IDENTIFYING PESTICIDE COMPETENCIES AND PERCEIVED COMPETENCE AMONG PESTICIDE SAFETY EDUCATORS

by

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(Under the Direction of Lorilee R. Sandmann)

ABSTRACT

The purpose of this study was to investigate the level of professional competence among county extension pesticide educators based upon an identified formalized set of competencies. In doing so, the research focused on defining competency development, soliciting self-reported competency measurement, and examining the relationship between personal characteristics and self-reported competency measurements in the Cooperative Extension Systems' Pesticide Safety Education Program.

Specifically, the study produced an expert ranked and validated set of essential pesticide safety education program competencies, studied self-reported competency levels among county extension educators who plan and present pesticide safety education programs, and analyzed county extension educators' personal characteristics in an effort explain their self-reported level of competence.

Two survey questionnaires were developed and administered to two groups. The first instrument was administered to Pesticide Safety Education Coordinators in the United States and its' territories. This survey asked these subject matter experts to rank each pesticide competency item based on its' impact in minimizing human health and environmental risks. This survey yielded 22 responses and validated the pesticide competencies used to measure self-reported competency among county extension educators in the second survey questionnaire. For the second survey questionnaire, a total of 315 county extension educator responses from 15 states were collected.

The study yielded an empirically based set of 34 pesticide safety education competencies that was identified and validated by pesticide subject matter experts as being essential in minimizing the human health and environmental risks associated with pesticide use. When examining the results from the second survey instrument, it was determined that county extension educators have a high self-reported level of pesticide competence in pest identification, pesticide label information, and the different pesticide license classifications. County extension educators have a low self-reported level of competence in areas dealing with mathematical calculations and pesticide spray equipment selection, calibration, and use. The findings show that personal characteristics have little or no relationship with self-reported competency levels.

The study findings indicate a need for area specific training for county extension educators who conduct pesticide safety education programs.

INDEX WORDS: Professional Competence, Competencies, Cooperative Extension, Pesticide Safety Education, Educational Program Planning

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CHAPTER 1

INTRODUCTION

Formalized standards of professional competence have been established in many professional fields including law, real estate, education and various health care related occupations. Often, these standards are designed to ensure that individuals have a minimum level of competency within a particular profession and can adequately perform the duties related to a particular occupation. Additionally, these standards serve as a tool to exclude individuals who cannot attain the required educational background or develop capacity to adequately perform in a given occupation. This, in theory, helps establish and maintain a level of performance in a given occupation while validating or legitimizing a profession. For the most part, qualifying exams, licensure and similar standards are developed from a set of pre-determined competencies that have been identified as essential by subject matter experts and/or a qualifying professional association in an occupation.

Eraut (1994) notes that these qualifying exams are often coupled with other qualifying standards including educational studies at the collegiate level, a period of professional internship or apprenticeship and other means. Although these standards exist in many occupational settings, there are many more that do not employ professional qualifying exams or other formalized measurements or standards into determining minimum occupational competencies. This in turn makes it difficult to determine what minimum level of competency is adequate for a given occupation. An example where this difficulty can be seen is within pesticide safety education programs administered by the Cooperative Extension System (CES) programs in the United States.

The Cooperative Extension System is a federal program consisting of state and local partners. The program is designed to provide various types of educational programming to people at the county and regional level. Pesticide safety education is a program area for the CES and a main source of pesticide safety educational program delivery in the CES system is conducted at the county level by what many refer to as county agents or county extension educators. County extension educators are charged with providing research-based information and instruction in all areas of agriculture as well as in family and consumer sciences, community resource and economic development and youth development (Herren & Donahue, 1991). This broad area of program responsibility provides a challenge to county extension educators. To help county extension educators, many CES state programs require county extension educators to possess a minimum of a Master of Science degree in a “field relevant to the position” (Journal of Extension National Job Bank, April 6, 2010). Although this standard exists on a state by state basis, it does little to address the assessment of competency within a given educational program area deemed significant by CES. This means that each county extension educator may or may not be competent in a subject relevant to the needs of their local audiences. In order to address this, the CES administration provides many professional development opportunities for county extension educators. In theory, professional development opportunities would help county extension educators gain subject matter competence. This competence, in turn, will enable county extension educators to effectively deliver educational programs in a variety of subjects.

In many states, both new and experienced county extension educators spend a considerable amount of time each year participating in formal in-service training. For example, newly hired county extension educators in Georgia, the home state of the researcher, spend about one month during their first 18 months of employment participating in in-service or professional development programs while experienced agents spend at least 10 days per year in these training programs (Tyson, October 11, 2005). This trend is true for other occupations in the United States. Daley (2001) indicates that employers in various professional occupations nationwide spend over $50 billion annually on formal employee training and education with an additional $180 billion spent on informal on-the-job training. Daley (2001) adds that despite the huge investment, there are few assurances that the knowledge learned in training programs is linked to sound professional practice. Additionally, research indicates that most professionals tend to gain competence from experience rather than classroom training (Merriam and Caffarella, 1999; Benner, 2001; Mieg, 2001). If this is the case, professional development programs for county extension educators need to be experience based in order to maximize effectiveness. Additionally, different CES state programs may take different approaches to professional development with some putting a greater emphasis on it than others.

In the case of pesticide safety education programs conducted by county extension educators, a learners' ability to use pesticides correctly depends on, at least in part, the county extension educators' expertise in delivering sound pesticide information. If this does not occur, the potential for pesticide misuses and accidents could increase with severe consequences.

Over the last several years, budget constraints and other factors have forced many CES programs to rethink its county delivery system. In 2002, Bequette stated that "nationwide, Extension has been feeling the effects of the declining economy. Hiring freezes, reductions in travel, and reduced operational funds are commonplace" (p.1). He adds that budget and related economic issues have made the task of maintaining existing programs a challenge for county extension educators, administrators and others charged with extension programming. Again in Georgia, statistics show that the CES budget has been reduced by over 22 percent from 2002 to 2004 (UGA Cooperative Extension, 2004). Additionally, Georgia Extension programs have seen a 44 percent decline in personnel since 1991. In 2009, continued budget constraints forced many programs to make even more cuts. Scott Angle, the Dean of the College of Agricultural and Environmental Sciences at the University of Georgia stated that "To avoid layoffs, a sizeable number of faculty and staff volunteered to retire. We knew that over the next five to 10 years about half of our seasoned county agents would retire. That has now been accelerated." (Southscapes, Spring 2009).

In an attempt to continue to offer quality educational programming during difficult budget years, many CES programs, including Georgia's, have derived alternative delivery methods. One method, incorporating multi-county responsibility among county extension educators, was employed in Georgia in the early 1990's. The use of multi-county responsibilities in CES allowed extension administration to combine county programs into a regional program delivery system. The CES programs in Nebraska (Rockwell, Furgason, Jacobson, Schmidt & Tooker, 1993) and Iowa (Jones & Jost, 1993) made the transition to a regional delivery system in the 1980's and several other states followed suit.

The federal extension organization in the United States, acknowledges that "the number of local extension offices has declined over the years, and some county offices have consolidated into regional extension centers" (USDA-CSREES, 2004). In 2004, the Georgia Cooperative Extension program hired new county extension educators to work multi-county assignments consisting of three or more counties (UGA CAES Employment website, 2004). Under this system, the county extension educators go beyond single county lines to provide educational programs across a greater geographic region. By covering a greater area, the CES has been able to employ fewer county extension educators than in years past. Benefits of this arrangement include more cost-effective programming, however, it has also meant less time for county extension educators to receive and implement training related to pesticide issues and other program areas. As the previously noted statistics show, there are fewer county extension educators charged with doing more across a greater geographic area, which creates a decrease in the amount of time a county extension educator has to learn about pesticide issues.

This situation is most likely leading to the notion that some county extension educators, at best, becoming competent more slowly than in years past. The decrease in time county extension educators have has been addressed to some extent with the use of technology to deliver information at the regional or state level (Kelsey & Mincemoyer 2001, Lippert et al. 1998), however, this hasn't addressed the acquisition of competence by county extension educators that plan, develop and deliver programs. With about 3,500 new individuals becoming certified pesticide applicators annually in Georgia, it is imperative to CES that county extension educators have a high level of competence regarding pesticide issues. Yet, there is no formal standard to measure competence levels among this group. Additionally, human and environmental concerns regarding pesticide use is also a significant concern making pesticide safety education programs all the more important.

Statement of the Problem

Each year, county extension educators provide pesticide safety training and education to thousands of pesticide applicators across the United States. County extension educators must have a high level of pesticide subject matter competence as well as the ability to plan, deliver and evaluate quality educational programs. Consequently, CES administrators address the challenge of providing professional development opportunities for county extension educators that will enable them to become competent in a variety of subject matter areas including pesticide safety. Providing sound professional development programs is one challenge that has been compounded by the fact that many county extension educators are being given more territorial and program responsibilities. The additional program and territorial responsibilities places a limit on the time in which a county extension educator has to gain competence in different subject matter areas such as pesticide education. In addition, the level of pesticide competence among county extension educators in Georgia and other states is not known, and no standard measurement of professional competence in this area exists. It could be assumed that some county extension educators are quite competent in this area while others may not be. The notion that the latter situation exists leads one to believe that baseline data regarding subject matter competence among county extension educators would be beneficial to CES programs and their attempt to deliver adequate professional development programs. In conclusion, there is no standard measurement of pesticide competence among county extension educators. This creates a problem when attempting to determine the effectiveness of the current pesticide education program administered by CES programs across the nation.

Purpose of the Study

The purpose of this study was to investigate the level of professional competence among county extension educators based upon an identified formalized set of pesticide safety education competencies. Specifically, the study addressed the following questions:

1. What components of a pesticide safety education program do state pesticide safety education program coordinators view as most essential in minimizing the risks associated with pesticides?
2. What is the self-reported level of competence among county extension educators with regards to the pesticide safety education components viewed as most essential?
3. To what extent do county extension educators' personal characteristics explain their self-reported level of pesticide safety education competence?

Significance of the Study

This study validated a set of formal professional competencies that are essential to any pesticide educational program within the Cooperative Extension System. This set of competencies is helpful in determining what is most important to a pesticide safety education program within the Cooperative Extension System. Currently, no such standard exists in this program area. The Environmental Protection Agency (2005) noted that the goal of a pesticide certification and training program "is to determine applicator minimum competency to safely, properly and effectively use restricted use pesticides. A number of means exist to achieve this goal, such as examinations, general education, training, and hands-on experience. While minimum standards of competency for certification have been established by EPA through regulation, comparable standards of training are necessary to ensure that training is conducted efficiently and effectively" (pp. 1-2). This statement indicates that a lack of consistency exists within and across pesticide safety education programs.

Additionally, this study also asked county extension educators to rate their current level of competency with the items deemed significant by the state pesticide safety educators. This study takes the idea of professional competence beyond the stage of identifying competencies needed to be successful and addresses current levels of competence as seen by the educator. The study also contributes to the existing body of literature in this area and will also serve as a guide for other program areas within CES or other areas of adult education practice that wish to determine a set of standards to measure professional competence.

The information is significant in that the CES program can refer to this baseline data to help determine if the current level of competence in presenting pesticide information among county extension educators is sufficient. If not, the findings of the study can guide additional professional development and related professional training programs for county extension educators. CES can also use this information to determine the effectiveness of its current pesticide education programs and related delivery methods. Determining how county extension educators and CES perceive their level of professional competence in this area allows CES programs to better address broader issues related to pesticide education and training programs for county extension educators. These issues include the evaluating the hiring requirements and initial training of county extension educators as well as the entire CES county program development and delivery system. Understanding these issues helps determine the direction of the pesticide education programs at an international level as CES continues to be a significant program in developing countries across the globe.

The study also examines demographic data among county extension educators, which could serve as an indicator of pesticide competence. This information could help CES determine what types of personal, pre-professional, and professional experiences develop a perceived high level of competence in pesticide safety education among county extension educators and it will also add to the existing literature related to the acquisition of professional competence.

CHAPTER 2

REVIEW OF THE LITERATURE

The purpose of this study was to investigate the level of professional competence among county extension educators based upon an identified formalized set of pesticide safety education competencies. To provide additional background for the study, various bodies of literature were reviewed.

The Cooperative Extension System

The Cooperative Extension System is a national system of non-formal education (Boone, 1989) that is publicly funded and links education and research from state land-grant universities, the United States Department of Agriculture (USDA) and county governments (Seevers, Graham, Gamon & Conklin, 1997). The CES is the largest adult education organization in the world (Seevers, 1995) and is designed to help people identify their own problems and provide them with research-based information that will help solve these problems (Herren & Donahue, 1991). The CES provides information and instruction in the areas of agriculture, family and consumer sciences, community resource and economic development and youth development (Herren & Donahue, 1991). Kelsey and Hearne (1949) stated that one of the fundamental objectives of CES is “the development of people”(p.1) and that extension work grew out of a need for the dissemination of scientific knowledge in agriculture.

Although CES formally began in with the passage of the Smith-Lever Act in 1914, extension work and actual extension roots date back much further in American history to the early settlement by Europeans. Prawl, Medlin and Gross (1984) pointed out that “the roots of the extension system in the United States can be traced to the ideas of such early day Americans as George Washington, Thomas Jefferson, Daniel Webster and Benjamin Franklin" (p.12).

By the late 1800's, traveling agricultural workshops, or "Farmers' Institutes" had been established in 47 states with over 500,000 farmers participating in the programs (Kelsey & Hearne, 1949). From these workshops grew a need for more in-depth agricultural research and education and by the beginning of the 20th Century, the federal government had established a formal Cooperative Extension system designed to disseminate research- based information to people in the areas of agriculture, home economics, resource development and related areas. The CES is a complex program supported with federal, state and local resources. The federal level works closely with the state land-grant universities, who in turn, employs individuals at the state and local level. However, its' primary source for delivering educational programs is the county extension educator.

The County Extension Educator

The county extension educator is charged with taking the researched-based information generated by land-grant universities at a local level. These educators receive support from academic and research specialists at the area and state level (Lindsey and Key, 1995) with a primary responsibility of initiating "the translation of research-based information to the lay person or end user" (p. 304). While seemingly straightforward, the county extension educators' job description is broad and diverse. In the role of county extension educator for agricultural programs, the individual must be competent in a variety of subjects. Lindsey and Key (1995) noted that the role of the county extension educator has many facets. For example, in a 2010 job advertisement for a county extension educator with the Ohio State Extension program, it noted that the county extension educator will be responsible for providing educational programs in the areas of "in farm management, livestock and crop production, food security, home horticulture/Master Gardeners, commercial horticulture, farm land use issues, innovative agricultural business opportunities, environmental quality and sustainability, renewable energy, and bio-based products". (National Job Bank, April 6, 2010). Similar educational responsibilities can bee seen in other CES state programs including Georgia's where county extension educators are to "Plan and conduct informal educational programs in production agriculture and related areas" (UGA CAES Employment website Jan. 2, 2007). This broad area of subject matter and educational program responsibility, coupled with the various administrative responsibilities, comprises most of county extension educators' duties. Lindsey and Key (1995) categorized the role of a county extension educator into three broad components. They note that county extension educators must locate information, deliver information and apply it. They continue by stating that the most difficult and most important of the three is the delivery of the information, or teaching.

Early Extension Work

Seaman Knapp and Booker T. Washington were two pioneers in the development of the county extension delivery system. During the late 1800's, Knapp began to promote the idea of on farm demonstrations while serving as a special educator, or agent for USDA. These demonstrations incorporated the most innovative research-based agricultural practices of the day. The demonstrations were successful and the USDA took notice and hired 20 county extension educators to help implement on-farm demonstrations (Kelsey & Hearne, 1949). By 1905, county extension educators were working in Texas, Arkansas, Louisiana, Mississippi and Tennessee. The educators began to address problems such as the infestation of the cotton boll weevil. Within a few years, the programs had dramatically reduced damage caused by boll weevils. Knapp's idea of the county educational program had been a major success and would serve as the blueprint for the formal extension system.

While Seaman Knapp was working in Texas, Booker T. Washington was providing Extension type education to African-American farmers in Alabama. Washington, a former slave, was the president and founder of the Tuskegee State Normal School in Alabama. He saw a need for more agricultural education among African-American farmers and began holding annual Farmers Conferences at Tuskegee. Rural African-American families could attend and learn improved methods of farming, home construction, food processing and related information (Rasmussen, 1989). These conferences were similar to the "Farmers' Institutes" being conducted in other regions. Although these programs were successful, Washington noted that the poorest African-American families were not attending the conferences. With that in mind, Washington decided to visit these families on their farms in an attempt to share this information. His plan worked and soon after, the United States Department of Agriculture asked Washington to help start a similar program called "Farmers on Wheels" which served hundreds of African-American farming families (Mayberry, 1991). Not only was this work instrumental in the social and economic development of blacks in the 20th Century, it also served as a building block for the Extension work that was to come.

Today, there are more than 100 land-grant institutions across the United States and its territories. These include the 1862 and 1890 programs as well as tribal schools established for Native Americans. The Cooperative Extension System has over 15,000 employees (Seevers, Graham, Gamon and Conklin ,1997) and county offices can be found in over 2900 counties (USDA-CSREES, 2004). Most of these 15,000 employees work at the local or county level in the role of county extension educator.

Extension Program Delivery Philosophy and Methods

As noted earlier, program delivery is perhaps the most important but also the most difficult task facing county extension educators. This is due in part to the background of many county extension educators, which is limited in the formal study of educational theory and pedagogy (Lindsey and Key, 1995). Lindsey and Key (1995) cited Gerling (1982) who reported that only 28 percent of county extension educators in Oklahoma had a degree in Agricultural Education. Despite this, the CES program places a major emphasis on training and educating its clientele. This has many CES programs adopting the teaching philosophies and strategies found in education, particularly adult education. Adelaine and Foster (1990) noted that extension has made use of several important adult education philosophies. One of these addresses the idea of adults being a key player in the educational program planning process. In other words, addressing the learner's needs has been of importance for CES programs. The notion of involving the learner in program planning stems from Malcolm Knowles theory of andragogy.

Andragogy is "the art and science of helping adults learn" (Knowles, 1980) and is characterized by a set of assumptions and methods designed to better meet the needs and learning styles of adults. Andragogy differentiates from pedagogy, or childhood learning, in that is seeks greater input from the learner and provides a much less rigid learning environment. Knowles' theory of andragogy identifies 5 specific ideas about adult learning. First, he says that adults tend to be more self-directed in their learning endeavors. Second, he recognizes that adults have experience and this experience can serve as a resource for learning. Third, Knowles notes that adults enter learning activities with an idea or predetermined notion of what they need to learn. Knowles' last two assumptions are that adults tend to be more problem centered with their learning and that adults are internally motivated to learn.

Kelsey and Hearne stated that "extension teaching requires many methods" (1949, p.232). The choice of methods depends on specific goals (van den Ban & Hawkins, 1996). Some of these methods such as the farm demonstration, the farmer's institutes or similar group meetings have been mentioned previously. By 1930, a set of methods had been identified (Rasmussen, 1989). These were: demonstrations, exhibits, farm and home visits, meetings, printed materials and newspapers and magazines. Kelsey and Hearne (1949) identified three delivery categories used in extension work. They defined these methods as ones that reach individuals, groups and masses.

Programs geared toward individuals are advantageous because they allow for one on one interaction between the farmer and the educator. This in turn allows the educator to develop a relationship with the farmer and increase trust (van den Ban & Hawkins, 1996). It also allows the educator to address specific problems faced by the farmer. This method has distinct disadvantages such as the increase in costs of time and travel, making it difficult to reach a large audience. Examples of programs delivered to individuals would be farm visits, telephone calls and office visits from the farmer.

Programs delivered to groups include general meetings with lectures, demonstrations and farm schools. These programs also have specific advantages and disadvantages. First, group programs allow the educator to interact with the farmers and vice versa. Additionally, farmers can interact with one another and share information about problems and experiences. A disadvantage is that the learner might not retain much of the spoken word presented in meetings. Demonstrations enable farmers to see the results of a practice or learn how to do something in a real life situation. A major disadvantage of demonstrations is the investment of time and labor required to develop them (van den Ban & Hawkins, 1996).

Mass oriented programs include all print media such as newspaper articles, mailed circulars, posters as well as radio programs. These programs can reach a large audience, but it has been noted that they are limited in influencing change (van den Ban & Hawkins, 1996). In the late 1940's, at the time Kelsey and Hearne published their work, they indicated that approximately 17% of the extension work was conducted at individuals, while 25% was aimed at groups. An additional 38% was aimed at the masses and another 19% of programming resulted in what they call indirect influence. Indirect influence is when a personal observation unrelated to the main program area is made by the learner, or when a neighbor speaks to another neighbor about a program topic. Prawl et al. (1984) expanded the teaching methods described by Kelsey and Hearne. They build on the prior work and reflect the technological changes that are influencing extension delivery. Their model takes three approaches (individual, group and mass) and identifies several teaching methods, tools, aids, devices and techniques. Table 1 classifies the methods employed for each audience type. Eberle and Shroyer

Table 1

Extension Teaching Approaches (Prawl, Medlin and Gross, 1984)

	Individual	Group	Mass
Teaching Method	Office call Letter Demonstration Farm and home visit Self-directed learning	Meeting Tour/field day School/class Workshop Conference Demonstration Lecture	Exhibit Radio Television Fair/show Movie Newspaper
Teaching tool, aid, device, technique	Telephone Computer terminals Audio cassette Video cassette Chart Chalkboard Bulletins Models Tools Specimens	Photograph Poster Leaflet Bulletins Movie Panel Projected visuals Flip charts	Gaming/simulation Teaching machine Television Buzz session Role playing Circular letter Displays

(2000) point out that as technology has advanced so has CES delivery methods. CES has successfully incorporated video, e-mail, the World Wide Web, cellular phones and satellite conferencing into its toolbox. Eberle and Shroyer (2000) asked “what is the impact of all these new educational technologies?” (p. 138) and are these just new tools or do they signal a change in CES program delivery? They pointed out that farmers have access to computers and obtain information from numerous sources, but still prefer to observe new practices under local conditions and prefer direct interaction with the educator. They concluded by stating that these new technologies are not new methods, but are merely new tools that can expand the reach of the traditional methods. The success of these tools lies in their ability to improve efficiency and reduce costs. They note that interaction between the teacher and the learner is still important. Additionally, the county extension educator must have a working knowledge and understanding of the various types of program delivery methods available and they must be capable of using these methods in an appropriate manner.

The CES has expanded the idea of the land-grant colleges and has grown into the largest adult education program in the world. This growth was due to an over-riding demand to educate people in order to improve their lives. The educational programs in CES are based on major adult learning theories, particularly andragogy. The CES philosophies also reflect the ideologies expressed in many adult learning theories. Although instructional tools continue to evolve, it appears that the basic delivery methods employed by CES remain significant and important in the eyes of the learners who participate in extension programs. It is imperative that county extension educators have a working knowledge of the subject matter for their programs as well as an understanding of the delivery methods and educational philosophies associated with these programs.

Pesticide History, Education and Regulation

During the last century, production agriculture in the United States has made several significant gains. Technological advancements and related agricultural practices have proven to be instrumental in increasing agricultural outputs. The development of these modern agricultural tools and practices has enabled agricultural producers to grow a higher quality crop with increased yields. Educational programs from the Cooperative Extension System have also played a key role by providing growers with information on new technologies to assist with their farming operations. These tools and practices are varied and include better plant and animal genetics, crop rotation strategies, improved farm equipment and perhaps most importantly, chemical weed and insect control, also known as pesticides.

The term pesticide is defined as “a substance which is used to control insect, plant or animal pests” (Herren & Donahue, 1991, p. 344). Delaplane (2000) stated that a pest is a human classification and it refers to any plant or animal that “endangers our food supply, health or comfort” (p. 2). The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides a legal definition. It states that a pesticide is “any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest” (Federal Insecticide, Fungicide and Rodenticide Act, 1997). Additionally, pesticides are classified into one of two categories, general use or restricted use.

Today, pesticides are utilized on over 900,000 farms and in 70 million homes in the U.S. alone (Delaplane, 2000, U.S. Census of Agriculture, 2007). The economic and biological significance of pesticides has been well documented. Whitford (2002) noted that pesticides are a key element in enabling only 2 percent of the U.S. population meet the food and fiber needs of the entire nation. Pesticide use in third world countries has been instrumental in reducing deaths and illnesses from diseases such as malaria. Additionally, pesticides have helped homeowners in the U.S. avoid countless losses from termite damage. Delaplane (2000) indicated that pesticides have enabled us to be efficient with our natural resources. He predicts that if pesticides were banned, we could expect rampant “food shortages with soaring prices” (p.1). Despite the many benefits, pesticides are dangerous chemicals designed to kill or damage human pests and do pose a potential threat to the environment and human health. These potential threats to human health and the environment, as well as other factors, prompted federal and state governments to implement a set of pesticide regulations designed to help reduce pesticide risks.

Although pesticides did not come into the forefront of agriculture until the early 1900's, various forms of pesticides have been used throughout time. Ancient Romans killed insect pests by burning sulphur. In the 1600's, ants were controlled by mixing honey with arsenic, and by the 19th century, farmers in the United States were using primitive forms of pesticides with limited success (Delaplane, 2000).

By 1970, many types of pesticides were in existence. In response to a growing need for greater environmental regulation, the federal government created the Environmental Protection Agency (EPA) and assigned the agency with the task of enforcing federal pesticide laws. In 1972, these laws were amended to include more regulations addressing pesticide risks. The amendment also facilitated a partnership, or cooperative agreement, between EPA and state departments of agriculture. The states, with EPA's assistance, would develop and administer a certification and training (C&T) program for commercial and private pesticide applicators (Lindsey & Key, 1995). This program was designed to help ensure safe and proper use of pesticides, thus minimizing human and environmental impacts. An additional agreement between EPA and the CES provided a mechanism for the educational training of pesticide applicators. This agreement became the educational program known today as the Pesticide Safety Education Program (PSEP). PSEP quickly became an important component of pesticide regulation. Under this program, CES provides required pesticide training and related educational programs for licensed pesticide applicators. These applicators are required by state and federal regulation to obtain a pesticide license in order to legally purchase and use restricted-use pesticides

(RUP’s). Bricker et al. (2004) noted that the “Environmental Protection Agency (and sometimes state pesticide regulatory agencies) will apply a restricted-use classification to certain pesticide products that, even when used according to label directions, may cause adverse effects on people or the environment (p.1)”.

As a part of these regulations, pesticide applicators must attend pesticide safety education programs in order to maintain their pesticide license. During the 2001-2002 program year, the United States Department of Agriculture (USDA) reported over 700,000 individuals nationwide participating in the PSEP program (USDA, 2004). This program combines the resources of local, state and federal agencies to educate pesticide applicators on the safe and effective use of pesticides. The state CES programs across the United States and its’ territories assist with this activity by conducting a variety of training and educational programs related to pesticide use and safety. The training provided by CES is the primary source of information and education for the general public with regards to pesticide issues.

Professional Competence, Expertise and its’ Characteristics

Professional competence can be defined as a measure of one’s intellectual knowledge base, skill, performance and related abilities pertaining to their professional setting. In short, competence can be considered a level of professional development. The term competent implies that one is capable of adequate performance with a particular skill set or area or that one has demonstrated a minimum level of knowledge, skills or abilities in a given professional field. Researchers have studied the idea of professional competence in many fields. This has been done in order to derive a better understanding on what should be considered competent for a particular profession, how professional competency is best obtained and how competency levels can improve performance in a given profession. Kaslow (2004, p.775) suggested that competence be defined as “the state or quality of being properly or well qualified” then notes that competence refers to one’s capacity and ability to perform tasks in a manner consistent with the predetermined expectations for a given profession. Kaslow indicated that competencies are elements of competence that are measurable, observable and derived by experts. He also stated that in some contexts the term competence “is used to imply a minimum threshold” (2004, p.775).

Eraut (1994) suggested that professional competence is related to performance of professionals in a particular setting. He states that “the public expects that a qualified professional will be competent in the discharge of normal professional tasks and duties” (1994, p.159) and indicates that from a historical sense, the validation of professional competence began with qualifying exams in fields such a law, medicine and engineering. As with the definition provided by Kaslow, Eraut also noted that competence may imply that one is merely satisfactory or exhibit a “minimum threshold” in their knowledge, skills or abilities and may still be lacking in some areas. Eraut pointed to the work of Dreyfus and Dreyfus, (1986) who incorporated the term competent as a midpoint in their stages of professional development of expertise.

In much of the research related to CES, one can see the interest of competence, more specifically, competencies. If competence is the minimum threshold of knowledge at the macro level, then competencies can be viewed as the specific core areas of knowledge, skills and abilities one must posses at the micro level. Together, these specific core areas help measure overall competence among county extension educators. Cooper and

Graham (2001) stated that “the success of Extension programs will be determined to a large degree by the ability of the Cooperative Extension Service to keep highly qualified agents” (2001, p. 1). They continue by stating that in order to keep qualified county extension educators, the CES must determine the competencies needed to become successful as an educator at the county level. They define competencies as knowledge, skills or abilities required of the job and indicate that Extension educators believe that subject matter proficiency and work experience are key competencies for success. Stone and Coppernoll (2004) echoed the need for professional competence measurements for Extension educators stating that “our strength as educational leaders are hinged on our professional competence and technical expertise” (2004, p.1). Their study of CES programs in Texas yielded the Texas Extension Competency Model which identifies several core categories of competencies which includes subject matter expertise.

Knowing competencies important to success in professional setting is paramount, however, it is only part of the total equation. One must also have a clear understanding of where professionals rank in their level of competence in a given area as well as how to measure this ranking. The goal for any professional organization is for all of its’ employees to become regarded as experts in their level of professional competence. The term expert implies that one has a greater than average level of competence in a given area.

Defining Expert and Expertise

Merriam-Webster’s dictionary (1995) defines expert as “thoroughly skilled” (p.116). Generally speaking, an expert is one who possesses a high amount of skill, knowledge and/or ability in a particular area. Two books (Chi, Glaser & Farr, 1988; Ericsson &

Smith, 1991) show experts and expertise in many fields, occupations and tasks ranging from motor skills such as sport, to restaurant work and medicine. In all of these cases, the authors note that experts are either individuals with high task performance ability or are highly educated professionals such as doctors. Swanson (1994) deemed experts as those who are able or expected to perform at a high level in a specialized realm of activity. Mieg (2001) noted that experts are experimentalists, who know from active, reflective practice. Another way to define expert is by using what Mieg (2001) called a differential approach, which compares experts with non-experts. Merriam and Caffarella (1999) provided a good example of this stating that "In terms of prior knowledge and experience one possesses, the difference between those who know a great deal about what they are experiencing (termed experts) and those who know very little (novices) is key" (p.206). They continue by pointing to the work of Sternberg (quoted in Merriam & Caffarella, 1999, p. 206) who stated that "perhaps the most fundamental difference between experts and novices is that experts bring more knowledge to solving problems…". Merriam and Caffarella (1999) also noted that experts are able to solve problems faster and have greater skill sets such as self-monitoring. Additionally, Mieg (2001) suggested that by looking at personality (intelligence, reasoning strategies and cognitive information processing) and learning conditions (training and formal education) one can determine an expert from a non-expert. Mieg combined these two approaches to describe expertise as "the result of a specific developmental, learning-based process that shapes a personality" (2001, p.3). Fook, Ryan and Hawkins (2000) noted that definitions of expert and expertise vary "according to situation, culture and values" (p.5).

Professional expertise could be defined more as a measure of the amount or level of skill, ability or knowledge one possesses in a particular job, profession or field. Benner (2001) indicates that "experience is requisite for expertise" (p.3) and Scribner, as quoted by Mieg (2001), wrote that "expertise is a function of experience" (p. 4). Daley (2001) indicates that expertise is seen as a view of professional development, which "encompasses the ideas of artistry, reflection and alternative ways of knowing" (p. 39). Ericsson and Smith (1991) indicated that the study of expertise begins by seeking to understand and account for individuals who perform at a high level versus those who do not. Lajoie (2003) pointed out that several common characteristics of expertise have been identified. When reviewing the definitions and descriptions above, one can clearly see these common characteristics, which shape our view of the terms expert and professional expertise. Table 2 outlines these common characteristics, which, for the purpose of this paper, will be placed in the context of expertise as it applies to performance in the workplace, i.e., professional expertise.

These characteristics provide a foundation for researchers wishing to explore the notion of professional expertise. Many of these researchers have developed theories or models of expertise based on observations in various professional or work settings. These models begin, by looking at the skill sets or abilities one might possess and how individuals' in turn use these skills and abilities in their performance of work related tasks. Many of these models consist of well-defined levels of expertise and note the ways individuals working within each level might use their current level of knowledge, skills and abilities and past experiences to learn, problem solve or participate in different situations.

Table 2

Definitions of Expertise

Author(s)	Expert/Expertise Characteristics
Webster's Dictionary (1995)	Skill
Chi, Glaser and Farr (1988)	Performance and/or education
Swanson (1994)	Performance
Mieg (2001)	Experience, reflection, intelligence and education
Merriam and Caffarella (1999)	Knowledge, problem solving ability, skill/experience
Benner (2001)	Experience
Daley (2001)	Knowledge and reflection
Ericsson and Smith (1991)	Performance

Historical Background and Models of Expertise

Expertise has been studied in many different settings. Some of the earliest research focused on cognitive psychology and tried to identify factors influencing high performance. Ericsson and Smith (1991) note the work of Galton, who in 1869, used social recognition to identify high performing individuals from a variety of fields. Galton then examined their familial and genetic origins in order to determine a link between performance and genetics. Galton concluded that high achievement came from intellectual ability and internal motivation. This study and others served as early attempts to describe expert characteristics and determine how experts become proficient in their respective areas of expertise. Despite the many areas where expertise has been explored, much of the research has focused on novice-expert differences (Glaser & Bassok, 1989) and has proven difficult to translate the findings into educational practice (Ericsson &

Smith, 1991). Alexander (2003) suggested that expert related research took shape in the 1970's. Other authors (Ericsson & Smith, 1991; Mieg, 2001) reinforce this by noting the works of deGroot (1965) and Chase and Simon (1973) who explored expertise as it applies to chess playing. The following section provides a historical review of expertise research and examines three major models of professional expertise.

History of Expertise Research

Holyoak (1991) stated that theories of expertise and expert related research has moved through two generations. The first focused on understanding expertise as a form of problem solving that could be applied across several domains. The second focused on specific professional development patterns in a variety of domains including physics, piloting and nursing. Studies in the second area indicated that professionals grow in expertise as they grow in experience within their professional domain (Daley, 1999).

Alexander (2003) noted that much of the early research in the 1970's and 1980's was largely framed by artificial intelligence and information processing theory, which was concerned with the problem solving performance of experts. The goal with this approach was to identify the characteristics and actions of experts and apply them to intelligent machines or teach them to non-experts.

The Dreyfus Model of Skill Acquisition and Benner's Novice to Expert Theory

Perhaps one of the more noted theories defining professional expertise is the Dreyfus Model of Skill Acquisition and Skill Development. Eraut (1994) stated that this model is widely noted in a range of disciplines that explore expert development. Brothers Hubert and Stuart Dreyfus developed the model in the 1970's. Its' development came about while exploring an Air Force sponsored research project examining fighter pilot flying skill. The brothers wanted to learn how expert pilots reacted to situations as compared to novice pilots. Additionally, the brothers also studied chess playing expertise and how it could be applied to developing artificial intelligence. While conducting their research, the brothers made several interesting observations (Dreyfus & Dreyfus, 1986). They note that individual skills such as teaching, driving and managing are not innate "like a bird's skill in building a nest" (p.19) and that people learn from trial and error. They also note that new skills are acquired by either written or verbal instruction, and that individuals' pass through five stages of expertise on a continuum as their skill level improves. These five stages came to be known as levels of expertise. The stages range from novice, which implies having little or no expertise, to expert, which implies having a great deal of experience and knowledge. Additionally, the model explores how individuals at different stages are influenced in future learning, decision-making, and other activities. The five levels outlined by Eraut (1994) are shown in Table 3. Benner (2001) also described the Dreyfus Model as being influential and further examines the five levels. In her research, she used the model to describe the movement clinical nurses make in becoming expert caregivers. She stated that "beginners have no experience of the situations in which they are expected to perform" (Benner, 2001, p. 20). Advanced beginners, she states, are marginal at best in demonstrating adequate performance. Competency, the third level, is reached when a nurse (or other professional) has been on the job long enough to see, among other things, the long-term goals in their work. One becomes proficient when they begin to perceive situations as a whole rather than just one or two aspects of the situation. Benner concluded with expert by stating that "the expert performer no longer relies on analytic principle to connect her or his understanding of the situation to an appropriate action" (2001, p.31). Additionally, Benner indicated that the five levels reflect changes in three general aspects of skilled performance. The first is a movement from reliance on the abstract principles espoused by someone else to the use of past experiences from within one's own life. Second, she noted a change in the learner's perception of bits of a situation into a vision of the whole of the situation.

Table 3

The Dreyfus Model of Skill Acquisition (Eraut, 1994)

Level 1- Novice	Rigid adherence to rules or plans Minimal situational perception Very little or no discretionary judgment
Level 2- Advanced Beginner	Guidelines for action based on attributes or aspects Situational perception is greater than novice, but still Limited Attributes are treated separately and given equal importance
Level 3- Competent	Coping with crowdedness Begin to see actions in terms of greater goals Conscious deliberate planning begins

Level 4- Proficient	Sees situations holistically rather than aspects Sees what is most important in a situation Perceives deviations from the normal pattern Decision making less difficult
Level 5- Expert	No longer relies on rules and/or guidelines* Intuitive grasp of situations based on tacit understanding Visualizes what is possible

*In regulated professions, one must remain within the regulatory framework

Lastly, she described as a movement from the role of detached observer to an involved performer who is engaged in the situation.

Benner's work is also important to the expert theory literature, because she built on the Dreyfus model by applying it to professionals, in this case, the nursing profession. Benner modified the five stages or levels from the Dreyfus model to develop seven domains of expertise found in nursing work. Within these domains, Benner identified 31 competencies found to be paramount in nursing. Although the domains are specific to the practice of nursing, they show how the Dreyfus model can be applied to various workplace settings. The seven domains include: the helping role, the teaching-coaching function, the diagnostic and patient-monitoring function, effective management of rapidly changing situations, administering and monitoring therapeutic interventions and regiments, monitoring and ensuring the quality of health care practices and organizational and work-role competencies (Benner 2001). Others followed Benner's lead and applied the Dreyfus model to different workplace settings. Fook, Ryan and Hawkins (2000) conducted research on the expertise of social work students and developed a model of expertise that was based, in part, on the Model of Skill Acquisition. They found that “our study confirms the suggestions of the Dreyfus and Dreyfus five stage model: learners do progress from relying on context free rules to developing situationally modified rules” (Fook et al., 2000, p.177). Additionally they noted that learners in their study progressed from relying on a decision-making process to using a more intuitive process. The work of Benner and Fook et al. are two examples of the Dreyfus model being applied to the development of professional expertise in the work place making it one of the more widely accepted models of professional expertise.

Schön’s Reflective Practitioner Model

Another model of professional expertise that is widely recognized is the Reflective Practitioner Model developed by Donald Schön (1983). Eraut (1994) recognized the importance of this model by stating that the book, *The Reflective Practitioner*, has been one of the most quoted books addressing professional expertise. Schön presented two arguments with his theory. First, he argued that there are limitations to the positivist approach to learning in the complexities of the real world. Second, he argued that technical rationality fails to account for how professionals work in practice in order to achieve their goals. Schön noted that much of learning in professional settings comes out of an individual’s response to problems related to their practice. He added to this by stating that for professionals, theory learned in school or other settings eventually gives way to practice, which is experienced based. This occurs because technical theories fail to account for unique situations in practice and cannot address these situations adequately. He stated that when research-based theories and techniques are inapplicable to the problem or issue at hand, the professional must be ready to reflect-in-action. In other words, when a professional encounters a problem that is unusual or ambiguous and cannot be addressed by theories, the individual must draw from prior experiences to solve the problem (Mott, 2000). Schön called this act “reflection-in-action” and maintains that, like the Dreyfus model, this is a developmental process for individuals (Mott, 2000). Smith (2001) referred to this act “thinking on our feet” in order to solve problems. Eraut (1994) identified three features of reflection-in-action: reflection is conscious, although it does not have to be communicated, reflection-in-action has a critical function, questioning the assumptions of knowing-in-action and reflection gives rise to on-the-spot experimentation.

Schön (1983) recognized the importance of an individual’s special knowledge which is embedded in evaluative frames and derived from past experiences. He noted the importance of this knowledge and the critical role it plays in the development of professional expertise and concluded that it could not be dismissed when addressing expertise.

Additional Theories and Models of Expertise

In addition to the works of Hubert and Stuart Dreyfus, Patricia Benner and Donald Schön, Eraut (1994) identified other works related to the development of expertise. Among these works is Hammond’s Cognitive Continuum Theory. This theory attempts to define analytic and intuitive thinking of individuals when addressing clinical decision making situations in medicine. It is displayed on poles of a continuum. Although there have been many theories on expertise employed in medicine, this theory is of interest because it can be applied to fields outside the clinical practice of medicine.

The first part of the theory attempts to answer specific questions related to how individuals decide to address problems. The theory states that most thinking is neither purely intuitive nor analytical and that individuals use a variety of modes of cognition that lie somewhere between the two. The decision continuum points out that in fast, ill-structured settings individuals will attempt to use peer or system aided judgement while in slow, well-structured settings individuals will conduct quasi-experiments or incorporate surveys to aid in decision making. The second part of the theory argues that an individual's reasoning is more effective when the mode of thinking corresponds with the features of the situation or task (Eraut 1994). A task continuum is employed which differentiates features of a task to help determine the best mode of cognition to use in a situation.

Contemporary Research on Expertise and Research Shifts

As stated earlier, Holyoak (1991) noted that the study of expertise has moved through two generations. The first focuses on expert problem solving while the second focuses on specific developmental patterns in professionals. Today, there is a movement toward a third generation of expertise related work. This third generation is necessary for two reasons. First, there is a need to address the problems encountered in the current theories (Holyoak 1991). Daley (1999) indicated that one such problem is the lack of connection between learning and the development of expertise. She used the Reflective Practice model as an example stating that Schön stopped short of identifying the actual learning processes used in reflective practice. Additionally, Lajoie (2003) stated that research has focused on novice-expert differences rather than the learning process.

The second reason to move towards a third generation of expertise study is to attempt to gain a better consensus about expertise and its attributes. Holyoak (1991) noted that although many expert theories have been developed with each acknowledging similar qualities, many of the findings about expertise, expert performance and related areas remains unexplained. A few of these unexplained areas are: experts sometimes achieve mediocrity, expert strategies are varied, teaching expert rules may not yield expertise, and rules elicited from experts may not predict their performance.

Of particular interest to many involved in current expertise research is the many aspects of the learning process that occurs during the transition from one level to another level of expertise. Daley (1999) analyzed the different learning processes undertaken by novices and experts. Rather than looking at the individuals' movement from novice to expert, Daley chose to look at the different characteristics of the two with regards to their individual learning processes. Like Benner, her work builds on the work from the Dreyfus model and describes how experts think, act, and process learning differently than their novice counterparts. Specifically, she notes that for novices a much more formal learning process is in place when compared to experts. Additionally, Daley determined that experts tend to incorporate prior learning and their current knowledge base into current learning situations while novices tend not to do this as frequently. Daley also found that experts are more self-directed in their learning than the novice counterparts.

Alexander (2003) examined how the Model of Domain Learning (MDL) compares and contrasts with other models of expertise. In her analysis, Alexander noted that MDL is a measure from student learning in academic settings rather than work related situations discussed in other theories. Like the other theories, MDL includes a series of levels to identify one's current state of expertise. These three levels are acclimation, competence and proficiency/expertise (Alexander, 2003). MDL has value in that it attempts to contribute to improved learning and teaching in academic settings. By using this approach, Alexander argues that teaching and learning is improved. This is reinforced with the work of Lajoie (2003).

Lajoie (2003) explored how the transition from novice to expert can be accelerated in educational settings when a plan for change is plotted and made visible to learners. The research also noted that if the models of expertise are introduced to learners early in the learning process and if expertise development is fostered in the students, that they can incorporate them into their learning practice, thus attaining higher levels of competence more quickly.

Mott (2000) also addressed the issue of professional expertise. She explored continuing professional education in the workplace and how professionals become experts in their fields of work. Mott explores the Mental Schema Model, the Skill Acquisition Model and Schön's Reflective Practice Model to answer the question of how professionals learn and gain expertise from Continuing Education Programs in the workplace. This is important because Mott makes an attempt to apply expert theory into practice, which, has been noted as one of the shortcomings of many models and theories of expertise.

It is apparent with these and other recent studies that expert theory has made the shift from an abstract idea that classified individuals' based on how they processed information and learned differently over time into a tool that can be useful in helping learners and teachers better understand the learning process. This greater understanding should in turn help to maximize the learning that occurs in a variety of professional settings.

Competence and Expertise Research in Cooperative Extension

As stated earlier, the CES is faced with the challenge of providing professional development opportunities for its employees that will help county extension educators gain expertise in both subject matter knowledge and teaching skills. In theory, this expertise will enable county extension educators to effectively deliver educational programs to individuals in a variety of subjects. White and Morales (1998) stated that "the success of extension programs depend on the competence and dedication of the professional staff" (p. 157). CES programs have recognized this and in turn have conducted research related to the identification and development of county extension educator competence, competencies and expertise. Boyd (2004) examined competencies needed for county extension educators to be successful administrators of adult volunteers. Williams (2001) explored county extension educators cross cultural competence in youth development programs and Cooper and Graham (2001) identified and ranked competencies needed to be successful county extension educators and supervisors. Conklin, Hook, Kelbaugh and Neito (2002) conducted research for CES in order to determine county extension educator professional development needs. This was done to help CES identify needs for professional development and lead to what the researchers call the development of "intellectual capital" or expertise (p. 1). Gibson and Brown (2002) provided an overview on how county extension educator competence can be gained through new county extension educator training program. Part of their training program consisted of a program development skills inventory completed by all new county extension educators. This inventory was completed in order to obtain information about the new county extension educators current level of competence in performing the tasks related to their jobs. Martin and Sajilan (1989) identified teaching competencies needed by extension workers in Malaysia. Their work identified and ranked teaching competencies perceived to be important when teaching adult farmers and was based in part on the works of Gonzalez (1982), Hawk (1977) and Witmer (1979) who each explored competencies of agricultural professionals who teach here in the United States.

Each of these studies hoped to shed light on the extension professionals' skills and abilities to perform their daily tasks in a competent or proficient manner. With a portion of CES funding reserved for county extension educator training, it is easy to understand why CES would want to explore these areas.

Cooperative Extension Professional Development and Training

It has been noted earlier that formal employee on-the-job training and education provides few assurances that the knowledge learned in training programs is linked to professional practice (Daley 2001). Additionally, the previously mentioned theories of expertise point out that most professionals tend to gain expertise from experience rather than training. If this is true, pesticide training for county extension educators must become experience based in order to maximize effectiveness.

If county extension educators are indeed the main source of information and education for pesticide applicators then an applicators' ability to use pesticides in a safe and effective manner depends on, at least in part, the county agents ability to effectively deliver pesticide educational programs to the applicator. If this does not occur, the risks of pesticide threats to humans and the environment are likely to increase. To address this concern, many CES programs have provided professional development opportunities and in-service training to county extension educators. However, in recent years, CES has faced reductions in funding which has forced many programs to rethink its county delivery system. As a result, many CES programs have adopted a multi-county delivery program in which county agents are responsible for program delivery in several counties. Because of this, many county agents complain that they have a limited amount of time for training meetings and related activities (Shenk, 1999). With these and other issues in mind, it would be beneficial for CES to examine the current level of pesticide expertise among county agents.

CHAPTER 3

METHODOLOGY

This chapter will describe the research methodology used to address the following research questions:

1. What components of a pesticide safety education program do state pesticide safety education program coordinators view as most essential in minimizing the risks associated with pesticides?
2. What is the self-reported level of competence among county extension educators with regards to the pesticide safety education components viewed as most essential?
3. To what extent do county extension educators' personal characteristics explain their self-reported level of pesticide safety education competence?

This chapter is divided into sections that will address the study's conceptual framework, instrumentation, study population, data collection, data preparation and analysis and study limitations.

Conceptual Framework

Each time a pesticide is used, there is a human benefit. However, a potential human health and environmental risk level also exists with each pesticide application. With the latter in mind, one can assume that sound pesticide education programs would help minimize the risks associated with pesticides. For this to occur, Pesticide Safety Education Programs (PSEP) in the United States need county extension educators who are competent in areas related to pesticide use. In Georgia as well as other states, county extension educators conduct a majority of the educational programs related to pesticide safety and use. Every year, Cooperative Extension System (CES) programs across the United States allocate time and resources in order to develop and improve the pesticide competency levels of county extension educators, yet no data or standards exist relative to pesticide competence, perceived or otherwise, among county extension educators. In order to better serve the audience of pesticide applicators, county extension educators working with the CES need to know which aspects of a pesticide educational program are most essential in helping minimize human health and environmental risks associated with pesticide use. Additionally, the CES administrators and PSEP coordinators should have an awareness of the effectiveness of these educational programs. This effectiveness is dependent upon a county extension educators' ability to deliver quality educational programs, which in turn depends in part upon their competence in the subject matter.

This study aimed a) validate a set of pesticide safety education competencies that PSEP Coordinators ranked as most essential in minimizing the human health and environmental risks associated with pesticide use and b) to examine the self-reported level of competency among county extension educators with regards to these pesticide safety educational competencies. Therefore, the development and acquisition of professional competency and expertise was the major exploration of the study, while it addressed the pragmatic aspect of educational program evaluation and needs assessment.

From a theoretical perspective, the study sought to examine and add to the existing body of research in the areas of professional competence and expertise outlined in Chapter 2. Figure 1 outlines predictor variables that may have a relationship on one's self-reported level of professional competence. It is important to note that research on the acquisition of professional competence and expertise indicates that these characteristics factor into the development of and current level of professional competence one possesses.

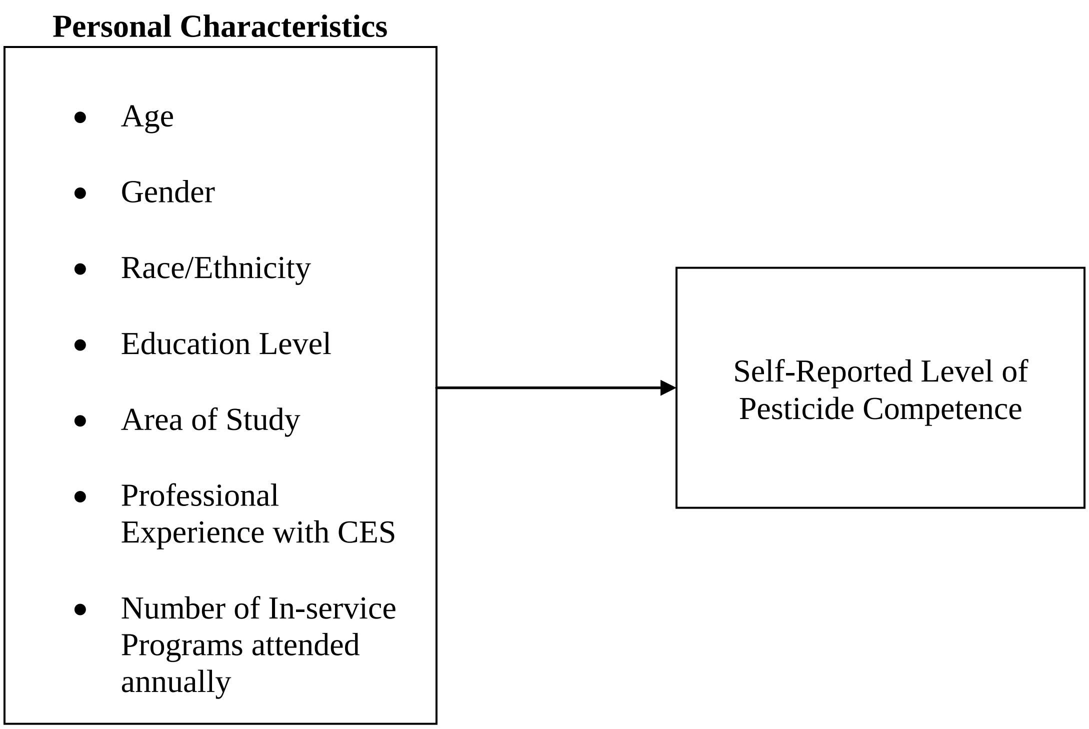

Figure 1
Self-Reported Competency Level Predictor Variables

In order to obtain the goals of the research, a quantitative approach was taken with the study consisting of a central construct with two components. The construct was designed to establish and validate a formal set of standards or competencies deemed as essential to any pesticide safety education program and then use these standards to determine the current self-reported level of competence among county extension educators in the United States. This study explored this construct by asking Pesticide Safety Education Coordinators (the state pesticide subject matter specialists) in the United States to determine which components of a pesticide safety education program are essential in helping minimize human and environmental risks associated with pesticides and therefore, should be included in a pesticide safety education program. Once these essential components were identified, county extension educators were asked to rate their level of competence with regards to each of the components. Table 4 provides definitions for the study construct components along with the type of instrumentation employed in order to address these components.

Knowing the county extension educators self-reported pesticide competence level provides a useful needs assessment tool for CES administrators and PSEP coordinators who plan professional development and related in-service training programs for county extension educators. Additionally, the study sought the input and validation from the PSEP coordinators who serve as subject matter specialists that provide training and supervision for the county extension educators in the area of pesticide safety education. By having the perspectives of each of the two components of the construct, insight was gained into the current state of pesticide safety education programs offered by county extension educators. In turn, this insight is useful in determining the pesticide education programs future direction with regards to hiring and training county extension educators. Additionally, the study examined the county extension educators' demographic characteristics. Particular characteristics such as educational background, age, gender, race/ethnicity and professional experience with Cooperative Extension were examined to determine if relationships exist between these characteristics and the county extension educators self-reported level of pesticide competence. This information is useful for CES administrators who must determine ways to facilitate the professional development

Table 4

Study Construct Components and Instrumentation

Construct Component	Definition	Instrumentation
Expert-based rating of the most essential pesticide safety education program competencies	Determines most essential program competencies	Questionnaire asking pesticide subject matter specialists in CES programs to rate various components of a pesticide safety education program
County extension educators self-reported rating for each competency	Determines county extension educators self-reported competence for area	Questionnaire asking county extension educators in CES to rate their current level of competence in each area determined essential in the first construct

of pesticide competence among current and future county extension educators. The assumption is that the demographic backgrounds of county extension educators influence their self-reported pesticide competency levels.

Instrumentation

Two instruments were developed to address the three research questions in this study. The first instrument was a researcher-developed survey questionnaire designed to address research question one which was to determine which competencies in a pesticide safety education program are essential in reducing human health and environmental risks associated with pesticide use.

Instrument Development for Research Question I

This survey instrument was a researcher-designed questionnaire administered to Pesticide Safety Education Program (PSEP) coordinators in the United States and its' territories. The responses to this questionnaire served as validation of the selected pesticide competency items and led to the development of second instrument to be used later in the research process.

The instrument development process began with an extensive literature review and discussions between the researcher and the study methodologist. The purpose of the literature review was to determine if a pre-existing questionnaire existed that could be used to measure subject matter competency levels among county extension educators or other education professionals in the United States. Initially, the questionnaire developed by Martin and Sajilan (1989) to determine teaching competencies needed by Cooperative Extension workers in transferring agricultural technologies to farmers in Malaysia was examined along with work done by Boyd (2004) who examined future competencies needed for extension educators with regards to their administration of volunteers were reviewed. Additionally, the research of Cooper and Graham (2001), Creswell (1990), Hawk (1977) and others who examined various aspects of professional competencies needed to be successful educators in agricultural settings were reviewed. Although each of these studies proved useful in helping develop a theoretical framework for the study, they stopped short of measuring subject matter competence among agricultural educators. Also, several studies reviewed by the researcher examined pesticide applicator training and certification programs, but focused on learner outcomes rather than county extension educator subject matter competency (Fishel, 1999 and others). As a result of this research, it was determined that a researcher-designed instrument would be the best option to measure self-reported pesticide competency levels among the county extension educators.

The next step in the instrumentation development process was to determine where to obtain a set of pesticide safety education competency items to use for the questionnaire. The researcher accomplished this by examining two publications used in pesticide safety education programs in Georgia. The first was a publication used to train county extension educators in Georgia and the second was a study guide used for potential commercial pesticide applicators in Georgia, South Carolina, Missouri, Michigan, Wyoming, Kentucky and several other states. The researcher selected the latter publication because it is a representative material found in a typical pesticide safety education program throughout the United States. The former publication served as supplemental reference material and provided the researcher with a means of cross-referencing what pesticide applicators are trained on with what county extension educators are trained on in Georgia.

The study guide for those seeking a commercial pesticide license in Georgia is titled *Applying Pesticides Correctly*, and was developed by the Ohio State University in cooperation with the United States Department of Agriculture, Cooperative Extension System and the United States Environmental Protection Agency, Office of Pesticide Programs. This publication contains basic pesticide and pest control information including information on principles of pest control, insect identification and damage, plant diseases, weed identification and control, pesticide labeling, formulations and many other issues related to pesticide use and safety.

The second publication, titled *Certification & Recertification of Private Pesticide Applicators in Georgia,* is a primary resource for county extension educators who provide training and initial certification for individuals seeking a Private Pesticide

Applicator License in Georgia. This publication outlines the many aspects of pesticide certification and licensure in Georgia and is accompanied by a training video that covers concepts similar to those addressed in the *Applying Pesticides Correctly* manual. This publication was developed by the University of Georgia, Department of Entomology with cooperation from the Georgia Department of Agriculture, Pesticide Section. After reviewing each of these publications, the researcher developed 34 pesticide safety themed competency items for the survey instrument.

Next, the researcher developed a rough draft of the ranking scale to be used in the study. This scale was originally based on two sources. The researcher followed the outline of designing a summated scale as described by Spector (1992). Additionally, the researcher attempted to incorporate the 5 levels of expertise developed by Dreyfus and Dreyfus (1986) to be used as the 5 point Likert item indicators of competency (novice, beginner, competent, proficient and expert). Later, because of the complexity of defining each level of expertise and the negative perception tied into being ranked a novice or beginner, it was determined that these indicators would not be as useful as a more traditional set of item indicators. The researcher then chose a 4-point Likert type scale with responses being not important, somewhat important, quite important and extremely important. A middle response item choice was omitted because of the potential for a respondent to remain undecided about the importance of a competency.

Demographic items were also added to the questionnaire. These items were derived from the previously mentioned studies that examined competency related issues among county extension educators. The instrument along with the demographic and related questions can be seen in Appendix A. Once the instrument was developed, the researcher conducted a final review of the questionnaire with the assistance of the research methodologist, sought and obtained IRB approval for the study and began the process of designing the questionnaire online using the SurveyMonkey Internet based survey design program.

Data Collection for Research Question I

After survey development and IRB approval, the researcher administered the first instrument in August 2008. The researcher obtained a contact list of PSEP coordinators for all 50 U.S. states and 5 U.S. territories. Included in this list were the physical addresses, phone numbers and email addresses for each PSEP coordinator. The PSEP coordinator list was obtained by the researcher from the IPM Centers web page (http://www.ipmcenters.org/contacts/PSEPDirectory.cfm).

The researcher then constructed a form letter to be sent via e-mail to each coordinator asking them to participate in the study. The e-mail included an introduction along with background information about the study and a link to the online questionnaire. The e-mail also provided a link for those wishing to opt out of the study. A copy of the e-mail sent to PSEP coordinators is included in Appendix B.

Upon the suggestion from the study methodologist, the researcher examined different Internet based survey software programs, eventually making the decision to use SurveyMonkey. The SurveyMonkey program contained several beneficial features useful to the study. These features included ease in online survey questionnaire formatting and construction, ease in administering the survey via e-mail and the ability to download survey data into Microsoft Excel format. After the initial contact, four follow up requests for participation were e-mailed to the study participants during a four week period as suggested by Dillman (2000). After a period of approximately one month, the responses were collected and the researcher closed the survey.

Of the 55 potential respondents for this questionnaire, a total of 22 useable questionnaires were completed resulting in a 40 percent response rate. In addition to the 34 competency items included in the questionnaire, the PESP coordinators were asked to identify any additional areas related to pesticide safety that were not included in the questionnaire. Specifically, the PESP coordinators were asked “Are there any other essential areas that are not included in the above?”

Instrument Validation

The first part of the construct of the study was to identify pesticide safety education program competencies deemed most essential in minimizing human health and environmental risks in the U.S. This part, outlined in the section above, served as a means of validating the survey instrument used for the second part of the construct.

The Pesticide Safety Education coordinators consist of professionals located at State Land Grant Universities in the United States and in U.S. Territories. These subject matter experts were contacted via e-mail and asked to complete an online self-completion survey by rating each item based on its’ importance in reducing human health and environmental risks. Once the responses were evaluated, the researcher analyzed the results, refined and eliminated competency items that were either redundant or not deemed significant to the study. As mentioned earlier, the result of this process helped the researcher eliminate three pesticide competencies not deemed essential to pesticide safety education. These items were three lowest ranking competencies and had response means of 3.04 or less. Also, the eliminated items do not have an association with any of the three pesticide safety themes tied to the comments made by the PSEP Coordinators. These three themes led the researcher to create three new items not included in the original questionnaire were identified by the PSEP coordinators as essential. These items were based on comments made by the Pesticide Safety Education Coordinators and are as follows:

- Understanding the different pesticide toxicity levels
- Knowing how to properly secure pesticides
- Understanding the potential environmental impacts of pesticides.

Meanwhile, Table 5 shows each competency item eliminated from the study along with each items' mean score and standard deviation.

Table 5

Items removed from Questionnaire based on PSEP Coordinator Response

Item Rank	Response Item	M	SD
32	Identifying and understanding the different commercial pesticide license categories	3.04	.86
33	Understanding the term pesticide residue	2.95	.80
34	Understanding the mode of action of a pesticide	2.82	.80

Study Population for Research Question I

The population for this study consists of all Pesticide Safety Education Program coordinators (PSEP) in the United States and its' territories. The PSEP coordinators were identified by the previously IPM Centers web page that contained an electronic listing of each PSEP coordinator along with their contact information. This group contained a total of 55 potential study participants. The personal characteristics collected from the PSEP

Coordinators who responded to the questionnaire can be reviewed in Table 6. A total of 22 responses were collected from the 55 PSEP Coordinators in the United States and its' territories. Twelve (54.5 percent) of the PSEP coordinators responded that they hold a doctorate degree while an additional 36.4 percent (8 respondents) hold a master's degree and 2 (9.1 percent) hold bachelor's degrees. Of the 22 respondents, 17 of (77.2 percent) of the PSEP coordinators indicated that they have more than 10 years of professional experience with the Cooperative Extension System while 22.7 percent (5 respondents) have 5 to 10 years experience.

Table 6

Personal Characteristics of the Pesticide Safety Education Coordinators (n=22)

Variable	Value	
Level of Education		
Bachelor's Degree	n=2	9.1%
Master's Degree	n=8	36.4%
Doctorate Degree	n=12	54.5%
Years of Experience with CES		
Less than 1 year	n=0	0.0%
1 to 5 years	n=0	0.0%
5 to 10 years	n=5	22.7%
11 to 15 years	n=3	13.6%
More than 15 years	n=14	63.6%

Instrument Development for Research Question II and III

The second research instrument was a modified version of the first research instrument. Modifications were made based on the responses provided by the PESP coordinators in the first questionnaire. The second instrument was used to determine the self-reported level of pesticide competence among county extension educators in the essential areas identified by the pesticide subject matter specialists. Additionally, the second survey instrument included a section that asked county extension educators to provide demographic information about themselves such as age, education background and level, professional experience as an educator, gender and race. This information was obtained in order to examine possible relationships between demographics and self-reported levels of pesticide competence. The second questionnaire, like the first, was administered online via SurveyMonkey to the county extension educators' across the United States. This questionnaire can be seen in Appendix B.

Although the questionnaire was similar to the first one, it did have some important modifications. First, the county extension educators were asked to self-report their level of competence for each of the 34 competency items using a 5-point Likert-Type scale with responses being poor, fair, good, very good and excellent. A similar scale was constructed by Benjamin (2002) to measure teaching competence among county extension educators. Benjamin's scale also used a 5-point Liket-type scale with ratings ranging from poor to excellent.

In addition to the Likert scale, the second research instrument contained a demographic section designed to address research question three. This section included questions regarding age, gender and ethnicity, formal education, occupational experience, professional development and professional degree type. This information, as stated earlier, could reveal a relationship between demographic background and self-report competence.

Research cited earlier showed that individuals with a high level of professional competence or expertise possess particular personal characteristics. Chi, Glaser and Farr (1988), Meig (2001), Benner (2001) and others stated that experience and educational background both play a major role in the development of a high level of professional competence. This notion makes age, years of professional experience, level of education, and area of educational study significant indicators of competence for this study. Also, demographic data such as gender and ethnicity could play a role in the acquisition of professional competence. Hayes (2001) noted that learning is not limited to cognitive dimensions. Learning contains a social dimension as well, which includes the learners' gender and race or ethnic background. Therefore, it is logical to conclude that these factors would have some influence on an individuals' level professional competence (self-reported or otherwise) thus making the inclusion of this data significant to the study.

Data Collection for Research Question II and III

The questionnaire addressing the second research question was administered in January 2009. With the exception of a few modifications, a similar protocol for data collection in the first research question was followed to collect data for the second research question.

Rather than contact county extension educators directly, the researcher contacted each state CES director and asked them to have their county extension educators participate in the study. This was done in order to increase participation with county extension educators by ensuring that the survey was sent to county extension educators who conduct pesticide safety education programs. The county extension educators were also directed to the SurveyMonkey web site in order to complete the survey. Four follow-up requests for participation were e-mailed to the study participants during a four week period as suggested by Dillman (2000). After a period of approximately one month, the responses were collected and the researcher closed the survey. For both surveys, the researcher drew from Dillman's (2000) Tailored Design Method for conducting Internet based surveys. This method includes guidance on question writing, questionnaire construction and survey implementation.

Study Population for Research Question II and III

The population for this research question was the county extension educators in each state that conduct pesticide safety education programs. The county extension educators who conduct pesticide safety education programs represented a much larger population than the PSEP Coordinators in the first research question. County extension educators can be found in every state and most counties in the United States. In order to determine which county extension educators to include in the study, the researcher asked CES administrators from each state to notify the county extension educators who conduct pesticide safety education. Responses were collected from a total of 15 states. Figure 2 shows each state that had county extension educators who participated in the study.

More detailed demographic information was collected from the county extension educators (age, gender, ethnicity/race, education level, professional experience and number of annual in-service trainings attended). These characteristics are reported in Table 7. For age, 294 responses were collected. Age ranged from 24 to 65 years old with a mean age of 47.14. For gender, 305 responses were reported with the majority of the respondents, 84.6 percent (n=259) being male and 15.4 percent (n=47) being female. The question regarding ethnic background collected 289 responses as follows: 96.5 percent (n=279) Caucasian, 1.4 percent (n=4) Hispanic and African American (n=4) and 0.7 percent (n=2) reporting Native American. Additional demographic data collected included the following: educational background (degree level and academic major/concentration), years of professional experience with the Cooperative Extension System, and continuing educational/in-service programs.

For determining the educational background of the participants, the researcher asked two questions. “What is the highest level of education you have completed” and “What

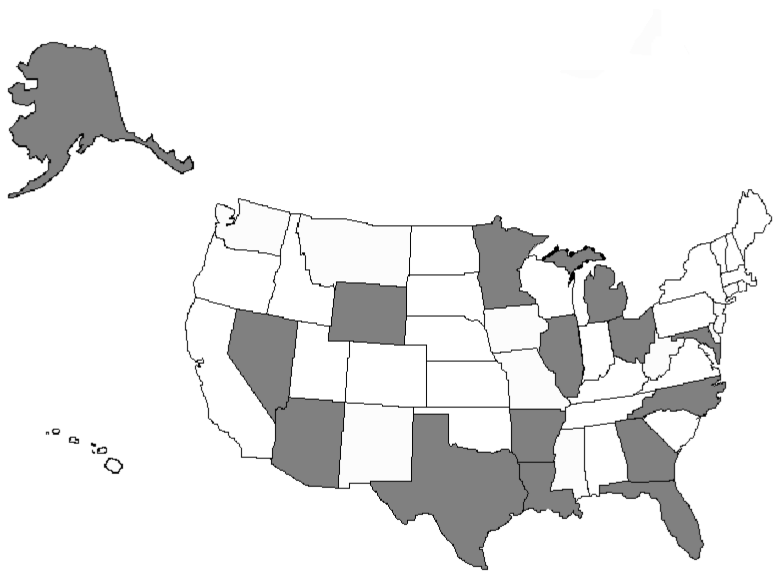

Figure 2
Map of Participating States
(Participating states depicted in gray)

area did you study for your degrees?” This was done in order to determine if there is a relationship between the county extension educators’ educational background and their self-reported level of competence with regards to pesticide safety education programs. A total of 310 responses were collected from the question “what is the highest level of education you have completed” with the following results: 14.5 percent (n=45) reported having a Bachelor of Science Degree, 78.7 percent (n=244) reported having a Master of Science Degree, and 6.8 percent (n=21) reported having a Doctorate Degree (Ph.D. or

Ed.D.). Additionally, respondents were asked to indicate their major area or of study. Of the 303 respondents, the majority of them (n=115) indicated that their educational area of study was in Plant and Soil Science (38.0 percent). An additional 21.5 percent of respondents reported Animal Science (n=65), while 20.1 percent reported Agricultural Education (n=61), 4 percent reported Entomology (n=12) and 2.6 percent reported Forestry and Natural Resources (n=8) as their educational major. Other areas of study completed this section with 42 responses (13.9 percent). The other areas of study included responses of Agricultural Business and Economics, Horticulture and Environmental Studies among others.

Study participants were asked to describe their professional experience with the Cooperative Extension System. The 310 responses ranged from less than a year (n= 12, 3.9 percent) to greater than 15 years (n= 159, 51.1 percent) with other responses being 1 to 5 years (n=47, 15.1 percent), 6 to 10 years (n= 54, 17.4 percent) and 11-15 years experience (n= 38, 12.2 percent). Additionally, study respondents were asked about additional occupational experience they had in agricultural professions. For this question, 282 responses were collected indicating that many of the county extension educators participating in the study had additional professional agricultural experience outside the Cooperative Extension System.

County extension educators were also asked to indicate the number of in-service training programs they attend on an annual basis. About one third of respondents (33.9 percent, n=104) indicated that they attend 4 to 5 in-service training programs annually and 31.9 percent (n=98) of the respondents indicated that they attend 2 to 3 programs annually. Only 22.1 percent (n=68) attend 6 or more in-service programs and 12.1

percent (n=37) said that they attend only one in-service program annually. As noted earlier, the demographic data was obtained in order to explore possible relationships between the county extension educators' personal and professional characteristics and their self-reported level of pesticide competence. In other words, these demographic characteristics could be tagged as predictors of high or low self-reported levels of pesticide competence. These predictor variables were gender, age, race, education level, area of study, professional experience and number of in-service trainings attended annually.

Table 7

Personal and Professional Characteristics of the County Extension Educators

Variable	Value	
Age (in years)	n= 294	M=47.14
Gender		
Male	n=259	84.6%
Female	n=47	15.4%
Race/Ethnicity		
Caucasian	n=279	96.5%
Hispanic	n=4	1.4%
African American	n=4	1.4%
Native American	n=2	0.7%
Highest Level of Education Completed		
Bachelor's Degree	n=45	14.5%
Master's Degree	n=244	78.7%
Doctorate Degree	n=21	6.8%
Area of Study		
Plant and Soil Science	n=115	38.0%
Animal Science	n=65	21.5%
Agricultural Education	n=61	20.1%
Entomology	n=12	4.0%
Forestry and Natural Resources	n=8	2.6%

Other Areas of Study	n=42	13.9%
Professional Experience with CES		
Less than one year	n=12	3.9%
One to five years	n=47	15.2%
Five to 10 years	n=54	17.4%
11 to 15 years	n=38	12.3%
Greater than 15 years	n=159	51.3%
In-service Programs attended annually		
One	n=37	12.1%
Two to Three	n=98	31.9%
Four to Five	n=104	33.9%
Six or More	n=68	22.1%

Data Preparation and Analysis for Research Question II and III

For research questions two and three, a survey questionnaire was developed, modified and administered to the respective study population. The study data was collected via the SurveyMonkey Internet survey program, transferred into Microsoft Excel, and then moved into SPSS version 14.0 for data cleaning and analysis. This analysis involved the following steps.

To determine the self-reported competency levels among the county extension educators, frequencies, means, standard deviations and related descriptive statistics were obtained for the 34 competency item responses on self-reported pesticide competency levels and for each of the demographic items (age, gender, race, education level, area of study, time with Cooperative Extension, and in-service programs attended annually).

The scale administered to the county extension educators was examined for reliability with 28 of the 311 participant responses being eliminated from the study. As a result, the researcher retained 283 useable responses for the study. Total competency scores were derived for each of the 283 usable participants to use with further statistical comparisons. Table 8 shows the scale reliability for the 34 pesticide competency items.

Table 8

Distribution and Reliability of Key Measures

Scale	Number of Items	M	SD	Mean Total Score	Alpha
Self-Reported Competence	34	4.08	24.00	138.68	.97

Spearman's Rank correlation coefficient, or Spearman's Rho was conducted between the demographic items age, education level, time spent with Cooperative Extension, and in-service programs attended and each of the county extension educators self-reported level of pesticide competence. This was conducted to determine if there was a relationship between these demographic items and the county extension educators self-reported level of pesticide competence.

T-tests were conducted for the demographic item gender. The T-Test was conducted to determine if gender had a relationship to the county extension educators self-reported level of pesticide competence.

A one-way ANOVA test was conducted for each of the items listed in the area of study demographic (animal science, plant and soil science, forestry, entomology, agricultural education and other areas of study). This was done in order to examine any relationships between area of study and the self-reported levels of pesticide competence among the county extension educators. The total competency score for each area of study was compared with the other areas in order to determine if any relationships exist.

Table 9 illustrates the demographic characteristics compared with the total competency scores obtained from the county extension educators.

Table 9

Demographic Characteristics Compared with Interval Data from Study

Demographic	Data Type/Comparison	Statistical Analysis
Age	Interval	Spearman's Rho
Gender	Dichotomous	T-Test
Race	Multi-categorical	ANOVA
Educational Background	Ordinal	Spearman's Rho
Area of Study	Multi-categorical	ANOVA
Time with CES	Interval	Spearman's Rho
In-Service Programs Attended Annually	Interval	Spearman's Rho

Study Limitations

Although care has been taken to ensure a quality study, there are limitations to the research. First, the study does not measure actual pesticide competency among county extension educators. This falls short of obtaining an actual competence score for the county extension educators with regards to their pesticide safety competency levels. Because the study only reports the self-reported competence in pesticide safety issues, it was possible for respondents to give themselves a score that is higher or lower than their actual competence levels. Importantly, a high level of pesticide safety competency may or may not translate into a quality educational program for pesticide applicators. In order to ensure a quality educational program, one must also consider the county extension educators' ability to effectively teach pesticide safety to the audience. This involves teaching skills and competence, which conceivably could be low among a county extension educator with a high level of subject matter competence.

CHAPTER 4

FINDINGS

The purpose of this study was to determine the self-reported level of professional competence among county extension educators based upon an identified formalized set of pesticide safety education competencies. Specifically, the study addressed three research questions:

1. What components of a pesticide safety education program do state pesticide safety education program coordinators view as most essential in minimizing the risks associated with pesticides?
2. What is the self-reported level of competence among county extension educators with regards to the pesticide safety education components viewed as most essential?
3. To what extent do county extension educators' personal characteristics explain their self-reported level of pesticide safety education competence?

Findings Related to Research Question I

The first question asked "What components of a pesticide safety education program do state pesticide safety education program coordinators view as most essential in minimizing the risks associated with pesticides?" This question was asked in a researcher-developed, 34 item, 4 point Likert-Type online questionnaire directed towards Pesticide Safety Education Program Coordinators in 50 states and five U.S. Territories. This instrument was administered as an online self-completion online survey to this group in order to establish a standard set of competencies that are deemed most essential in helping minimize human health and environmental risks associated with pesticide use.

This questionnaire received 22 useable responses from PSEP Coordinators in 20 states and two U.S. Territories. Participants were asked to rank each competency item in one of the four following categories: 1(Not Important), 2(Somewhat Important), 3(Quite Important), and 4(Extremely Important). Additionally, the researcher determined that the 34 competency items could be categorized into three major pesticide educational areas: Reducing Pesticide Exposure to Humans, Reducing Pesticide Exposure to the Environment, and Proper Pesticide Storage, Security and Disposal. The PSEP Coordinators responses to each item and the educational areas each one is associated with are noted in Table 10. Responses from this questionnaire resulted in the identification of three competency items not included in the survey and the deletion of 3 competency items not deemed essential by the PESP Coordinators.

The additional competencies not included in the original survey were based on responses from PSEP Coordinators in survey question two which asked “Are there other essential areas not included above?” For this question, the PSEP Coordinators provided 10 responses. These responses were reviewed by the researcher and led to the addition of the following competency items in the survey sent to county extension educators:

- Understanding the different pesticide toxicity levels
- Knowing how to properly secure pesticides
- Understanding the potential environmental impacts of pesticides.

The PSEP Coordinators additional comments from the questionnaire are included in Appendix G.

Table 10

Rank Order Listing of Competencies Identified by PSEP Coordinators (n=22)

Rank	Competency Item	M	SD	Frequencies (n) %			
				Not Important	Somewhat Important	Quite Important	Extremely Important
1	Understanding how to manage pesticide spills	3.87	.34	(0) 0.0%	(0) 0.0%	(3) 13.6%	(19) 86.4%
2	Determining if an area may be sensitive to pesticides	3.82	.39	(0) 0.0.%	(0) 0.0%	(4) 18.2%	(18) 81.8%
3	Determining the proper personal protective equipment required for a pesticide application	3.78	.52	(0) 0.0%	(1) 4.5%	(3) 13.6%	(18) 81.8%
4	Understanding the mixing directions on a pesticide label	3.74	.45	(0) 0.0%	(0) 0.0%	(6) 27.3%	(16) 72.7%
5	Ability to differentiate the differences among insecticides, herbicides and fungicides	3.74	.62	(0) 0.0%	(2) 9.1%	(2) 9.1%	(18) 81.8%
6	Understanding the term “pest”	3.69	.57	(0) 0.0%	(1) 4.5%	(5) 22.7%	(16) 72.7%

7	Understanding how to dispose of unwanted pesticides	3.69	.56	(0) 0.0%	(1) 4.5%	(5) 22.7%	(16) 72.7%
8	Pest identification (plant, insect and disease)	3.69	.63	(0) 0.0%	(2) 9.1%	(3) 13.6%	(17) 77.3%
9	Understanding the meanings of various signal words on a pesticide label	3.65	.49	(0) 0.0%	(0) 0.0%	(8) 36.4%	(14) 63.6%
10	Understanding how a pesticide may move from a target site	3.65	.57	(0) 0.0%	(1) 4.5%	(6) 27.3%	(15) 68.2%
11	Calibrating various types of spray equipment	3.65	.49	(0) 0.0%	(0) 0.0%	(8) 36.4	(14) 63.6%
12	Determining the best way to dispose of pesticide rinsate	3.60	.58	(0) 0.0%	(1) 4.5%	(7) 31.8%	(14) 63.6%
13	Knowing how to safely transport pesticides	3.60	.50	(0) 0.0%	(0) 0.0%	(9) 40.9%	(13) 59.1%
14	Understanding how to address leaky containers	3.60	.58	(0) 0.0%	(1) 4.5%	(7) 31.8%	(14) 63.6%
15	Identifying the different types of personal protective equipment used in pesticide applications	3.56	.59	(0) 0.0%	(1) 4.5%	(8) 36.4%	(13) 59.1%

16	Identifying a suitable mixing and loading area	3.52	.59	(0) 0.0%	(1) 4.5%	(9) 40.9%	(12) 54.5%
17	Understanding how nozzle type and spacing can influence pesticide applications	3.52	.59	(0) 0.0%	(1) 4.5%	(9) 40.9%	(12) 54.5%
18	Determining the most effective spray nozzle for a pesticide application	3.52	.59	(0) 0.0%	(1) 4.5%	(9) 40.9%	(12) 54.5%
19	Understanding the state and federal laws that govern pesticide use	3.47	.79	(1) 4.5%	(1) 4.5%	(6) 27.3%	(14) 63.6%
20	Understanding the difference between a brand name and an active ingredient	3.43	.73	(0) 0.0%	(3) 13.6%	(7) 31.8%	(12) 54.5%
21	Identifying the differences between a general and restricted use pesticides	3.43	.73	(0) 0.0%	(3) 13.6%	(7) 31.8%	(12) 54.5%
22	Explaining how to dispose of pesticide containers	3.43	.59	(0) 0.0%	(1) 4.5%	(10) 45.5%	(11) 50.0%
23	Understanding the different pesticide record keeping requirements	3.43	.73	(0) 0.0%	(3) 13.6%	(7) 31.8%	(12) 54.5%
24	Understanding the Worker Protection Standard Regulation	3.34	.78	(0) 0.0%	(4) 18.2%	(7) 31.8%	(11) 50.0%

25	Calculating pesticide target size	3.34	.71	(0) 0.0%	(3) 13.6%	(9) 40.9%	(10) 45.5%
26	Understanding the pesticide license process	3.26	.69	(0) 0.0%	(3) 13.6%	(10) 45.5%	(9) 40.9
27	Understanding the principles of Integrated Pest Management	3.21	.80	(1) 4.5%	(2) 9.1%	(11) 50.0%	(8) 36.4%
28	Determining the most effective spray equipment for a pesticide application	3.21	.80	(0) 0.0%	(5) 22.7%	(8) 36.4%	(9) 40.9%
29	Knowing how to test a pesticide breathing respirator	3.21	.74	(0) 0.0%	(4) 18.2%	(9) 40.9%	(9) 40.9%
30	Selecting the proper pesticide formulation	3.17	.72	(1) 4.5%	(1) 4.5%	(14) 63.6%	(6) 27.3%
31	Understanding the difference between a commercial and a private pesticide license	3.18	.73	(0) 0.0%	(4) 18.2%	(10) 45.5%	(8) 36.4%
32	**Identifying and understanding the different commercial pesticide license categories**	**3.04**	**.86**	**(1) 4.5%**	**(5) 22.7%**	**(10) 45.5%**	**(6) 27.3%**
33	**Understanding the term pesticide residue**	**2.95**	**.80**	**(0) 0.0%**	**(7) 31.8%**	**(9) 40.9%**	**(6) 27.3%**
34	**Understanding the mode of action of a pesticide**	**2.82**	**.80**	**(0) 0.0%**	**(9) 40.9%**	**(8) 36.4%**	**(5) 22.7%**

The ten highest ranked competencies included nine competencies deemed essential to reducing pesticide exposure to the environment, seven competencies were deemed essential in reducing pesticide exposure to humans and two competencies had ties to proper pesticide storage, security and disposal. Six of the ten highest ranked competencies contained more than one of the constructs and two of the top ten competencies contained all three constructs. The three lowest ranking competencies had lower response means and did not have a direct association with any of the three pesticide safety education themes derived from the PSEP coordinators.

Findings Related to Research Question II

This research question sought to build on the first question by asking "What is the self-reported level of competence among county extension educators with regards to the pesticide safety education components viewed as most essential?" This question was addressed by modifying the survey in question one to reflect the most significant competencies listed by the PSEP Coordinators. To address the question with county extension educators, the researcher contacted Cooperative Extension System administrators in each of the 50 U.S. states and 5 territories and asked them to encourage their county extension educators to participate in the study. The administrators were given a web link to the online self-completion survey that county extension educators could use to address their self-reported level of competence in each area. The county extension educators were asked to rank their level of competency for each item. The response items for each question were as follows: 1 (novice), 2 (beginner), 3 (competent), 4 (proficient) and 5 (expert). For this part of the survey a total of 283 usable responses were collected from a 5 point Likert scale administered to county extension educators in

15 states. Table 11 provides a rank order listing of the county extension educators' responses for each competency identified by the PSEP coordinators.

Results from this section show that county extension educators feel more competent in the areas such as defining pests, understanding pesticide label language (brand name versus active ingredient, signal words and mixing directions) and differentiating the types of pesticide licenses (commercial versus private). The county extension educators felt less competent in areas dealing with pesticide spray equipment selection and use (pesticide spray equipment selection, spray nozzle types and selection, calculating pesticide target size and equipment calibration). The county extension educators also felt less competent in the area of testing pesticide breathing respirators and understanding the Worker Protection Standard (WPS) regulation. Although these areas were rated the lowest by the county extension educators', it should be noted that the mean for each of these areas was above 3.0 or competent on the survey scale. Despite this, differentiation was observed from the county extension educators' responses.

Findings Related to Research Question III

Research question three asked "to what extent do county extension educators' personal characteristics explain their self-reported level of pesticide safety education competence?" This question was addressed by asking the county extension educators to answer demographic questions regarding their age, race, gender, educational background, professional experience and number of in-service programs attended annually. A significance test was conducted for each of the seven demographic items to address research question three.

Table 11

Rank Order Listing of County Extension Educators Self-Reported Level of Competence (n=311).

Rank	Item	Competency Item	M	SD	Frequencies (n) %				
					Poor	Fair	Good	Very Good	Excellent
1	1	Understanding the term pest	4.68	.60	(1) 0.3%	(2) 0.6%	(14) 4.5%	(58) 18.7%	(235) 75.8%
2	5	Understanding the difference between a brand name and an active ingredient	4.62	.70	(2) 0.6%	(2) 0.6%	(18) 5.8%	(61) 19.6%	(228) 73.3%
3	6	Understanding the meanings of various signal words on a pesticide label	4.53	.78	(1) 0.3%	(6) 1.9%	(30) 9.6%	(65) 20.9%	(209) 67.2%
4	30	Understanding the difference between a commercial and a private pesticide license	4.52	.71	(1) 0.3%	(4) 1.3%	(30) 9.7%	(77) 24.8%	(198) 63.9%
5	8	Understanding the mixing directions on a pesticide label	4.41	.75	(1) 0.3%	(3) 1.0%	(32) 10.3%	(105) 33.9%	(169) 54.5%
6	4	Identifying the differences between a general and restricted use pesticides	4.38	.82	(1) 0.3%	(6) 1.9%	(43) 13.8%	(86) 27.7%	(175) 56.3%

7	7	Understanding the different pesticide toxicity levels	4.36	.87	(1) 0.3%	(10) 3.2%	(46) 14.8%	(75) 24.2%	(178) 57.4%
8	34	Understanding the principles of Integrated Pest Management	4.34	.79	(0) 0.0%	(6) 1.9%	(40) 12.9%	(103) 33.2%	(161) 51.9%
9.5	14	Determining the proper personal protective equipment required for a pesticide application	4.33	.85	(1) 0.3%	(10) 3.2%	(43) 13.9%	(96) 31.1%	(159) 51.5%
9.5	3	Ability to differentiate the differences among insecticides, herbicides and fungicides	4.33	.87	(3) 1.0%	(8) 2.6%	(40) 12.9%	(91) 29.3%	(169) 54.3%
11	13	Identifying the different types of personal protective equipment used in pesticide applications	4.32	.83	(0) 0.0%	(10) 3.2%	(49) 15.8%	(97) 31.2%	(155) 49.8%
12	12	Knowing how to properly secure pesticides	4.28	.83	(0) 0.0%	(8) 2.6%	(53) 17.0%	(97) 31.2%	(153) 49.2%
13	17	Explaining how to dispose of pesticide containers	4.25	.90	(3) 1.0%	(14) 4.5%	(41) 13.3%	(100) 32.4%	(151) 48.9%
14	11	Understanding how a pesticide may move from a target site	4.24	.87	(1) 0.3%	(12) 3.9%	(46) 14.8%	(106) 34.1%	(146) 46.9%

15	31	Understanding the potential environmental impacts of pesticides	4.19	.82	(0) 0.0%	(8) 2.6%	(58) 18.7%	(113) 36.5%	(131) 42.3%
16	29	Understanding the pesticide license process	4.18	.96	(5) 1.6%	(15) 4.8%	(52) 16.8%	(93) 30.0%	(145) 46.8%
17	18	Determining the best way to dispose of pesticide rinsate	4.17	.93	(5) 1.6%	(15) 4.8%	(42) 13.5%	(111) 35.8%	(137) 44.2%
18	25	Knowing how to safely transport pesticides	4.12	.89	(2) 0.6%	(14) 4.5%	(57) 18.4%	(117) 37.9%	(119) 38.5%
19	9	Selecting the proper pesticide formulation	4.04	.93	(2) 0.6%	(18) 5.8%	(61) 19.7%	(117) 37.7%	(112) 36.1%
20	28	Understanding how to dispose of unwanted pesticides	4.01	.99	(5) 1.6%	(21) 6.8%	(64) 20.6%	(103) 33.1%	(118) 37.9%
21	16	Identifying a suitable mixing and loading area	4.00	.97	(6) 1.9%	(16) 5.2%	(71) 23.0%	(104) 33.7%	(112) 36.2%
22	19	Understanding the different pesticide record keeping requirements	3.96	1.03	(10) 3.2%	(20) 6.5%	(62) 20.0%	(108) 34.8%	(110) 35.5%
23	10	Determining if an area may be sensitive to pesticides	3.92	.93	(3) 1.0%	(19) 6.1%	(78) 25.1%	(120) 38.6%	(91) 29.3%

24	26	Understanding how to address leaky containers	3.82	1.07	(9) 2.9%	(34) 10.9%	(68) 21.9%	(102) 32.8%	(98) 31.5%
25	2	Pest identification (plant, insect and disease)	3.81	.93	(3) 1.0%	(24) 7.7%	(82) 26.4%	(126) 40.5%	(76) 24.4%
26	27	Understanding how to manage pesticide spills	3.79	1.03	(9) 2.9%	(34) 10.9%	(68) 21.9%	(102) 32.8%	(98) 31.5%
28	33	Understanding the state and federal laws that govern pesticide use	3.77	.97	(4) 1.3%	(28) 9.0%	(84) 27.1%	(122) 39.4%	(72) 23.2%
28	20	Determining the most effective spray equipment for a pesticide application	3.77	.98	(6) 1.9%	(28) 9.1%	(90) 29.1%	(107) 34.6%	(78) 25.2%
28	24	Understanding how nozzle type can influence pesticide applications	3.77	1.06	(7) 2.3%	(34) 11.0%	(83) 26.8%	(96) 31.0%	(90) 29.0%
30	32	Understanding the Worker Protection Standard Regulation	3.76	1.02	(8) 2.6%	(27) 8.7%	(96) 30.9%	(97) 31.2%	(83) 26.7%
31	23	Calculating pesticide target size	3.63	1.19	(20) 6.6%	(39) 12.8%	(75) 24.6%	(84) 27.5%	(87) 28.5%
32	22	Calibrating various types of spray equipment	3.60	1.17	(20) 6.6%	(43) 13.9%	(71) 23.0%	(96) 31.1%	(79) 25.6%

33	21	Determining the most effective spray nozzle for a pesticide application	3.45	1.05	(15) 4.8%	(47) 15.2%	(104) 33.5%	(92) 29.7%	(52) 16.8%
34	15	Knowing how to test a pesticide breathing respirator	3.33	1.28	(33) 10.6%	(57) 18.4%	(79) 25.5%	(73) 23.5%	(68) 21.9%

The following values were obtained from responses in each demographic item listed below:

- Age   r =.20   p =.001
- Education Level r_s =.15   p =.014
- Time with CES   r =.21   p =.0001
- In-Service   r =.05   p =.453

With regards to each of the findings above one can conclude the following: A small but significant relationship between age, level of education and time spent with CES and self-reported level of competence was observed. Although these observations were statistically significant, they were not substantively important and limited predictive power is associated with each variable. The relationship between the number of in-service programs attended annually and self-reported level of competence was not significant.

The relationship between gender and the self-reported competence level was also examined with the following results:

Table 12
Self-Reported Level of Pesticide Competence by Gender

Variable	Value		
Males	n= 236	M=140.02	SD=23.04
Females	n=43	M=131.41	SD=26.80

While the findings do suggest a relationship between gender and self-reported competency (t =2.194, df =277, p =.03), the relationship is not significant and variation could be attributed to the response self-reporting differences exhibited between males and females. Several studies (Braskamp and Ory, 1994 and Atwater, 1998) indicate that ones' gender does influence self-assessment reporting accuracy and reliability.

The research question also explored the relationship between race and the self-reported level of pesticide competence. Although 289 responses were obtained, only 10 of these responses were not Caucasian. Due to the low number of responses from African Americans, Hispanics, and Native Americans, an analysis of this data was not conducted.

The multi-categorical comparison between area of study and the self-reported level of pesticide competence was also examined. To explore possible relationships in this demographic, the researcher employed a Oneway ANOVA test.

Table 13

Self-Reported Level of Pesticide Competence by Area of Study

Variable	Value		
Animal Science	n= 59	M=133.66	SD=23.87
Plant and Soil Science	n=103	M=142.47	SD=23.01
Forestry	n=7	M=111.86	SD=27.61
Entomology	n=11	M=138.90	SD=29.63
Agricultural Education	n=58	M=139.08	SD=21.69
Other	n=38	M=138.81	SD=25.97

The ANOVA results show significance (F =2.84, df =5, p= .016). It was determined that county extension educators with a background in forestry had notably lower self-reported competency levels than those in with other educational backgrounds. However, post-hoc test of significance did not suggest there were notable differences except between county extension educators with an educational background in forestry and those with an educational background in plant and soil science. Also, as with the case of the race demographic, it was determined that there were too few study participants (n=7) to conclude that this relationship exists.

Summary

In summary, this study answered the three research questions. First, through soliciting the Pesticide Safety Education Program Coordinators in the U.S., a set of 34 essential pesticide safety education competencies was identified that is most essential in helping minimize the human health and environmental risks associated with pesticide use.

Second, county extension educators in 15 states provided a self-reported of their level of competence for each of the areas identified by the PSEP Coordinators as essential. The county extension educators reported being more competent in the areas such as defining pests, understanding pesticide label information (brand name versus active ingredient, signal words and mixing directions) and differentiating the types of pesticide licenses (commercial versus private) and less competent in areas dealing with pesticide spray equipment selection and use (pesticide spray equipment selection, spray nozzle types and selection, calculating pesticide target size and equipment calibration), testing pesticide breathing respirators and understanding the Worker Protection Standard (WPS) regulation.

Third, it was determined that the demographic factors examined in this study have minimal or no impact on the county extension educators self-reported level of pesticide competency.

CHAPTER 5

INTERPRETATION OF FINDINGS AND CONCLUSIONS

This chapter will discuss the research findings reported in Chapter 4 and draw conclusions and recommendations based on these findings. This section will also address implications for practice and research with regards to pesticide safety education programs, professional competence and expertise.

Summary of the Study

The purpose of this study was to investigate the level of professional competence among county extension educators based upon an identified formalized set of pesticide safety education competencies. Specifically, the study looks to address the following questions:

1. What components of a pesticide safety education program do state pesticide safety education program coordinators view as most essential in minimizing the risks associated with pesticides?
2. What is the self-reported level of competence among county extension educators with regards to the pesticide safety education components viewed as most essential?
3. To what extent do county extension educators' personal characteristics explain their self-reported level of pesticide safety education competence?

To address these questions, the researcher developed and administered two survey questionnaires. The first questionnaire was administered to Pesticide Safety Education Program Coordinators in the United States. Twenty-two responses were collected and the results validated 31 of the 34 pre-determined pesticide related competencies deemed essential to a pesticide safety education program. The responses also yielded three additional pesticide competencies not included in the original questionnaire.

The second questionnaire was a modified version of the first questionnaire and was administered to county extension educators conducting pesticide safety education programs in the United States. This questionnaire addressed research questions two and three. Responses were collected from 311 survey participants in 15 states. The primary findings for the research questions were as follows: 1) a total of 34 competencies were identified and validated as being essential in helping minimize human health and environmental risks associated with pesticide use. Each of the 34 items can be categorized into 3 major pesticide educational areas: Reducing Pesticide Exposure to Humans, Reducing Pesticide Exposure to the Environment, and Proper Pesticide Storage, Security and Disposal. Competencies that were removed from the list (identifying and understanding the different commercial pesticide license categories, understanding the term pesticide residue, and understanding the mode of action of a pesticide) either ranked low or did not fit into any of the three educational areas above. This process provided the researcher with empirically based data from subject matter experts in the field of pesticide safety education. 2) county extension educators reported being more competent in the areas such as defining pests, understanding pesticide label information (brand name versus active ingredient, signal words and mixing directions) and differentiating the types of pesticide licenses (commercial versus private) and less competent in areas dealing with pesticide spray equipment selection and use (pesticide spray equipment selection, spray nozzle types and selection, calculating pesticide target size and equipment calibration), testing pesticide breathing respirators and understanding the Worker Protection Standard

(WPS) regulation. 3) the county extension educators' age, gender, level of education and time spent working with the Cooperative Extension System all showed a small relationship with their self-reported levels of pesticide competence. Although these observations were statistically significant, they were not substantively important and limited predictive power is associated with each variable. With that in mind, the researcher concluded that there was no significant relationship between self-reported levels of competence and these demographics.

In addition, the relationship between the number of in-service programs attended annually and self-reported level of competence was not significant. The findings between gender and self-reported competence do suggest a relationship, however, the relationship is not significant and the slight variation reported could be attributed to the response self-reporting differences exhibited between males and females. For example, when examining the perceived online skill differences between men and women, Hargittai and Shafer (2006) found that "women are much more likely to shortchange themselves when it comes to self-perception of their online skills". This finding is consistent with the work of others who also found that women are less likely to perceive themselves as skilled in science and technological based careers (Correll, 2001). Phillips and Zimmerman (1990) found that girls, in general, have been found to underestimate their ability, while boys tend to overestimate their ability (1990). Also, as noted earlier, Braskamp and Ory (1994) and Atwater (1998) both indicated that gender influences self-assessment accuracy and reliability and should be considered when small variances are observed.

Likewise, the relationship between race and self-reported competence was not significant. Finally, it was determined that county extension educators with a background in forestry had a lower self-reported competency level than respondents from other educational backgrounds. However, further data analysis showed no notable differences except between county extension educators with an educational background in forestry and those with an educational background in plant and soil science. Also, it was determined that there were too few study participants to conclude that this relationship exists.

Discussion of Findings and Conclusions

Conclusion #1

First, the study yielded a set of essential competencies in pesticide safety education program. This set of competencies, like those found in health care and other professions, helps establish standards for professionals in the field that can be used in any state pesticide safety education program. Eraut (1994, p.200) stated that “many professions do not, as yet, have documents specifically designed to communicate their occupational standards.” He continued by adding that “this makes it difficult to find out what qualified people are competent to do and to judge the validity of their assessment systems”. By seeking an expert opinion to identify and quantify the most essential pesticide competencies, one could argue that the dilemma facing those charged with assessing pesticide safety education programs and those who teach them is lessened. In other words, the process of identifying essential pesticide competencies yielded an expert validated tool to help pesticide safety education programmers communicate program related standards of competence and measure self-reported effectiveness in delivering these competencies in an educational setting. A similar approach was taken by Benner (2001) who called on hospital administrators to identify experienced nurses who were “highly skilled clinicians” (p.15) to help establish a set of essential competencies needed in order to provide expert clinical care. Similarly, this study tapped the wisdom of those closest to the field practice and content expertise to establish this set of competencies.

An empirically-based set of pesticide safety education competencies was identified and validated by pesticide subject matter experts as being essential in minimizing the human health and environmental risks associated with pesticide use. This provides pesticide safety education stakeholders with a better understanding of the most essential pesticide training needs for pesticide applicators. This set of competencies provided the basis for a tool that measures competency levels in the most essential pesticide safety education areas among those charged with delivering pesticide safety education programs.

Conclusion #2

Additionally, this research provides evidence that, for the most part, county extension educators have a high self-reported level of competence. Other studies dealing with self-assessment of competence have shown that study participants respond as they think they “should” and not as they actually believe. The term often used to describe these pressures is *social desirability* (Shrauger and Osberg, 1981; Breakwell et al., 1995). This indicates that the actual level of competence may be lower than what is reported in this study.

County extension educators reported a high level of competence in the areas of defining pests, understanding pesticide label information (brand name versus active ingredient, signal words and mixing directions) and differentiating the types of pesticide licenses (commercial versus private). In contrast, a low self-reported level of competence in areas dealing with pesticide spray equipment selection and use (pesticide spray equipment selection, spray nozzle types and selection, calculating pesticide target size and equipment calibration), testing pesticide breathing respirators and understanding the Worker Protection Standard (WPS) regulation was reported. This indicates that there are specific program areas within the 34 pesticide competencies that should be addressed with county extension educators. PSEP Coordinators and CES administrators should consider these responses when planning in-service training and other educational programs for county extension educators. Specifically, responses to competencies that require the use of mathematical calculations and the selection and use of spray and protective equipment rated low. This suggests that more training emphasis should be placed in areas such as pesticide target size calculation, spray equipment selection, calibration and use, spray nozzle selection and breathing respirator testing.

In the 2005 Strategic Program Assessment of the Pesticide Safety Education Program, the U.S. EPA noted that pesticide applicator training programs need to examine the effectiveness of pesticide applicator training methods. They noted that this could lead to a change in training program formats. One can conclude that an examination of the current self-reported level of pesticide competence among those who conduct these training programs would be a key component in such an assessment.

Conclusion #3

The demographic characteristics had a minimal influence on self-reported competency levels. The characteristics age, gender, race, level of education, area of study, professional experience and number of in-service trainings attended annually were examined. Results showed weak statistical relationships or no relationship at all for each demographic when compared to the self-reported competency scores. With this in mind, it can be concluded that the selected demographic factors have a minimal impact on the county extension educators' self-reported levels of pesticide competence. However, it should be noted once again that the area of race and area of study in forestry resulted in too little variability among the study participants to compare this variable with self-reported competency.

In the case of in-service training this information suggests that an increase in the number of in-service and related professional development programs does not result in an increase in the self-reported levels of pesticide competence, however, it should be noted that the study did not ask the county extension educators to differentiate the types of in-service programs they attended. In other words, the in-service programs attended may not be directly related to pesticide safety education.

Implications for Practice

When examining the findings from this study one can draw several implications related to the practice of identifying competencies and developing professional competence among county extension educators in pesticide safety education and other adult educators and other subject matter areas.

This set of competencies gives county extension educators a tool to assist them in developing a pesticide safety education program that will have a positive impact on pesticide use. Additionally, this tool can serve assist county extension educators and others in assessing competency levels in the area of pesticide safety education. Also, other program areas within the Cooperative Extension System and professions outside CES could use this study as a template for other areas of study in developing and validating similar program competencies. Finally, this research provides stakeholders with additional program needs assessment information to use in determining future overall program planning and direction.

Findings from the study show that county extension educators have a higher self-reported level of competence in some areas and a lower self-reported level of competence in other areas. These findings should be reviewed by CES administrators and considered when planning professional development programs in this area. One could use this tool to obtain baseline data about a state pesticide education program and provide information to stakeholders and others who are concerned with program evaluation and outcomes.

Related to this is the finding that professional development or in-service training had no positive influence on the county extension educators self-reported level of competence. CES programs have expressed concerns with the effectiveness of in-service training (Smith & Woeste 1983; Fitzpatrick, et al. 1997; Mincemoyer & Kelsey 1999). This study further adds to the concerns with the effectiveness of in-service training programs.

Additionally, research shows that professionals gain competence from experience rather than classroom training (Merriam and Caffarella, 1999; Benner, 2001; Mieg, 2001). With that in mind, the CES administrators and others who plan in-service training for county extension educators should consider adopting a hands-on pesticide safety education training program that will foster experience and skill acquisition over one that is limited to traditional lecture.

Implications for Research

This study extends the existing body of research in the area of professional competence and expertise. Schön (1983), Dreyfus and Dreyfus (1986) and Benner (2001), all noted that experience builds expertise and that skills (competencies) are not innate. This study showed a weak relationship between level of professional experience and self-reported levels of competence. Although many of the early theories on expertise point to experience as a pre-requisite for expertise, Ericsson et al. (2009) stated that "there is now ample evidence from many domains that the number of years experience is a poor indicator of objective professional performance" (p.2). The weak relationship between level of professional experience and self-reported competence could be attributed to the afore-mentioned research which attributed self-reporting flaws to social pressures (Shrauger and Osberg, 1981; Breakwell et al., 1995).

The weak statistical relationship between age and a higher self-reported level of competency also supports this notion in the existing research as does the finding that showed a higher self-reported level of competence with the county extension educators who have a higher level of education. Chi, Glaser and Farr (1988) and Mieg (2001) indicated that education plays a role in the development of competence and expertise, which was not clearly consistent with the findings of this study.

Also, this study adds to and expands on an existing body of research which addresses the professional development of county extension educators in the Cooperative Extension Service. Earlier, the researcher noted works from many sources that focused on task-specific competency identification and development for county extension educators in Cooperative Extension programs (Boyd 2004, Cooper and Graham 2001, Conklin et al.

2002, etc.) but did not address subject matter competency measurement for county extension educators.

Recommendations for Further Study

This study validated a set of essential pesticide safety education competencies, established baseline data on the self-reported levels of competence among county extension educators in each essential pesticide safety education area and determined the effects of certain demographic factors on the self-reported levels of pesticide competence. However, there are limitations and questions that warrant future attention.

First, as stated earlier in the study limitations, this study is not an actual assessment of the level of competence among county extension educators in the area of pesticide safety education. The study does not measure actual levels of pesticide competence or expertise, it merely asks the county extension educators to rate themselves in each essential area. A study for future consideration could build on this study by determining a way to measure the actual level of professional competence of county extension educators with regards to the pesticide safety education programs they administer.

A high level of competence, self-reported or otherwise, may not translate to superior performance in pesticide safety education programs administered by county extension educators. Another question to explore is the area of educational program planning and delivery. Specifically, it would be useful to seek the current level of teaching competence among county extension educators who conduct pesticide safety education programs. Assuming that subject matter competence leads to successful educational programs would be erroneous. By conducting a teaching and program delivery competency study similar to this one, valuable information can be obtained about the county extension educators teaching skills.

Also, a study examining the number of and types of in-service program offerings for pesticide safety education trainings directed towards county extension educators should be considered. This will enable program administrators to further examine if a relationship exists with additional training and self-reported competence.

Additionally, further refinement of the study research questionnaires is warranted. Specifically, the demographic areas could be refined in order to obtain more specific information regarding the types of professional experience held by county extension educators. For example, the study does not ask the county extension educators to indicate the amount of professional experience they have specifically in pesticide safety education program areas. Knowing when county extension educators assumed these roles would prove useful in further delineating the relationship between level of experience and self-reported competence. Also, the survey instrument could be strengthened by examining the types of in-service programs the county extension educators attend annually. Again, this was not explored in the study and could, upon refinement, show a relationship with self-reported competence.

Finally, because competencies that require the use of mathematical calculations and the selection and use of spray and protective equipment rated low, county extension educators levels of anxiety towards math and technology should be explored further.

Summary

In conclusion, this study yielded insights that are important to the understanding of competence in Extension-based adult educators and the practice of pesticide safety education programs. First, a set of expert validated pesticide competencies were derived from the study. This set of competencies carries a high level of validity in that it was the pesticide subject matter experts that ranked and validated the competencies based on their impact in reducing the risks associated with pesticide use. This study, as a model, can be replicated and used to measure self-reported competence in other occupational areas. That is, the process used to obtain the competencies in this study provides a framework for future research and exploration into professional competency identification and validation. The study also employed the competency set to determine a self-reported level of competence among county extension educators. This process revealed pesticide competency areas where county extension educators rank themselves high and other areas where they rank themselves low. This suggests that additional pesticide safety training in specific pesticide safety areas may be needed.

Finally, the study determined that the demographic characteristics examined in this study do not impact the county extension educators self-reported level of competence. All the findings extend the literature on professional competence, particularly adding to the literature of Extension educator and further suggests recommendations for practice, theory, and future research.

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APPENDICIES

APPENDIX A

E-MAIL TO PESTICIDE SAFETY EEDUCATION PROGRAM COORDINATORS

The University of Georgia

Dear Pesticide Safety Education Coordinator:

Pesticide safety education continues to play a significant role in helping to reduce pesticide related risks which can be harmful to humans and the environment. Part of your role as a Pesticide Safety Education Program (PSEP) coordinator requires you to provide oversight to the pesticide education programs conducted by county extension educators each year. In Georgia, we have over 25,000 licensed commercial and private pesticide applicators who must attend educational programs to maintain their pesticide license. The educational programs these individuals attend are often programs that county extension educators plan, deliver and evaluate.

As part of my doctoral dissertation in the Adult Education program at The University of Georgia, I am seeking to establish a formalized set of pesticide safety education topics that are essential in minimizing human and environmental risks. Once these topics are identified, I plan to ask county extension educators in all willing states to rate their perceived level of competence in these areas.

This study is being conducted under the direction of Dr. Lorilee Sandmann. The study will provide Cooperative Extension System (CES) programs with an established list of pesticide topics that PSEP coordinators agree are essential in minimizing pesticide risks as well as baseline information about the current competency level of the county extension educators who deliver pesticide safety education programs. The study will also help CES administrators better understand how to approach the hiring and training of county extension educators.

In order to complete this study I would like to ask for your help in completing an online survey. The survey will consist of two parts: background/demographic information and your opinion on a list of pesticide topics relative to their importance in minimizing pesticide risks. The survey should take about 30 minutes to complete. Your participation in the study is voluntary and your responses will be kept confidential.

Thank you for your time and assistance.

To complete the survey, go to the following online link:

Survey Link [Insert Link]

This link is uniquely tied to this survey and your email address; please do not forward the link for others to complete.

Regards,

Stephen E. Cole
Doctoral Candidate, Adult Education

Additional questions or problems regarding your rights as a research participant should be addressed to IRB Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia, 30602; Telephone (706) 542-3199; E-mail Address IRB@uga.edu.

APPENDIX B

E-MAIL TO COUNTY EXTENSION EDUCATORS

The University of Georgia

Dear County Extension Educator:

Pesticide safety education continues to play a significant role in helping to reduce pesticide related risks which can be harmful to humans and the environment. Part of your role as county extension educator requires you to provide pesticide education programs to many individuals each year. In Georgia, we have over 25,000 licensed commercial and private pesticide applicators who must attend educational programs to maintain their pesticide license. The educational programs these individuals attend are often programs that you plan, deliver and evaluate.

As part of my doctoral dissertation in the Adult Education program at The University of Georgia, I am examining the current perceived level of pesticide competence among county agents in the United States. This study is being conducted under the direction of Dr. Lorilee Sandmann, and will provide Cooperative Extension System (CES) programs with baseline information about the current level of the pesticide safety education program. The study will also help CES administrators better understand how to approach the hiring, training and continuing education of county extension educators.

In order to complete this study I would like to ask for your help in completing an online survey. The survey will consist of two parts: background/demographic information and your self-perceived level of competence as it relates to you teaching pesticide safety education programs. The survey should only take about 30 minutes to complete. Your participation in the study is voluntary and your responses will be kept confidential. Thank you for your time and assistance.

To complete the survey, go to the following online link:

Survey Link [Insert Link]

This link is uniquely tied to this survey and your email address; please do not forward the link for others to complete.

Regards,

Stephen E. Cole
Doctoral Candidate, Adult Education

Additional questions or problems regarding your rights as a research participant should be addressed to IRB Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia, 30602; Telephone (706) 542-3199; E-mail Address IRB@uga.edu.

APPENDIX C

IMPLIED CONSENT FORM

The University of Georgia

Consent Form

You are invited to participate in a research study titled *Pesticide Safety Education: Establishing Program Standards and Determining Perceived Competence in Pesticide Safety Education Programs in the Cooperative Extension System.* The purpose of this research is to identify a standardized set of pesticide competencies for pesticide safety education programs and to determine the current perceived level of competence in these areas among county extension educators in the United States. Please know that this research activity is being conducted by the below individual, under the supervision of Dr. Lorilee R. Sandmann, and the results may be published.

Stephen E. Cole
Study Director
University of Georgia
1840 Stone Forest Dr.
Lawrenceville, GA 30043
(770) 338-2206
secole@uga.edu

As a participant in this study, you will complete an online survey about pesticide education program areas. There are no foreseen risks to your participation. Your participation is voluntary. You may refuse to participate or withdraw at any time without penalty or loss of benefits to which you are otherwise entitled. You may also skip any questions that you feel uncomfortable answering. It should take approximately 30 minutes to complete the online questionnaire.

Benefits of this study include the potential development of a nationally recognized set of educational topics that are essential in minimizing the risks associated with pesticide use. The study will examine pesticide safety educators (County Extension Educators) current self-assessed ability to teach these topics. Knowing this will help Cooperative Extension Programs understand how to prepare County Extension Educators to be successful pesticide educators (in-service training, formal education, etc.). This in turn may help minimize risks associated with pesticide use in the United States. Additionally, this study could be replicated to other educational program areas administered by State Cooperative Extension Systems in the United States as well as other professions looking to improve their educational or training programs. The research may also help survey participants by enabling their administration to provide them with more effective professional development opportunities.

All of your responses will be confidential and will not be associated with your name or email address; however, a unique number will be assigned to each respondent through use of a “cookie” that has no meaning outside of the survey website. If necessary, this will allow each respondent to return to an incomplete survey and be taken directly to the point of exit. Only the researcher will have access to the data. If the survey remains incomplete, it can not be accessed by the researcher and the answers will not be used as part of the study.

Please note the following:
Internet communications are insecure and there is a limit to the confidentiality that can be guaranteed due to the technology itself. However, once the completed survey is received by the researcher, standard confidentiality procedures will be followed. In addition, only summary data will be reported.

In addition, given that communication via the Internet is more risky in regards to privacy, if you prefer, you can open a pdf version of the survey instrument located at [insert link], complete by hand, and then submit via fax or US mail to the address above.

If you have any questions, do not hesitate to ask now or at a later date. You may contact Steve Cole, Study Director, at (770) 338-2206 or secole@uga.edu.

Additional questions or problems regarding your rights as a research participant should be addressed to IRB Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia, 30602; Telephone (706) 542-3199; E-mail Address IRB@uga.edu.

APPENDIX D

FOLLOW-UP PARTICIPATION REQUEST

The University of Georgia

Dear [Name of Subject],

I want to take this opportunity to follow up to an email you received on [date] requesting your participation in a pesticide safety education survey.

As you may recall, this study is looking at different aspects of pesticide safety education in the Cooperative Extension System. Additionally, I am currently conducting this research study to complete the requirements for my doctoral program in the Adult Education program at the University of Georgia under the supervision of Dr. Lorilee Sandmann.

You have been chosen to provide valuable input to improve pesticide safety education programs; therefore, your participation is important. The results will benefit the field and we will become better equipped to hire and train new county extension educators. As a working professional in the agricultural industry and a part time graduate student, I recognize the value of your time. Your participation is voluntary and your responses will be confidential. No individual data will be used, only summary data will be reported. The survey is designed to take about 30 minutes to complete. Your input is valuable to the study and I appreciate your consideration.

To complete the survey, follow the link for online completion.
Survey Link: [insert survey link]

This link is uniquely tied to this survey and your email address; please do not forward the message for other individuals to complete.

With appreciation,

Stephen E. Cole
Doctoral Candidate, Adult Education

Additional questions or problems regarding your rights as a research participant should be addressed to IRB Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia, 30602; Telephone (706) 542-3199; E-mail Address IRB@uga.edu.

APPENDIX E

SURVEY QUESTIONNAIRE I

The University of Georgia College of Education
Lifelong Education, Administration, & Policy
Adult Education Program

Part I. Identifying Essential Pesticide Competencies

Pesticides, when used properly, can be beneficial to everyone in American society. However, when used improperly, they can be both dangerous and wasteful. This questionnaire will ask you to determine which pesticide competencies are important when teaching pesticide courses in the Cooperative Extension System. Your responses will help identify competencies that are essential to any pesticide safety course taught by county extension educators in the Cooperative Extension System. We hope you'll take the time to give us a thoughtful assessment of these individuals with regards to their level of competence in each area listed below. Your answers are strictly confidential.

	Please rate each item relative to its' importance when teaching pesticide safety education	*Not Important*	*Somewhat Important*	*Quite Important*	*Extremely Important*
1.	Understanding the term pest	1	2	3	4
2.	Pest Identification (plant, insect and disease)	1	2	3	4
3.	Ability to differentiate the differences among insecticides, herbicides and fungicides	1	2	3	4
4.	Identifying the differences between general and restricted use pesticides	1	2	3	4
5.	Understanding the difference between a brand name and an active ingredient	1	2	3	4
6.	Understanding the meanings of various signal words on a pesticide label	1	2	3	4
7.	Understanding the mode of action of a pesticide	1	2	3	4
8.	Understanding the mixing directions on a pesticide label	1	2	3	4
9.	Selecting the proper pesticide formulation	1	2	3	4
10.	Determining if an area may be sensitive to pesticides	1	2	3	4
11.	Understanding how a pesticide may move from a target site	1	2	3	4
12.	Understanding the term pesticide residue	1	2	3	4
13.	Identifying the different types of personal protective equipment used in pesticide applications	1	2	3	4

14.	Determining the proper personal protective equipment required for a pesticide application	1	2	3	4
15.	Knowing how to test a pesticide breathing respirator	1	2	3	4
16.	Identifying a suitable mixing and loading area	1	2	3	4
17.	Explaining how to dispose of pesticide containers	1	2	3	4
18.	Determining the best way to dispose of pesticide rinsate	1	2	3	4
19.	Understanding the different pesticide record keeping requirements	1	2	3	4
20.	Determining the most effective pesticide spray equipment for a pesticide application	1	2	3	4
21.	Determining the most effective spray nozzle for a pesticide application	1	2	3	4
22.	Calibrating various types of spray equipment	1	2	3	4
23.	Calculating pesticide target size	1	2	3	4
24.	Understanding how nozzle type and spacing can influence pesticide applications	1	2	3	4
25.	Knowing how to safely transport pesticides	1	2	3	4
26.	Understanding how to address leaky pesticide containers	1	2	3	4
27.	Understanding how to manage pesticide spills	1	2	3	4
28.	Understanding how to dispose of unwanted pesticides	1	2	3	4
29.	Understanding the pesticide license process	1	2	3	4
30.	Understanding the difference between a commercial and private pesticide license	1	2	3	4
31.	Identifying and understanding different commercial pesticide license categories	1	2	3	4
32.	Understanding the Worker Protection Standard regulation	1	2	3	4
33.	Understanding the state and federal laws that govern pesticide use	1	2	3	4
34.	Understanding the principles of Integrated Pest Management	1	2	3	4

35. Are there other essential areas that are not included above?

____

____

____

36. Any Additional Comments?

____

____

____

37. What is the highest level of education you have completed?
- o Bachelor’s
- o Master’s
- o Doctorate
- o Other ___________________________

38. Length of time you have served with the Cooperative Extension System
- o Less than 1 year
- o 1 to 5 years
- o 6 to 10 years
- o 11 to 15 years
- o More than 15 years

APPENDIX F

SURVEY QUESTIONNAIRE II

The University of Georgia
College of Education
Lifelong Education, Administration, & Policy
Adult Education Program

County Extension Educators Pesticide Competence Questionnaire (Based on Responses from Pesticide Safety Education Coordinators)

Instructions: Please mark your classification under each item or fill in the blank. (Check only one item under each heading).

Part I. Pesticide and Competence Questionnaire

Pesticides, when used properly, can be beneficial to everyone in American society. However, when used improperly, they can be both dangerous and wasteful. This questionnaire will ask you to evaluate your ability with regards to each pesticide education concept. We hope you'll take the time to give us a thoughtful assessment of yourself with regards to your level of competence in each area listed below. Your answers are strictly confidential.

	Section I. Proficiency with Pesticide Content	
	Please rate your level of pesticide competence in each area	**Check one choice for each item**
1.	Understanding the term pest	o Poor o Fair o Good o Very Good o Excellent
2.	Ability to identify various pests (plant, insect and disease)	o Poor o Fair o Good o Very Good o Excellent
3.	Ability to differentiate the differences among insecticides, herbicides and fungicides	o Poor o Fair o Good o Very Good o Excellent
4.	Identifying the differences between general and restricted use pesticides	o Poor o Fair o Good o Very Good o Excellent

5.	Understanding the difference between a brand name and an active ingredient	o Poor o Fair o Good o Very Good o Excellent
6.	Understanding the meanings of various signal words on a pesticide label	o Poor o Fair o Good o Very Good o Excellent
7.	Understanding the mode of action of a pesticide	o Poor o Fair o Good o Very Good o Excellent
8.	Understanding the mixing directions on a pesticide label	o Poor o Fair o Good o Very Good o Excellent
9.	Selecting the proper pesticide formulation	o Poor o Fair o Good o Very Good o Excellent
10.	Determining if an area may be sensitive to pesticides	o Poor o Fair o Good o Very Good o Excellent
11.	Understanding how a pesticide may move from a target site	o Poor o Fair o Good o Very Good o Excellent
12.	Understanding the term pesticide residue	o Poor o Fair o Good o Very Good o Excellent
13.	Identifying the different types of personal protective equipment used in pesticide applications	o Poor o Fair o Good o Very Good o Excellent

14.	Determining the proper personal protective equipment required for a pesticide application	o Poor o Fair o Good o Very Good o Excellent
15.	Knowing how to test a pesticide breathing respirator	o Poor o Fair o Good o Very Good o Excellent
16.	Identifying a suitable mixing and loading area	o Poor o Fair o Good o Very Good o Excellent
17.	Explaining how to dispose of pesticide containers	o Poor o Fair o Good o Very Good o Excellent
18.	Determining the best way to dispose of pesticide rinsate	o Poor o Fair o Good o Very Good o Excellent
19.	Understanding the different pesticide record keeping requirements	o Poor o Fair o Good o Very Good o Excellent
20.	Determining the most effective pesticide spray equipment for a pesticide application	o Poor o Fair o Good o Very Good o Excellent
21.	Determining the most effective spray nozzle for a pesticide application	o Poor o Fair o Good o Very Good o Excellent
22.	Calibrating various types of spray equipment	o Poor o Fair o Good o Very Good o Excellent

23.	Calculating pesticide target size	o Poor o Fair o Good o Very Good o Excellent
24.	Understanding how nozzle type and spacing can influence pesticide applications	o Poor o Fair o Good o Very Good o Excellent
25.	Knowing how to safely transport pesticides	o Poor o Fair o Good o Very Good o Excellent
26.	Understanding how to address leaky pesticide containers	o Poor o Fair o Good o Very Good o Excellent
27.	Understanding how to manage pesticide spills	o Poor o Fair o Good o Very Good o Excellent
28.	Understanding how to dispose of unwanted pesticides	o Poor o Fair o Good o Very Good o Excellent
29.	Understanding the pesticide license process	o Poor o Fair o Good o Very Good o Excellent
30.	Understanding the difference between a commercial and private pesticide license	o Poor o Fair o Good o Very Good o Excellent
31.	Identifying and understanding different commercial pesticide license categories	o Poor o Fair o Good o Very Good o Excellent

32.	Understanding the Worker Protection Standard regulation	o Poor o Fair o Good o Very Good o Excellent
33.	Understanding the state and federal laws that govern pesticide use	o Poor o Fair o Good o Very Good o Excellent
34.	Understanding the principles of Integrated Pest Management	o Poor o Fair o Good o Very Good o Excellent

Part II. County Extension Educator Information

Section I. Demographic Data

1. What year were you born?____________________

2. What is your gender?
   - o Male
   - o Female

3. What best describes your ethnic background? _________________________

4. Where were you raised?
   - o Urban
   - o Suburban
   - o Rural farm
   - o Rural non-farm

Section II. Education and Experience

1. What is the highest level of education you have completed?
   - o Bachelor’s
   - o Master’s
   - o Doctorate
   - o Other ____________________________

2. What area did you study for your degree?
- o Animal Science
- o Plant Science (Plant and Soil Science, Plant Pathology, Agronomy, etc.)
- o Forestry and Natural Resources
- o Entomology
- o Agricultural Education
- o Other ____________________________

3. Name of the University/Institution(s) you attended

____

(University/Institution)

____

(City) (State)

4. Length of time you have served with the Cooperative Extension System
- o Less than 1 year
- o 1 to 5 years
- o 6 to 10 years
- o 11 to 15 years
- o More than 15 years

5. What occupational experience have you had in other agricultural professions? (If none, write none)

Agricultural Profession	Years Experience
______________________________	______________ years
______________________________	______________ years
______________________________	______________ years

6. Approximately how many times do you attend in-service training per year?
- o Less than 3
- o 3 to 5
- o 6 to 10
- o 11 or more

This concludes the questionnaire, thank you for your participation!

APPENDIX G

ADDITIONAL ESSENTIAL COMPETENCIES IDENTIFIED

BY PSEP COORDINATORS

PSEP Free Response	Theme(s)
Effect of pesticides to the environment	Reducing Pesticide Exposure to the Environment
Understanding what resistance is. Understanding principles of resistance management. Understanding how to prevent drift.	Reducing Pesticide Exposure to the Environment Reducing Pesticide Exposure to Humans
An understanding of the potential human toxicity issues and have a working knowledge of the Farm Family Exposure study and the Ag Health Study	Reducing Pesticide Exposure to Humans
Understanding the disease triangle. Understanding the three C's spill management. Understanding environmental hazards and pesticide exposure. Understanding math calibration.	Reducing Pesticide Exposure to the Environment Reducing Pesticide Exposure to Humans Proper Pesticide Storage, Security and Disposal
Understanding pesticide toxicity and environmental concerns (endangered species, water quality, etc.)	Reducing Exposure to the Environment Reducing Pesticide Exposure to Humans
Professionalism and ethics of pesticide application. Pesticide storage, security and terrorism-eco and international	Proper Pesticide Storage, Security and Disposal
Understanding the concept of pesticide toxicity based on LD50 values and other exposure routes. Understanding the environmental fate of pesticides. Understanding the pros and cons of different pesticide formulations	Reducing Pesticide Exposure to the Environment Reducing Pesticide Exposure to Humans
Importance of site definitions and meanings of plant back restrictions	Reducing Pesticide Exposure to the Environment
Working with fire departments and dealing with problems and complaints, placement of storage areas and tanks, insurance needs	Reducing Pesticide Exposure to the Environment Reducing Pesticide Exposure to Humans Proper Pesticide Storage, Security and Disposal
There are different needs in what operators need to know vs. applicators. Also, different needs based on categories- fumigators need to know about respirators while most other categories do not need them.	Reducing Pesticide Exposure to Humans