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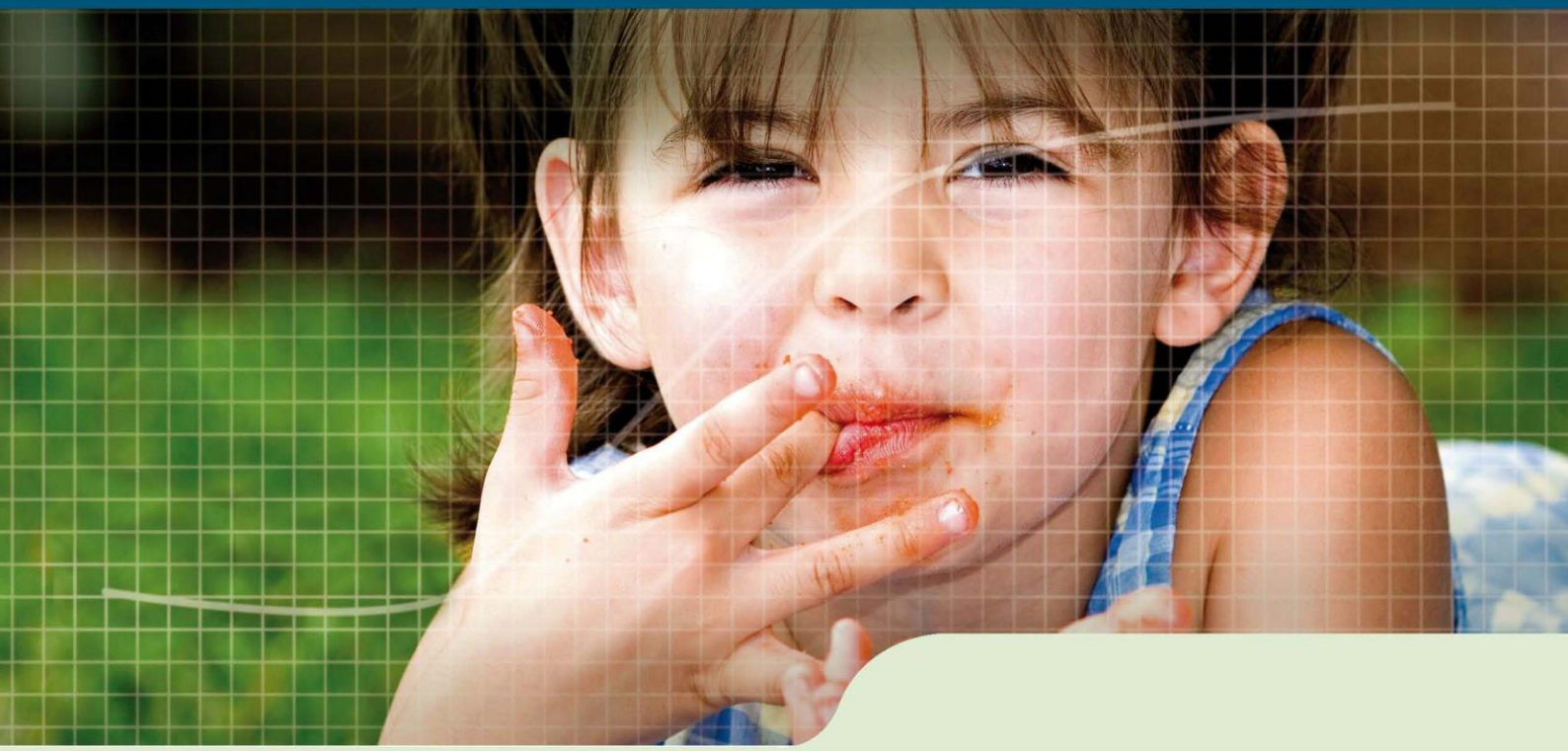

Report 713

Evaluation Meyn Footpad Inspection System

December 2013

LIVESTOCK RESEARCH
WAGENINGEN UR

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Colophon

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Wageningen UR Livestock Research and Central Veterinary Institute of Wageningen UR, both part of Stichting Dienst Landbouwkundig Onderzoek (DLO Foundation), together with the Department of Animal Sciences of Wageningen University comprises the Animal Sciences Group of Wageningen UR (University & Research centre).

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Abstract
This report describes the evaluation of an automated system to score footpad lesions at the slaughter plant.

Keywords
Automation, broiler, evaluation, footpad lesion, slaughter plant

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Ministry of Economic Affairs

Foreword

Meyn Food Processing Technology developed a camera system in cooperation with Wageningen UR to automatically score footpad lesions on the slaughter line. This report describes an evaluation of this system at the end of the development process. This evaluation was conducted at the request of the Ministry of Economic Affairs.

Ingrid de Jong (Project Leader)

Summary

During previous years, Meyn Food Processing Technology BV developed a camera system to measure footpad lesions automatically at the slaughter line. Wageningen UR Livestock Research validated this camera system at different slaughter plants in 2011. From that study it was concluded that the camera system performed well, but that a further improvement of the software for classification of the feet was necessary before their system could be implemented in practice instead of a trained quality officer or veterinarian at the plant.

Meyn subsequently worked on a further improvement of the software and the system is currently installed at two Dutch broiler slaughter plants. Before the camera can be used to perform measures under the Broiler Directive (Council Directive 2007/43/CE), a final evaluation of the system is necessary. The aim of the current study was to evaluate the camera system during one day at a Dutch broiler slaughter plant.

Measures were performed during one day for all flocks slaughtered on that particular day. Multiple samples were taken per flock if possible. The camera score was compared with a manual scoring of the feet for a total of 13 samples. Per sample, 100 right feet were scored manually of a total number of 300 feet scored with the camera. A comparison of manual and camera scoring for exactly the same feet was impossible due to the high speed of the slaughter line.

The scoring of the quality officer of the slaughter plant correlated significantly with the scoring of the assessor of WUR-LR. Therefore, for the current evaluation study we also used the comparison between scores of the quality officer (from a sample of 100 feet according to the Broiler Directive) and the camera scoring of the whole flock on seven subsequent days after the visit of WUR-LR.
The percentage of feet receiving a score from the camera system was very high, on average on the evaluation day 96.2% of the feet was scored. Feet that are turned in the shackles cannot be scored by the camera system. The correlation between the scoring of the camera and the assessor of WUR-LR was high. For three samples, the difference between the camera and the assessor was more than 20 points. However, it should be taken into account that these flocks predominantly had lesions receiving the middle score (score 1), implicating that many feet were at the border of score 0 and score 1, or at the border of score 1 and score 2. Even a trained assessor would presumably not score all these feet correctly.

Additional data of other days, where scores of the quality officer and the camera (entire flock score) were compared showed a high degree of correspondence between the camera and the quality officer. In conclusion, based on this limited evaluation the Meyn Footpad Inspection system seems to perform well. An advantage of the automated system is that it scores many more feet per flock as compared to a trained quality officer or veterinarian.

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1 Introduction

In 2006, Meyn Food Processing Technology and Wageningen UR Livestock Research developed a camera to automatically measure footpad lesions from broilers on the slaughter line. At the end of the project, a prototype camera was available with the potential to develop into a reliable and objective method for measuring footpad lesions (De Jong et al, 2008). After this project, Meyn made some improvements to the system. In 2011, Meyn Food Processing Technology and Wageningen UR Livestock Research tested the system in a number of Dutch broiler slaughterhouses. This study showed that the system has improved compared to the previous prototype, but further improvements in the software were necessary before the camera could be used as a measurement instrument for footpad lesions rather than measurement by a veterinarian or slaughter plant assessor on the slaughter line (De Jong et al, 2011). Subsequently, Meyn further improved the software for scoring footpad lesions by comparing the performance of the camera with the scores of a trained slaughter plant assessor or veterinarian in a number of slaughterhouses in Denmark and the Netherlands. Currently, June 2013, the camera is installed in two Danish slaughterhouses and two Dutch slaughterhouses. Before the camera can be used to measure footpad lesions in the Netherlands within the context of the Broiler Directive (Council Directive 2007/43/CE), a final evaluation is necessary.

1.1 Objective

The objective of this study was to assess the Meyn Footpad Inspection System during a typical day at a Dutch broiler slaughterhouse.

2 Method

2.1 Camera System

The camera validation is conducted at a Dutch broiler slaughterhouse. For a description of the camera system, we refer to De Jong et al. (2011). The camera was installed to carry out measurements after the feet are cut off. To enable correct positioning of the feet within the camera image, a positioning unit was installed before the camera on the line (Figure 1). Figure 2 shows the camera as it was installed at the slaughterhouse. Figure 3 shows a camera image of the feet in the shackle during measurements and a screenshot of the system.

Figure 1 Positioning unit before the camera in the slaughter line

Figure 2 Camera set up at the slaughterhouse visited

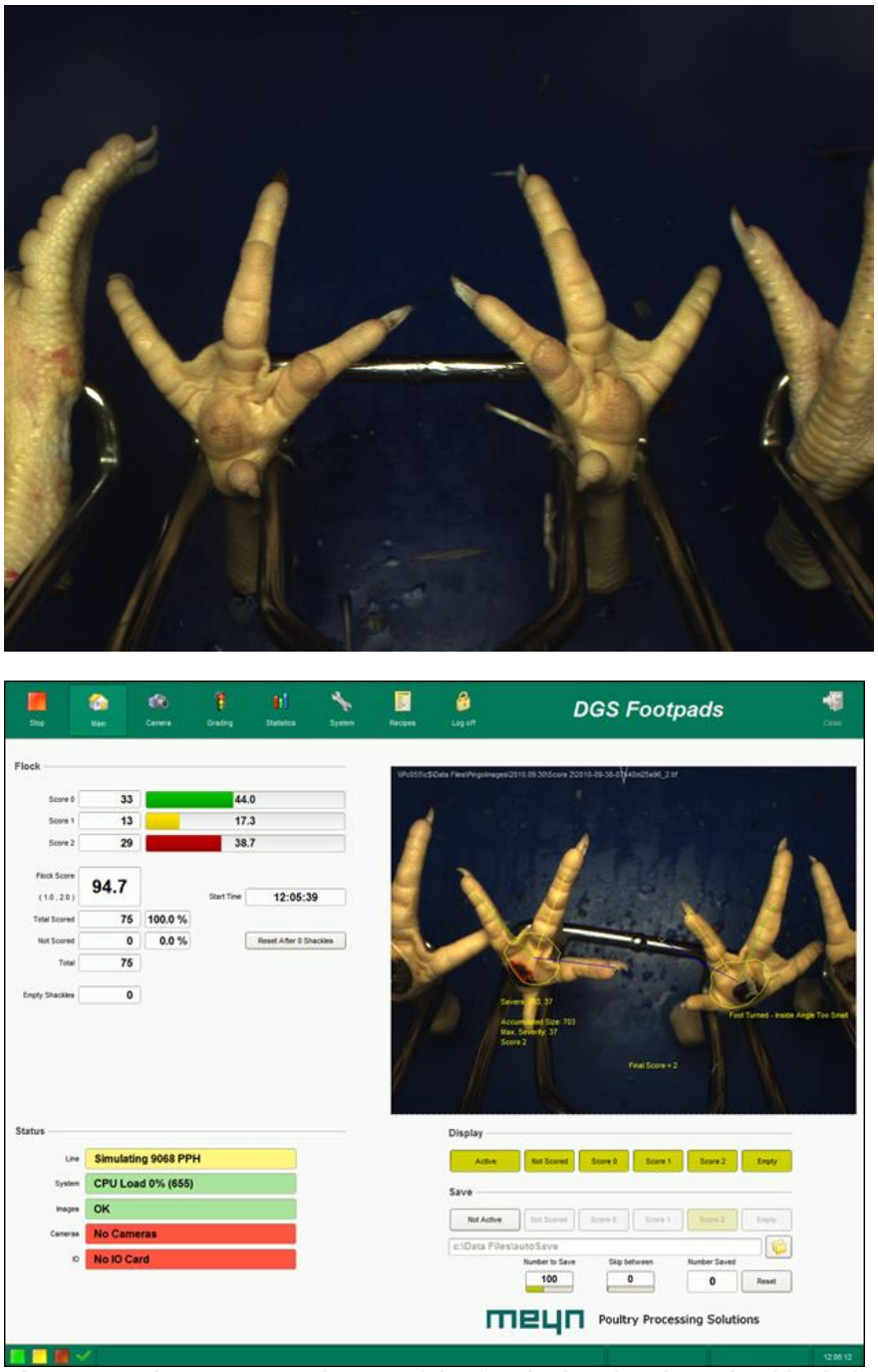

Figure 3 Above: camera image of the feet in the slaughter shackle during measurement (these legs were scored 0); screenshot of the system (below)

2.2 Collecting feet and images

During a one day (June 5, 2013) visit to the slaughterhouse (low scalding temperature), measurements were carried out on all broiler flocks slaughtered that day. A flock is defined as all animals from the same broiler house that were delivered to the slaughterhouse at the same time. One or more measurements were carried out for each flock (depending on the size and the time of slaughter) using the camera and by trained assessors. In total, thirteen samples were taken out of seven flocks from five farms. The samples were divided over the flocks that is to say, at approximately 1/3 and 2 /3 of the flock a sample was taken. The last flock was sampled once. Each sample was coded with a letter (differs per flock) and a number (for the sequence of the sample in a flock).

Due to the high line speed, it was not possible to make a one-to-one comparison between the camera score and the manual score. An adapted method was therefore selected in which images of the feet were stored and scored over a period of several minutes, while a sample of approximately 100 feet was simultaneously taken from the same series of feet of which the images were stored. This was achieved as follows: one person sat in the office at the computer with the Meyn Footpad Inspection system. Another person stood at the line, directly after the camera. The person at the line gave an audible signal to indicate that the sampling started, the person behind the Meyn Footpad Inspection system switched on the image storing. A third person then took approximately 100 right feet from the slaughter shackles. When these were collected, another audible signal was given to the person at the Footpad Inspection system, and the image storing was stopped. This ensured the series of stored images corresponded with the feet collected. The images were then scored by the camera and the sample of feet were manually scored by two people:

1. A WUR Livestock Research assessor, with years of experience scoring footpad lesions;
2. A trained slaughterhouse assessor with 8 months of experience scoring footpad lesions.

To score the images made by the camera the software set up named 2013_LS_NL (appendix 1) was used, which this specific slaughterhouse uses for scoring feet. The software contains a specific section for each slaughterhouse in order to ensure the position of the feet in the middle of the camera set up. The software also includes a section for lesion detection which is the same for all slaughterhouses. Finally, there is a setting for recognizing the class boundary. This setting differs between high or low scalding temperature slaughterhouses.

2.3 Comparison of camera with manual measurement

For validation of the camera system, it is important how the system results are in comparison to the independent WUR Livestock Research assessor. Because the slaughterhouse also records the score of the slaughter plant assessor and the camera system as a standard procedure, this data can also be used to assess the camera system. Therefore it is important that the score achieved by the slaughterhouse assessor is in accordance with the score by the WUR Livestock Research assessor. To do so, a comparison was made between the score of the slaughter plant assessor and the WUR Livestock Research assessor. Because there was a high correlation between the slaughter plant assessor and the WUR-LR assessor (see results), both scores were used to evaluate the system.

The feet were scored using the scorecard developed by Wageningen UR Livestock Research in 2011 that is based on the so-called “Swedish” scoring method for footpad lesions (Berg, 1998). This method divides the footpad lesions into three classes, briefly described as:

- Class 0: no discoloration or very slight brown discoloration of the footpad or almost healed lesion;
- Class 1: superficial damage, brown or black discoloration;
- Class 2: damage to the deeper layers of skin (lesion), including subcutaneous inflammation and/or bloody scabs or swollen foot (“bumble foot”).

Only the footpad is included in the scoring (De Jong et al, 2011). The camera also only scores the sole and does not count discoloration of the toes.

Camera data and manual measurement of footpad lesions are compared as follows:

- comparison of the percentage of lesions in class 0, 1 and 2;
- comparison of flock scores using the formula FPD score (flock score) = ([number of class 1 feet x 0.5] + [number of class 2 feet x 2]) x 100/Ntotal (De Jong et al., 2011).

2.4 Calculation correlations

Correlations (Spearman rank correlations) between flock scores from the camera, slaughter plant assessor and WUR-LR were calculated using the statistical software Genstat (version 15.2). When interpreting the data, the limited size of the sample must be taken into account.

3 Results

3.1 Percentage measured images

The camera cannot score feet that are hanging tilted or rotated in the shackles. The software determines if the foot can be scored based on the number and position of the toes. When only one foot can be scored, that particular score is recorded for the pair. When two feet can be scored, the most severe score is recorded. Figure 4 shows an example of camera images where only one foot has been scored.

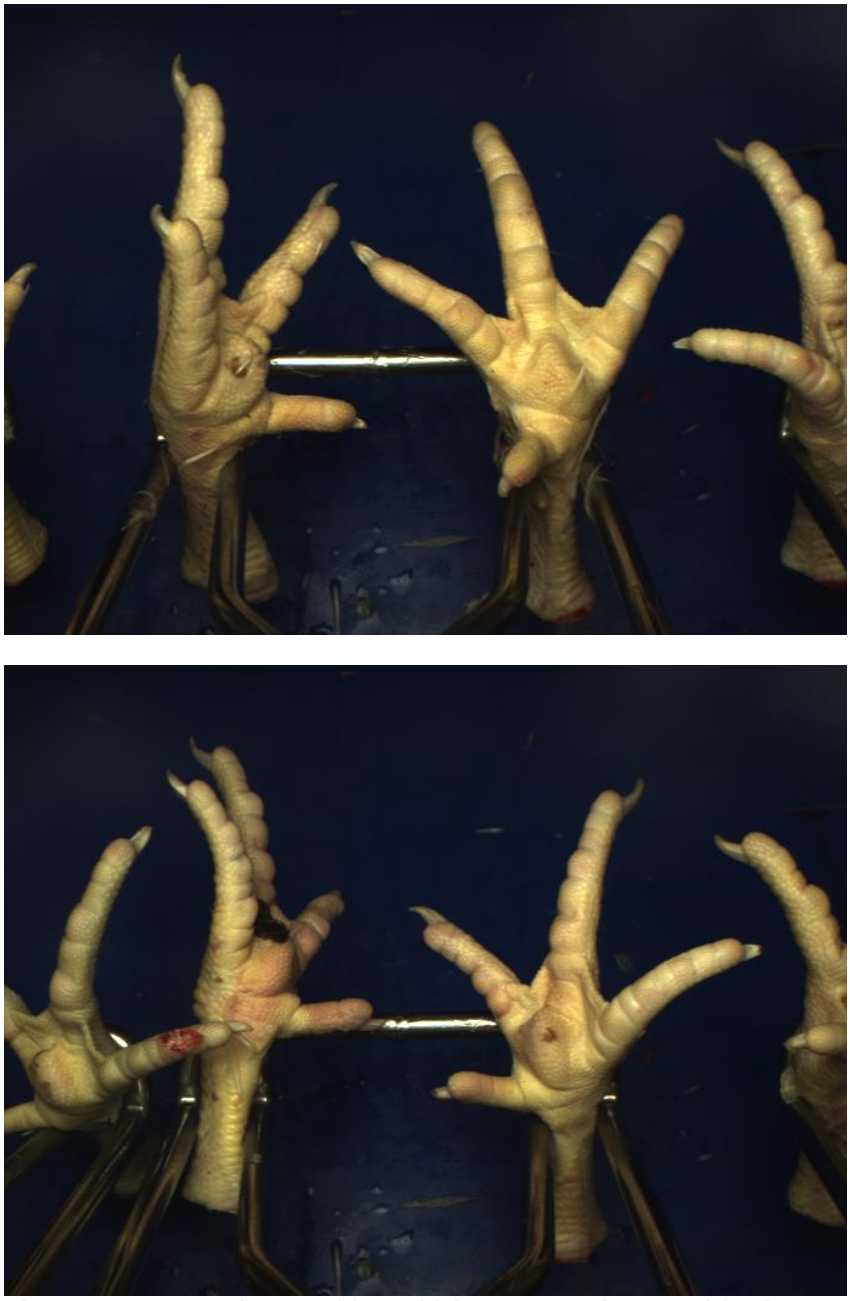

Figure 4 Camera image of feet which are severely rotated for the camera and so no score can be given (the left foot in both pictures). Due to the severely rotated position, the software excluded these feet from scoring. Both foot pairs were scored as class 0 (no lesion) despite the lesion on the foot in the bottom left picture.

Table 1 indicates the percentage of images in each sample that could be scored. On average, 96.2% of the images across all samples were scored.

Table 1 Percentage of images scored by the camera for each sample

Sample	% scored images
A1	93.7
A2	96.4
B1	96.6
B2	95.3
C1	94.9
C2	96.4
D1	96.9
D2	95.7
E1	97.4
E2	96.4
F1	96.9
F2	97.4
G1	97.1

3.2 Comparison of slaughter plant assessor scores and WUR-LR scores

The slaughterhouse assessor is trained in scoring footpad lesions in the basic course offered by PTC+ (Expertise and Training Centre, Barneveld, the Netherlands). His flock scores were compared with those of the WUR-LR assessor and the correlation between the slaughter plant assessor and WUR-LR was high (r_{sp}= 0.94, P<0.001) as shown graphically in Figure 5. Based on this, it was decided, for this evaluation, to also look at the correlation of the camera system scores per flock and the plant assessor scores per flock during the period between the 10th and 18th of June 2013. The camera system can then be evaluated based on a larger number of observations.

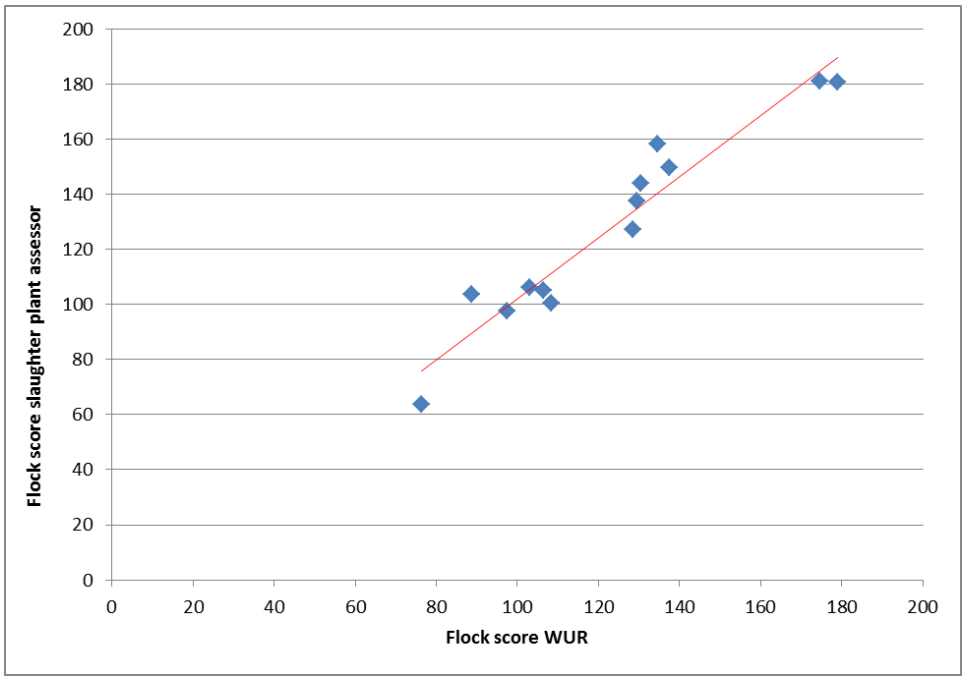

Figure 5 Relationship between the flock scores given by WUR-LR and the slaughter plant assessor

3.3 Comparison at the level of individual scores

The percentage of feet in a certain class as scored by the plant assessor, by WUR-LR and the camera is shown for each sample in Appendix 2. If the deviation in a given class was greater than 10%, this is indicated. The table shows that the percentages for class 1 and class 2 in particular can vary in some samples by more than 10%, but it must be taken into consideration that the camera scored a much larger number of feet than the assessors. It can therefore not be excluded that the distribution of classes in the total number of stored images differs from the sample of approximately 100 feet and it is not caused by incorrect scoring.

3.4 Comparison at the level of flock scores

Appendix 2 also shows the flock score by the camera, the slaughter plant assessor and the WUR-LR assessor for each sample. For three flocks, the flock score deviated from that of the WUR-LR assessor and the slaughter plant assessor by more than 20 points. Nevertheless, the correlation between the score from the slauther plant assessor and the camera was high (r_{sp}=0.88, p<0.001, Figure 6) as was the correlation between the WUR-LR assessor and the camera (r_{sp}=0.87, p<0.001) (Figure 7).

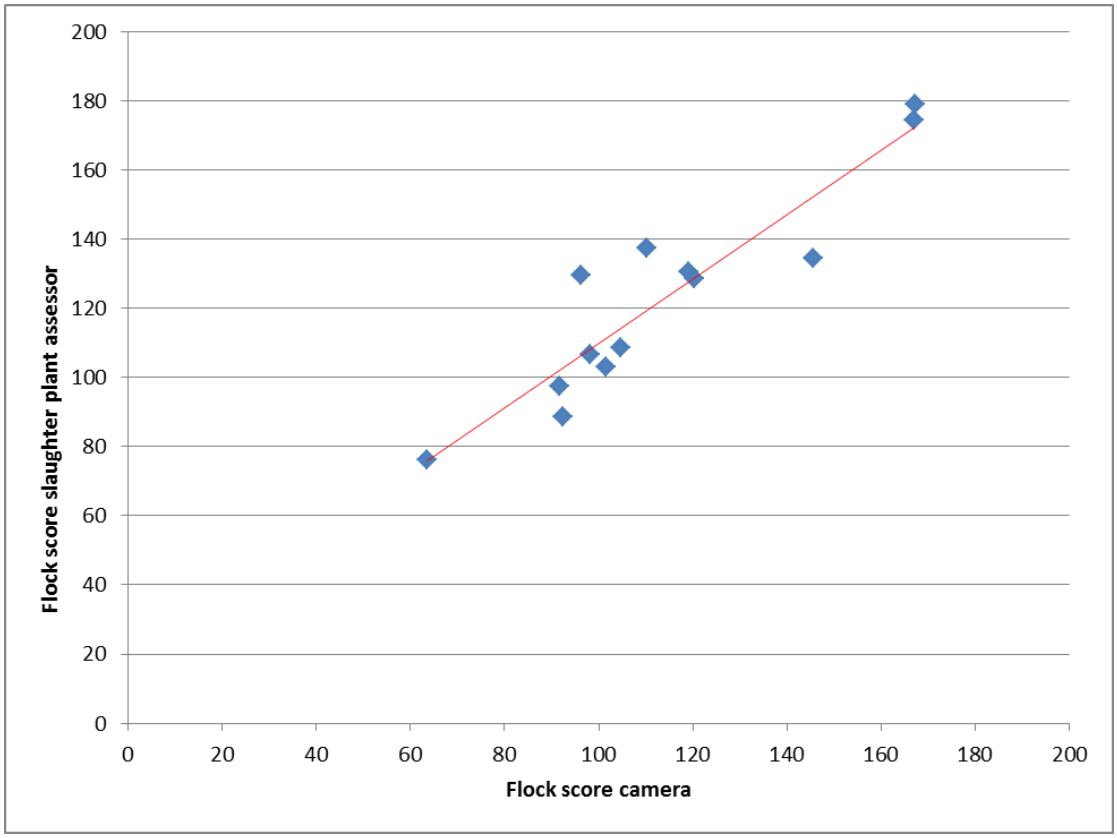

Figure 6 Relationship between the flock scores given by the camera and the slaughter plant assessor

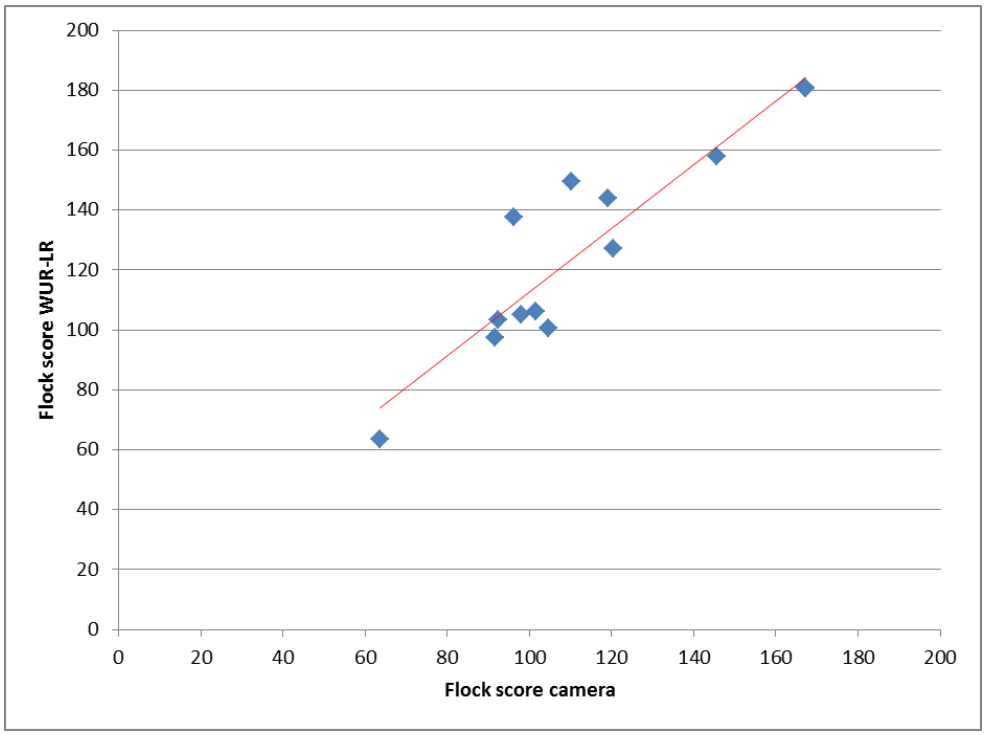

Figure 7 Relationship between the flock scores given by the camera and WUR-LR

Figure 8 shows the flock scores for each sample and assessor. As is apparent from this figure, the camera generally follows the score of the two evaluators, with the exception of three samples. These three samples were taken from flocks in which another sample was taken (flocks C, D and E) and where the scores from the assessors and the camera do match.

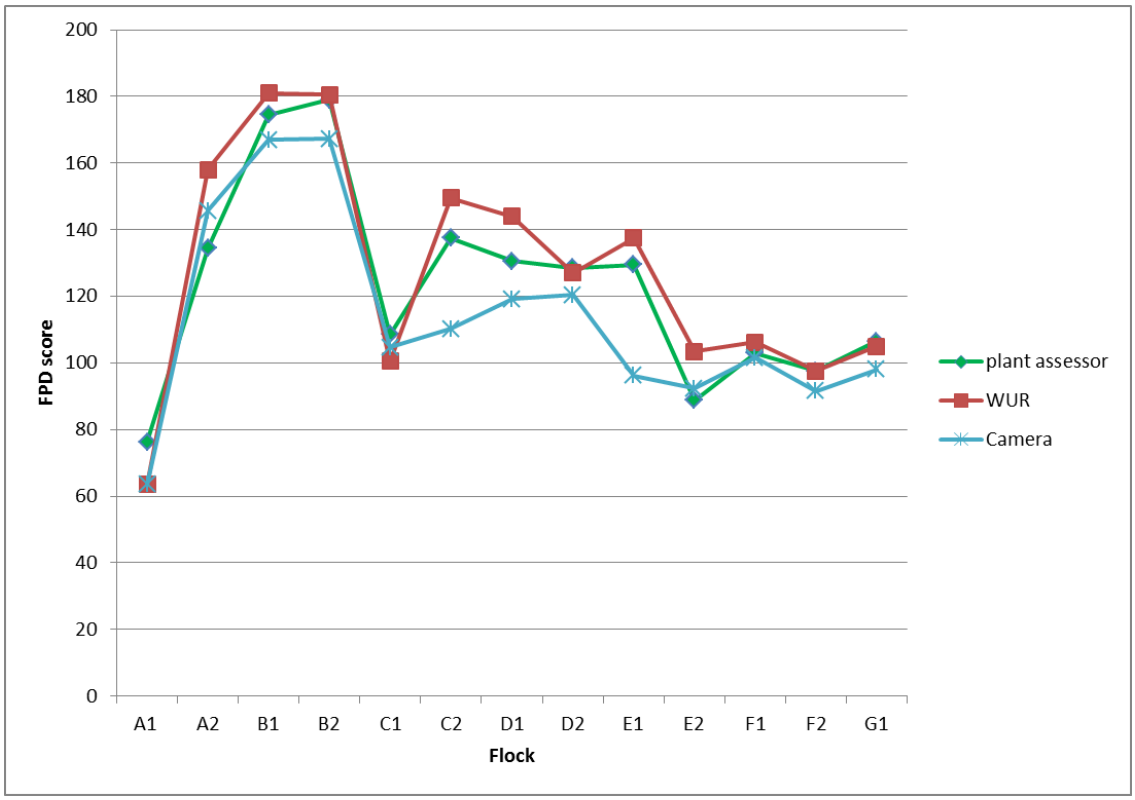

Figure 8 Flock scores as determined by the plant assessor, WUR-LR and camera

3.5 Additional data collected by the slaughterhouse

Figure 9 shows the data collected by the slaughterhouse between 10 and 18 June 2013. The FPD score for these 44 flocks was determined by both the plant assessor and by the camera. The slaughter plant has completed the scoring of a sample of 100 feet in the standard manner, while the camera is based on the entire flock. The correlation between the score by the plant assessor and the camera was high: R_{sp}=0.97, p<0.001. In four of the 44 flocks, the deviation of the camera was more than 20 points relative to the slaughter plant assessor (flocks 7, 21, 22, 42 in the graph).

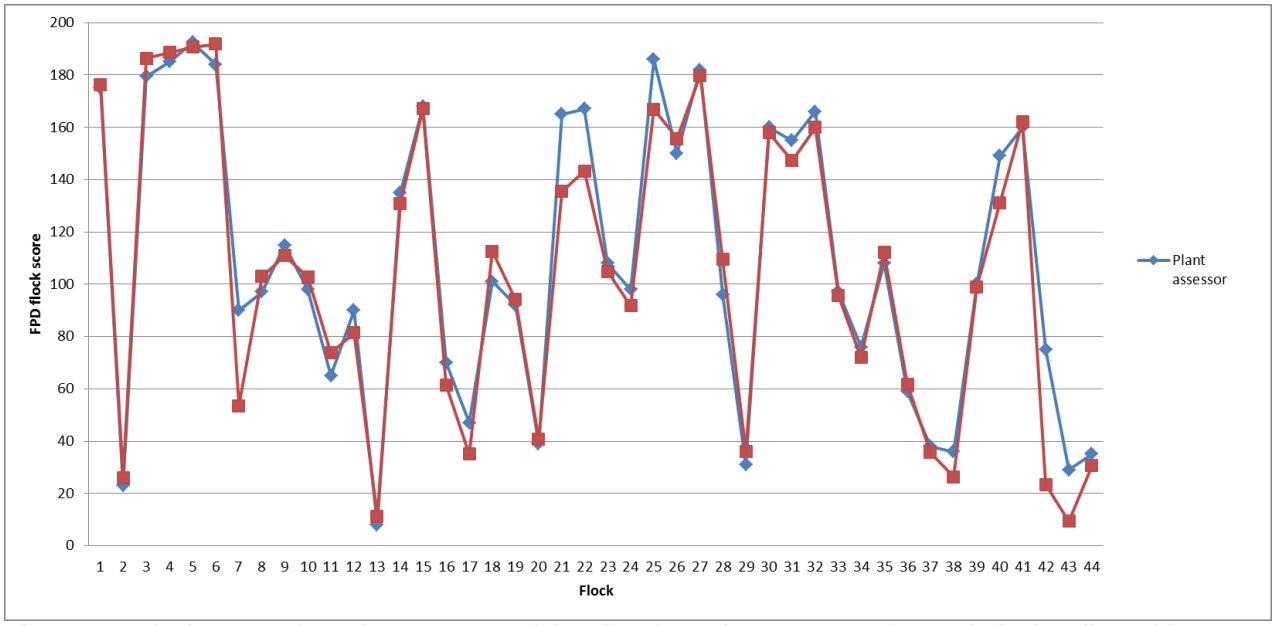

Figure 9 Flock scores from the camera and the slaughter plant assessor for each flock collected by the slaughterhouse during a 7 day period

4 Discussion and conclusions

The number of feet that was scored by the camera was well above the 70% minimum defined in previous research (De Jong et al., 2011) and well above the average number of feet scored at three slaughterhouses as measured in the same study (De Jong et al., 2011). Compared to the previous version, the Meyn Footpad Inspection system seems to be greatly improved on that point.

On the day of visit to the slaughterhouse, a significant number of flocks were slaughtered, which allowed 13 samples to be taken. Furthermore, while measuring, the flocks were found to be in the "middle range", i.e. predominantly not scored 0 (no lesions) or 2 (severe lesions), but the lesions were spread across the three classes. These are the most difficult flocks for the automatic camera system and the assessors to score since there are usually a large number of lesions which are on the border between 0-1 and 1-2. In this case, there were mainly lesions on the border between class 1 and class 2.

The conformity between the camera and the WUR-LR assessor is considered to be good in general. The correlation between the camera and WUR-LR assessor was high. If the individual samples are considered, there is a deviation of more than 20 points found between the camera and the WUR-LR assessor in three flocks. When the entire study is considered, the WUR-LR assessor usually scored slightly higher than the camera and the slaughterhouse assessor is between the two. It must be noted that it was sometimes difficult for the WUR-LR assessor as well as the slaughter plant assessor to correctly classify the lesions. Frequently, the surface area of the lesions on the epidermis was small, but the deeper layers of the skin had been affected. It is also very likely that both assessors classified feet incorrectly.

The assessment of the camera system, based on samples taken on one slaughter day, is very limited. Therefore, a number of Meyn reports are also included in this discussion to allow a better assessment of the system, as well as an additional dataset in which the scores from the slaughterhouse assessor are compared with the flock scores determined by the camera system.

The Meyn reports and additional data indicate that, after adjusting the software, the camera predominantly performs well compared to manual scoring by inspectors or veterinarians on the slaughter line (Pieterse and Capiau, 2013; van Poorten undated; personal communication C. Pieterse, Meyn, May 2013 and June 2013, additional data 10-18 June 2013). A number of changes implemented in the software since the system was validated in 2011 have collectively led to lesions in the central area in particular (score 1) being recognized much better. Occasionally there is a deviation between the camera and the slaughter plant assessor, but it should be kept in mind that an slaughter plant assessor will not score the feet correctly 100% of the time. Moreover, such a deviation may also be due to the small sample seen by the slaughter plant assessor in a highly variable flock.

In conclusion, based on a limited comparison of footpad lesions scoring by the Meyn Footpad Inspection system and WUR-LR, the camera system appears to perform correctly. The correlation can be considered good based on the flock scores, especially since the flocks were in the middle range. It should also be taken into consideration that inspectors or other trained evaluators will not always operate flawlessly and can only sample a very limited portion of the flock. The large number of feet that can be scored is a major advantage of the camera system since a manual sample of only 100 feet (according to the Broiler Directive, Council Directive 2007/43/CE) is very small in flocks of 20-30,000 broilers. Scoring variation may occur within a flock, for example wet spots in the hatchery may cause an increase of footpad lesions in a portion of the flock. In such a case, the camera will provide a more reliable overall picture of the flock.

Literature

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Poorten, P. van., zonder datum. Report Working Footpad Camera in Dutch plant. Meyn interne rapportage.

Appendices

Appendix 1 Software settings '2013_LS_NL'

```
[MeasureGroupFront]
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ScoreThresholdSize0to1=100
ScoreThreshold1to2=26
ScoreThresholdSize1to2=700
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bWeighingFactor2=2.000000

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Horizontality=110
ShackleCenter=0
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FootDistanceDiff=70
ToeLength=85
ToeAngle=33
ShrinkFootArea=15
LesionThreshold=24
LesionThresholdRed=60
LesionThresholdGreen=38
IgnoreVerySmall=79
SevereAtSize=20
IgnoreLightRed=10
IgnoreDarkShadow=100
ExtraRuleSeverityMin=2
ExtraRuleSeverityMax=26
ExtraRuleSizeMin=200
ExtraRuleSizeMax=800
```

Appendix 2

The table below shows the score for each assessor (slaughter plant ('inspector') or WUR-LR) per sample (1) and for the camera (2) with software set up "2013_LS_NL". In three samples, there is a difference in the total number of feet assessed by the WUR-LR and the inspector (yellow shading). Because the feet are scored independently, a counting error may have occurred in either. Numbers were also sometimes verbally given to a third party to record and there may be errors in scoring due to noise in the environment. Because it is not known where the error has occurred, the calculated percentages based on the total number of feet assessed have been used. Subsequently, the percentages in a particular class are shaded if the difference with respect to the camera is greater than 10% (blue for the inspectors, red for WUR-LR). For the flock scores, differences of more than 20 points are shaded.

Sample	Assessor	% score 0	% score 1	% score 2	Flock score	Number of feet
A1	inspector	53.54	11.11	35.35	76.3	99
	WUR	57	15	28	63.5	100
	Camera	**48.9**	**25.8**	**25.3**	**63.5**	**415**
A2	inspector	11	29	60	134.5	100
	WUR	9	16	75	158	100
	Camera	**9.4**	**23.6**	**66.9**	**145.7**	**351**
B1	inspector	9	5	86	174.5	100
	WUR	8	2	90	181	100
	Camera	**3.8**	**17.0**	**79.2**	**167**	**395**
B2	inspector	9	2	89	179	100
	WUR	9	1	90	180.5	100
	Camera	**6.6**	**13.1**	**80.3**	**167.2**	**244**
C1	inspector	33	17	50	108.5	100
	WUR	34	21	45	100.5	100
	Camera	**30.2**	**23.3**	**46.5**	**104.7**	**374**
C2	inspector	17	19	64	137.5	100
	WUR	17	11	72	149.5	100
	Camera	**21.0**	**31.8**	**47.2**	**110.2**	**352**
D1	inspector	16	25	59	130.5	100
	WUR	19	12	69	144	100
	Camera	**19.7**	**27.7**	**52.7**	**119.1**	**376**
D2	inspector	20	21	59	128.5	100
	WUR	26	14	60	127	100
	Camera	**16.5**	**31.1**	**52.4**	**120.4**	**334**
E1	inspector	18	23	59	129.5	100
	WUR	14	23	63	137.5	100
	Camera	**13.3**	**51.5**	**35.2**	**96.2**	**369**
E2	inspector	37.25	24.51	38.24	88.72	102
	WUR	31	23	46	103.5	100
	Camera	**22.6**	**41.6**	**35.8**	**92.4**	**296**
F1	inspector	42.43	8.08	49.49	103.0	99
	WUR	39.17	10.31	50.51	106.2	97
	Camera	**27.2**	**29.4**	**43.5**	**101.6**	**313**
F2	inspector	46	7	47	97.5	100
	WUR	43	11	46	97.5	100
	Camera	**35.1**	**25.5**	**39.4**	**91.6**	**368**
G1	inspector	40	9	51	106.5	100
	WUR	37	14	49	105	100
	Camera	**26.0**	**33.2**	**40.8**	**98.1**	**373**

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