another 0.5 % the hens re-entered in the same FNB in less than 5 minutes (reading gaps of less than 5 minutes are interpreted as permanent stays in the nest box) and in 1.2 % the hens could not be identified for at least 5 minutes and therefore, the stay in the nest box was wrongly finished. A total amount of 4.5 % floor eggs, which is an average value for alternative group housing systems (LANGE, 1996), showed that the FNB was well adopted by the hens.

The analyses of the laying performance and behaviour for the entire experimental period could be done on 277 LS hens (Figure 2). Only hens that were in the flock for the whole observation time, did not loose their transponder and were found in the flock in each monthly control were included in the evaluation. 8 hens (2.9 %) have never laid an egg in the FNB, another 27 hens (9.7 %) laid between 1 and 200 eggs in the FNB, 88 hens (31.8 %) between 201 and 275 eggs and 154 hens (55.6 %) between 276 and 325 eggs. Preferences for some nest boxes by individual hens could not be observed and the minimum number of FNB's used to lay all eggs was 18 (for hens with more than 200 eggs). A reason for the high amount of different nest boxes used for laying could be that the number of hens per nest box was on a very high level (7.6 : 1). Therefore, the nest load was very high during the main laying activity in the early morning hours and reached more than 80 % for one hour in the upper nest row and for more than two hours in the lower nest row (THURNER and WENDL, 2006). This could have forced the hens to use each available nest box for laying, rather than waiting for their favourite nest box.

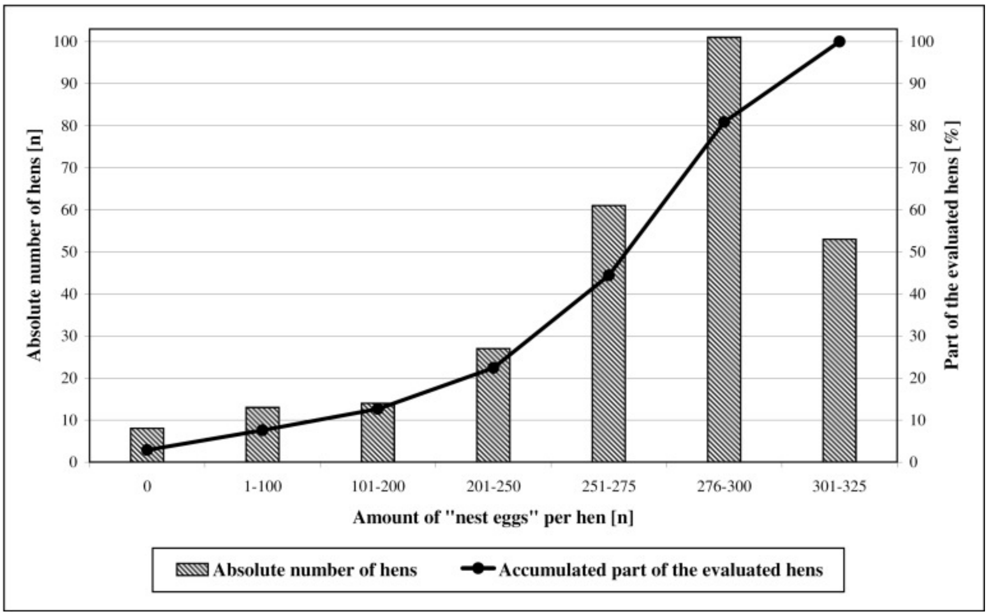

Figure 2 Amount of “nest eggs” per hen (277 LS hens were evaluated over the entire observation time)

The infection with *M. haemolytica* caused a slump in laying performance and affected the laying behaviour of the hens. Therefore only data after the cure of the infection, from the start of the fifth laying period to the end of the observation time, were used for the further evaluations. The duration of an average nest visit with a laid egg and the duration of an average nest visit without a laid egg is shown in Figure 3 for all evaluated hens. Nest visits without a laid egg had an average duration for all hens of 10.28 minutes and they were shorter than nest visits with a laid egg with an average duration of 28.57 minutes. All individual hens had nest visits without a laid egg. For the majority of the hens

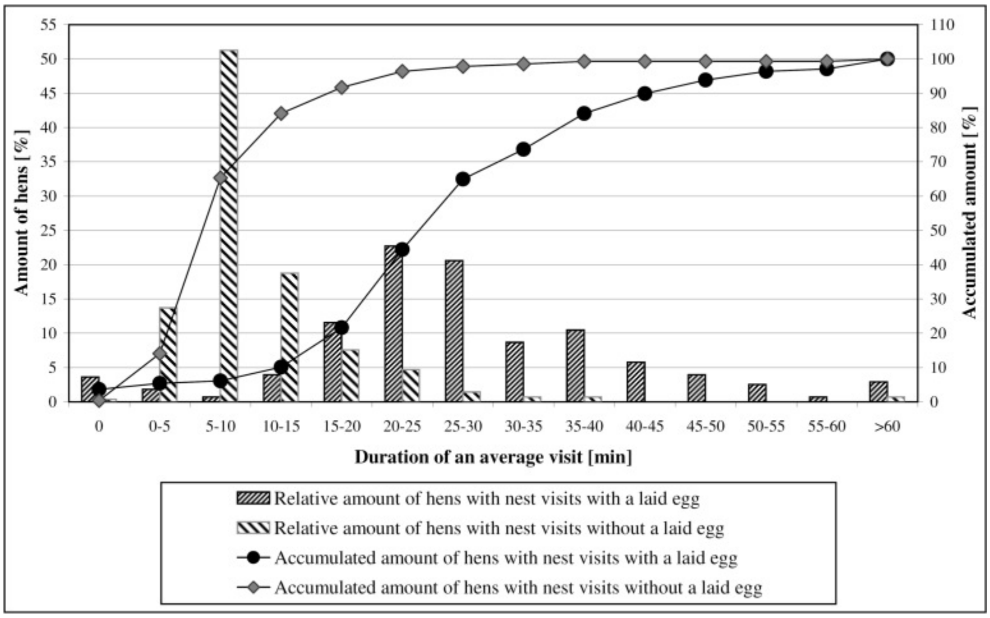

Figure 3 Average duration of all nest visits of each hen (277 LS hens, starting with laying period 5 (22.04.2005)) separated for nest visits with a laid egg and nest visits without a laid egg

these visits lasted on average between 5 and 10 minutes and for more than 90 % of the hens, they lasted no longer than 20 minutes. The highest value for a hen was 102.87 minutes. The average duration of nest visits with a laid egg was distributed over a wider time range. Nevertheless nearly 55 % of all hens stayed on average 15 to 30 minutes in a nest box to lay an egg. There were 10 hens (3.6 %) that did not lay an egg and 9 hens stayed on average more than 60 minutes in a nest box for a visit with a laid egg, with the highest value for a hen at 100.58 minutes.

PETHERIK et al. (1993) found in an experiment with ISA Brown pullets and different quantities of litter in nest boxes an average duration for nest visits where an egg was laid of 14.0 minutes, ranging from 0.5 to 88.0 minutes. Therefore the average duration was lower than with the LS hens in this experiment, but the range was similar. COOPER and APPLEBY (1995) found that an average ISA Brown hen spent in total 55 minutes in the nest box during three hours before oviposition. In another study with Hisex Brown medium hybrid hens the total duration of nest visits ranged between 29 and 41 minutes, depending on the width of the entrance to the nest area (COOPER and APPLEBY, 1996). Therefore, the total average time a hen spent in the nest box found in this experiment, which was 38.85 minutes, was located in the same band.

The FNB also allows to register automatically the exact laying time of each egg. Therefore, it was possible to calculate the absolute values of the time delay between consecutive eggs of the same laying sequence. Thereafter, an average time delay was calculated for each hen with more than 3 eggs (259 hens laid more than 3 eggs). The results are shown together with the total amount of registered eggs per hen and the average amount of eggs per laying sequence in Figure 4. The hens were sorted by the average amount of eggs per laying sequence, where "hen 1" had 28 laying sequences with an average amount of 2 eggs and "hen 259" had three laying sequences with an average amount of 80 eggs. The first half of the hens had on average 2 to 17 eggs per laying sequence with a total amount of 47 to 229 eggs and the average time delay varied between 11 and 76 minutes. The other half of the hens had on average 18 to 80 eggs per laying sequence with a total amount of 172 to 240 eggs and an average time delay varying between 10 and 29 minutes. Therefore, a lower time delay between the eggs was associated with a longer average laying sequence and a higher laying performance.

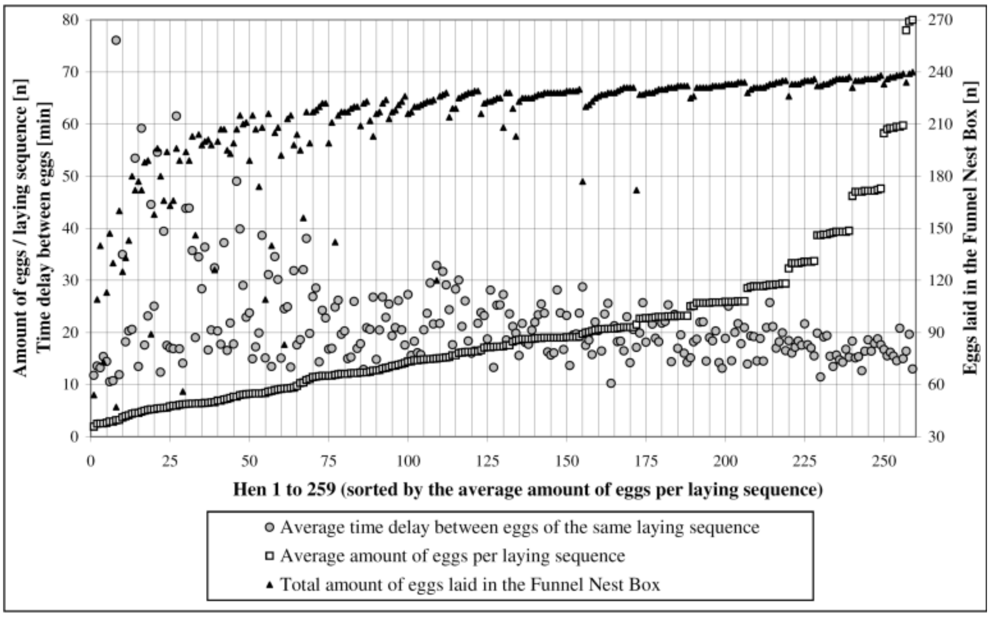

Figure 4 Average time delay between eggs of the same laying sequence for 259 hens and the total amount of eggs laid in the Funnel Nest Box, sorted by the average amount of eggs per laying sequence

LILLPERS (1991, pp. 15-17) found similar results for three groups of hens with two different breeds that were selected by different criteria (White Leghorn I: egg number; White Leghorn II: egg mass; Rhode Island Red: egg mass and food consumption). The hens of each group were divided into three types: Type A: 2 to 3 egg sequences, type B: sequences of 3 or more eggs and type C: one egg approximately at the same time every day. For all groups the total number of eggs was growing from type A to type C and therefore with increasing sequence length. Furthermore, the concentration around the mean oviposition time, which was calculated for each type of the three groups, showed a rising value when going from type A to type C, for all groups. Which means nothing else than the longer the sequence length the more concentrated around a mean value were the oviposition times. Even that Figure 4 does not exactly reflect the three types of LILLPERS (1991), the same trends can be found.

The FNB can be regarded as a reliable system to record laying performance and behaviour of laying hens in alternative group housing systems. Therefore, with this system it is possible to evaluate different lines and families in non-cage environments, to improve breeding programs with more emphasis on the requirements for group housing systems and to carry out different behavioural studies. In combination with the EPH the needs of the hens will be better known and the management but also the housing systems can be adequately modified.

Acknowledgements

This project was funded by the German Federal Ministry of Education and Research (Berlin) and by Lohmann Tierzucht GmbH (Cuxhaven).

References

COOPER, J.J. and APPLEBY, M.C. (1995) Nesting behaviour of hens: Effects of experience on motivation. *Applied Animal Behaviour Science* **42**: 283-295.

COOPER, J.J. and APPLEBY, M.C. (1996) Demand for nest boxes in laying hens. *Behavioural Processes* **36**: 171-182.

LANGE, K. (1996) Untersuchungen zum Leistungsverhalten verschiedener Legehennenhybriden in alternativen Haltungssystemen. *Lohmann Information* **4/96**: 7–10.

LILLPERS, K. (1993) Oviposition patterns and egg production in the domestic hen. Published PhD thesis, Swedish University of Agricultural Sciences, Department of Animal Breeding and Genetics, Uppsala.

MARX, G., KLEIN, S. and WEIGEND, S. (2002) An automatic nest box system for individual performance testing and parentage control in laying hens maintained in groups. *Archiv für Geflügelkunde* **66(3)**: 141-144.

N.N. (2004) Legehennen Management Programm Lohmann Silver. Lohmann Tierzucht GmbH, Am Seedeich 9-11, 27454 Cuxhaven; www.ltz.de. Accessed 31 August 2004.

PETHERIK, J.C., SEAWRIGHT, E. and WADDINGTON, D. (1993) Influence of quantity of litter on nest box selection and nesting behaviour of domestic hens. *British Poultry Science* **34**: 857-872.

PREISINGER, R. (1997) Züchtung von Legehybriden für alternative Haltungssysteme. *Lohmann Information* **3/97**: 9–11.

PREISINGER, R. (1998) Neue Linienkombinationen für Alternativhaltung. *Lohmann Information* **3/98**: 17–19.

PREISINGER, R., MÜLLER, J. and FLOCK, D.K. (1999) Ökologische Eierproduktion aus züchterischer Sicht. *Lohmann Information* **2/99**: 7–9.

THURNER, S. and WENDL, G. (2006) Nestauslastung automatischer Einzellegenester bei Legehennen in Gruppenhaltung. *Landtechnik* **61(3/2006)**: 164-165.