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Prevention of Occupational Respiratory Symptoms Among Certified Safe Farm Intervention Participants

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ABSTRACT. Certified Safe Farm (CSF) is a multifaceted intervention including clinical Occupational and wellness screening, education, and on-farm safety audits with set safety standards, and performance incentives. Five years of respiratory health outcomes are reported in 150 CSF intervention farmers and 158 matched controls. Standardized health interviews and occupational histories were analyzed with descriptive statistics to determine prevalence rates. There was a 100% response rate from the standardized telephone interviews, and respectively a 94% and 89 % response rate from the self-administered occupational health history questionnaire for the CSF intervention and the comparison population. The overall rate for occupational respiratory conditions was 17/100 person-years. At baseline there was no difference between the prevalence of respiratory symptoms between the CSF and control groups. However, over the course of the intervention, the CSF farmers increased their use of personal protective respiratory equipment at work, and experienced fewer episodes of acute symptoms of organic dust toxic syndrome (ODTS). The Certified Safe Farm intervention appeared to affect increased use of respiratory protection and decreased symptoms of ODTS.

KEYWORDS. Agriculture, hazard, health and safety, pork, respiratory disease, swine

BACKGROUND

The need for effective and sustainable illness and injury prevention programs in farming has been recognized for many years.[1] However, published reports of successful and sustainable preventive programs are rare.[2]

Multifaceted, incentive-driven programs appear to provide the best chance for effectiveness and sustainability.[2–5] Certified Safe

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Farm (CSF) is a multifaceted intervention, first initiated in 1996 in Iowa. The CSF intervention evolved from a variety of prior experiences. A portion of the CSF concept originated in farmer's health programs in Sweden and Finland in the late 1970s where public policy supported the proposition that farmers should have access to occupational health services equivalent to those of other industries.[6–8]

This concept led to a series of intervention programs in Iowa that encompassed multiple factored interventions incorporating components of several different theories of behavior change, including the health belief model,[9] attribution theory,[10] and the theory of reasoned action.[11] These programs include the Iowa Agricultural Health and Safety Service Network (now the AgriSafe Network; www.AgriSafe.org),[12,13] the Swine Producer Respiratory Disease Prevention Program,[14–16] and the Tractor Risk Abatement and Control Program.[17] These previous interventions also included components of different theories of behavior change, as mentioned above.[9–11] Taking what we learned through experience and evaluation of these programs, we reflected on both the behavior change theories and our background knowledge of the cultural, social, and economic realities of the farm community we serve. From these considerations, we developed the Iowa Model of Farm Health and Safety Intervention as a comprehensive approach to farm safety and health.[4] The "Iowa model" was used to design the Certified Safe Farm (CSF), a program in current use. The CSF program includes five components: (1) clinical screenings for occupational illnesses or injuries, (2) clinical wellness screenings, (3) on-farm safety reviews, (4) farmer health and safety education, and (5) incentives. Although the CSF program aims broadly at occupational health and safety prevention, this report focuses on respiratory health.

The long-term goal of the CSF program is to help sustain farming through reduction of occupational illnesses and injuries in farmers and farm workers, while concomitantly creating value for insurance companies and agribusinesses through lowered claims and preservation of human resources. Further aspects of CSF results have been described elsewhere.[4,18–21] A prior analysis of self-reported data from this study indicated that insurance companies would save up to 47% on medical care costs for occupational illnesses and injuries.[22] A qualitative assessment has revealed a high level of participant satisfaction with this program.[23] Additional results of the CSF program have been reported elsewhere.[4,18,21]

Respiratory health is a significant aspect of farm safety and health and is a component within CSF. This article focuses on the respiratory component and features an analysis of occupational respiratory conditions comparing farmers in the CSF program to controls.

Respiratory conditions have long been recognized as a major occupational concern among farmers in both North America and Europe.[4,24–26] Numerous studies have defined that organic dust exposures are associated with a cluster of occupational respiratory conditions among farmers that are defined by symptoms. The symptoms associated with exposure to agricultural organic dusts include a syndrome previously described[4] that includes one or more of the following conditions: acute and chronic bronchitis, atopic asthma, asthma-like syndrome (nonallergic occupational asthma), mucous membrane irritation, organic dust toxic syndrome, and hypersensitivity pneumonitis.[4,27,28] Using the symptoms assessment instrument of the American Thoracic Society (ATS) for chronic conditions without reference to exposures,[29] symptoms of airways dysfunction in farmers are often elevated compared to the general population. Starting with the ATS instrument, a special questionnaire to assess symptoms of occupational airways disease in farmers was developed by Rylander and coworkers.[30] This assessment tool has been utilized in several studies in conjunction with occupational history assessments to define occupational respiratory conditions in farmers.[15,20]

Although use of personal protective equipment (PPE) is required by the Occupational Safety and Health Administration (OSHA) in certain situations, the bulk of agriculture is exempt from unannounced inspection and enforcement of OSHA regulations if there are fewer than 11 employees. Although general use

of respiratory protection is not commonly practiced among workers in production agriculture, several studies have shown there is a positive effect from respirator use.[4,14–17,31]

The specific objectives of this study were to (1) report the prevalence of occupationally-related respiratory symptoms among a cohort of Midwestern (US) farmers; and (2) assess the effectiveness of the Certified Safe Farm intervention program in reducing exposure to respiratory hazards through various means, with a focus on increasing behaviors affecting the use of respiratory protection; and (3) evaluate the effectiveness of the CSF program to reduce the prevalence of occupational respiratory symptoms among farmers. It was our hypothesis at the beginning of the study that fulfillment of CSF requirements by individual producers would in fact result in (a) increased use of respirators, and (b) decreased symptoms indicative of respiratory illnesses.

METHODS

Study Design

The CSF study was a prospective cohort intervention conducted in a nine-county area in Northwest Iowa between 1998 and 2003. The study population was randomly selected from the total farms in the nine-county area. The unit of randomization was the farm. A farm was defined by the US Department of Agriculture definition of having at least $1000 of annual sales. The sample was selected by the Iowa Agricultural Statistics Service. We targeted a population with the goal of maintaining a minimum (based on power calculations) of 125 CSF intervention farms and 125 control farms over the study period. Prior to assigning farms to intervention or control, the farms were stratified based on similarities of farm size, type of commodity production, and frequency of self-reported farm injuries. These farms were then paired within strata of the variables mentioned above and randomly assigned to either the intervention or control group (CSF intervention, $n = 150$ control, $n = 158$).

The unit of study was the principal operator of the farm (the person who reports as primary owner, manager, and providing a significant portion of the labor). For the entire CSF project multiple components of the farm and health and safety outcomes were studied, but for this study only one producer per farm was studied for information relative to respiratory health. Details of the study design are published elsewhere.[18,22]

The CSF project was approved by the University of Iowa College of Medicine Institutional Review Board for the protection of human participants in research.

Study Population

A total of 308 farms were recruited into the study from a random sampling of the total farm population in the nine-county area. Almost all commercial commodity farms in the upper Midwest raise corn and soybeans, and 30% of the farms (at the time of this study) produce pork. Production of beef cattle, dairy, and poultry follow in that order in terms of frequency of production. The principal operators on the farms in this nine-county area averaged 51.3 years of age at the beginning of the study (52.4 for all Iowa), with 96% male (95% Iowa). The average farm size in this region of the state was 404 acres (343 for all Iowa). The average acreage for the farms in the study was 601. Table 1 shows that the producers that were included in the study were similar to the area producers in gender, age, and education level, except with larger farm size. Comparing the intervention and control groups, age, gender, farm size, and distribution of farm sizes, the two groups were very similar. An exception is that 12% more of the CSF group had bachelors degrees or higher compared to the controls.

The Certified Safe Farm Intervention

The CSF intervention consists of a multifactor program that targets general farm occupational illness and injury prevention as well as wellness. The CSF intervention group completed all aspects of the program as outlined below. The control group had none of the intervention, but received the same phone and mail surveys to record their experience with

TABLE 1. Baseline Characteristics of Study Population by Intervention Status

Characteristic	CSF intervention farms		Control farms	
	Number	%	Number	%
Total farms	150	100%	158	100%
Sex, men	147	98%	156	99%
Sex, mean for region		96%		96%
Age in years at study entry				
<45	67	45%	64	41%
45–59	49	33%	62	39%
≥60	34	23%	33	20%
Mean age of group/mean for region	51/51.3		51/51.3	
Baseline year				
1998–1999	132	88%	114	72%
2000–2002	18	12%	44	28%
Education level				
Less than bachelors degree	92	61%	116	73%
Bachelors degree or more	58	39%	42	27%
Farm size in acres				
<250	35	23%	41	26%
250–749	69	46%	65	41%
≥750	46	31%	52	33%
Mean acres per farm	640		610	
Any livestock production, yes	89	59%	96	61%
Farm hours per week, ≥40 all year	123	82%	120	76%
Work with grain, yes	141	94%	140	89%
Any swine confinement	59	39%	59	37%
Confinement hours per year, ≥500	36	24%	34	22%
Injuries reported in prior year	26	17%	27	17%
Current smoker, yes	4	3%	12	8%

Note. Data from the occupational history survey.

occupational illnesses and injuries as well as safety and wellness behaviors.

1. *Occupational and wellness clinical screening services.* The CSF intervention principal operators (producers) presented to an AgriSafe clinic, and underwent the following procedures:
   a. A detailed, standardized occupational history was conducted to detect exposures and health risks from their farming operation.
   b. Pulmonary function testing (PFT) was performed along with various other clinical screenings. (A full description of all components of the clinical screening are published elsewhere.[22])
   c. A detailed consultation with the participant was conducted by a trained AgriSafe nurse (Registered Nurse who has taken the approved 40 hour agricultural medicine course, http://www.publichealth.uiowa.edu/icash/education/agmedtraining.html) who discussed and explained the relationship between the individual's farm exposures, risks, and personal health data (e.g., PFT results), to personalized farm preventive practices.
   d. Recommendations for specific personal protective equipment were provided, with demonstration of the recommended equipment. The participants were allowed to try on the equipment, and fit testing of respirators was performed as indicated by the nurse, with training on how to "self fit-test" PPE in the field.
   e. Occupational health and wellness goals were presented to the participant on

personalized general preventive measures along with specific PPE selection and fitting. Participants had the choice of purchasing PPE from the clinic at the time of the examination, or ordering it from one of several nurse-recommended suppliers.

f. The nurse made follow-up phone call to check on progress of the health goals.
g. This process was repeated yearly over the 5-year course of the study.

2. *Educational supports*. Quarterly newsletter, Web site access, and yearly group educational meetings were included in the intervention to enhance and expand the personal education of the CSF producers that occurred with the nurse.
3. *Farm audit*. On-farm safety audits were conducted annually on participants' farms.
   h. Following the clinical visit, one of the CSF trained auditors conducted a standardized inspection of the farm site—the principal operator (producer) was required to accompany the auditor in order for him to understand what safety or health risks might be present, and how to remedy the risk. The auditor also looked for evidence of proper PPE on hand, stored in the correct place, and evidence of its usage.
   i. The auditor scored the farm, with the goal of achieving at least an 85%. If the farm did not achieve 85% (CSF status) on first visit, a follow-up visit was made.
4. *Incentive.* Farms that achieved at least an 85% audit score were awarded CSF status, and the principal received a $200 payment, annually, as long as CSF status was maintained.

Data Collection Procedures

Self-reported health and injury data were collected from the CSF intervention principal operators as well as the control population by two methods; a quarterly computer aided telephone interview (from trained interviewers, who were blinded as to the intervention status of the subjects) and an annual paper occupational history questionnaire. Clinical data were obtained annually at an occupational and wellness screening on the CSF intervention group by the trained agricultural health nurses.

The phone interviewers asked questions on occupational injuries and illnesses experienced the previous quarter, whereas the written questionnaire asked questions on changes in exposures (farming operation safety changes recommended by the auditors) and occupational illnesses and injuries experienced over the previous 12 months. Questions pertaining to respiratory health were taken from the American Thoracic Society respiratory health questionnaire, modified by a consensus process to detect agricultural occupational respiratory symptoms as reported by Rylander and coworkers.[30]

Examples of respiratory health questions included, "How often have you had any of the following symptoms associated with your farm work?" (1) Dry cough, (2) Chest tightness, (3) Cough with phlegm, (4) Throat irritation, (5) Wheezing chest. The possible responses to this question were scaled as never, less often than monthly, monthly, weekly, or daily. Case definitions of respiratory conditions were based on reported symptoms, and according to the guidelines from farm occupational respiratory questionnaire as described by Rylander and coworkers.[30] Acute bronchitis was defined by a questionnaire response of a dry cough associated with farm work, and occurring monthly, weekly, or daily but for 2 years or less. Chronic cough with phlegm for at least 3 months of the year for over 3 years was classified as chronic bronchitis. Chest tightness or wheezing associated with farm work was classified as asthma. Throat, nasal, eye, or sinus irritation was classified as mucous membrane irritation. For the classification of organic dust toxic syndrome (ODTS), the question was "During the past 12 months, after an extra heavy dust exposure, such as cleaning a grain bin, moving/sorting hogs, opening a silo, have you ever had any of the following symptoms?" (fever, shivering, muscle or joint aches, tiredness, weakness, cough, chest tightness, shortness of breath, or

headache) Those responding yes to at least three of these symptoms within this symptom complex were classified as a case of ODTS.

The occupational health history included questions on farm characteristics, work exposures, injuries, and illnesses. For the use of respiratory protection, the use was confirmed by the response of at least 75% to the following question on the written questionnaire: "What percentage of time did you use respiratory protection when working among grain dust?"

Testing of respiratory function was conducted according to American Thoracic Society Criteria[29] by trained (NIOSH spirometry course, and AgriSafe Network provider training) nurses at the annual occupational health screening at specialized AgriSafe agricultural occupational health clinics.

The AgriSafe provider nurses (RNs) were required to complete the 40-hour Agricultural Medicine Core Course (www.public-health.uiowa.edu/icash) and pass a certificate examination conducted by faculty and staff of Iowa's Center for Agricultural Safety and Health. The on-farm-safety reviews were conducted by trained independent consultants with past agricultural experience. These auditors received a 16-hour training program, and participated in a continual quality assurance program. A standardized pretested instrument was used to conduct the audit and score the level of safety on the farm. A minimum score of 85% was required for the farm to become certified. The AgriSafe nurses also provided one-on-one occupational health and wellness education, based on individual results from the occupational history, clinical examination, and wellness screening. General farm health and safety training of participants was provided by CSF staff through quarterly newsletters with targeted educational pieces, a Web site targeting information to the participants, and annual face-to-face educational meetings.

Variables

The variables used to evaluate the respiratory component of the intervention included symptoms of occupational airways symptoms as well as symptoms of organic dust toxic syndrome. These variables are seen in the assessment tool designed for farm organic dust exposure, as developed by Rylander and coworkers.[30] Further, the variable on the standardized questionnaire re use of respirators were additional variables compared between the intervention and control.

Data Analysis

Results reported here are the surveillance data acquired over the 5-year course of the study. Data from 2525 quarterly call interviews, 1171 annual paper questionnaires (from the combined CSF intervention and controls), clinical data, and farm audit data were analyzed, using descriptive statistics and the Mantel-Haenszel chi-square for tests with the SAS statistical software.[32]

RESULTS

Demographics of Farmers in CSF Study

Demographics of the 308 producers in the study population are seen in Table 1. The demographics and exposure characteristics of the CSF intervention and control groups were comparable. Smoking status was low and no significant difference was seen between groups (3% and 8%, respectively, CSF and controls). Data from the study sample were analyzed for respiratory health indicators, use of personal protective equipment, and intervention status.

Prevalence of Occupational Respiratory Symptoms and Respirator Use at Baseline

Results From Quarterly Phone Interviews

Of the 2525 quarterly phone interviews completed, representing 748 person-years of observation, 127 farmers reported having a farming-related respiratory illness, as defined by the case definition seen above (i.e., case; refer to Data Collection Procedures, para. 3). The overall rate was 17 respiratory illnesses per 100 person-years.

TABLE 2. Comparison of Self-Reported Respiratory Symptoms at Entry to Study by Intervention Status*

	CSF		Control	
	n	%	*n*	%
Total farms	141	100%	140	100%
Symptoms				
Dry cough	19	13%	20	14%
Chest tightness or wheezing	20	14%	20	14%
Cough with phelgm	42	30%	39	28%
Throat irritation	21	15%	19	14%
Any of the above four symptoms	60	43%	51	36%
Organic dust toxic symptoms	52	37%	48	34%

*Data from occupational history survey; based on returns of this self-reported (mailed) paper survey, which had a 94% response from the CSF intervention group, and an 89% response from controls.

Results From Annual Occupational Health Questionnaire

The annual occupational history questionnaire revealed details on the type of conditions seen. Table 2 shows that at baseline, the percentages of CSF and control producers were nearly identical with regards to prevalence of airways symptoms. Table 2 also shows that symptoms of the acute condition of ODTS were nearly identical at baseline for both CSF and controls (37% and 34%, respectively).

Respirator Use Following Intervention

The use of respiratory protection by the CSF group and the control group was nearly identical at baseline (35% and 36%, respectively) (Table 3). After initiation of the intervention, the usage of PPE in the CSF increased to 47% and held relatively stable near that level over the course of the study. The mean increase in PPE usage over time by the CSF intervention group was highly statistically significant ($p = .0094$). On the other hand, the control group stayed almost at the same lower level of 36% over the course of the study. Comparing PPE usage of the CSF group to controls by year, the increased PPE usage in the former was near significance in years 1 and 2 ($p = .08$), and reached high significance in year 3 ($p < .01$) (Table 3). However, the difference was not as great in year 4. Further, Table 4 illustrates that respirator usage was also influenced by age of the producer. The younger producers (<45 years) tended to use PPE at a higher prevalence than the older producers. Tables 5 to 7 track different age groups and how they responded over time to respirator usage. We observed that the difference in increased respirator use in the CSF intervention was more pronounced in the CSF intervention group who were under 60 years of age.

Respiratory Symptoms Following Intervention

Although the overall prevalence of chronic respiratory symptoms was comparable between groups, the prevalence of ODTS symptoms in the CSF intervention group fell over the course of the study ($p < .05$). Table 8 indicates that the decrease in ODTS was progressive over the 5 years of observation, and in comparison to the control group in each year reached statistical

TABLE 3. Respirator Use Among Certified Safe Farm Study Participants by Intervention Status*

	CSF (no. of farms)	Yes, PPE use		Control (no. of farms)	Yes, PPE use		Significance (*p* value)†
Baseline	141	50	35%	140	51	36%	.87
+1 year	129	60	47%	126	45	36%	.08
+2 years	120	56	47%	108	38	35%	.08
+3 years	99	47	47%	71	20	28%	.01
+4 years	75	33	44%	55	21	38%	.50

*Data from the occupational history survey; based on returns of this self-reported (mailed) paper survey, which had a 94% response from the CSF intervention group, and an 89% response from controls.
†Chi-square test.

TABLE 4. Baseline Year Respirator Use (Combined CSF and Control)

	Total	*n*	%
Ages 45 and under	119	47	40%
Ages 46 to 59	98	34	35%
Ages 60 and over	64	20	31%

significance by year 4 ($p = .05$). Table 9 demonstrates that the symptoms of ODTS episodes were more prominent in the younger age groups. Tables 10 to 12 suggest that the effect of the CSF intervention on reduction of ODTS was seen primarily in the age group under 60 years.

DISCUSSION AND CONCLUSIONS

Demographically, the producers in the groups on study farmed slightly more acres than the general farming population of Iowa. The average farm size was slightly over 600 acres. This compares the average 404 acres for the region.[33] Despite these demographic differences, these farms are likely a fair representation of commercial commodity farms in the state. There are many part-time or lifestyle small farms that bring the total average size down. However, based upon our experience, it takes farms of the size in this population to be viable commercial commodity farms.

TABLE 5. Respirator Use in the Certified Safe Farm Study Over Time, Ages 45 and Under

	CSF (no. of farms)	Yes, PPE use		Control (no. of farms)	Yes, PPE use		Significance (*p* value)†
Baseline	62	26	42%	57	21	37%	.57
+1 year	56	27	48%	51	15	29%	.05
+2 years	50	24	48%	39	16	41%	.51
+3 years	42	19	45%	25	7	28%	.16
+4 years	32	13	41%	17	6	35%	.72

†Chi-square test.

TABLE 6. Respirator Use in the Certified Safe Farm Study Over Time, Ages 46 to 59

	CSF (no. of farms)	Yes, PPE use		Control (no. of farms)	Yes, PPE use		Significance (*p* value)†
Baseline	45	14	31%	53	20	38%	.49
+1 year	44	24	55%	48	20	42%	.22
+2 years	42	21	50%	44	16	36%	.20
+3 years	33	18	55%	31	8	26%	.02
+4 years	23	12	52%	27	10	37%	.28

†Chi-square test.

TABLE 7. Respirator Use in the Certified Safe Farm Study Over Time, Ages 60 and Over

	CSF (no. of farms)	Yes, PPE use		Control (no. of farms)	Yes, PPE use		Significance (*p* value)†
Baseline	34	10	29%	30	10	33%	.73
+1 year	29	9	31%	27	10	37%	.67
+2 years	28	11	39%	25	6	24%	.23
+3 years	24	10	42%	15	5	33%	.61
+4 years	20	8	40%	11	5	45%	.77

†Chi-square test.

TABLE 8. Comparison of Self-Reported Respiratory Symptoms* of ODTS by Year of Certified Safe Farm Study by Intervention Status

	CSF (no. of farms)	Farms with 3 or more symptoms		Control (no. of farms)	Farms with 3 or more symptoms		Significance (p value)†
Baseline	141	52	37%	140	48	34%	.65
+1 year	129	19	15%	126	29	23%	.09
+2 years	120	16	13%	108	19	18%	.37
+3 years	99	14	14%	71	11	15%	.81
+4 years	75	9	12%	55	14	25%	.05

*Data from the occupational history survey.
†Chi-square test.

TABLE 9. ODTS Symptoms in Study Participants at Baseline Year (Combined CSF and Control)

	Total	n	%
Ages 45 and under	119	50	42%
Ages 46 to 59	98	34	35%
Ages 60 and over	64	16	25%

The intervention and control farms were pair-matched on demographic and injury history, as well as randomly assigned to either the intervention or control group, increasing the probability of a representative comparison population. The demographics of the two groups were similar in every aspect, except that the former had slightly more producers (12%) with a bachelor-level or higher education. Baseline assessment of respiratory symptoms of the CSF and control groups was quite similar in terms of respiratory health status, further suggesting these groups are comparable. Random selection, matching, and blindness to group status of the trained phone interviewers assisted in helping to reduce bias in the study.

In summary, the effectiveness of the CSF intervention was demonstrated in two important outcomes. The intervention farmers used respiratory protection more commonly than controls after initiation of the intervention. The intervention farmers had significantly reduced prevalence of the acute respiratory condition ODTS following intervention, suggesting that use of PPE is associated with the observed decrease in ODTS. This increased use of PPE and decreased risk of ODTS was primarily seen in the younger age group, suggesting that additional methods may be necessary to achieve protection of senior farmers.

Regarding the effects of the intervention, it was observed that the intervention farmers used respiratory protection much more frequently following the intervention relative to controls. Interestingly, the auditors did not report the lack of PPE on any of the intervention farms, suggesting that affecting use of PPE goes beyond just having the equipment on the farm, and

TABLE 10. Comparison of Self-Reported Respiratory Symptoms of ODTS by Intervention Status, Ages 45 and Under

	CSF (no. of farms)	Farms with 3 or more symptoms		Control (no. of farms)	Farms with 3 or more symptoms		Significance (p value)†
Baseline	62	23	37%	57	27	47%	.26
+1 year	56	11	20%	51	14	27%	.34
+2 years	50	7	14%	39	11	28%	.10
+3 years	42	8	19%	25	6	24%	.63
+4 years	32	6	19%	17	6	35%	.20

†Chi-square test.

TABLE 11. Comparison of Self-Reported Respiratory Symptoms of ODTS by Intervention Status, Ages 46 to 59

	CSF (no. of farms)	Farms with 3 or more symptoms		Control (no. of farms)	Farms with 3 or more symptoms		Significance (p value)[†]
Baseline	45	19	42%	53	15	28%	.15
+1 year	44	4	9%	48	14	29%	.02
+2 years	42	6	14%	44	5	11%	.69
+3 years	33	5	15%	31	4	13%	.79
+4 years	23	1	4%	27	7	26%	.06

[†]Chi-square test.

TABLE 12. Comparison of Self-Reported Respiratory Symptoms of ODTS by Intervention Status, Ages 60 and Over

	CSF (no. of farms)	Farms with 3 or more symptoms		Control (no. of farms)	Farms with 3 or more symptoms		Significance (p value)[†]
Baseline	34	10	29%	30	6	20%	.39
+1 year	29	4	14%	27	1	4%	.19
+2 years	28	4	14%	25	3	12%	.81
+3 years	24	1	4%	15	1	7%	.73
+4 years	20	2	10%	11	1	9%	.94

[†]Chi-square test.

that usage was influenced by the multiple intervention components of the CSF program. The intense personalized and group education, consultation, and incentive likely increased the usage of PPE.

Regarding differences in respiratory symptoms between intervention and nonintervention, there was little difference in chronic symptoms (e.g., bronchitis, asthma, and mucous membrane irritation). However, the intervention did show a strong effect in reducing symptoms of ODTS (an acute condition). Because the CSF intervention had only been in effect a relatively short time (5 years), it is not likely that the CSF program could be expected to affect chronic respiratory outcomes. Therefore, a decrease in chronic respiratory symptoms within the 5-year time frame was not necessarily expected. However, it is important for an intervention to identify and reduce acute symptoms, because acute symptoms often lead to chronic symptoms. Furthermore, once chronic symptoms occur, it may take many years for the symptoms to dissipate, even with excellent protection from the work environment. Without protection, symptoms could progress leading to irreversible changes.

Although ODTS is an acute condition, there are observed chronic consequences. Those who experience episodes tend to develop more severe symptoms with less exposure in future incidents.[4] Furthermore, exposed individuals may develop a chronic form of ODTS manifested as chronic fatigue and dyspnea.[4] Although the positive effects of wearing respirators in the agricultural work environment have been shown before,[33] this is the first agricultural health intervention study to show a decrease in ODTS.

In order to decrease the need for use of respiratory PPE, controlling dust exposure in production agriculture should be the primary means of minimizing the respiratory exposures. The more engineering and management controls that can be implemented in production agricultural operations, the better, since affecting human behavior change is very difficult. In addition to proper use of respirators in production agricultural work, we recommend deployment of air quality assessments, especially in enclosed work

environments (e.g., livestock confinement buildings) with set goals for limits of air contaminants and appropriate follow-up.

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