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Assessing Extension Agent Knowledge and Training Needs to Improve IPM Dissemination in Uganda

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Abstract

Frontline extension agents' lack of awareness and understanding of integrated pest management (IPM) has been identified as an impediment to effective transfer of IPM strategies to farmers in sub-Saharan Africa. Developing effective in-service educational and training programs is an important method for addressing this problem, but it is a solution that requires the engagement of extension agents in the training needs assessment process. The main purpose of this study was to assess extension agent knowledge of IPM and to determine their priority pest management educational and training needs. An instrument to assess pest management competencies on the basis of knowledge and importance was designed and administered to a sample of 82 extension agents from Eastern Uganda. All 20 pest management competencies were considered to be very important. Weighted discrepancy scores indicated that the three highest ranked training needs were Field Pest Sampling Procedures, Differentiating Crop Diseases, and Knowledge of IPM. Nearly half (46%) of the sample had low levels of IPM knowledge. Comparing the training needs of those with low and acceptable IPM knowledge levels reveals important differences for designing pest management training programs. Based on these findings alternative pest management training programs for extension agents in Uganda are presented.

Keywords: Competencies, Discrepancy Analysis, Extension Agents, Integrated Pest Management, Training Needs, Uganda

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Introduction

Reducing crop losses due to pests is essential to increasing food security, poverty reduction and sustainable agricultural development (Van Huis & Meerman, 1997; Oerke, Dehne, Schonbeck, & Weber, 1994). Chemical pesticides continue to be the main form of pest control recommended by extension agents and used in much of the developing world (Natural Resources Institute, 1991). However, excessive pesticide use can threaten food and user safety, the environment, and increasingly, the export of agricultural products to global markets. Integrated pest management (IPM) has been promoted as an alternative to sole reliance on chemical pesticides. Its primary goal is to control destructive pest populations while simultaneously eliminating or reducing the use of chemical pesticides (Erbaugh, Donnermeyer, & Kyamanywa, 2002). It employs a variety of techniques, including pest monitoring, the use of biological and cultural controls, and host plant resistance. These techniques are then integrated into a pest management system.

Unfortunately, attempts to develop and extend IPM systems to small scale farmers in sub-Saharan Africa over the past twenty years have met with limited success (Yudelman, Ratta, & Nygaard, 1998; Morse & Buhler, 1997). Although a variety of policy, research, and market related factors are acknowledged to have constrained IPM adoption; many indicate that the central problem is one of transferring IPM knowledge and information to farmers and, more specifically, deficiencies in extension systems' capacity to provide effective farmer education and training programs (Gutierez, Kogan, & Stinner, 2003; Morse & Buhler, 1997; Rajotte, Norton, Luther, Barrera, & Heong, 2005). These programs are fundamental to the successful dissemination of complex technologies such as IPM.

Frontline extension agents are vital to IPM program implementation because they provide the necessary links with farmers and communities, manage on-farm research efforts, and deliver education and training programs. However, many have identified frontline extension agents' lack of awareness and understanding of IPM as an impediment to effective transfer of IPM strategies to farmers (Dent, 1995; Yudelman et al., 1998; Zalom, 1993). Knowledge and awareness are generally considered prerequisites to adoption of new technologies, and change agent success in securing adoption is related to clients' perception of change agent credibility (Rogers, 1995). Change agent credibility is linked to clients' perceptions of change agent knowledge and technical competence. Thus, extension agent knowledge is a vital link in the implementation of IPM systems.

The provision of in-service educational and training programs prior to program delivery is one strategy for improving extension agent competence and credibility. However, in sub-Saharan Africa the availability of these programs remains limited and IPM training occurs in formal academic settings or is relegated to learn-as-you-go training through involvement in programs such as farmer field schools or participatory IPM research programs. As frontline extension agents are critical to broader dissemination and adoption of IPM, it also is critical that they be engaged in the training needs assessment process to help ensure training relevance and to enhance their knowledge of IPM.

In Uganda, the United States Agency for International Development (USAID) supported Integrated Pest Management Collaborative Research Support Program (IPM CRSP), has engaged in the participatory development of IPM systems for small scale farmers since 1995. An assessment of these efforts conducted in 1999 indicated that although they were having the desired impact on farmer participants, the number of project beneficiaries was small. Using extension agents to reach a broader audience was contemplated; however, a pilot assessment of ten extension agents conducted in 1998 indicated limited awareness and knowledge of IPM, pests, and pesticide management (Erbaugh & Kyamanywa, 2001). This assessment along with demands from donors and other stakeholder groups led Makerere University's Department of Crop Science to develop in-service pest management related training programs for extension agents, pesticide dealers, and farmers. This study was undertaken to provide a more comprehensive assessment of extension agents' IPM and pest management knowledge and training needs.

Purpose and Objectives

The main purpose of this study was to assess extension agent knowledge of IPM and to determine their pest management educational and training needs. The main objectives were to:

1. determine extension agent knowledge of IPM;
2. describe the importance of pest management practices as reported by extension agents;
3. describe extension agents' self-reported competencies with pest management practices;
4. determine pest management training needs of extension agents; and
5. identify background factors linked to knowledge of IPM.

Methods

A descriptive survey design was used in 2004 to assess IPM knowledge and pest management training needs of extension agents in Kumi, Soroti, and Iganga districts in Eastern Uganda. These districts were selected because IPM-related project activities had been implemented there either by the IPM CRSP or the United Kingdom's Department for International Development (DFID). As these projects involved extension agents it was anticipated that they would more likely be aware and knowledgeable of pest management practices and training needs.

A sampling frame consisting of known agricultural extension agents (Ministry of Agriculture), certified agricultural service providers (National Agricultural Advisory Service), and extension specialists associated with various NGOs was assembled for the three districts (N = 132) in Eastern Uganda. These extension agents were sent letters inviting them to attend meetings at district headquarters with an enumerator from the Department of Agricultural Extension Education at Makerere University. Extension agents were asked to complete the prepared questionnaire at these meetings, resulting in the completion of 82 questionnaires, or 62% of the target population.

The assessment instrument consisted of three parts. The first part focused on extension agent demographic and background characteristics including age, sex, and education. Part 2 asked questions that directly assessed extension agent knowledge of IPM. These questions have been used and validated in past farmer surveys in Uganda and other IPM CRSP research sites around the world (Erbaugh, Donnermeyer, & Kibwika, 2001). Part 3 adhered to the model of training needs assessment developed by Borich (1980) because it facilitates instrument construction, data collection and analysis, and results interpretation (Edwards & Briers, 1999). Weighted discrepancy scores (WDS) for an array of competency statements were calculated and used to evaluate and rank priority training needs. A WDS score for each item was derived by first calculating the difference between extension agent-determined levels of importance and self-reported knowledge of a pest management competency. These scores were multiplied by the mean importance rating for each competency to arrive at a weighted discrepancy scores.

Respondents were requested to assess the importance and knowledge (competency) of pest management competency statements using a five point Likert scale: 5 = Very High Importance/Knowledge; 4 = High; 3 = Intermediate; 2 = Low; and 1 = Very Low Importance/Knowledge. The list of pest management competencies was assembled from a review of IPM CRSP Uganda Site annual reports (Erbaugh & Kyamanywa, 2001-2003), the Ohio Competency Analysis Profile (OCAP) for Horticulture and Natural Resources (1992), and Makerere University, Crop Science Course 605: Principles of Pest Management Systems (Kyamanywa, 2003). To establish content validity, all items were reviewed in Uganda by the Ministry of Agriculture's Crop Protection Commissioner, and the Department Head of Crop Science at Makerere University. The Cronbach's alpha measure of reliability for the importance and knowledge scales were .90 and .95 respectively. The final list consisted of 20 competencies, divided into three competency areas: pests (insects, plant diseases, and weeds) identification, pesticide management, and IPM principles. The questionnaire was pre-tested with seven extension professionals prior to taking the instrument to the selected districts.

Knowledge of IPM

Knowledge of a concept, tool or innovation occurs when an individual knows both its function and application (Rogers, 1995). The function of IPM is to manage destructive pest populations using a variety of practices to reduce or eliminate chemical pesticide usage (Morse & Buhler, 1996).Its application or "how-to" knowledge (Rogers, 1995) begins with an understanding of pest identification and monitoring; requires familiarity with an array of alternative pest management practices; and, knowledge of its limitations and advantages, including the potential harmful effects of chemical pesticides. Several of these dimensions were established from earlier participatory activities with Ugandan farmers (Erbaugh, et al., 2001), but were considered to be equally important for extension agents if they are to successfully convey the full benefits of a knowledge intensive system of pest management such as IPM.

Since the conceptual knowledge base that comprises IPM is complex and multi-dimensional (Dent, 1995; Morse & Buhler, 1997), seven items or dimensions were combined into a summated ratings scale to measure extension agent knowledge of IPM. The coefficient of reliability for the knowledge of IPM scale was .74, indicating an acceptable level of reliability (Nunnally, 1978). Extension agents were requested to directly assess their knowledge of each item by identifying characteristics or associated skill dimensions. The first item requested extension agents to define dimensions of IPM on a 0-3 scale, where 0 indicated no knowledge of IPM; 1, indicated the use of one concept such as reduction or selective use of pesticides, alternative non-chemical practices, integration, thresholds, environmental protection, or maintenance of ecological balance; 2, indicated the use of two concepts; and, 3, indicated a complete definition (Erbaugh et al., 2001).

The second and third items asked extension agents to describe advantages and limitations of IPM on a 0-3 scale, with no advantages or limitations coded 0, and the naming of each additional advantage or limitation coded 1, 2, or 3 respectively. The most commonly mentioned advantage of IPM was cost reductions, followed by environmentally friendly, safer for users/less exposure to pesticides, and accessibility or local availability. The most common limitations of IPM were that farmers' lacked knowledge, were unsure of results, liked pesticides and quick results, and considered IPM to be time consuming and labor intensive.

A fourth item asked agents if they could identify arthropod natural enemies, with a no response coded 0, and naming one, two or three coded 1, 2, or 3 respectively. A fifth item asked agents if they knew other practices to control pests and diseases besides using pesticides, with a no (0) response indicating that they were not aware of other means to control pests, and the mentioning of alternative control methods coded 1-3. Commonly mentioned alternatives were crop rotation, early or timely planting, resistant varieties, and bio-rational products such as neem extracts or wood ash. A sixth item asked agents if they were aware of possible negative effects from using pesticides, and was coded 0 if they were unaware and 1-3 if they were aware of potential negative effects from using pesticides. Commonly mentioned negatives of pesticide use were human poisoning, kill beneficial organisms, expensive, and harmful to the environment (Erbaugh et al., 2001).

A seventh item asked agents to identify the correct procedures for conducting pest and disease field sampling, and was coded 0 if they were unaware of any sampling procedures, and 1 or 2, if they could identify procedural elements such as random field measures, random row sampling, not using field perimeters for sampling, sampling every tenth plant, and methods for making pest damage assessments.

Findings

Objective one was to determine extension agent knowledge of IPM using the method of direct assessment. Table 1 presents descriptive information for each item and for the IPM Knowledge scale. Agents were most familiar with advantages of IPM, alternatives to pesticides and beneficial (natural enemies) insects. Agents were least knowledgeable of field sampling procedures, harmful effects of using pesticides and defining IPM. The mean IPM knowledge score was 12.46 or 62% of the total.

Table 1

Mean Scores for Items Comprising Direct Assessment of IPM Knowledge by Extension Agents in Eastern Uganda, 2004

Item description	Range	*M*	*SD*
Definition of IPM	0-3	1.79	.81
Advantages of IPM	0-3	2.22	.92
Limitations of IPM	0-3	1.80	.90
Identification of natural enemies	0-3	2.02	.92
Awareness of alternative pest mgt. practices	0-3	2.08	.99
Negative effects of pesticides	0-3	1.66	.85
Pest field sampling procedures	0-2	.88	.73
Scale Total	20	12.46	3.83

Note. Scale adjusted Cronbach's alpha = .74

The different levels of extension agent IPM knowledge are presented in Table 2. Results indicate that 44 (54%) of the extension agents had acceptable levels (medium and high) of IPM knowledge. An acceptable level of knowledge was assumed if the test score was at or greater than the scale mean.

Table 2

Levels of Extension Agent Knowledge of IPM in Eastern Uganda, 2004

Level	Range	*f*	%
Low	1-12	38	46.0
Medium	13-16	35	42.7
High	17-20	9	11.3
Totals	2-20	82	100

Objective two was to describe the importance of pest management practices as perceived by extension agents in Eastern Uganda. Extension agents were asked to rate the importance of each pest management practice in their role as pest control advisor (Table 3). Extension agents were presented with 20 pest management practices to rate. Findings indicated that extension agents considered all 20 pest management practices to be very important (mean ratings > 4.0), with pesticide mixing (*M* = 4.58, *SD* = .72) rated highest and pesticide record keeping (*M* = 4.05, *SD* = 1.02) rated lowest. Averaged importance scores for items comprising the three competency areas were nearly the same at 4.35, 4.36, and 4.38 for pest identification, pesticide management and IPM principles respectively.

Table 3

Importance and competence ratings and training needs in pest management practices by agricultural extension providers in Eastern Uganda (N = 82), 2004

	Importance Level		Competence Level				
Pesticide Management Practice	*M*	*SD*	*M*	*SD*	DS[1] Score	WDS[2]	WDS Rank
I. Pesticide Management							
Pesticide Safety	4.49	.99	3.41	1.06	1.08	4.85	4
Pesticide mixing (calculate concentrations)	4.58	.72	3.63	1.03	.95	4.35	7
Pesticide record keeping	4.05	1.02	2.99	1.23	1.06	4.29	9
Know how to choose the correct pesticide	4.54	.74	3.61	.94	.93	4.22	10
Sprayer calibration	4.26	.77	3.27	1.25	.99	4.22	11
Awareness of different pesticides	4.27	.90	3.43	1.08	.84	3.59	15
Identify application times, frequency, method, and amounts	4.34	.87	3.61	1.11	.73	3.17	17
Can differentiate between pre emergent and post emergent weed treatments.	4.18	.86	3.49	1.18	.69	2.88	18
Interpret chemical labels	4.49	.76	3.88	1.03	.61	2.74	20
Total Pesticide Management	39.20		31.32		7.88		
Mean Pesticide Management	4.36		3.48		.88	3.83	
II. Pest Identification							
Field Sampling Procedure for insects/diseases/weeds	4.32	.77	2.71	1.15	1.61	6.96	1
Differentiate between fungal, viral, & bacterial diseases	4.37	.94	3.20	.98	1.17	5.11	2
Recognition of major crop insect pests	4.46	.77	3.43	.89	1.03	4.59	5
Recognition of major crop diseases	4.49	.74	3.51	.96	.98	4.40	6
Assess degree of damage	4.26	.77	3.25	1.01	1.04	4.30	8
Identify various types of insect damage	4.24	.90	3.30	.95	.94	3.99	13
Recognition of major weeds	4.28	.78	3.63	.99	.65	2.78	19
Total Pest Identification	30.42		23.03		7.39		
Mean Pest Identification	4.35		3.29		1.06	4.61	

Table 3 (continued)

Pesticide Management Practice	Importance Level		Competence Level		DS[1]	WDS[2]	WDS
	M	*SD*	*M*	*SD*	Score		Rank
III. IPM Principles							
Knowledge of IPM	4.48	.80	3.38	1.03	1.10	4.93	3
Cultural Control of Pests	4.49	.76	3.58	1.15	.91	4.09	12
Biological Control of Pests	4.08	1.11	3.15	1.14	.93	3.79	14
Knowledge of chemical/cultural/biological pest control options	4.45	.85	3.65	1.06	.80	3.56	16
Total IPM Principles	17.50		13.76		1.10		
Mean IPM Principles	4.38		3.44		.94	4.12	

Note. [1]Discrepancy score; [2]Weighted Discrepancy Score.

Objective three was to describe extension agents' level of knowledge (competence) of pest management practices by asking them to rate their current level of knowledge of each pest management practice (Table 3). Findings indicated that extension agents had high levels of knowledge on 18 items (means > 3.00) and intermediate knowledge (means < 3.00) of two practices, with knowledge of field sampling procedures for pests the lowest (M = 2.71, SD = 1.15). The highest level of knowledge reported was interpreting pesticide labels (M = 3.88, SD = 1.03). Averaged competency scores for items comprising the three competency areas were 3.29, 3.48, and 3.44 for pest identification, pesticide management and IPM principles respectively, indicating that extension agents assessed themselves as most competent with pesticide management and least competent with pest identification.

Objective four was to determine the priority pest management training needs of extension agents (Table 3). This was accomplished by calculating and ranking the weighted discrepancy scores (WDS). The five highest ranked training needs (WDS of 4.50 and above) in priority order were: field sampling procedures for pests; differentiating among fungal, viral, and bacterial diseases; knowledge of IPM; pesticide safety; and recognition of major crop insect pests. Extension agents considered themselves competent and not requiring training in three areas: interpreting pesticide labels; recognition of major weeds; and differentiating between pre and post emergent weed treatments. Competency area WDS were 4.61, 3.81, and 4.12 for pest identification, pesticide management, and IPM principles respectively, indicating that pest identification training was most important with four of the highest ranked weighted discrepancy scores.

In order to examine training needs in greater detail, the IPM Knowledge scale (Objective 1) was used to calculate separate WDS for agents who had acceptable and low levels of total IPM knowledge (Table 4). A score range for each (pest management practice) item was calculated for importance, knowledge, and WDS by subtracting the score for agents with less than acceptable over-all knowledge levels from agents with acceptable over-all knowledge levels.

Table 4

Importance, Knowledge, and Weighted Discrepancy Scores for Agents with Low (L), Acceptable (A), Overall Knowledge Levels, and Range (Acceptable minus Low) in Eastern Uganda, 2004

	Importance			Competence			WDS		
Items	L[a]	A[b]	R[c]	L[a]	A[b]	R[c]	L[a]	A[b]	R[c]
Pesticide Safety	4.33	4.62	.29	3.26	3.55	.29	4.63	4.94	.31
Pesticide mixing (calculate concentrations)	4.45	4.68	.23	3.62	3.63	.01	3.69	4.91	1.22
Pesticide record keeping	3.71	4.33	.62	2.84	3.12	.28	3.23	5.24	2.01
Know how to choose the correct pesticide	4.38	4.67	.29	3.50	3.71	.21	3.85	4.48	.63
Sprayer calibration	4.21	4.30	.09	3.51	3.05	-.46	2.95	5.38	2.43
Awareness of different pesticides	4.09	4.43	.34	3.41	3.45	.04	2.78	4.34	1.56
Id. Application times, freq., method & amounts	4.17	4.48	.31	3.51	3.69	.18	2.75	3.54	.79
Difference between pre & post emergent pesticides	3.94	4.39	.45	3.47	3.50	.03	1.85	3.91	2.06
Interpret chemical labels	4.34	4.61	.27	3.62	4.10	.48	3.12	2.35	-.77
Total pesticide management	37.60	40.50	2.89	30.70	31.80	1.98			
Mean pesticide management	4.18	4.50		3.42	3.53		3.20	4.36	1.16
Field Sampling procedure for insects/diseases/weeds	4.26	4.38	.12	2.53	2.88	.35	7.37	6.57	-.80
Differentiate fungal, viral & bacterial diseases	4.18	4.52	.34	3.24	3.17	-.07	3.93	6.10	2.17
Recognition of major crop insect pests	4.29	4.61	.32	3.37	3.49	.12	3.95	5.16	1.22
Recognition of major crop diseases	4.33	4.61	.28	3.57	3.46	-.11	3.29	5.30	2.01
Assess degree of damage	4.03	4.45	.42	3.24	3.27	.03	3.18	5.25	2.07
Id. Various types of damage	4.03	4.40	.37	3.18	3.41	.23	3.43	4.36	.93
Recognition of major weeds	4.26	4.29	.03	3.46	3.78	.32	3.41	2.19	-1.22
Total pest identification	29.40	31.20	1.88	22.60	23.50	.87	6.79	7.80	
Mean pest identification	4.20	4.47		3.23	3.35		4.07	4.98	.91
Knowledge of IPM	4.34	4.60	.26	3.16	3.57	.41	5.12	4.74	-.38
Cultural controls for pests	4.44	4.53	.09	3.38	3.76	.38	4.71	3.49	-1.22
Biological control for pests	3.83	4.29	.46	3.08	3.22	.14	2.87	4.59	1.72
Knowledge of chemical/ cultural/biological pest control options	4.17	4.69	.52	3.50	3.78	.28	2.79	4.27	1.47
Total IPM Principles	16.80	18.10	1.33	13.20	1.21				
Mean IPM Principles	4.20	4.53		3.28	3.58		3.84	4.28	.44

Note. [a]Agents with Low Weighted Discrepancy Scores; [b]Agents with Acceptable Weighted Discrepancy Scores; [c]Range (Acceptable – Low) of Agents' Weighted Discrepancy Scores

Agents whose total IPM knowledge was low rated every knowledge item as less important than agents with acceptable knowledge levels. Despite higher over-all knowledge scores, agents with acceptable knowledge actually scored lower than agents with low over-all knowledge on three items. These included sprayer calibration, recognition of major crop diseases, and differentiating between fungal, viral, and bacterial diseases. However, except for sprayer calibration, the differences were small.

Different WDS were found between agents with acceptable versus low over-all knowledge on many of the items. There were 11 WDS with differences greater than +1.0 between the two groups, indicating that agents with low knowledge scores had much lower WDS than agents with acceptable over-all knowledge levels. For two items (recognition of major weeds and cultural controls for pests), the differences in WDS were greater than -1.0, indicating that agents with low over-all knowledge levels had the higher scores. For the remaining 8 items, WDS between the two groups was between +1.0 and -1.0.

At first glance, the results would suggest that agents with acceptable knowledge levels have greater training needs. That may be the case insofar as they are far more likely to believe that various pest management practices are important. Clearly, however, it is true that agents with less than acceptable over-all knowledge of IPM achieve lower discrepancy scores because they are less likely to perceive specific pest management practices as important. This suggests that agents with different levels of over-all knowledge see importance for training very differently, which has implications for the design of training programs.

Objective five was to identify background characteristics of extension agents associated with the IPM knowledge scale used in objective 1. Background characteristics considered were sex, age, level of education, pesticide attitudes, current position level, and post-degree pest management (IPM and pesticide) training. Regression procedures indicated that the full model was moderately successful, explaining 28% (Adjusted $R^2 = .280$) of the variance, in knowledge of IPM. The two independent variables that accounted for the explained variance were pest management training (22%) and age (6%), with younger extension agents being more knowledgeable of IPM.

Conclusions

Regression results appear to validate the importance and the need for post-formal educational training programs as those who had received pest management training was the most important variable explaining extension agent knowledge of IPM. However, 46% of the sampled extension agents had low levels of IPM knowledge. Considering that farmers continue to view extension agents as the primary source of agricultural production information, this level of IPM knowledge is not considered to be sufficient. The training needs assessment reinforces this impression, with extension agents acknowledging that their pest management toolkit (e.g. pests sampling and disease identification) is limited and needs attention. Thus, it is recommended that a series of in-service IPM training programs be developed for extension agents in Uganda.

Extension agents considered all pest management practices to be fairly important and they rated themselves as having high or intermediate knowledge (competence) of these practices. Examining the five top ranked WDS (training needs) suggests an in-service training program that would concentrate on pest sampling and identification but include additional content on IPM and pesticide safety. As pest management decision making, including IPM, is based on field pest sampling to determine pests and damage thresholds, and sampling depends on being able to identify pests, such a program would reinforce pest management fundamentals and facilitate dissemination of IPM.

An alternative training program is suggested by examining the three pest management competency areas: pest identification, pesticide management, and IPM principles. Although averaged importance scores were similar for the three competency areas, averaged knowledge scores indicated that extension agents were most competent with pesticide management and least competent with pest identification. Averaged weighted discrepancy scores indicated that pest identification training was most needed with four of the highest ranked weighted discrepancy scores. These findings suggest a sequenced, three-part, pest management certification program. It would begin and emphasize pest identification, followed by sections on IPM and pesticide management. Each section would be offered independently to allow extension agents maximum flexibility to participate and would consist of an intensive one or two week training program, ending with an exam. Agents would be required to pass all three exams to receive pest management certification.

Comparing weighted discrepancy scores for agents with low over-all IPM knowledge scores with those who have acceptable knowledge levels reveals an important dimension for designing in-service training. Those with acceptable knowledge levels are always more likely to believe that specific pest management practices are important. This suggests that agents who already have acceptable knowledge are also more motivated to receive additional information.

This finding corresponds with traditional diffusion theory that maintains that awareness-knowledge of a new concept (innovation) often creates a need and motivation for an individual to seek additional information about “how-to” apply the concept. In common parlance, this is called “preaching to the choir.” In contrast, those with less than acceptable knowledge always perceive specific pest management practices to be less important, which may mean that they are also less motivated to receive additional information. The implications of this finding is clear: Only calculating discrepancy scores without breaking down those scores by knowledge level may mask some important differences that are essential for the design of effective in-service training.

The results of this study demonstrate that there is a group of agents who not only need more knowledge, but also need information that will help them understand why specific pest management practices are important. Without helping them increase the perceived relevance of the information, they are not likely to learn and transfer this information when they work with farmers. Hence, we recommend that in the future, when feasible, trainers conduct pre in-service assessments of knowledge and importance, and then compare discrepancy scores between participants by their level of knowledge.

The results might identify the need to divide in-service training participants into different groups each receiving information in a way that is sensitive to both their level of knowledge and how important or relevant they believe the information to be.

We suspect that similar differences will be found for other agricultural practices and technologies; not only amongst agents, but amongst farmers as well. Therefore, we recommend that future users of weighted discrepancy scores for the design of both field and in-service training conduct similar analyses in order to better appreciate the diverse training needs of participants.

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