

ENVIRONMENTAL CERTIFICATION SYSTEMS AND IMPACTS OF THEIR IMPLEMENTATION ON OCCUPATIONAL HEALTH AND SAFETY IN CHILEAN FOREST COMPANIES*

C. ACKERKNECHT[†]

Asociación Chilena de Seguridad (Chilean Safety Association),
Vicuña Mackenna 152, Santiago, Chile

C. BASSABER, M. REYES, and H. MIRANDA

Universidad de la Frontera (University of La Frontera),
P.O. Box 54-D, Temuco, Chile

(Received for publication 28 June 2005; revision 2 February 2006)

ABSTRACT

Environmental management systems developed by Chilean forest companies in fast-grown plantations and implemented for ISO 14001:1996 certification, best forest management practices certified by the Forest Stewardship Council, and occupational health and safety (OHSAS 18001:1999), have been analysed to evaluate their effects on profitability due to the decrease in work accidents.

The study was a statistical analysis of data on accident rate, risk rate, and average time lost per accident for up to 25 companies over 7 years. A second phase of the study was extended to 10 years with the same companies and dependent variables. Analysis of variance was used to compare the incidence of occupational accidents before and after the environmental systems, best forest management practices, or occupational health and safety were implemented.

Results varied between companies, according to the specific dependent variables analysed. Nevertheless, after the environmental systems or best forest management practices were implemented most companies showed there were improvements in accident rate, risk rate, and average time lost per accident. For most companies implementation of ISO 14001 and Forest Stewardship Council requirements helped to increase competitiveness by improving safety indicators in a statistically significant way.

Keywords: occupational health and safety; certification of fast-grown forests; environmental management systems; risk prevention; accident rate; risk rate; average time lost per accident.

* Corresponding author: cackerknecht@achs.cl

INTRODUCTION

Management systems are gradually integrating quality, environment, and safety (Fredericks & McCallum 1995). In this regard, norms for quality and the environment have been established by the International Standards Organisation (ISO 9001:2000; ISO 14001:1996), and for occupational health and safety by the Occupational Health and Safety Assessment Series (OHSAS 18001:1999). The implementation of those integrated management systems by forest companies has optimised operating and profit aspects.

Chile loses US\$3.9 to 5.9 millions every year through accidents in forest operations (Ackerknecht 2003). Because of this, any move towards the implementation of management systems leading to a decrease in accidents in the forest is welcomed.

The relationship between quality and occupational health and safety was first observed in the ISO 9000 series (López-Valcarcel 1996):

- Process control: ISO 9001, Section 4.9.1.a; ISO 9002, Section 4.8.1.a
- Management responsibility and quality objectives: ISO 9004, Section 4.3.1
- Risk prevention and legal responsibility of the product: ISO 9004 (1987), Section 19.

The International Standards Organisation prepared ISO 14001:1996 for environmental management systems in order to establish programmes for companies with objectives, a control process, and verification. The programmes emphasise the customer's requirements, control of processes, and continuous improvement, which help the whole organisation adhere strictly to safe work procedures.

In 1999 the Occupational Health and Safety Assessment Series were established as a guide to evaluate management systems on occupational health and safety. The continuous improvement concept (British Standards Institution 1996) made that norm compatible with ISO 9001:2000 and ISO 14001:1996 in order to integrate all of them.

In the forest sector there are some references to occupational health and safety which should be kept in mind when implementing a management system related to risk prevention. For instance, the Forest Stewardship Council states in Principle 4.2 that forest managers should comply with or exceed all laws or regulations relating to occupational health and safety of the workers and their families. Also, Principle 6.5.b in the Montreal Process warns about accident rates in the main categories of forest employment.

The only reference to a probable effect of an environmental management system on work accidents was by De Bonafos (2001), who reported occupational accident reduction after the implementation of ISO 14001 in a Chilean forest company. However, since the organisation was conducting an efficient risk prevention

programme at the same time, the study was unable to isolate the effect of ISO 14001 implementation in that accident decrease.

METHODS

Initial Scenario

An initial Phase 1 study was first conducted on 25 logging contractors working for four different forest companies in a *Pinus radiata* D. Don plantation in the Central-South area of Chile. The companies had implemented management systems towards certification for ISO 14001:1996 and/or the Forest Stewardship Council, and all were affiliated with the Chilean Safety Association (ACHS). The selected logging contractors were those with longer experience and better adherence to regulations and management imposed by the forest companies regarding environmental and occupational health and safety concerns. The names of the forest companies and their logging contractors are confidential.

Statistical Analysis

Phase 1 of this study compiled data from the monthly statistical reports of the Chilean Safety Association from August 1994 to December 2001 (7 years). The information collected was: month and year; accidents of the month; workers in the month; accident rate of the month; accumulated accidents (last 12 months); accumulated number of workers (last 12 months); accident rate (12-month period); accumulated lost time (12-month period); risk rate (12-month period); and average time lost per accident (12-month period). Formulas used for accident rate, risk rate, and average time lost per accident were:

$$\text{accident rate} = \frac{\text{accumulated number of accidents (12 months)}}{\text{accumulated number of workers (12 months)}} \times 100$$

[refers to the number of work accidents in a 12-month period for every 100 workers]

$$\text{risk rate} = \frac{\text{accumulated lost time (days in 12 months)}}{\text{accumulated amount of workers (12 months)}} \times 100$$

[refers to the number of lost days in 1 year for every 100 workers, caused by a work accident]

$$\text{accumulated time lost per accident} = \frac{\text{accumulated lost time (days in 12 months)}}{\text{accumulated accidents (12 months)}}$$

[refers to the average days lost for every work accident]

The experimental design was a Parametric ANOVA with one factor completely at random according to three situations: no environmental management system, environmental management system (ISO 14001), and best forest management practices (Forest Stewardship Council), performed for each group of logging contractors according to forest company. The dependent variables evaluated were

accident rate, risk rate, and average time lost per accident. Significant differences from analysis of variance were identified using a Duncan Test.

The results were prepared by groups of logging contractors according to each forest company taking accident rate, risk rate, and average time lost per accident separately. In each graph the dates of implementation for the different risk prevention and environment management processes were also identified (Table 1; Fig. 1, 2, 3, and 4).

TABLE 1—Breakdown by management programme or systems implemented by each forest company in Phase 1: 7 years.

Forest company	Management programme or system	Starting date
1	Risk Prevention Programme 1	January 1994
	Risk Prevention Programme 2	January 2000
	ISO 14001	March 2000
2	Risk Prevention Programme 1	October 1997
	FSC	March 2001
3	ISO 14001	November 1995
	FSC	January 2000
4	ISO 14001	June 1999

Final Scenario

After the initial study, a second phase was conducted with the same groups of logging contractors working for their forest companies, and this extended the period of analysis up to June 2004 (10 years of observations in total) with the same dependent variables. In the meantime, two of the forest companies had started implementation of OHSAS 18001, which made possible an additional analysis for an integrated management system (environment and occupational health and safety).

Second Statistical Analysis

In Phase 2, a Kolmogorov-Smirnov Test was applied to examine whether a dependent variable was normally distributed. As the results showed a non-normal distribution, a second analysis for accident rate, risk rate, and average time lost per accident was necessary. The database was processed using a nonparametric Kruskal-Wallis one-way ANOVA Test at a 95% confidence level to identify significant differences between average values for forest companies and their logging contractors.

These results were also prepared by groups of logging contractors according to each forest company taking accident rate, risk rate, and average time lost per accident.

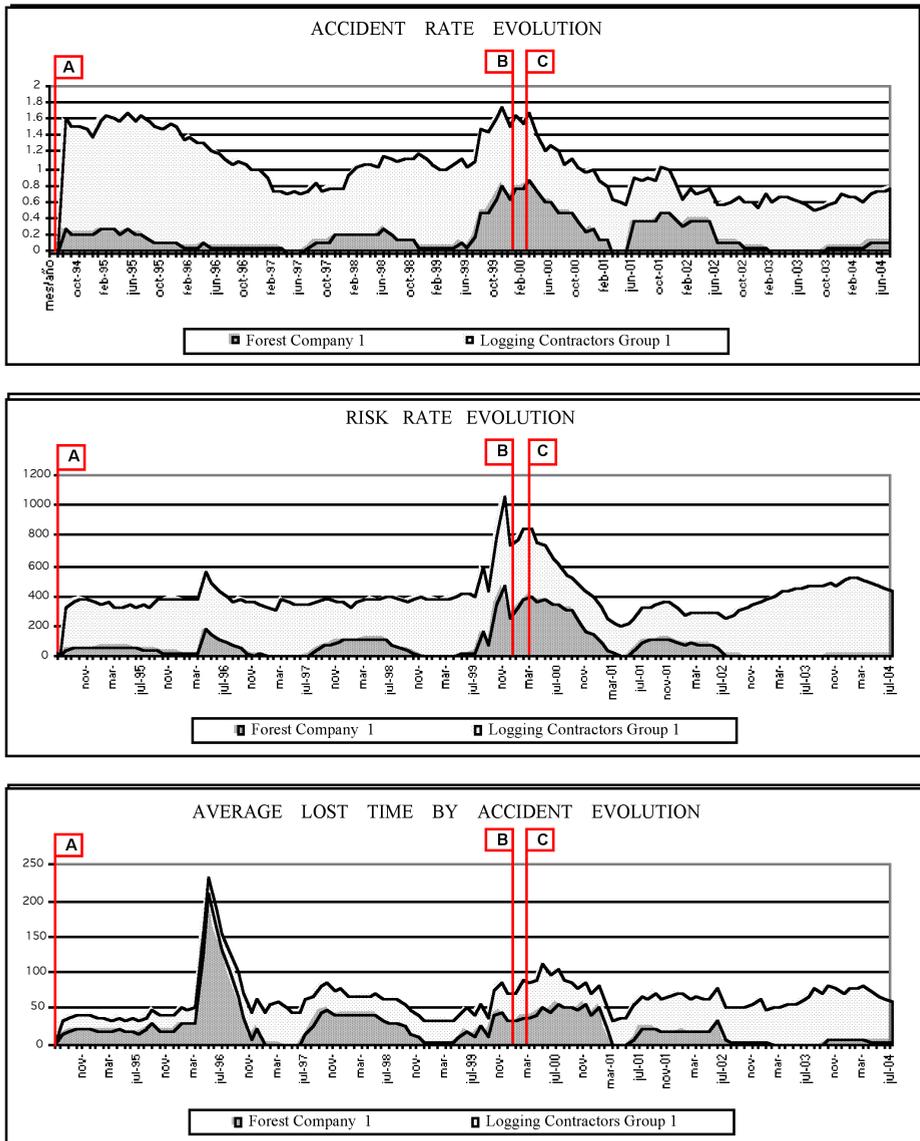


FIG. 1—Occupational health and safety indicator evolution for Company N° 1
(A: Risk prevention Programme 1; B: Beginning of risk prevention Programme 2; C: Beginning of ISO 14001)

The dates of implementation for the different processes in the 10-year period were identified as well (Table 2; Fig. 1, 2, 3, and 4).

The additional data for Phase 2 were compiled again from the monthly statistical reports of the Chilean Safety Association from January 2002 till July 2004 in order to complete 10 years of observations. The information collected was the same as

TABLE 2—Management programme or systems implemented by each forest company in Phase 2: 10 years.

Forest company	Management programme or system	Starting date
1	Risk Prevention Programme 1	January 1994
	Risk Prevention Programme 2	January 2000
	ISO 14001	March 2000
2	Risk Prevention Programme 1	October 1997
	FSC	March 2001
3	ISO 14001	November 1995
	FSC	January 2000
	OHSAS 18001	May 2003
4	ISO 14001	June 1999
	OHSAS 18001	January 2004

that for Phase 1 (see above). Additionally, information on the average cost of accidents in logging operations for 1994, 2001, and 2004 was collected (1994 = US\$2,100/accident; 2001 = US\$2,550/accident; 2004 = US\$3,000/accident).

RESULTS AND DISCUSSION

In most cases the results in Phase 1 (7 years of observation) did not show clear evidence of the impacts of the recent implementation of environmental management systems and best forest management practices on occupational health and safety. The analysis and discussion here are based on the results of the second phase (10 years of observation).

Parameters

The indicators for comparing forest companies against the general results in occupational health and safety in all logging companies affiliated with the Chilean Safety Association from 1994 to 2004 are given in Table 3. In the beginning of Phase 1 (1994) indicators for accident rate, risk rate, and average time lost per accident for the enterprises in this study were similar to those for all logging companies in Chile. The selected group represented 10% of the total accidents, 10% of total workers, and 10% of total lost time.

By the end of Phase 2, the study group of companies reduced total accidents by 64% in relation to 1994, while employment increased by 16%. That caused a sharp fall in accident rate to 0.45/yr/100 workers (a reduction of 70%). In comparison, all the logging companies with the Chilean Safety Association only achieved a figure of 0.75/yr/100 workers (a 49% reduction) for accident rate in the same 10-year period.

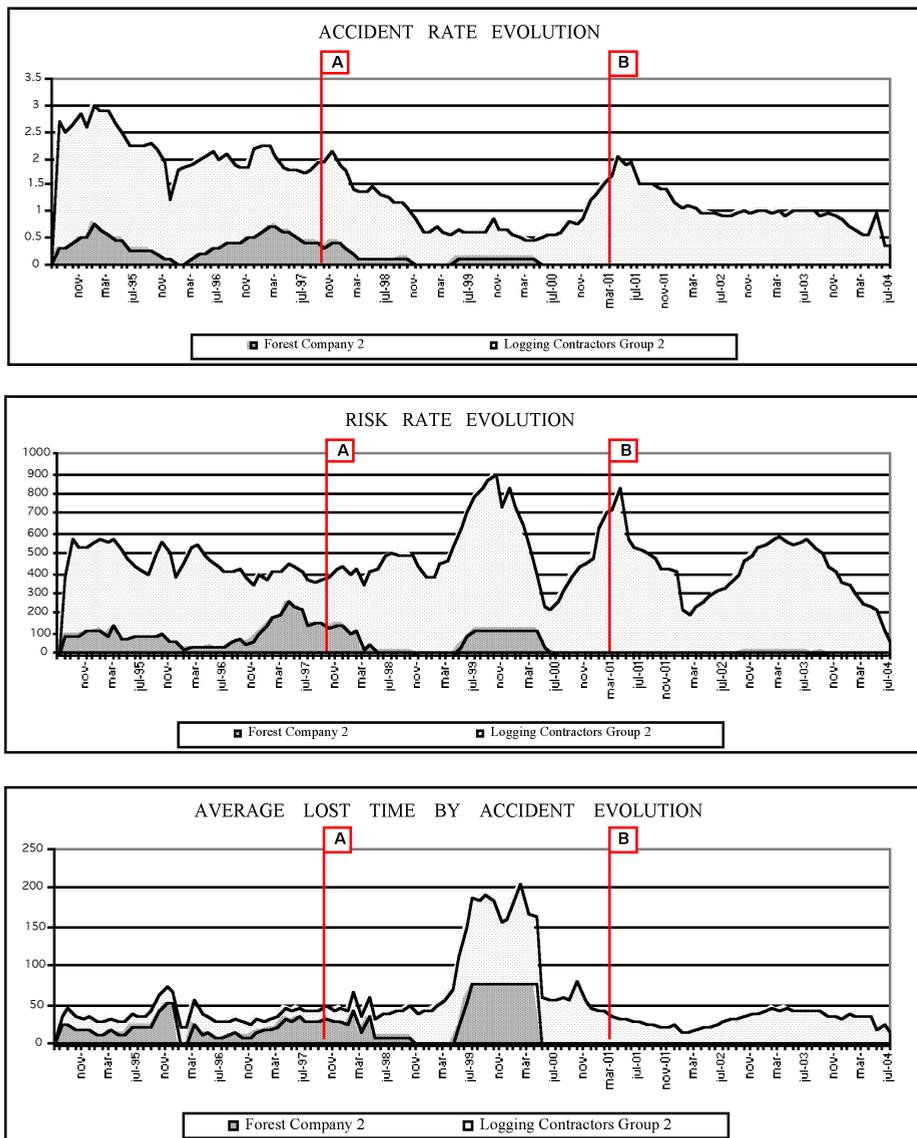


FIG. 2—Occupational health and safety indicator evolution for Company N° 2
(A: Beginning of risk prevention Programme 1; B: Beginning of FSC)

Despite the excellent improvement in accident reduction, the study group of companies could not prevent many of the serious cases which caused an increase of 167% in average time lost per accident to 43.09 days lost per accident. All logging companies with the Chilean Safety Association increased average time lost per accident by 64% to 26.64 days, part of a general upsurge in those activities in the last decade. But, due to a work force increase of 16% and a 5% decrease in total

TABLE 3—Occupational health and safety indicators of companies in the study compared to all logging activity in Chile for the years 1994 and 2004 (Source: Chilean Safety Association)

	Study 1994	Chile 1994	Study 2004	Chile 2004
Total accidents	253	2 426	90	781
Total workers	1 421	14 187	1 652	8 710
Total lost time (days)	4 082	40 026	3 878	20 805
Accident rate	1.48	1.48	0.45	0.75
Risk rate	287	285	235	239
Average time lost per accident (days)	16.13	16.19	43.09	26.64

lost time, the study group got a risk rate similar to all logging companies affiliated with the Chilean Safety Association (235 and 239 correspondingly). In other words, stricter work procedures introduced by management systems (OHS laws or regulations enforcement, penalties on high accident rates or non-reported accidents, better supervisors' control of operations, training follow-up, certification of workers competencies, and improvements in contractor selection) helped to eliminate some of the severe and non-severe accidents.

Analysis of variance (ANOVA) was carried out on those data that could be analysed after the nonparametric test was applied (Table 4).

TABLE 4—Average and standard deviation for risk rate, accident rate, and average time lost per accident for logging contractors by management programme or systems implemented by each forest company (Phase 2: 10 years)

Forest company	Management system or programme	Risk rate		Accident rate		Average time lost per accident	
		Average	s.d.	Average	s.d.	Average	s.d.
1	None	75.460 ^a	92.190	0.192 ^a	0.186	33.098 ^a	37.070
	ISO14001	83.920 ^a	118.720	0.225 ^a	0.218	17.735 ^b	18.820
2	None	77.089 ^a	62.944	0.244 ^a	0.220	24.903 ^a	24.259
	FSC	4.025 ^b	6.624	0.000 ^b	0.000	0.000 ^b	0.000
3	None	16.619 ^a	14.606	0.117 ^a	0.058	12.238 ^a	14.585
	ISO14001	117.295 ^a	104.692	0.106 ^a	0.084	64.409 ^a	57.014
	FSC	0.100 ^b	0.632	0.000 ^b	0.000	3.400 ^b	6.205
	OHSAS18001	0.000 ^b	0.000	0.000 ^b	0.000	0.000 ^b	0.000
4	None	85.500 ^a	60.632	0.354 ^a	0.209	20.000 ^a	8.927
	ISO14001	16.017 ^a	19.588	0.389 ^b	0.454	10.994 ^b	11.088
	OHSAS18001	0.000 ^b	0.000	0.000 ^c	0.000	0.000 ^c	0.000

^{a b c} = Values followed by the same superscript letter are not significantly different at the 95% confidence level

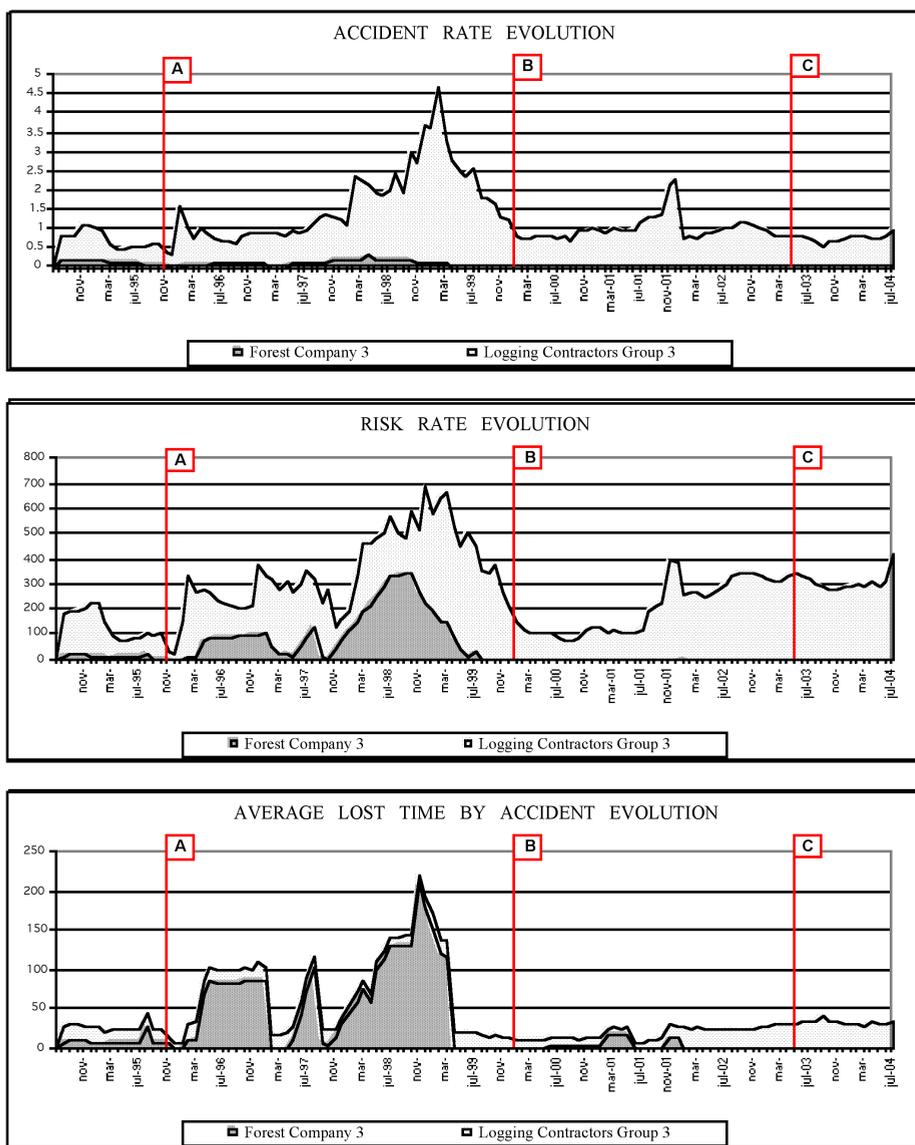


FIG. 3—Occupational health and safety indicator evolution for Company N° 3 (A: Beginning of ISO 14001; B: Beginning of FSC; C: Beginning of OHSAS 18001)

Nonparametric Test

The results from Kruskal-Wallis Test are presented in Table 5, with significant differences in terms of accident rate, risk rate, and average time lost per accident for the four forest companies (S = significant; NS = not significant).

TABLE 5—Summary of Kruskal-Wallis Test and significant differences for accident rate, risk rate, and average time lost per accident for logging contractors by forest company, according to management programme or system (Phase 2: 10 years)

Parameter	Forest company 1	Forest company 2	Forest company 3	Forest company 4
	----- None vs ISO 14001	----- None vs FSC	----- None vs ISO 14001 FSC OHSAS 18001	----- None vs ISO 14001 OHSAS 18001
Accident rate	0.621 (NS)	0.000 (S)	0.000 (S)	0.000 (S)
Risk rate	0.274 (NS)	0.000 (S)	0.000 (S)	0.000 (S)
Average time lost per accident	0.003 (S)	0.000 (S)	0.000 (S)	0.000 (S)

In general, the implementation of ISO 14001, Forest Stewardship Council, or OSHAS 18001 resulted in a significant trend in improving the rates of accident expressed as accident rate, risk rate, and average time lost per accident. The only exception to this was the non-significant effect on accident rate and risk rate when ISO 14001 was implemented soon after a second risk prevention programme by Forest Company 1; this could be explained by their environmental management system norm in occupational health and safety matters being lower than Forest Stewardship Council and OHSAS 18001. The effect of ISO 14001 would probably be increased when that norm was implemented under an integrated management system.

The extension of the observation period for an additional 3 years emphasised the influence mainly of Forest Stewardship Council best forest management practices on reducing accident rate, risk rate, and average time lost per accident, reinforced by the later implementation of OHSAS 18001.

Other findings in the study reveal that most of individual contractors had significant reductions in total numbers of accidents but no decrease in their severity after implementing ISO 14001 or Forest Stewardship Council, in comparison with no systems.

Accident Costs

Accident costs and increase in profitability per year for logging operations, because of the reduction in numbers of injured workers for the study group and for the whole of Chile, are summarised in Table 6.

By 1994, after 7 years of implementing ISO 14001 and Forest Stewardship Council, the four forest companies were saving around US\$314 550 per year, due to a

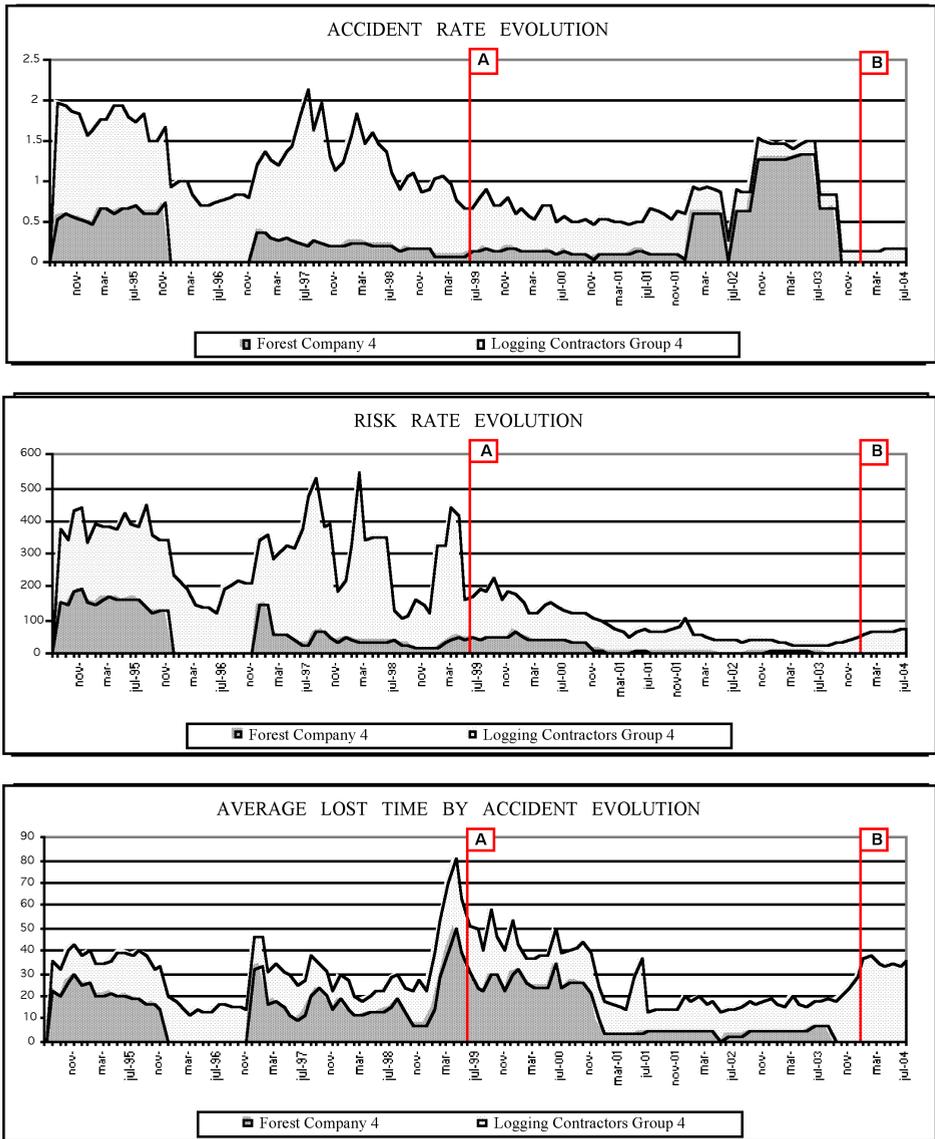


FIG. 4—Occupational health and safety indicator evolution for Company N° 4 (A: Beginning of ISO 14001; B: Beginning of OHSAS 18001)

reduction in work accidents by the end of Phase 1 (2001). Over the 10 years to 2004 the savings were 51% (or US\$261 300 yearly) in relation to 1994.

The study group represented 11% of the total accidents in logging operations in Chile for 2004 and just the 10% of the total profitability (with respect to 1994) for all logging activities in the country that year.

TABLE 6—Comparative total loss and corresponding savings in logging operations for the study groups of forest companies and for all logging companies in Chile from 1994 to 2004 (Source: Chilean Safety Association)

Year	Total accidents in logging	Total loss in logging (US\$/year)	Savings in logging (US\$/year in relation to 1994)
Study 1994	253	531 300	—
Study 2001	85	216 750	314 550
Study 2004	90	270 000	261 300
Chile 2004	781	2 343 000	2 751 600

CONCLUSIONS

- The implementation of Forest Stewardship Council best forest management practices in fast-grown *P. radiata* plantations involved reductions in occupational health and safety accident rate indicators for logging operations in the group of companies participating in the study.
- The development of an environmental management system with ISO 14001 did not have a clear effect on accident rate and risk rate in logging activities in the group of companies included in the study.
- For the participating logging contractors and forest companies, the implementation of integrated management systems had a positive effect in terms of accident rate, risk rate, and average time lost per accident.
- In general, it was clear that the implementation of management systems reduced accidents by reducing the less severe cases, a consequence of which was a strong and progressive increase in average time lost per accident.
- The implementation of Forest Stewardship Council, and probably ISO 14001 in certain cases, contributed to an increase in entrepreneurial profitability and competitiveness due to reductions in work accident losses in the group of logging companies involved in the study.

ACKNOWLEDGMENTS

Thanks to Chilean Safety Association (Asociación Chilena de Seguridad) and University of La Frontera (Universidad de la Frontera) for technical and financial assistance to conduct the study. Also to the students Patricio Zúñiga and Braulio Tapia for their contribution during the data processing step.

REFERENCES

- ACKERKNECHT, C. 2003: Bosque: Vida y Trabajo. Perspectiva de Salud y Seguridad Ocupacional. P. 261 in Vol A, Proceedings of XII World Forest Congress, Québec, Canada.

- BRITISH STANDARDS INSTITUTION 1996: "Guide to Occupational Health and Safety Management Systems. BS 8800:1996". London, England. 38 p.
- DE BONAFOS, H. 2001: Un Análisis de los Beneficios y Costos Generados por un Sistema de Gestión Ambiental Certificado ISO 14.001 para Empresas Forestales en Chile. Thesis Magíster en Ciencias Forestales Mención Manejo de los Recursos Forestales. Universidad de Chile. Santiago, Chile. 167 p.
- FREDERICKS, I.; McCALLUM, D. 1995: International Standards for Environmental Management Systems: ISO 14000. *In* "Canadian Environmental Protection", Vancouver, Canada. 6 p.
- LOPEZ-VALCARCEL, A. 1996: Seguridad y Salud en el Trabajo en el Marco de la Globalización de la Economía. Oficina Internacional del Trabajo y Seguridad Social de España. Documento de Trabajo N° 26 Proyecto Regional Seguridad y Salud en el Trabajo en los Procesos de Integración y Globalización. Lima, Perú. 33 p.