AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Analysis of pesticide application and applicator's training level in greenhouse farms in Galicia, Spain

S. Lamosa Quinteiro, M. F. Marey Pérez,*
C. Cabaleiro Sobrino, M. Barrasa Rioja

Abstract
The aim of this paper is to determine whether training level affects the safe use of pesticides amongst pesticide applicators of Galician greenhouse farms (Spain). The relationship between pesticide applicator training and safe use of pesticides was statistically analyzed using non-parametric tests. Results did not reveal any relationship between the training level of pesticide applicators and the implementation of good practices in pesticide use. This paper questions current training systems for pesticide application and points to the need for the implementation of methods that assess and monitor the results and added value of training to pesticide applicators' practices.

Keywords: *Training, safe use, pesticides, pesticide applicator, non-parametric test*

Introduction

Intensification of agriculture around the world has led to an increase in the use of pesticides. Many authors have studied the health and environmental effects and consequences of the use of pesticides at the global and regional level (Ecobichon, 2001; Kishi and Ladou, 2001; Ergonen *et al*., 2005; Chelme-Ayala *et al*., 2008; Buchanan *et al*., 2009).

According to some authors, farmers are aware of the health and environmental effects of the use of pesticides in agriculture despite their low level of education or specific training in pesticides (Recena *et al*., 2006; Atreya, 2007; Zhang and Lu, 2007). Pesticide hazard awareness encourages farmers to: 1) use less toxic pesticides (FFTC, 2004), 2) increase the use of personal protective equipment (PPE) (Perry and Layde, 2003), 3) create an awareness on the potential danger of indiscriminate use of pesticides (Mandel *et al*., 2000), 4) improve safe storage of pesticides (Bury *et al*., 2005), 5) reduce expenditure on pesticides (Yamazaki and Resosudarmo, 2008), 6) increase crop yield (van den Berg, 2004), and, in general, 7) increase the safety measures taken by farmers (Salameh *et al*., 2004; Atreya, 2007; Sam *et al*., 2008).

Yet, the analysis conducted by Damalas *et al*. (2008) in Greece revealed the existence of poor practices among farmers, such as inappropriate disposal of pesticide packages, leftover spray solution or rinsates generated from washing the application equipment. Other authors verified a low use of personal protective equipment during pesti-

* Department of Crop Production, Escola Politécnica Superior.
Universidade de Santiago de Compostela, Campus Universitario de Lugo. 27002 Lugo, Spain
telfs. 00 34 982 823 111, 00 34 609 591 013, e-mail santiago.lamosa@usc.es

cide handling (Zhang and Lu, 2007; MacFarlane *et al*., 2008) and low levels of reading and understanding of pesticide labels (Avory and Coggon, 1994; Waichman *et al*., 2007).

Pesticide applicator training is considered one of the most relevant aspects in the reduction of pesticide exposure and, consequently, of intoxications, as well as in the improvement of pesticide handling safety. Many authors have observed that training leads pesticide applicators to: 1) an improvement in diffusion of knowledge and integrated pest management (Feder *et al*., 2004a; Feder *et al*., 2004b; Hashemi *et al*., 2008; Yang *et al*., 2008; Hashemi *et al*., 2009), 2) an increase in safe use of pesticides (Winstead, 1993; Mandel *et al*., 2000; Sam *et al*., 2008; Yamazaki and Resosudarmo, 2008) and 3) a reduction in the use of pesticides (Matthews, 2008; Mancini *et al*., 2009). Moreover, Matthews (2008) verified that training caused increased crop yield, while Mancini *et al*. (2009) reported a positive effect of training on the decrease in the number of intoxication events, and MacFarlane *et al*. (2008) concluded that training increased the use of personal protective equipment.

Despite the positive effects mentioned in the above paragraph, some authors did not find a definite effect of training on the implementation of good handling practices by pesticide applicators. For example, Prochaska (1998) analyzed a population of Ohio Certified Private Pesticide Applicators and found no significant differences between level of education and reading pesticide labels. Feder *et al*. (2004a; b) did not find any improvement in farming activities among farmers who had attended the Farmer Field School (FFS), whereas Yamazaki and Resosudarmo (2008) reported an improvement in agricultural practices among farmers who had attended training courses, but verified that improvements decreased considerably over time. Moreover, other authors have found that knowledge is not transferred between pesticide applicators who have been trained and those of their neighbours who have not been trained (Feder *et al*., 2004a; Tripp *et al*., 2005; Hashemi *et al*., 2008; Yang *et al*., 2008; Hashemi *et al*., 2009).

European and Spanish legislation regulating the use of pesticides, as well as Spanish Order 43/2002 of 20th of November governing Plant Health (BOE, 2002), enforce pesticide handlers and applicators to take training courses or exams that certify and ensure that they meet minimum training standards. In Spain, the requirements for getting a pesticide applicator license are regulated by Royal Decree 1311/2012 of 14th of September establishing the framework for action to achieve the sustainable use of plant protection products (BOE, 2012). The Galician legislation envisages six levels of certification: basic, qualified, fumigator, special certification for the application of toxic and very toxic pesticides to disinfect agricultural soils, special certification for the application of pesticides against micromammals in agricultural soils, and pest control aircraft pilot for agriculture and forestry (DOGA, 2009).

In this legal context, many farmers have taken training courses in the last decade. Actually, the number of farmers involved amounted to more than 2500 in specific years. Yet, this pesticide applicator training policy has not been monitored and its effectiveness has not been tested, such that the actual improvements in the practices of pesticide applicators remain unknown.

The objective of this study is to determine whether the training of the pesticide applicators affects the safe use of pesticides in greenhouse crops in Galicia, a region in Northwest Spain.

Materials and methods

A survey was conducted among greenhouse pesticide applicators in Galicia. According to data made available by the Galician Department of Rural Affairs, *Consellería de Medio Rural, Xunta de Galicia*, in 2009 there were 1260 farms specialized in indoor crops with an area equal to or over 500 m² in this region. The mean area of these farms was 1932 m^2 per farm.

This paper focuses on farms specialized in indoor crops because pesticide applicators are most exposed in this type of farms, insofar as applications are more frequent than in open-air fields, environmental conditions are extreme (high temperature and relative humidity), and ventilation is poor in partially-closed spaces.

The stratifying variable was selected based on the criteria defined by ASPROGA (2001), which suggest farm area as the variable with the strongest influence on the differentiation of farm management and crop yield per unit. Based on farm area, four types of strata were defined (Table 1). To calculate sample size, a single-stage stratified sampling strategy was used, and an error of 5% at 95% confidence level was assumed (Dalenius and Hodges, 1959), which provided a sample size of 301 pesticide applicators, which accounted for 23.9 % of greenhouse farmers. The final distribution of surveys across the region was randomly determined by defining a proportion of farms based on the area covered by greenhouse farms in each province. Table 1 shows the distribution of surveys according to the strata considered in the analysis and the representativity of the surveys.

Personal interviews with pesticide applicators were carried out (INE, 2009) between April and September 2009. First, applicators were contacted by telephone to arrange an appointment for a personal interview at their workplace. The questionnaire included 71 questions divided into 11 blocks.

Table 1. *Distribution of population and sampled farms by types (area of greenhouses) and provinces*

TYPE		***PROVINCES***								***GALICIA***	
		A CORUÑA		***LUGO***		***OURENSE***		***PONTEVEDRA***			
		POP	***SA***	***POP***	***SA***	***POP***	***SA***	***POP***	***SA***	***POP***	***SA***
E1	No.	169	31	24	4	96	11	292	50	581	96
	%	35.1	26.7	45.3	28.6	50.0	25.0	54.7	39.4	46.1	31.9
E2	No.	175	39	13	4	69	18	157	45	414	106
	%	36.4	33.6	24.5	28.6	35.9	40.9	29.4	35.4	32.9	35.2
E31	No.	109	37	11	5	27	15	72	30	219	87
	%	22.7	31.9	20.8	35.7	14.1	34.1	13.5	23.6	17.4	28.9
E32	No.	28	9	5	1	0	0	13	2	46	12
	%	5.8	7.8	9.4	7.1	0.0	0.0	2.4	1.6	3.6	4.0
TOT	No.	481	116	53	14	192	44	534	127	1260	301
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TYPE (by area of greenhouses): E1, 500 - 1000 m²; E2, 1000 - 2000 m²; E31, 2000 - 5000 m²; E32, >5000 m².

POP, population; SA, sample; TOT, total

The training level of the surveyed applicators was assessed through six questions:
1) time the respondent has been performing pesticide application activities,
2) general level of education,
3) specialized training in pesticides,
4) surface area of the greenhouse farm,
5) working time (part-time work, full-time work, etc.),
6) technical advice received. Answers to the questions were assigned values from 0 to 3, the most unfavourable answer being 0 and the best answer being 3.

All the questions were assigned the same weight, such that the value obtained for each pesticide applicator corresponded to the sum of the answers to the six questions. Based on the scores obtained, the pesticide applicators of the analyzed farms were grouped into three groups according to training level as follows:
1) high (≥12), 2) medium (>9, <12), 3) low (≤9).

This classification results from rescaling the scores from 0 to 10. Thus, a value of 9 corresponds to 5.0. Respondents under a score of 5.0 were considered to be insufficiently qualified. Scores between 9 and 12 (5.0-6.5) correspond to pesticide applicators with minimum qualification, and scores over 12 (6.5-10.0) correspond to the group of highly qualified pesticide applicators.

Good practices in pesticide use and application were evaluated through 25 questions classified into six blocks of identical weight. The answers to each question were assigned a value between 0 and 3, 0 being the value of the most unfavourable question and 3 the value of the best response. Each block was assessed by calculating the mean value of the answers to the questions included in the block. The final score was obtained by adding the values obtained for each block.

To analyze the correlation between the level of qualification of the surveyed pesticide applicators and the implementation of good practices in pesticide application, analyses were carried out using the Kruskall–Wallis test (Kruskal and Wallis, 1952) and the U-Mann-Whitney test (Corder and Foreman, 2009), followed by a testing procedure analogous to the Bonferroni pairwise comparison procedure, as described in Neter *et al.* (1996). These techniques are commonly used to differentiate situations (Kragten and Snoo, 2008). The R.2.10.1 software was used for statistical analysis (*R* Development Core Team, 2008). The method developed in this paper has been widely used in this type of survey (Litchfield, 2005; Dasgupta *et al.*, 2007; Zyoud *et al.,* 2010).

Results

Overall, the pesticide applicators interviewed in this study show a very homogeneous profile, with 92.1% having primary education qualification and 7.9% having no education qualification at all.

The rank-based analysis of the characteristics of the pesticide applicators surveyed in this study reveals that the applicator with a high level of qualification (score≥12 points) show the highest levels of general and specific training and own the farms included mainly in strata E31 and E32. Moreover, pesticide applicators with a high level of qualification are the most experienced applicators (only 16.7% have less than 10 years experience) and are engaged in agriculture full-time or belong to cooperatives or agricultural processing companies. In addition, 97.4% of these farmers have received technical advice (Table 2).

Table 2. *Main characteristics of the groups according to the level of qualification of pesticide applicators*

GROUP	*High*	*Medium*	*Low*
VALUE	≥12	>9, <12	≤9
TYPE	E31, E32	E2	E1
TRAINING	High	High	Medium
EXPERIENCE	High	Medium	Low
WORKING TIME	Full-time	Full-time	Full-time / Part-time
ASSOCIATIONS	High	High	Moderate
TECHNICAL ADVICE	High	High	Moderate

Pesticide applicators with a medium level of qualification (9<score<12) have basic levels of general education (73.8% have primary education qualification) or specific training (92.1% have attended a basic course on pesticide handling), own greenhouse farms included mainly in stratum E2, and are mid-experienced applicators (28.6% have less than 10 years experience). These pesticide applicators are usually engaged in agriculture full-time and receive technical advice (95.2%).

Pesticide applicators with a low level of qualification (score≤9) show low levels of general education (18.0% have no education qualification) or specific training (22.0% did not attend any training course), own greenhouse farms included mainly in stratum E1 and are the least experienced farmers (39.0% have less than 10 years experience). Most pesticide applicators in this group are engaged in agriculture full-time, but 27.1% of the applicators with a low level of qualification are engaged in agriculture only part-time. In addition, only 51.2% of these applicators have received technical advice.

Table 3. *Results of non-parametric tests for training groups*

TRAINING GROUP	*N*	*Rank*	*Mean*	*df*	*As. sig.*	*Chi-square*
Good practices	1	98	137.40	2	0.169	3.560
	2	126	157.01			
	3	77	158.47			
	Total	301				

N: Training group; Rank: number of items in group

Does the training level of workers have any correlation with the implementation of good practices in the application of pesticides? As shown in table 3, the non-parametric test does not find any correlation between both variables. According to these results, higher levels of qualification do not result in better practices in pesticide handling.

Discussion

Results suggest that there is no correlation between training level and the implementation of good pesticide application practices, which contrasts with the results reported by other authors, who have verified that both general education and specific training have positive effects on various aspects of agriculture in general and specifically on pesticide handling, insofar as training increases awareness of the consequences of irrational use of pesticides on health (Mancini *et al*., 2005; 2009). Yet, our results are in agreement with the results reported by other authors who did not find any beneficial effects of training on aspects such as reading pesticide labels (Prochaska, 1998), improving the professional activity after taking professional certification courses (Feder *et al*., 2004a; b) or sustaining the good practices over time (Yamazaki and Resosudarmo, 2008).

In our study, the differences found in the positive effects of pesticide applicator training are probably associated with the level of education of the populations studied. For example, in the analysis performed by Atreya (2007), the percent of surveyed farmers with a primary education qualification amounted to 38.2%, while 61.8% did not have any qualification. On the contrary, the population analyzed in this study shows a very homogeneous profile. Such a homogeneity can be the cause for the small influence of level of education and specific training on pesticide application habits.

Most of the authors cited above analyzed the situation in developing countries, whose population is characterized by a low level of education. In this study, the level of education and/or training of pesticide applicators is reasonably high, such that the improvements attained can be more subtle or even not perceived, as suggested by Mandel *et al*. (2000), who observed modest improvements in the use of individual protective equipment within a group of Minnesota farmers aged 40 years and older who received specific training. In that case, 82.8% of the population were high school graduates and 17.2% did not have such a qualification.

Based on the literature review conducted, we have observed that the efficiency of improvements in pesticide applicator training and training activities may increase with the decrease in the degree of development of the country and in the general education of the population.

Another characteristic that might have affected the results is the fact that the population surveyed is old and highly experienced, particularly if compared with other surveys carried out in less developed countries. In the analysis conducted in Nepal by Atreya (2007), 46.1% of the population was less than 31 years old and only 4.9% was older than 50, while in the analysis performed in India by Mancini *et al*. (2009), 34.4% was younger than 30 years and 7.7% was older than 50. Conversely, in the population surveyed in our study, 43.3% of pesticide applicators were older than 50 and 4.2% were younger than 30, which is indicative of the gradual ageing undergone by Spanish and European farmers, with 4.5 % and 1.8% of their population younger than 35 years, respectively (ASAJA, 2010).

Because attendance to professional training courses reduces concern about issues related to safe use of pesticides (Yamazaki and Resosudarmo, 2008), the high training level of the surveyed pesticide applicators must not reassure the authorities who are in charge of pesticide applicator training. Such a decrease in farmers' concern becomes more serious in the Spanish context, given that Spanish legislation compels farmers who must apply pesticides to obtain a certified qualification as pesticide applicators (BOE, 2005). This compulsory measure does not envisage the personal motivations of farmers and, consequently, the measure does not imply greater training efficiency.

Conclusions

Our results suggest that in Galicia, a higher level of education and/or training of pesticide applicators does not result in better practices in pesticide application and handling.

The high level of training and experience of Galician pesticide applicators and the compulsory nature of specialization courses may be the reasons behind the lack of the expected positive effects of training on the practices of Galician pesticide applicators.

Policy makers should create new models of specific training to promote the voluntary participation of farmers and their motivation about these issues. Moreover, new models for the evaluation and control of results must be developed to determine the actual effectiveness of specialization courses.

References

ASAJA (2010) Report on the European Congress of Young Farmers 2010. *Tierra y Vida. Revista informativa profesional de la Asociación Agraria de Jóvenes Agricultores de España. ASAJA*, pp. 381, 8-15. [In Spanish].

ASPROGA (2001) Ornamental horticulture in Galicia. *Vida Rural,* 130, pp. 42-44. [In Spanish].

Atreya, K. (2007) Pesticide use knowledge and practices: A gender differences in Nepal. *Environmental Research,* 104, pp. 305-311.

Avory, G. and Coggon, D. (1994) Determinants of safe behaviour in farmers when working with pesticides. *Occupational Medicine,* 44, pp. 236-238.

BOE (2002) *Order 43/2002, of 20 November governing plant health. Boletín Oficial del Estado No. 279/2002*. [In Spanish].

BOE (2012) *Royal Decree 1311/2012 of 14th of September establishing the framework for action to achieve the sustainable use of plant protection products. Boletín Oficial del Estado No. 223/2012*. [In Spanish].

Buchanan, I., Liang, H.C., Khan, W., Liu, Z.K., Singh, R., Ikehata, K. and Chelme-Ayala, P. (2009) Pesticides and Herbicides. *Water Environment Research,* 81, pp. 1731-1816.

Bury, D.L., Dbrowski Z.T. and Labanowska B.H. (2005) Survey of current crop and pest management practices on black currant plantations in Poland. *Journal of Fruit and Ornamental Plant Research,* 13, pp. 91-100.

Chelme-Ayala, P., Li, X.F., Wang, Y.N., Pourrezaei, P., Smith, D.W. and El-Din, M.G. (2008) Pesticides and Herbicides. *Water Environment Research,* 80, pp. 1564-1624.

Corder, G.W. and Foreman, D.I. (2009) Nonparametric Statistics for Non-Statisticians: A Step-by-Step Approach. Wiley, New Jersey.

Dasgupta, S., Meisner, C., Wheeler, D., Xuyen, K., Thi Lam, N. (2007) Pesticide poisoning of farm workers-implications of blood test results from Vietnam. *International Journal of Hygiene and Environmental Health*, 210(2), pp. 121-132.

Dalenius, T. and Hodges, J.Jr. (1959) A minimum variance stratification. *Journal of American Statistical Association,* 54, pp. 88-101.

Damalas, C.A., Telidis, G.K. and Thanos, S.D. (2008) Assessing farmers' practices on disposal of pesticide waste after use. *Science of the Total Environment,* 390, pp. 341-345.

DOGA (2009) *Joint Order of the Galician Ministries of Health and Rural Environment of 14th of April 2009 governing specific training for people who must handle and apply plant protection products in the Autonomous Community of Galicia, and the creation of the Technical Committee for Plant Production Products. Diario Oficial de Galicia No. 77/2009*. [In Spanish].

Ecobichon, D.J. (2001) Pesticide use in developing countries. *Toxicology,* 160, pp. 27-33.

Ergonen, A.T., Salacin, S. and Ozdemir, M.H. (2005) Pesticide use among greenhouse workers in Turkey. *Journal of Clinical Forensic Medicine,* 12, pp. 205-208.

Feder, G., Murgai, R. and Quizon, J.B. (2004a) Sending farmers back to school: The impact of farmer field schools in Indonesia. *Review of Agricultural Economics,* 26, pp. 45-62.

Feder, G., Murgai, R. and Quizon, J.B. (2004b) The acquisition and diffusion of knowledge: The case of pest management training in farmer field schools, Indonesia. *American Journal of Agricultural Economics,* 55, pp. 221-243.

FFTC (2004) *Monitoring of pesticide residue on crops and farmer's education on safe use of pesticide*. [on line] FFTC, Food and Fertilizer Technology Center for the Asian and Pacific Region. <http://www.agnet.org/library/pt/2004029/> [Accessed 28 October 2011].

Hashemi, S.M., Hosseini, S.M. and Damalas, C.A. (2009) Farmers' competence and training needs on pest management practices: Participation in extension workshops. *Crop Protection,* 28, pp. 934-939.

Hashemi, S.M., Mokhtarnia, M., Erbaugh, J.M. and Asadi, A. (2008) Potential of extension workshops to change farmers' knowledge and awareness of IPM. *Science of the Total Environment,* 407, pp. 84-88.

INE (2009) *Agricultural Census 2009. Project Version*. Instituto Nacional de Estadística, Madrid. [In Spanish].

Kishi, M. and Ladou, J. (2001) International pesticide use. Introduction. *International Journal of Occupational and Environmental Health,* 7, pp. 259-265.

Kragten, S. and Snoo G.R. (2008) Field-breeding birds on organic and conventional arable farms in the Netherlands. *Agriculture, Ecosystems and Environment,* 126, pp. 270–274.

Kruskal, W.H. and Wallis, W.A. (1952) Use of ranks in one-criterion variance analysis. *Jounal of American Statistical Association,* 47(260), pp. 583–621.

Litchfield, M.H. (2005) Estimates of acute pesticide poisoning in agricultural workers in less developed countries. *Toxicological Reviews*, 24(4), pp. 271-278.

Macfarlane, E., Chapman, A., Benke, G., Meaklim, J., Sim, M. and Mcneil, J. (2008) Training and other predictors of personal protective equipment use in Australian grain farmers using pesticides. *Occupational and Environmental Medicine,* 65, pp. 141-146.

Mancini F., Van Bruggen A. H.C., Jiggins, J.L.S., Ambatipudi, A.C. and Murphy, H. (2005) Acute pesticide poisoning among female and male cotton growers in India. *International Journal of Occupational and Environmental Health,* 11, pp. 221–232.

Mancini, F., Jiggins, J.L.S. and O'malley, M. (2009) Reducing the Incidence of Acute Pesticide Poisoning by Educating Farmers on Integrated Pest Management in South India. *International Journal of Occupational and Environmental Health,* 15, pp. 143-151.

Mandel, J.H., Carr, W.P., Hillmer, T., Leonard, P.R., Halberg, J.U., Sanderson, W.T. and

Mandel, J. S. (2000) Safe handling of agricultural pesticides in Minnesota: Results of a county-wide educational intervention. *Journal of Rural Health,* 16, pp. 148-154.

Matthews, G.A. (2008) Attitudes and behaviours regarding use of crop protection products - A survey of more than 8500 smallholders in 26 countries. *Crop Protection,* 27, pp. 834-846.

Neter, J., Kutner, M.H., Nachtsheim, C.J. and Wasserman, W. (1996) *Applied Linear Statistical Models.* Times Mirror Higher Education Group, Chicago.

Perry, M.J. and Layde P.M. (2003) Farm pesticides-outcomes of a randomised controlled intervention to reduce risks. *American Journal of Preventive Medicine,* 24, pp. 310–315.

Prochaska, S.C. (1998) Ohio farmer use of the pesticide label. *Journal of Extension* 36:1, [on line]. Available at <http://www.joe.org/joe/1998february/rb2.html> [Aceessed 28 October 2011].

R Development Core Team (2008) *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria.

Recena, M.C.P., Caldas, E.D., Pires, D.X. and Pontes, E. (2006) Pesticides exposure in Culturama, Brazil - Knowledge, attitudes, and practices. *Environ Res,* 102, pp. 230-236.

Salameh, P.R., Baldi, I., Brochard, P. and Saleh, B.A. (2004) Pesticide in Lebanon: a knowledge, attitude and practice study. *Environmental Research,* 94, pp. 1-6.

Sam, K.G., Andrade, H.H., Pradhan, L., Pradhan, A., Sones, S.J., Rao, P.G.M. and Sudhakar, C. (2008) Effectiveness of an educational program to promote pesticide safety among pesticide handlers of South India. *International Archives of Occupational and Environmental Health,* 81, pp. 787-795.

Sokal, R.R. and Rohlf, F.J. (2000) *Biometry: The Principles and Practices of Statistics in Biological Research.* W.H. Freeman and Company, New York.

Tripp, R., Wijeratne, M. and Piyadasa, V.H. (2005) What should we expect from farmer field schools? A Sri Lanka case study. *World Development,* 33, pp. 1705-1720.

Van Den Berg, H. (2004) *IPM Farmer Field Schools: A Synthesis of 25 Impact Evaluations.* Report prepared for the FAO Global IPM Facility. Wageningen University [on line]. Available at: <http://www.fao.org/docrep/006/ad487e/ad487e00.htm> [Accessed 28 October 2011].

Waichman, A.V., Eve, E. and Nina, N.C.D. (2007) Do farmers understand the information displayed on pesticide product labels? A key question to reduce pesticides exposure and risk of poisoning in the Brazilian Amazon. *Crop Protection,* 26, pp. 576-583.

Winstead, C.B. (1993) How pesticides are handled in a rural North Carolina county: a survey of farmers. *American Association of Occupational Health Nurses Journal*, 41, pp. 24-32.

Yamazaki, S. and Resosudarmo, B.P. (2008) Does sending farmers back to school have an impact? Revisiting the issue. *Developing Economies,* 46, pp. 135-150.

Yang, P.Y., Liu, W.X., Shan, X.N., Li, P., Zhou, J.Y., Lu, J.P. and Li, Y.H. (2008) Effects of training on acquisition of pest management knowledge and skills by small vegetable farmers. *Crop Protection,* 27, pp. 1504-1510.

Zhang, H. and Lu, Y.L. (2007) End-users' knowledge, attitude, and behavior towards safe use of pesticides: a case study in the Guanting Reservoir area, China. *Environmental Geochemistry and Health,* 29, pp. 513-520.

Zyoud, S.H., Sawalha, A.F., Sweileh, W.M., Awang, R., Al-Khalil, S.I., Al-Jabi, S.W. and Bsharat, N.M. (2010) Knowledge and practices of pesticide use among farm workers in the West Bank, Palestine: safety implications. *Environmental Health and Preventive Medicine*, 15(4), pp. 252-261.