Journal of Rural Studies 55 (2017) 122–130

Contents lists available at ScienceDirect

Journal of Rural Studies

journal homepage: www.elsevier.com/locate/jrurstud

Public health science in agriculture: Farmers' perspectives on respiratory protection research

Brandi Janssen [a, *], Matthew W. Nonnenmann [b]

[a] University of Iowa, 145 N Riverside Dr, S329 CPHB, Iowa City, IA 52242, United States
[b] University of Iowa, 145 N. Riverside Dr, Iowa City, IA 52242, United States

ARTICLE INFO

Article history:
Received 24 February 2017
Received in revised form
9 August 2017
Accepted 14 August 2017
Available online 17 August 2017

Keywords:
Scientific agriculture
Agricultural safety and health
Broiler chicken production
Respiratory protection

ABSTRACT

Although agriculture in the US is now firmly rooted in scientific investigation, farmers were dismissive of agricultural science for many decades. Currently, there is a well-established body of scientific evidence related to occupational hazards on farms, as well as strategies to mediate them. However, rates of injuries and illness remain higher in agriculture than almost any other industry. This paper, based on in-depth interviews with poultry producers in Texas, suggests that farmers are not receptive to health and safety research in agriculture. They do not trust researchers' agendas, they fear that there will be negative economic consequences, and they do not agree that the questions asked by safety and health researchers are scientifically valid. As a result, agricultural safety and health research resembles earlier iterations of agricultural science in which the industry is resistant to accept the validity of the research process, approach, or evidence presented.

1. Introduction

Despite what appears to be a general popular consensus that decision-making should be based on scientific evidence, the acceptance and adoption of scientific principles by the general public has been uneven and fraught with controversies. The current dialogue about climate change provides one notable example (Lewandowsky et al., 2013). Even in realms where science appears to be foundational, such as in US agriculture, a closer read of agricultural history shows that the relationship between agricultural scientists and farmers has been slow to develop and the two populations have often been at odds with each other. The current iteration of agricultural science has bridged the perspectives of scientists and farmers by emphasizing efficient production based on chemical inputs, biotechnology, and specialized equipment.

When public health science addresses agriculture, the focus is typically food access, nutrition, or the environmental impact of farming practices. However, the past three decades have also seen a growing body of research examining occupational safety and health outcomes of agricultural populations (DeRoo and Rautiainen, 2000). Agricultural workers experience high rates of occupational fatalities, injuries, and illnesses. The Bureau of Labor Statistics reports that an agricultural worker is more than seven times likely to die on the job than workers in other industries. Agricultural workers also experience high rates of chronic illness related to their occupation, including musculoskeletal disorders, skin and lung disease (Lessenger, 2006; Donham and Thelin, 2006). There has been a response by both public health researchers and federal agencies over the past decades to improve these rates; however, agriculture has been much slower to change than other industries and in fact fatalities among agricultural workers has increased in recent years (CFOI Macken-Walsh (2016)).

This paper examines qualitative data collected from broiler chicken producers in the southeastern US to better understand their barriers to participating in health and safety research on farms. The study was developed in response to a lack of participation by broiler producers in an educational intervention to increase respirator use among those working in the production barns. While some researchers have examined barriers to changing safety and health behaviors on farms, there is little attention to producers' willingness to participate in the research that supports occupational safety and health interventions in agriculture.

2. Science in agriculture and public health

The merger of science and agricultural knowledge into what we

* Corresponding author.
E-mail addresses: brandi-janssen@uiowa.edu (B. Janssen), matthew-nonnenmann@uiowa.edu (M.W. Nonnenmann).

http://dx.doi.org/10.1016/j.jrurstud.2017.08.008
0743-0167/

now know as "scientific agriculture" in the United States has a long trajectory. For much of agriculture's history, the bulk of experimentation, change and knowledge rested with farmers who perfected plant varieties, selectively bred livestock, and observed optimal soil and environmental conditions for production. In the 1860s, the new field of soil chemistry spread, as scientists trained by Justus Leibig returned to the US to apply their new knowledge (Danbom, 1986). In the US, the federal government expanded the development of the land-grant university system in the form of the Morrill Act of 1862, and again later with the 1887 Hatch Act and 1914 Smith-Lever Act. These established, respectively, agricultural experiment stations for research and the infrastructure for a network of county extension agents whose role was to disseminate the findings from the university and experiment station research (Hassanein, 1999).

Despite these investments, it was not until the middle of the 1900s that agricultural science became normalized in rural communities (Buttel, 1993). Earlier populist movements among farmers railed against perceived exploitation by lenders, railroads, input dealers and others, including federally funded research programs (Hassanein, 1999, 13). Although farmers were resistant, the national focus on science and productivity made the romanticized agrarian traditions of the past less palatable for a more urbanized society. Farmers were now judged by their productive capacity, rather than their connection to the land. The embedding of scientifically derived knowledge into agricultural practices was a slow process, hampered both by farmers, who deplored "book learning," as well as other scientific fields, which were critical of the practical focus of agricultural research (Danbom, 1986).

Some have characterized the slow pace with which scientific knowledge gained legitimacy as reflecting the competing values of ordinary, folk, or indigenous knowledge and new realms of scientific knowledge which were, at times, oppositional to traditional or religious knowledge (Kloppenburg, 1991; Buttel, 1993). Likewise, this tension played out in agriculture as agricultural scientists slowly gained legitimacy in the eyes of farmers, policy makers and, most significantly, business interests. This culminated into what Fredrick H. Buttel has deemed a "productionist ideology, the doctrine that increased production is intrinsically socially desirable, and that all parties benefit from increased output" (1993:7). A productionist ideology provides a point of confluence for farmers, scientists, agribusinesses, policy makers, and others in that all parties can align in support of increased agricultural outputs.

A productionist approach to agriculture is further entrenched as other technological advances continue to make the practice of farming more complex (Bye and Fonte, 1993). The introduction of chemical fertilizers, hybridized, or more recently genetically modified, seeds, veterinary techniques, precision application, and other practices embed agriculture firmly in the realm of science and technology, rather than local, indigenous or "folk" knowledge.

As science has been embraced by agriculture, it has also legitimized agricultural practice. This can be seen most clearly in organic and alternative production. As science becomes a legitimate form of knowledge generation in agriculture, those farming practices that are vetted scientifically also gain legitimacy. Michael S. Carolan (2006a) has written about this exchange, as it relates to trust, noting that mainstream agriculture, with its basis in science, was trusted by policy makers, whereas alternative practices were seen as "emotional" or "irrational." Ultimately, "by drawing on the public's trust of science, it appears that sustainable agriculture has been able to concomitantly attain a degree of truthworthiness that previously had been lacking" (2006:331).

Public health science has its own trajectory and set of controversies in which the public diverges on the scientific merit of, for example, climate change or vaccinations (Patil, 2011). Public health science has become foundational in the identification, evaluation and control of occupational health and safety hazards (Murphy et al., 1990). Scientific methods employed in public health research are foundational to the fields of epidemiology, exposure assessment, injury and illness prevention and behavioral health. These methods are used to identify and mitigate occupational hazards experienced by workers in agricultural sectors. Much of the public health research is funded by the National Institute for Occupational Safety and Health (NIOSH), part of the Center for Disease Control and Prevention (CDC), which then provides recommendations for best safety and health practices in occupational settings. NIOSH recommendations may inform regulatory action enforced by the Occupational Safety and Health Administration (OSHA). However, unlike other industries, many American farms are exempt from OSHA inspections because they employ fewer than 11 non-related persons per year. Furthermore, the creation of new OSHA regulations has historically been a slow process and requires substantial scientific evidence and political support.

In 1990, following a sentinel publication "Agriculture at Risk, a Report to the Nation" (Merchant et al., 1989) funding was appropriated to create research centers with a mission to generate knowledge on injury, illness and fatality prevention among agricultural workers. The NIOSH Agricultural Centers were established as part of a CDC/NIOSH Agricultural Health and Safety Initiative to conduct research, education, and prevention projects that address the nation's pressing agricultural health and safety problems. Geographically, the Centers are distributed throughout the nation to be responsive to the agricultural health and safety issues unique to the different regions. These centers were the first federally funded efforts to focus exclusively on agricultural safety and health, adopting a public health perspective unique in scientific research related to agriculture.

The heightened attention to agricultural injuries and fatalities has resulted in more than 30 years of intervention efforts by the NIOSH centers and others. Attempts to understand why agriculture remains such a dangerous occupation have largely focused on farmers' knowledge and attitudes about occupational hazards (Murphy, 1981) or safety behaviors among farmers (Yavuz et al., 2014). Some have also focused on the difficulties of providing services, or oversight, to the farming community, which is rural, often isolated, and highly dispersed (Sandfort, 1990). In some cases, researchers have taken a participatory approach, employing social networks to promote safer behaviors (Stave et al., 2007; Schiller et al., 2010). Despite the investments in education and interventions, most farm safety endeavors are not well evaluated, and tend to emphasize changes in knowledge or attitudes, rather than measuring changes in actual injury rates (DeRoo and Rautiainen, 2000). To our knowledge, there have not been any previous studies specifically relating to farmers' perceptions or engagement in public health research; thus, this issue is even less well understood than safety and risk taking behaviors. Given the focus in public health on evidence-based approaches, it is important to evaluate the extent to which farmers are receptive to public health research. Our aim here is to examine how one cohort of farmers views public health research that focuses on respiratory protection.

3. The burden of lung disease in poultry production

Lung disease among agricultural workers has been recognized for some time, and estimates suggest that nearly 1,000,000 agricultural workers are at risk for lung disease (Clark et al., 1983;

Donham, 1986; Linaker and Smedley, 2002; Merchant et al., 1995; Omland, 2002; Thelin et al., 1984). A clinical pulmonary disease burden has been identified among workers in several sectors of agriculture including, both crops (e.g., cotton), and livestock production (e.g., poultry). In particular, pulmonary illnesses such as hypersensitivity pneumonitis, allergic and non-allergic rhinitis, occupational asthma, organic dust toxic syndrome (ODTS), and chronic bronchitis have been identified among poultry workers (Iversen et al., 2000; Radon et al., 2001; Whyte, 1993). Additionally, self-reported pulmonary and systemic symptoms such as chronic cough, wheezing, chest tightness, phlegm, nasal congestion, eye irritation, dyspnea, headache and fatigue have been also been observed among poultry workers (Donham et al., 2000; Kirychuk et al., 2003, 2006). Furthermore, investigations using pulmonary health diagnostics (e.g., spirometry) have observed decreased pulmonary function after exposure to aerosols and contaminant gases in the poultry work environment (Donham et al. 1990, 2000; Kirychuk et al., 2003, Kirychuk et al., 2006; Larsson et al., 1999; Radon et al., 2001; Whyte, 1993). This decrease in pulmonary function suggests pulmonary inflammation or the onset of obstructive lung disease.

Some information about aerosol exposure in poultry production exists. Kirychuk et al. (2006) collected personal aerosol exposure information among broiler workers. Their research measured personal exposure to total dust, respirable dust, endotoxin and ammonia exposures. Total dust and ammonia exposures are significantly greater among workers in floor housed poultry buildings ($n = 80$), compared to cage housed operations ($n = 31$). Of the 111 poultry workers who participated in the study, 25% reported current cough and 19% reported chronic phlegm. Workers who were above the 50th percentile for exposure to endotoxin (an inflammatory component of the gram-negative bacteria) reported chronic phlegm at a significantly greater proportion ($OR_{adj} = 1.69$; 95% CI 1.01–2.83). The generalizability of these results to broiler workers in the US is not clear as this study consisted of Canadian workers in both the broiler and turkey industries. However, Donham et al. (2000) reported mean total dust concentrations of 6.5 mg/m^3 (SD = 7.8), respirable dust 0.63 mg/m^3 (SD = 0.98), total dust endotoxin 1589 EU/m^3 (SD = 3394), and respirable dust endotoxin 59 EU (endotoxin units)/m^3 (SD = 97). This exposure information was collected among a variety of jobs in the US poultry industry and only 26 of the 257 participants were broiler growers. The small sample makes it difficult to generalize aerosol exposure concentrations among growers across sectors of poultry production. However, the following exposure concentrations were associated with significant pulmonary function decrements: 2.4 mg/m^3 total dust, 0.16 mg/m^3 respirable dust, 614 EU/m^3 endotoxin, and 12 ppm ammonia. This information suggests an association between worker inhalation exposures in the poultry industry and pulmonary inflammation or disease. Therefore, respiratory protection through either engineering controls that improve air quality or personal protective equipment, such as respirators, is needed for workers in the poultry production industry.

Information about inhalation hazards specific to the broiler industry are limited (Ellen et al., 2000; Louhelainen et al., 1987; Takai et al., 1998). A European study conducted during one, seven-week broiler growth period found that inhalable and respirable dust concentrations increased to 8 mg/m^3 and 2 mg/m^3, respectively (Ellen et al., 2000). Similar research in the swine industry has also reported that aerosol concentrations may increase with the age of the animal, lower relative humidity, and during the cooler winter months (Ellen et al., 2000; Takai et al., 1998). A study conducted in Switzerland found that broiler workers were exposed to increasing concentrations of inhalable dust, respirable dust, and endotoxin as broilers aged. Workers involved in catching mature broilers were exposed to inhalable dust concentrations of 37.6 mg/m^3 and average endotoxin exposure levels of approximately 6198 EU/m^3 (Louhelainen et al., 1987). How these exposure concentrations relate to US broiler production is not clear. New molecular biology tools are being used to characterize the diversity of bioaerosols that workers are exposed to in broiler production, however, the health implications of bioaerosol exposure is unclear (O'Brien et al., 2016; Nonnenmann et al., 2010). These studies do suggest that both aerosol concentrations and inhalable dust exposure are present during work in broiler production which may pose a pulmonary health risk. Therefore, focusing on engineering and personal respiratory protection among workers in poultry production may be especially important.

In 2001, a voluntary survey of U.S. employers regarding the use of respiratory protective devices was conducted by NIOSH and the U.S. Department of Labor's Bureau of Labor Statistics (BLS). This survey provided more detail about job related respirator use than any previous survey and indicated that 1152 livestock farms reported using respirators. Of those, nearly 60% indicated that respirator use was voluntary, and not required by farm administrative policy. Among all agriculture sectors, air sampling was only used on 5.9% of the surveyed farms as a tool to guide respirator selection and the majority of respiratory protection program administrators had no formal training in respiratory protection program management. The majority of the surveyed farms used disposable “dust masks” and nearly half of the workers received no training on how to use a respirator [BLS/NIOSH 2003]. These findings are difficult to generalize to smaller operations as only farms with 11 or more employees were included in the survey. Similarly, in east Texas, students in undergraduate programs who become broiler workers and managers receive no training on respirator use or the respiratory hazards present in the poultry industry (Joey Bray, PhD., personal communication). Workers in the poultry industry, even those with formal education, may not receive adequate training on respiratory protection use and the barriers to respirator use in the poultry production industry are unknown.

4. Materials and methods

In 2011, one of the study authors (Nonnenmann) began a five year educational intervention among broiler chicken producers. After collecting baseline data on respiratory exposures during different work tasks, growers were sent a questionnaire by US mail and later invited to events focusing on improving rates of respirator use. Although the response to the survey was fairly robust (about 30% of the study population), growers were largely unwilling to attend events related to the project.

Because of the challenges encountered implementing the final component of the project, the research team determined the need to systematically identify some of the barriers to participating in health and safety research among agricultural populations. In particular, we wanted to better understand the perspectives and knowledge of agricultural producers about federally-funded safety and health research. To elicit this information, the authors developed a semi-structured interview tool, which was designed to be used during a Computer Assisted Telephone Interview (CATI). The interviews were conducted by trained interviewers at the University of Iowa's Social Science Research Center. The interviewers received the interview tool in advance and met with the research team to learn about the context of the project and the type of farmers they would be speaking with, as well as to answer any of their questions.

The total study population consisted of 1172 broiler chicken growers from Texas, Kentucky, North Carolina, and Mississippi.

About 195 growers responded with a completed questionnaire about their use and perceptions of respiratory protection while working in broiler production facilities. Of the respondents 180 indicated that they would be interested in additional information about the study. To recruit for the interview, letters were sent out to those 180 potential informants prior to contacting them by phone. Interviewers made three attempts to contact growers by phone. Interviewers were successful in contacting and interviewing thirty growers, providing a critical-case sample from which logical generalizations could be made based on in-depth, narrative data (Bernard, 2006). Participation in this study was voluntary and all study procedures were approved by the University of Iowa Institutional Review Board.

The interview questions addressed issues pertaining to a very specific population, broiler chicken growers in the US. The interview script asked informants broad, open-ended questions that would elicit narrative responses, taking up to 40 min per interview. Interviewers were provided potential follow-up questions to encourage more discussion as needed. The eight question script included questions that asked respondents to speak to their own perceptions (such as: "Is there anything that may prevent you from participating in research on your farm?") as well as to speak more broadly about their peers in the poultry industry (for example, "What suggestions do you have for encouraging growers to talk with researchers about health and safety topics?"). Other questions asked about respiratory protection and publicly funded research, such as:

- Do you think growers are interested in respiratory protection?
- What are your thoughts when I ask about university researchers doing federally funded (or government based) research on your farm?
- What do you think some of the challenges would be for performing workers safety and health research in the broiler chicken industry?

The CATI system allowed interviewers to transcribe the responses as they were given; written transcriptions were then provided to the research team for analysis.

Data analysis was conducted using a grounded theory approach, in which narrative data is read, and re-read to identify emerging themes and ideas. Rather than approaching the data with a hypothesis or other pre-conceived notion of the content, this iterative approach allows for researchers to better understand a topic from the perspective of the informants (Glaser and Strauss, 1967; Strauss and Corbin, 1990, 1998). The 30 interviews resulted in 219 discrete responses, each of which was analyzed as a unit of text. Responses were analyzed both in the context of the question asked, and in isolation of the question for consistency and to help ensure that the research team members' coding decisions were not affected based on the question associated with the response. Through close readings of the text, the interview team identified seven themes (Choice, Fear, Trust, Low Priority, Already Use Respiratory Protection, and Positive Toward Research). Each of these was divided into more detailed subthemes, for example, "research agenda" and "knowledge of researchers" were subthemes of "Trust" (Bernard, 2006; DeWalt and DeWalt, 2002). These were assigned numeric codes to aid sorting and comparison.

This paper focuses on two major themes identified in the interview transcripts: trust and fear. Taken together, respondents' lack of trust in and fear of the results of health and safety research result in this research not being seen as scientifically legitimate in the eyes of agricultural producers.

5. Results

5.1. Trust

One important theme that emerged from the data analysis was a lack of trust in research. The interview questions were designed to be open-ended and none of the interview questions included the word "trust." Nevertheless, 48 (22%) out of 219 coded individual responses had a primary, secondary, or third code related to trust. Out of 30 informants, fully half (15) introduced the concept of trust in their responses to the interview questions.

In some cases, statements about lack of trust were generally critical of research in agriculture, suggesting that there is a disconnect between academia and the farming community. Respondent number 125 sums up his feelings on the issue of trust in agricultural research:

> "There is such a bad feeling between producers and liberal academia that we feel like they don't understand us and never will and they are out to hurt us."

This informant goes on to suggest that research has been inconsistent with the needs of the farming community, hence the lack of trust:

> "I think the most important thing is to build that trust back. I don't know where to do that. You are going to have to gain the trust back with the farmer. Make them know that the research wants what is best for the industry or the farmer. If you asked 1000 farmers, on the issue of trust, they wouldn't want to talk to you. They feel they have been taken advantage of so many times. For me it isn't, it is purely a trust thing."

In particular, informants pointed to a lack of trust because the agenda of researchers is inconsistent with what the farmers see as appropriate research. When asked during the interview if there were factors that would prevent or encourage farmers from having research conducted on their farms, several suggested that they would first need to understand the purpose and specific objectives of the study. For example:

> "Well, you need to be up front about what the research is for" (respondent 64)

> "It also depends on what type of research is involved" (respondent 119)

> "I don't have a problem with it as long as it's a needful study" (respondent 120)

> "If it was for the right reason, I'd do it on my farm" (respondent 5)

Not only do informants want to understand the purpose of the research, they want to make sure that the objectives of the research are consistent with their views of important and relevant research topics. Respondent 301 states:

> "Well, just to be honest, from my point of view, a whole heck of a lot of money is wasted on studies that are useless; so if I feel that way, probably a big majority of chicken growers do … We're not against all research, but it should be limited to important issues and shouldn't be limited to how many times a chicken lowers its neck in a lifetime."

This comment suggests that growers view some research as frivolous and unnecessary. Instead, these growers call for research that is more driven by production gains than safety and health of the farmer or farmworker. Respondent 50 states:

> "I would be more willing if the objective of the research is something I consider beneficial. Things like increasing efficiency and decreasing costs."

Demonstrating that research will have a positive economic effect is one way to get growers to allow researchers on their farms:

> "I think if they see a direct benefit for their bottom line they would but otherwise I think they would see it as a hindrance or a bother or a waste of time" (Respondent 11)

Another important component of research, for farmers, is ensuring that there is no research "bias." In some cases, farmers felt that there was a profit motive behind research, even when conducted by a government agency or university:

> "I think it might be a waste of taxpayer money. Depends on what company is behind the research besides the government" (Respondent 64)

Of particular concern was the potential for a sales strategy, hidden in the guise of a research agenda:

> "My main concern is: I saw the call today was from a university and I think people are concerned for being scammed or have someone give them a sales pitch for their newest respirator they have." (Respondent 161)

> "It sounds to me like somebody who wants to sell respirators. It probably sounds like a sales pitch" (Respondent 301)

> "A lot of them probably think it's a sales technique. It's something all the growers do. It used to be that somebody would come out with something new and somebody calling on the phone soliciting sales. I especially don't answer the phone a whole lot. I really don't like phone solicitation. When you've got people calling that got no idea who you are or what you do and would give you this, I'm not really into that. Organizing in person meetings also appear as sales pitches. A lot of times, they brought somebody in to sell us stuff." (Respondent 302)

In addition, farmers want researchers to approach their work without preconceived notions about farming or the results they hope to obtain.

> "It seems like before they go into research, they have their mind made up about what they want to find. They are going to skew it to fit their idea. They have their mind made up so they are going to skew their research to fit their preliminary research. I think that is what a lot of people in agriculture think." (Respondent 125)

Tellingly, at the conclusion of one interview, the informant said to the interviewer, "good luck with the research, hope you find what you're looking for."

In addition to trusting that the research agenda is consistent with the needs of producers and is free of bias, farmers also expressed discomfort with the researchers themselves, in part because the researchers may be people who are unknown to them. Respondent 64 noted: "I would want to trust the researchers. I know nothing about the University of Iowa." Farmers also expressed concerns about the agricultural knowledge base of public health researchers. If researchers appear uninformed about the daily realities of farming, growers are less inclined to participate in their studies:

> "If the growers could trust the researchers might know what raising chickens is like, they might be more willing to participate" (Respondent 301)

> "We can try to do things better but it will never be perfect no matter what a farmer does will be able to pacify or please someone in academia or research because they don't understand what we go through and how hard we work. The chicken business is a 24-h a day job - up in the middle of the night. It is a calling." (Respondent 125)

This lack of knowledge about farming appears especially clear to farmers when public health researchers suggest interventions that are not compatible with their day to day responsibilities on the farm.

> "When there's something that's being suggested that's so impossible to do then you lose faith in the person doing the questioning. You think they absolutely don't know what they're talking about and you don't want to deal with them … You can't get chicken farmers to use a dust mask. The people that are suggesting do this don't know what a chicken house is like. It's full of chickens, and you are sweating even if it's cool. You couldn't breathe, or move, if you had a respirator. It would be a big waste of taxpayer money and a useless suggestion." (Respondent 301)

> "I feel like the people who're making laws that impact us are very far from the actual things. I think people that do the work need to be consulted. If you think there's a problem you need to talk to the person who's doing the job to really find out" (Respondent 5)

Other, more subtle comments also suggest that farmers see a lack of knowledge among researchers. One question asked respondents to speculate why growers did not attend events hosted by the researchers. Respondent 119 stated, "Well, if you know much about farming you know they don't get together a lot. You don't really leave your business."

5.2. Fear

The lack of trust in research agendas and in the researchers' knowledge about farming ultimately leads to a sense of fear among growers that the research outcomes will negatively affect their livelihoods. The interviews asked respondents about factors that would prevent them from allowing safety or health research on their farm. Of 219 responses, 55 (25%) were coded as related to fear. A few indicated fear of public perception ($N = 5$) or of increased government regulation ($N = 8$). Many more responses indicated that they would hesitate to allow on-farm research because they fear a reaction from the company for which they produce ($N = 18$) or that the long term effect of the research would result in changes that would reduce their profitability or cause financial loss ($N = 24$).

Poultry producers were highly aware of the complicated interactions between their farms, the companies they worked with, the public, and government regulators. However, because the integrators were the primary point of contact for the producers and because the companies had the most immediate control over the

growers, informants were likely to first express concern about the reaction of the company. Respondent 5 states, "our company often doesn't want outsiders coming on the farm. They're afraid of negative light from the media and bad publicity."

Others indicated that their company expressly prohibited visitors entering chicken houses, a policy that respondent 111 supports:

> "On my particular farm, I'm limited on what I can allow, the company itself prohibits it; and I would be a little concerned myself on letting people come and potentially passing something on to my birds or something. We're supposed to keep people out of the chicken houses. I think there's a big disease going through northern Missouri; we do our best to keep people out. Only my wife and I go into the chicken houses, it's not only a company rule it's my rule too."

Others express similar sentiments, especially related to disease and biosecurity:

> "I would be okay with that, but my company would not be okay with that. They don't like other people coming to the farm because we don't know where that person has been and they could infect the birds that we grow." (Respondent 268)

> "I probably wouldn't want that. I figure my employer wouldn't want that." (Respondent 47)

> "I think the company is going to prohibit people coming on the farm due to the disease." (Respondent 126)

> "The company would be a challenge because they don't want any diseases being passed onto the chickens." (Respondent 268)

In addition, the companies may be uncomfortable with the growers participating in public meetings, another strategy of the project intervention that was difficult to implement. In some cases this may also be related to biosecurity:

> "The integrators themselves don't encourage us to meet because of the possibility of the spread of disease. We are discouraged to go places other growers would meet." (Respondent 117)

But, the concerns about meetings are also related to the growers' relationship with the company and the potential to spread unrest or dissatisfaction with the companies' policies:

> "Well, they might think that the integrator might not want them to and we've had meetings in the past where we get everybody together and everyone just gripes about the integrator. I would think that it would be pretty hard to get people involved in something like that." (Respondent 300)

> "I think if our contractor had a grower meeting, we would be willing to do surveys there. [One company] does not do that, but I know [another that] does. It depends on the integrator. [One company's] growers used to get together, seven or eight years ago. They did not like us meeting. They thought of us as rebels. We just wanted to learn from each other, but they did not like it." (Respondent 117)

Informants also often expressed fear of financial loss that might result from research findings as well as the research process. In some cases, this was tied to a possible change in a regulatory structure that would require new equipment or procedures:"My biggest concern is that the new rules or regulations that come into play would lower my sales and I would not be compensated. I would be glad to comply with any rules or regulations as long as it doesn't cost me money." (Respondent 109)

> "If it's going to cost them money, it's something they don't want to hear. If some regulations came out that required certain devices that cost X amount of dollars, it goes right to the bottom line." (Respondent 195)

Other growers noted that if they were to allow a researcher on their farm, it could interfere with their workday and, ultimately, their profitability.

> "The challenges would be the time that it would take out of the growers' work time. Growers might not be willing to sacrifice their time. Even if you compensated the growers, they might still not be interested." (Respondent 117)

> "I guess what kind of compensation I get for having other people out here. I don't want all these people coming out here and keeping me from my job then I go bankrupt." (Respondent 47)

Some informants pointed out that both they and their companies would be concerned about lowered profitability:

> "Cost; people are reluctant to spend money. Growers, integrators, the cost to them, it's more difficult to sell. That's about it." (Respondent 195)

> "They have a monopoly on this and they don't want anyone interfering. Anything that would cause them not to do business as normal they would be against." (Respondent 47)

Finally, growers pointed out that it's already difficult to be economically successful in their line of work. Experimental changes, or trying new strategies that do not work in the long run may damage their economic viability

> "I'm 26 and it's hard to make it growing chickens. I can't just try something if it doesn't work. Every time, I go out of chickens, it's important that I do well. It's tough to make it growing chickens." (Respondent 314)

> "It's like doing a lot of things. I'm open to suggestions, but I at least want to break even." (Respondent 302)

5.3. Questioning scientific authority

Growers expressed both lack of trust and fear of potential negative outcomes of research. Several comments, across all themes, also subtly questioned the scientific merit of conducting research in the first place. Sometimes they expressed this by noting that their work was not particularly dangerous to begin with, suggesting that researchers are investigating questions not relevant to the farm community:

> "I don't know … just we really don't have any major things. We have dust in the houses and there's a chance of falling and getting cut or hurt. We don't have any major challenges. It's just common sense with what we do. On a daily basis we have to be a plumber and a carpenter and environmental regulator. It just takes some common sense to get through it and be as safe as you can." (Respondent 5)

> "I don't see where there are a whole lot of hazards really. There are just two of us on the farm. Most of it is hand work. As long as you don't let the forklift run over you, you are in good shape. Also we are pretty simple-minded around here and don't like when things get too complicated." (Respondent 93)

> "I guess so; we're always looking for better ways to do things but it's not rocket science. We know what we're doing and it's not really what I would consider a dangerous environment." (Respondent 5)

Some growers also pointed out that they already know how to use respiratory protection, and do so regularly. Thus, there is little need for further research or education about how to reduce respiratory exposures in the barns.

> "I don't think that we really need to do research on respirators. We use them when we need to. I feel like we can take care of that on our own. I don't really like people coming down here and snooping around." (Respondent 86)

> "I've been doing this for 20 years, and what we do now seems to work." (Respondent 106)

> "I think you're talking about something they've already dealt with. If they're already satisfied with what they're doing, they're not going to spend their time learning about it. We want to learn about things we don't know about or things we are not satisfied with. I don't know anyone that's not satisfied with their masks." (Respondent 139)

6. Discussion and conclusion

Other qualitative approaches in agricultural safety and health have taken community and participatory approaches to identifying areas of concern and developing community based interventions (Petrea and Aherin, 2008). Some have found that farmers and farm families are willing to participate in safety oriented programming (Schiller et al., 2010). However, there is extremely limited knowledge about producers' perceptions of and willingness to participate in formative agricultural safety and health research. This study aimed to address that gap in knowledge. The research presented in this paper is limited by the small sample size and reliance on respondents, mostly located in the southeastern United States, who were already enrolled in a study related to respiratory health. The opinions of poultry farmers who declined to participate in the original research are not included. It therefore may not reflect the perceptions of the general population of poultry producers or those who engage in other farming enterprises. Qualitative software was not used in the thematic analysis of responses. The data analysis is subject to human error, though the research team took steps to ensure reliability and consistency throughout the process.

While the field of agricultural safety and health, and the need for respiratory protection in poultry production, is scientifically well supported, our data show that agricultural safety and health science has not been legitimized by agricultural producers. Instead, farmers question the methods and agendas of safety and health researchers, fearing that the results of such research will work against their economic success. Further, they actively question the basic legitimacy of the research questions and topic.

Although it was not immediate, US farmers have largely adopted scientific agriculture as the standard approach, to the extent that scientific examination serves to legitimize agricultural practices, as seen particularly in organic production (Carolan, 2006b). Importantly, the merger of science and agriculture is predicated on an agreement by both researchers and farmers that scientific evidence should lead to economic productivity (Buttel, 1993). This presents a challenge for public health researchers who may find it difficult to identify how their work has a direct impact on a farmer's bottom line. Because of this gap, the farmers in this study expressed fear and a lack of trust in health and safety research. Where public health researchers hope to improve worker safety and health, and see this as a benefit to growers, the growers fear other consequences. Some of these consequences include disease transmission, loss of work time, loss of privacy, or additional regulations. Importantly, they also fear loss of economic productivity, a central tenant for successful scientific research related to agricultural production.

Although informants were not asked to comment specifically on how much trust they have in publicly funded safety and health research, they readily noted that lack of trust is a barrier to their participation. This lack of trust extends from the initial research agenda, which they question, to the effect of the findings, which they suggest may have negative consequences for their farm and industry. Comments about studies being "needful," suggest that research on respiratory protection in broiler production may be frivolous or unnecessary. Respondents also noted that research agendas may be based primarily on the profit motives of companies who sell respirators. The fear of a sales pitch is particularly ironic, given the close relationship between research in biotechnology and profitability for large agribusiness corporations that sell such products.

Similarly, informants suggest that they fear potential repercussions from the companies they contract with, the risk of disease, and potential financial loss that might result from safety and health research. Because the topics of research are not seen as particularly important, growers are not willing to undermine company policies. While contracts in integrated production are notoriously restrictive for growers, there are instances of growers who negotiate contract changes based on their individual farm needs, for example using alternative bedding for organic production (Janssen, 2017). However, allowing researchers on farms for health and safety research, for the growers in this study, is not worth their perceived risks to their contracts or farm profitability.

Finally, growers question the basic scientific merit of research related to improving the use of respiratory protection in their poultry barns. The research does not appear to be based in the producers' best economic interests, therefore it is also scientifically suspect. Despite the body of research that indicates an increased risk for lung disease among animal production workers and associated inhalation exposures in chicken production with pulmonary symptoms among workers, respondents in this study suggest that their farms are not particularly dangerous and their current precautions are sufficient. These responses suggest that public health science and knowledge may still fall in the realm of folk-knowledge, where farmers know more than scientists. Responses indicating that respiratory protection is simply "common sense" or statements like "we know what we need to do" suggest that farmers do not need public health scientists to tell them. However, the scientific evidence of lung disease among this group of agricultural workers also suggest that poultry workers may not be adequately protecting their lungs from inhalation exposures in the chicken barn.

Researchers have found that workers are provided little information about use of inhalation exposure control, including respirators (Donham, 1986; Donham et al., 1990; Donham et al., 2010). This has caused safety and health researchers to assume that agricultural workers, including farmers, lack knowledge about respiratory hazards and how to use respiratory protection. This

assumption then leads researchers to predict that an educational intervention should be sufficient to improve the rate of respirator use among the population. However, based on responses from participants in this study, this assumption about growers' knowledge and response appears incorrect. The participants in this study indicated that they know how to manage their own respiratory health. Ultimately, because the logic and evidence used to justify the approach and research agenda was not clear to potential participants, they did not trust the agenda or the results of the project. More importantly, informants also perceived a research agenda that is inconsistent with their production goals and farming methods.

Farmers are interested in production research that will help them increase efficiency, which is consistent with Buttel's production ideology. Further, based on the information gathered from the participants in this study, growers perceive public health research as reducing productivity. The growers promote their own expertise as it relates to production practices and "common sense" to suggest that the scientific questions posed by public health researchers in this project lack validity. As a result, public health researchers find themselves in a similar position to agricultural scientists in the early 20th century. Farmers are resistant to turn their everyday, common sense practices into scientific questions. For their part, public health researchers look to the body of evidence about respiratory illness in agriculture and seek to improve farmers' use of respiratory protection. Public health researchers have more work to do to engage with the economic realities of agriculture and communicate the ways that prevention and protection are consistent with farmers' production goals.

References

Bernard, H. Russell, 2006. Research Methods in Anthropology: Qualitative and Quantitative Approaches, Fourth Edition. AltaMira Press, Lanham, MD.

Buttel, Frederick H., 1993. Ideology and agricultural technology in the late twentieth century: biotechnology as symbol and substance. Agric. Hum. Values 10 (2), 5–15.

Bye, Pascal, Fonte, Maria, 1993. Towards science-based techniques in agriculture. Agric. Hum. Values 10 (2), 16–25.

Carolan, Michael S., 2006a. Social change and the adoption and adaptation of knowledge claims: whose truth do you trust in regard to sustainable agriculture? Agric. Hum. Values 23 (3), 325–339. http://dx.doi.org/10.1007/s10460-006-9006-4.

Carolan, Michael S., 2006b. Sustainable agriculture, science and the Co-production of 'expert' knowledge: the value of interactional expertise. Local Environ. 11 (4), 421–431.

Clark, S., Rylander, R., Larsson, L., 1983. Airborne bacteria, endotoxin and fungi in dust in poultry and swine confinement buildings. Am. Industrial Hyg. Assoc. J. 44 (7), 537–541.

Danbom, David B., 1986. Publicly sponsored agricultural research in the United States from an historical perspective. In: Dahlberg, Kenneth A. (Ed.), New Directions for Agriculture and Agricultural Research: Neglected Dimensions and Emerging Alternatives. Rowman and Allanheld, Totwa, NJ, pp. 107–131.

DeRoo, Lisa A., Rautiainen, Risto H., 2000. A systematic review of farm safety interventions. Am. J. Prev. Med. 18 (4, Suppl. 1), 51–62. http://dx.doi.org/10.1016/S0749-3797(00)00141-0.

DeWalt, Kathleen M., DeWalt, Billie R., 2002. Participant Observation: a Guide for Fieldworkers. AltaMira Press, New York, NY.

Donham, K., 1986. Hazardous agents in agricultural dusts and methods of evaluation. Am. J. Industrial Med. 10 (3), 205–220.

Donham, Kelley J., Thelin, Anders, 2006. Agricultural Medicine: Occupational and Environmental Health for the Health Professions. Wiley-Blackwell.

Donham, K., Leistikow, B., Merchant, J., Leonard, S., 1990. Assessment of U.S. Poultry worker respiratory risks. Am. J. Industrial Med. 17 (1), 73–74.

Donham, K., Cumro, D., Reynolds, S., Merchant, J., 2000. Dose-response relationships between occupational aerosol exposures and cross-shift declines of lung function in poultry workers: recommendations for exposure limits. J. Occup. Environ. Med. 42, 260–269.

Donham, K.J., Lange, J., Kline, B.A., Rautiainen, R., Grafft, L., 2010. Prevention of occupational respiratory symptoms among certified safe farm intervention participants. J. Agromedicine 16 (1), 40–52.

Ellen, H.H., Bottcher, R.W., von Wachenfelt, E., Takai, H., 2000. Dust levels and control methods in poultry houses. J. Agric. Saf. Health 6 (4), 275–282.

Glaser, Barney G., Strauss, Anselm, 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine, Chicago.

Hassanein, Neva, 1999. Changing the way America farms: knowledge and comunity in the sustainable agriculture movement. In: Flora, Cornelia, Francis, Charles A., Olson, Paul (Eds.), Our Sustainable Future. University of Nebraska Press, Lincoln, NE.

Iversen, M., Kirychuk, S., Drost, H., Jacobson, L., 2000. Human health effects of dust exposure in animal confinement buildings. J. Agric. Saf. Health 6 (4), 283–288.

Janssen, B., 2017. Making Local Food Work: The Challenges and Opportunities of Today's Small Farmers. University of Iowa Press, Iowa City, IA.

Kirychuk, S., Ambikaipakan, S., Dosman, J., Juorio, V., Feddes, J., Wilson, P., Classen, H., Reynolds, S., Guenter, W., Hurst, T., 2003. Respiratory symptoms and lung function in poultry confinement workers in Western Canada. Can. Respir. J. 10 (7), 375–380.

Kirychuk, S., Dosman, J., Reynolds, S., Wilson, P., Senthilselvan, A., Feddes, J., Classen, H., Guenter, W., 2006. Total dust and endotoxin in poultry operations: comparison between cage and floor housing and respiratory effects in workers. J. Occup. Med. 48 (7), 741–748.

Kloppenburg Jr., Jack, 1991. Social theory and the de/reconstruction of agricultural science: local knowledge for an alternative agriculture. Rural. Sociol. 56 (4), 519–548.

Larsson, B., Larsson, K., Malmberg, P., Martensson, L., Palmberg, L., 1999. Airway responses in naive subjects to exposure in poultry houses: comparison between cage rearing system and alternative rearing system for laying hens. Am. J. Industrial Med. 35 (2), 142–149.

Lessenger, J.E., 2006. Agricultural Medicine: a Practical Guide. Springer Science & Business Media, Inc.

Linaker, C., Smedley, J., 2002. Respiratory illness in agricultural workers. Occup. Med. 52 (8), 451–459.

Louhelainen, K., Vilhunen, P., Kangas, J., Terho, E.O., 1987. Dust exposure in piggeries. Eur. J. Respir. Dis. 152, 80–90.

Macken-Walsh, Áine, 2016. The potential of an "agriculture of the middle" model in the context of EU rural development: an american solution to an Irish Problem?" 2016, 1 (4), 12. http://dx.doi.org/10.5304/jafscd.2011.014.018.

Merchant, James A., Burton C. Kross, Kelley J. Donham, and David S. Pratt. 1989. Agriculture at Risk: A Report to the Nation. National Coalition for Agricultural Safety and Health.

Merchant, J., Reynolds, S., Zwerling, C., 1995. Assessment of workers. In: Corbett McDonald, J., Kingdom, United (Eds.), The Epidemiology of Work-related Diseases. BMJ Publishing Group.

Murphy, Dennis J., 1981. Farm safety attitudes and accident involvement. Accid. Analysis Prev. 13 (4), 331–337. http://dx.doi.org/10.1016/0001-4575(81)90057-9.

Murphy, Dennis J., Seltzer, Barbara L., Yesalis, Charles E., 1990. Comparison of two methodologies to measure agricultural occupational fatalities. Am. J. Publ. Health 80 (2), 198–200.

Nonnenmann, M.W., Bextine, B., Dowd, S.E., Gilmore, K., Levin, J.L., 2010. Culture-independent characterization of bacteria and fungi in a poultry bioaerosol using pyrosequencing: A new approach. J. Occup. Environ. Hyg. 7 (12), 693–699. http://dx.doi.org/10.1080/15459624.2010.526893.

O'Brien, Kate M., Chimenti, Michael S., Farnell, Morgan, Tabler, Tom, Bair, Thomas, Bray, Joey L., Nonnenmann, Matthew W., 2016. High throughput genomic sequencing of bioaerosols in broiler chicken production facilities. Microb. Biotechnol. 9 (6), 782–791. http://dx.doi.org/10.1111/1751-7915.12380.

Omland, O., 2002. Exposure and respiratory health in farming in temperate zones–a review of the literature. Ann. Agric. Environ. Med. 9 (2), 119–136.

Patil, Rajan R., 2011. Public health controversies: common characteristics. J. Glob. Infect. Dis. 3 (1), 97–98. http://dx.doi.org/10.4103/0974-777X.77308.

Petrea, Robert E., Aherin, Robert A., 2008. Evaluation findings of an agricultural health and safety community leadership development process. J. Agromedicine 5 (2), 77–89.

Radon, K., Weber, C., Iversen, M., Danuser, B., Pedersen, S., Nowak, D., 2001. Exposure assessment and lung function in pig and poultry farmers. Occup. Environ. Med. 58, 405–410.

Sandfort, Del, 1990. Reaching the difficult audience: an experiment to provide occupational health services to farmers and ranchers in Colorado, U.S.A. Am. J. Industrial Med. 18 (4), 395–403. http://dx.doi.org/10.1002/ajim.4700180408.

Schiller, L.F., Donham, K., Anderson, T., Dingledein, D.M., Strebel, R.R., 2010. Incorporating occupational health interventions in a community-based participatory preventive health program for farm families: a qualitative study. J. Agromedicine 15 (2), 117–126. http://dx.doi.org/10.1080/10599241003622491.

Stave, Christina, Törner, Marianne, Eklöf, Mats, 2007. An intervention method for occupational safety in farming — evaluation of the effect and process. Appl. Ergon. 38 (3), 357–368. http://dx.doi.org/10.1016/j.apergo.2006.04.025.

Strauss, Anselm, Corbin, Juliet, 1990. Basics of Qualitative Research: Grounded Theory, Procedures, and Techniques. Sage, Newbury Park, CA.

Strauss, Anselm, Corbin, Juliet, 1998. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Sage, Newbury Park, CA.

Takai, H., Pedersen, S., Johnsen, J.O., Metz, J.H.M., Groot Koerkamp, P.W.G., Uenk, G.H., Phillips, V.R., Hodlen, M.R., Sneath, R.W., Short, J.L., White, R.P.,

Hartung, J., Seedorf, J., Schroder, M., Linkert, K.H., Wathes, C.M., 1998. Concentrations and emissions of airborne dust in livestock buildings in northern europe. J. Agriculutral Eng. Res. 70, 59–77.

Thelin, A., Tegler, O., Rylander, R., 1984. Lung reactions during poultry handling related to dust and bacterial endotoxin levels. Eur. J. Respir. Dis. 65 (4), 266–271.

Lewandowsky, Stephan, Gignac, Gilles E., Vaughan, Samuel, 2013. The pivotal role of perceived scientific consensus in acceptance of science. Nat. Clim. Change 3 (4), 399–404. http://www.nature.com/nclimate/journal/v3/n4/abs/nclimate1720.html-supplementary-information.

Whyte, R.T., 1993. Aerial pollutants and the health of poultry farmers. World's Poult. Sci. J. 49 (2), 139–156.

Yavuz, Hasret, Simsek, Zeynep, Akbaba, Muhsin, 2014. Health-risk behaviors in agriculture and related factors, southeastern anatolian region of Turkey. J. Agromedicine 19 (4), 364–372. http://dx.doi.org/10.1080/1059924X.2014.945706.

Interlibrary Loans and Journal Article Requests

Notice Warning Concerning Copyright Restrictions:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One specified condition is that the photocopy or reproduction is not to be *"used for any purpose other than private study, scholarship, or research."* If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Upon receipt of this reproduction of the publication you have requested, you understand that the publication may be protected by copyright law. You also understand that you are expected to comply with copyright law and to limit your use to one for private study, scholarship, or research and not to systematically reproduce or in any way make available multiple copies of the publication.

The Stephen B. Thacker CDC Library reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law.

Terms and Conditions for items sent by e-mail:

The contents of the attached document may be protected by copyright law. The CDC copyright policy outlines the responsibilities and guidance related to the reproduction of copyrighted materials at CDC. If the document is protected by copyright law, the following restrictions apply:

- You may print only one paper copy, from which you may not make further copies, except as maybe allowed by law.
- You may not make further electronic copies or convert the file into any other format.
- You may not cut and paste or otherwise alter the text.