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Identification and Development of the Support Needs in Nematology for Arkansas Cooperative Extension Personnel

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by

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ABSTRACT

County extension agents are vital to the land-grant university system and are responsible for transferring current, research-based knowledge from the university to the community. In-service training allows agents the means to maintain a current, sound knowledge base. Needs identified by leading nematologists led the researcher of this study to assess if nematology education was a topic that warranted in-service training development for Arkansas Cooperative Extension Service (CES) agents. The researcher also assessed agents' comfort level with job related technology. Of the respondents, 67% identified general knowledge of plant parasitic nematodes necessary to meet the needs of their clientele. Findings from the needs assessment indicated agents had a high level of comfort with job related technologies, and had some need for training in nematology topics to better assist their clientele. Along with budgetary and staff constraints, respondents' self-assessed comfort and interest level with technology was deemed sufficient to warrant development of an online in-service training opportunity that was implemented as a pilot study. Pilot study participants were purposively selected extension agents and research support staff in the Arkansas CES Delta District. Three online nematology modules were developed and administered to participants to assess the effectiveness of the modules as a training tool. Mean pretest (M= 84.97, SD = 11.55) and posttest (M = 94.39, SD = 6.07) scores collected during the pilot study showed a significant increase in participants' nematology knowledge gained after instruction from the modules. Participant responses from pre- and posttest surveys showed an increase in participants' comfort level with some nematology topics after instruction. Additionally, participants of the pilot study found the modules to be an effective method of presenting information and learning. It is recommended that for future research practices that materials are tested with groups that are not agriculturally literate to

further assess the utility and effectiveness of the pilot study materials. Materials should also be retested in a more controlled setting to determine if the knowledge change was due to treatments, or external factors. Additionally, it is recommended that materials, such as the educational modules developed in this study, be available to the general public.

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Chapter I: INTRODUCTION

Need for the Study

Leading experts in the plant pathology field have expressed the need for a greater foundational knowledge of plant and soil nematodes because of their substantial impacts on society (Barker et al., 1994). Nematodes are significant and impactful because of the extent of their habitats, economic influences, and their effects on the present and future food and fiber supply. Although only 3% of nematode species have been studied and described, nematodes can be found in every imaginable environment, with millions being able to inhabit one square meter of soil (Barker et al., 1994). All plant and animal species are vulnerable to some type of parasitic nematode, and some nematode species even play a valuable role in the process of organic material decomposition (Barker et al., 1994).

In economic terms, damages by plant-parasitic nematodes cause an estimated $8 billion in losses to major crops throughout the United States every year (Barker, 1998; Jagdale, 2011). Plant-parasitic nematodes are responsible for up to 10% of all United States cotton production losses, and individual fields may reach yield losses up to 50% (Blasingame & Patel, 2005; Koenning, Overstreet, Noling, Donald, Becker, & Fortnum, 1999). Worldwide, plant-parasitic nematode damages to major crops are estimated at $78 billion (Barker, 1998) to $100 billion annually (Mitkowski & Abawi, 2003). The projected losses attributable to nematodes can be underestimated because the resultant plant symptoms from nematode damage are generic and can go unattributed to nematodes and unnoticed; and because of nematode interactions with other plant parasitic pests (Barker et al., 1994; Koenning et al., 1999).

A substantial driving force for nematology as a whole is to efficiently provide more food and fiber outputs while using less land and reducing losses from nematode (Webster, 2012).

However, advancing research and education in nematology are constrained by limited resources, lack of effective and environmentally safe management practices, and lack of awareness and appropriate programs (Barker, et al., 1994). Researchers in the plant pathology sector recognize that effectively facilitating the development and dissemination of nematology knowledge requires new approaches and innovation, such as the use of distance education and emerging educational technologies (Barker et al., 1994; Francl, 1998).

The use of new technologies in nematology education, research, and extension is vital to the success of nematology programs. The use of current telecommunication technologies is necessary to provide expanded, regional service of nematology programs in Extension (Barker et al., 1994). A committee of leading researchers in nematology previously identified the Cooperative State Research Service, now consolidated into a part of the National Institute of Food and Agriculture (NIFA), as the most suitable outlet to "supply enhanced support for nematode and research and education programs when those resources become available" (Barker et al., 1994. p. 137). The Cooperative Extension Service (CES) is a non-credit educational network that provides practical, research based information about a multitude of topics to all types of audiences (NIFA, n.d.). Nematology is one of many agricultural topics addressed by professionals in the CES.

Problem Statement

The advancement of nematology research, education and extension are largely constrained by lack of resources, lack of ecologically sound management practices, and the lack of nematology programs and awareness in most states (Barker et al., 1994). A lack of resources is evident in many scientific communities, and can be a major limiting factor to their success and

advancement. Nematology has fewer scientists, facilities, and the support needed to maintain productivity levels that will meet future agricultural needs (Barker et al., 1994).

Likewise, two major challenges facing the CES are (1) the need to utilize methods that allows CES to reach new audiences while also maintaining a relationship with more traditional clientele and (2) to effectively maintain a connection at the local level while increasing the reach of the CES in a "global society" (Diem et al., 2011, Recommendations section, para. 1). Researchers across multiple agricultural disciplines agree there is a need to use innovative and new technologies to disseminate information (Barker et al., 1994; Diem, Hino, Martin, & Meisenbach, 2011). However, multiple barriers such as time, money, and training constrain professionals in the CES from adopting the use of new technology and innovations (Diem et al., 2009). The CES is faced with the challenge of providing up-to-date resources and information with limited means, while also progressing with changing technologies and innovations.

Purpose of the Study

The purpose of this study was to identify Arkansas agricultural county extension agents' preferred methods of in-service training about plant-parasitic nematodes of cotton and soybean, and the effectiveness (through knowledge change) and acceptance of an online introductory nematology educational training module through a pilot study.

Research Objectives

Needs Assessment Objectives

This study was guided by the following objectives:

(a) Determine perceptions and technological comfort level of Arkansas agricultural county extension agents;

(b) Determine Arkansas agricultural county extension agents' perceived utility of current job related resources;

(c) Determine the frequency that Arkansas agricultural county extension agents are consulted about nematology topics;

(d) Determine Arkansas agricultural county extension agents' level of need for training about nematology topics;

(e) Determine Arkansas agricultural county extension agents' preferred types of in-service training;

Pilot Study Objectives

(f) Assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' change in knowledge; and

(g) Assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' feedback.

Definition of Terms

Asynchronous E-Learning – A type of learning "commonly facilitated by media such as e-mail and discussion boards, supports work relations among learners with teachers, even when participants cannot be online at the same time. A key component of flexible e-learning" (Hrastinski, 2008, p. 51-52).

Cooperative Extension Service – an organization that provides "research-based information through non-formal education to help Arkansans improve their economic well-being and the quality of their lives" (University of Arkansas Division of Agriculture, n.d., para. 1).

County Extension Agent – "experts who serve to provide useful, practical and research-based information to agricultural producers, small business owners, youth, consumers and others" (NIFA, n.d., para. 1).

Educational Training Module – a short unit of educational material developed using Articulate Storyline software.

E-learning – "the use of computer network technology, primarily over an intranet, or through the Internet, to deliver information and instruction to individuals" (Welsh, Wanberg, Brown, & Simmering, 2003, p. 246). "Instruction delivered via all electronic media including the Internet, intranets, extranets, satellite broadcasts, audio/video tape, interactive TV, and CD-ROM" (Govindasamy, 2002, p. 288).

Nematode – "an unsegmented, wormlike animal (phylum Nematoda), parasitic in or on plants and animals, or free-living in soil, decaying matter or water; a generally microscopic tubular roundworm with a cuticle, a hydrostatic skeleton, abundant in many soils. Practically all plant-parasitic nematodes pierce plant cells with a stylet and suck juices. Nematodes play an important role in providing wounds by which bacteria and fungi may enter, as well as transmitting microorganisms and viruses into plants" (Shurtleff & Averre, 1997, p. 208).

Nematology – "the science or study of nematodes" (Shurtleff & Averre, 1997, p. 208).

Plant Pathology – "the science or study of plant disease; also phytopathology" (Shurtleff & Averre, 1997, p. 208).

Staff – research support staff such as program associates, and program assistants in the Arkansas Delta District of the University of Arkansas Cooperative Extension Service.

Staff Chair – a county extension agent who receives a stipend to assume management responsibilities in addition to their program responsibilities (University of Arkansas Cooperative Extension Service [UACES], 2013).

Subject Matter Expertise – "knowledge and skills in the performance of a given task or subject matter area" (UACES, n. d., p. 2).

Assumptions

The following assumptions were made for the purpose of this study:

1. Participants responded honestly to needs assessment and survey questions.
2. Participants performed to the best of their abilities during knowledge assessments.
3. Participants had the necessary skills to navigate through the online modules with minimal instruction.
4. Participants read pertinent directions and instructions that accompanied components of the study e.g., survey instruments, course interface, and modules.
5. Participants were proficient enough in personal computer use to access the necessary modules and surveys.
6. Non-response is not due to dislike and/or discomfort of computers. All agents had access to, and are required to use, computers throughout the normal scope of their job duties.

Limitations

The study was subject to the following limitations:

1. Participation was voluntary, creating opportunity for non-response error.
2. Instruments were self-administered, therefore the researcher could not control conditions of testing, and conditions are unknown.

3. Previous knowledge of the research and/or course outline could influence participants' perceptions.
4. Previous relationships with the Cooperative Extension Service Program and Staff Development Department could influence participants' perceptions.
5. The instrument was not distributed by the principle researcher, limiting the researcher's control of reminder timing and instrument distribution.
6. The online training modules and knowledge assessments were only distributed to purposively selected Arkansas Cooperative Extension Services county agents and staff. Results of the study cannot be generalized beyond the population of the study.
7. Needs assessment participants may be unaware about nematodes and the specific damages and/or impacts to crops, and therefore unaware of how often they are actually answering client questions about nematology topics.
8. The timing of the study could be a limiting factor in response rates, responses to instrument questions, and what participants inferred the instrument questions were asking.
9. Questions in the needs assessment were not specifically focused on the timeframe that crops affected by nematodes are in the ground, which could skew results responses and results to questions about the frequency agents are consulted about nematology topics.
10. Pilot study participants could potentially complete pre and posttest in a short timeframe.
11. Differences in the format and length of pretests and posttests used in the pilot study could be a limiting factor in the results obtained from the tests.

Chapter II: REVIEW OF LITERATURE

Food and Fiber Needs

Present day agriculture is faced with the pressure to double food production by 2050 to provide for a growing world population (United Nations, General Assembly, 2009). Because of changing trends in food consumption and an estimated world population of 9 billion by 2050, some researchers estimate food demand will increase 75% from 2010 to 2050 (Keating, Carberry, Bindraban, Asseng, Meinke, & Dixon, 2009). At the same time, an increase in the demand for agricultural products and land for nonfood purposes, such as urban development and biofuels, could cause an overall increase of 75-100% in demand for agricultural products by 2050 (Keating et al., 2010). Likewise, findings from recent studies indicate that global crop production is not increasing at a rate adequate enough to meet future production needs (Ray, Mueller, West, & Foley, 2013). An annual crop production growth rate of 2.4% will be necessary to double agricultural production by 2050 (Ray et al., 2013).

Multiple obstacles impede the necessary advances of agricultural crop production. Limited resources are often cited across all agricultural disciplines as a cause for delay in agricultural advancements. For example, a shortage of scientists in the nematology field is expected to severely limit future research (Barker et. al., 1994). While the need to produce higher quantities of food is pressing, sustainable agricultural practices are also necessary to conserve available natural resources and environment (Falvey & Maguire, 1997, p. 15).

Cooperative Extension Service

Organizations such as Heifer International, Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, Winrock International and many others aim to address world hunger issues through direct assistance, education about

conservation of natural resources, as well as sustainable small- and large-scale agricultural production, education, and assistance.

In the United States, the CES is an important organization that addresses a multitude of agricultural topics. The CES was formally created in 1914 as a nationwide, non-credit educational network to address rural and agricultural issues (NIFA, n.d.). The CES is an organization essential to fulfilling the triadic mission of the land-grant university: education, research, and outreach. Before creation of the CES, the land-grant university system was established by the Morrill Act of 1862 with the purpose of providing agricultural and mechanic arts colleges (Seevers & Graham, 2012). To provide the means for "organized scientific research" in conjunction with land-grant universities, state agricultural experiment stations were later developed in 1887 (Cash, 2001, p. 433). The CES was the next component established and served as a network linking practical and useful research from land-grant universities to the needs of communities in the respective states (Seevers & Graham, 2012). Together, land-grant universities, state agricultural experiment stations, and the CES produce and diffuse agricultural information to the public (Cash, 2001).

Extension personnel, usually county extension agents, have the responsibility of working as a liaison between research universities and the general public. Thus, the extension agent plays a valuable role in the dissemination of research-based information, and educational materials needed by agricultural producers. The traditional transfer of technology model used to disseminate research and technologies developed at land-grant universities is a process which flows in the order of researchers to extension specialists to extension county agents to producers (Cooper & Graham, 2001; Food and Agriculture Organizations of the United Nations, 1997). The extension agent plays a valuable role in the dissemination of research-based information and

educational materials needed by agricultural producers. Extension offices throughout the United States are staffed by "experts who serve to provide useful, practical, and research-based information to agricultural producers, small business owners, youth, consumers, and others" (NIFA, n.d., para. 1). The CES receives funding on the federal level from the United States Department of Agriculture, the state level though the state Land-Grant University, and local levels of government (McDowell, 2013).

Extension has recently been charged with expanding the scope of their responsibilities to include being a part of "agricultural innovation systems" (Rivera & Sulaiman, 2009, p. 267). An agricultural innovation system is broadly defined as "a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use," along with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge (World Bank, 2006, p. vi-vii). Originally, Extension served a primarily rural population, but now must also meet the needs of clients from urban and suburban areas (Abrams, Meyers, Irani, & Baker, 2010). As an agricultural innovation system, Extension has the added responsibility to be an "object of reform," while also being part of the traditional extension – research – teaching triad (Rivera & Sulaiman, 2009, p. 267). In an agricultural innovation system, emphasis is placed on increasing the scope of key players involved in innovation, for example, including the private sector (World Bank, 2006). Furthermore, a key view in the innovation systems concept is that availability of research based knowledge is as important as "creating an enabling environment to support the use of knowledge" (World Bank, 2006, p. 26).

The role of Extension has historically included providing leadership for adopting innovative tools and practices, such as hybrid corn and irrigation practices (Diem et al., 2011).

To meet the needs of a "progressive and growing constituency," Extension must extend their leadership to practices of using technology (Diem et al., 2011, Summary and Conclusions, para 1). Recent innovations in extension agent training and education include e-learning, the use of the Internet and Smartphone applications. Research has shown Internet-based training for extension agents is effective, and many agents are open to this method of training (Lippert, Plank, & Radhakrishna, 2000; McCann, 2007). A study that compared Internet-based and traditional face-to-face instruction found that posttest results of a "multimedia-rich, highly interactive online environment" were as statistically significant as posttest results of traditional instruction (McCann, 2007, Differences Between Learning Environments, para 2).

Arkansas Agriculture

Agriculture is deeply rooted in the heritage of Arkansas' history, dating back to 1842 when Governor Archibald Yell requested funds from the state legislature for agricultural scientific research (University of Arkansas Libraries, n.d.). Presently, Arkansas agriculture plays an important role in the state's economy. Arkansas ranks in the top 25 states for production of 24 agricultural commodities, such as rice, broilers, catfish, cotton, and soybeans (University of Arkansas Division of Agriculture, 2012). Agricultural contributions in Arkansas account for "$16 billion of value added to the Arkansas economy in 2010" (University of Arkansas Division of Agriculture, 2012, p. 3). Arkansas agriculture also provides almost $9.8 billion of Arkansas' total labor income, and about one in every six jobs in the state (University of Arkansas Division of Agriculture, 2012).

Arkansas is well suited for agricultural industries, and encompasses 33.3 million acres of diverse land (Arkansas Forestry Commission, 2010). In 2011, approximately13.5 million acres, or 41% of total land area, in Arkansas was farmland (Economic Research Service [ERS], 2013;

United States Department of Agriculture, National Agricultural Statistics Service [USDA, NASS], 2011). Of that farmland, approximately 8.4 million acres were dedicated to cropland (ERS, 2013). Two commodities especially important to the success of Arkansas agriculture, and the state's economy, are soybeans and cotton. Of the 75 million acres of soybeans planted nationally, 3.3 million acres were planted in Arkansas in 2011 (USDA, NASS, 2011; USDA, NASS, 2013). Nationally, 14.7 million acres of cotton were planted in 2011 (USDA, NASS, 2013). Of those acres, 680,000 acres were planted in Arkansas (USDA, NASS, 2011).

Soybean and cotton production make significant contributions to Arkansas agriculture annually. In 2010, Arkansas ranked number 14 in the nation in agricultural cash receipts (University of Arkansas Division of Agriculture, 2012). Arkansas ranked third in cotton (upland) production, fourth in cottonseed production, and ninth in soybean production during the 2011 production year (University of Arkansas Division of Agriculture, 2012). In 2012, the cotton industry provided approximately 14,000 jobs, and over $1.6 billion in revenue for Arkansas (National Cotton Council [NCC], 2013). According to the National Agricultural Statistics Service (2011) state agriculture overview for Arkansas, the value of soybean production was $1.49 billion. In 2011 alone, soybean and cotton exports accounted for approximately $1.2 billion (ERS, 2013).

As highly valued crops, it is important for producers to plan for effective disease management in soybean and cotton. Annually, crop losses caused by plant diseases in the United States are an estimated $33 billion (Pimentel, 2010). The scientific field dealing with plant disease research is plant pathology. Plant pathology is "an interdisciplinary science that includes knowledge of botany, microbiology, crop science, soil science, ecology, genetics, biochemistry, molecular biology, and physiology" (The American Phytopathological Society, n.d., para. 1).

Of the pathogens that are a concern for cotton and soybean producers, nematodes are especially concerning. Nematodes are the most numerous Metazoa on earth, and while in essence aquatic animals, they occur in almost every habitat (Decraemer & Hunt, 2006; Gardner, 2001). Nematodes are:

> An unsegmented, wormlike animal (phylum Nematoda), parasitic in or on plants and animals, or free-living in soil, decaying matter or water; a generally microscopic, tubular roundworm with a cuticle, a hydrostatic skeleton, abundant in many soils. Practically all plant-parasitic nematodes pierce plant cells with a stylet and suck juices. Nematodes play an important role in providing wounds by which bacteria and fungi may enter, as well as transmitting microorganisms and viruses, into plants. (Shurtleff & Averre, 1997, p. 208)

The three main types of nematodes are plant-parasitic nematodes, free living nematodes, and animal-parasitic nematodes. Animal-parasitic and free living nematodes account for 44% and 40% of all described nematode species, respectively, while plant-parasitic nematodes only account for 15% of all described nematode species (Lambert & Bekal, 2009).

Estimating the annual losses caused by plant parasitic nematodes is imprecise, and sources report a variety of estimates. Likewise, there are few studies that make efforts to calculate economic losses from plant disease outbreaks and efficacy of response strategies Worldwide crop losses to plant-parasitic nematodes are estimated at $78 billion (Barker, 1998) to $100 billion annually (Mitkowski & Abawi, 2003). The Society of Nematologists (n.d.) estimates damages from plant-parasitic nematodes to cause over $3 billion worth of damage annually in the United States. Other researchers estimate annual damages and losses to plant parasitic nematodes to cause $8 billion in damages annually in the United States (Barker, 1998; Jagdale, 2011).

Currently, the most economically important plant-parasitic nematodes threatening Arkansas row-crop production are the root-knot nematode *(Meloidogyne incognita)*, the reniform

nematode *(Rotylenchulus reniformis),* and the soybean cyst nematode *(Heterodera glycines)* (Kirkpatrick & Thomas, n.d.). Together, these plant parasitic nematodes are estimated to "account for at least 90 % of nematode-induced crop losses" in Arkansas annually (Kirkpatrick & Thomas, n.d., para 2).

Innovations in Agriculture, Education, and Extension

The types of available innovations are diverse and can manifest from different end goals. From the economic aspect of their impacts, innovations can be divided into the following categories: new products, yield-increasing innovations, cost-reducing innovations, innovations that enhance product quality, and innovations that protect health and the environment (Sunding & Zilberman, 1999). In some cases, innovations can belong to multiple categories (Sunding & Zilberman, 1999). When strategically applied, innovation can also be the process of implementing, adapting, transferring and using new ideas to "improve social and economic conditions" (Argabright, McGuire, & King, 2012, para 4). The results of innovation put to practice are products that can lead to a new way of accomplishing things (Argabright et al., 2012).

Theoretical Framework

The development of this study was guided by theories of instructional design for online learning, and the Technology Acceptance Model (TAM). Witkin's and Altschuld's (1995) guide to planning and conducting needs assessments was also used to develop this study.

The TAM introduced by Davis (1986), is a model of user acceptance of information systems and computers (see Figure 1). TAM theorizes that an individual's behavioral intention to use a system is determined by the "perceived usefulness" and by "perceived ease of use" (Davis, 1986, p. 24). Within the context of TAM, perceived usefulness is 'the degree to which

an individual believes that using a particular system would enhance his or her job performance' (Davis, 1986, p. 26). Additionally, perceived ease of use is "the degree to which an individual believes that using a particular system would be free of physical and mental effort" (Davis, 1986, p. 26). Davis (1986) also theorized that perceived ease of use has a causative effect on the users' perceived usefulness. Perceived usefulness was found to have a dominate role in TAM, because it has an influential effect on people's attitude toward using, and a strong direct effect on self-predicted usage behavior (Davis, 1986). External variables include additional factors not included in the model, such as training, demographics and personal characteristics, and effect the intention to use, but are intermediated by perceived usefulness and perceived ease of use (Davis, 1986).

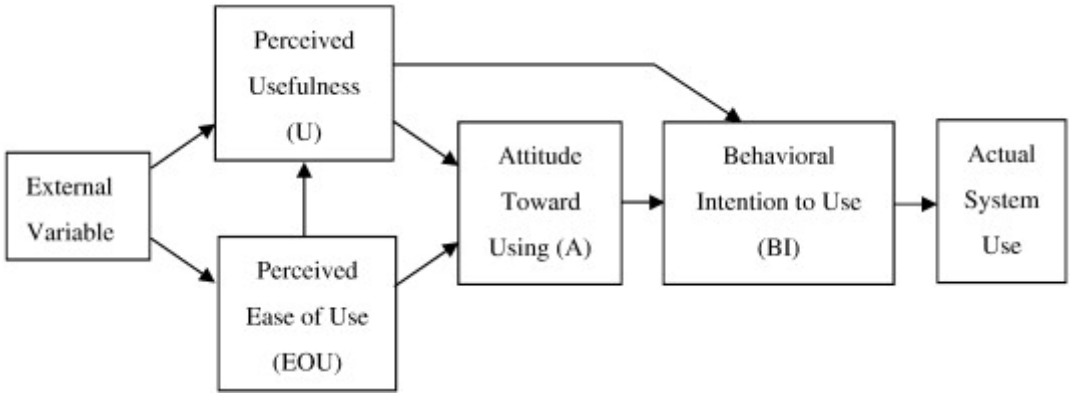


Figure 1. Technology Acceptance Model (Davis, Bagozzi, & Warshaw, 1989)

Needs assessments are tools used to "determine the needs of the people for whom the organization or system exists" (Witkin & Altschuld, 1995, p. 12). Needs assessments have commonly been used in the CES to assess continuing education and training needs of county agents (Brian, Irani, Hodges, & Fuhrman, 2009; Gibson & Hillison, 1994; Kluchinski, 2012; Murphy, Coleman, Hammerschmidt, Majewski, & Slonim, 1999; Schwarz & Gibson, 2010). For the purpose of this study, a needs assessment was chosen as it has been identified as a systematic

approach of gathering data for the specific purpose of setting priorities, determining criteria for solutions, and initiating actions to improve programs or operations (Witkin & Altschuld, 1995).

The theories guiding the design of educational resources were Gagné's Nine Events and the ADDIE process. The ADDIE process is an instructional model used to complete the process of instructional design (Allen, 2006; Shelton & Saltsman, 2007). The ADDIE model utilizes a process of analyzing, designing, developing, implementing, and evaluation for training (Allen, 2006). The analysis phase of ADDIE requires instructional designers to analyze the need for training, and to compare the need with the "skills, knowledge, and abilities" of the students (Allen, 2006, p. 436). The necessary instruction and training needed requires identifying the audience (Shelton & Saltsman, 2007), and depends on the current knowledge and skill level of the students (Allen, 2006). During the design phase, a "detailed plan of instruction" is developed, which reviewing and selecting includes instructional methods, media, and instructional strategies (Allen, 2006, p. 436). The design phase is also used to develop instructional objectives and an implementations plan (Allen, 2006). Lesson materials and revisions are completed during the development phase, along with validation of materials (Allen, 2006). Validation of the instructional materials can include: (1) internal review of the instruction and materials for accuracy, (2) individual and small-group tryouts, (3) operational tryouts of the 'whole' system, and (4) revision of unites and/or modules… as they are validated, based on feedback from formative and summative evaluation activities" (Allen, 2006, p. 437). During the implementation phase, the completed instruction is applied, and feedback is collected (Allen, 2006). The final phase of evaluation is ongoing as long as the developed instruction is being used (Allen, 2006).

The nine events of instruction outlined by Gagné, Briggs, and Wager (1992) were also used to guide the study. Gagné's nine events facilitate a process that allows learners to progress from their current level of knowledge, to achieving the set objectives (Gagné et al., 1992). The first event of instruction is "gaining attention," which is accomplished by "use of stimulus change" or appealing to "learner's interest" (p. 190). The second event of instruction is to inform learners of the objective, which serves the purpose of informing learners what they should learn after completion of the instruction. Stimulating recall is the third event, and is based on the premise that learning involves building upon, and "combining," previously learned concepts (p. 192). The fourth event is to present the appropriately designed content to learners, and to ensure a "variety of examples" are provided (p. 193). The fifth event is to provide "learning guidance" (p. 194). The purpose of learning guidance, such as a series of leading questions or hints, is to stimulate the direction of learner's thoughts, thus keeping the learner focused and increasing the "efficiency of learning" (p. 195). The sixth event of instruction is to elicit performance from learners that shows what they have learned thus far. The function of the seventh event, "providing feedback," is to communicate to learners the "correctness of their performance" (p. 197). The next event is to assess learners' performance, which involves assessing the reliability and validity of the learning outcomes. To determine the reliability of learner performance, and if learners achieved the learning objectives, multiple, different instances of eliciting performance should be used. If the learner performance is deemed valid, it should meet the following stipulations: (1) the learner performance should align with, and "accurately reflect the objective" and (2) learner performance should occur in a manner that shows "learned capability" is "genuine" and "free of distortion" (Gagné et al., 1992, p. 197). The final event is to enhance retention and transfer of knowledge and information. To enhance

retention and transfer of leaning it is suggested that learners perform a “variety” of new tasks that require the application of what has been learned in situations that differ substantially from those used for the learning itself (Gagné et al., 1992, p. 198).

Chapter III: METHODOLOGY

Purpose Statement (Restated)

The purpose of this two-phased study was to first identify Arkansas agricultural county extension agents' preferred methods of in-service training about plant parasitic nematodes of cotton and soybean, objectives a - e. During the second phase of the study, objectives f – g, online nematology educational training modules were developed and effectiveness was assessed through a pilot study.

The overall study was guided by the following objectives:

Needs Assessment Objectives

(a) Determine perceptions and technological comfort level of Arkansas agricultural county extension agents;

(b) Determine Arkansas agricultural county extension agents' perceived utility of current job related resources;

(c) Determine the frequency that Arkansas county extension agents are consulted about nematology topics;

(d) Determine Arkansas agricultural county extension agents' level of need for training about nematology topics;

(e) Determine Arkansas agricultural county extension agents' preferred types of in-service training;

Pilot Study Objectives

(f) Assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' change in knowledge; and

(g) Assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' feedback.

Institutional Review Board

Compliant with policies for testing on human subjects, a proposal was submitted to the University of Arkansas Institutional Review Board for approval. The Institutional Review Board approved the research prior to the needs assessment data collection (IRB Protocol # 13-04-637, Appendix A). Prior to data collection for the pilot study, an addendum was submitted and approved by the Institutional Review Board (Appendix B).

Needs Assessment: Population and Sample

The population for this study was agricultural county extension agents in Arkansas. A census of agricultural county extension agents ($N = 46$) and extension staff chairs ($N = 73$) in Arkansas was utilized. Staff chairs in the Arkansas CES are county extension agents who receive a stipend to assume management responsibilities in addition to their program responsibilities (UACES, 2013). Because the sampling frame did not identify staff chairs' program areas, all staff chairs were surveyed. The survey instrument used for this study contained a question to identify staff chairs with agricultural program area responsibilities so that only the target population completed the full needs assessment. The sampling frame used in this study was the Arkansas CES personnel directory in April 2013.

Demographics of the respondents were collected during the study. At the conclusion of the survey period 68 usable responses were received for a 57% response rate. Because responses were anonymous, follow-up with non-respondents was not feasible. Instead, a comparison of early and late respondents was conducted to test for non-response error (Linder, Murphy, & Briers, 2001; Miller & Smith, 1983). Agents and staff chairs responding to the initial contact (*n*

= 30) and those responding to the follow-up contacts (*n* = 38) were compared on their comfort with technology and need for training. No statistically significant differences were found for any variable, the researchers concluded that non-response error was not a threat to the study.

Needs Assessment: Research Design

To conduct the needs assessment, a survey research design method was used. Data for this portion of the study was collected using an online survey instrument that was self-administered by respondents. Emails were sent to Arkansas agricultural county extension agents that included a cover letter and a link to the survey, which was available through Qualtrics, an online survey platform.

Needs Assessment: Data Collection

An introductory letter and a link to the survey instrument were emailed to agricultural county extension agents on April 23, 2013. The introduction included the purpose of the study, IRB approval information, consent information, a confidentiality statement, and a statement about the voluntary nature of the study (Appendix C). One week later, an email reminder was sent to county agents with a link to the survey instrument (Appendix D). A final reminder was sent to county agents approximately two weeks after the initial contact (Appendix E). After all contacts and reminders were sent to respondents, 68 usable responses were received for a 57% response rate. Since all responses were anonymous, follow-up of non-respondents was not possible. Therefore, a comparison of early and late respondents was conducted to test for non-response error (Linder, Murphy, & Briers, 2001; Miller & Smith, 1983). Agents and staff chairs responding to the initial contact (*n* = 30) and those responding to the follow-up contacts (*n* = 38) were compared on their comfort with technology and need for training; since no statistically

significant differences were found for any variable, the researchers concluded that non-response error was not a significant threat to the study.

Needs Assessment: Instrumentation

A questionnaire was developed by the researcher to determine Arkansas agricultural county extension agent need for training about plant parasitic nematodes (Appendix F). The questionnaire consisted of questions about agents' comfort using technology common for the job duties of agricultural county extension agents, frequency agents are consulted for help with plant parasitic nematode topics, need for training about plant parasitic nematode topics, and general demographic questions. The instrument was available electronically using the Qualtrics survey platform. Due to time and financial constraints, the instrument was distributed solely by email.

Section one of the instrument consisted of Likert-type scale questions to assess respondents' comfort using computer technologies related to their job duties. The technologies in question were internet resources, computers, smartphones, and iPads. All respondents completed this section of the instrument regardless of their program area. Questions were also included to determine respondents' perceived usefulness of various online Extension resources such as the University of Arkansas Cooperative Extension website, the University of Arkansas Cooperative Extension In-service website, University of Arkansas Cooperative Extension Employee Development Center, and eXtension.org. Agents were asked to rate their comfort using each item according to the following five point scale: 1 = "strongly disagree", 2 = "disagree", 3 = "neither agree nor disagree", 4 = "agree", and 5 = "strongly agree. " This section concluded with a skip logic question to determine if general knowledge of plant parasitic nematodes in cotton and/or soybean crops is needed to meet the needs of extension clientele in their area. Respondents who indicated they assist clients with plant parasitic nematodes

continued to section two. Respondents that indicated they do not assist clients with plant parasitic nematodes continued to the last section of the survey instrument, which consisted of general demographic questions.

Section two of the instrument contained questions to determine the frequency agents are consulted about eight different topics pertaining to plant parasitic nematodes. The topics ranged from general questions about cotton and soybean crops to specific topics about developing nematode management recommendations. Agents were asked to indicate the frequency they were consulted about each topic according to the following seven point scale: "never", "less than once a month", "once a month," "2 – 3 times a month", "once a week," "2 – 3 times a week", and "daily."

Section three of the instrument consisted of questions to determine agents' self-assessed need for training about different nematology topics. The topics in question were: (1) general knowledge of plant parasitic nematodes, (2) recognizing symptoms of nematode damages, (3) diagnosing nematodes, (4) collecting soil samples for nematode detection, (5) handling soil samples for nematode detection, (6) submitting soil samples to the Arkansas Nematode Diagnostic Clinic, (7) general nematode management, and (8) developing nematode management recommendations. Agents were asked to indicate their need based on the following five point Likert-type scale: "no need at all", "little need", "some need", "a need", and "a great need". This section concluded with an open response question that was used to identify other topics about plant parasitic nematodes in which agricultural county extension agents could identify need for training.

The next section of the instrument contained questions to determine the current sources used by agents to obtain information about plant parasitic nematode topics. Respondents were

asked to indicate if they used any of the sources on the checklist by answering "yes" or "no" to a list of the assumed common sources used. Space was included for agents to identify resources they use that were not provided in the checklist, if they chose to do so. Respondents were then asked to rank their preferred method for receiving training or information about plant parasitic nematodes on a Likert-type scale. The following six options were given to agents to rank for preference: "on-line resources," "printed instructional material," "face to face in-service workshops with state faculty and specialists," "self-paced on-line training module," "one-on-one mentoring with a specialist," and "instructor guided on-line course." These were categories previously used in Extension personnel assessments.

The last section of the instrument consisted of general demographic questions to determine respondents' current position in Extension, length of time in position, age, gender, highest level of education completed, and county in which the agent works. Respondents were also asked to indicate their program focus area. The last three questions on the instrument were to determine the respondents' undergraduate major(s), and graduate major if completed.

A panel of agricultural and extension education faculty from the University of Arkansas reviewed the instrument for face and content validity. The instrument was revised based on the recommendations of the panel. Ex post facto reliability coefficients were calculated for six constructs within the needs assessment. The constructs, and their coordinating Cronbach's alpha coefficients were: comfort using technology (.89), perceived utility of job related resources (.55), job duties (.95), nematology education needs (.97), educational sources (.80), and in-service preferences (.70). Reliability of the demographic section was not calculated because non-sensitive demographic items "are subject to little measurement error," according to Salant and Dillman (1994, p. 87). The low reliability of the "perceived utility of job related resources"

construct was deemed sufficient based on Nunnally (1967) stating a modest reliability is sufficient during the early stages of research. Data analysis consisted of descriptive statistics. Because of the ordinal nature of Likert-type scale questions median, mode, and frequencies are the most appropriate analysis (Boone & Boone, 2012).

Pilot Study: Population and Sample

The population for the pilot study of nematology online educational modules was agricultural county extension agents and research support staff in the Arkansas Delta district. The sample consisted of agricultural county extension agents located in the Arkansas Delta district (n = 26), and extension research support staff (n = 15). The subjects were purposively selected by the Arkansas CES Program and Staff Development Department faculty, and the Arkansas CES Associate Director of Agriculture and Natural Resources.

Pilot Study: Research Design

A one group pre-posttest design was used for pilot study (Campbell & Stanley, 1963). The materials were administered as an asynchronous, self-guided e-learning course. All materials were made available on the University of Arkansas CES in-service training site, www.learn.uaex.edu. The in-service training site was powered by Moodle, an e-learning management system, which is an acronym for "Modular Object-Oriented Dynamic Learning Environment" (moodle.org, 2013).

Pilot Study: Data Collection

Prior to initiation of the pilot study and data collection, potential participants were notified by the University of Arkansas CES Associate Director of Agriculture and Natural Resources about the pilot study. This communication with participants was not made available to the researcher. On November 25 and November 27, 2013 participants were contacted by

faculty from the University of Arkansas CES Program and Staff Development Department via email about the nature of the study and were provided with instructions for accessing the materials (Appendix G). An email reminder was sent to all participants on December 3, 2014 (Appendix H). A second email reminder from a Program and Staff Development faculty member was sent on December 10, 2013 to the entire sample (Appendix I). A final email reminder was sent to non-completers on December 16, 2013 by a Program and Staff Development faculty member (Appendix J). Participants had approximately three weeks to complete the materials.

Data was collected at multiple points during the pilot study. A pretest (Appendix K) was developed to assess respondents' nematology knowledge prior to completion of the modules. The pretest collectively consisted of quiz questions taken from each module and was administered prior to participants attempting the modules. Participants were not able to see the questions and answers of items answered incorrectly. Some posttest questions were not included on the pretest because of different formatting and administration of the tests. Questions that were not included in both the pretest and posttest were not included in the data analysis. A pre-survey (Appendix L) was also administered prior to module attempts. The pre-survey consisted of demographic questions and Likert-type scale questions. For each module, respondents were required to review a lesson and then complete the corresponding posttest (Appendices M – O) to determine knowledge change after completion. A final post assessment survey (Appendix P) was administered after completion of all three modules to determine participants' feedback and perceptions of the modules. Participants had 21 days to complete all items, including the pretest, pre-survey, modules, posttests, and post assessment survey. Participants could have potentially completed all items in less than 2.5 hours.

Pilot Study Instrumentation

The pilot study consisted of three modules covering nematology topics. The modules covered basic introductory information about plant-parasitic nematodes, signs and symptoms of plant diseases, and soil sampling for plant parasitic nematodes. Each module consisted of a short lesson and a quiz. All modules were designed in Articulate Storyline, software used for authoring interactive e-learning content. All nematology content presented in the modules was based on research and information taken from peer-reviewed journals, extension fact sheets, and extension recommendation publications.

Unit one of the course was titled "Introduction to Nematodes." The objectives of this module were for participants, after instruction completion, to be able to: (1) list the main types of nematodes, (2) identify characteristics of plant parasitic nematodes, and (3) identify major nematodes of soybean and cotton crops in Arkansas. The keywords for the section included the following terms: nematode, stylet, and cuticle. The unit ended with a nine question quiz to determine knowledge gained.

Unit two of the online educational module was titled "Signs and Symptoms of Plant Disease." The objectives of this section were for participants, after instruction completion, to be able to: (1) explain the difference between signs and symptoms of plant disease, (2) describe examples of plant disease signs, (3) describe examples of plant disease symptoms, and (4) to describe the disease triangle. The keywords for the section included the following terms: signs, symptoms, plant disease, disease triangle, host, and pathogen. The unit ended with a four question quiz to determine knowledge gained.

Unit three of the online education module was titled "Soil Sampling for Nematodes." The objections of this section were for participants, after instruction completion, to be able to:

(1) identify the reasons for sampling crop fields for plant parasitic nematodes, (2) illustrate proper nematode sampling patterns, and (3) give examples of how to submit soil samples for nematode assays. The keywords for the section included the following terms: population density, assay, and soil sample. The unit ended with a five question quiz to determine knowledge gained.

Data Analysis

Analysis of data included descriptive statistics and paired sample t-tests. Responses from Likert-type scale questions were analyzed by calculating the median and mode to measure central tendency. Variability was measured by calculating frequencies. Because Likert-type scale questions are ordinal in nature, the most appropriate analyses are median, mode, and frequencies (Boone & Boone, 2012). These calculations were used to identify the range of consensus among responses. Responses from pre- and post-survey questionnaires and pre- and posttests were analyzed with paired sample t-tests to determine if there was a significant difference between pre- and post- knowledge, perceptions, and comfort levels of participants.

Chapter IV: RESULTS AND FINDINGS

Needs Assessment

Participant Demographics

A majority of respondents (62%) indicated they held the additional responsibilities of county staff chair, and 38% of respondents identified their position as solely county agent. The majority (53%) of respondents indicated they had been an Extension employee for more than 15 years. Of the remaining respondents, 8% had worked for Extension less than 1 year, 11 % for 2 to 5 years, 20% for 6 to 10 years, and 8% for 11-15 years. A majority (81%) of respondents were male. The highest level of education completed by 89% of respondents was a Master's degree. Of the remaining respondents, 5% had completed a Bachelor's degree, and 6% had some graduate work. Respondents were also asked to indicate their program focus area. They were able to choose more than one if they had responsibilities in multiple areas. The majority of respondents (97%) indicated they had responsibilities in the Agriculture and Natural Resources program area. The 4-H Youth Development was the next largest program area with 39% of respondents indicating they had responsibilities in the program area. A general knowledge of plant parasitic nematodes of cotton and/or soybean crops was needed by 67% of respondents to meet the needs of extension clients in their area.

Objective One: Determine perceptions and comfort level of Arkansas agricultural county extension agents concerning technology use

The perceptions and comfort level of agents concerning technology use was assessed with Likert-type scale questions (Table 1). Overall, participants strongly agreed they were comfortable using a computer, Internet resources, and iPad/tablets for job related duties.

Table 1

*Respondents' Comfort Using Job Related Technologies (*n = *65)*

Statement	Median	Mode	Likert-type Scale Frequencies				
			SD	D	N	A	SA
I am comfortable utilizing a computer to search for information needed to assist extension clientele	5	5	1	2	1	28	33
I am comfortable utilizing Internet resources to research job related topics	5	5	1	1	2	26	35
I am comfortable utilizing an iPad/tablet to search the Internet for information needed to assist extension clients	4	5	2	10	16	18	19
I am comfortable utilizing a Smartphone to search the Internet for information needed to assist extension clients	4	4	2	4	6	29	24

Note. Likert-type scale: SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree.

Objective Two: Determine Arkansas agricultural county extension agents' perceived utility of current job related resources

The second objective of the study was to determine agricultural county extension agents' perceived utility of job related resources (Table 2). To rate the usefulness of job related resources, respondents were asked to answer if they had used the resource in question. Respondents who had used the resource rated its utility on a Likert-type scale of 1 to 5 with 1 meaning "strongly disagree" and 5 meaning "strongly agree." Overall, respondents agreed that all job related resources in question were useful to them. The overall median and mode for all resources was 4.

Table 2

Respondents' Perceived Utility of Job Related Resources

Statement	*n*	Median	Mode	Likert-type Scale Frequencies				
				SD	D	N	A	SA
The University of Arkansas Cooperative Extension website (uaex.edu) is a useful resource for my job	64	4	4	0	4	4	30	26
The in-service classes offered through the University of Arkansas Cooperative Extension In-Service Training website are a useful resource to me	60	4	4	0	2	9	43	6
The University of Arkansas Cooperative Extension "Employee Development Center" website (develop.uaex.edu) is a useful resource to my job	8	4	4	0	0	3	5	0
Overall, the University of Arkansas Cooperative Extension In-Service Training website (learn.uaex.edu) is a useful resource for my job	61	4	4	0	6	18	32	5
The website for the national Cooperative Extension System (eXtension.org) is a useful resource for my job	32	4	4	3	0	7	21	1

Note. Likert-type scale: SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree.

Objective Three: Determine the frequency that Arkansas county extension agents are consulted about nematology topics

Agents were asked to indicate the frequency they were consulted about various nematology related topics (Table 3). Respondents were first asked to indicate if nematology knowledge was necessary to meet the needs of clientele in their area. Only agents who indicated nematology was necessary for their job duties were asked to indicate the frequency they were consulted about various nematology topics. On average 33.3% of respondents were asked

general questions about cotton and/or soybean crops 2-3 times per week. About 33.3% of respondents indicated they are asked general questions about plant parasitic nematodes less than once a month. Of the respondents, 37.8% indicated they were asked how to recognize symptoms and diagnose nematodes in crops less than once a month

Table 3

*Respondents' Time Spent on Nematology Related Assistance (*n = *45)*

On average, how often are you asked:	%						
	Never	<1x per month	Once per month	2-3x per month	Once per week	2-3x per week	Daily
General questions about cotton and/or soybean crops	8.9	2.2	4.4	15.6	8.9	33.3	26.7
General questions about plant parasitic nematodes in cotton and/or soybean crops	11.1	33.3	13.3	24.4	8.9	8.9	0.00
How to recognize symptoms of nematode damages in cotton and/or soybean crops	11.1	37.8	20.0	15.6	6.7	8.9	0.00
How to diagnose plant parasitic nematodes in cotton and/or soybean crops	11.1	37.8	15.6	24.4	4.4	6.7	0.00
How to collect soil samples for diagnosing nematodes in cotton and/or soybean crops	13.3	53.3	15.6	11.1	4.4	2.2	0.00
How to submit soil samples to the Arkansas Nematode Diagnostic Clinic	13.3	46.7	20.0	13.3	2.2	2.2	2.2
About nematode management practices in cotton and/or soybean crops	11.1	42.2	15.6	20.0	6.7	2.2	2.2
For assistance in developing nematode management recommendations for clients	20.0	44.4	13.3	6.7	11.1	4.4	0.00

Objective Four: Determine Arkansas agricultural county extension agents' level of need for training about nematology topics

Extension agents' level of need for training about nematology topics was assessed with Likert-type scale questions. Agents were asked to indicate on a scale of 1 to 5, with 1 meaning "no need at all" and 5 meaning "a great need," their perceived need for training about various nematology topics. All nematology training topics and resources had a median and mode of 3, meaning respondents indicated they had "some need" in all of the topic areas.

Table 4

*Respondents' Need for Nematology Training and Resources (*n *= 45)*

			Likert-type Scale Frequencies				
Item	Median	Mode	NN	LN	SN	N	GN
Developing nematode management recommendations.	3	3	2	7	16	14	6
Recognizing symptoms of nematode damages.	3	3	3	6	17	12	7
General nematode management.	3	3	2	6	18	15	4
Diagnosing Nematodes	3	3	2	6	18	15	4
General knowledge of plant parasitic nematodes	3	3	3	5	20	12	5
Collecting soil samples for nematode detection	3	3	6	10	13	11	5
Handling soil samples for nematode detection	3	3	5	12	13	11	4
Submitting soil samples to the Arkansas Nematode Diagnostic Clinic	3	3	6	11	15	9	4

Note. Likert-type scale: NN = No Need at All, LN = Little Need, SN = Some Need, N = A Need, GN = A Great Need.

Objective Five: Determine Arkansas agricultural county extension agents' preferred types of in-service training

The fifth objective of the study was to determine extension agents' preferred types of training for nematology topics. To achieve the objective respondents were asked to identify

where they currently obtain information for their job (Table 5). The most common sources of nematology information used by respondents were: fact sheets (89%), Arkansas State Extension Specialists (89%), University of Arkansas CES printed materials (86%), University of Arkansas CES website (82%), and extension in-service training (80%). Only 31% of respondents indicated they utilize research journal articles to obtain nematology information. Extension specialists in other states were the least utilized resource, with only 18% of respondents indicating they used this source. Agents were also asked to rank their preferred method of in-service training (Table 6). Face-to-face in-service workshops with state faculty and specialists, online resources, one-on-one mentoring with a specialist, and printed instructional material were all strongly preferred in-service methods. Each method had a median and mode of 4. Respondents indicated they were indifferent about instructor guided online courses and self-paced online training modules as a preferred type of in-service training, with a median and mode of 3.

Table 5

Respondents' Sources for Nematology Information

		Yes	
Statement	*n*	Frequency	%
Fact Sheets	45	40	89
Arkansas State Extension Specialists	45	40	89
University of Arkansas CES Printed Materials	44	38	86
University of Arkansas CES Website	45	37	82
Extension In-Service Training	45	36	80
Industry Professionals	45	17	38
Research Journal Articles	45	14	31
Extension Specialists in states other than Arkansas	44	2	18

Table 6

Respondents' In-Service Preference for Nematology Education

				Likert-type Scale Frequencies				
Item	*n*	Median	Mode	VSA	SA	I	SP	VSP
Face-to -face in-service workshops with state faculty and specialists	44	4	4	1	1	5	23	14
On-line resources (e.g. fact sheets, research publications, reporting guides, resource links, etc.)	44	4	4	1	1	8	26	8
One-on-one mentoring with a specialist	44	4	4	2	1	12	19	10
Printed instructional material (e.g. training manuals, books, lecture notes, etc.)	44	4	4	1	1	11	26	5
Instructor-guided on-line course	43	3	3	7	8	21	3	4
Self-paced o n-line training module	43	3	3	8	11	17	3	4

Note. Likert-type scale: VSA = Very Strongly Avoid, SA = Strongly Avoid, I = Indifferent, SP = Strongly Prefer, VSP = Very Strongly Prefer

Pilot Study

Participant Demographics

During the online nematology module pilot, demographics were collected during a pre-assessment questionnaire. Of the participants in the study, 33% (*n* = 9) were county agents, 33% (*n* = 9) were county agents with responsibilities of a county staff chair, 22% (*n* = 6) were program associates and 11% (*n* = 3) were program technicians. A majority (81%) of participants were male. Most (74%) participants had a Master's degree, 22% had a Bachelor's degree, and 4% had completed some graduate course work. Participants aged 46 to 55 years represented the

largest (37%) age group, with 18 to 33 and 34 to 45 years of age each representing the next largest (22%) age groups, and ages 56 to 64 represented 19% of the participants.

Objective Six: To assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' change in knowledge

Data from pre-and posttests were used to assess participants' change in knowledge (Table 7). The average score on the overall pretest was 84.97 (*SD* = 11.5). The average overall posttest score was 94.39 (*SD* = 6.07). A matched pairs *t*-test was performed to determine if the difference in mean test scores was significant. Test statistics from the analysis showed there was a significant difference between the overall pretest scores and overall posttest scores; $t(28) = 5.18$, $p = <0.001$.

Table 7

Mean Test Scores and Paired Sample t-test Results from Pilot Study Pretest and Posttest Scores

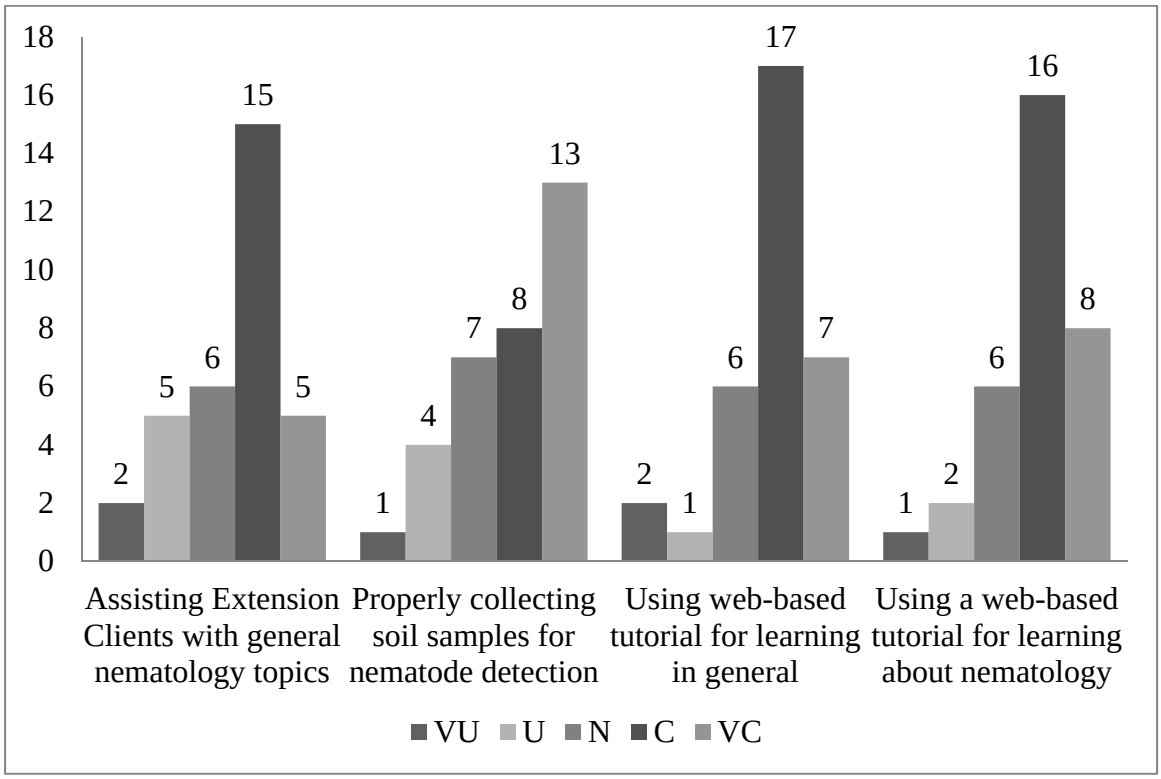
Test	*n*	*M*	*SD*
Overall Pretest	33	84.97	11.55
Module 1 Posttest	30	94.07	6.99
Module 2 Posttest	29	96.55	6.22
Module 3 Posttest	29	92.72	9.96
Overall Posttest	29	94.39	6.07

Objective Seven: To assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' feedback

Data from pre- and posttest surveys were used to assess participants' perceived utility of the online nematology educational modules, and post-instruction comfort with addressing nematology topics. For a majority of participants (52%, *n* = 27), the online nematology modules

were the first web-based tutorial they had completed. Additionally, all first time users responded on the posttest survey that they planned to use web-based learning tools again in the future.

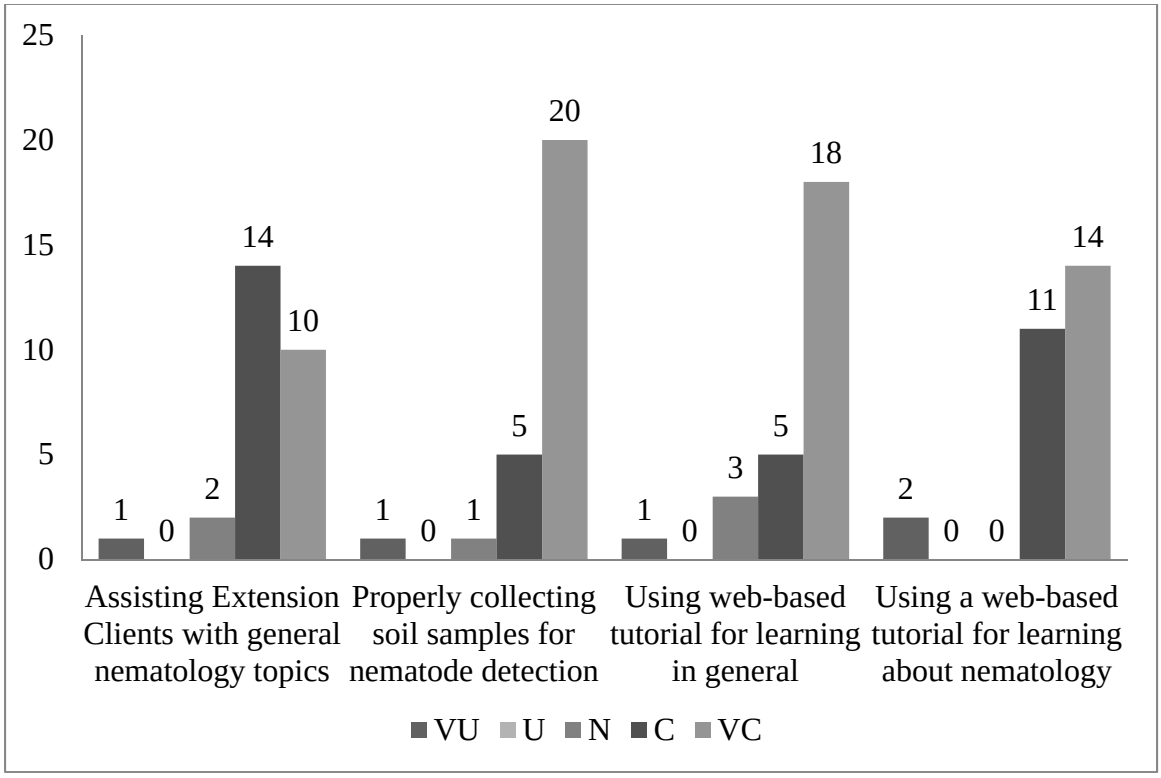
Prior to accessing the nematology modules, participants completed a pretest survey. Overall, participants indicated they were "comfortable" with the assisting Extension clients with general nematology topics, using web-based tutorials for learning in general, and using a web-based tutorial for learning about nematology (Figure 2). With a median of 4, and mode of 5, a majority of respondents indicated they were "very comfortable" collecting soil samples for nematode prior to instruction.



Note. Likert-type scale: VU = Very Uncomfortable, U = Uncomfortable, N = Neutral, C = Comfortable, VC = Very Comfortable

Figure 2. Respondents' Comfort with Nematology Topics Before Instruction; *n = 33*

After instruction, participants were asked to indicate their comfort level with the same nematology topics presented in the pretest survey. Participants indicated they were "very comfortable" with properly collecting soil samples for nematode detection, using web-based tutorials for learning in general, and using web-based tutorials for learning about nematology after instruction. Participants indicated that overall their comfort level with the topics increased from "comfortable" to "very comfortable" after instruction (Figure 3). After instruction a majority of participants still ranked their comfort with assisting Extension clients with general nematology topics as "comfortable." However, after instruction a majority of respondents identified themselves as "comfortable" and "very comfortable, and prior to instruction respondents' comfort levels were not as concentrated in the upper end of the spectrum.



Note. Likert-type scale: VU = Very Uncomfortable, U = Uncomfortable, N = Neutral, C = Comfortable, VC = Very Comfortable

Figure 3. Respondents' Comfort with Nematology Topics After Instruction; *n = 27*

Participants were also asked to indicate their perceived effectiveness of the online nematology modules after instruction by responding with their agreement with three statements addressing the effectiveness of the modules, and one addressing their comfort with the modules. Most participants strongly agreed that the online nematology modules were an effective method of presenting information and an effective method of learning (Table 8). When asked if the tutorial was just as effective for learning as traditional "face-to-face" classes, most participants agreed (median = 4, mode = 4). Participants were also asked to rank their agreement with the statement "I feel comfortable using this web-based tutorial as a way of learning." Overall, participants responded they strongly agree with the statement (median = 5, mode = 5).

Table 8

Respondents' Perceived Utility of Online Educational Nematology Modules After Instruction

				Likert-type Scale Frequencies				
Item	*n*	Median	Mode	SD	D	N	A	SA
I found this tutorial to be an effective method of presenting information	27	5	5	0	0	0	13	14
I found this tutorial to be an effective method of learning	27	5	5	0	0	2	9	16
I found this tutorial to be just as effective for learning as traditional "face-to-face" classes	27	4	4	1	1	8	11	6
I feel comfortable using this web-based tutorial as a way of learning	27	5	5	1	0	2	8	16

Note. Likert-type scale: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Chapter V: CONCLUSIONS AND RECOMMENDATIONS

Research Overview

Leading researchers in the plant pathology field previously expressed the need for a greater foundational knowledge of plant and soil nematodes topics because of their significant impacts on society as a whole (Barker et al., 1994). The overall purpose of this study was to identify extension agents' preferred methods of in-service training about nematology topics, and to assess the effectiveness and acceptance of an online introductory nematology educational training module through a pilot study. The findings from this study can be used to contribute to a knowledge base that will support future research in nematology education, as well as professional development and in-service needs of county agents.

The purpose of this study was to identify extension agents' preferred methods of in-service training about plant parasitic nematodes of cotton and soybean, and to assess the effectiveness and acceptance of an online introductory nematology educational training module through a pilot study. Data for the findings of this study were collected during two phases-the needs assessment, and a pilot study. A majority of the extension agents (67%) had a client base that needs information about plant parasitic nematodes, making knowledge of nematology topics necessary for their job duties. Conclusions from the study are summarized throughout the rest of this chapter by each objective.

Summary of Findings

Objective One: Determine perceptions and comfort level of Arkansas agricultural county extension agents concerning technology use

A needs assessment survey was used to determine the perceptions and comfort level of extension agents concerning technology use. Sixty five respondents rated their agreement with

four statements about their comfort utilizing common job related technologies. Using median and mode to assess the central tendency of participants' responses, the results indicated most respondents "strongly agreed" they were comfortable using a computer and Internet resources to research job related topics (median = 5, mode = 5). Responses from extension agents also indicated they "agreed" they were comfortable using iPads/tablets to search the Internet (median = 4, mode = 5), and using a Smartphone to search the Internet (median = 4, mode = 4).

In the context of the Technology Acceptance Model, the perceived usefulness is "the degree to which and individual believes that using a particular system would be free of physical and mental effort" (Davis, 1986, p. 26). Based on the results of this study and the TAM, agents would be likely to adopt the online nematology educational modules based on their comfort, or "perceived ease of use" (Davis, 1986).

Objective Two: Determine Arkansas agricultural county extension agents' perceived utility of current job related resources

Determining participants' perceived usefulness of the modules was an important component of the study for predicting the acceptance of the online modules as a training tool. TAM theorizes that "perceived usefulness" and "perceived ease of use" determine an individual's intention to use a system (Davis, 1986, p. 24). To determine if county agents perceived their current job related resources as useful they were first asked if they used a specific resource. Agents who responded they had used the resource rated the usefulness. The University of Arkansas Cooperative Extension website (uaex.edu), in-service classes offered through the University of Arkansas Cooperative Extension In-Service Training website (learn.uaex.edu), and the University of Arkansas Cooperative Extension In-Service Training website as a whole were the most utilized resources listed in the survey. The 64 agents who

indicated they had used uaex.edu "agreed" the website was a useful resource for their job (median = 4, mode = 4). Of the 60 agent who had taken in-service classes offered through learn.uaex.edu, most "agreed" they classes were a useful resource (median = 4, mode = 4). Overall, agents identified University of Arkansas Cooperative Extension In-Service Training website as a useful resource (median = 4, mode = 4). Only eight agents indicated they had used the University of Arkansas Cooperative Extension "Employee Development Center" website (develop.uaex.edu), and only 32 agents indicated they had used the website for the national Cooperative Extension System (eXtension.org). Since respondents "agreed" that all resources were useful to them or for their job (median = 4, mode = 4), they should be more likely to use the resources offered by Extension, including online educational modules.

Objective Three: Determine the frequency that Arkansas county extension agents are consulted about nematology topics

Frequency that extension agents are consulted about nematology topics was assessed by first determining if a general knowledge of plant parasitic nematodes in cotton and/or soybean crops was needed to meet the needs of extension clients in their area. Agents were then asked to specify how often they are consulted about various nematology related topics. Forty five (67%) of the agents participating in the needs assessment survey indicated nematology knowledge was necessary for the scope of their job duties, yet they indicated they were not consulted frequently about nematology topics. Respondents indicated they were most frequently asked general questions about cotton and/or soybean crops—33.3% of agents were consulted 2-3 times per week, and 26.7% were consulted daily. General questions about plant parasitic nematodes were asked of 33.3% of agents less than once per month, and 24.4% of agents were asked 2-3 times per month.

Although Arkansas is abundant in crops that are susceptible to nematodes, and 67% of respondents indicated nematology knowledge was necessary for their job, agents indicated that they are not frequently consulted about nematology topics. This could possibly be in part due to nematode crop damages being generic, and often going unnoticed or unattributed to nematodes (Barker et al., 1994; Koenning et al., 1999).

Objective Four: Determine Arkansas agricultural county extension agents' level of need for training about nematology topics

Agents' level of need for training about nematology topics was assessed by asking agents to rank their level of need for training in eight different topics on a Likert-type scale. The topics were: developing nematode management recommendations, recognizing symptoms of nematode damages, general nematode management, diagnosing nematodes, general knowledge of plant parasitic nematodes, collecting soil samples for nematode detection, handling soil samples for nematode detection, and submitting soil samples to the Arkansas Nematode Diagnostic Clinic. The median and mode for all eight topics were three on the Likert-type scale, meaning agents identified they had "some need" for training and resources in all topics.

Objective Five: Determine Arkansas agricultural county extension agents' preferred types of in-service training

Successful instructional design of training, based on the ADDIE process, first requires identifying the audience (Shelton & Saltsman, 2007). Additionally, the instruction and training needed depends on the current knowledge and skill level of the student (Allen, 2006), in this case agricultural extension agents and research support staff. The agents' preferred types of in-service training was determined by asking agents to identify if they currently obtained information from any of the listed resources. Agents were also asked to rank their preference for

six types of in-service training. Agents identified face-to-face in-service workshops with faculty and specialists, online resources, one-on-one mentoring with a specialist, and printed instructional materials as "strongly preferred" types of in-service for nematology education. Agents were identified that they were overall "indifferent" about instructor guided online courses and self-paced online training modules as an in-service option for nematology education.

Objective Six: To assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' change in knowledge

Assessing the utility of the modules was essential to completing the process of instructional design in accordance with the ADDIE method (Allen, 2006; Shelton & Saltsman, 2007). Extension agents' and staffs' change in knowledge after instruction from an online nematology educational training module was assessed by pretest and posttest scores of participants. Posttest scores after instruction were significantly higher than pretest scores; $t(28) = 5.18$, $p = <0.001$.The overall average score of participants' pretest was 84.97 ($n = 33$, $SD = 11.55$). The overall average score of participants' posttest was 94.39 ($n = 29$, $SD = 6.07$). Based on the scores as an indicator of change in knowledge, the modules were highly effective.

Objective Seven: To assess the utility of an online nematology educational training module based on Arkansas agricultural county extension agents' and staffs' feedback

Feedback was collected from participants through pre- and posttest surveys to assess participants' comfort with nematology topics before and after instruction. Providing feedback is an essential function of Gagné's nine events—the process that allows learners to progress from their current knowledge level, to achieving the set objectives of the lessons and instruction (Gagné et al., 1992). After completing the modules, participants were asked to rate effectiveness of the modules using a Likert-type scale. Prior to instruction, a majority of participants indicated

they were “comfortable” assisting Extension clients with general nematology topics (median = 4, mode = 4), using web-based tutorials for learning about nematology (median = 4, mode = 4), and using web-based tutorials for learning in general (median = 4, mode = 4). A majority of participants responded they were “very comfortable” with properly collecting soil samples for nematode detection (median = 4, mode = 5). After completing the modules the majority of participants’ comfort level with assisting Extension clients with general nematology topics and properly collecting soil samples did not increase if observing the median and mode. At the same time, graphical representation of the responses showed a shift of more respondents being more comfortable after instruction. A majority of participants’ comfort level with using web-based tutorials for learning about nematology topics (median = 5, mode = 5), and learning in general (median = 5, mode = 5) increased to “very comfortable.” A majority of participants indicated they “strongly agree” that the tutorial was an effective method of presenting information (median = 5, mode = 5), an effective method of learning (median = 5, mode = 5), and that they felt comfortable using the web-based tutorial as a way of learning (median = 5, mode = 5). Overall, feedback from participants indicated the modules were useful, and respondents were comfortable using the modules.

Recommendations for Future Research

A “sufficient scientific and professional workforce that addresses the challenges of the 21st century” was previously identified as a major research priority area by the American Association for Agricultural Education (Doerfert, 2011, p. 18). Not only is preparation of the future agricultural workforce a necessity, but fostering an atmosphere that recognizes the improvement of existing human capital, such as county agents, as a “life-long process” is essential (Doerfert, 2011, p 19). Extension agents are an important part of the agricultural

workforce, responsible for addressing new and old challenges. The aim of this study was to identify preferred methods of training, and then the effectiveness of online training methods in order to provide more tools for extension agents to be successful at their jobs.

A number of limitations narrow the scope and impact of the results of this study, and warrant further research. The first recommendation for future research is to expand the population of this study. The expanded population could include agents in other states, extension agents that do not have an agricultural focus, non-extension professionals in the agricultural industry, and non-agricultural individuals. Expanding the population in future research would broaden the scope of understanding about needs for nematology education

Future research should also examine the perceptions and comfort level of extension agents concerning technology use and job related resources on a larger scale. New technology is continuously being updated, and created. The technology and resources included in the needs assessment for this study were broad, and not specific. Assessing comfort and perceived utility of more specific, and a wider range of resources could provide a more comprehensive outlook on agents' perceptions and comfort level with technology. Mobile apps, video conferencing, social media, and evolving devices are examples of elements that could be assessed in the future.

A more accurate method for determining the frequency that Arkansas county extension agents are consulted about nematology topics is necessary to further assess the significance of nematology as an agent training topic. First, the frequency agents are consulted about nematology topics should be specified and narrowed down to a timeframe that nematodes are actually a concern to agricultural producers. Narrowing the timeframe to when agricultural crops are being prepared for planting, in the ground, and being harvested could provide more accurate results about the importance of nematology topics to agents and producers. Second, nematology

is a diverse science and includes many other topics not included in the needs assessment used for this study. The topics used for the purpose of this study were broad. While this was an effort to encompass all nematology topics that might be asked of an extension agent, it could have been too broad to effectively assess and determine the importance of nematology as a topic for training. Furthermore, symptoms and damage from nematodes can often be mistaken for other crop problems, such as nutrient deficiencies, drought, insect damage, or other plant diseases. Agents may in fact be consulted about nematode problems without realizing the question is pertaining to a nematode related topic. Future research should also assess the frequency that the Arkansas Nematode Diagnostic Clinic and the Arkansas Plant Health Clinic are consulted about nematology topics.

It is also recommended that future research assess the level of need for training about nematology topics on a wider scale by examining more specific topics, with the goal being to determine a more complete view of agents' level of need for training in nematology topics. In addition to having agents self-assess their need for training, methods for accurately testing agents' actual application of nematology knowledge should be examined. In this study, participants pretest and posttest knowledge was assessed, but participants' application of nematology knowledge was not assessed. Previous research found that while the participants indicated they were confident in their abilities to collect soil samples and conduct soil tests, they ultimately lacked the skills and knowledge to perform the tasks correctly (King, 1999). Application of knowledge could be assessed by having study participants perform nematology related skills such as collecting soil samples, identifying signs and symptoms of nematodes on crops, developing nematode management recommendations, and other applied skills that are related to nematology topics.

Modules should be replicated and further investigated to determine if the change in knowledge can be attributed to the instruction received from the modules. Future research design should maintain control for factors that might affect the study results. Specifically, future research designs should include a group of posttest only to assess if participants in fact learned new knowledge.

Recommendations for Practice

There are numerous practical applications from the results of this study. For future nematology training needs, it is recommended that developed training aligns with current technology trends, while strongly considering agent comfort and perceived utility of current resources and technologies. Leading nematologists believe using current technologies is necessary to provide expanded service of Extension nematology programs (Barker et al., 1994). Although online training was the least preferred in-service training method, findings from other aspects of the needs assessment indicated online training should not be removed from consideration for future development of in-service training needs. TAM posits perceived usefulness and perceived ease of use determine an individual's intention to use a system (Davis, 1986). Results from this study indicated agents view their current in-service classes and internet resources as useful. Additionally, agents agreed they were comfortable using Internet resources, computers, smartphones, and iPads. Based on these agent views, it is suggested that using the mentioned resources will contribute to the success of newly developed training. Davis (1986) suggested TAM can be used as a framework for development organizations, such as the CES, to successfully design and develop new systems. Based on that position, developing in-service training that is perceived as useful and easy to use should increase the acceptance and use of

developed training methods. Furthermore, budgetary constraints and limited availability of staff nematologists make it necessary to consider alternative methods of training.

Finally, the methods developed and implemented to educate county agents as a result of this study should align with the goal of meeting the needs of the changing Extension clientele. Catering to the needs of a "progressive and growing constituency" includes Extension being a leader in their use of technology (Diem et al., 2011, Summary and Conclusions, para 1). Because the CES was developed as a network to address rural and agricultural issues (NIFA, n.d.), Extension should make research, materials and resources readily available and accessible to the general public as soon as they are developed.

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Appendices

Appendix A

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

April 15, 2013

MEMORANDUM

TO:	Mia Gentry Leslie Edgar
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	13-04-637
Protocol Title:	*A Needs Assessment of Extension Faculty for In-Service Training Preferences, and Knowledge of Plant Parasitic Nematodes of Cotton and Soybean*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 04/15/2013 Expiration Date: 04/14/2014

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (http://vpred.uark.edu/210.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 200 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.

210 Administration Building • 1 University of Arkansas • Fayetteville, AR 72701
Voice (479) 575-2208 • Fax (479) 575-3846 • Email irb@uark.edu

Appendix B

210 Administration • Fayetteville, Arkansas 72701 • (479) 575-2208 • (479) 575-3846 (FAX)
Email: irb@uark.edu

Research Compliance
Institutional Review Board
October 30, 2013

MEMORANDUM

TO:	Mia Gentry Leslie Edgar
FROM:	Ro Windwalker IRB Coordinator
RE:	PROJECT MODIFICATION
IRB Protocol #:	13-04-637
Protocol Title:	*A Needs Assessment of Extension Faculty for In-Service Training Preferences, and Knowledge of Plant Parasitic Nematodes of Cotton and Soybean*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 10/30/2013 Expiration Date: 04/14/2014

Your request to modify the referenced protocol has been approved by the IRB. **This protocol is currently approved for 200 total participants.** If you wish to make any further modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

Please note that this approval does not extend the Approved Project Period. Should you wish to extend your project beyond the current expiration date, you must submit a request for continuation using the UAF IRB form "Continuing Review for IRB Approved Projects." The request should be sent to the IRB Coordinator, 210 Administration.

For protocols requiring FULL IRB review, please submit your request at least one month prior to the current expiration date. (High-risk protocols may require even more time for approval.) For protocols requiring an EXPEDITED or EXEMPT review, submit your request at least two weeks prior to the current expiration date. Failure to obtain approval for a continuation *on or prior to* the currently approved expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.

Appendix C

Dear County Extension Agents,

I am writing to request your participation in a brief survey. I am a graduate student at the University of Arkansas. Currently, I am working on my master's thesis under the direction of Drs. Terry Kirkpatrick and Leslie Edgar.

The purpose of this study is to determine the training needs and perceptions of Arkansas extension agents, regarding plant parasitic nematodes in cotton and soybean.

You were selected to participate in this survey because you are an Agricultural County Extension Agent, and/or a Staff Chair. Your participation will require approximately 10 – 15 minutes. **We want you to participate whether or not you are directly involved with plant parasitic nematodes in your normal job activities**. Your participation and responses are valuable.

To participate in the survey, click http://uark.qualtrics.com/SE/?SID=SV_86UOxOlnUmLwcKh

Responding to the survey indicates your consent to participate in this study. This research study has been reviewed and approved by the Institutional Review Board at the University of Arkansas. Research related problems and questions concerning subjects' rights can be directed to Ro Windwalker, the University of Arkansas Compliance Officer, at (---) ------- or ---@----.edu. Any questions regarding the survey can be directed to Mia Gentry at (---) --------, or ---------- Your assistance with this research is greatly appreciated.

Sincerely,

Mia G. Gentry, Graduate Assistant

Department of Agricultural and Extension Education

University of Arkansas

Fayetteville, AR 72701

E-mail: ----------

Phone: ----------

Appendix D

County Extension Agents and Staff Chairs,

You should have received an email last week with a link to a survey asking for your participation in a research study relating to nematology education project. If you have already completed the survey, we greatly appreciate it. If not, could you please complete the survey as soon as possible?

You can access the survey by clicking the link below, or by copying the lint and pasting it into your internet browser.

http://uark.qualtrics.com/SE/?SID=SV_86UOxOlnUmLwcKh

Even if you are not directly involved with Nematology, your response is valuable to the research study. The survey was sent to a small sample of extension agents, and all responses are vital for accurate results. If you have any questions feel free to contact Mia Gentry (---) --- ---- or ------ @----.----.edu) or myself.

Mia Gentry

Graduate Assistant

Department of Agricultural and Extension Education

University of Arkansas

Fayetteville, AR 72701

E-mail: ----------

Phone: ----------

Appendix E

Good morning,

I would like to thank you for participating in the Nematology Training Needs & Perceptions Survey. Not only are you providing valuable insight, but you are also helping me move closer to fulfilling my goal of graduating with my master's degree. If you would like a copy of the compiled survey results, e-mail me and I will send you a report once it has been finalized.
For those that haven't completed the survey, there is still time. The survey will be available at the link below, until next Friday, May 17th. As part of a small group selected for the study, all responses are valuable and helpful, even if you do not work directly with nematodes. The survey is anonymous, and only takes approximately 10 – 15 minutes. If you have any questions or concerns, please feel free to contact me.

http://uark.qualtrics.com/SE/?SID=SV_86UOxOlnUmLwcKh

Again, thank you for your time. I realize this is a busy time of year, and your time is very valuable. This will be the last reminder for the survey.

Sincerely,

Mia Gentry
Graduate Assistant
Department of Agricultural and Extension Education
University of Arkansas
Fayetteville, AR 72701

E-mail: ----------
Phone: ----------

Appendix F

Section 1

The purpose of this survey is to determine the training needs of extension agents regarding plant parasitic nematodes in cotton and soybean crops. Participation in the survey should take approximately 15 minutes to complete. There are no risks, and no benefits associated with participation in this survey. Responses to the survey will remain confidential and anonymous, and records will only be viewed by the researchers. No identifiers linking you to the study will be included in any report that might be published. Participation is voluntary and you have the right to discontinue participation at any point. Responding to the survey indicates consent to participate in this study.

1. Please indicate your level of agreement with the following statements by selecting the appropriate response for each. (Mark one in each row)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am comfortable utilizing **Internet resources** to research job related topics.	○	○	○	○	○
I am comfortable utilizing a **computer** to search for information needed to assist extension clients.	○	○	○	○	○
I am comfortable utilizing a **Smart phone** to search the Internet for information needed to assist extension clients.	○	○	○	○	○
I am comfortable utilizing an **iPad/tablet** to search the Internet for information needed to assist extension clients.	○	○	○	○	○

2. Have you utilized the University of Arkansas Cooperative Extension website **(uaex.edu)**?

○ Yes

○ No

2. (b) Please indicate your agreement with the following statement by selecting the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The University of Arkansas Cooperative Extension website **(uaex.edu)** is a useful resource for my job.	○	○	○	○	○

3. Have you utilized the University of Arkansas Cooperative Extension In-Service Training website **(learn.uaex.edu)**?

○ Yes

○ No

3. (b) Please indicate your agreement with the following statement by selecting the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Overall, the University of Arkansas Cooperative Extension In-Service Training website **(learn.uaex.edu)** is a useful resource for my job.	○	○	○	○	○

3. (c) Please indicate your agreement with the following statement by selecting the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The **in-service classes** offered through the University of Arkansas Cooperative Extension In-Service Training website **(learn.uaex.edu)** are a useful resource to me.	○	○	○	○	○

4. Have you used the University of Arkansas Cooperative Extension "Employee Development Center" website **(develop.uaex.edu)**.

○ Yes

○ No

4. (b) Please indicate your agreement with the following statement by selecting the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The University of Arkansas Cooperative Extension "Employee Development Center" website **(develop.uaex.edu)** is a useful resource to my job.	○	○	○	○	○

5. Have you used the website for the national Cooperative Extension System **(eXtension.org)**?

○ Yes

○ No

5. (b) Please indicate your agreement with the following statement by selecting the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The website for the national Cooperative Extension System **(eXtension.org)** is a useful resource for my job.	○	○	○	○	○

6. Is a general knowledge of **plant parasitic nematodes** in cotton and/or soybean crops needed to meet the needs of extension clients in your area?

- Yes
- No

7. In reference to your typical job duties, please indicate how often you complete the following tasks by selecting the appropriate response. (Mark one in each row)

	Never	Less than Once a Month	Once a Month	2-3 Times a Month	Once a Week	2-3 Times a Week	Daily
I am asked general questions about cotton and/or soybean crops.							
I am asked general questions about plant parasitic nematodes in cotton and/or soybean crops.							
I am asked how to recognize symptoms of nematode damages in cotton and/or soybean crops.							
I am asked how to diagnose plant parasitic nematodes in cotton and/or soybean crops.							
I am asked how to collect soil samples for diagnosing nematodes in cotton and/or soybean crops.							
I am asked how to submit soil samples to the Arkansas Nematode Diagnostic Clinic							
I am asked about nematode management practices in cotton and/or soybean crops.							
I am asked for assistance in developing nematode management recommendations for clients.							

8. Please indicate your level of need for training and/or resources related to plant parasitic nematodes of cotton and soybean. (Mark one in each row)

	No Need at All	Little Need	Some Need	A Need	A Great Need
General knowledge of plant parasitic nematodes.					
Recognizing symptoms of nematode damages.					
Diagnosing nematodes.					
Collecting soil samples for nematode detection.					
Handling soil sample for nematode detection.					
Submitting soil samples to the Arkansas Nematode Diagnostic Clinic.					
General nematode management.					
Developing nematode management recommendations.					

9. Would you benefit from training or information about any other topics related to plant parasitic nematodes of cotton and/or soybean crops not mentioned in the previous question? If so, please list or explain in the space provided below

10. Do you currently obtain information about plant parasitic nematodes of cotton and soybean crops from any of the following resources? (Mark one in each row)

	Yes	No
Extension In-service Training	○	○
University of Arkansas Cooperative Extension Service Website (www.uaex.edu)	○	○
University of Arkansas Cooperative Extension Service Printed Materials	○	○
Industry Professionals	○	○
Research Journal Articles	○	○
Fact Sheets	○	○
Arkansas State Extension Specialists	○	○
Extension Specialists in states other than Arkansas	○	○
Other (please specify)	○	○

11. Please indicate your **preference for receiving training and/or information about plant parasitic nematodes of cotton and soybean crops**. (Mark one in each row)

	Very Strongly Avoid	Strongly Avoid	Indifferent	Strongly Prefer	Very Strongly Prefer
On-line resources (e.g. fact sheets, research publications, reporting guides, resource links, etc.)	○	○	○	○	○
Printed instructional material (e.g. training manuals, books, lecture notes, etc.)	○	○	○	○	○
Face-to-face in-service workshops with state faculty and specialists	○	○	○	○	○
Self-paced on-line training module	○	○	○	○	○
One-on-one mentoring with a specialist	○	○	○	○	○
Instructor-guided on-line course	○	○	○	○	○

Demographic Questions

What is your current position in extension?

- ○ County Agent
- ○ County Staff Chair

- ( ) Other. (please specify)

What is your current program focus area? (select all that apply)

- [ ] Family and Consumer Sciences
- [ ] Agriculture and Natural Resources
- [ ] 4-H Youth Development
- [ ] Community and Economic Development
- [ ] General Programming (Not Specific to a Subject Matter Area)
- [ ] Other. (please specify)

How long have you been an extension employee?

- ( ) 3 months or less
- ( ) 4 months - 1 year
- ( ) 2 - 5 years
- ( ) 6 - 10 years
- ( ) 11-15 years
- ( ) More than 15 years

How old are you?

- ( ) In years:

In which Arkansas Extension district do you work?

- [ ] Ouachita
- [ ] Ozark
- [ ] Delta
- [ ] Other. (please specify)

What is your gender?

- ( ) Male
- ( ) Female

What is your highest level of education completed?

- Some college
- Bachelor's degree
- Some graduate work
- Master's degree
- Doctoral degree
- Other (please specify)

What is your primary undergraduate major?

- Please indicate:

What is your secondary undergraduate major? (skip if you do not have a secondary undergraduate major)

- Please indicate:

What is your graduate major? (skip if you do not have a graduate major)

- Please indicate:

Appendix G

Hi Everyone!

Earlier this week Dr. Rick Cartwright notified you about an online nematology course that Mia Gentry, a graduate student in the Department of Agricultural Education, Communications and Technology at UAF, has developed. Mia's course was created in collaboration with Dr. Terry Kirkpatrick and Ronnie Bateman and under the guidance of Dr. Leslie Edgar.

A key component of the online course development process is pilot/beta testing the materials. We are asking for your assistance with this pilot test. Your input and feedback will assist Mia with revising the course content.

We realize your time is valuable. Your feedback will serve two key purposes: 1) a course review process is part of the requirements for Mia to complete her graduate degree program and 2) your input will assist Extension in assuring the quality of the course meets the standards required for online publication of this course in the future.

Attached is an online course pilot test form for you to complete as part of the course review. This form is used to evaluate all online courses, so not all items may apply to the nematology course you are reviewing. Any question or item that you believe does not apply, just skip. After completing the course review, please either email or mail the competed evaluation to Julie at -----@----.edu or

Julie Robinson
University of Arkansas, Division of Agriculture
Program & Staff Development
Cooperative Extension Service
2301 S University Ave
Little Rock AR 72204-4940

To access this course, log into learn.uaex.edu. You will be manually enrolled in this course and will receive an email from learn.uaex.edu administrator. Once logged into learn.uaex.edu, you can find the course: 1) under the 'My Courses' tab - Introduction to Plant Parasitic Nematodes on Cotton and Soybean in Arkansas (FY14) or 2) under the 'Courses' tab - Subject Matter Expertise section – Plant Pathology – Introduction to Plant Parasitic Nematodes on Cotton and Soybean in Arkansas (FY14).

If you have any problems logging into learn.uaex.edu or finding and accessing the course, please email the site administrator at learn@uaex.edu or call (----) --------, 8:00 am to 4:30 pm, Monday-Friday.

Feel free to contact Mia -----@---------.edu or myself ---------@----.edu if you have any questions. Again thank you for taking the time to help us with this exciting new online course.

Mia Gentry & Julie Robinson

Julie Robinson, Ph.D.
Program & Staff Development
University of Arkansas, Division of Agriculture
Cooperative Extension Service
2301 S University Ave
Little Rock AR 72204-4940

Appendix H

Just a friendly reminder to ask for your participation in completing the Introduction to Plant Parasitic Nematodes on Cotton and Soybean in Arkansas Course. If you have already completed the course, we thank you for your time and participation. If you have not completed the course, the deadline to complete the course is December 10. The course will take you approximately 2 hours to complete.

If you have questions regarding this course you may contact Mia Gentry ------@----.----.edu, or Julie Robinson ---------@----.edu. Your feedback is extremely important in this process, so please consider completing the course. We realize your time is valuable, and we thank you for your willingness to help out with this project.

Sincerely,

Mia Gentry & Julie Robinson

Julie Robinson, Ph.D.
Program & Staff Development
University of Arkansas, Division of Agriculture
Cooperative Extension Service
2301 S University Ave
Little Rock AR 72204-4940

Appendix I

Just a friendly reminder to ask for your participation in completing the Introduction to Plant Parasitic Nematodes on Cotton and Soybean in Arkansas course. The deadline to complete the course is Monday, December 16 at 4:30 P.M. The course will take you approximately 2 hours to complete.

If you have any questions regarding this course you may contact Mia Gentry ------@-------.edu or Julie Robinson --------@----.edu. Your feedback is extremely important in this process, so please consider completing the course. We realize your time is valuable, and we thank you for your willingness to help out with this project.

Sincerely,

Mia Gentry & Julie Robinson

Julie Robinson, Ph.D.
Program & Staff Development
University of Arkansas, Division of Agriculture
Cooperative Extension Service
2301 S University Ave
Little Rock AR 72204-4940

Appendix J

Just a friendly reminder to ask for your participation in completing the Introduction to Plant Parasitic Nematodes on Cotton and Soybean in Arkansas course. The deadline to complete the course is 4:30 P.M. TODAY. The course will take you approximately 2 hours to complete.

If you have any questions regarding this course you may contact Mia Gentry ------@-----.edu or Julie Robinson -----@-----.edu. Your feedback is extremely important in this process, so please consider completing the course. We realize your time is valuable, and we thank you for your willingness to help out with this project.

Sincerely,
Mia Gentry & Julie Robinson

Julie Robinson, Ph.D.
Program & Staff Development
University of Arkansas, Division of Agriculture
Cooperative Extension Service
2301 S University Ave
Little Rock AR 72204-4940
Phone:(---) -------
Cell:(---) -------
Fax:(---) -------
-----@-----.edu

Appendix K

Question 1
Answer saved
Marked out of 1.00
Flag question
Edit question

A nematode is a microscopic roundworm.

Select one:
- True
- False

Question 2
Answer saved
Marked out of 1.00
Flag question
Edit question

A nematode is unsegmented.

Select one:
- True
- False

Question 3
Answer saved
Marked out of 1.00
Flag question
Edit question

Nematodes are generally microscopic and tubular in shape.

Select one:
- True
- False

Question 4
Answer saved
Marked out of 1.00
Flag question
Edit question

The best time to collect soil samples for nematode detection and densities is generally after harvest.

Select one:
- True
- False

Question 5
Answer saved
Marked out of 1.00
Flag question
Edit question

The nematode population density generally reaches its peak during September through November in Arkansas.

Select one:
- True
- False

Question 6
Answer saved
Marked out of 1.00
Flag question
Edit question

Soil samples for nematode detection should represent more than 20 acres of a field.

Select one:
- True
- False

Question 7
Answer saved
Marked out of 1.00
Flag question
Edit question

Field areas with differing soil types and/or symptoms of nematode damage should be sampled separately from other areas of the field.

Select one:
- True
- False

Question 8
Answer saved
Marked out of 1.00
Flag question
Edit question

Storing soil samples for nematode detection in an ice chest or cooler, without ice, is an effective method of short-term storage.

Select one:
- (•) True
- ( ) False

Question 9
Answer saved
Marked out of 1.00
Flag question
Edit question

A [Stylet ▼] is a pointed, rigid, hollow feeding organ in the mouth of plant parasitic nematodes used for piercing and withdrawing nutrients from plant cells.

Question 10
Answer saved
Marked out of 1.00
Flag question
Edit question

Fungi, viruses, nematodes, and bacteria are examples of _____.

Select one:
- (•) a. pathogens
- ( ) b. hosts
- ( ) c. the disease triangle
- ( ) d. none of the above

Question 11
Answer saved
Marked out of 1.00
Flag question
Edit question

Crops, trees, grasses, and bushes are examples of _____.

Select one:
- (•) a. hosts
- ( ) b. pathogens
- ( ) c. parasites
- ( ) d. none of the above

Question 12
Answer saved
Marked out of 1.00
Flag question
Edit question

Select common reasons to sample crop production fields for nematodes.

Select one or more:
- [ ] a. to estimate population density of nematodes in the field
- [ ] b. to determine if nematodes are present
- [ ] c. to estimate nematode distribution in a field
- [ ] d. to determine what nematode species are present in the field
- [x] e. all of the above

Question 13
Answer saved
Marked out of 1.00
Flag question
Edit question

At least how many soil cores should be collected to represent one 20 acre field when submitting a soil sample for nematode detection.

Select one:
- (•) a. 20
- ( ) b. 1
- ( ) c. 5
- ( ) d. 10

Question 14
Answer saved
Marked out of 1.00
Flag question
Edit question

Match each nematode body part to its corresponding description.

The portion of the digestive system between the stylet and the beginning of the intestine	esophagus ▼
The terminal portion of the nematode digestive system	anus ▼
A pointed, rigid, hollow feeding organ in the mouth of plant parasitic nematodes	stylet ▼

The outermost covering of the nematode	cuticle ▼
A simple tube in which digestion occurs	intestine ▼

Question 15

Answer saved

Marked out of 1.00

Flag question

Edit question

Match the following words to their definition.

Any indication of disease on a host plant from visible portions of the pathogen or its products	signs ▼
Indication of disease by reaction of the host; visible effect produced by a pathogen	symptoms ▼
A continuous disturbance of a plant that interferes with its normal growth, development, economic value, or aesthetic quality and leads to development of symptoms	plant disease ▼
An organism capable of causing disease in a particular host. Most are parasites	pathogen ▼
A concept used to explain how diseases develop, consists of: a host, pathogen, and favorable environment	disease triangle ▼
A living organism harboring or invaded by a pathogen, from which the pathogen obtains food	host ▼

Question 16

Answer saved

Marked out of 1.00

Flag question

Edit question

Match the following words to their definition.

Level of infestation in a field	population density ▼
A test to determine nematode population	assay ▼
A representative amount of soil from a field to determine type and number of nematodes present	soil sample ▼

Question 17

Answer saved

Marked out of 1.00

Flag question

Edit question

The three main groups of nematodes are: _____, _____, and _____. Select all that apply.

Select one or more:

- [x] a. plant parasitic nematodes
- [x] b. animal parasitic nematodes
- [x] c. free living nematodes
- [ ] d. heartworms
- [ ] e. soil parasitic nematodes

Question 18

Answer saved

Marked out of 1.00

Flag question

Edit question

The three major plant parasitic nematodes of economic concern in Arkansas soybean and cotton crops are _____, _____, and _____. Select all that apply.

Select one or more:

- [x] a. reniform nematode
- [x] b. root-knot nematode
- [x] c. soybean cyst nematode
- [ ] d. lesion nematode
- [ ] e. spiral nematode

Appendix L

1. What is your current position in Extension?
    a. County staff chair
    b. County agent
    c. State/departmental faculty
    d. Program manager/director
    e. Program associate
    f. Program technician
    g. Program assistant
2. How long have you been an Extension employee?
    a. 3 months or less
    b. 4 months – 1 year
    c. 2 – 5 years
    d. 6 – 10 years
    e. 11 – 15 years
    f. more than 15 years
3. What is your gender?
    a. Male
    b. Female
4. What is the highest level of education you have completed?
    a. Bachelor's degree
    b. Some graduate work
    c. Master's degree
    d. Doctoral degree
5. What is your age?
6. What county do you work in?
7. On a scale of 1 to 5, rate your current comfort level with the topics listed below.

	Rating Scale				
Statement	VU	U	N	C	VC
Assisting Extension clients with general nematology topics.	1	2	3	4	5
Recognizing signs and symptoms of plant disease.	1	2	3	4	5
Properly collecting soil samples for nematode detection.	1	2	3	4	5
Using a web-based tutorial for learning in general.	1	2	3	4	5
Using a web-based tutorial for learning about nematology topics.	1	2	3	4	5
***Note*. Scale: VU = Very Uncomfortable, U = Uncomfortable, N = Neutral, C = Comfortable, VC = Very Comfortable**					

Appendix M

Module 1: Posttest

1. A nematode is a microscopic roundworm
    - **a. True**
    - b. False
2. A nematode is unsegmented.
    - **a. True**
    - b. False
3. Nematodes are generally microscopic and tubular in shape.
    - **a. True**
    - b. False
4. A _____ is a pointed, rigid, hollow feeding organ in the mouth of plant parasitic nematodes used for piercing and withdrawing nutrients from plant cells. (stylet)
5. Image Question(OMITTED)
6. Image Question(OMITTED)
7. Match each nematode body part to its corresponding description
    - a. The portion of the digestive system between the stylet and the beginning of the intestines. (esophagus)
    - b. The terminal portion of the nematode digestive system. (anus)
    - c. A pointed, rigid, hollow feeding organ in the mouth of the plant parasitic nematodes. (stylet)
    - d. The outermost covering of the nematode. (cuticle)
    - e. A simple tube in which digestion occurs. (intestine)
8. The three main groups of nematodes are_____, _____, and _____. Select all that apply.
    - **a. Plant parasitic nematodes**
    - **b. Animal parasitic nematodes**
    - **c. Free living nematodes**
    - d. Heartworms
    - e. Soil parasitic nematodes
9. The three major plant parasitic nematodes of economic concern in Arkansas soybean and cotton crops are _____, _____, and _____. Select all that apply.
    - **a. Reniform nematode**
    - **b. Root-knot nematode**
    - **c. Soybean cyst nematode**
    - d. Lesion nematode
    - e. Spiral nematode

Appendix N

Module 2: Posttest

1. Match the following words to their definition.
    a. Any indication of disease on a host plant form visible portions of the pathogen or its products. (signs)
    b. Indication of disease by reaction of the host; visible effect produced by a pathogen. (symptoms)
    c. A continuous disturbance of a plant that interferes with its normal growth, development, economic value, or aesthetic quality and leads to development of symptoms. (plant disease)
2. Match the following words to their definitions.
    a. An organism capable of causing disease in a particular host. Most are parasites. (pathogen)
    b. A concept used to explain how diseases develop, consists of a host, pathogen, and favorable environment. (disease triangle)
    c. A living organism harboring or invaded by a pathogen from which the pathogen obtains food. (host)
3. Image Question(OMITTED)
4. Image Question(OMITTED)
5. Fungi, viruses, nematodes, and bacteria are examples of:
    a. Pathogens
    b. Hosts
    c. Disease triangle
    d. None of the above
6. Image Question(OMITTED)
7. Crops, trees, grasses, and bushes are examples of:
    a. Hosts
    b. Pathogens
    c. Parasites
    d. None of the above

Appendix O

Module 3: Posttest

1. What are the common reasons to sample crop production fields for nematodes?
    a. To estimate population density of nematodes in the field
    b. To determine if nematodes are present
    c. To estimate nematode distribution in a field
    d. To determine what nematode species are present in the field
    e. All of the above
2. Match the following words to their definition.
    a. Level of infestation in a field. (population density)
    b. A test to determine nematode population. (assay)
    c. A representative amount of soil from a field to determine type and number of nematodes present. (soil sample)
3. At least how many soil cores should be collected to represent one 20 acre field when submitting a soil sample for nematode detection?
    a. 20
    b. 1
    c. 5
    d. 10
4. Image question. (OMITTED)
5. Image question. (OMITTED)
6. The best time to collect soil samples for nematode detection and densities is generally after harvest.
    a. True
    b. False
7. The nematode population density generally reaches its peak during September through November in Arkansas.
    a. True
    b. False
8. Soil samples should represent more than 20 acres of a field.
    a. True
    b. False
9. Field areas with differing soil types and/or symptoms of nematode damage should be sample separately from other areas of the field.
    a. True
    b. False
10. Storing soil samples in an ice chest or cooler, without ice, is an effective method of short-term storage.
    a. True
    b. False

Appendix P

Post Assessment Questionnaire

*1
Is this the first web-based tutorial that you have completed?

○ Yes ○ No

2
If yes, do you plan to use web-based learning tools in the future?

○ Yes ○ No ◉ No answer

*3
Indicate your level of agreement with the following statements by selecting the appropriate response for each.

1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

	1	2	3	4	5
I found this tutorial to be an effective method of presenting information.	○	○	○	○	○
I found this tutorial to be an effective method of learning.	○	○	○	○	○
I found this tutorial to be just as effective for learning as traditional "face-to-face" classes.	○	○	○	○	○
I feel comfortable using this web-based tutorial as a way of learning.	○	○	○	○	○
I feel comfortable using a web-based tutorial for learning in general.	○	○	○	○	○

*4
On a scale of 1 to 5, rate your current comfort level with the topics listed below.

1 = very uncomfortable, 2 = uncomfortable, 3 = neutral, 4 = comfortable, 5 = very comfortable

	1	2	3	4	5
Assisting Extension clients with general nematology topics	○	○	○	○	○
Properly collecting soil samples for nematode detection	○	○	○	○	○
Using a web-based tutorial for learning about nematology topics	○	○	○	○	○

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Do you have any general feedback, comments, criticisms, or suggestions to improve the tutorials "Introduction to Nematodes," "Signs and Symptoms of Plant Disease," and "Soil Sampling for Nematodes?" If yes, please respond below.

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