Evaluation of the Agricultural Safety and Health Best Management Practices Manual

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Abstract

The Agricultural Safety and Health Best Management Practices (ASHBMP) Manual was developed as an alternative intervention tool to help identify and correct farmwork hazards. A modified pretest-posttest control group experimental design was used to test the effectiveness of the manual with three intervention groups and a control. Testing consisted of conducting baseline and post-intervention audits on 150 farms in Pennsylvania. Significant differences were found among groups of farmers who were given the ASHBMP Manual and those who were not given the manual. The results of the data analysis also showed a positive significant difference among farmers who reduced their farm hazard levels through use of the ASHBMP Manual over farmers who received the Control (traditional safety fact sheets). The data supports the conclusion that the ASHBMP Manual is an effective tool for helping farmers reduce workplace hazards.

Keywords. Agricultural safety and health best management practices, ASHBMP, Best management practices, Hazards, Audit.

The Agricultural Safety and Health Best Management Practices (ASHBMP) Manual was developed as an alternative intervention tool to help identify and correct farm work hazards. The ASHBMP Manual uses pictures to show degrees of hazards, and utilizes the concepts of “Best Management Practices” (BMPs) and hazard auditing as a way of identifying and correcting hazards. The audit portion of the manual incorporates the use of gradated hazard scales. This article reports on an evaluation of the ASHBMP Manual that was completed by conducting hazard audits on different groups of farms. The ASHBMP Manual is a very flexible intervention tool that can be altered to suit the needs of farmers, the insurance industry, and safety educators.

The primary purpose for development of the ASHBMP Manual was to find an effective means of encouraging farmers to reduce farmwork hazards. Underlying this main purpose, however, were a few additional goals. There is ample evidence that farmers can recognize the work hazards that surround them, and that they know how to reduce these hazards (e.g., See Elkind, 1993; Whitman and Field, 1995; Kidd et al., 1996; Thu et al., 1998). Farmers, however, do not have the same motivations to reduce workplace hazards as do other occupational groups with high work injury and death rates. For example, owner/operators of underground mines,

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steel mills, and high rise construction sites all have greater economic, regulatory and sociopolitical incentives to reduce workplace hazards (Brauer, 1994). Farmers do not have an equal threat of fines from OSHA for not correcting hazards (see additional discussion in Hazard Audit section), nor are farmers able to directly pass along the costs of implementing hazard reduction measurers. Farmers cannot simply add the costs of hazard reduction expenditures to their products as most other hazardous industries can.

The insurance industry, through insurance premiums and safety services, often helps high hazard occupational groups to reduce workplace hazards. Insurance premiums (casualty and liability, including workers compensation) are based, in part, upon the number and severity of hazards workers and others are exposed to in the workplace. One way the insurance industry helps many high hazard clients is through regular hazard audits (one or more per year) of the workplace. The insurance industry has not routinely audited farms on such a schedule, though there is anecdotal evidence that this may be changing. Thus, developing an effective hazard audit tool for use by the insurance industry was an underlying goal of the ASHBMP Manual project. The hazard audit can be used independent of the rest of the manual.

There has been no one comprehensive, easy to understand, and standardized document that effectively communicates to a farmer how to reduce workplace hazards on the farm. Similarly, farm safety and health educators have not had a comprehensive, easy to understand, and standardized tool to use as a guide in their work. Traditional methods of safety education has been primarily through mass media approaches, such as fact sheets, slides sets and videos, and through dichotomous auditing forms.

Best Management Practices

Best Management Practices (BMP) provide one method for promoting agricultural safety and health while facilitating hazard auditing. The concept of BMP originated with the Environmental Protection Agency (EPA) in 1975 to protect surface waters from contamination by pollutants (Porter et al., 1975). Best Management Practices are defined as practices or procedures that are qualitative in nature, and are designed to be flexible to fit specific situations (EPA, 1993). Best Management Practices are often a listing of good management and housekeeping techniques, and have been used as a management tool in agriculture and other industries, although the words "best management practices" are not usually included in the title of the document. For example, state Bureaus of Forestry utilize voluntary forest-practice guidelines to manage private forestlands. Siegel (1987), the author of these guidelines, noted that "in the now familiar jargon, the guidelines are better known as 'Best Management Practices' or 'BMPs'. Other agriculturally related BMPs that utilize different titles include the *Horse Industry Handbook* , the *Swine Industry Handbook* , and the *Manure Management for Environmental Protection* series (Graves, 1986a-h). Safety is one component in each of these handbooks. An example of a use of BMPs more directly tied to agricultural safety and health is the University of Florida's *Best Safety and Health Management Practices* (BSHMP) which has been available since 1993 at the university's web site: <http://edis.ifas.ufl.edu/scripts/htmlgen.exe?MENU_AS>. The BSHMPs from the University of Florida appear to be the first BMP-like document specifically assembled for use in agricultural safety and health.

Hazard Auditing

Hazard auditing (also referred to as hazard inspections) is an established practice in the safety and health field, and has been used extensively in all types of industries (Teplow, 1987; Sherry, 1993; Wickens et al., 1997). Hazard audits can be used in process and product safety, occupational health and medicine, and industrial hygiene and pollution control (Krieger and Montgomery, 1997). Safety audits were first used in factories in 1835 by the Manufacturers Mutual Fire Insurance Company of Providence Rhode Island (Teplow, 1987). Other early examples of hazard auditing are in mining (1869) and the food industries (1940). Hazardous industries have routinely conducted hazard audits to maintain regulatory compliance with federal safety and health regulations such as the Occupational Safety and Health Act (OSHA) and the Mine Safety and Health Act (MSHA) (Brauer, 1994). Hazard audits in industry are most often conducted by federal and state inspectors, the insurance industry, labor unions, or a company's safety committee.

Agricultural operations are not routinely audited for work hazards. Farm operations that are owned and operated strictly by family members do not fall under the jurisdiction of OSHA. And since 1976, Congress has prohibited enforcement of OSHA regulations on most farms with 10 or fewer employees. The 1997 Census of Agriculture suggests that these two factors combine to exclude approximately 92% of farm operations from routine work hazard inspections by OSHA.

Nor do agricultural insurance providers regularly conduct detailed work hazard audits on farms (Kirkham, personal communication, 1999). Most agricultural clients do not generate enough insurance premium for insurance agencies or companies to justify providing this service. But, if an insurance company could pool the resources of several insurance types, then it may be more practical to justify conducting hazard audits on farms.

There have been many hazard audit forms developed and used by farm safety and health educators and researchers to identify farm work hazards. These audit forms have generally been dichotomous in nature; that is, response categories usually consist of "Yes/No", "Safe/Unsafe", or "Satisfactory/Unsatisfactory" options. However, hazards do not generally exist in a dichotomous state. There is usually a degree, or gradation, of hazard associated with a particular item (e.g., tractor, equipment, structure). A gradated agricultural hazard audit was originally developed for a separate research project (Murphy et al., 1998). The audit form was revised for use in this study (how the audit form was revised is explained in the next section). The advantage of a gradated audit is that the degree of hazard associated with an item being audited can be better determined. Rollover protective structures (ROPS) for tractors provide an example of how dichotomous and gradated audit forms vary. In a dichotomous audit, the type of knowledge gained is whether or not a ROPS is present on a tractor. With a gradated audit/inspection form, the auditor could report if the ROPS was:

1. A full ROPS cab with all glass and doors in place.
2. A full ROPS cab, but with glass or doors missing; or a four-post ROPS.
3. A two-post ROPS.
4. A homemade or modified ROPS.
5. A ROPS is not present or only a weather cab is present.

The Agricultural Safety and Health Best Management Practices Manual

The ASHBMP is comprised of three sections. The first section provides information on how the manual is organized, suggestions on how to use the manual, and explanations of personal protective equipment (PPE) icons. The second section is educationally oriented and provides information about specific hazards. The educational section also provides information that a farmer can use to reduce hazard levels. The third section contains the agricultural safety and health gradated audit that can be tailored to fit individual farms. A sample page of the ASHBMP is shown in figure 1.

The ASHBMP Manual was designed to address the following principles and needs:

1. Reach three audiences: farmers, educators, and the insurance industry.
2. Provide safety and health hazard knowledge and information.
3. Maximize the information given with a minimal amount of text.
4. Guide users toward a reduction in number and degree of hazards and risk.
5. Facilitate an easy-to-use standardized hazard auditing process.

This resulted in the ASHBMP Manual being designed to address each hazard topic on two pages. The first page included:

- A five-point Likert-type scale that lists the best or most safety protection (listed as a 1) to the worst or least protection (listed as a 5) for identified features. The text, utilized in the scale, defines the hazard condition and the text is further reinforced through graphics and pictures. (The original gradated audit form used only the Likert-type scale with text to describe hazard conditions).
- The graphics and pictures that correspond to the 1, 3, and 5 levels used in the Likert-type hazard scale.
- A text and graphics box that identifies PPE that should be worn.
- A text box to remind the reader of the consequence of not protecting an operator from the hazard and/or other information about protection from that particular hazard.

The second page included:

- A list of national consensus standards, federal and state regulations, and laws that have a direct impact on the hazard and/or associated equipment.
- A section titled “Other Information” that provides additional information on the hazard being discussed. This may also appear in the graphics box for Standards, Regulations, and Laws.
- A graphics box for one or two visuals that relate to the standards, regulations, laws, and/or other information.

The authors believed that by visualizing low and high hazard conditions, using a Likert-type scale to rank hazard conditions, and by reinforcing the visual message and hazard rankings with specific but minimal text, that the ASHBMP Manual would be an improvement over traditional hazard audit forms and mass media types of safety education materials. Having an individual page for each of the many possible components of the item being audited would also contribute to its user-friendly format.

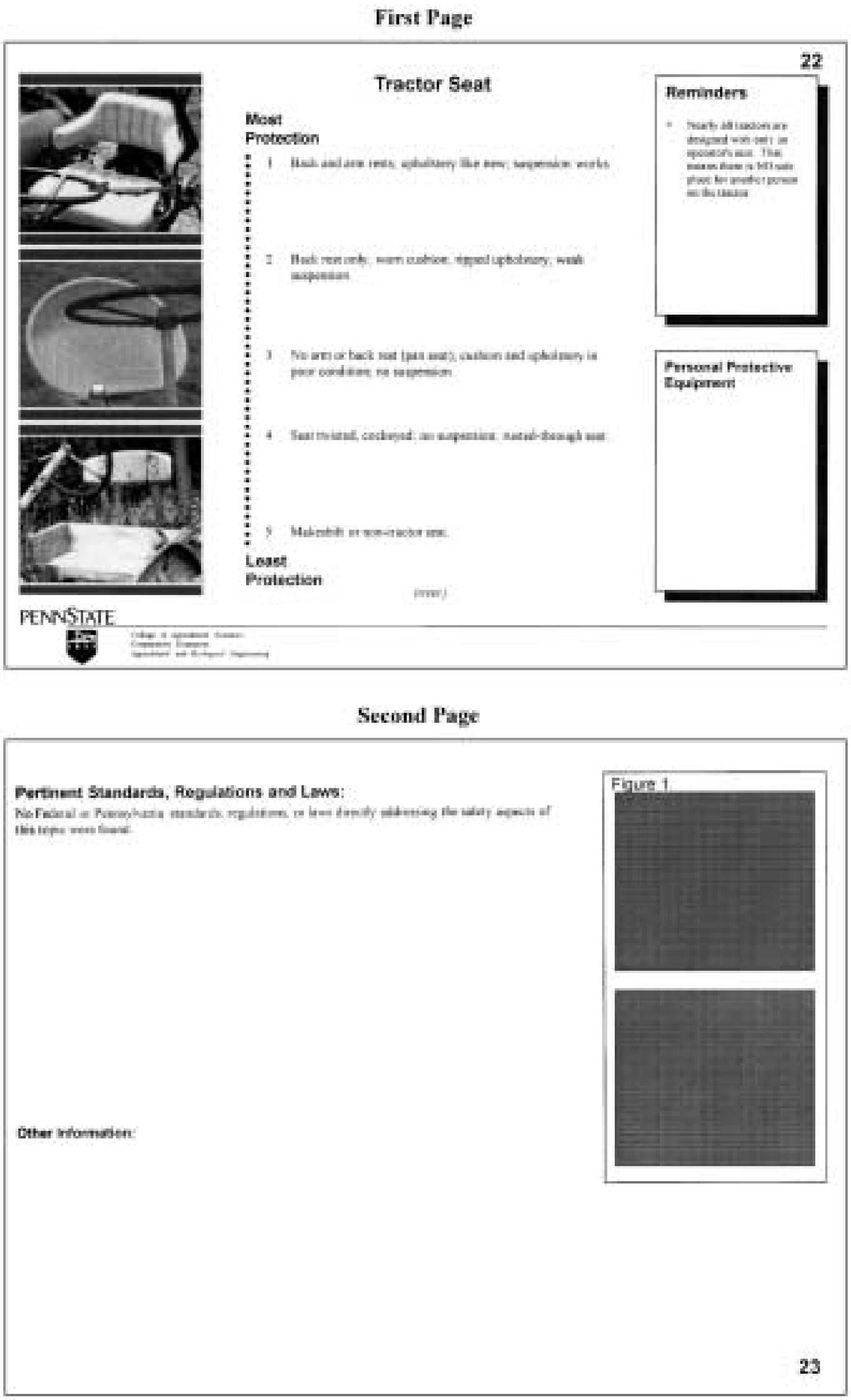

Figure 1–Sample of a hazard topic addressed in the ASHBMP manual.

Methods and Procedures

Experimental Design

The pretest-posttest control group experimental design (Campbell and Stanley, 1963) was used as the foundation for the design of the study. The design was modified to fit the needs of evaluating the ASHBMP Manual. There were three treatments and one control used in the study. In Treatment 1, farmers received a copy of the ASHBMP Manual and the results of the hazard audit conducted during the first visit. In Treatment 2, farmers received only a copy of the ASHBMP Manual, and in Treatment 3 farmers received only the result of the hazard audit. The Control group (Treatment 4) received only agricultural safety and health fact sheets.

A procedure developed by Cohen and implemented in EX-SAMPLE (Brent et al., 1993) was employed to estimate the sample size as required for analysis of covariance with one interaction. The resulting experimental design is shown in table 1.

Procedures

To fully evaluate the ASHBMP Manual, seven null hypotheses were tested. The first hypothesis tested for differences among all four treatments, while hypotheses two through seven tested for differences between specific combinations of treatments.

The hypotheses tested were:

HO1: There is no significant difference in hazard reduction effectiveness (change between Hazard Audit 1 and Hazard Audit 2) between those farmers who received both the ASHBMP Manual and the results of Hazard Audit 1, only the ASHBMP Manual, only the results of Hazard Audit 1, or only safety fact sheets (Control).

HO2: There is no significant difference in hazard reduction effectiveness between those farmers who received the ASHBMP Manual and those farmers who did not receive the ASHBMP Manual.

HO3: There is no significant difference in hazard reduction effectiveness between farmers who received the ASHBMP Manual only and those who received the results of Hazard Audit 1 only.

Table 1. A 2 × 2 factorial design

Treatment No. 1, n = 37	R	$O_{1\ (audit)}$	$X_{\text{ASHBMP, Hazard Audit 1Feedback}}$	$O_{2\ (audit)}$*
Treatment No. 2, n = 37	R	$O_{3\ (audit)}$	X_{ASHBMP}	$O_{4\ (audit)}$*
Treatment No. 3, n = 37	R	$O_{5\ (audit)}$	$X_{\text{Hazard Audit 1 Feedback}}$	$O_{6\ (audit)}$*
Treatment No. 4, n = 37†	R	$O_{7\ (audit)}$		$O_{8\ (audit)}$*

R	= randomization
O	= pretest or posttest (results of farm audit)
$X_{\text{ASHBMP, Hazard Audit 1 Feedback}}$	= treatment of ASHBMP Manual and Hazard Audit 1 feedback
X_{ASHBMP}	= treatment of ASHBMP Manual only
$X_{\text{Hazard Audit 1 Feedback}}$	= treatment of Hazard Audit 1 feedback only

* All farms were visited twice at least 90 days apart.

† Control consists of providing farmers with the following safety and health fact sheets: (1) Rural Accident Prevention Bulletin No. 18:B Safety with Animals, NSC; (2) Rural Accident Prevention Bulletin No. 12:B Fire Protection on the Farm and Ranch, NSC; (3) Slow-moving Vehicle Emblem, E-1, Penn State; (4) OSHA ROPS and Operator Instruction Requirements, E-9, Penn State; (5) Power Take-off (PTO) Safety, E-33, Penn State; Tractor Overturn Hazards, E-34, Penn State; Rural Accident Prevention Bulletin: Hazard Checklist for Agriculture, NSC.

HO4: There is no significant difference in hazard reduction effectiveness between farmers who received the ASHBMP Manual and the results of Hazard Audit 1 (Treatment 1) and those who received only the safety fact sheets (Control).

HO5: There is no significant difference in hazard reduction effectiveness between farmers who received only the ASHBMP Manual (Treatment 2) and those who received only the safety fact sheets (Control).

HO6: There is no significant difference in hazard reduction effectiveness between farmers who received the ASHBMP Manual and the results of Hazard Audit 1 and the combined effect of those farmers who received either the ASHBMP Manual or the results of Hazard Audit 1 only.

HO7: There is no significant difference in hazard reduction effectiveness between those farmers who received the ASHBMP or the results of the hazard audit and those who received only safety fact sheets (Control).

Three experienced agricultural safety and health professionals conducted all of the audits. Two auditors each conducted 40% of the audits while the third auditor conducted the remaining 20% of audits. The audits were assigned to auditors to minimize travel expenses and to accommodate time constraints among the three auditors. The lead author, who co-developed the ASHBMP, trained the other two auditors to conduct audits using the ASHBMP and to follow a specified protocol during the farm visit. The three auditors were tested for reliability with the ASHBMP hazard audit by conducting independent hazard audits on the same tractors, machines and structures. A Kendall's ω test for reliability was calculated to be 0.64. This value corresponds to a $\chi^2_{df = 2}$ value of 11.57 with an $\alpha \leq 0.005$.

Regardless of the treatment, auditors limited discussion with farm operators to a brief overview of the purpose for the visit and of the materials they were being given. For example, farm operators were told only that Penn State was trying out different approaches to helping farmers identify and reduce farm hazards. When the ASHBMP manual was presented, the farm operator was shown only how the manual was organized and structured. All treatments were provided to the farm operator at the completion of the first farm visit.

The same auditor audited each farm twice with at least 90 days between the visits. Farm audits typically took 45 min to 1 h to complete. The farm operator accompanied the auditor on some portion of the audit about 75% of the time during the initial audit, and about 50% of the time during the post intervention audit. These percentages held true for all four treatment groups. The data collected during the first audit is referred to as Hazard Audit 1.

The Hazard Audit 1 mean score for each treatment group and the control group was used as the covariate variable. Treating the baseline score as a covariate has two effects: (1) it allows for evaluation of all three treatments and the control as statistically equivalent; and (2) the error variance is significantly reduced. Therefore, a more robust and higher standard is set for accepting or rejecting hypotheses (Kirk, 1982; Kennedy and Bush, 1985). The data for testing HO1 were computed using the GLM-Factorial Model and the ANOVA procedures (Ott, 1988). The data for the remaining hypotheses were analyzed using only the GLM-Factorial Model. All analyses were conducted with SPSS version 8.0®.

Sample Selection

The population for this study were Pennsylvania farm operators who were insured by Old Guard Insurance Group. Old Guard is the largest farm insurer in the state, had a client base of 4,871 farm operations from which the sample was selected, and did not have an active loss control program for farmers prior to the project. This client base was geographically distributed throughout the state. To maximize generalizability of the results to all Pennsylvania farms, the sample was stratified to fit the distribution of farms throughout the Commonwealth as identified by the Pennsylvania Department of Agriculture. To be eligible for the study, each farm and its operator had to have the following characteristics:

- Average at least 40-h per week working on the farm over the previous year.
- Intended to continue farming with at least the same level of production over the next few years.
- A gross product of at least $10,000 (a medium size Pennsylvania farm).
- At least two tractors that are used regularly.
- At least three PTO-powered machines that are used regularly.
- Two of the following types of agricultural structures:
  - A building/structure used to house livestock;
  - A building/structure used for storage and/or repair of tractors and machinery; or
  - A bank barn that has at least one silo attached to it.

A single building/structure was acceptable to participate in the study if the building/structure was used for more than one purpose and if those purposes were in distinct areas.

One hundred-fifty eligible farm operators agreed to participate in the study. This represented a participation rate of 66.4%. Farmers were not offered any financial incentive to be a part of the study. Those farmers who stated that they were not interested in participating in the study were not contacted again to obtain information about themselves or their farm. Farm operators who agreed to participate were randomly assigned to one of the four treatment groups by the random number generator in Excel®.

Results

Of the 150 farms that agreed to participate, 145 completed the study. From these farms, 327 tractors, 413 PTO-powered machines, and 381 buildings, structures or other facilities were evaluated using the ASHBMP audit.

The data analyses for hypotheses one (HO1), four (HO4), six (HO6), and seven (HO7) revealed no significant differences among the treatment groups, therefore these results are not presented, except for HO1.

Hypothesis 1 (HO1) tested for differences among the four treatments (see fig. 2). The data for HO1 did not show a significant difference at the 0.05 probability level ($F_{3,\ 1054} = 2.204$ and $p < 0.086$) between those farmers who received both the ASHBMP Manual and Hazard Audit 1 results (Treatment 1), only the ASHBMP Manual (Treatment 2), only the results of Hazard Audit 1 (Treatment 3), or only easily obtainable safety fact sheets (Control). Figure 2 shows the estimated marginal means on the y-axis and the treatment groups on the x-axis. The estimated marginal means represents the estimated difference in the mean values between Hazard Audit 1 and Hazard Audit 2. Figure 2 shows a clear difference in the estimated marginal means between Treatments 1 and 2 versus Treatments 3 and 4. This difference and the fact that the p-value for the test approached the 0.05 level indicates that further testing was appropriate.

The purpose of hypothesis two (HO2) was to test whether or not there was a significant difference between farmers who received the ASHBMP Manual and farmers who did not receive the ASHBMP Manual. To complete this analysis,

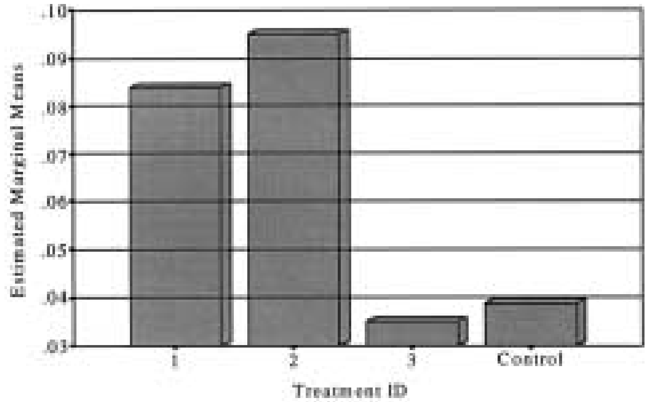

Figure 2–Estimated marginal means for overall change across all sections of the hazard audit.

Treatments 1 and 2 were combined and renamed as Treatment 1A, and Treatment 3 and the Control were combined and renamed as Treatment 2A, as the essential difference between the combined treatments was the farmer receiving the ASHBMP Manual or not. Combining the treatments results in reduced degrees of freedom, thus a higher F value is required to obtain significance. Hypothesis 2 was rejected as a positive significant difference ($F_{1,\ 1056} = 6.454$ and $p < 0.011$) was found (see fig. 3). That is, farmers who received the ASHBMP Manual reduced hazards more than farmers who did not receive the manual.

The purpose of HO3 was to test whether or not there was a significant difference between farmers receiving only the ASHBMP Manual (Treatment 2) and farmers receiving only the results of Hazard Audit 1 (Treatment 3). Figure 4 illustrates that a significant difference ($F_{1,\ 510} = 4.4441$ and $p < 0.036$) was found. Farmers who received the ASHBMP Manual reduced hazards more than those receiving only the hazard audit results.

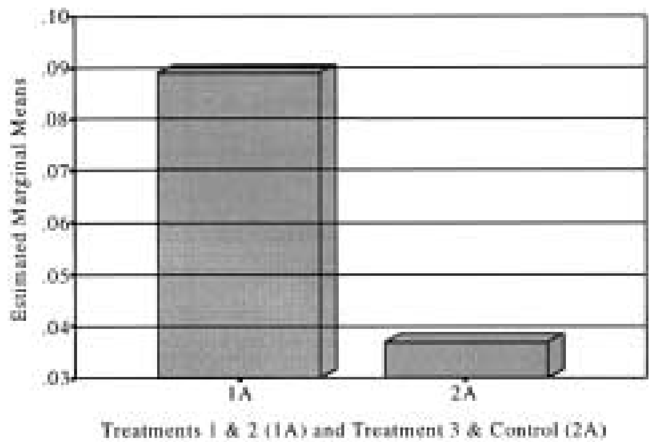

Figure 3–Estimated marginal means for treatments 1 and 2 (1A) and Treatment 3 and Control (2A).

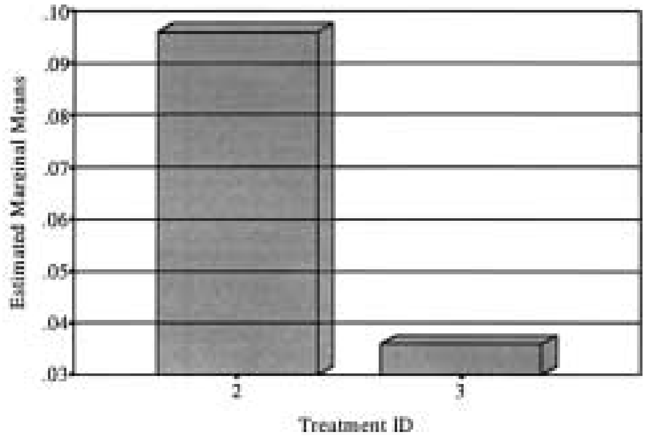

Figure 4–Estimated marginal means for Treatments 2 and 3.

The purpose of HO5 was to test if there was a significant difference between farmers who received either the ASHBMP Manual or the safety fact sheets. There was a positive significant difference ($F_{1, 502} = 4.088$ and $p < 0.044$) in the reduction of hazard levels found on farms when farmers used the ASHBMP Manual versus the safety fact sheets (see fig. 5).

Discussion

The analysis of HO1 data revealed two unexpected findings. We expected that Treatment 1 (ASHBMP Manual plus the results from Hazard Audit 1) would have the greatest positive effect on reducing farm hazard levels because it provided the farm operator with the most information. As figure 2 shows, the greatest reduction

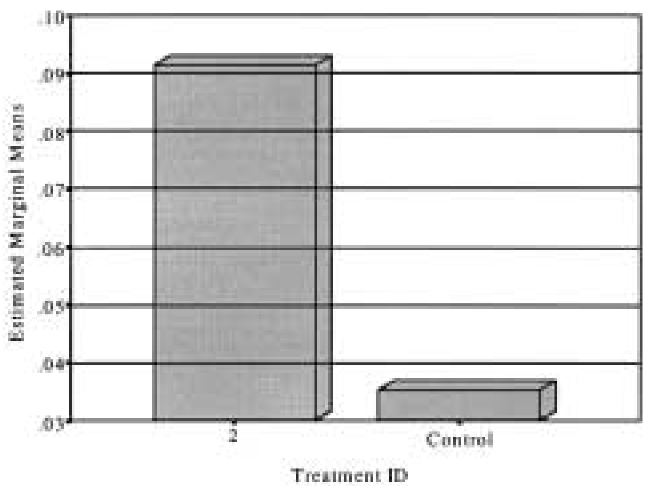

Figure 5–Estimated marginal means for Treatment 2 and Control.

in hazard levels was with Treatment 2 (ASHBMP Manual only). We also expected that Treatment 3 (results from Hazard Audit 1) would have a greater positive effect for reducing hazard levels than the Control (safety fact sheets only). Figure 2 also shows that this did not occur. One explanation for these unexpected results is that any safety or hazard audit may trigger a negative reaction on the part of the farm operator. Such audits or inspections are likely to focus attention on conditions that need to be corrected. These corrections usually result in expenditures of time and money that farm operators may not want to expend. Another explanation may be that the farmer isn't comfortable having negative aspects of the operation identified.

The second and third hypotheses (HO2 and HO3) tested whether or not the ASHBMP Manual, by itself or when combined with the results of Hazard Audit 1, contributed to a significant reduction in farm hazards. Both of these hypotheses showed that there was a significant reduction in farm hazard levels on the farms studied. These results offer good evidence that the ASHBMP Manual is a tool that can be used by farmers to reduce farm hazard levels.

The fifth hypothesis tested whether or not a significant difference was found between farmers who received only the ASHBMP Manual and those who received only the safety fact sheets. There was a significant difference between farmers who received the ASHBMP Manual and those who received the safety fact sheets. This finding is consistent with the findings of HO2 and HO3.

The analyses consistently showed that those farmers who had the ASHBMP Manual had the greatest levels of hazard reduction. Providing the results of the hazard audit to farmers lowered slightly their hazard reduction activity, but this still produced significantly lower hazard levels than the control treatment (safety fact sheets). The slight negative effect the hazard audit had on farmers' willingness to reduce farm hazards may be alleviated in the future if insurance companies use the information gained from the hazard audit to give financial incentive to farmers who participate in hazard reduction activities.

Hypothesis four, six, and seven tested whether or not there was a significant difference between those farmers who received various combinations of the ASHBMP manual, results of Hazard Audit 1, and only the safety fact sheets. A significant difference at the $p = 0.05$ level was not found. It is hypothesized that the possible negativism associated with receiving hazard audit results kept the differences between these various groups from reaching significance.

The essence of each of the four treatments involved providing farm operators "educational" information on farm hazards and how to reduce them. The positive results associated with use of the ASHBMP Manual can be interpreted as supportive of safety education as a method for reducing farm hazards. In the authors' opinion, the format of the ASHBMP Manual alleviates some limitations of mass produced, general appeal types of educational materials (See Murphy, 1992, for more discussion of these limitations).

The ASHBMP Manual is not considered a finished document by the authors, and evaluation of the manual has not been completed. The manual developed and tested for this study is strongly oriented toward tractors and mobile farm equipment, with a lesser emphasis on farm buildings, structures, facilities or animals.

Summary

The ASHBMP Manual was developed to be an alternative tool that could be used by farm operators, the insurance industry and safety and health educators to reduce farm work hazards. Research was conducted with Pennsylvania farmers to determine if the manual was more effective in encouraging farmers to reduce hazards as compared to providing farmers with safety and health fact sheets. Differences among groups of farmers with combinations of the ASHBMP Manual, hazard audit results, and the fact sheets were also examined. Significant differences were found between groups of farmers who were given the ASHBMP Manual and those who were not given the manual. The data supports the conclusion that the ASHBMP Manual is an effective tool for helping farmers reduce workplace hazards.

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