Current perceptions, use, and needs of precision poultry farming systems amongst academia

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Abstract

Precision Livestock Farming (PLF) technologies offer a way to improve production and labor efficiency while also addressing welfare concerns that consumers express regarding how poultry is grown. There is an extreme lack of knowledge on the current perceptions and need of PLF within the U.S. poultry academia. The objective of this study was to design a survey to understand the perceptions and needs of PLF by academia. An online survey was designed via Qualtrics consisting of 25 questions. The survey was distributed via email to 276 poultry researchers in the U.S. acquired via search on university websites. The survey was made available for one month and yielded 68 total responses (N=68). The results were exported from Qualtrics and analyzed using SPSS. Respondents were separated into groups based on job type (extension specialist, researcher, both) and research type (animal science, engineer, vet). Results were analyzed using a chi-square test, frequency analysis, and the Monte Carlo feature to account for the relatively small sample size. Amongst researchers, results from this study show that 92% of researchers agree that cost influences a grower's decision to implement PLF technology and 86% of researchers agree usability influences a farmer's decision to implement. The results also show most poultry researchers are familiar with the term PLF (92%), however, only 55% of respondents have or currently use PLF technologies. Researchers also agree that PLF will be very important in improving poultry production (97%), and health and welfare (91%) when compared by research type there were no significant differences (p=0.36) found amongst groups regarding health and welfare, however, it was found that engineers agree more than animal scientists that PLF will be important to improve future poultry production with 61% of engineers strongly agreeing comparing to only 34% from animal scientists (p=0.02). Significant differences were also found when the researchers who already use PLF in which 57% strongly agreed that PLF will allow them to expand their research compared to researchers who do not use PLF in which only 13.3% strongly agreed (p=0.01). It can be concluded that poultry researchers have realized the importance of PLF's role in poultry production, but applications of PLF technologies in research remain to grow. In addition, perceptions on PLF vary among researchers with different backgrounds.

Keywords: perceptions, precision livestock farming, health and welfare, production, academia

Introduction

The demand for poultry products continues to increase along with the world's population, and to meet the nutritional needs of the world, we will need to drastically increase food production especially protein production (United Nations, 2013). The poultry industry is the livestock industry best set up to take on this challenge, primarily because the poultry industry can efficiently produce protein at an exceptional feed conversion ratio, on a very small amount of land (Mottet et al., 2017). In recent years, however, the poultry industry has come under scrutiny from consumers and animal rights groups about animal welfare. Of these complaints lameness, disease, growth rates, stocking densities, and antibiotic use seem to be the most prominent (Erian et al., 2017). The European Union recently has begun a reform requiring farmers to show that their flocks are raised in a good state of welfare throughout the production cycle, as well as investigate

the viability of animal-based indicators in monitoring systems (Simonin and Gavinelli, 2019). Soon the U.S. poultry industry may have to adapt to these consumer demands to remain in production, which raises the question of how to solve this welfare problem. Researchers have proposed to do this using precision livestock farming (PLF).

Precision livestock farming is defined as real-time monitoring of animals to measure health and well-being via cameras, sensors, etc. (Berckmans, 2014). Precision livestock farming could prove to be an effective solution as it allows farmers to monitor their flocks closely always, gives them better insight into their flock, and reduces the need for labour especially when labour is already hard to find. A review study done in 2019 has shown an increase in PLF publications regarding poultry recently, especially in the last 10 years, however, of the 254 papers the author reviewed only 10 were found to have commercially available products (Rowe et al., 2019). The focus on these papers seems to be on testing new technologies entering the markets. With the increase in papers published under the PLF name, there is interest in PLF from researchers, however, very little known is about farmers opinions regarding PLF. The few papers that have been published mainly center around European markets, where PLF research has been going on the longest. The majority papers have been published in the dairy, swine, and other small ruminant species. Currently there are no papers focusing on poultry producers' opinions of PLF in the U.S. This is concerning considering the difference in growth and regulation between the U.S. poultry industry and the E.U.; This demonstrates the need for a survey regarding researchers and growers' opinions in the U.S. on PLF technologies and systems to see the potential for future use and focus technologies on areas that U.S. poultry growers will use.

In the surveys that have been done (though done in a different livestock industry and in the E.U.) the major takeaways from farmers are that their biggest barriers of implementation include the high cost of technology, the usability of the technology, and the still unsure feeling on how PLF will improve their operation (Hartung et al., 2017; Abeni et al., 2019; Lima et al., 2018). Consumer surveys have also been done regarding PLF, and results have shown scepticism from consumers as well. Consumers are concerned of possible abuse of PLF systems and reduced physical presence on the farm by growers and workers (Krampe et al., 2021). Studies like this one could provide a good model for researchers in their region to focus on and tailor their research to create products that will be used by local growers. Next, it will be very important to do research in a commercial setting to account for the harsh environment of the poultry house to see what problems arise. This will allow researchers to prove to producers the potential benefits of PLF and the hardiness and longevity of whichever PLF system is being implemented. The objective of this study is to identify current perceptions, use and needs of PLF amongst poultry researchers. Secondly differences amongst groups regarding job type, research type, and level of experience with PLF would be examined.

Materials and methods

Survey design

To design this survey the Qualtrics online survey system was utilized. Qualtrics was seen as the best option to allow for best distribution and ease of access to the survey. The survey was designed in a way to encourage completion of the survey and consisted of 23 multiple choice questions and 2 matrix tables (5 statements each) to be answered on a Likert scale ranging from strongly disagree to strongly agree. The first section of the survey consisted of background questions related to the researcher's field, job type, years of experience, industry, record collection, and which areas within poultry production they would like to see improvement in. The next section then asks the survey taker questions regarding their technology use and skill and if they know what the term PLF is. If they answered yes to this question, they were then asked a follow up question regarding where they first learned about PLF and if they have or do use any PLF technologies in their lab. Next were a set of questions in which survey takers were asked what they see as important indicators for poultry productivity and indicators for poultry health and welfare. The final

questions in the third section asked recipients what they saw as the most promising technologies for poultry productivity and the most promising technologies for poultry research and what they saw as an acceptable price range for technology use in each sector. Next were a set of matrix tables to be answered with statement to be answered on a Likert type scale based on the survey takers level of agreement or disagreement with the statement. Finally, the survey concludes with a few demographic questions in which no data is reported in this paper.

Survey distribution

To gather recipients to take this survey, U.S. university and USDA research websites were visited, and a list of faculty members was acquired based on if they had a relation to the poultry industry. All forms of poultry researchers were recruited including vets, animal scientist, engineers, and others to try and best represent all groups of poultry researchers. Qualtrics was seen as the best option to allow for best distribution and ease of access to the survey. The emails of possible recipients were compiled into a csv and uploaded to the Qualtrics online survey system. An email was sent out to request participation in the survey within a month and it was successfully distributed to 276 poultry researchers in the U.S. All responses from the survey were recorded anonymously to negate any possibility of bias in the results and all incomplete surveys were removed prior to analysis.

Data analysis

The results collected from the survey were exported to SPSS for statistical anlysis. First, all answer choices were recoded to numerical results to ease in analysis. For example, in a yes or no question option "1" would be assigned to represent "yes" and a "2" to represent "no". Desciptive statistics were performed including frequency analysis to yield a general summary of results based on various criteria differences. In order to get as much out of the data as possible, many angles were investigated to find signifigant interactions between results such as job type and what survey takers saw a simportant indicators for productivity, or what group (engineers,animal scientist, veterinarians) agrees PLF is more beneficial, etc. Using the crosstabs function in SPSS chi-square test were performed, a Monte Carlo simulation was also ran at (10,000 samples with a 99% confidence interval) to mitigate the relatively small sample size.This yielded many signifigant differences between job types, research roles, PLF background, years in poultry production and more. Based on these results it was decided to summarize the responses to each question for each group and report any signifgant differences found in the chi-sqare test. A correlation analysis was also performed alongside the chisquare test, which yielded several signifigant weakly positive relationships related to job and research type.

Results

The survey was closed after a month of data collection, this yielded 68 total responses. Of our survey respondents 62.7% identified themselves as a researcher while 16.4 % identified themselves as an extension specialist and 20.9% identified as both. When asked what best represents their research type 57.6% of our respondents identified as animal scientist, 34.3% identified as engineers, and 5.9% identified as veterinarians. Every aspect of the poultry industry was represented in the survey with 89.4% of respondents working with broilers, 57.6% of respondents working with layers, and 28.8% collaborating with breeders. The number of years the respondent has been involved in poultry research was also very diverse and when groups are combined it yields a representation of 61.2% for those involved for 0-20 years, 34.3% for those involved for 20-40 years, and 4.5% have been involved in poultry research for more than 40 years. Respondents were then asked what areas within poultry production would they like to see improvements in. The top 5 results yielded from this include: disease control (60.3%), welfare (63.2%), Environment management (64.6%), automation (51.5%), and litter management (51.5%).

The survey then shifts focus from background related to questions to the PLF knowledge section. Of our respondents 92.4% indicated that they were familiar with the term PLF and the most common method of learning PLF includes peers (43.1%) and conferences (21.5%). Though 92.4% of respondents know the concept of PLF, the results show that only 55% of researchers do or have used PLF technologies. The top 5 technologies currently being used by our respondents includes: temperature sensors (78.4%), video cameras (75.7%), humidity sensors (75.7%), thermal cameras (64.9%), and gas sensors (54.1%). Survey takers were then asked their opinions on the most promising indicators for poultry productivity with the top 3 results yielding poultry weight gain (92.5%), poultry feed and water intake (79.1%), and poultry activity (46.3%). This question was followed up by a similar question, however, respondents were asked to indicate important indicators for poultry health and welfare which yielded poultry footpad health (86.6%), poultry activity (80.6%), and poultry gait score (76.1%). To follow up with these questions, respondents were then asked their opinion on which PLF technologies can best help improve poultry productivity this resulted in sensors (77.6%), cameras (74.6%), and data management systems (71.6%). The same question was then asked again but regarding poultry research rather than production, which resulted in cameras (79.4%), sensors (76.5%), and data management systems (64.7%). The next question asked respondents to indicate what they consider an acceptable price range for industry use (68.8% responded $0-20,000, 23.4% responded $20,000-50,000, and 7.8% responded greater than $50,000). When asked the same question, but regarding research rather than industry use, the results included 63.5% ($0-20,000), 23.8% ($20,000-50,000), and 12.7% (greater than $50,000).

Following these respondents were then asked to indicate their level of agreement (strongly disagree, disagree, neither agree or disagree, agree, or strongly agree) to a series of statements. When asked if PLF can replace the farmer in the barn, 73.8% of respondents indicated they disagreed in some way with this statement and 7.7% had no opinion. When asked if PLF technology can increase the amount of social or free time for the farmer, 23.4% of respondents disagreed in some way while 40.6% responded neither disagree nor agree. When asked if the cost of technology influences a farmer's decision to purchase 92.2% agreed with this statement with only 4.7% having no opinion. The next statement asked if the amount of time it takes to learn PLF influences a farmer's decision to purchase, and this resulted in 87.6% of respondents agreeing and only 7.7% having no opinion. The final statement for the first matrix table asked if PLF technology will allow respondents to expand their research which yielded 81.5% of respondents agreeing and 15.4% having no opinion. The second matrix table focused on the perceived benefits of PLF. The first statement asked respondents if PLF technology can provide cost savings, this resulted in 64.6% of respondents agreeing with the statement and 30.8% having no opinion. The next statement stated that PLF can improve poultry production. This resulted in 97% of respondents agreeing and 1.5% having no opinion. When given a similar statement but focusing on health and welfare rather than production 91% of respondents agreed and 6.1 % had no opinion. Respondents were then asked if they agreed that PLF is usable in a commercial setting in which 78.7% agreed and 16.7% had no opinion. Next, survey takers were asked if they agreed the PLF can provide cost savings in which 87.8% agreed and 10.6% had no opinion. Finally, respondents were asked a series of demographic questions including age range which yielded 6.4% (age 20-29), 21.2% (age 30-39), 25.8% (age 40-49), 22.7% (age 50-59), 24.2% (over 60). Respondents were also asked to list their highest level of education received which resulted in 100% of respondents holding advanced degrees, which was to be expected. The respondents included 67.7% males, 26.2% female, and 6.2% preferred not to say.

Chi-square test and correlation

The primary goal of performing the crosstabs analysis using the chi-square test is to understand if there are any significant differences regarding groups, particularly in response to the Likert scale questions asked in the matrix tables. First when comparing job type (extension specialist, researcher, both) very little differences were found between groups, however, no differences were seen in opinions regarding PLF being

usable in a commercial poultry setting with 45% of researchers strongly agreeing while 16.6% of those with an extension background (respondents who selected both included) strongly agreed (P = 0.055). Next respondents were grouped by research type (animal science, engineer, veterinarian) and opinions regarding PLF being usable in a commercial poultry setting were analyzed. Again, very little significant differences were found amongst groups when prompted with "PLF is usable in a commercial setting", however, engineers and veterinarians did show a significant difference compared to animal scientist when prompted with the statement, PLF can improve poultry production. 50% of veterinarians and 60.8% of engineers strongly agreed that PLF can improve poultry production, while only 34% of animal scientist strongly agree (P= 0.017). There was also a weakly positive correlation was found regarding the responses of the groups (P = 0.059) (R= 0.238). Options of different groups when asked if the cost of technology influences a farmer's decision to purchase are significantly different (P = 0.007), however, the correlation is weak (R= 0.324). Next results were compared against number of years spent in the poultry industry. No significant differences were found when comparing against the Likert-style questions, however there was a positive weakly correlation (P=0.15) when given the statement "PLF can help me expand my research." When compared against the respondent's level of skill and experience with technology significant differences were found when asked if the usability of PLF influences a farmer's decision to purchase (P=0.04). There was also a weakly positive correlation found amongst respondents related to their level of experience with technology (P=0.01) (R=0.307). When researchers were asked if PLF is usable in a commercial setting significant differences were found when compared against if they previously were familiar with PLF prior to taking this survey (P=0.01). Significant differences were also found when respondents were asked if PLF will be important for future poultry production(P=0.46), with 60% of respondents who were not familiar with PLF having no opinion compared to 6.7% of researchers familiar with PLF. Of the researchers that were familiar with PLF only 53.8% of respondents are or have used PLF. When compared against the Likert statements the results show a significant difference (P=0.01) between opinions on if PLF can help expand their research, with 83.3% of those already using PLF strongly agreeing, compared to 16.7% for researchers not using PLF. Finally, the Likert statements were analyzed against the demographic questions which yielded a significant difference on the statement "PLF can replace the farmer in the barn" (P=0.02) when comparing respondents by age. No respondents in the 20-29 age range strongly disagreed with this statement while 64.7% (age 40-49) and 53.3% (age 50-59) strongly disagreed with this statement.

Discussion

The results from this study show that though poultry research is done in many distinct roles or job types there is an agreement amongst researchers that PLF can improve poultry production in the future. Most researchers were familiar with the term prior to taking this study, however, only a little over half (55%) have or are using PLF. This indicates a need for more research to be done to expand the fast-growing knowledge of the PLF field. The results also show, in alignment with previous studies, that researchers believe the biggest barrier to implementation for growers is the cost of the technology and the usability of technology (92.9% and 87.6%). Some producers and researchers also believe the role of PLF is to replace the farmer in the barn which is not the goal. Though this is not the purpose of PLF, 73.8% of respondents indicated that they disagreed with the statement that PLF can replace the farmer in the barn which indicates most researchers believe replacement is not the goal of PLF.

The results also indicate that there is a general agreement amongst researchers regarding the best indicators for poultry productivity, health, and welfare, as few significant differences were found when the results were analysed across job types and research areas. It will be important for future studies to analyze the differences in opinions between researchers and growers. It is interesting to note that of the researchers that currently use PLF technologies, 57% strongly agree that PLF will help them expand their research, compared to 13.3% for those who do not currently use PLF. This demonstrates the confidence that producers have in PLF after

they have used it. It can be assumed that the same trend we see in studies done with European producers (regarding usability being a large factor in their willingness to implement) is found in researchers. In fact, in almost every comparison that was analyzed, the most significant differences were found when comparing responses of researchers" experiences with PLF.

This paper aimed to bridge the gap in understanding between PLF perceptions and usage amongst researchers in the U.S. poultry industry. It was hypothesized that cost of technology and usability of PLF would be considered the biggest barriers of implementation by researchers, and this is supported with the results in this paper. Many researchers believe that PLF technology is the future in poultry production and will be particularly important in bridging consumer interest and transparency, however, there is diverse opinions regarding which technologies would be best to research for poultry use, how expensive they should cost, and which animal-based indicators should be targeted during monitoring. With the extreme lack of knowledge that is currently present in the field, this paper should serve as a great baseline for targeting PLF research that is the most likely to be used. The next step in this research is to examine the differences in perceptions and usage between poultry growers and researchers. It is presumed that there is a gap present in preferences or opinions on the biggest barriers of implementation between groups, so this next step will be very important in further targeting PLF research.

With the poultry industry ever changing it will be very important for growers to keep up with competition to continue producing. Further research should be done on how PLF technologies can influence farmers well-being, quality of life, and cost to profit ratio, to ensure usable products are being researched to improve the production cycle for the grower and the bird.

Conclusions

It was concluded that the majority of researchers regardless of job or research type agree that PLF will be important for future poultry production, however, opinions regarding the future usage of PLF were different based on if the respondent has previously used PLF technologies. The results also show that though many researchers are familiar with PLF only about half of researchers are currently using PLF technologies.

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