Health and Safety Issues and Perceptions of Forest Harvesting Contractors in Ireland

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ABSTRACT

The aim of this study was to examine the extent and severity of accidents and long-term health problems, and to evaluate perceptions of health and safety issues among forest harvesting contractors and sub-contractors in Ireland. A postal questionnaire was distributed to 450 forest harvesting (sub)contractors with the co-operation of the Irish Forestry Contractors Association (IFCA) and Coillte Teoranta (the State Forestry Company, referred to as Coillte). The questionnaire was completed and returned by 61 respondents. The majority of these were chainsaw, harvester and forwarder operators. The occurrence of an accident (requiring medical attention) in the last three years was reported by two respondents, while long-term health problems were reported by 23 (40%) of the respondents. Results showed that long-term health problems were not significantly correlated to age or training level. The two work elements in forest harvesting operations that were found to be most hazardous were operating a chainsaw and machine maintenance. When asked about the perceived dangers in the industry and the obstacles to improvements, 59% of the respondents identified harvesting work as dangerous, while 62% described financial pressure as the main barrier to improvements in safety, followed by the pressure of work (39%) and a lack of adequate training (36%). Suggestions on ways to improve the overall health and safety situation within forest harvesting included improved training and safety education (45%) and reduced work pressure (36%).

Keywords: *Accidents, forest harvesting, health and safety, long-term health problems, questionnaire, Ireland.*

INTRODUCTION

Forest harvesting has traditionally been a sector associated with a high accident rate and serious work-related long-term health problems. In the past this was accepted as being an inherent part of the work and of the difficult work environment. However, in recent years, society has put more emphasis on the health and safety aspect of industrial operations, including forestry related activities. Improved legislation, new health and safety regulations and certified training are indicators of the importance of the inclusion of health and safety aspects at all levels of operational planning and control in the industry. In Ireland, the Health and Safety Authority (HSA) is responsible for the enforcement of health and safety legislation and regulations, on-site inspections, provision of advice and information, and the general promotion of better health and safety attitudes within the workforce. The HSA was set up under the 1989 Safety, Health and Welfare Act. It is a state-sponsored body operating under the auspices of the Department of Enterprise, Trade and Employment. The main objective of the HSA is to ensure that safety and health standards are met in the working environment. These standards are backed up by existing legislation [20].

This article reports on a study that was initiated by the HSA because of the paucity of available health and safety information relating to the forest harvesting industry. Changed work practices in recent years have further aggravated this shortage of relevant information. These changes involved the rapid transition to fully mechanised operations (since the early 1990's), an increase in the amount of contract work and in the number of contracting companies (since the late 80's), and the wide-spread introduction of piece-rate based payment schemes (since the mid 80's). The specific objective of this study was to investigate potential linkages between forest harvesting activities and the extent and severity of injuries and long-term health problems. The areas examined include the demographic profile of the workforce involved in harvesting activities, the prevalence of injuries and long-term health problems among the members of this workforce, and their attitudes towards and opinions of all aspects of health and safety in forest harvesting [31].

BACKGROUND TO THE STUDY

Timber volumes harvested annually are increasing in Ireland, with 1.8 million m^3 harvested in 1993 [5] while the volume is expected to reach 5.0 million m^3 by 2015 [15]. Projected figures indicate that the largest increase in employment levels within the expanding forest industry will occur in the area of harvesting and haulage, with employment expected to rise from under 5,000 in 1992 to nearly 9,000 in 2020 [9].

The mechanisation level in the forest harvesting sector has been increasing for a variety of reasons, including developments in technology, labour availability and cost,

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demands for increased quality and precision in felling, and increasing emphasis on overall cost efficiencies [9]. In 1994 it was estimated that 22% of the total harvest volume was mechanically harvested, with the remaining 78% produced in motor-manual harvesting operations [5]. The planned harvest volume to be produced in operations directly controlled by Coillte for 2001 is estimated at 1,225,000 m^3 and 85% of this will be produced in mechanical harvesting operations [4]. Coillte standing sales are expected to produce an additional 1,671,000 m^3, and close to 100% of this volume will be harvested mechanically [28]. These figures indicate that the percentage of total harvesting carried out in fully mechanised operations in Ireland has increased by a factor of four within a decade.

Developments in mechanisation and working techniques have contributed to a steady reduction in forest worker accident rates in recent years [33]. Increased mechanisation levels have also been found to bring about a change in the type of injuries and health issues associated with harvesting operations [39]. Surveys have indicated that a large proportion of machine operators had long-term health problems that are connected to their work [1, 3]. These problems arise from spending excessive periods of time in a machine, where the operator is continuously carrying out the same task and working a limited number of muscles [41].

Work related stress is another contributor to long-term health problems and can result from several causes, such as: too much or too little work; time pressure and deadlines; too many difficult decisions to make; fatigue from physical strain; fatigue from excessive noise or vibration; long working hours; and the costs of making mistakes (both in terms of the financial consequences and the possibility of dismissal) [12]. The presence of more than any one of these or other causes can result in a dramatic increase in the severity and number of health problems, as many of these factors re-enforce the effect of each individual cause. Research has shown that stress can result in decreased productivity, depleted job satisfaction, increased susceptibility to accidents, and higher levels of absenteeism [27]. One factor that has been identified in studies in several countries as contributing to accident rates is the method of payments [1, 27]. An earlier Swedish study from 1983 clearly linked a reduction in (both the frequency and severity of) accident rates of chainsaw operators to the introduction of a payment method that was partly based on time-based wages, replacing a purely piece-rate payment method [36].

Quantifying Health and Safety in Forestry

It is difficult to assess and compare the levels of health and safety in forestry and harvesting activities internationally. The differences in reporting procedures and hazard classification systems at the national levels make it problematic to appraise statistical information [2]. The International Labour Office (ILO) has attempted to lay down a guide for collecting and analysing health and safety statistics [22]. However, it has been acknowledged worldwide that forestry related accidents are often under-reported [10, 11, 33, 42]. New Zealand is one of the few countries that has a satisfactory forestry accident reporting system in operation where information is issued on a regular basis [30]. In contrast, the situation in Ireland is similar to most other countries. Under-reporting of accidents has been considered a major hurdle in quantifying accident and injury rates, and as a result available statistics were unsuitable for accurate trend analysis [26].

Health and Safety Legislation in Ireland

The 1989 Safety, Health and Welfare at Work Act (subsequently referred to as the 1989 Act), provides a framework for securing safety, health and welfare in the work place in Ireland [32]. The 1989 Act and the Safety, Health and Welfare at Work (General Application) Regulations, 1993 (subsequently referred to as the 1993 Regulations) both aim to raise the awareness of employers, self-employed, employees and others, of their obligations with regard to health and safety at work. They are also aimed at ensuring that there is communication and consultation with regard to health and safety issues between all concerned parties in the work place [21].

Forestry Training and Education

Skills and knowledge determine the effectiveness of work, while safety and health issues are inherently linked with effective work practices [23, 25]. Safety awareness and training are considered to be particularly important factors when addressing the reduction and prevention of injuries incurred in mechanised harvesting operations [39]. In Ireland a liaison group on education and training was set up as a result of the 1996 strategic plan for development in the forest sector [9]. The liaison group has reported on the difficulty in recruiting new entrants and in retaining operatives in some areas of the industry. They also observed that there was an urgent need to improve knowledge, awareness and skills in the industry in order to maintain productivity. The area of improvements in health and safety for forest operations and forest contractors was identified as requiring immediate attention [14]. Because of the lack of accurate information, and as a result of the liaison group's conclusions, the HSA initiated the study reported in this article.

MATERIALS AND METHODS

In order to improve the knowledge and understanding of health and safety issues in forest harvesting in Ireland, more detailed and more accurate information was required about the number and type of accidents, injuries and long-term health problems associated with forest harvesting operations. In addition background demographic information (age, experience, training, type(s) of occupation, etc.) for the forest harvesting work force was needed to investigate any correlation between demographics and the occurrence of accidents or long-term injuries. Finally, the attitudes of the people involved in forest harvesting towards health and safety issues were also to be investigated in order to draw up recommendations for the improvement of health and safety standards in the industry.

It was decided, in consultation with representatives from the Health and Safety Authority (HSA), the Irish Forestry Contractors Association (IFCA) and Coillte, that the use of a questionnaire was the best method (in terms of costs, time and manpower) to collect information in this study. The study sought information on accidents within a narrowly defined time period of three years (1998 to 2000), in order to enhance the validity of reporting past circumstances [6]. Due to the wide geographic spread of the study population, the isolation of their working conditions and their irregular and long working hours, a self-administered postal questionnaire was chosen as the most appropriate and efficient way of collecting the relevant information. The questionnaire contained twenty-six questions divided into three sections:

1. Background information about the respondent and his/her work experience;
2. Information about accidents (if any had occurred) and long-term health problems;
3. Opinions about safety and health aspects of forestry work and suggestions for improvements.

Only accidents that required medical attention (i.e. a visit to the hospital or doctor) were to be included. A pilot study was carried out and the final version of the questionnaire was decided upon in light of suggestions obtained during this pilot survey. A detailed description of the questionnaire, including the organisation and format of individual questions, is presented in the thesis of M. Lyons [6], which is available (through inter-library loan) from University College Dublin.

Sample Selection and Survey Administration

Two populations were used in the sample selection process, the IFCA membership and the list of Coillte approved contractors. Together these lists represented 100% of the harvesting contractors operating on Coillte land and circa 90% of commercial operators on private land. A number of adjustments were made to these lists (i.e. elimination of duplication, removal of individual and company names no longer operating, removal of companies not involved in harvesting activities, identification of companies with more than one employee) before a decision was made on the sampling fraction. As a result of these adjustments, the number of companies and the estimated associated number of machine operators in the population was reduced to such an extent as to allow the full population to be included in the survey population.

A total of 450 questionnaires was sent out, 375 of these to 302 companies on the IFCA list and 75 questionnaires to 58 companies on the Coillte contractor list. The actual mailing and tracking of returned questionnaires was carried out by IFCA and Coillte staff in order to ensure confidentiality. One month after the original mailing, a reminder was sent to all companies that had not responded. This reminder included a copy of the original questionnaire.

RESULTS

A total of 450 questionnaires were posted out to 360 companies. Of these, 89 (or 19.8%) were returned. However, 28 of the returned questionnaires had to be excluded from further analysis because the respondents were no longer involved in harvesting work and did not complete the questionnaire. As a result, 61 correctly completed questionnaires were included in the analysis, giving a response rate of 13.6%. Results are presented as numbers of respondents, followed by the percentage values in brackets. It should be noted that, as not all questions were answered by all of the respondents, the total sample (N) for each question varied and is therefore included with the results for each question.

Background Information About the Respondents and Their Work Experience

The average age of the respondents was 39.7 years, while the mean length of time individuals had spent in their current employment was just under 11.5 years. The mean length of time individuals were involved in harvesting activities was 15 years (ranging from less than 1 year to a maximum of 35 years). Nine different job types were reported in the survey (Table 1). Many of the respondents were involved in more than one job type within forest

harvesting. 'Chainsaw operator' was the most common occupation, indicated by 22 respondents, followed by 'harvester operator' reported by 20 respondents.

Table 1. Job descriptions (N = 61).

Type of job	Number (and percent) of responses
Chainsaw operator	22 (36.1)
Harvester operator	20 (32.8)
Forwarder operator	19 (31.2)
Management	7 (11.5)
Skidder operator	7 (11.5)
Timber measurement & inventory	5 (8.1)
Mobile sawmill operator	3 (5.9)
Mechanical fitter	1 (1.6)
Horse logger	1 (1.6)

Note: as respondents could identify more than one type of job, the total number of responses adds up to more than 61 and the total percentage to more than 100%.

Of the 61 respondents, 33 indicated that they had received some form of job training. Of these 33 respondents, 29 indicated that they obtained a relevant training certificate. Certificates received were awarded by the UK based National Proficiency Test Council (NPTC) and through courses organised by Coillte. Statistical analysis indicated that the proportions of respondents with certified training did not vary significantly between age categories (Figure 1).

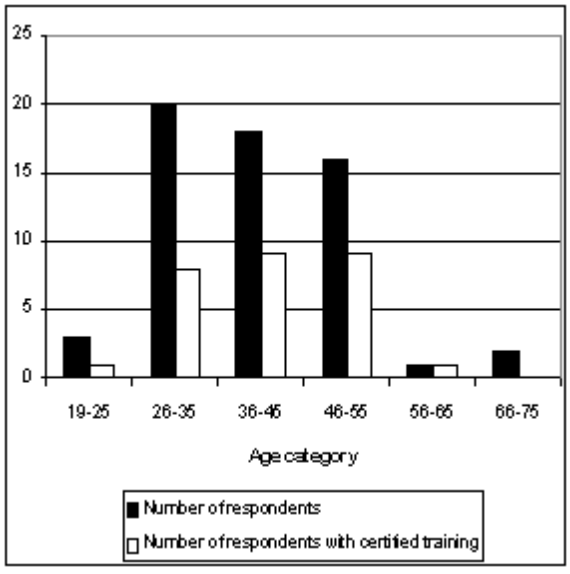

Figure 1. The total number of respondents and the number with certified training, in each age category.

Accidents and Long-Term Health Problems

Accidents (requiring medical attention) were reported by two respondents. Twenty three respondents (from the total of 61) reported some long-term health problems associated with forest harvesting work, while six of these indicated that they suffered from more than one problem. The most common problem recorded was 'back pain', followed by 'hearing impairment' and 'neck/shoulder injuries' (Table 2). Statistical analysis showed that there was no significant link between the age of the respondents and the type and number of long-term health problems reported. Analysis also showed that 14 (or 42.4%) of the 33 respondents with certified training reported long-term health problems, while nine (or 32.1%) of the 28 respondents without certified training reported similar problems.

Table 2. Long-term health problems affecting respondents (N=23).

Health problem	Number (and percent) of responses
Back pain	16 (69.6)
Hearing impairment	7 (30.4)
Neck/shoulder injuries	5 (21.7)
White finger syndrome	4 (17.4)
Repetitive strain injury	2 (8.7)
Joint pain	2 (8.7)
Stress	1 (4.3)

Note: as respondents could identify more than one health problem, the total number of responses adds up to more than 23 and the total percentage to more than 100%.

Perceptions About Health and Safety

Forest harvesting work was described as 'dangerous' by 36 of the 61 respondents, while 18 felt it was 'relatively safe' or 'very safe' compared to other sectors. In the replies, 38 out of 61 respondents indicated that the high productivity demand, due to financial requirements, was the main barrier to an improvement in safety levels in harvesting (Table 3). Work pressure also featured highly, while a lack of adequate training was listed as the third most important barrier.

Suggestions for improvements in health and safety in forest harvesting were made by 53 of the respondents, while many of these made more than one suggestion. The area of improvement identified most frequently related to the need for additional training and education in forest

harvesting (Table 4). Many contractors also felt that pressure of work and shift length contributed to health and safety problems in forestry.

Table 3. Barriers to improvements in safety levels (N=61).

Description of barrier	Number (and percent) of responses
Financial restrictions	38 (62.3)
Pressure of work	24 (39.3)
Lack of training	22 (36.0)
Lack of advice/guidelines	9 (14.8)
No improvement necessary	3 (4.9)
No opinion	2 (3.3)

Note: as respondents could identify more than one barrier, the total number of responses adds up to more than 61 and the total percentage to more than 100%.

Table 4. Suggested areas for health and safety improvements (N=53).

Area of improvement	Number (and percent) of responses
Enhanced safety training and education	24 (45.3)
Reduction of the pressure of work and shift length	19 (35.8)
Better consideration of site factors in payment rates	7 (13.2)
Machine design	5 (9.4)
Safety rules	5 (9.4)
Safety gear	3 (5.7)
No improvements necessary	2 (3.8)
Recent advancements are sufficient	2 (3.8)
Publication of up-to-date accident statistics	1 (1.9)

Note: as respondents could identify more than one area of improvement, the total number of responses adds up to more than 53 and the total percentage to more than 100%.

DISCUSSION

This study was initiated because of a serious lack of accurate accident and injury statistics for the forest harvesting sector in Ireland. This lack of data has meant that comparisons between the findings of this study and previous Irish studies were not possible. In addition, it is acknowledged that the extent of the data was limited and, as a result, conclusive (statistical) analysis could not always be carried out. However, several factors that may have contributed to the low response rate can be identified. As indicated in the Material and Methods section, a number of adjustments had to be made to the IFCA and Coillte lists to filter out any companies that should not be included in the sample population.

Companies were only eliminated from the lists if it was absolutely clear that they were not involved in harvesting operations. Despite this the sample population included a proportion of companies for which the questionnaire was not relevant, as (partly) illustrated by the fact that 28 unfilled questionnaires were returned by respondents not involved in harvesting work. In addition, multiple copies of the questionnaire were sent to contracting companies which were thought to employ a number of operators. As a result, questionnaires may have been dispatched to non-existant operators. Furthermore, questionnaires may not have been handed down by company executives to employees or sub-contractors. Given these circumstances, staff from the IFCA and Coillte considered that the response rate was reasonably high. In addition, staff of these organisations were of the opinion that the respondents represented a reasonable sample of harvesting operatives in Ireland [13, 40]. As a result of these considerations, the researchers feel confident that some general conclusions can be drawn from the results of the analysis of the information provided by the 61 respondents.

The personal characteristics of persons involved in accidents are important considerations in accident research and prevention. The age, work experience, health and training of the individual workers all influence the occurrence and severity of accidents [35, 41]. The average age of the respondents in this study was just under 40 years. This is considered somewhat old compared to the average age in other industrial sectors in Ireland, such as manufacturing or construction, where the average age falls in the lower age bracket of 25 to 34 years [29]. The group of respondents, on the whole, can be considered as experienced in their jobs, with an average period of over 11 years spent in their current job(s) and an average of 15 years spent in harvesting. This long work experience may have contributed to the fact that only two accidents were reported in the survey. Experience (and age) has been shown to have implications with regard to safety in harvesting [25, 35, 39]. Over half of the 22 chainsaw operators listed additional activities, mainly as machine operators, in their job description. This is indicative of the recent transition from motor-manual to fully mechanised harvesting operations.

Proper operator selection procedures and adequate job

training are an integral part of occupational health and safety management [16, 18, 23, 24, 34]. Over 50% of the respondents in the survey indicated that they had received formal job training. This level of training could be considered quite low, given the highly mechanised and skilled nature of harvesting work. However, compared to similar surveys in the U.S.A. [38], New Zealand [17] and Canada [7], it is actually high. This relatively high level of formal training indicated that forestry contractors are willing to participate in organised training courses and are aware of the long-term benefits of such investments. However, a (perceived) lack of adequate training opportunities was identified by 22 respondents as a barrier to improving health and safety standards in harvesting.

Two of the 61 respondents reported having had an accident between 1998 and 2000. It is difficult to surmise if this is an accurate representation of the situation in the sector, due to the lack of comparable accident and labour force statistics. The results, do however, agree with forest contractor insurance claims. The main insurance company for forest contractors reported that no accidents had been reported to them by forest harvesting contractors over the period 1999 – 2000 [8]. The first accident occurred while the respondent, a forwarder operator, was maintaining a machine. This agrees with other studies which have shown that machine operators are especially at risk when carrying out maintenance or repairs, lifting or transferring fuel or walking on site [2, 24]. The second accident happened to a chainsaw operator. Again, this area of harvesting work has been found to be particularly dangerous in several studies [2, 35, 39], with the risk of injury to chainsaw operators even significantly higher than to machine operators [2, 41].

Increased mechanisation and the move away from motor-manual or partially mechanised felling operations to fully mechanised operations has also signified a change in the types of injuries that occur in harvesting operations [39]. Surveys carried out have indicated that a large proportion of operators (including more than one third of respondents in this study) have long-term health problems connected with their work [3]. The results of this study showed that there was no significant link between the length of work experience of the respondents and the long-term health problems described by them, indicating that these problems could not be directly attributed to the length of exposure to the health hazard(s).

When asked about the dangers of harvesting work, nearly 56% of the respondents considered it ‘very dangerous’ or ‘more dangerous’ compared with other forestry work activities, while only 13% considered it ‘very safe’. This implies that the majority of respondents was aware of the potential danger associated with forest harvesting operations and of the health and safety aspects of their jobs. The introduction of compulsory Safety Statements under the 1989 Act [19] and of mandatory liability insurance for forestry contracting work, are likely contributing factors to the high level of health and safety awareness among the respondents. A large proportion of respondents provided information on (perceived) barriers to, and suggestions for, improvements in health and safety in forest harvesting. These practical suggestions will be of great value to operations managers and safety representatives. They were similar to those put forward as a result of several health and safety studies of harvesting operations in other countries [11, 37, 39, 41, 43]. Financial restrictions and pressure of work were identified by respectively 62% and 39% of the respondents as barriers to improvements in safety levels. This indicates the perceived importance of the dominant payment method (i.e. piece rate) as a constraint to health and safety improvements.

CONCLUSION

One of the main conclusions to emerge from the study was that between 1998 and 2000 the rate of accidents was not as high as was expected by staff in the Health and Safety Authority. This may be attributed to the recent and substantial shift from motor-manual to fully mechanised harvesting systems in Ireland. However, the number of respondents reporting work-related, long-term health problems (at 37.7%) was higher than expected by HSA staff. Some of these types of chronic injuries were found in the past to be linked with motor-manual systems (e.g. hearing impairment, vibration-related problems), while other types (e.g. repetitive strain injury) are relatively new and have been linked with (the increased use of) fully mechanised systems.

The attitude of the majority of respondents towards health and safety was positive and their suggestions for improvement were practical and informed. A lack of training opportunities was the most common problem area highlighted by respondents, with suggestions made for more frequent and up-to-date training programmes at an increased number of venues around the country. The pressure of work and excessive shift length were also among the problem areas raised, and suggestions for improvement included better differentiated (and increased) rates of payment, especially for difficult sites, and a revision of the tax system for forest contractors. The increased emphasis on health and safety issues in Irish society, resulting in the introduction of new legislation and the formation of the HSA, coupled with the rapid changes that have occurred in the forest harvesting industry in recent years, make the knowledge obtained in this study

an important base from which to start our attempts to improve health and safety practices and standards in Irish forestry operations.

ACKNOWLEDGEMENTS

The authors are grateful for comments made by three referees and by the Editor. This research project was co-funded by the Health and Safety Authority (HSA), the National Council for Forest Research and Development (COFORD), Coillte Teoranta and University College Dublin.

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REFERENCES

[1] Alexsson, S. and B. Ponten, 1990. New Ergonomic Problems in Mechanised Logging Operations. Int. J. of Indust. Econ. 5 (1990): 267-273.

[2] Alexsson, S. 1998. The Mechanisation of Logging Operations in Sweden and its Effect on Occupational Safety and Health. J. For. Eng. 9(2): 25-31.

[3] Byers, J. 1997. Operator Health - a Survey of Feller-buncher Operators. LIRO Ltd. Report 22(17).

[4] Clear, R. 2001. Personal communication from Richard Clear, Coillte Harvesting Division, Coillte Teoranta. June 2001.

[5] COFORD, 1994. Pathway to progress. A programme for research and development. COFORD, Nat. Council for For. Res. and Dev., UCD, Belfield, Dublin.

[6] Converse J. and S. Presser. 1986. Survey Questions: Handcrafting the Standardised Questionnaire. Quantitiative Applications in the Social Sciences No. 63. Sage University Papers, London.

[7] Courteau, J. 1996. Operator Attitudes towards Advanced Technologies in Forest Equipment. For. Eng. Res. Inst. of Can. Field Note No. 47.

[8] Cox, B. 2001. Personal communication from Brian Cox, Aon MacDonagh Boland Insurance Company, Dublin.

[9] Department of Agriculture, Food and Forestry. 1996. Growing for the Future: A Strategic Plan for the Development of the Forestry Sector in Ireland. Government Publications Sales Office, Dublin. 98pp.

[10] Dewar J. 2000. Personal communication from Jim Dewar, Forestry Commission Safety Officer. British Forestry Commission, Edinburgh.

[11] Driscoll, T., G. Ansari, J. Harrison, M. Frommer and E. Ruck. 1995. Traumatic Work Related Fatalities in Forestry and Sawmill Workers in Australia. J. Safety Res. 26(4): 221-233.

[12] FAO. 1992. Introduction to Ergonomics in Forestry in Developing Countries. FAO Forestry Paper 100. Food and Agriculture Organisation of the United Nations, Rome, Italy.

[13] Fitzpatrick, D. 2001. Personal communication with Donal Fitzpatrick, Chief Executive of the Irish Forestry Contractors Association.

[14] Forest Service. 1998. Final Report of the Liaison Group on Education and Training in the Forestry Industry. Department of Marine and Natural Resources, Government Publications Sales Office, Dublin. 20pp.

[15] Gallagher, G. and J. O'Carroll. 2001. Forecast of Roundwood Production from the Forests of Ireland 2001-2015. COFORD, National Council for Forest Research and Development, UCD, Belfield, Dublin.

[16] Garland, J. 1990. Machine Operator Selection and Training. Timber Harvesting and Extension Specialist, Forest Engineering Department, Oregon State University. Unpublished Article.

[17] Gaskin, J., B. Smith and P. Wilson. 1989. The New Zealand Logging Worker - a Profile. Logging Ind. Res. Assoc. Rep. No. 44.

[18] Holman, R., A. Olszewski and R. Maier. 1987. The Epidemiology of Logging Injuries in the North-West. J. Trauma. 27(9): 1044-1050.

[19] Health and Safety Authority. 1998. Safety in Forestry Operations. Dublin.

[20] Health and Safety Authority. 1999. Health and Safety Authority Annual Report. Dublin.

[21] Health and Safety Authority. 2000. Guide to the Safety, Health and Welfare at Work Act, 1989 and the Safety, Health and Welfare at Work (General Application) Regulations, 1993. Dublin.

[22] Anonymous. 1998. Safety and health in forestry work: an ILO code of practice. International Labour Office, Geneva, Switzerland. 166pp.

[23] Jokiluoma, H. and H. Tapola. 1993. Forest Worker Safety and Health in Finland. Unasylva, 175, 44: 57-63.

[24] Jones, W., C. Saunders and E. Ramsay. 1999. The Health and Safety Implications of Increased Mechanisation in Forestry. Landwards 54(3): 14-18.

[25] Kirk, P., J. Byers, R. Parker and M. Sullman. 1997. Mechanisation Developments within the New Zealand Forest Industry: the Human Factors. J. For. Eng. 8(1): 75-80.

[26] Kobayashi, Y. 2001. Personal communication from Dr. Yukiko Kobayashi, Researcher and Statistician with the Health and Safety Authority, Hogan Place, Dublin. May 2001.

[27] Landy, F. 1985. Psychology of work behaviour (3rd edition). Dorsey Series in Psychology. Dorsey Press.

[28] Layton, T. 2001. Personal communication from Traolach Layton, Director and Wood Procurement Manager of Palfab Ltd., Lissarda, Co. Cork. June 2001.

[29] Linehan, J. 2001. Personal communication from Jim Linehan, Information Officer, Central Statistics Office, Dublin. May 2001.

[30] LIRO. 1999. LIRO Ltd., New Zealand. Report 24(6).

[31] Lyons, M. 2001. Health and Safety Isues in Forest Harvesting. Unpublished M.Agr.Sc. Thesis, University College Dublin, Ireland.

[32] Maguire B., M. O' Reilly and M. Roche. 1999. Irish Environmental Legislation. Round Hall Sweet And Maxwell, Dublin. 982pp.

[33] McLean, L. and J. Richards. 1998. Ergonomics Codes of Practice: the Challenge of Implementation in Canadian Workplaces. J. For. Eng. 9(1): 55-64.

[34] Myers, J. and D. Fosbroke. 1994. Logging Fatalities in the United States by Region, Cause of Death, and Other Factors-1980 through 1988. J. Safety Res. Vol. 25(2): 97-105.

[35] Peters, P. 1991. Chainsaw Felling Fatal Accidents. Am. Soc. Agr. Eng., Pap. No. 90-7536.

[36] Petterson, B. 1983. Enhanced Safety in Forestry – a Campaign of Action for one Branch of Industry. Skogsarbeten Bulletin No. 14. 79 p.

[37] Poschen, P. 1993. Forestry a Safe and Healthy Profession? Unasylva 172. Volume 44: 3-12.

[38] Schuh, D. and L. Kellogg. 1985. Timber Harvesting Mechanisation in the Western United States: an Industry Survey. W. J. App. For. 3(2): 33-36.

[39] Shaffer, R. and J. Milburn. 1999. Injuries on Feller-Buncher/Grapple Skidder Logging Operations in the South-Eastern United States. For. Prod. J. 49(7-8): 24-26.

[40] Shekleton, F. 2000. Personal communication with Fred Shekleton, Coillte Chief Safety Officer. Leeson Lane, Dublin 2.

[41] Slappendel, C., I. Laird, I. Kawachi, S. Marshall and C. Cryer. 1993. Factors Affecting Work-Related Injury among Forestry Workers: a Review. J. of Safety Res. 24(1):19-32.

[42] Vayrynen, S. 1980. Health Hazards and Accident Risks in the Maintenance of Heavy Forest Machinery. Work Conditions 33. Institute of Occupational Health. Helsinki, 1980.

[43] Vayrynen, S. 1984. Safety and Ergonomics in the Maintenance of Heavy Forest Machinery. Accident Analysis and Prevention 16(2):115-122.