Evaluation of Veterinary Training on Egg-laying Hen Welfare and Keel Bone Damage Assessments in Kenya

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HEALTHIER HENS

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Executive Summary

Healthier Hens (HH) recently conducted a comprehensive two-day workshop in Kenya, in collaboration with the University of Nairobi, targeting veterinary professionals to enhance their understanding of egg-laying hen welfare and keel bone damage (KBD). The workshop, attended by 18 selected participants including veterinarians and para-veterinarians, focused on equipping attendees with both theoretical and practical skills and knowledge crucial for on-farm welfare assessments.

This two-day in-person training comprised diverse modules covering topics from animal welfare principles to hands-on KBD assessment techniques, delivered through a blend of facilitator presentations, live webinars, laboratory sessions, and on-farm visits. By adopting this multifaceted approach, the aim of the workshop was to provide participants with a comprehensive understanding of hen welfare and bone health, essential for effective veterinary practice and improved welfare outcomes for hens.

Data collection involved pre-, post-, and follow-up workshop surveys, offering insights into participants' baseline and endline knowledge, perceptions, and motivations and impact of the workshop. Additionally, a key informant survey was administered six weeks later to two participants, eliciting valuable feedback on the practical application of newly acquired skills in their professional settings.

Analysis of the results showed a 6% to 33% increase in knowledge of animal welfare, hen welfare and welfare-driven housing systems, demonstrating significant improvements in knowledge and motivation among participants. Nonetheless, disparities were noted in recognizing and implementing good hen welfare practices, underscoring the urgency to address outdated beliefs such as those related to debeaking and hormone use. Participants expressed a strong desire to further explore areas such as practical keel bone examination, the connection between hen welfare and productivity, and humane handling practices during routine procedures like vaccination and transportation.

Based on the findings, we proposed several recommendations for improving future workshops, including providing guidance on sustainable alternatives to unacceptable welfare practices, the development of tailored learning modules, extension of training durations, and increased resources for keel bone scoring demonstration. Despite the positive outcomes observed, it is essential to acknowledge the study limitations posed by participant diversity and potential biases. In conclusion, the workshop's success is evident in the enthusiasm and commitment demonstrated by participants in applying newfound knowledge. Addressing identified limitations and implementing the proposed recommendations can further amplify the impact of future initiatives, ultimately fostering improved hen welfare practices within the poultry industry.

Acknowledgements

We extend our appreciation to the organisational team of the Faculty of Veterinary Medicine at the University of Nairobi who partnered with us to provide this unique training for Kenyan veterinary professionals. We found the collaboration to be fruitful and successful in terms of the overwhelmingly positive response from the participants.

Dr. Michael Toscano for facilitating the training, preparing the content and structure of the hands-on parts of the training and his time flying out to Kenya to run this training programme.

Ms. Eve Kavinya, our intern, for her vital role in managing the event. All of the presenters, who were able to deliver key hen welfare content in-person and via video calls, making this training ever so informative.

The supporting staff of the University of Nairobi, who helped run the training smoothly and the caterers of Vetlab Sports Club for the nourishing meals.

Ms. Monica Njicha for agreeing to host the in-farm welfare assessments at her farm, showcasing great interest from and collaboration opportunities with the industry.

Their contributions enabled operations and enhanced the success and depth of the training.

thank you

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Introduction and Background

Healthier Hens is an animal health and welfare non-profit organisation established to find cost-effective interventions to mitigate the issues of poor bone health in egg-laying hens. Egg-laying hens face significant risks to their bone health due to the demands of their breeding and egg-laying cycles, which often lead to daily egg production. This process places specific nutritional requirements on hens, including the need for adequate levels of calcium, phosphorus, and vitamin D3. Consequently, deficiencies in these nutrients (among other issues like genetics, housing and management) can lead to bone health problems, commonly manifesting as keel bone damage and other deformities. Such issues are not only detrimental to the hens' well-being but also pose significant welfare concerns.

In the course of Healthier Hens' initial field work and research in Kenya – our pilot country of operations – we have discovered that layer-hen feed may not be meeting appropriate standards for key nutrients of interest, particularly calcium, phosphorus, vitamin D3 and protein, deficiencies of which are high-risk factors for poor bone health. These results provide credence to the hypotheses that there might be a high prevalence and risk of poor bone health and keel bone damage in hens in Kenya. It is important to note that in the global north where there is a lot of data on this, the prevalence of KBDs is high. Furthermore, during our stakeholder engagement, we have further learnt that the awareness of hen welfare, KBD and keel bone fractures (KBF) and assessing such welfare issues on farms is limited. This poor awareness is prevalent among veterinary professionals, albeit less so as compared to cage-free poultry farmers.

Assessments of keel bone damage can be done by a variety of techniques which include live-bird palpation, radiography, and post-mortem evaluations. Live-bird palpation is the most widely employed technique due to its low cost and high processing speed. However, the method has limitations when it comes to accuracy, reliability, and subjectiveness. Furthermore, since the majority of KBFs occur at the caudal tip, where assessor agreement is typically low, specialised training for palpation is recommended (Tracy et al., 2019) for personnel who engage in KBD assessments.

There is strong evidence in scientific literature that palpation experience and dedicated training can improve assessment performance, with accuracy increasing with familiarity (Chargo et al., 2019), inter-observer repeatability (Gebhardt-Henrich et al., 2019), and both accuracy and assessor agreement (Petrik et al., 2013). Also, despite the fact that assessors with prior experience are shown to be more accurate in general, some improvement can be achieved quite quickly even in inexperienced assessors (Buijs et al., 2019).

Therefore, the Healthier Hens team embarked on a project to pilot a workshop to train a group of veterinarians in Kenya, build their knowledge on hen welfare and provide hands-on capacity building and exercises on KBD assessment in layer hens.

Methodology

Description of Training Workshop

A two-day training workshop was held on 17th and 18th November 2023 to train select veterinary and para-veterinary professionals in Kenya on hen welfare and KBD assessment in layer hens. The training included a variety of relevant topics including an introduction to animal welfare, good hen welfare practices, and bone health issues, followed by practical demonstrations of KBD assessment via live-bird palpation and visual assessment post dissection. The training was conducted in collaboration with the University of Nairobi, where the Faculty of Veterinary Medicine provided support with organisation, planning, and logistics, and facilitated the inclusion of the training as a Continuous Professional Development (CPD) course with the Kenya Veterinary Board (KVB). In this way, participants (veterinarians and para-veterinarians) who completed this course successfully satisfied some of their annual CPD points requirements.

To recruit participants, a general call for applications was drafted and published on the Healthier Hens platforms, and then promoted by our partners and stakeholders at the University of Nairobi, Kenya Poultry and Pigs Veterinary Association (KEPOVA), and Africa Network for Animal Welfare (ANAW) who shared it on the various veterinary professional WhatsApp groups. While there were about 73 applications for the training, only 22 were shortlisted and selected to participate in the training workshop due to limited space availability. Key selection criteria were the number of farms and total hens served, as we wanted potential benefits to have a large impact. Other criteria included being a veterinarian or para-veterinarian, having considerable work experience and interest in the poultry sector, a key demonstration of motivation and interest in the training, and a commitment to utilising and applying the lessons learned and skills in their regular work with egg-laying hen farms.

Throughout the two-day workshop, 11 modules were taught by several facilitators using a variety of educational methods which included powerpoint presentations by facilitators, video presentation, class discussions, practical sessions in the veterinary surgery room and a site visit to a cage-free poultry farm. The modules taught included:

1. Introduction to Egg-Laying Hen Welfare
2. Overview of animal welfare progress in Kenya
3. Life Cycle of Egg-Laying Hens, Welfare issues
4. Handling and Examination of Egg-Laying Hens (Practical)
5. Hen welfare assessment with live hens & palpation (Practical)
6. Welfare-compliant hen euthanasia (Practical)
7. Early-life and Environment impact on Welfare
8. One Health, One Welfare
9. Understanding behaviour, stress & Enrichment for Hens
10. Showcasing good on-farm practices (Practical)
11. Hen dissection PM keel bone damage assessment (Practical)

Facilitators for these modules included:

- **Dr. Michael Toscano;** University of Bern, Switzerland
- **Dr. Joyce Maina;** University of Nairobi
- **Professor Paul Mbugua,** University of Nairobi
- **Dr. Kelvin Osore;** Kenchic
- **Dr Oluwaseun Iyasere;** Humboldt University of Berlin, Germany; Federal University of Agriculture, Abeokuta, Nigeria
- **Mia Fernyhough;** The Humane League
- **Dr. Elynnalma Njeri**; Africa Network for Animal Welfare (ANAW)
- **Dr. Lynn Namarome;** Kenya Pig and Poultry Veterinary Association (KEPPOVA)
- **Dr. Kikiope Oluwarore;** Healthier Hens

In addition, participants were provided with workshop materials and equipment such as writing materials, personal protective equipment (PPEs), surgical and post-mortem instruments and live cage-free hens. For quality assurance purposes, a representative of the Kenya Veterinary Board was also present throughout the course of the training to monitor the progress of the workshop and ensure compliance of organisers and participants with the board's CPD requirements.

Data Collection

A mixed-methods approach was utilized to assess the progress and impact of the training workshop on the participants. Data collection primarily involved administering pre- and post- and post-post workshop survey questionnaires to the participants, supplemented by post-workshop key-informant surveys.

Survey Questionnaires

At the workshop, participants were provided with pre- and post-workshop survey questionnaires hosted on Google Forms, before the training started and immediately after the training, respectively. The pre-survey questionnaire was applied to measure the baseline knowledge, information and experiences that participants had on hen welfare and KBDs, while the post-survey questionnaire was applied to measure the change (if any) and level of knowledge acquired from the workshop, evaluate their perception of the quality and impact of the workshop and their motivation for subsequent application and use in their day-to-day professional work with poultry farms. An additional post-post survey questionnaire was deployed to measure similar elements as the post-survey questionnaire but with an emphasis on retention and field application of lessons learned.

The pre-survey questionnaires was administered just before the onset of the workshop on the first day and it collected information on the demography of participants, with baseline knowledge of animal welfare, hen welfare and KBDs. The post-survey was administered after the completion of the workshop on the 2nd day of the workshop and post-post survey questionnaires was administered 3 momths after the workshop. Both collected the same information (excluding demographics) as the pre-survey questionnaires and included additional data on participants' perceptions of the impact of the workshop and motivation for application and use after the workshop.

Key Informant Questionnaires

6 weeks after the workshop, 2 participants were engaged in a key informant questionnaire to provide their feedback and insights into the impact of the workshop on their fieldwork on poultry farms, their application of new skills and lessons learned so far.

Data Analysis and Storage

Data collected were stored and managed on restricted access folders on the internal Healthier Hens Google Drive platform. Also, informed consents were received, and all survey respondents were anonymized. Qualitative data were evaluated through content analysis and survey data were subjected to descriptive statistics using Microsoft Excel 2010.

Results

Demography

A total of 18 trainees participated in the workshop and completed the pre- and post-test questionnaires. The trainees were residents in a variety of counties such as Nairobi, Garissa, Nakuru, Machakos, Lakipia, Bungoma, Kericho and Kirinyaga. 89% (16) of respondents were male and 11% (2) were female. 50% (9) of respondents were between the age group of 25 to 34 while 33% (6) of the respondents were between the age group of 35 to 44. Participants included a mix of veterinarians and para-veterinarians with varying educational levels. Half of the trainees had an undergraduate veterinary degree (BVM or BVMS), 11% had a bachelor's degree. Others have attained a postgraduate degree with Masters (22%) and PhD (6%). 78% (14) of the trainees wre practising veterinarians, while the minority included 3 para-veterinarians (17%) and 1 student (6%). More information on the demography of participants is included in Table 1.

Demography of Respondents; N=18			
		N	%
Gender	Male	16	89%
	Female	2	11%
Age group	18 – 24	1	6%
	25 – 34	9	50%
	35 – 44	6	33%
	45 – 54	1	6%
	55 – 64	1	6%
	> 65	0	0%

Educational level attained	Student	1	6%
	Diploma	1	6%
	Bachelors (BSc)	2	11%
	Veterinary degree (BVM/BVMS)	9	50%
	Masters	4	22%
	PhD	1	6%

Table 1: Demography of Respondents

Pre-Workshop Survey

This section presents the results of the data collected from the pre-workshop survey.

Knowledge of Animal Welfare

Respondents were asked questions to test their knowledge of animal sentience, the five freedoms of animal welfare and animal welfare regulations in their country, Kenya. Results show that the majority of respondents (83%) gave correct answers that demonstrated their understanding of animal sentience. Also, respondents were asked to identify the 5 freedoms of animal welfare, from a list of 5 correct answers and 3 incorrect answers. The list of answer options included Freedom to be cared for, Freedom from hunger and thirst, Freedom from discomfort, Freedom from pain,

Table 2: Which of the following are part of the Freedoms of Animal Welfare?

Score 1 - 2	11%
Score 3 - 4	17%
Score 5 - 6	17%
Score 7 - 8	56%
Perfect score (8)	56%

injury or disease, Freedom to reproduce, Freedom to express normal behaviour, Freedom from disorders and defects, and Freedom from fear and distress. However, just over half of respondents (56%) demonstrated an excellent knowledge of the freedoms of animal welfare.

Furthermore, when asked to recall the existing animal welfare legislation in Kenya, only 50% of respondents were able to state the correct legislative framework for the country which is The Prevention of Cruelty to Animals, Chapter 360. Other legal provisions stated by some respondents included the Animal Diseases Act and the Meat Control Act which is said to explain animal welfare guidelines during slaughter.

Knowledge of Hen Welfare

Respondents were asked several questions to test their knowledge and understanding of hen welfare, hen welfare behaviour and practices, various housing systems and their impact on hen welfare. All respondents (100%) indicated that they believe that hens can experience pain and suffering. Reasons for their answers included a recognition that hens are sentient beings, hens' exhibition of fear when inflicted with pain, and the presence of neuro-sensory organs in hens.

"Animals just like humans are sentient beings".

"Hens do have nerves that can sense pain. They are also a change in health, feeding and showing natural behaviour when an animal is feeling pain".

Figure 1: Sample of Participant responses on Hen Sentience

Score 1 – 3	6%
Score 4 – 6	0%
Score 7 – 9	6%
Score 10 - 12	89%
Perfect score (12)	**39%**

Table 4: Which of the following is considered normal behaviour indicative of good welfare in hens?

Also, respondents were prompted to identify normal and natural behaviours of hens that indicate a state of good welfare, from a list of 7 correct and 5 incorrect answers. This list of answer options included Brooding, Nesting, Feather pecking, Cannibalism, Dustbathing, Stretching, Foraging, Flapping of wings, Toe pecking, Piling, Perching, and Aggression. While the majority of respondents (89%) had at least 10 out of 12 answers correct, only 39% had a perfect score that demonstrated an excellent knowledge of natural hen welfare behaviour.

Respondents were asked if there was a difference between hen health and hen welfare. This question was asked as there is often a misconception that an animal can be considered as being in a good state of welfare, just by being apparently healthy and free of disease. Results showed that 78% agreed that there was a difference while 22% indicated that there was no difference. Some reasons given by participants who indicated a difference have been documented in the table below:

"Hen health deals with diseases treatment and control measures. Hen welfare deals with provision of comfortable rearing environment, free from pain, distress, lack of hunger, thirst, etc."

"I think hen health tends to focus on the general wellbeing of hens, them being free from disease while hen welfare focuses on hens ability to express natural behaviour"

"Health is just a subset of what welfare is. Welfare is broad and includes other parameters such as the affective state of the animal".

Figure 2; Sample of Participant responses on Hen health and Hen Welfare

Respondents were asked to select the most relevant, key inputs to hen welfare, and this consisted of 8 correct and 3 incorrect answers. The answer options included Nutrition, Price of eggs, Gender of hens, Biosecurity, Stocking density, Water quality, Eggshell colour, Housing, Air quality, Health management, and antimicrobial stewardship. While the majority of respondents (67%) had at least 10 out of 11 answers correct, only 28% had a perfect score that demonstrated an excellent knowledge of important inputs and activities that contribute to hen welfare.

Score 1 – 3	0%
Score 4 – 6	11%
Score 7 – 9	22%
Score 10 - 12	67%
Perfect score (12)	**28%**

Table 5: Which of the following are important to Hen Welfare

Respondents were also asked to identify which farm management practices were good or bad for hen welfare. Their responses have been analyzed in the table below and the results show that while most participants chose the correct farm management practices, there were obvious variations with beliefs that over-feeding, use of hormone stimulants, debeaking, declawing, and battery cages are good farm management practices

Table 6: Identify any of the following as good,

	Verdict	% Good	% Bad	% Don't Know
Overcrowding	Bad	0%	100%	0%
Overfeeding	Bad	6%	83%	11%
Underfeeding	Bad	0%	100%	0%
Poor hygiene	Bad	0%	100%	0%
Antibiotics misuse	Bad	0%	100%	0%
Hormones/ stimulants	Bad	17%	67%	17%
Debeaking	Bad	28%	67%	6%
Declawing	Bad	28%	61%	11%
Battery Cages	Bad	17%	72%	11%
Free-range housing	Good	100%	0%	0%
Cage-free deep llitter	Good	94%	0%	6%
Nesting areas	Good	100%	0%	0%
Env. enrichment	Good	94%	0%	6%

Respondents were asked to rate how much hen welfare was important to poultry farms and over 80% indicated the high importance of hen welfare to poultry farms and all respondents indicated that hen welfare must be integrated into farm management practices. Respondents were asked to indicate their preference for housing systems for hens. Most respondents indicated that the free-range system was best for hen welfare while the deep-litter system was best for egg production.

	Best Housing system for Hen welfare	Best Housing system for Egg production
Battery cage system	6%	22%
Deep Litter system	22%	61%
Free-range system	72%	17%

Table 7: Preference for housing systems

Knowledge of Keel Bone Damage (KBD)

Also, respondents were prompted to identify basic nutrients needed for bone health in hens, from a list of 3 correct and 4 incorrect answers. This list of answer options included Phosphorus, Calcium, Vitamin D3, Vitamin A, Vitamin C and Molybdenum. While over 70% of respondents had at least 6 out of 7 answers correct, 61% had a perfect score that demonstrated an excellent knowledge of nutrients necessary for good bone health in hens.

Score 1 – 3	6%
Score 4 – 5	22%
Score 6 – 7	72%
Perfect score (7)	**61%**

Table 8: Nutrients help in maintaining bone integrity and preventing bone fractures in hens

When asked if bone fractures cause pain and suffering, 100% of respondents agreed to this. Also, 61% of respondents indicated that they had heard of KBDs while only 33% indicated that they had seen KBDs before.

	Heard about KBDs	Seen KBDs
Yes	**61%**	**33%**
No	**33%**	**6%**
I'm Not Sure	**6%**	**61%**

Table 9: Heard or seen KBDs

Finally, participants were provided with pictures of 5 keel bones that were retrieved from 5 respective birds that were culled and taken to slaughter. They were asked to score each respectively. For 4 out of 5 keel bones that were presented, only between 50 - 61% of participants gave the correct scores of the keel bone. For the 5th keel bone (KBF 1), only 17% gave the correct scoring.

	Verdict	Healthy	Deviated	Fractured
KBF 1	Healthy	**17%**	50%	33%
KBF 2	Deviated	39%	**56%**	6%
KBF 3	Healthy	**61%**	28%	11%
KBF 4	Fractured	6%	33%	**61%**
KBF 5	Fractured	11%	39%	**50%**

Table 10: Respondent evaluation of KBF

Post-Workshop Survey

Knowledge of Animal Welfare

Respondents were asked questions to test their knowledge of animal sentience, the five freedoms of animal welfare and animal welfare regulations in their country, Kenya. The results on demonstration of understanding of animal sentience did not change from the pretest: 83% of respondents answere correctly. Also, respondents were asked to identify the 5 freedoms of animal welfare, from a list of 5 correct answers and 3 incorrect answers. However, the percentage of respondents who demonstrated an excellent knowledge of the freedoms of animal welfare increased from 56% to 67%.

Score 1 – 2	11%
Score 3 – 4	6%
Score 5 – 6	17%
Score 7 - 8	67%
Perfect score (8)	**67%**

Table 11: Which of the following are part of the Freedoms of Animal Welfare?

Furthermore, when asked to recall the existing animal welfare legislation in Kenya, respondents who were able to state the correct legislative framework for the country which is The Prevention of Cruelty to Animals (CAP 360) increased from 50% to 67%. The Livestock bill, which has provisions for animal welfare was also mentioned by several respondents.

Knowledge of Hen Welfare

Respondents were asked several questions to test their knowledge and understanding of hen welfare, hen welfare behaviour and practices, various housing systems and their impact on hen welfare. All respondents (100%) indicated that they believe that hens can experience pain and suffering, the same as pre-test results.

Also, respondents were prompted to identify normal and natural behaviours of hens that indicate a state of good welfare, from a list of 7 correct and 5 incorrect answers, same as in pre-test. While all (100%) respondents had at least 10 out of 12 answers correct compared to 89% of respondents in the pre-test, 39% (as in pre-test) had a perfect score that demonstrated an excellent knowledge of natural hen welfare behaviour.

Score 1 – 3	0%
Score 4 – 6	0%
Score 7 – 9	0%
Score 10 - 12	100%
Perfect score (12)	**39%**

Table 12: Which of the following is considered normal behaviour indicative of good welfare in hens?

Respondents were asked if there was a difference between hen health and hen welfare. Results showed that the number of respondents who agreed that there was a difference increased from 78% in pre-test to 83% in post-test.

Respondents were asked to select the most relevant key inputs to hen welfare, and this consisted of 8 correct and 3 incorrect answers, the same as in the pre-test. The majority of respondents that had at least 10 out of 11 answers correct increased from 67% in pre-test to 83%, and the number of respondents who had a perfect score increased from 28% to 50%.

Score 1 – 3	6%
Score 4 – 6	0%
Score 7 – 9	11%
Score 10 - 11	83%
Perfect score (11)	**50%**

Table 13: Which of the following are important to Hen Welfare

Similar to the pre-test, respondents were also asked to identify which farm management practices were good or bad for hen welfare. Their responses have been analyzed in the table below and the results show that while most participants chose the correct farm management practices, there were variations with beliefs that over-feeding, use of hormone stimulants, debeaking, declawing, and battery cages are good farm management practices. There were also additional variations and divergences in beliefs that free-range housing, cage-free deep litter, nesting areas and environmental enrichment were bad for hen welfare - all of which were not present in the pre-test.

	Verdict	% Good	% Bad	% Don't Know
Overcrowding	**Bad**	0%	**94%**	6%
Overfeeding	**Bad**	0%	**89%**	11%

Underfeeding	**Bad**	0%	**94%**	6%
Poor hygiene	**Bad**	0%	**100%**	0%
Antibiotics misuse	**Bad**	0%	**100%**	0%
Hormones/ stimulants	**Bad**	6%	**83%**	11%
Debeaking	**Bad**	22%	**72%**	6%
Declawing	**Bad**	22%	**78%**	0%
Battery Cages	**Bad**	0%	**94%**	6%
Free-range housing	**Good**	**94%**	6%	0%
Cage-free deep llitter	**Good**	**78%**	22%	0%
Nesting areas	**Good**	**89%**	11%	0%
Env. enrichment	**Good**	**89%**	11%	6%

Table 14: Identify any of the following as good, bad or I don't know

Respondents were asked to rate how much hen welfare was important to poultry farms and just as in the pre-test over 80% indicated the high importance of hen welfare to poultry farms and all respondents indicated that hen welfare must be integrated into farm management practices. Respondents were asked to indicate their preference for housing systems for hens. The answers during the pre-test did not change from the post-test as the same percentage of respondents indicated that the free-range system was best for hen welfare while the deep-litter system was best for egg production.

	Best Housing system for Hen welfare	Best Housing system for Egg production
Battery cage system	6%	22%
Deep Litter system	22%	61%
Free-range system	72%	17%

Table 15: Preference for housing systems

Knowledge of Keel Bone Damage (KBD)

Respondents were prompted to identify basic nutrients needed for bone health in hens, from a list of 3 correct and 4 incorrect answers. However, compared to the pre-test, there was a decline in the number of respondents who answered the questions correctly. While over 70% of respondents had at least 6 out of 7 answers correct in pre-test, this reduced to 56% in post-test. In the same vein, only 50% had a perfect score in the post-test, a decline

Score 1 – 3	22%
Score 4 – 5	22%
Score 6 – 7	56%
Perfect score (7)	**50%**

Table 16: Nutrients help in maintaining bone integrity and preventing bone fractures in hens

from the 61% of respondents in post-test that demonstrated an excellent knowledge of nutrients necessary for good bone health in hens. When asked if bone fractures cause pain and suffering, 96% of respondents agreed to this, a decline from the 100% of respondents who agreed in the pre-test. Conversely, 89% of respondents indicated that they had heard of KBDs, an increase from the 61% in pre-test, while 56% indicated that they had seen KBDs before, an increase from 33% in pre-test. This shows that uncertainty was decreased and indicates that the training on KBDs including the examinations proved useful.

	Heard about KBDs	Seen KBDs
Yes	**89%**	**56%**
No	**11%**	**44%**
I'm Not Sure	**6%**	**0%**

Table 17: Heard or seen KBDs

Finally, as with the pre-tests, participants were provided with the same pictures of 5 keel bones. They were asked to score each respectively. For 3 out of 5 keel bones that were presented, between 61 - 78% of participants gave the correct scores of the keel bone, an increase from the pre-test. For the remaining 2 keel bones (KBF 1 and 2), the percentage of participants who gave the correct scores decreased from 17% to 11% for KBF 1 and from 50% to 39% for KBF 2.

	Verdict	Healthy	Deviated	Fractured
KBF 1	**Healthy**	**11%**	39%	50%
KBF 2	**Deviated**	33%	**39%**	28%
KBF 3	**Healthy**	**78%**	11%	11%
KBF 4	**Fractured**	6%	33%	**61%**
KBF 5	**Fractured**	6%	22%	**72%**

Table 18: KBF evaluation

First Evaluation of Training

Finally, respondents were asked to provide a general evaluation of the various aspects of the training including the training topics and modules, interest and commitment to utilising learnings, logistics of the training and likelihood to recommend the training to their colleagues. Participants were asked to rate the training modules and topics from "1" as the least interesting to "5" as the most interesting. Overall, the training topics that the participants found the most interesting were "One Health, One Welfare", "Hen welfare assessment with live hens & palpation", "Understanding behaviour, stress & Enrichment for Hens", "Hen dissection PM keel bone damage assessment", and "Showcasing good on-farm practices".

Also, participants indicated that in the future, they would like to learn more about keel bone examination, the linkage between hen welfare and productivity, humane handling of birds during vaccination and transportation, hen welfare assessment indicators and promoting awareness of hen welfare and KBDs to the public.

Rating from most Interesting (5) to least Interesting (1)	5	4	3	2	1
Introduction to Egg-Laying Hen Welfare	**56%**	33%	6%	0%	6%
Overview of animal welfare progress in Kenya	22%	**61%**	11%	0%	6%
Life Cycle of Egg-Laying Hens, Welfare issues	**39%**	**39%**	6%	6%	11%
Handling and Examination of Egg-Laying Hens	**44%**	39%	11%	0%	6%
Hen welfare assessment with live hens & palpation	**78%**	11%	6%	0%	6%
Welfare-compliant hen euthanasia	28%	**50%**	17%	0%	6%
Early-life and Environment impact on Welfare	**50%**	33%	11%	0%	6%
One Health, One Welfare	**78%**	17%	0%	0%	6%
Understanding behaviour, stress & Enrichment for Hens	**67%**	28%	0%	0%	6%
Showcasing good on-farm practices	**61%**	28%	6%	0%	6%
Hen dissection PM keel bone damage assessment	**61%**	33%	0%	0%	6%

Table 19: Participants' rating of training modules and topics

Participants were asked to rate the specific aspects and logistics of the training from "5" as most interesting to "1" as the least interesting. Overall, the most highly-rated aspects of the training included the level of presenters, refreshment organisation and the lunch. Some specific feedback on how the training can be improved included the timing of the training to be during weekdays, the duration of the training to be extended to 3 days or more, the need for more hands-on practicals, consideration for accommodating all participants, and the need for a quieter location with less external sound interference.

Rating from most Interesting (5) to least Interesting (1)	5	4	3	2	1
Training duration	33%	**44%**	22%	0%	0%
Organisation	**67%**	28%	6%	0%	0%
Level of presenters	**72%**	22%	6%	0%	0%
Refreshments	**72%**	22%	6%	0%	0%
Lunch	**67%**	22%	11%	0%	0%
Time of the event	**56%**	39%	6%	0%	0%
Location	**56%**	39%	6%	0%	0%

Table 20: Participants' rating of specific aspects and logistics of the training.

Furthermore, most of the participants (94%) indicated that they would utilise the lessons learned from the training at every farm visit, and 89% indicated that they would recommend the training to their colleagues. To utilise the lessons learned successfully, participants indicated that they would need additional support with access to learning materials, keel bone models and demonstration materials, and financial assistance for organising further workshops and extension programs with farmers.

Post-Workshop Survey

Knowledge of Animal Welfare

Twelve (12) participants responded to the post-post survey conducted two months after the workshop. The results showed that the percentage of participants demonstrating an understanding of animal sentience increased from 83% (achieved during pre- and post-workshop survey) to 92%.
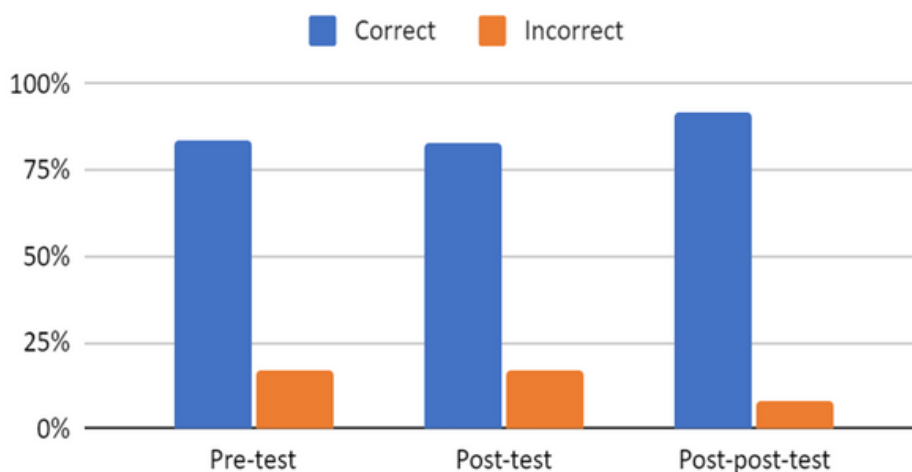
Figure 2: Participants' belief that animals are sentient

Also, the percentage of participants demonstrating high knowledge (scores 7 to 8) of the freedoms of animal welfare increased from 67% in the post-workshop survey to 75%. However, the percentage of participants demonstrating excellent knowledge of the freedoms of animal welfare decreased from 67% in the initial post-workshop survey to 50%.
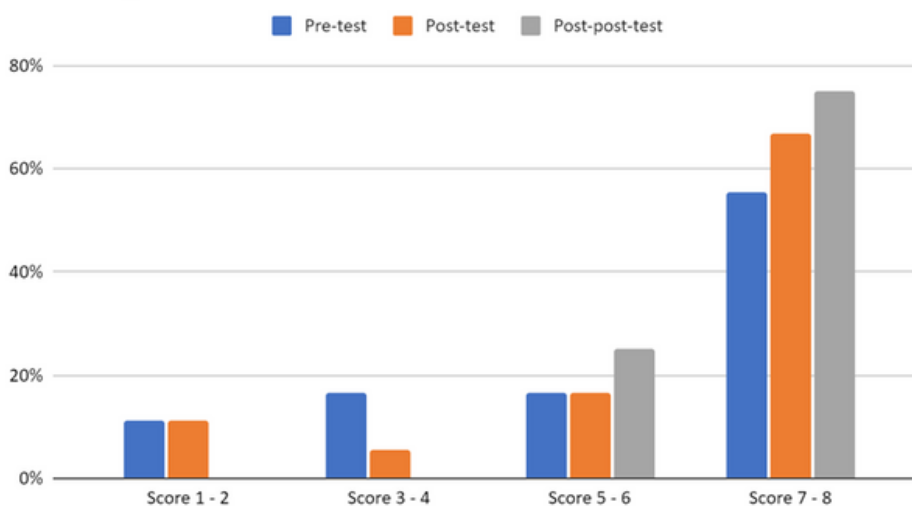

Figure 3: Knowledge of freedoms of animal welfare

When asked to identify Kenyan animal welfare legislation they were familiar with, respondents who correctly named the legislative framework for the country, The Prevention of Cruelty to Animals (CAP 360), increased from 67% during the post-workshop survey to 83%.

Figure 4: Knowledge of Kenyan Animal Welfare laws

Knowledge of Hen Welfare

Respondents were asked to identify normal and natural behaviours of hens that indicate a state of good welfare similar to previous tests. In this survey, the percentage of respondents with at least 10 out of 12 correct answers dropped from 100% in the pre-test to 92%. However, the percentage of participants who achieved a perfect score, demonstrating excellent knowledge of natural hen welfare behaviour, increased to 50%, surpassing the rate of 39% in both pre and post-workshop tests.
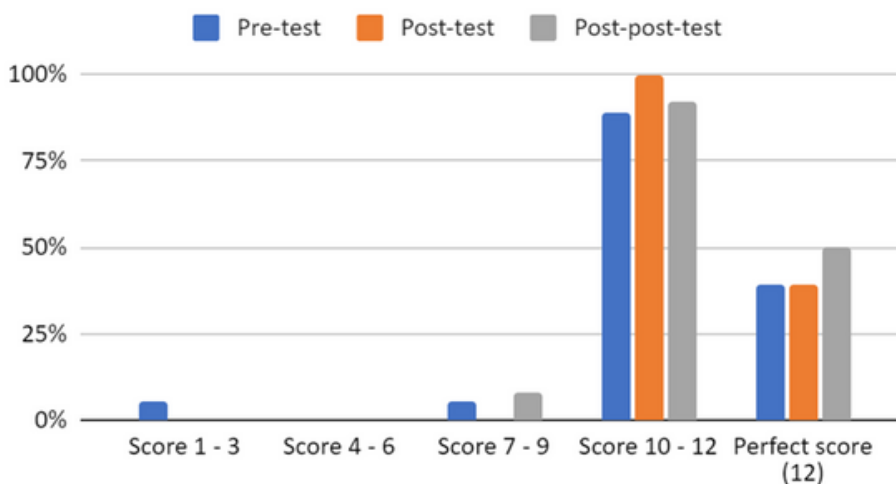
Figure 5: Knowledge of normal Hen Welfare Behaviour

92% of participants acknowledged a distinction between hen health and hen welfare, marking an increase from 78% and 83% in the pre-test and post-test respectively
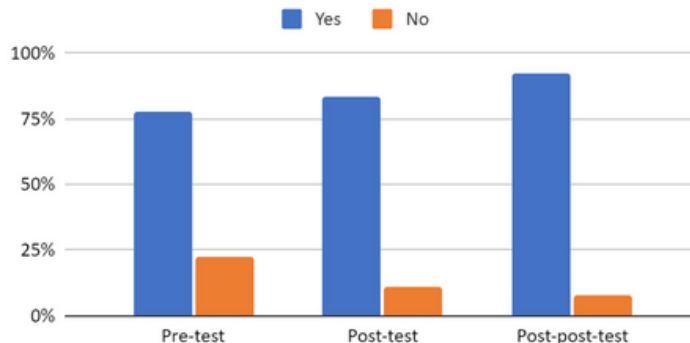
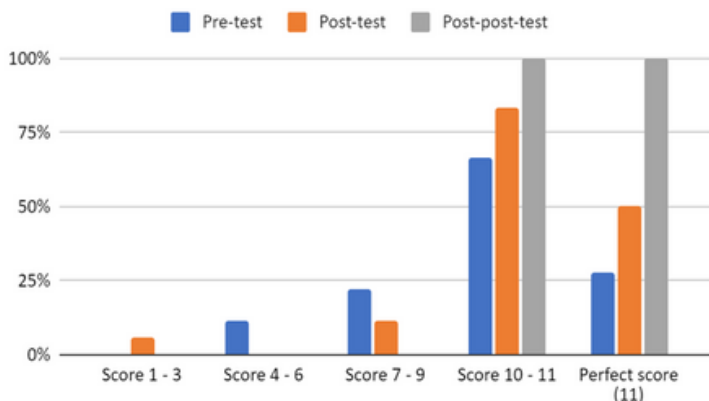Figure 6: Knowledge of the difference between Hen Health and Hen Welfare

Figure 7: Knowledge of important Hen Welfare practices

Also, all respondents achieved a perfect score when asked to select the most relevant key inputs to hen welfare, compared to 67% in pre-test, 83% in post-test.

Respondents were asked to identify which farm management practices were good or bad for hen welfare. The results, analysed in the table below, indicate that the majority of participants correctly identified the beneficial practices. However, there was an increase in the percentage of respondents who considered debeaking (from 28% in the pre-test, 22% in post-test to 33%) and declawing (from 28% and 22%to 42%) as good practices. Nevertheless, nearly all respondents agreed that free-range housing, cage-free deep litter systems, nesting areas, and environmental enrichment were beneficial for hen welfare.
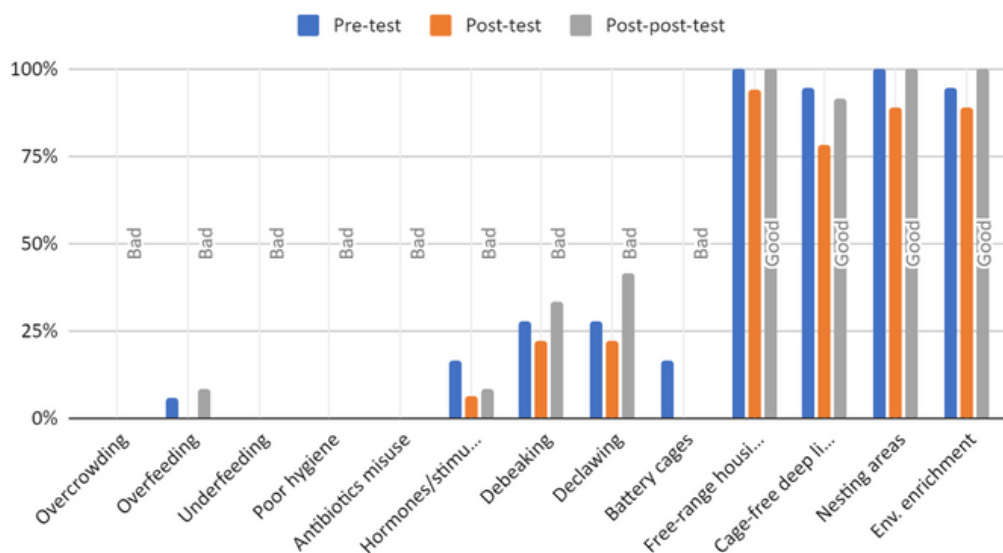

Figure 8: Knowledge of good or bad practices

Respondents were asked to express their preference for housing systems for hens. For Hen Welfare, the majority of respondents favoured the free-range system as the best option increasing from 72% in post-test to 92%, and decreasing for deep-litter system from 22% in post-test to 8%. For egg production, similar trends were observed with the choice of deep-litter system decreasing slightly from 61% in the pre-test to 58%, and increasing (17% in post-test to 25%) for free range systems.
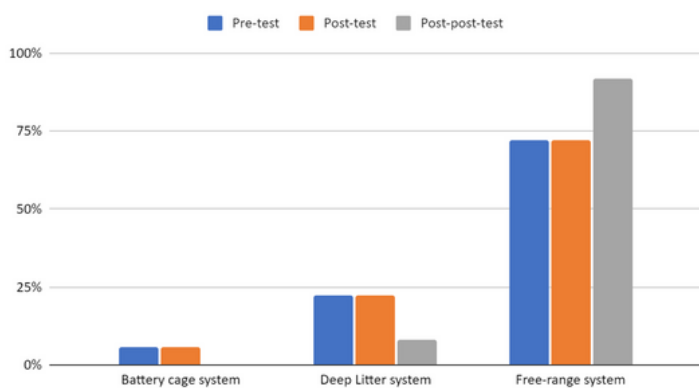

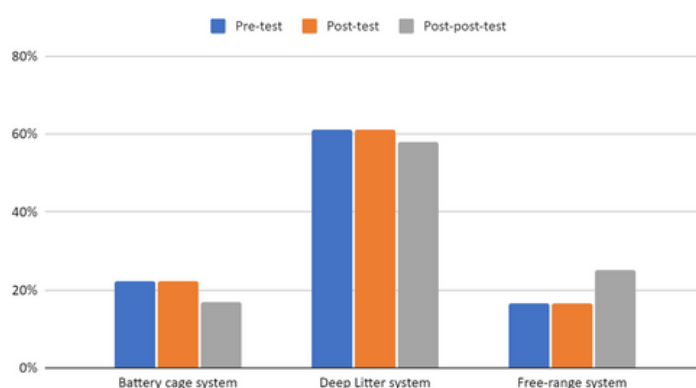Figure 9: Best housing system for Hen Welfare

Figure 10: Best housing system for Egg production

Knowledge of Keel Bone Damage (KBD)

58% of respondents indicated that they had observed egg-laying hens with bone fractures on farms before, compared to 33% in the pre-test and 56% in the post-test. Finally, participants were asked to score pictures of 5 keel bones. For 4 out of 5 keel bones that were presented,

between 58 - 100% of participants gave the correct scores of the keel bone. All participants were able to correctly identify KBF 5 and KBF 3, compared to 50% and 61%, respectively, in the pre-test, and 72% and 78%, respectively, in the post-test. For KBF 1, only 8 % gave the correct scoring which is a marked decrease from the 17% at pre- test and 11% in post-test .

	Verdict	Healthy	Deviated	Fractured
KBF 1	Healthy	8%	75%	17%
KBF 2	Deviated	17%	58%	25%
KBF 3	Healthy	100%	0%	0%
KBF 4	Fractured	0%	33%	67%
KBF 5	Fractured	0%	0%	100%

Table 21: KBF evaluation

General Evaluation of Training

Findings on the general evaluation of the training - including topics and modules, commitment to utilising learnings, and likelihood to recommend the training to their colleagues - were similar to the post-survey responses.

Rating from most Interesting (5) to least Interesting (1)	5	4	3	2	1
Introduction to Egg-Laying Hen Welfare	56%	33%	6%	0%	6%
Overview of animal welfare progress in Kenya	22%	61%	11%	0%	6%
Life Cycle of Egg-Laying Hens, Welfare issues	39%	39%	6%	6%	11%
Handling and Examination of Egg-Laying Hens	44%	39%	11%	0%	6%
Hen welfare assessment with live hens & palpation	78%	11%	6%	0%	6%
Welfare-compliant hen euthanasia	28%	50%	17%	0%	6%
Early-life and Environment impact on Welfare	50%	33%	11%	0%	6%

One Health, One Welfare	78%	17%	0%	0%	6%
Understanding behaviour, stress & Enrichment for Hens	67%	28%	0%	0%	6%
Showcasing good on-farm practices	61%	28%	6%	0%	6%
Hen dissection PM keel bone damage assessment	61%	33%	0%	0%	6%

Table 22: Participants' rating of training modules and topics

Participants were asked to rate the specific aspects and logistics of the training from "5" as most interesting to "1" as the least interesting. Overall, the most highly-rated aspects of the training included the level of presenters, refreshments organisation and the lunch. Some specific feedback on how the training can be improved included the timing of the training to be during weekdays, the duration of the training to be extended to 3 days or more, the need for more hands-on practicals, consideration for accommodating all participants, and the need for a quieter location with less external sound interference.

Rating from most Interesting (5) to least Interesting (1)	5	4	3	2	1
Training duration	33%	44%	22%	0%	0%
Organisation	67%	28%	6%	0%	0%
Level of presenters	72%	22%	6%	0%	0%
Refreshments	72%	22%	6%	0%	0%
Lunch	67%	22%	11%	0%	0%
Time of the event	56%	39%	6%	0%	0%
Location	56%	39%	6%	0%	0%

Table 23: Participants' rating of specific aspects and logistics of the training.

Furthermore, most of the participants (94%) indicated that they would utilise the lessons learned from the training at every farm visit, and 89% indicated that they would recommend the training to their colleagues. To utilise the lessons learned successfully, participants indicated that they would need additional support with access to learning materials, keel bone models and demonstration materials, and financial assistance for organising further workshops and extension programs with farmers.

100% of participants claimed to have utilised and applied the learnings from the training at least twice in the last three months. Additionally, 92% had discussed the workshop or its learnings with fellow veterinarians. The most recalled topics, in order of increasing frequency, were keel bone assessment, hen welfare, poultry housing, animal welfare laws, and the One Health approach. The topic participants still needed more information or explanation on, based on frequency, was "feed fortification," with 50% of participants showing interest in it. Animal welfare practices, animal welfare laws in Kenya, hen farm housing, and keel bone fractures were also requested.

The specific challenges the participants still face in assessing Hen welfare on farms revolve around farmers' lack of knowledge, cooperation, and incentives. The participants recommended some solutions to address these challenges, such as providing training and demonstrations for farmers on animal welfare, raising awareness, offering resources and incentives, and enforcing legislation and animal welfare policies.

Discussion

The demography, educational level and education sector of workshop participants showed that they all had an intermediate to advanced level of education, knowledge and understanding of the basics of animal management, handling, and clinical experience. Also, with over 80% being between the ages of 25 to 44, the workshop participants consisted of young adults who would have some considerable years of experience, and yet are vibrant and open to learning new ways to upskill in their professional work. For animal welfare knowledge, participants demonstrated a consistently increasing absorption and retention of knowledge from pre to post and post-post-test. The initial limited knowledge of the freedoms of animal welfare and existing animal welfare legislation in Kenya indicate that these topics are not generally discussed and widely known.

The high positive response to knowledge on identifying normal and natural behaviours of hens indicates good basal knowledge of good hen welfare indicators. The marginal increases in the knowledge of hen welfare behaviour assert that learning from the workshop was absorbed by participants. However, the variations in participants' responses with regards to which practices are considered good or bad for hen welfare indicated that some trainees did not have clarity on the welfare impacts (or otherwise) on some practices. These variations were consistent across the pre, post and post-post survey responses. The practices which some respondents maintained were good included the use of 'Hormones/stimulants', 'Debeaking', and 'Declawing'. For many years, some researchers and practitioners recommended the use of hormones to enhance productivity (Long et al., 2017; Williams, 2005) and for debeaking and declawing to minimise cannibalism and injuries (Bonzer & Hart,1953; Fisinin, 2016). Although these practices have historically been influenced and encouraged by a combination of cultural, economic, and practical factors, these practices have since been discredited and demonstrated to be both inhumane and detrimental to health. Nevertheless, many practitioners in livestock farming still believe debeaking and declawing to be a necessity in both caged and cage-free farming systems.

Learning adoption and behaviour change are influenced by capability, opportunity, and motivation (Mitchie et al., 2011). This training addresses their capability in practice; however,

a sustainable behaviour change would not be immediate unless convincing alternatives are proffered and readily available. This indicates a need to incorporate modules addressing out-dated practices and misconceptions into subsequent workshops and proffering sustainable and welfare-friendly alternatives. It also indicates a need to update the university-level curricula to reflect comprehensive teaching on animal welfare and clarity on good welfare-enhanced farm management practices.

For differences between Hen Health and Hen Welfare, and an understanding of the relevant key inputs to hen welfare, participants demonstrated a consistently increasing absorption and retention of knowledge from pre to post and post-post test. Also, for the preference on welfare-driven housing systems, there was a demonstrated increase and/or absorption of knowledge from post to post-post-test seeing that battery cage was no longer indicated as a preferred housing system, there was a decrease in the preference of deep litter system and a considerable increase in the preference for free-range system. Nevertheless, there needs to be a paradigm shift towards a consistent increased animal welfare education to reinforce the importance of housing systems and relations to hen welfare. According to current global animal welfare standards, it is generally established that over-feeding, use of hormone stimulants, debeaking, declawing, and battery cages are not good management practices, and that free-range housing, cage-free deep litter, nesting areas and environmental enrichment are good for hen welfare. While there seemed to be decreased acceptance or understanding of this in post-test, an increase was seen in post-post-test.

In assessing the change in knowledge for KBF, there were varying levels of demonstration of knowledge comparing the pre- and post-test. While there was an increase in the number of respondents who had heard of and seen KBFs, there was a decline in the respondents' demonstration of knowledge of nutrients necessary for good bone health in hens, and belief in if bone fractures cause pain and suffering for hens. In the number of correct scorings to the keel bones presented, there was a demonstrated increase in knowledge comparing the post-test and post-post-test. However, the initial drop in knowledge from pre to post-test may be due to information fatigue given that the post study survey was taken immediately upon the completion of the 2-day workshop. Studies show that long periods of learning could affect concentration and in turn, influence the way survey questions are answered.

Researchers studying ways palpation accuracy can be improved emphasise that all assessors should possess knowledge and understanding of how the keel is shaped and what its biological function is. Besides this theoretical/visual knowledge, they should also have the opportunity to palpate keels of various damage severity scores, ranging from healthy keel bones of non-impacted morphology, all the way to severely deviated and fractured keels. Finally, after familiarising with the keel bone and its various shapes, palpation scoring should be practised via visual assessment during dissection. A vital part of educational activities is discussion, where consensus among multiple assessors can be attained, especially when it comes to the overall score and possible sources of error for specific keels (Casey-Trott et al., 2015).

The observed initial decline in knowledge regarding KBD and bone health nutrients in hens could result from a variety of factors such as fatigue, distraction during the practical sessions due to sound interference, insufficient interaction with course material etc. While participants provided positive feedback, it's important to recognize that activities promoting rapid learning and high learner satisfaction may not always translate into effective retention (Bell et al., 2008). An effective strategy could involve encouraging learners to reorganise information for practical application, introducing key principles and techniques in diverse contexts, and allowing space for refreshment before administering follow-up assessments (Endres et al., 2020). This approach aims to enhance long-term knowledge retention by fostering active engagement, contextual understanding, and memory reinforcement. Furthermore, utilising teach-backs proves effective in enhancing retention. By prompting learners to teach back what they have learned, they articulate concepts in their own words, fostering a deeper understanding (White et al., 2013). This method offers a valuable opportunity for trainers to identify any gaps or challenges in comprehension.

Generally, participants showed enthusiasm and acceptance of the training modules and presentations as all modules received were rated either a 4 or 5 by most participants. Participants indicated their willingness to learn more about keel bone examination, the linkage between hen welfare and productivity, humane handling of birds during vaccination and transportation, hen welfare assessment indicators and promoting awareness of hen welfare and KBDs to the public. While the level of presenters, refreshments organisation and the lunch were most rated, some specific feedback on how the training can be improved included the timing of the training to be during weekdays, the duration of the training to be extended to 3 days or more, the need for more hands-on practicals, consideration for accommodating all participants, and the need for a quieter location with less external sound interference. Furthermore, it was great to see that most of the participants (94%) indicated that they would utilise the lessons learned from the training at every farm visit, and 89% indicated that they would recommend the training to their colleagues. To utilise the lessons learned successfully, participants indicated that they would need additional support with access to learning materials, keel bone models and demonstration materials, and financial assistance for organising further workshops and extension programs with farmers.

In conclusion, the overwhelmingly positive response from participants underscores the success of the training workshop in fostering enthusiasm and acceptance of key concepts in hen welfare and keel bone assessment. The commitment of participants to apply the acquired knowledge in their farm visits and recommend the same to their colleagues highlights the potential for widespread impact which will be crucial in sustaining and expanding these valuable training initiatives.

Recommendations and Conclusions

While the training provided valuable opportunities for learning and education on related topics of animal welfare, hen welfare and keel bone damage evaluations in hens, there were varying degrees of uptake and retention of learning modules among participants. This varied from a considerable increase and uptake in knowledge especially in topics of animal welfare with general satisfaction in training modules and organisation of workshop; to differing demonstration of understanding of topics around hen welfare and keel bone damages.

The following recommendations are proposed to improve teaching and learning among participants in subsequent training programs.

- Allocating resources to research sustainable alternatives for hormone use and practices like debeaking/declawing and making them readily available might not only foster the adoption of better hen welfare practices but also ensure the long-term effectiveness of workshop learnings.
- Supporting the creation of context-specific learning modules that debunk prevalent myths and misconceptions surrounding poultry management. Such a more targeted educational approach might contribute to broader industry awareness and adoption of humane practices.
- Extending the duration of training might allow for a more comprehensive exploration of topics and increased depth in hands-on practical sessions. This extension might enhance participants' skill acquisition and implementation.
- The increased availability of keel bone demonstration models and manuals could support practitioners in better assimilating new knowledge and applying learned techniques in real-world scenarios.
- Conducting a post-post test to further evaluate retention of learning from the workshop and demonstration of application of learnings on the field, and in their work.

Study Limitations

In addressing the limitations of our study, it is imperative to highlight several key aspects. Firstly, the backgrounds of the participants varied, potentially influencing the generalizability of our findings. On the other hand, relative homogeneity in some aspects (e.g., gender, professional exposure to egg farms) of the participant group may also limit the applicability of the results. Factors like prior knowledge, skills, or motivation of participants could influence the outcomes and we saw different levels of previous knowledge and engagement expressed throughout the training. Geographical representation is another limitation, as the study may not fully capture the diversity of perspectives across different regions. The size of the participant pool was small, affecting the generalizability of the results.

Furthermore, it is essential to note that our case study lacked follow-up activities, which could have provided valuable insights over an extended period. Further, outcome assessments could be performed to evaluate the sustainability of the training effects. In the evaluation surveys, we attempted to minimise the risks for social desirability bias, but the participants might still provide desirable responses, rather than reflecting their true knowledge. Finally, limitations in budget, time and personnel might have affected the depth and breadth of the training program, influencing the outcomes.

Moreover, all training participants were provided with travel compensation in cash and certificates as a token of appreciation for their involvement in the training. This acknowledgement underscores our commitment to recognizing and valuing the contributions of those who took part in our study but may have introduced bias. Additionally, transparency is crucial, and it should be acknowledged that the two key informants integral to our study were recruited and remunerated by HH, possibly introducing biases in their perspectives.

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