Topic 2
“Prevention and risk analysis in agro-forestry work environments”

Oral Presentation

A Risk Assessment Procedure for the Users of Narrow Track Tractors

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Abstract
The impact of the introduction of the directive 2006/42/CE in EU Countries is quite significant for companies, both users and producers, because of the new Essential Health and Safety Requirements (EHSRs), as well as due to the extension of its scope. In such a context, the research work presented in this paper is focused on the field of machines for agriculture, and in particular tractors. Starting from the analysis of accidents occurred in the sector, the study was aimed at bringing to light the aspects which must be investigated by using the new Machinery Directive approach while performing the risk assessment activities, focusing the attention on the users' behaviour.

Keywords: occupational safety, machine directive, risk assessment, agricultural tractors

Introduction

Standards and regulations concerning occupational health and safety have become more and more severe in last decades. Despite this, in EU countries the number of accidents and victims has not significantly decreased. According to official statistics, the situation is particularly critical for small and medium sized enterprises (SMEs) where safety regulations are more difficult to be applied: in Italy, agriculture sector is certainly one of the most affected by this situation, especially taking into account the occurrence of serious injuries and fatalities. The issue of the new machinery directive (2006/42/EC) introduced additional requisites for both machine producers and users, including agricultural tractors in its scope. On one hand such an improvement, makes the safety level of operators higher. On the other hand, the compliance with new safety requisites results in being more difficult, due to the specific characteristics of the sector. Actually, the large variety of activities usually carried out by companies, the use of obsolete machines and equipments, as well as the continuous change of workplaces are all alone factors which make the management of agricultural activities harder to deal with.
On these considerations, the paper presents a procedure for risk assessment, which was developed with the aim of supporting all stakeholders involved in the use of tractors in being in compliance with the new regulations. The proposed approach was focused on the importance of the users' behaviour in the occurrence of accidents by means of its application to an agricultural and forestry narrow-track tractor.

2. Recent developments in Agricultural Safety

Nowadays there is a growing awareness of the importance of safety in the agriculture and forestry fields: this is mainly due to the latest developments of legislation and standards in the sector, concerning both occupational and machine safety. Thus, on one hand we have to underline the improvements brought by the introduction of the new machine directive (2006/42/CE) at EU level, and by the update of the Italian law on occupational safety. They have increased the safety level of workers, making stricter the safety requirements that have to be satisfied. At the same time, also international standards affecting machine safety have been improved recently, and in particular the ISO 14121:2007 standard, concerning risk assessment procedures resulted in being very significant.

On the other hand, difficulties related with the implementation of safety measures are numerous, in particular for small and medium sized companies (SMEs), which can not afford additional costs for the compliance with these safety requirements. As a matter of fact, SMEs represent more than the 80% of enterprises operating in the agricultural sector, and most of them are very small sized, run by family members. Beside this, we also have to consider the fact that there is a large number of part-time workers, who are involved in agricultural activities in their spare time, and for this reason they are not registered as farmers, avoiding in this way to fall under the scope of the above mentioned legislation.

With the aim of bringing to light the main aspects of the situation, it is also necessary to analyze accidents which occurred recently in the sector.

Latest data concerning the occurrence of occupational accidents in the sector of agriculture show that the problem is very relevant in Italy both considering its absolute value, and taking into account accidents which have occurred in agricultural activities compared to sectors of other activities. On the basis of data published by INAIL (Italian Workers' Compensation Authority), in Table 1 the comparison of accidents which occurred in agriculture and industry sectors is shown [INAIL, 2010].

Table 1. Accidents which occurred in agriculture in Italy.

Injuries							
SECTOR	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Agriculture	71.379	69.263	66.467	63.083	57.206	53.354	52.629
difference with previous year (%)	-2,9	-3,0	-4,0	-5,1	-9,3	-6,7	-1,4
Industry	456.333	446.210	422.254	413.375	400.103	366.159	297.290
difference with previous year (%)	-2,7	-2,2	-5,4	-2,1	-3,2	-8,5	-18,8
Fatalities							
SECTOR	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Agriculture	128	175	141	124	105	125	125
difference with previous year (%)	-23,4	36,7	-19,4	-12,1	-15,3	19,0	0,0
Industry	763	673	616	678	611	532	490
difference with previous year (%)	5,4	-11,8	-8,5	10,1	-9,9	-12,9	-7,9

In fact, in last year a minimum decrease of the number of accidents was achieved (-1,4%), but this is not so significant if we consider the number of workers operating in the sector, i.e. the frequency factor (number of accidents per 1000 of employees). And most of all, the number of fatalities has not changed at all.

Analyzing these data from the "material agent" point of view, it emerged that in agriculture the most dangerous sub-sector (e.g. considering the number of permanent injuries and fatalities which occurred) is represented by the activities which involve the use of machines and mechanical equipments, and in particular tractors. Data collected by ISPESL (National

Institute for Occupational Safety and Prevention) show that in 2008 a number of 169accidents related to the use of tractors occurred, causing 114 fatalities. In 2009, 257 cases of serious injures were registered, and among them 149 cases led to the operator's death. In both cases the number of accidents related with the use of tractors resulted in being very large: 212 workers injured and 126 fatalities. At this point it has to be underlined the fact that since 1993 in Italy the Compensation Authority does not include in official statistics accidents occurred to self-employed workers. For this reason, the real number of accidents registered taking into account reports of both police departments and inspectors of the national health service is different from official statistics for compensation.
Furthermore, also accidents occurred on the road were considered: in the period May 2009-April 2010, according to ASAPS [ASAPS, 2010], 296 cases involving tractors were registered, causing 174 fatalities among tractors' drivers and passengers. As emerged from previous studies [Fargnoli et al., 2010], the main reasons of such a situation can be found in the following aspects:

- technical obsolescence of tractors, i.e. the age limit over which the machine starts losing its technical efficiency and functionality is estimated in 15 years;
- a large number of machines used in agricultural activities are not up-dated following the recent development of safety standards and regulations;
- the number of workers specifically trained for the use of tractors and agricultural machinery is very small.

This is particularly true at an operative level: the lack of knowledge and expertise in both risk assessment and safety management is significant also because of the large number of part-time operators, elderly or foreign workers, who have rarely received professional training for the activities they are asked to perform. In particular, information concerning safety instructions of different working tasks and the use of PPEs (Personal Protection Equipments), difficulty in keeping the company in compliance with up-to-date laws and regulations, as well as hindrances in carrying out the regular maintenance of equipment and safety devices (which are often very old and obsolete), are quite common in the sector, as also underlined by several authors (e.g. [Schenker and Orenstein, 2002]), and by the latest reports of EU-OHSA (European Agency for Safety and Health at Work).

3. Tractor's safety

The analysis of data concerning accidents in the agricultural sector brought to light the importance of problems related with the use of tractors. For this reason a detailed study of safety requisites of laws and regulations affecting this kind of machinery was carried out. Among all of them, the following ones are certainly the most important:

- Tractor Directive (Directive 2003/37/EC): it defines technical requirements that all new vehicles belonging to categories T1, T2 and T3 have to satisfy following the "EC type-approval" certificate (Categories T1, T2 and T3 are defined in Annex II of Directive 2003/37/EC).
- New Machinery Safety Directive (Directive 2006/42/EC): this directive represents a significant novelty in the field. Actually, until the process of updating the Tractors Directive is completed taking into account all risks related to tractors, also tractors fall into its scope, and thus manufacturers are asked to verify the conformity of the tractor with the Essential Health and Safety Requirements (EHSRs) listed in Annex I, following the same process as traditional machines. Other relevant aspects of this law concern: the possibility of applying the full quality assurance procedure provided for in Annex X for roll-over protective structures (ROPS) and falling-object protective structures (FOPS); the need of providing a Risk Assessment Report for all the risks

currently not covered by Directive 2003/37/EC concerning agricultural or forestry tractors. Machinery mounted on these vehicles fall in the scope of the directive with no exceptions. This Directive came into force on December 29th, 2009.

- National law concerning Occupational Health and Safety (Decree 81/2008): in Italy this law was issued in April 2008 and updated in August 2009: it takes into account the safety procedures which have to be followed during all kind of working activities, the requisites which have to satisfied by the Risk Assessment Report, the minimum safety and health requirements for the use of work equipment by workers at work, and for maintenance operations of working equipments.
- The OECD Standard Codes, which set common rules (and harmonized procedures) for the Official Testing of Agricultural and Forestry Tractors in OECD countries: usually requisites of OECD Codes are implemented in EU directives, as in the case of the recent Directive 2010/22/EU of 15 March 2010.

More in details, as emerged by the study carried out by a technical EU Commission, residual risks which are not covered by the directive 2003/37/EC are the following:

- falling objects;
- penetration of objects into the cabin;
- seat-belt anchorages for passenger seats;
- extreme temperatures;
- hazardous substances;
- users' manual.

Thus manufacturers have to issue a CE Declaration of Conformity (and affix the CE mark), declaring that these risks were taken into account in conformity with the Machinery Directive prescriptions. Another aspect which emerged from the analysis performed is the lack of specific requisites for operators, who have to work with tractors, i.e. a specific "driving licence" or mandatory training course. As a matter of fact, there is a strong relationship between safety rules for road users (established by the Italian Highway Code) and safety requirements for workers: users of agricultural or forestry tractors have to deal with general safety requirements for driving a vehicle, including the vehicle maintenance and its conformity with technical requisites. For example, the use of a tractor without ROPS is forbidden not only in working activities, but also in public roads. Furthermore, as emerged from the accidents' statistics, numerous accidents with tractors occur on the road, both when users go to or came back from working sites ("in itinere" accidents), and when they use the tractors as a normal vehicle.

4. Research approach

As emerged from the analyses carried out in collaboration with the Interregional Working Group for Occupational Safety in Agricultural and Forestry activities, the number of companies operating in the field not complying with safety requisites is still very large. The lack of safety in this sector is caused mainly by the difficulty of companies in implementing safety requirements in accordance with compulsory regulations. This is due to the specific characteristics of working activities in agriculture, such as:

- the large number of different of activities usually carried out in this sector;
- the frequent exchange of tasks among workers within the same company or the frequent exchange of workers for the same activity (e.g. seasonal workers);
- the variety of work environments, which is not easy to foresee in advance, when risk assessment is carried out (e.g. different grounds, atmospheric conditions, etc.);

- the stress caused by seasonal jobs (in some situations workers have to work continuously for a period of time which is longer than an usual shift, and this might cause stress, fatigue, tiredness, etc.).

In such a situation, even a correct application of safety requirements by company's managers might result in being less effective: spreading information concerning risk prevention and providing right procedures, which should be followed with the aim of reducing the occurrence of accidents, is certainly more difficult than in traditional industry sectors. In such a context, the development of a correct Risk Assessment Report, which takes into account also risks related with the skills of the tractors' users is fundamental. The goal of the present research work is to provide a solution to such a problem, throughout the development of a risk assessment procedure of a general nature, which can be applied in different work situations, overcoming the complexity of regulations in the sector. More in details, starting from the issues of the new Machinery Directive, a general framework for Hard Analysis (HA) activities was developed, adopting the procedure for risk assessment and risk reduction proposed in section 5.1.3 of the standard ISO 12100-1:2003 (considering also the indications of a general nature proposed by the standard ISO14121-1:2007). Starting from such this general scheme, the Risk Assessment stages were analyzed (Figure 1), focusing our attention on the residual risks for tractors, which are not considered by the directive 2003/37/EC. With this aim in mind, the analysis of a narrow-track tractor was performed. Main characteristics of the vehicle analyzed are the following: wheeled tractor with a maximum design speed of not more than 40 km/h, with a track width of 1.147 mm and length of 3.750 mm, with an unladen mass of 2.450 kg (without cabin), and an engine power of about 70 HP.

5. Hazard Analysis

In order to make the Risk assessment more detailed, the following tools for carrying out Hazard Analysis activities were used. Firstly, we applied the Preliminary Hazard Analysis (PHA): this method allows engineers to bring to light most significant risks of the machine, providing a qualitative estimation of them [Clifton, 2005]. The use limits of the tractor were taken into account considering the following use phases: access to the driving position; mechanical coupling between tractor and towed equipment; use in the field; maintenance operations. Results of this analysis showed that most dangerous risks are: roll-over and rear-up tendency; use of the power take-off; improper behaviour of the user. Since the first two of the above mentioned risks concern mainly constructive solutions, whose design requisites are well established by technical standards, we fixed the attention on the third one, i.e. the behaviour of the operator.

For this purpose, the Fish Bone Diagram (FBD) method [Clifton, 2005] was used, with the aim of finding out the possible causes of the improper use of the tractor (e.g. operator, management of working activities, etc.). This application was carried out analyzing types and causes of significant and fatal accidents registered in the ISPESL accidents' database, as well as literature backgrounds (e.g. [Yadav and Tewari, 1998] and [Myers et al., 2009]). In Figure 2 an excerpt of this application is shown.

As far as the human error is concerned, according to [Rasmussen, 1983; Reason, 1990], the main causes can be found in:

- a skill-based behaviour (automatic, unconscious and used to perform a task in parallel with other activities), which usually leads to slips, i.e. misapplied competence;
- a knowledge based behaviour (used to solve problems consciously), leading to mistakes generated by lack of knowledge;
- a rule based behaviour (able to recognize situations and follow already defined procedures), which brings the operator to mistake due to a failure of expertise.

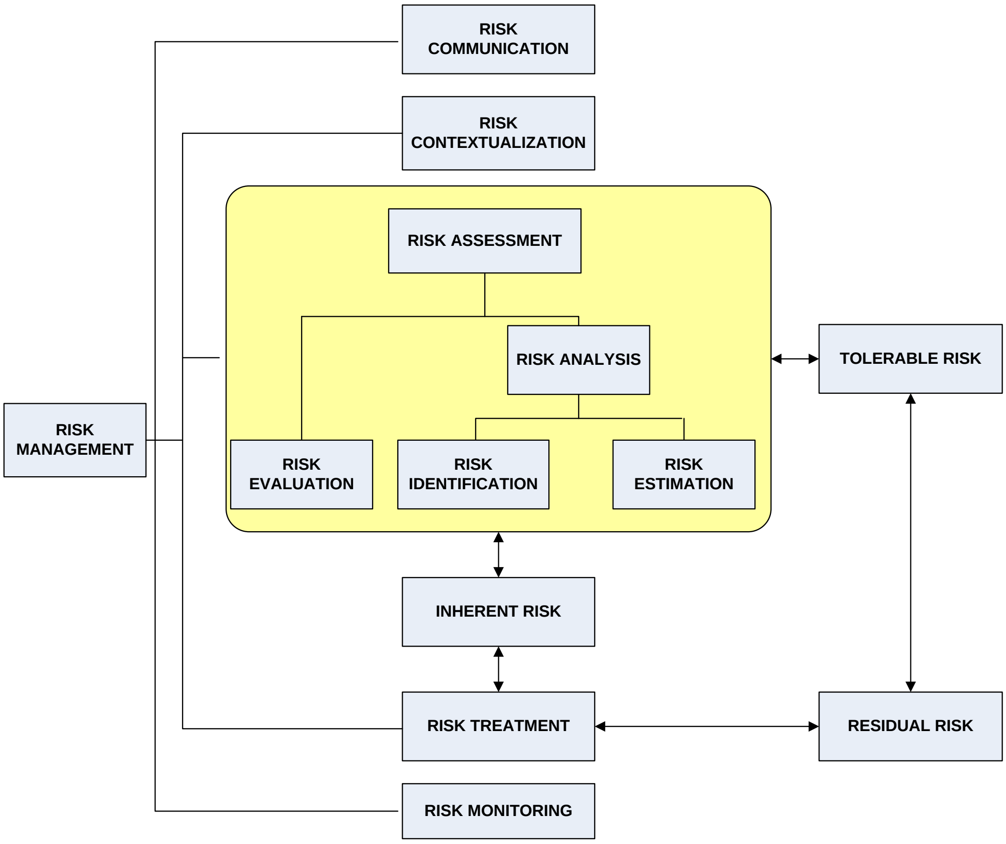

Figure 1. Risk management framework.

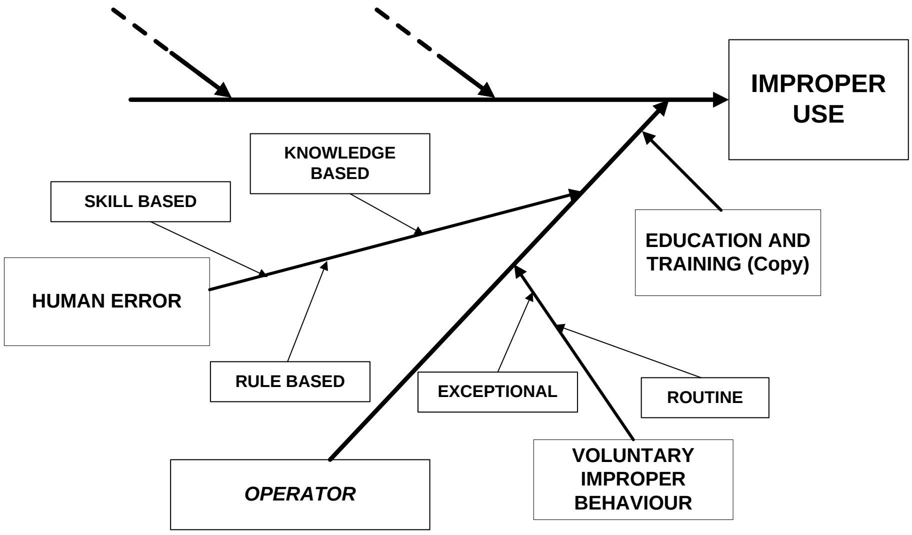

Figure 2. Excerpt of the application of the FBD method.

Results obtained showed that numerous factors can lead to an improper behaviour of the tractor's user, but most of them are related with the operator's training and education concerning safety and operative issues. In order to esteem the influence of such aspects on the level of safety of the operator, the ISSA (International Social Security Association) technique [ISSA, 2000] was used. This method allows the calculation of the risk of accident (*Ra*), which is the result of the formula shown in the equation (1), where R_G represents the global risk and *W* represents the skills of operator in managing the risk:

$$R_A = R_G - W \times \frac{Mat}{30} \qquad (1)$$

More in details, the operator skills can be estimated considering the following three aspects: the qualification degree of the operator, a coefficient which takes into account the physiological concerns, and the organization of working activities. Following these criteria, four different working situations (scenarios) were considered:

A. tractor working in a vineyard (slope), with towed equipment and front side ROPS, which can be dismounted manually;
B. tractor working in a vineyard (slope), with towed equipment and front side ROPS, which can be dismounted only using a specific tool;
C. tractor working in a vineyard (slope), with towed equipment and rear side ROPS, which can be dismounted only using a specific tool;
D. tractor working in a greenhouse (plain), with towed equipment and front side ROPS, which can be dismounted only using a specific tool.

For each one of them three different typologies of operator were taken into account:

1. skilled and expert user (Op.1);
2. skilled, but beginner (Op.2);
3. beginner, i.e. without experience (Op.3).

Main results of the analysis are shown in Figure 3, where the tolerance limit, i.e. the level of risk which can be considered acceptable, is represented by the dashed bold line: below this level, the user can manage the risk and most probably avoid the accident.

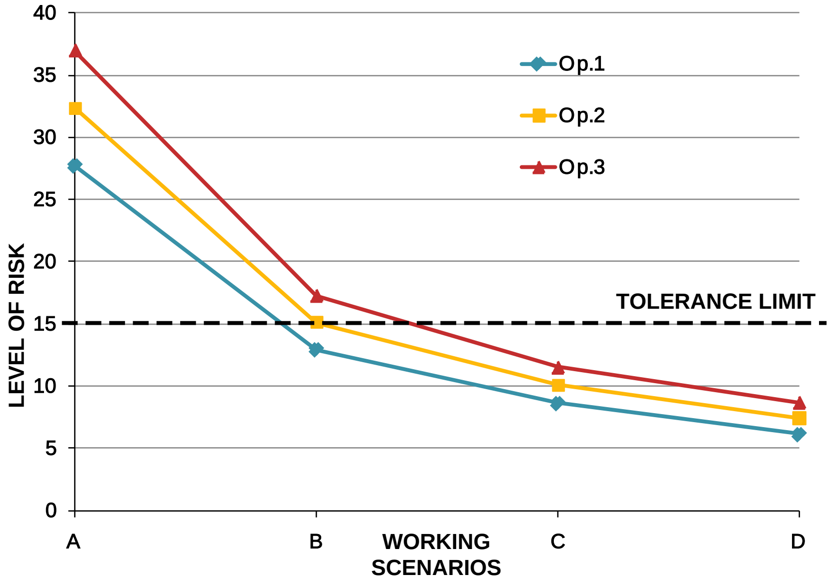

Figure 3. Influence of operator's skills on the level of risk.

The level of risk of skilled users, i.e. operators who received a specific training in using tractors and in managing occupational safety issues, resulted in being rather acceptable in most situations. The only situations whose risk was higher than the tolerance limit occurred in the case of non skilled users (scenario B), and non conformity of the machine (scenario A).

It has to be underlined that in many cases the operator voluntary remove the ROPS when operating in narrow environments, such as greenhouses or vineyards; but quite often do not set it back when moving to different places. Thus, apart from novel design solutions which could be applied for the development of new machines, prevention measures for reducing the risks connected with this kind of working activities concern mainly information and training measures for operators.

6. Conclusion

The new Machinery Directive, as well as recent updates of Italian law on occupational safety, have a significant impact on agricultural and forestry activities: tractors' manufacturers and users have to consider numerous risks, which have been disregarded so far.

The approach developed for performing the risk assessment activities resulted in being a supportive framework for the analysis of these types of machines, allowing us to bring to light the importance of information, training and education of tractors' users.

At the same time, we have to underline that tractors (at least most of them) and a large number of self-propelled agricultural machinery can be considered as special vehicles from safety point of view, such as trucks, buses or forklift trucks, and indeed for this reason their users should need a specific licence or a specific training, as suggested also by art. 73, c.5 of the Italian Law about occupational safety. With this aim in mind, the present research work is currently in progress, focusing the attention on tools for assessing the human factor, with the goal of defining a set of criteria for the training of tractors' users.

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A Predictive Model for Vibration Risk Evaluation in Agricultural Machinery

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Abstract
Several popular National and International Standards provide different limits relevant to workers' vibration exposure. The agricultural activity is characterized by seasonal work peaks, in which operators widely exceed the traditional 8-hours work per day, alternated to other long time periods of relatively light activity.
On the other hand, agricultural machinery management involves many different jobs, as in terms of implements to be conducted, as considering the variety of operating conditions. As a consequence, the evaluation of the operator's vibration risk exposure is very difficult, and the results obtained are normally very poor, because they take into account as inputs only the vibrations levels published on the machinery instruction manuals, that are relevant to theoretical and often non realistic working conditions.
On the basis of a suitable campaign of field trials, in the present paper the building of a predictive model of the vibration exposure is proposed, starting from the worldwide most popular agricultural machine, the tractor, and similarly probably by the most frequently operation carried out, the ploughing. In any case, this job represents a very effective example, as for its high frequency of execution, as because ploughing is normally (both in-furrow and out-of-furrow) a very hazardous task under vibrational point of view.

Keywords: vibration, agricultural machinery, ploughing, decision support system

Introduction
Among the health risks of the agricultural operators, the mechanical vibration is very important, especially for the recent increase of the machinery use. For tractor drivers this risk is particularly significant.
The vibration risk assessment evaluation in agriculture is generally difficult, because of many sources and operating conditions. In many cases, the vibrational values of the dedicated databases are not sufficiently accurate to provide a valid basis on which calculate correct vibration exposure levels.
The enduring lack of data in specific literature confirms this difficulty. A study devoted to the prediction of the vibrational levels of the most common agricultural tasks, without the need of carrying out specific field measurement, could be then a suitable solution.
To do this, in this study the multicriteria technique was taken into account. The fundamental assumption underlying this technique is that it is possible to decompose the analysis item in simple factors (named criteria, which describe it comprehensively) and alternatives.
The multi-criteria analysis is then an approach that includes a variety of techniques that are based on the same pattern: to make explicit the contributions of the different options of choice in respect of the different criteria or attributes.
The criteria is the means by which the various alternatives are compared to each other, on the base of the decision maker purposes.

Materials and Methods

Multi-Criteria Decision Analysis (MCDA) has undergone a dramatic development during the last 30 years. MCDA is not a tool providing the "right" solution in a decision problem, since no such solution exists. The solution provided might be considered the best one only for the decision maker, who provide their values in the form of weighting factors, while other decision maker values may indicate other alternative solutions. Furthermore, several weighting techniques have been developed to help decision makers involved in a MCDA procedure become aware and articulate their preferences.

Structural elements

The core elements in a MCDA problem are certainly the set of alternative actions and the set of criteria along which these actions have to be evaluated. However, there are a given number of structural and external characteristics that go beyond an arithmetic definition of these basic elements. To help the approach of these characteristics in a consistent and systematic way several possibilities are available. *Criteria* represent the decision makers points of view along which it seems adequate to establish comparisons. Indeed, there are two main approaches to determine the set of criteria, reflecting the two ways of building a MCDA problem.

The first is the top-down approach, in which criteria are built in a hierarchical structure, known as '*value tree'*, leading from primary goals to main objectives, which are further broken down to specific criteria.

The second is the bottom-up approach, that supports "alternative-focused thinking", where criteria are identified through a systematic elicitation process, and may subsequently grouped in broader categories.

Alternatives are usually thought as "given", in the sense that they are *a priori* and strictly defined. However, alternatives may result from the systematic exploration of the objectives pursued in the considered situation. Finally, alternatives may be defined as combinations of discrete actions.

Decision makers involved in the decision situation are those identifying the nature of the problem and driving the solution procedure towards the preferred direction.

Acknowledging *uncertainty* is another crucial element of MCDA problems. The main cause of uncertainty is the limited knowledge about external parameters that may influence the performances of the considered actions. In addition, decision makers have to handle internal uncertainty caused by hesitations during the structuring process problem.

In the present study, a "top-down" method, an Analytic Hierarchy Process (AHP), was adopted. It is a MCDA approach introduced by Thomas L. Saaty in the '70s. AHP can be used in making decisions that are complex, unstructured and contains multiple-attributes. The decisions that are described by these criteria contain both physical and psychological elements. It is used a multi-level hierarchical structure of objectives, criteria, subcriteria and alternatives. The pertinent data are derived by using a set of pairwise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. AHP provides a method to connect these elements (that can be quantified) and the subjective judgment of the decision maker in a way that can be measured. This method is composed of 3 steps: the description of a complex decision problem as a hierarchy, the prioritization procedure and the calculation of results.

A problem is put in a hierarchical structure (**fig. 1**), in which the *level I* reflects the overall purpose of the decision; *level II* contains criteria for the decision, (*level III* is relevant to possible subfactors) and *level IV* is composed of the alternatives (*Nataraj S., 2005*). The comparison of criteria and alternatives is made using a fundamental scale of absolute numbers (**table 1**). It converts individual preferences into ratio scale weights that can be combined into a linear additive weight for each alternative. It represents the importance of criteria.

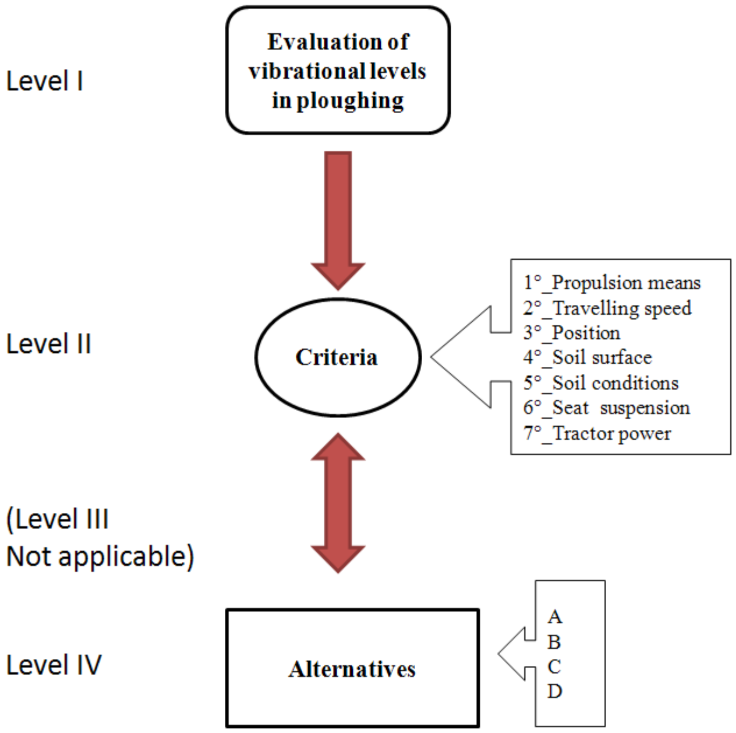

Figure 1. Scheme of the hierarchic model applied for the analysis.

Table 1. Relative importance scale (by Saaty).

Importance intensity	Definition	Description
1	Equal importance	Two activities contribute equally to the objective
2(*)		
3	Weak importance of one over another	Experience and judgment slightly favour one activity on another
4(*)		
5	Essential or strong importance	Experience and judgment strongly favour one activity on another
6(*)		
7	Demonstrated importance	An activity is strongly favoured and its dominance demonstrated in practice
8(*)		
9	Absolute importance	The evidence favouring one activity on another.

(*) = 2, 4, 6, 8: intermediate values

The AHP was adopted for analyzing the parameters influencing the vibrational levels during ploughing. The purpose of the present study was to assign a suitable weight to each of these parameters, starting from a certain number of cases of measured vibrational levels (**fig. 2**).

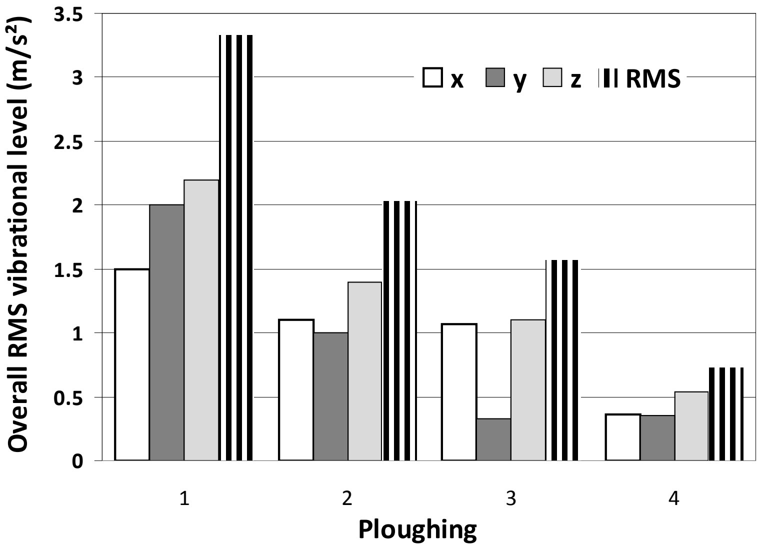

Figure 2. Whole-body vibrational levels measured on the tractor driver's seat during 4 ploughing tasks.

Each criteria can be described using different options, summarized in **table 2.** The structure of the typical decision problem consists of a number of alternatives, and a number of criteria (**table 3**). Through the choice among these options decision maker can describe each criteria.

Table 2. Criteria options.

Criteria	Options
Propulsion means	tyre, track
Travelling speed	low (ts <5 km/h), medium (5 km/h < ts < 8 km/h), high (ts >8 km/h)
Plough working	in furrow, out of furrow
Soil surface profile	regular, rough, very rough
Soil conditions	good, not good, poor
Seat suspension type	mechanical, pneumatic
Tractor power	numerical value (kW)
Overall RMS vibration level	recorded value (m/s^2)

Results

All the elements of the hierarchical model have been compared. In a simple situation, all the criteria are expressed in the same unit, but in many real problems, and also here, many criteria may be expressed in different dimensions. Saaty's scale helps comparing both criteria (**table 4**) and alternatives, because it links absolute number with linguistic description about the relative importance of each elements.

Table 3. Matrix about criteria and alternatives considered in the present study.

	Case	Alternatives			
		a	**b**	**c**	**d**
Criteria	Propulsion means	tyre	tyre	tyre	tyre
	Travelling speed	medium	low	medium	medium
	Plough working	in furrow	in furrow	in furrow	in furrow
	Soil surface profile	very rough	very rough	very rough	regular
	Soil conditions	poor	good	poor	good
	Seat suspension type	pneumatic	pneumatic	pneumatic	pneumatic
	Tractor power	119 kW	92 kW	96 kW	141 kW
	Overall RMS vibration level	3.33 m/s²	2.04 m/s²	1.57 m/s²	0.73 m/s²

Comparisons among criteria and alternatives produce weighting factors (**table 5**), which are multiplied, in order to obtain a single weight for each criteria and for a single alternative.

Table 4. Application of comparison among criteria, using Saaty's scale.

	PM	**TS**	**PW**	**SP**	**SC**	**ST**	**TP**
Propulsion Means (PM)	1	6	7	7	8	8	9
Travelling speed (TS)	1/6	1	5	6	6	7	8
Plough working (PW)	1/7	1/5	1	3	3	4	4
Soil surface profile (SP)	1/7	1/6	1/3	1	3	3	3
Soil conditions (SC)	1/8	1/6	1/3	1/3	1	3	3
Seat suspension type (ST)	1/8	1/7	1/4	1/3	1/3	1	2
Tractor power (TP)	1/9	1/8	1/4	1/3	1/3	1/2	1

Table 5. Single criteria weights (W) and their normalized values (W_n).

	W	W_n
PM	0.450	**0.268**
TS	0.240	**0.143**
PW	0.110	**0.066**
SP	0.758	**0.453**
SC	0.055	**0.033**
ST	0.036	**0.021**
TP	0.026	**0.016**

The overall RMS vibration levels calculated during real tests were considered. As a result of previous trials, it was found that vibration levels during ploughing are generally higher than 0.42 m/s2. Considering a reduction of this value of about 10 % (due to measurement and instrument calibration inaccuracy), 0.38 m/s2 might be considered the minimum overall RMS vibration level measured during ploughing (offset). The difference (D) between the obtained RMS levels and the defined offset for each of the examined cases is then shown in table 6.

Table 6. Difference D between the overall RMS vibration levels and the defined offset (m/s^2).

	a	b	c	d
Overall RMS vibration level	3.33	2.04	1.57	0.73
Offset		0.38		
D	**2.95**	**1.66**	**1.19**	**0.35**

Starting from these values (D) thus obtained, using the criteria weights previously calculated (Table 5), it was possible to estimate the influence of each criteria within each of the 4 tests carried out (table 7).

Table 7. Criteria influence on the overall RMS vibration level of the 4 tests examined.

Criteria	Normalized weight	Overall RMS vibration level contribution			
		a	b	c	d
Propulsion means	0.268	0.78	0.45	0.32	0.09
Travelling speed	0.143	0.41	0.24	0.17	0.05
Plough working	0.066	0.18	0.12	0.08	0.02
Soil surface profile	0.453	1.33	0.75	0.54	0.16
Soil conditions	0.033	0.09	0.05	0.04	0.01
Seat suspension type	0.021	0.06	0.03	0.02	0.01
Tractor power	0.016	0.04	0.02	0.02	0.01
Σ	**1**	**2.95**	**1.66**	**1.19**	**0.35**

Conclusions

Purpose of this study was to define a given number of criteria and their relevant weighting in order to ascertain the influence on overall RMS vibration levels recorded during the agricultural operations. Aim of this model is to predict the vibrational level produced at the driver’s seat of a tractor coupled to a specific implement.

The Analytic Hierarchy Process (AHP) model was then applied, taking into account the measured overall RMS vibration values during 4 cases of ploughing. This is just a demonstration, so conducted with very few data; the next step will be to acquire enough data to cover suitably all the options considered, in order to define as exactly as possible the influence of each criteria. The studied method could also be applied for changing the decision makers points of view referred to the considered criteria.

Furtherly, it should be extended to all field/farming agricultural operations. The ultimate goal will be the creation of a complete database with a careful selection of the criteria options. The database will be the means to predict the vibrational level of each agricultural operation, without instrumental measurements.

Finally, the last step will be to evaluate the overall operator’s vibration exposure, by taking into account his/her agricultural tasks carried out, weighted over the working time dedicated to each of them.

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Risk Assessment in Plant Nursery Characterized By Several Working Task With Annual Turnover

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Keywords: ergonomics, repetitive tasks, OCRA

Objectives

In agriculture, biomechanical demand of tasks varies over the annual cycle and exposure of workers varies in duration and intensity every month.
In nurseries main work tasks involve the re-invasion of cuttings and pruning for the growth of vegetation, but these are only part of several tasks that are employed in the greenhouse and in the field during the year.
This study performs a complete tasks analysis during the annual cycle and asses the intrinsic risk of upper limb injury and of carrying loads, calculated for every task and detailed, specifying the duration of each task.

Methods

Introduction

Agriculture poses many health hazards and musculoskeletal problems to the workers, but one of the difficulties in dealing with agriculture is that it's a very complex and heterogeneous sector. It involves a number of specific situations that vary from each type of sectors, is based on its seasonal periods. Therefore, long term exposure to material handling, awkward postures and combined stresses of work environment are present; even though statistics have shown agricultural activity to be one of the most hazardous activities in the world, there is very little history of application of ergonomics principles to agricultural environments.

The flower-growing segment of agriculture is a very characteristic that has peculiarity for the aspect of cultural, economic and social. Nursery flowers are the branch that concern both cultivation and sale of flowers, houseplants and garden. This is characterized by strong seasonality of products due to specific periods of flowering and growth. The characteristics of many species concerned give rise to a complex and various market demand. Currently, the species covered by the workers in nursery plant are about 2000 in various families; the flower-growing category includes flowers, leaves and fronds. Crops can be in the greenhouse and field. Currently, the sector is growing on the world scene, with new producer countries.

Plant nursery in the world

The total world area devoted to floriculture is between 260,000 and 290,000 acres, plus 650,000 hectares of nurseries with a workforce of 2,000,000: the distribution affects all continents but particularly some African countries have become exporters, and China has a strong development. In South America the largest producer of cut flowers is Colombia with 140,000 employees in companies and another producing country is Ecuador.

The floriculture sector in Italy has a population of about 38000 companies (Istat) operating on 32000 hectares of total area with a number of employees that exceeds 100,000 people. Traditionally, companies are small family-run.

WMSDs in nurseries workers

Review of reported occupational injuries in California agriculture by AgSafe shows that sprains and strains predominate as major types of injury, accounting for 43% of all reported agricultural occupational injuries. It should also be noted that according to the AgSafe data nurseries shared with other agricultural commodities a pattern of high rates of sprain and strain injuries. Those data suggested that 48,9% of all reported injuries in horticultural specialities (including nurseries) were sprains and strains. The problem of WMSDs in nurseries workers is well known but the study of the relationship between diseases and work has not been well assessed yet.

Task analysis in plant nursery - Tasks in annual cycle

Task performed in the floriculture and plant nursery work are very seasonal and there are only few tasks that are performed more than half of the year.

In figure 1 the main tasks are detailed, additional tasks may appear, for example in a particularly field or new greenhouse.

Conduction system of growing

Companies involved in cultivating and growing the different types of varieties according to the specified on the species. The workings occur in cycles and seasonal due to the need for growth and dormant. Among the most frequently repeated stage, independently of the variety, it can be include:

- re-invaded cuttings
- planting
- pruning
- grooming plants
- manual irrigation.

Ordinary activities for the management and maintenance of nurseries and greenhouses are indicated in the following phases:

- weeding blooms and grooming
- cleaning supported systems.

Figure 1: the main work tasks during annual cycle

MAIN WORK TASK		
Invaded cuttings and planting	Regular grooming	Regular arrangement of vegetation
		
Re invaded and manual planting of annual plants	Pruning of potted plants	Re invaded mechanized
		
Preparation trolleys for shipment	Transports with wheelbarrows	Spriklers manual
		

Case study

The study was conducted according to the duration of the annual work cycle, the different activities performed by employees in relation to individual phases. For this application was selected an group of workers, homogeneous for activities performed, equipment used, working seniority and experience.
Each month involves different phases of work depending on the cultivar and vigor of the plant if growing season or in the latent stage. Work tasks were considered from at least 1% lenght in the reference month

Each task was filmed for the duration of a single phase over several cycles, in different situations: front, from behind, the left side and right side in order to get as much details as possible about the repetitive movements and awkward postures of the shoulder, elbow, wrist, hand and fingers. They also show the whole body posture to assess the position of the neck, spine and lower limbs.

<u>Intrinsic upper-limb level of every task</u>

As requested by Italian legislation (EN 1005-5) and European (ISO 11288-3, 2007), for assessing the risk of upper limb biomechanical overload, we used the method OCRA.

The method consists of two specific tools: OCRA index and OCRA checklist. For this study, given the particular time of the annual cycle and the number of stages and substages to be evaluated, the checklist OCRA was used as more appropriate for estimating the presence of risk.

Intrinsic risk level of a task is defined as the risk level of a worker who performs a task during the day. In the case studied, the duration of the shift is 8 hours, with a break for
lunch and two breaks lasting 20 minutes (one in the morning and one in the afternoon) for a total of 440 minutes worked. Thus was defined as recovery factor value of 4. All the intrinsic values of right upper limb obtained are detailed in table 1.

Table 1: Checklist OCRA intrinsic value

TASKS	Re	Fr	Fo	Side	Sh	El	Wr	Ha	St	Tot Po	Co	Tot
Plant research dresser	4	2,5	2	DX	2	0	4	4	0	4	0	12,5
Grooming and pruning	4	4	0	DX	4	2	2	4	0	4	0	12,0
Hairdo vegetation	4	6	0	DX	2	0	2	4	0	4	0	14,0
Wheelbarrow planting	4	5	1,5	DX	2	2	0	4	1,5	5,5	0	16,0
Flaring and pruning roses	4	4	0	DX	2	2	2	4	0	4	0	12,0
Re-labeling pot roses	4	4,5	2	DX	6	4	2	2	0	6	2	18,5
Repotting roses	4	2,5	2	DX	2	2	2	4	0	4	2	14,5
Adding compost and manure rose	4	5	1,5	DX	2	2	0	4	1,5	5,5	0	16,0
Planting roses	4	4,5	2	DX	2	4	4	6	0	6	0	16,5
Insert manual irrigation roses	4	4	0	DX	1	2	0	6	0	6	0	14,0
Soil transport	4	4,5	2	DX	2	6	2	0	1,5	7,5	0	18,0
Manual watering banana	4	4,5	2	DX	4	0	0	0	1,5	5,5	0	16,0
Sampling jars blooms	4	4,5	0	DX	12	4	4	4	0	12	0	20,5
Pruning flowering	4	4,5	0	DX	1	2	2	0	0	2	0	10,5
Preparation trolleys	4	4,5	2	DX	8	3	4	6	1,5	9,5	0	20,0
Cargo truck	4	2,5	4	DX	6	2	0	3	1,5	7,5	0	18,0
Truck loading various materials	4	2,5	3	DX	3	0	3	4	1,5	5,5	0	15,0
Preparing trays peat pots	4	5	0	DX	1	2	2	6	1,5	7,5	0	16,5
Fill pots and hole	4	3	2	DX	1	0	3	3	1,5	4,5	0	13,5
Repotting and replanting	4	4	0	DX	1	0	0	4	1,5	5,5	0	13,5
Planting with wheelbarrow	4	2,5	2	DX	1	2	0	2	1,5	3,5	0	12,0
Pruning wisteria	4	4,5	2	DX	6	2	0	0	0	6	0	16,5
Banding and change barrels wisteria	4	2,5	4	DX	2	0	2	0	0	2	0	12,5
Planting wisteria	4	2,5	2	DX	2	2	0	0	1,5	3,5	0	12,0
Aeration roots and repotting perenni	4	2,5	0	DX	2	0	0	4	0	4	0	10,5
Fill	4	3	0	DX	2	3	2	4	1,5	5,5	0	12,5
Planting perennial blooms	4	2	2	DX	1	0	2	2	1,5	3,5	0	11,5
Pruning clematis	4	4	0	DX	6	0	2	6	0	6	0	14,0
Change clematis trellis	4	4	3	DX	8	4	0	4	1,5	9,5	0	20,5
Combing and binding clematis	4	4,5	0	DX	8	4	0	0	0	8	0	16,5
Planting clematis	4	2,5	2	DX	1	2	2	4	1,5	5,5	0	14,0
Compost bags	4	3	3	DX	3	2	2	4	1,5	5,5	0	15,5
Preparation pots	4	8	0,5	DX	6	4	4	6	3	9	2	23,5
Cuttings	4	7	0	DX	3	3	3	4	3	7	1	19,0
Finishing basket	4	3	1	DX	3	2	3	3	1,5	4,5	0	12,5
Hanging basket	4	4,5	1	DX	0	0	3	6	0	6	0	15,5
General grooming	4	3	0	DX	2	2	3	4	1,5	5,5	0	12,5
Accommodation in greenhouse	4	3	1	DX	3	2	2	3	0	3	0	11,0
Cleaning	4	4,5	1	DX	2	3	0	0	0	3	0	12,5

Intrinsic postures level of every task

To complete the picture of the biomechanics demand required to workers, it was assessed the postural commitment of any task, phase and sub phase with regard to the neck, back and lower limbs. Indeed, the particular type of work, involves prolonged and frequently repeated postures.

The neck was assessed for posture in extreme flexion or extension in relation to the position maintained by the trunk (which can be in full flexion, moderate flexion or extension). The lower limbs are particularly busy: positions on the floor with knees fully flexed or partially kneeling or with a muscular effort due to the squatting posture.

For any particular posture the commitment was quantified for the duration of the task, as evidenced when it is maintained for at least half the time, almost all the time or for as long as no changes of position, as shown in Table 2.

Table 2: identification of the main postures of the back of the neck and lower limbs taken during the working phases.

POSTURES OF THE NECK, UPPER LIMB AND BACK	OPERATIONAL AREA	DURATION	VALUE
Lumbar posture in complete alternating bending or kneeling posture or partially kneeling	below the knees	as long	8
Posture of the lumbar flexion in total, alternating with kneeling posture or partially kneeling	below the knees	as long	8
Crouching posture with static muscular work, neck flexion	operational area at eye	as long	8
Fully flexed lumbar	below the knees	as long	4
Back in extension with arms above the head	above the height of the head	more than half of the time	4
Static posture of the upper limbs with loads		as long	4
Walking long distances carrying weights with both arms		more than half of the time	4
Frequent changes of posture squatting with static muscular effort and standing with weights		more than half of the time	3
Changes in posture of neck flexion - extension		as long	2
Lumbar posture in demi-flexions	about the hieght of the knees	as long	2
Lumbar posture in demi-flexions with neck flexion	operational area at eye	as long	2
Working position, standing with his back kept almost straight	operational area at eye	as long	1
Sitting back supported	operational area at eye	as long	0,1

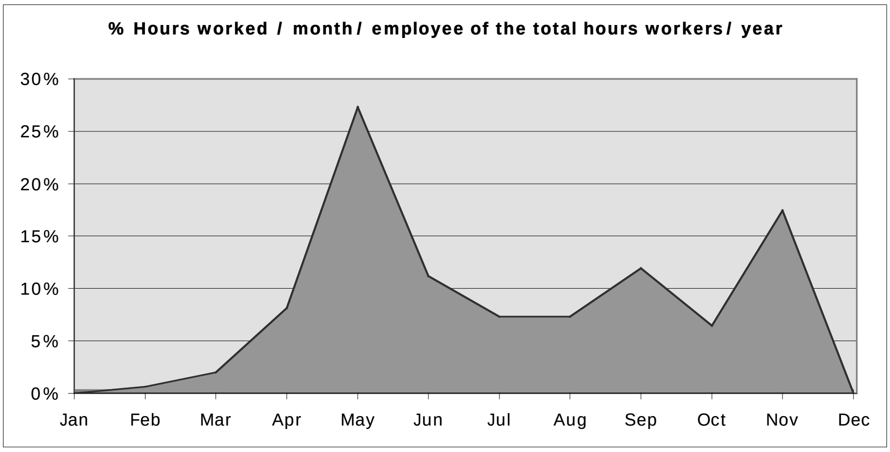
Results

Annual exposure analysis

The special annual activities that involve the various stages in rotation according to the particular types of plants, are carried out with intensity and duration variables. In Table 3 are represented the various activities in each month duration, calculated in hours / month for the homogeneous group of workers considered.

It represents the different activities during each month of the year: each stage data was collected on worked hours by verifying themselves and written in company records.

Table 3: % Hours worked / Month / Employee of the total hours worked / year



Annual exposure analysis

Studies for the quantification of risk by biomechanical overload of the upper limbs were recently proposed using four models for calculating (Colombini et al, in press in August 2009):

a) Weighted average with classical daily rotation
b) Hyperbolic qualitative average weighted index
c) Quantitative weighted average index
d) Multitask complex OCRA method index.

The four models proposed have been applied to both upper limbs, using the intrinsic risk values calculated on the temporal assignments, and the results of annual exposure index values obtained are as follows:

WEIGHTED AVERAGE		INDEX SEMI-WEIGHTED AVERAGE QUALITY		INDEX WEIGHTED AVERAGE QUANTITY		MULTITASK COMPLEX	
DX	SX	DX	SX	DX	SX	DX	SX
14,8	**13,4**	**12,5**	**11,5**	**15,5**	**14,1**	**17,4**	**9,5**

Conclusions

The results obtained indicate that the method a) and the method d) are actually the best indicators to estimate and predict the risk in an annual exposure, but to complete those studies more data need to be collected on farms in the sector possibly related to comprehensive clinical data.

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Topic 2
"Prevention and risk analysis in agro-forestry work environments"

Poster Presentation

Analysis of the Main Critical Points in Protected Crops on Risk Prevention in Sicily

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Abstract
The evaluation of the safety conditions inside the greenhouses is a matter of primary importance in order to safeguard the operators' health who are exposed to high chemical and physical risk factors.
The aim of this paper was to evaluate these risk factors for the operators inside the greenhouses through the estimation of some parameters related to the environmental quality inside the greenhouse. Temperature, relative humidity, CO_2 and VOC (Volatile Organic Compounds) were monitored inside different greenhouses before, during and after chemical treatments.
The results of these measurements gave useful indications about the risk for the operators' health.

Keywords: risk prevention, protected crops, greenhouse

Introduction
In the last decade the vegetable crop production in greenhouses has highly increased. Enlarging the harvesting period of tomato, pepper, melon, aubergine, courgette, strawberry, etc. gives, in fact, the chance to obtain higher prices and, therefore, the growing of the profit of the farmer.
Unfortunately, crop production in greenhouses needs the use of chemicals and requires high levels of temperature and relative humidity. This can cause risks for the health of the operators, especially if they are not equipped with protection devices.
The aim of this paper is to evaluate the risks for the operators through the estimation of some parameters related to the environmental quality inside the greenhouse.

Materials and methods
The tests were carried out in April-June 2009 in some farms located in Western Sicily in the neighbouring of Balestrate, Marsala and Mazara del Vallo. The outdoor temperature in the daytime was higher than 20°C. The pesticide treatments were performed during the afternoon; the following active principles were used: indoxcarbon 30%, thiamethoxan 25%, ciproconazolo 10% and famoxadone.
The investigated greenhouses were different in type of the structure, covering materials and crop production (table 1).
Temperature, relative humidity, VOC (Volatile Organic Compounds), NO_2 and CO_2 were measured by means of an electronic system equipped with a data logger and a photo ionisation sensor.
High temperatures, above 41°C, associated with high humidity levels (above 70%) and lack of ventilation, can produce to man hyperthermia (heat stroke). The man, in fact, is an omeotermic with a normal body temperature of about 36.7°C.

Regarding carbon dioxide, concentrations between 8% and 15% by volume in air may give headaches, nausea and vomiting. Concentrations higher than the last threshold, can cause heart failure also with fatal results. The maximum permissible concentration for exposures of 8 hours per day for 5 days per week is 5,000 ppm by volume in air.

Table 1. Characteristics of the investigated greenhouses.

Test site	Town	Structure	Covering	Span [n]	Shape of the roof	Exposure	Crop
A1	Balestrate	Steel	Plastic film	3	Ellipse	East-West	Plant nursery
A2		Steel	Glass	3	Sloping	East-West	Plant nursery
B1	Marsala	Wood	Plastic film	1	Sloping	North-South	Strawberry
B2		Wood	Plastic film	1	Sloping	North-South	Tomato
C1	Mazara del Vallo	Steel	Plastic film	3	Ellipse	East-West	Tomato
C2		Steel	Glass	3	Sloping	East-West	Tomato

The oxides of nitrogen is a very toxic compound. The maximum allowable concentration in the mixture with air, for exposures of 8 hours per day for 5 days a week, is 3 ppm by volume.
It 's a strong irritant of the airways: a moderate concentration causes acute coughing, chest pain, convulsions and circulatory failure. The attack to the pulmonary apparatus may cause irreversible damages whose most serious injuries may occur many months after the attack.
With the designation of volatile organic compounds (VOC) the vapors arising from complex mixtures are indicated
The compounds that fall into this category are more than 300; among the best known there are the aliphatic hydrocarbons (n-hexane, n-hexadecane and metilesani), terpenes, aromatic hydrocarbons (benzene and derivatives, toluene, o-xylene, styrene), chlorinated hydrocarbons (chloroform, dichloromethane, chlorobenzenes), alcohols (ethanol, propanol, butanol, and derivatives), esters, ketones, and aldehydes (formaldehyde).
In confined spaces where agriculture is performed, sources of VOC are found in pesticides. Exposure to VOC can cause both acute and chronic effects based on concentrations; the acute effects may include irritation to eyes, nose, throat headache, nausea, dizziness and asthma. Chronic effects may include cancer, damage to kidneys, liver and central nervous system. To reduce exposure to VOCs is advisable to make a proper room ventilation during and after treatment and keep the humidity between 40 and 60%.
Two indoor air quality monitor (IAQRAE PGM – 5210 and MultiRae IR PGM-54) were used during the tests. These portable instruments provide real time measurements every 120 s and activate alarm signals when exposure exceeds preset limits. The recorded data were downloaded to a personal computer through the software ProRAE-Suite. The range of the measurements were: 0° - 50°C for temperature, 0 – 100% for relative humidity, 0 – 200 ppm for VOC, 0 – 20 ppm for NO_2 and 0 – 20.000 ppm for CO_2.

During the tests the instruments were placed inside each greenhouse at 1.6 m from the ground in the middle of the room (fig. 1) before pesticide treatment; the measurements were recorded along 24 hours.
Outside temperature and relative humidity were recorded by means of a data logger (Babuc M) equipped with a thermo hygrometer probe (BSU401) and providing real time measurements every 120 s along 24 hours.

Fig. 1. Instruments inside the greenhouses.

Results

Figure 2 shows the results obtained in the test sites named A1 and A2; temperature obtained in A2 are higher than A1; there are no differences in relative humidity between test site A1 and A2; in the daytime CO_2 was always under 100 ppm; the VOC concentration increases, both in A1 and in A2, immediately after the pesticide treatment.

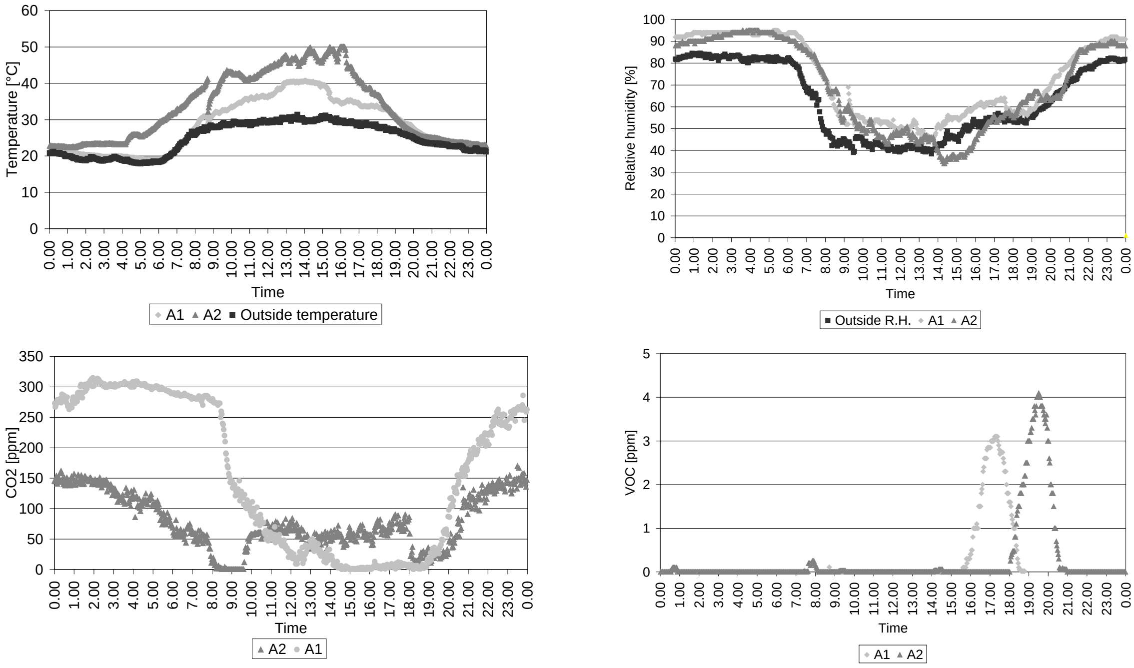

Fig. 2. Test sites A1 and A2 – Temperature, relative humidity, CO_2, VOC measured.

In figure 3 the results of test sites B1 and B2 are shown; the highest temperatures were obtained in test site B2; relative humidity values are similar for test sites B1 and B2; CO_2 values obtained in B2 are higher than B1 due to the presence of tomato that is characterized by an higher growth of the crop; the VOC concentration increases, both in B1 and in B2, immediately after the pesticide treatment.

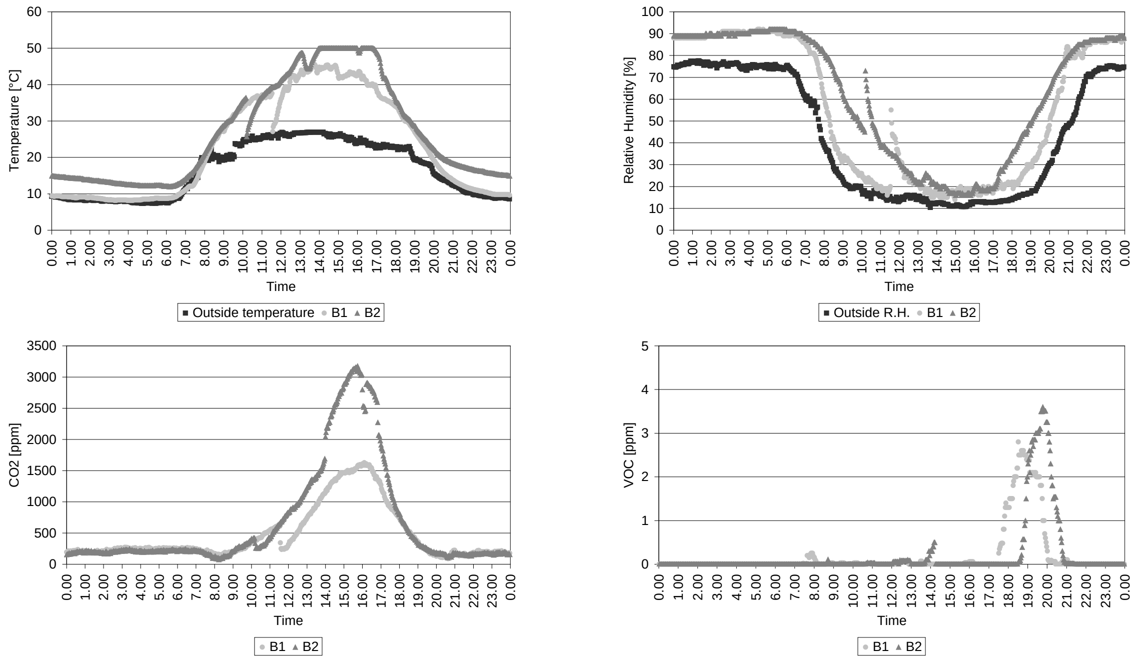

Fig. 3. Test sites B1 and B2 – Temperature, relative humidity, CO_2, VOC measured.

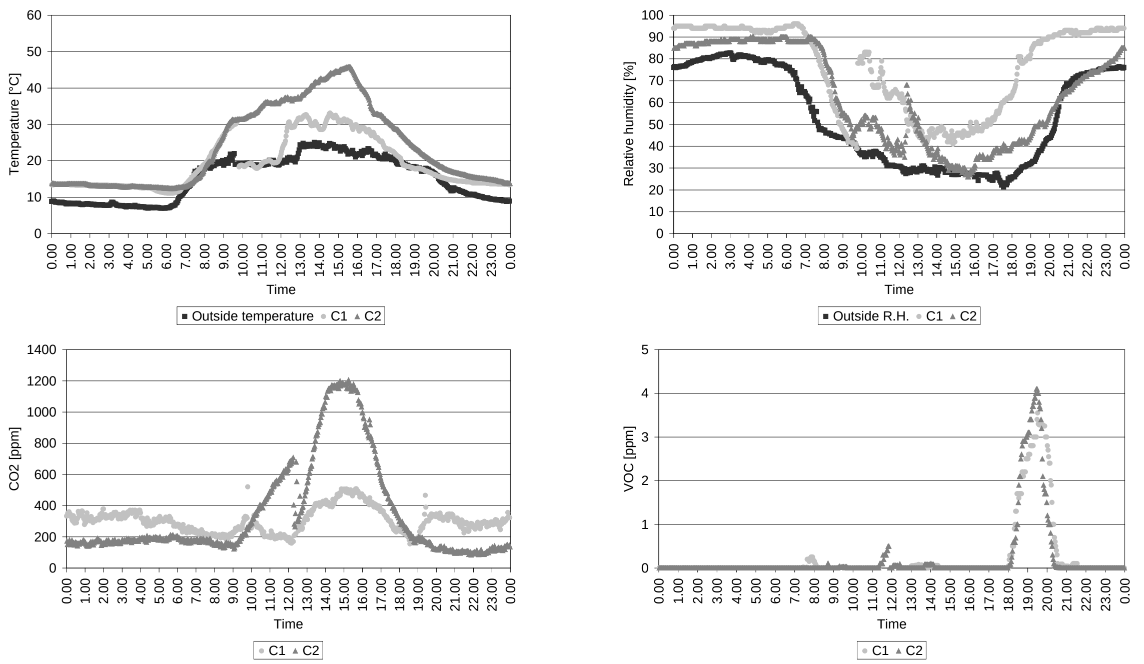

Fig. 4. Test sites C1 and C2 – Temperature, relative humidity, CO_2, VOC measured.

In figure 4 the results of test sites C1 and C2 are reported; the highest temperatures were obtained in test site C2 while relative humidity in C1 was higher than C2; CO_2 concentration shows a peak (1200 ppm) between 14.00 and 16.00 in test site C2; the VOC concentration increases, both in C1 and in C2, immediately after the pesticide treatment.

Conclusions

Some interesting conclusions can be drawn from the results of the investigation.

In the greenhouses covered with glass panels, temperature data have proved to be higher than the corresponding values obtained in greenhouses with plastic cover exceeding the limit temperature (41 °C) beyond which there may be phenomena of hyperthermia (heat stroke man), in the period from 10.00 to 17.00 in which farming operations are usually carried out.

The critical values of relative humidity (higher than 70%) were always recorded during the night, when no operator was inside the greenhouses.

The highest CO_2 values were recorded during the night, always lower than the minimum danger threshold for man (5000 ppm).

The concentration of VOC, as a result of pesticide treatments, had a permanence of about 90 minutes from time when treatment was performed, 18:00 to 19:30 hours; in this period relative humidity takes increasing values in all the greenhouses. The obtained values are close to the threshold of danger for man (5.00 ppm).

Finally, NO_2 values were always equal to zero.

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Safety in the Equestrian Compartment

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Keywords: horses, safeness, equestrian environments

Objectives

The evaluation of risks in the equestrian compartment, both in trot and canter racecourses than in simple equestrian schools, contains in itself a notable complexity that doesn't make the assignment simple neither for the employer than for the advisor that doesn't own a specific formation in equestrian subject. Procedures are poorly standardized and conditioned very much by the variability of the implicated subjects, both in animal and human terms. The great difference among the environments and the conditions in which involved people operate, as well as the subjective differences of single horses also in terms of reactions to the specific context, makes it difficult to generalize the applications in safety terms, being however on the other hand forced to compile all-round valid guidelines. The innovations introduced by the D.Lgs. 81/08 focus the attention on some characteristic elements of working compartments, such as the precariousness of the job, the appeal to poorly specialized and foreigner manpower, the difficulty to introduce in consolidated practices new management procedures that would produce an effective reduction of risk and stress, the difficulty of communication with the always greater number of foreign workers.

Methods

Practical application of the D.Lgs. 81/2008

The Evaluation of Risks

The entrepreneur's choice, that from now on we will call Employer (D.L.), to adjust his own stable to the normative in safety terms has an inderogabile forced departure: the evaluation of the risks. This must unwind according to different formality in relationship to the dimension of the firm, essentially determined by the number of employees.

The evaluation of risks must be done on the base of specific technical norms and keeping in mind that the risk is calculated through the formula:

risk = probability x magnitudo

that is the measure of the entity of the esteemed damage compared to the probability that this happens.

First of all it is necessary to identify the sources of risks, then individualize and subsequently esteem the risks of exposure so to classify the entity of the risk (irrelevant – acceptable – low – medium - high). On the base of this classification, the employer, together with the other figures involved in the management of the business safety, will therefore undertake the necessary actions to reduce or eliminate the esteemed risks at the source, also through a programmed prevention.

The experiences matured while appraising the risks in different firms specialized in breeding, in athletic and competitive preparation and even just in the daily management of horses, have brought to program the phases of individualization of the risks contextually to the analysis of the environments, of the fittings and of the machineries, of all products used, both in alimentary terms and for disinfecting or cleaning environments, followed by phases of improving interventions both in the general context and in operational manualities, without neglecting the conditions of horses' comfort which will greatly influence the sphere of physical risk from contact with the horse himself.
Not indifferent difficulties are met then in the projectual and ergonomic coordination: that is the creation of a correct match between projectual-building solutions and physical and psychological demands of the binomial worker-horse, especially in old dated constructions, readapted to an equestrian use.

Prevention and Protection Service
An important objective of the employer (D.L.) is to create a team, technically called Prevention and Protection Service, that will help him, side by side, in a not simple task, for which he will probably do not have a suitable preparation.
With this Service and it's Responsible Chief (RSPP), that can be the D.L., a worker or an external Advisor, with the aid of a figure named among the workers themselves, the Workers' Representative for Safety (RLS) and with the Competent Physician, he will work in the individualization of the greatest number of tools of prevention and protection, on a careful visual signaling of devoted runs and reserved access areas, individualized by descriptive posters that report, in a clear way, the obligations and the prohibitions, as well as on an encoded procedure of control of risks and above all of working procedures. Other very important chapter is a solid formulation related to the management of the emergencies, with an increasing attention devoted to the formation and information of the personnel with the most simple and comprehensible methodics possible.
A specific assignment of the Competent Physician will be to foresee and perform all the visits and diagnostic examinations held necessary, emerged by the classification of the risk performed in the moment of their analysis, with specific attention to biological, chemical, noise and vibration risk.

Specific risks
The concept of risk is used to quantify safety of every human working activity. This concept derives by the economy of insurance companies, in whose context was given, for the first time in the XVIII century, the following definition:

$$\mathbf{R = PD \times D}$$

in which:
R = Risk
D = Damage entity
PD = Probability that the damage is verified
Usually a determined activity doesn't involve only one danger (entity D) but a whole range of possible damages according to the environmental circumstances, to the intervention or less of protective and safety systems, to the intervention or less of expert people who are able to influence the evolution of the accident.
Having quantified the safety of a human activity with the aforesaid relationship, it is evident how the risk can be reduced reducing at least one of the two factors.

The first factor **PD** can be reduced increasing the preventive measures proper to limit the probability that an event will happen (information, formation, advising posters, machine safety systems, etc.).
The second factor **D** can be reduced increasing protective measures: among these the collective type must be preferred in comparison to the individual ones: for example a rotation of the employees in a noisy activity rather than the use of ear-protections; the use of less toxic chemical products rather than the use of masks and gloves and so on.
It must be underlined however that, also adopting the most sophisticated techniques to effect equipments protection and well programmed organizational measures, it is not possible to bring the system to risk *"zero"* that is to a total absence of danger. To minimize such **residual risk**, the formation of workers employed assumes a fundamental importance.

Among all the computable risks in the evaluation of the man-horse sphere, some emerge in great relief in comparison to others and must be treated with greater detail accordingly to underline better their peculiarities.
We are going to list them in decreasing order of incidence in our sector:

- Physical risk from contact with the horse
- Biological risk
- Different physical risks (noise, vibrations, external temperatures, manual movement of heavy loads)
- Chemical risk
- Electric and Fire risk
- Mechanical risk

The first two types of risk are specific and characteristic of this compartment, while the following ones, also not losing importance because of their more general nature, are verifiable also in the greatest part of other working compartments. For this motive, in this study, we will analyze only the first two.

- **Physical risk from contact with the horse**

Among those people who operate with horses, many, unfortunately however not all, know that their behavior is finalized to the search of pleasant sensations or to avoid pain and suffering, that can also be individuated in impatience. Nevertheless the effect that the instinct has on the perception of such feelings isn't always considered: the stress provoked by frustration of instincts can sometimes reveal itself worse of the pain itself for a horse. Stress condition is of such importance in horses that its presence is also noticed by the increase of blood levels of cortisol and catecholamine. Accordingly an important equestrian safety parameter consists in understanding the instincts of the horse and acting so to create him the less possible emotional conflicts. Forcing a horse to do something with strength means to sensitively increase its emotional stress up to make it react in an unpredictable and dangerous way.
Such premise wants to bring to the indication of the most frequent, harmful and investigated of the physical agents: the aggressive action of the horse, that is manifested with kicks, bites and crushing with limbs or the whole body.
Then we must necessarily add the traumas not consequential to a specific reaction of the horse, that means the falls during the sporting activity. These should be divided in accidental and unpredictable accidents, not originated from the willing of the horse, and accidents that draw origin from a reaction of the horse to a negative action of the rider. But here we should

analyze the validity of instructors' equestrian formation and what they are able to transmit to their students: we would surely touch aching keys that are not specific of this study.
The equestrian accidents, even if poorly investigated in Italy being partly gathered in the sector of agriculture and in the greatest part passed under silence for the strong percentage of irregular workers in this sector, on the base of more detailed studies conducted by foreign universities, constitute a serious sanitary problem, still underestimated, that deserves a well conceived assignement of prevention in every category of workers involved, underlining the importance, to the preventive goals, of the formation of workers to sensitize to a correct perception of risk, to the use of personnel protection devices and the use of correct procedures.

- **Biological Risk**

The biological risk for human health is connected with the exposure to organisms and microorganisms both pathogenic or not, animal and human endoparasites, that can be present in the working environment.
The biological agent is any microorganism, even if genetically modified, animal or human ecto - or endoparasites able to provoke infections, allergies or poisonings: basing on the D.Lgs. 81/2008, all biological agents are listed in classes according to the degree of dangerousness.
The biological risk consists, on one side, in the danger that an illness of the horse can be transmitted to humans, producing in them an analogous pathology for etiological agent and often also for symptomatology: in such cases we about zoonosis. On the other side, a different risk consists in the onset of a pathology, of an illness, or of a sanitary problem instigated by polluting or allergenic agents proper of the horse and of its vital sphere. In such case we speak about mycosis, hyper sensitization or allergies to mites or to the horses' dandruff rather than to its hair or to the dust usually present in foods and litters.
The evaluation of this type of risk must obligatorily be executed in collaboration with the competent physician that must have a deep knowledge of the illnesses that can strike the horses with which workers have contacts and that can be transmitted to humans, as well as of the relative clinical demonstrations in the man himself. A consolidated and constant synergy must exist between competent physician, RSPP and the veterinarian that knows the state of health of the stable.

Results

This study on safety conditions or, better, on their lack, in the most different equestrian environments, from small barns up to great international fairs, is born from a multiplicity of occasions in which we have observed seriously risky situations, in which the accident sometimes didn't happen, such others unfortunately did and this among a general amazement and surprise, as if clear premonitory symptoms have never existed.
The world of equestrian work in fact has been poorly investigated until now by the point of view of prevention of professional and sanitary risks. We usually see interventions only following accidents or after occasional inspections from vigilance organs. Only in rare happy islands we have found associations of firms (as for instance the many small stables of the gallop of the racecourse of San Siro in Milan) that have faced together, and with a notable reduction of costs, all the aspects of preventing of accidents, drawing a benefit of it in terms of diminution of the number of accidents, both in stable works than during the runs.

It is not clear neither the motive for so much reluctance from the employers in the application of prevention systems in a context with so many risks neither the scarce attention of the competent organs both for a sanitary point of view that for accidents.
The only reasonable explanation for what regards the first ones, is the tendency to invest as less as possible in expenses of which an immediate necessity is not understood; for the seconds perhaps does not exist a facility of such a capillary control as it can happen in other sectors: for example in housebuilding, where every open yard must be signalled
in a formal way. If it also subsisted in the equestrian environment the obligation to signal in preventive way, for example, every contest, competition or demonstration, the competent local sanitary firms (ASL) surely could not close their eyes on safety conditions. Or still, if training organizations had an obligation, if wanting to be affiliated to the relative federations, to show the compliance of laws in safety terms, a cut would be given to the negligence from the managers of the structures and to their ignorance of the normative obligations. Again, if facilitations in the economic treatment of the employees were applied to the equestrian structures that apply the normative devices of the D.Lgs 81/08, surely the employers of the sector would gather the occasion not to risk uselessly.
The concept that we desire to make emerge from this analysis is that, for how much undeniable it is that safety has some costs, both in terms of time and money, the lack of safety surely has greater costs.

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Rules for Safety in the Equestrian Sector

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Objectives

In this analysis the evaluation of risks is essential to prevent any and every possible danger for operators' and riders' health and safety both on working, competitive and fun places. A detailed search of risk derives from the fact that the legislator implies that all the obligations contained in the norms in force has already been carried out, and therefore, to promote the improvement of safety, imposes to the employers to examine and to potentially intervene on all those possibly dangerous situations, not yet disciplined by specific norms of law. It is obvious that all the people who operate in the horse sector know safety rules, but these are often badly practised and therefore cause of frequent physical damages.

Methods - Principal procedures of prevention

In this document we report the following 10 recommendations to minimize the risks to which workers and riders are exposed:

1- Approach with the horse

Going near the horse, it is necessary to speak to him, to call him, to look at him in his eyes. A good thing is to caress the animal as a light rubbing, avoiding the point of his nose. Check his expression before going near and be calm and concentrated, never be nervous. Make him understand what you are going to do and therefore learn how to interpret his temperament and his reactions. If the horse is tied up, make him look towards you.

2- Grooming skills

Before entering the horses' stall, wear a working overall, gloves and accident preventing shoes and check that the area in which you are working is clear from trash, old utensils and nails.

Enter in the stall with caution, avoiding to make rough movements or noises that could bother the horse. Go near to him from the front and caress him; fasten the leadropes to the headcollar and conduct the horse outside. Cross-tie the horse, fastening the headcollar to two appropriate chains with a rapid release knot. Then begin cleaning skills remaining on a side, even while brushing the tail: in this way if he kicks you will not be stroke with full strength. Do the same if you have to pass behind the animal. When hoofs must be cleaned, slowly lift one leg at a time, making your hand slide down from the hip to the legs and then to the foot. When you have finished all these operations, you can bring the horse back to his stall passing for first through the door. Once inside, move by a side and let him enter completely.

3- Saddling the horse

The first thing that must be done is to inspect both the horse and the saddle before saddling; verify in this way that all the buckles are sure, that the saddlecloth is clean as well as the horse's back and belly. Place the saddlecloth on the withers, making it slightly skid towards the back, smoothing the hair of the horse; make the saddle fit to the horse's back, without letting it fall brusquely, with stirrups tied up. First fasten loosely the girth strap, then, after the saddle is well positioned, hook up all the accessories. Before sitting on the saddle, make the horse walk a bit. The girth must be checked three times: after having saddled, before mounting on the horse and after having the horse walked for a brief line.

4 – How to put on the bridles

Untie the horse, staying next to his head, just a little bit back and on his side, preferably on the left side, maintaining the control of the horse. Handle the horse's ears with care and watch out to not bump his teeth when putting on or pulling off the bite. Insert two fingers at the angle of the mouth, so the horse will open it. Verify that the bridles are worn correctly and check the bite before riding. The drawstring under the horse's throat should be settled so to be able to insert three fingers between the throat of the horse and the drawstring itself. The headcollar should be relatively tightened so to be able to insert only a finger between it and the nose of the horse. Never leave the horse eat while he is wearing bridles.

5 – How to lead the horse from ground

Always go near the horse from the front, calling him first and possibly caressing him on the neck, then fasten the leadrope to the halter. When leading the horse, walk on his side, between the head and the shoulder. Use a rather long leadrope and hold it with both hands; a good habit is to extend your right elbow and hold it slightly behind compared to the horse. If the horse comes too near, his shoulder will bump the elbow first and he will move over. Don't wind the leadrope or the reins around your hand, your wrist or any part of your body and don't drape it around the shoulders or the body. Jewels, rings, earrings or bracelets shouldn't be worn. Pay a lot of attention when leading the horse through a tight opening: get through quickly for first and then move on a side to make him pass too.

6 – Mounting and dismounting

Don't mount or dismount the horse near fences, trees or prominences in which you can remain trapped. Keep the horse still while you get on or off: to do this you have to have the control of his head with the reins. After dismounting, tie up the stirrups and bring the reins over the horse's head so to lead him easily.

7- Riding

When riding, wear appropriate boots and a protective helmet, which must be adherent and laced. Until you haven't got a feeling with the horse you are going to ride, it is better to stay inside a delimited area. If the horse gets frightened, it's important to stay calm, to talk to the horse with a quiet tone and give him the time to overcome his fear. It's a good habit to walk slowly where there is danger of slides or falls. When crossing roads with a lot of traffic, the horse should be conducted by hand and if riding along a road, stay on the edge with a distance equal to the length of the horse. In the last part of your ride, before the arrival, it is opportune to proceed with a slow step.

8- Mucking litter from the stalls

This operation must be carried out after the horse has been taken out of the stall. Wear overalls, gloves, accident preventing shoes and masks, especially those who suffer from allergies. In the initial phase the material used for the litter is withdrawn from specific storing zones, using proper mechanic means (pitchfork, tractor, wheelbarrow) and positioning it near the stalls. Then remove the dirt from the bedding with appropriate equipment and trying not to lift dust. The litter removed with shovel, pitchfork and plastic comb will be set inside containers positioned outside the stables (or in a ribbon conveyor). Proceed distributing with shovel and rake the new bedding material over the litter remained after cleaning. At the end of these operations, it's a good habit to brush the working garments and wash them with frequency, at least two times a week.

9 – Feeding inside the stalls

Always wear working overall, gloves and accident preventing shoes. In inside stalls, feed is withdrawn from silos or sacks and mixed with other components if necessary. During these operations, watch out for not inhaling feed's dusts. Subsequently, feed and hay are transported with a wheelbarrow or with a tractor provided with pitchfork and positioned near the stalls. Distribution of feed must be done remaining outside the stalls (if the structure is endowed with specific openings). If it is necessary to go inside the stall to feed the horse, follow meticulously paragraph 1.

10 – Feeding in paddocks

If feeding takes place in paddocks, after having withdrawn and prepared feed or hay, distribution will be done without immobilizing the horses. During these operations take care to not lift and inhale the dusts originated from moved materials. If lifting manually some loads, it is preferable not to move loads heavier than 25 kilos for man and 15 kilos for woman. The use of the mechanical equipments must be done in base of what described on use and maintenance manual of each equipment. Entering the paddock, we recommend caution, avoiding abrupt movements and excessive noises that could bother the horses.

Results

The need to keenly reduce the risks of every activity that concerns the horse and the operators that work in this sector, is a fundamental aspect on which every form of safety control, worth this definition, founds itself. The rigorous and systematic application of the above specified procedures (mainly because they are simple, linear and therefore easily feasible) automatically gives place to a diminution of critical or dangerous situations and, side by side, the control of safety levels, both of the activities of the horse and of whom works in the horse sector, will be more easily realizable and it will always improve the quality of the life for both.

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The Manual Handling risk in Vine Growing and Wine Production: a Survey in Friuli-Venezia Giulia

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Abstract
Vine growing and wine production are key sectors in the regional economy of Friuli-Venezia Giulia (North-East of Italy), with increasing quality levels in the final products and a high potential for export. This has encouraged in the last years the use of machinery both in the field and in the wine cellar, but manual handling of loads is, nevertheless, still necessary in most of related activities, and still represents a difficult-to-solve problem. In fact, the number of accidents and professional illnesses reported in 2008 has increased by 68% over the previous year (INAIL), with a substantial share (10%) of skeletal muscle pathologies. The objective of the present research has been to analyze the worker's exposure due to the manual handling of loads, and to define the most critical risk profiles related to the specific activities. In order to asses safety risks related on manual handling operations, a representative sample of 40 vine-growing and wine-producing farms was selected in Friuli-Venezia Giulia. The most critical risk profiles in the vine-growing sector were related to (mainly) seasonal workers employed in the cultivation / management of the vineyard, and grape harvesting. A substantial percentage of situations involving a Lifting Index (LI) higher than 1.25 (as defined by Italian law, D.L. 81/08) was found. Only 50% of the surveyed farms were applying periodical medical inspections, as required by the law in such cases, which also represents a clear indication of how much the problem is still being underestimated.

Keywords: survey, safety, risk analysis, wine cellars

Introduction
Vine growing and wine production are key sectors in the regional economy of Friuli-Venezia Giulia (North-East of Italy), with increasing quality levels in the final products and a high potential for export. This has encouraged in the last years the use of machinery both in the field and in the wine cellar, but manual handling of loads is, nevertheless, still necessary in most of related activities, and still represents a difficult-to-solve problem. In fact, the number of accidents and professional illnesses reported in 2008 has increased by 68% over the previous year (INAIL, Workers Compensation Authority), with a substantial share (10%) of skeletal muscle pathologies: many studies report that muscle-skeletal disorders (MSDs) are a major cause of disability in the working population. As reported by OSHA, they cover a broad range of health problems. The main groups are back pain and injuries, and Work Related Upper Limb Disorders, commonly known as "repetitive strain injuries" (RSI). Lower limbs can also be affected. MSDs are one of the most common work-related health problems affecting millions of European workers across all employment sectors at a cost of billions of Euros to European employers. This is not surprising, as 45% of European workers report working in painful or tiring positions; 33% are required to handle heavy loads in their work. European workers commonly report MSDs as a work related health problem: 30% complain

of backache; 17% complain of muscular pains in their arms and legs. The 30% who complain of backache each year amounts to a figure of 44 million European Workers. Health problems range from discomfort, minor aches and pains to more serious medical conditions requiring time off work, medical and hospital treatment. In more chronic cases, treatment and recovery are often unsatisfactory, and the result can be permanent disability, with loss of job. However, much of the problem could be prevented or reduced by complying with existing health and safety law and following guidance on good practice. Musculoskeletal disorders are a particular problem in agriculture, where almost 60% of workers in agriculture and fishing are exposed to painful positions at work half the time or more, the highest of any sector; nearly 50% of workers in agriculture and fishing carry heavy loads half the time or more; over 50% of workers in agriculture and fishing are exposed to repetitive hand movements half the time or more. Workers in the agriculture and construction sectors are most at risk to lower back disorders, and those in agriculture, forestry, and fisheries face the greatest risk of work related upper limb disorders. Consequently, in this direction we have turned our work: the objective has been to analyze the worker's exposure due to the manual handling of loads, and to define the most critical risk profiles related to the specific activities.

Methods

In order to asses safety risks related on manual handling operations, a representative sample of 40 wineries was selected in Friuli-Venezia Giulia (table 1).

Sample N.	Vine Area	Full time workers	Seasonal workers	Sample N.	Vine Area	Full time workers	Seasonal workers
W 1	35	1	5	**W 21**	70	6	9
W 2	73	16	7	**W 22**	5	1	0
W 3	42	11	9	**W 23**	7	1	1
W 4	17	5	12	**W 24**	12	1	2
W 5	30	4	4	**W 25**	22	4	0
W 6	45	5	11	**W 26**	90	11	10
W 7	25	3	12	**W 27**	45	2	2
W 8	32	1	3	**W 28**	200	6	6
W 9	45	5	11	**W 29**	28	2	3
W 10	60	8	15	**W 30**	20	2	3
W 11	60	15	15	**W 31**	140	9	7
W 12	150	22	30	**W 32**	38	2	9
W 13	75	7	2	**W 33**	25	3	4
W 14	8	1	1	**W 34**	230	11	12
W 15	10	1	0	**W 35**	140	9	7
W 16	130	10	25	**W 36**	38	2	9
W 17	35	6	3	**W 37**	np	3	1
W 18	21	2	2	**W 38**	np	6	0
W 19	15	3	1	**W 39**	np	4	1
W 20	35	4	2	**W 40**	np	4	1

Table 1. Analyzed sample

From a methodological point of view the survey has been developed during 2009/2010, by dividing the search into three phases:

1. cognitive analysis;
2. risk evaluation and identification of critical points;
3. analysis of compliance in terms of safety at the workplace and management of the manual handling risk.

The starting point has been the reconstruction of the working phases in which the risk of manual handling of loads is more present; the definition of risk profiles, then, led up to the identification of 4 main tasks: seasonal agricultural laborer; tractor driver; cellar laborer; store man. Concerning the exposure analysis, the working time involving manual handling of the loads have been detected. For a validation of cognitive analysis, during the last phase of the works a questionnaire has been handed to the employer in order to verify the collected data and the operating environment.
The assessment of manual handling risk took place by recurring to the "Niosh" method, for the calculation of the lifting compound index: in order to assist employers in reducing the risk of lifting-related injuries, the National Institute for Occupational Safety and Health (NIOSH) developed a lifting equation designed to determine the safety of lifting tasks. The NIOSH lifting equation is one of several important tools used in a comprehensive effort to prevent overexertion injuries. The estimate of the level of physical stress is defined by the relationship of the weight of the load lifted and the recommended weight limit. For an analysis of multi-task manual lifting jobs (in which there are significant differences between tasks) a specialized procedure is used: the Composite Lifting Index (CLI) , that equals the sum of the largest Single Task Lifting Index (STLI) and the incremental increases in the CLI as each subsequent task is added. The incremental increase in the CLI for a specific task is defined as the difference between the Lifting Index for that task at the cumulative frequency and the Lifting Index for that task at its actual frequency. This method has been used to analyze collected data, according to parameters and risk levels showed in the following table:

Value	situazione di rischio
CLI < 0,75	Acceptable risk level
0,75< CLI <1,25	Threshold level
1,25< CLI <3	Not acceptable risk level

Table 2. Parameters for the discovery of the critical points.

Concerning the analysis of the conformity in terms of safety, risk management and manual handling of loads, the last phase of experimental protocol foresaw the compliance with the legislative obligations, in particular regarding:

- presence of the risk assessment document;
- hierarchical organization in terms of safety at the workplace;
- evaluation of the manual handling risk;
- information and training of workers about the manual handling risk;
- activation of health surveillance.

Results

y analyzing the loads handled by 4 profiles, the weights are very variable, ranging from a few kg up to handling barrels (56 kg) and bags weighing 50 kg. In all operations workers operate alone and this dramatically increases the risk.

Also in the wineries where the most part of productive processes are mechanized (in the vineyard) and technologically advanced (in the wine cellar), the lifting index stands above the limit of 0.75. The most critical risk profiles are mainly related to seasonal workers employed in the cultivation/ management of the vineyard and grape harvesting. In the wine cellar, the most exposed profiles were related to moving and/or lifting operations while using small machinery such as pumps, cleaning operations of wine containers, and storage - displacement of materials. Only 50% of the surveyed farms were applying periodical medical inspections, as required by the law in such cases, which also represents a clear indication of how much the problem is still being underestimated.

Conclusions

Analyzing the situation of safety in a sample of wineries, a substantial percentage of situations involving a Lifting Index (LI) higher than 1.25 (as defined by Italian law, the Legislative Decree 81/08) was found. This work wants be a starting point for further analysis concerning safety at the workplace in this particular sector, with a further aim of creating (or diffusing) a culture of safety.

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Work Related Stress for Greenhouse Workers: a Proposal for Evaluating the Risk in Pot Plants Productions

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Abstract
The work, carried out in four greenhouses in Tuscany, has the aim to set a first methodology to evaluate work related stress risks and to provide parameters to activate a project of prevention and promote the organization of wellbeing in the greenhouse sector. The study has analysed, structures, plants, mechanization, organization of the work and the safety structures of the companies.
The applied metodology has permitted to evaluate the level of the risk; this one has shown everywhere "low" with the objection of workers in the bigger company where problem in the organization of a large number of workers determined a "medium" level of the risk.

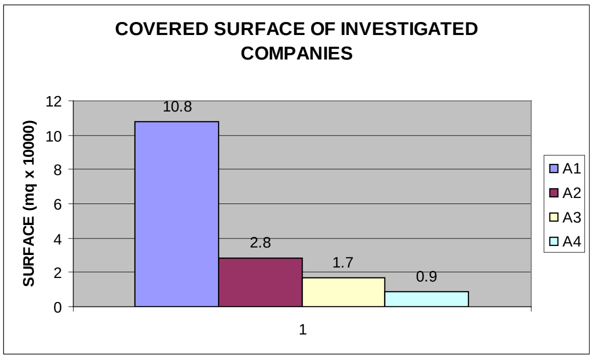
Keywords: risk prevention, stress, wellbeing, greenhouses

Introduction
Working in a greenhouse cultivating pot plants is today done within companies using structures, systems, machines, job cycle and organization processes which can cause stress in workers. The study carried out sets out to create a first methodology to evaluate work related stress risks and to provide parameters to activate a project of prevention and promote the organization of wellbeing in the greenhouse sector.
The evaluation method is based on the analysis of n°5 main themes of which n.3 objective and n.2 subjective:
<u>Main theme objective</u>
1. general risk indicators
2. correlated indicators
3. psychosomatic symptoms

<u>Main theme subjective</u>
1. stress indicators related to the subjective perception
2. existence of stressful situations outside of work

Materials and methods
The study has been conducted in n.4 tuscany greenhouse companies selected for different dimensions, structures, organization and number of workers.
The companies, named with letters A1, A2, A3, A4, have different cultivated surfaces as showed in chart 1.

Chart n°1 - Comparison of surfaces of the different companies



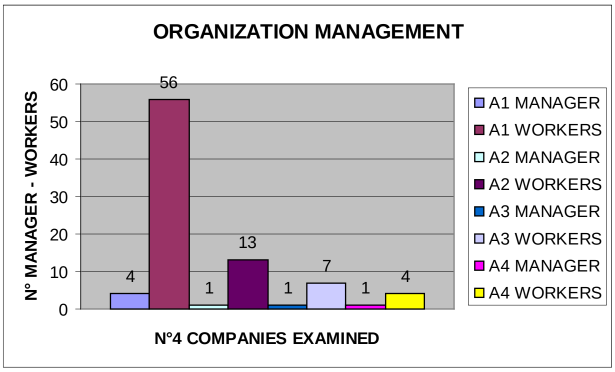
The related companies have been submitted to visits aimed to acquire information around structures, plants, and instruments employed. The results are related in table n.1.

Tab.1 - Main features of the structures, systems and mechanization level.

		A1	A2	A3	A4
Greenhouse	**Structures**	Galvanized steel	Galvanized steel	galvanized steel	galvanized steel
	Coverage	film PE	film PE	film PE	film PE
Plants	**Irrigation**	Ebb and flow with carriageable floor tanks	Drip irragation	Drip irragation	Drip irragation
	Thermal	underfloor heating	heating indoor air	Heating indoor air	Heating indoor air
	Humidity control	hot air generators	Hot air generators	Hot air generators	Hot air generators
Computerization	**Ventilation**	yes	yes	yes	yes
	Microclimate control	yes	yes	yes	yes
	Producion management	yes	no	no	no
Mechanization		high	low	low	low

<u>Organization of the work</u>
The companies have various organization management that are related in chart n.2.
The study has investigated the rate between managers/workers and the organization management (fig.1).

Chart n.2 - Rate between managers/workers



Organization of work safety

The study has evaluated also the work safety organization to verify the level of application of the principal law in Italy for the safe at work (D.lgs 81/08).
The structure of the work safety organization of the companies is related in the table below.

Tab. 2 - Structure of the work safety organization

COMPANY		**A1**	**A2**	**A3**	**A4**
Prevention and protection service		Yes	Yes	Yes	Yes
Responsible prevention and protection service		D.L	D.L	D.L	D.L
Company's doctor		Yes	Yes	Yes	Yes
Worker representing		Yes	Yes	No	No
Risk evaluation document		Yes	Yes	Self-certification	Self-certification
ACTIONS	**INFORMATION**	Yes	Yes	Yes	Yes
	TRAINING	Yes	Yes	No	No

***D.L.** = Employer*

Work cycle, number of involved workers and their duties

The cycle is the typical one that we can find in the production company of the ornamental pot plants, and it is schematically represented by the flow chart of fig. 2.
In the phase of investigations, groups of workers have been selected for homogeneous duties; to these workers were submitted questionnaires to define the factors involved in stress risks.
The elaborated method for the evaluation of work related stress has been discussed then with the holders of the firms with the medical staff and with the workers representative.
The methodology that has been adopted, based on the analysis of three of the five main themes, has allowed to compile an evaluation of the risk based on three tables n.3,4,5 that were used to investigate the main theme objective:

1. general risk indicators
2. correlated indicators
3. psychosomatic symptoms

Tab. n.3 – Table to evaluate general risk indicators

General risk indicators	Manager		Employer		Worker	
	YES	NO	YES	NO	YES	NO
Little annoying sound and within standard limits						
Microclimate and Suitable air quality						
Enviromental suitable confort						
Suitable Leeway						
Friendly and not obsolete forniture and ergonomic equipment						
Regular working time						
Absence of fragmented and ripetitive labor						
Absence of contact with public						
Risk evaluation						

Tab. n.4 – Table to evaluate related indicators

Related Indicators	Manager		Employer		Worker	
	YES	NO	YES	NO	YES	NO
Absenteism within standard limits						
Accidents on the job and/or occupational disease reduced						
Low, uncommon or non-existent personnel turnover						
Absence of the disciplinary action						
Absence of the conflicts and controversy						
Presence in the company of a environmental, quality and safety work policy						
Risk evaluation						

Tab. n.5 – Table to evaluate psychosomatic symptoms

Psychosomatic symptoms	Manager		Employer		Worker	
	YES	NO	YES	NO	YES	NO
Chronic tiredness						
Decreased ability to concentrate						

Mental and physical fatigue associated with more emotional problems (headache, muscle pain, anxiety)						
Skin diseases (eczema, rashes)						
Dyspepsia and gastralgia						
Anxiety-depression syndrome						
Changes in feeding behavior						
Tachycardia, extrasystoles and hypertension						
Risk evaluation						

In this phase there weren't evaluated the main theme subjective:

- stress indicators related to the subjective perception
- existence of stressful situations outside of work

The risk was deter mined counting the number of "Yes" or "Not" of the various report.

Results

The evaluation of stress risk has regarded managers, employer and workers. The results obtained are related in table n.6, n.7, n.8. For every job in work organization it was valued the stress risk level as low, medium, high.

Table n. 6 – Risk evaluation for manager in greenhouses A1, A2, A3, A4

	A1 -Manager	**A2 -Manager**	**A3 -Manager**	**A4 -Manager**
General risk indicators	**6Y/2N**	**6Y/2N**	**6Y/2N**	**6Y/2N**
Related Indicators	**5Y/1N**	**5Y/1N**	**5Y/1N**	**5Y/1N**
Psychosomatic symptoms	**6Y/2N**	**5Y/3N**	**6Y/2N**	**7Y/1N**
STRESS RISK EVALUATION	**LOW**	**LOW**	**LOW**	**LOW**

Table n. 7 – Risk evaluation for employer in greenhouses A1, A2, A3, A4

	A1 -Employer	**A2 -Employer**	**A3 -Employer**	**A4 -Employer**
General risk indicators	**6Y/2N**	**6Y/2N**	**6Y/2N**	**6Y/2N**
Related Indicators	**5Y/1N**	**5Y/1N**	**5Y/1N**	**5Y/1N**
Psychosomatic symptoms	**6Y/2N**	**5Y/3N**	**6Y/2N**	**7Y/1N**
STRESS RISK EVALUATION	**LOW**	**LOW**	**LOW**	**LOW**

Table n. 8 – Risk evaluation for workers in greenhouses A1, A2, A3, A4

	A1 - Worker	**A2 - Worker**	**A3 - Worker**	**A4 - Worker**
General risk indicators	**4Y/4N**	**6Y/2N**	**6Y/2N**	**6Y/2N**
Related Indicators	**4Y/2N**	**5Y/1N**	**5Y/1N**	**5Y/1N**
Psychosomatic	**5Y/3N**	**5Y/3N**	**6Y/2N**	**7Y/1N**

symptoms				
STRESS RISK EVALUATION	**MEDIUM**	**LOW**	**LOW**	**LOW**

Conclusions

The methodology that has been adopted, based on the analysis of three of the five main themes, has allowed a first evaluation of the risk that also allows to identify the type of organization to prevent work related stress risks and to promote the wellbeing in the greenhouse sector.
All the risk are everywhere low except for workers in big companies that showed a significant level of stress risk (medium). This circumstances was determined by problems concerning organization of the work and overall by the problems in managing multiethnic workers. No problems were found in the structures and plants.

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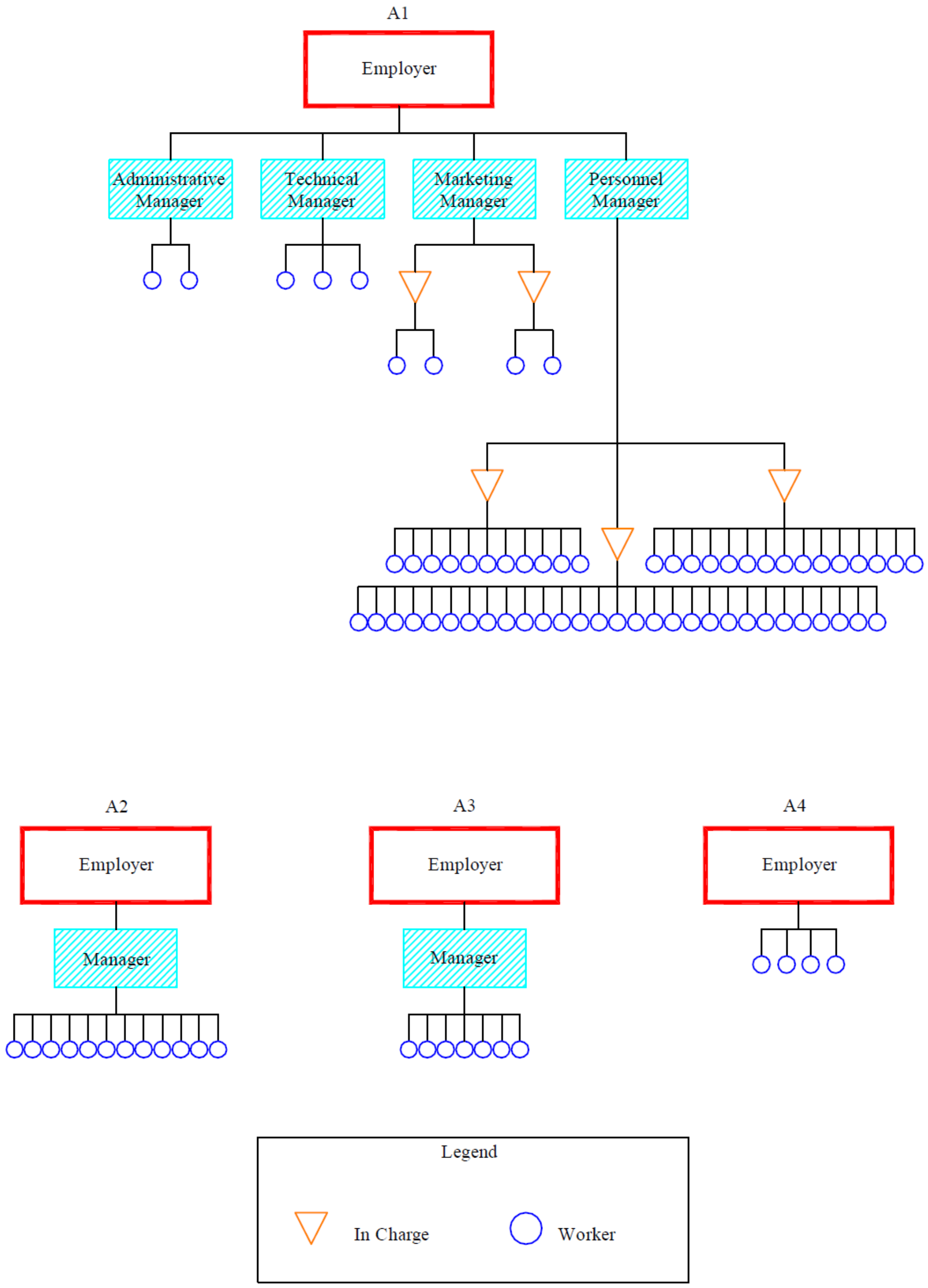

Fig.1 – Chart of greenhouse work organization

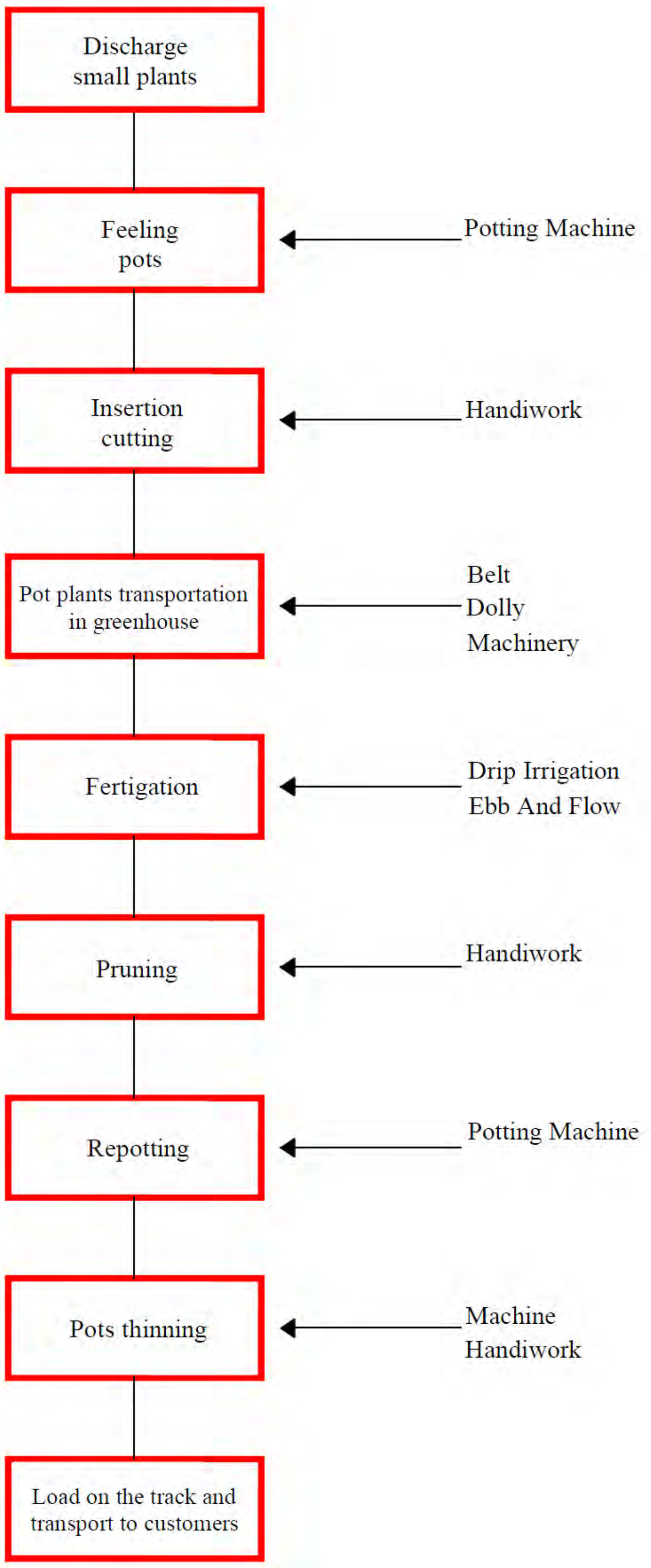

Fig.2 – Flow chart of productive cycle

The Production and Management of Powders Obtained During the Wood Working

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Abstract
The production and the management of the residual from the milling is often object of several research in order to evaluate the opportunity of re-use them. This study has the objective to estimate the residual products at the end of the working cycle, to understand how the powders, sawdust, and wood shavings are recovered, to analyze the several their destinations and to show the system reducing their concentrations in job atmospheres.
The trials has been carried out in G R Systems. In order to find the final refuse cubature, we collected the length of the elements, because the section remained unchanged in income and in escape, as only one dimensional variable changing of the wood elements. The results demonstrated that the greater incidence of the refuse is had in the phase of planing, during which are concentrated nearly 80% of the sawdust as refuse. This product, stored in silos, comes partially destined like fuel in the company for the system of combustion of medium dimensions, about 450.000 Kcal/h, and partially for the production of pellet in an other company with productive capacity of 345 kg/h of pellets. With regard to the powder production has been clear that the drainage of the sawdust and the reintroduction in circle for a new pressing has been the critical steps because the system of aspiration does not succeed to capture all the powders. In that steps the mainly powders is raised in air and easily inhaleted as such as it is advised the use of facial filtering.

Keywords: powders, wood, residual, milling

Introduction

Actually is asserting the knowledge that the atmosphere is a planetary good and that therefore its safeguard demands participations on scale are premises that total, with immediate provisions and in the long term (Hasselmann *et al.*, 2003). On this logic a strong cultural interest regarding the production is based and consequent use of biomasses deriving from agricultural and forest field that has realized in policies and technologies times to the recovery of the refuse to the energetic aims contributing to the performance of the protocol of Kyoto. So, today it is not spoken more than refusal than a working or of a production process but of residual; if then the production process regards the primary industry of milling, politics of the biomasses concur to the development of strategies that increasing their productivity in forestry sector. In particular in some type of lumber workings, the produced refuse are partially a completely usable material to fine energetic and also powders of hard wood now recognized as cancerogenous for human health. The dangerousness of such thus fine materials by now is for a long time assessed, being emerged a direct correlation cause and effect between exposure to wood powders and carcinoma of the nose. The relation between the exposure to wood powders and the insorgence of adenocarcinoma very clearly appear or like association or in the result of some studies case-control (Cirla et al., 2008). It is particularly obvious in the industries of the furniture fabrication, while absent for forestry workers (IARC, SCOEL). So, our study has the objective to characterize and to determine the productivity experimentally, in terms of residual of wood and powders, of a system for the production of lamellar wood for uses buildings during each step of the production process and to assume the reuse of the residual products.

Materials and methods

The experimental trials were done to characterize and to determine the productivity experimentally, of residual of wood and powders during each steps in the G R Sistemi Holzindustrie Company, in Tito, in an area of great industrial expansion next to Potenza. In this company it is produced, mainly, lamellar wood for uses buildings and several types of panels for the building to action carrying and elevated thermal insulation; such product is constituted from a double layer of boards of white fir with interposed heat insulator constituted from polystyrene expanded synthetized (EPS) with equal density to 35 kg/m^3, high insulating and structural properties.

THE PRODUCTION PROCESS OF THE G.R. SYSTEMS are the following one:

- **Choise of the lumber wood** of pinewood classified on the origin depending on defined categories trades;
- **Drying stiff operation** to obtain that humidity degree of the wood compatible with the type of glue and, above all, suitable to the destination. Generally it must be between 7 and 16%;
- **Quality control of the boards.** At first the splicer works on the boards and then there's a control of the humidity and the defective state, partially automated, and eventual elimination of the more serious defects using a dedicated machine;
- **Joint of head**. Fingers or comb joints (concur to obtain a wide surface of gluing). Successively to the milling, the gluing of head of the boards is done, carried out from appropriate blots some that apply variable forces of jam in relation to the length of the teeth of the joints;
- **Planing and gauging of the boards**. It concurs to obtain superficial smooth, requirement a lot important in phase of gluing;
- **Gluing of the laths**. The adhesives must establish intermolecular ties between the same glue and the substances that constitute the wood, that is the fibers of cellulose and lignin ("cables glue spreader");
- **Pressing;**
- **Planing of the beams** (to give to the elements the ended thickness and to make smooth uniforms and superficial the lateral ones);
- **Finishing and impregnation**. The beam comes registered realizing the necessary bending of plan, holes and cuts for the assemblage of metallic elements and application of products impregnating through painting, substances that is with function to protect the wood from bugs, fungi, humidity and with a pigment that confers to the beams the desired colour. Once characterized the production process, for each phase refuse kind and amounts have been estimated considering also the job carried out from the system for the recovery and the removal of powders from the job places. In particular for the esteem of the refuse amount produced in each phase card "OUTCUT" that concurs to find the quantitative ones input and to confront them with

those output of every phase, so as to have an accurate numerical data of the refuse has been obtained experimentally.

Results

The trials done demonstrated that the first requirement of guarantee of the end product was the choice of the lumber: the technical characteristics of the finished product depend from the base material. It is obvious that in order to obtain turned out reliable, is necessary to leave from a raw materials being had characteristic the most homogenous and uniforms possible. The drying then has carried the product to humidity values of 13%, compatible with the glue use. Before the veneer jointing the boards quickly have a control of the humidity and the defective state, partially automated, finalized to the elimination of the boards with more serious defects. In this phase our relief is begun considering the working refuse obtained from the radial cut of the boards, in which only the variable one determine the proportions them has been the length of the elements. The refuse on approximately 20 m3 of worked wood has been equal to 0.44 m3, approximately 2.25% on the total of the raw materials worked; the type of refuse is characterized in great part from tablets of equal medium dimensions about mm 46 x 155 x 180/200. In the successive phase of veneer jointing, the cross seams currents between the several ones laths come carried out with said comb joints or fingers.

The refuse of working of the splice is obtained from the cross-sectional milling of the boards; the final cubature of the refuse is calculated considering geometry of the tool, usually a moulder that directly executes the working on the wood removing in constant way always the same amount of material.

Table 1. Veneer jointing

INPUT				
DIMENSIONI			fresa	scarto
SP	BASE	LH / mm.	impulsi	mc
0,023	0,25	0,02	402	0,04623
0,05	0,245	0,02	146	0,03577
0,046	0,15	0,02	758	0,104604
0,038	0,175	0,02	808	0,107464
TOTALI				0,294068

As shown in the table 1, the refuse has been calculated multiplying the section of the boards of wood per the number of milled (impulses) carried out from the system, considering like constant the step of the equal tool to 0.02 mm. During the planing and gauging of the boards Table 2) the composed boards have been planed in order to offer superficial flat in sight of the gluing of the faces of the boards for the next formation of the beam. This type of operation, with the gauging through which boards of constant thickness are obtained, avoids establishing itself of tensions that can give rise to the formation of checks during the pressing. Moreover the planing concurs to obtain superficial smooth, requirement a lot important in phase of gluing.

The collected refuse, in the phase of unframing, is those obtained from the planing on the four faces of the boards; for being able to find the cubature total of the refuse, they have been brought back in the calculation table the dimensional changes them of the ligneous elements in entrance and escape from the machinery. The significant dimensional change was the section, in fact like Planing can be found from the table "Gluing" (Table n.2), the difference between section in income and that in escape is about 6 mm on 15 mm thickness on the width of the board. This phase of the process, represents approximately 14% of the refuse of the raw materials worked on the examined productive cycle. The biomass of refuse is constituted from small chip, sunder dust and powders.

Table 2. Planing – Gluing

INPUT					OUTPUT					DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI			N° PZ	MC.	
SP	BASE	LH / ml.			SP	BASE	LH / ml.			
0,044	0,151	10	52	3,45488	0,0425	0,15	10	52	3,315	0,13988
0,023	0,215	4	114	2,25492	0,0225	0,21	4	114	2,1546	0,10032
0,0465	0,12	7,05	56	2,202984	0,046	0,115	7,05	56	2,088492	0,114492
0,0465	0,12	5,53	30	0,925722	0,046	0,115	5,53	30	0,877611	0,048111
0,046	0,175	4	40	1,288	0,043	0,17	4	40	1,1696	0,1184
0,023	0,215	4	40	0,7912	0,0225	0,21	4	40	0,756	0,0352
0,046	0,15	11,4	18	1,41588	0,0315	0,135	11,4	18	0,872613	0,543267
0,023	0,215	4	72	1,42416	0,0225	0,21	4	72	1,3608	0,06336
0,023	0,215	4,7	60	1,39449	0,0225	0,21	4,7	60	1,33245	0,06204
0,023	0,215	4,7	24	0,557796	0,0225	0,21	4,7	24	0,53298	0,024816
0,023	0,215	4	4	0,07912	0,0225	0,21	4	4	0,0756	0,00352
0,046	0,245	6	46	3,11052	0,043	0,24	6	46	2,84832	0,2622
0,038	0,175	11,3	14	1,05203	0,031	0,17	11,3	14	0,833714	0,218316
0,038	0,175	11,3	14	1,05203	0,031	0,17	11,3	14	0,833714	0,218316
0,05	0,245	6	40	2,94	0,043	0,24	6	40	2,4768	0,4632
0,023	0,215	4	100	1,978	0,0225	0,21	4	100	1,89	0,088
0,023	0,215	4	72	1,42416	0,0225	0,21	4	72	1,3608	0,06336
0,023	0,215	4	148	2,92744	0,0225	0,21	4	148	2,7972	0,13024
0,023	0,215	4	212	4,19336	0,0225	0,21	4	212	4,0068	0,18656
0,023	0,215	4	72	1,42416	0,0225	0,21	4	72	1,3608	0,06336
0,023	0,215	4	70	1,3846	0,0225	0,21	4	70	1,323	0,0616
0,023	0,215	4	58	1,14724	0,0225	0,21	4	58	1,0962	0,05104
0,046	0,245	4	44	1,98352	0,043	0,24	4	44	1,81632	0,1672
0,038	0,22	2,4	24	0,481536	0,034	0,215	2,4	24	0,421056	0,06048
0,038	0,22	3	14	0,35112	0,0335	0,215	3	14	0,302505	0,048615
0,038	0,22	3,2	20	0,53504	0,0325	0,215	3,2	20	0,4472	0,08784
0,023	0,215	4	20	0,3956	0,018	0,19	4	20	0,2736	0,122
0,023	0,215	4	44	0,87032	0,018	0,19	4	44	0,60192	0,2684
0,023	0,215	4	80	1,5824	0,018	0,19	4	80	1,0944	0,488
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	70	1,3846	0,018	0,19	4	70	0,9576	0,427
0,023	0,215	4	100	1,978	0,018	0,19	4	100	1,368	0,61
TOTALI				54,90783					47,4337	**7,474133**

The next phase of refuse production is the planing of the beams, where the produced refuse is that one obtained from the material removal on the four faces of the beam. By the research we checked the dimensional changes of the ligneous elements in entrance and escape from the machinery. The dimensional change taken in account was the section, in fact as shown in table n 3 during that phase of the process there was the production of approximately 18% of the refuse of the raw materials worked on the examined productive cycle. The biomass of refuse is constituted from small chip, powders and sunder dust.

The refuse of the final working is variable according to the type of shape, cut or milling to carry out, following technical specification of the graphical elaborated ones. In the table 4 and 5 "Working - simple" and "Working - Capitello" can be found the refuse differences between two wrappings standard taken to champion. The biomass of refuse is introduced under form of solid wood of crude fir with volumic mass about 450 Kg /Mc.

Table 3. Planing – Finishing

INPUT					OUTPUT					DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI			N° PZ	MC.	
SP	BASE	LH / ml.			SP	BASE	LH / ml.			
0,046	0,245	4	44	1,98352	0,043	0,24	4	44	1,81632	0,1672
0,0425	0,075	10	28	0,8925	0,039	0,06	10	28	0,6552	0,2373
0,0225	0,21	4	114	2,1546	0,02	0,19	4	114	1,7328	0,4218
0,046	0,115	7,05	56	2,088492	0,032	0,098	7,05	56	1,238093	0,850399
0,046	0,115	5,53	30	0,877611	0,032	0,098	5,53	30	0,520262	0,357349
0,043	0,17	4	40	1,1696	0,042	0,15	4	40	1,008	0,1616
0,0225	0,21	4	40	0,756	0,02	0,19	4	40	0,608	0,148
0,0225	0,21	4	72	1,3608	0,02	0,19	4	72	1,0944	0,2664
0,0225	0,21	4,7	60	1,33245	0,02	0,19	4,7	60	1,0716	0,26085
0,0225	0,21	4,7	24	0,53298	0,02	0,19	4,7	24	0,42864	0,10434
0,0225	0,21	4	4	0,0756	0,02	0,19	4	4	0,0608	0,0148
0,043	0,24	6	46	2,84832	0,04	0,22	6	46	2,4288	0,41952
0,043	0,24	6	40	2,4768	0,04	0,22	6	40	2,112	0,3648
0,0225	0,21	4	100	1,89	0,02	0,19	4	100	1,52	0,37
0,0225	0,21	4	72	1,3608	0,02	0,19	4	72	1,0944	0,2664
0,0225	0,21	4	148	2,7972	0,02	0,19	4	148	2,2496	0,5476
0,0225	0,21	4	212	4,0068	0,02	0,19	4	212	3,2224	0,7844
0,0225	0,21	4	72	1,3608	0,02	0,19	4	72	1,0944	0,2664
0,0225	0,21	4	70	1,323	0,02	0,19	4	70	1,064	0,259
0,0225	0,21	4	58	1,0962	0,02	0,19	4	58	0,8816	0,2146
0,043	0,24	4	44	1,81632	0,04	0,22	4	44	1,5488	0,26752
0,02	0,21	4	20	0,336	0,018	0,19	4	20	0,2736	0,0624
0,02	0,21	4	44	0,7392	0,018	0,19	4	44	0,60192	0,13728
0,02	0,21	4	80	1,344	0,018	0,19	4	80	1,0944	0,2496
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	70	1,176	0,018	0,19	4	70	0,9576	0,2184
0,02	0,21	4	100	1,68	0,018	0,19	4	100	1,368	0,312
TOTALI				45,35559					36,53364	**8,821958**

Table 4. Primary manifacturing

INPUT					OUTPUT					DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI			N° PZ	MC.	
SP	BASE	LH / ml.			SP	BASE	LH / ml.			
0,032	0,098	5,53	30	0,520262	0,032	0,098	5,5	30	0,51744	0,002822
0,0315	0,135	11,4	18	0,872613	0,0315	0,135	11,38	18	0,871082	0,001531
0,1	0,2	2,71	5	0,271	0,1	0,2	2,7	5	0,27	0,001
0,1	0,2	2,7	4	0,216	0,1	0,2	2,54	4	0,2032	0,0128
0,1	0,2	2,54	4	0,2032	0,1	0,2	2,38	4	0,1904	0,0128
0,1	0,16	2,57	1	0,04112	0,1	0,16	2,51	1	0,04016	0,00096
0,1	0,16	2,57	1	0,04112	0,1	0,16	2,54	1	0,04064	0,00048
0,1	0,16	2,51	1	0,04016	0,1	0,16	2,35	1	0,0376	0,00256
0,1	0,16	4,58	1	0,07328	0,1	0,16	4,55	1	0,0728	0,00048
0,035	0,165	4	1	0,0231	0,035	0,165	3,15	1	0,018191	0,004909
0,023	0,21	4	23	0,44436	0,023	0,21	3,52	23	0,391037	0,053323
0,07	0,24	4,03	18	1,218672	0,07	0,24	3,9	18	1,17936	0,039312
0,16	0,24	6,62	24	6,100992	0,16	0,24	6,59	24	6,073344	0,027648
TOTALI				10,06588					9,905254	**0,160625**

In the table 6 has been reported the amount of residual, the type and the use

Tabella 5. Manifacturing - Capitello

INPUT					OUTPUT				DELTA
DIMENSIONI			N° PZ	MC.	DIMENSIONI		N° PZ	MC.	
H	BASE	LH / ml.			SUP. (HxLH)	BASE			
0,15	0,08	2,7	12	0,3888	0,3898	0,08	12	0,374208	0,014592
0,15	0,08	3,75	2	0,09	0,5473	0,08	2	0,087568	0,002432
0,2	0,12	3,03	1	0,07272	0,583	0,12	1	0,06996	0,00276
0,12	0,08	1,77	5	0,08496	0,204	0,08	5	0,0816	0,00336
TOTALI				0,63648				0,613336	0,023144

Tabella 6. Amount, type and reuse of residual

Work done	Type of refuse		*Amount Mc.	** % refuse	Storage
Optimization	Solid		0,44	6,30	Grinding/ silos
Veneer jointing	Sawdust		0,30	3,40	Silos
Planing – Gluing	Sawdust		7,50	39,50	Silos
Planing – Finishing.	Sawdust		8,82	50,80	Silos

Processing	Solid		Variable	Variable	Container

* With regard to each sample examined per operation.
** % of total refuse amount.

For how much it concerns the powder production during the working cycle and their management, relatively to the operations of milling, planing and gauging of the boards it used to inhale them from a closed loop system with evacuation and filtering of the exhausted air (system to localized aspiration); in fact, all the equipment are connected to a system of rigid and flexible pipages which directed the sawdust and the powders inhaled in the two silos of collection, with total capacity of 160 m^3, placed outside of the working structure (Figures n.1 and 2); the stored sawdust was characterized by a humidity comprised between the 8 and 12%.

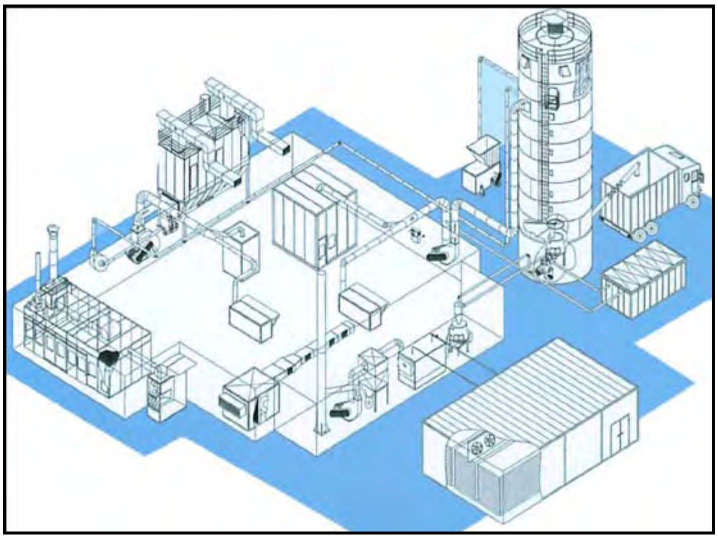

Figure 1. Design of working cycle

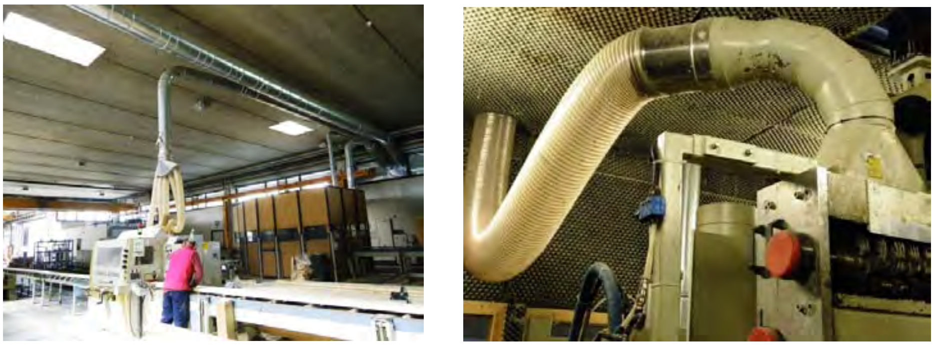

Figure 2. Particular of system of dust suction

Conclusions

The experimentation done has confirmed of the guidelines generalized in the industry of the working of the wood. Normally the refuse comes reused inside of the company for the heating of the premises and in the production process. The wood refuse has also a market, and the companies complete the choice between the various destinations on the base of variables as the energetic internal necessities of the company, the abilities to investment in technologies for re-use, the conditions of market of the refuse and it law obligation. This at least partially explains the high variability of the relative data to the energetic employment. After all the quantitative ones of wood material recovered every year from the industries of the field wood - furnishing is remarkable: approximately 5,6 million residual tons of coming from first and the second milling which are reused as raw materials or fuel in order to produce energy or heat. The use of these residual ones as raw materials so diffused that, in order to satisfy the request of the companies, every year the imports pile to beyond 1,2 million tons. The economic value of these huge quantitative ones of WOOD TO RECYCLE is gone currently around 175 million euro per year, without to forget that the development of the differentiated collection sure will carry to an increase of the turnover (Source: Federlegno-Furnishings elaborations).

Regarding the powder emission, the presence of a system to aspiration localized with a system of cartridge filtering is to high effectiveness and efficiency. However, even if it comes used a system of localized aspiration, in spite of the considerable inferior concentration of powders in the air or to the value limit equal to 5 mg/m^3 from the D.Lgs. 81/08, remain however a lowest potentially injurious powder concentration; for which in order increasing to the effectiveness of the systems the workers they would have to use the personal protective apparatus them as, for example, during the operation of manual smoothing. Anyway, the risk for the workers to accuse disturbances to the health, because of the powder inhalation, diminishes drastically in the factories in which the systems to localized aspiration are present. Our study follows to conclude that the system examined can represent a valid example of management optimized of the residual ones of milling, with suitable technologies adapted and to the materials, systems to norm and above all safeguard of the sanitary conditions of the places of job and the workers.

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Each author contributed in that paper in the same measure.

ISPESL Standardization Activities in the Field of Agricultural and Forestry Machineries

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Abstract
Article 9 of directive 2006/42/EC (new machinery directive) refers to potentially hazardous machinery and defines specific procedures to deal with them. According to this, National Institute for Occupational Safety and Prevention (ISPESL) during its market surveillance activity reported several non-compliances common to entire group of machines: agricultural self-propelled machines, hydraulic backhoes, telehandlers (self-propelled variable reach trucks), ride-on lawnmowers, log-splitters and risk of roll-over for passenger seat on tractor. ISPESL attending to the international working group for standardization, both CEN and ISO, encouraged the partial or complete revision of the specific standard related to the machinery listed above or, where there are no standards, the development of a new specific standards.

Keywords: new machinery directive, potentially hazardous machineries

Introduction

The directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery provides (article 7) that machinery manufactured in conformity with a harmonised standard, the references to which have been published in the Official Journal of the European Union, shall be presumed to comply with the essential health and safety requirements covered by such an harmonised standard. The European Commission, acting in accordance with the procedure referred to in article 8 of directive 2006/42/EC, may take any appropriate measure connected with the implementation and practical application of this directive. In particular the Commission may take any appropriate measure to restrict the placing on the market of machinery referred to in article 9 (Specific measures to deal with potentially hazardous machinery).

A first measure may be used whenever a product can be deemed hazardous on the basis that the reference harmonised standard does not entirely satisfy the essential health and safety requirements which it covers and which are set out in annex I to directive 2006/42/EC. In this case the Commission may take measures requiring Member States to prohibit or restrict the placing on the market of machinery with technical characteristics presenting risks due to the shortcomings in the standard, or to make such machinery subject to special conditions.

A second measure can be invoked against a machine or an entire group of machines whenever they present the same risk, by virtue of its technical characteristics, of a machine whose free movement has been restricted according to the procedures of the safeguard clause, as defined in article 11.

According to this, ISPESL during its market surveillance activity reported several non-compliances common to entire group of machines. Thus, attending to international working group for standardization, both CEN and ISO, ISPESL encouraged the partial or complete revision of specific standards related to the machinery listed in the next paragraph, or, where there are no standards at all, the development of a new specific working item.

Standardization activities

ISPESL developed many research activities in order to support the standardization procedure. The following standards are a partial example of the standards which have been revised due to ISPESL market surveillance and standardization activities:

- EN 609-1 Agricultural and forestry machinery - Safety of log splitters - Part 1: Wedge splitters;
- EN 690 Agricultural machinery - Manure spreaders - Safety;
- EN 709 Agricultural and forestry machinery - Pedestrian controlled tractors with mounted rotary cultivators, motor hoes, motor hoes with drive wheel(s);
- EN 836 Garden equipment - Powered lawnmowers – Safety;
- EN 1459 Safety of industrial trucks - Self- propelled variable reach trucks.

Moreover three new working items have been defined for the development of specific EN standards on:

- hydraulic backhoes;
- roll-over risk for agricultural self-propelled machines;
- roll-over risk for passenger seat on agricultural or forestry tractors.

EN 609-1 log splitters

In the last months the agricultural and forestry wedge splitters have been deeply investigated in order to verify if safety problems related to their use or to lack in the reference standard EN 609-1:1999 may arise. This investigation has been developed after that two serious accidents occurred and, consequently, the market surveillance authority reported a presumption of non conformity for the machinery involved. In particular, the safety problem encountered refers to technical measures necessary to prevent the unintentional actuation of two-hand controls used to start the splitting process. ISPESL already aroused this matter in the second half of 2008 during a discussion with manufacturers which led to a rationale and a proposal to amend the standard EN 609-1 submitted to CEN/TC 144/WG 8 at the beginning of 2009. This Italian proposal has been included in the revision process of EN 609-1:1999 started in the second half of 2009. In particular the actual standard EN 609-1:1999 requires that the splitting zone shall be protected by means of an interlocking guard associated with guard locking or alternatively equipping the machine with two-hands control devices. These devices shall meet the requirements defined in clause 4.6 letter b) of EN 609-1:1999 in the following summarized:

- *the two-hands controls shall be of the "hold-to-run" type, i.e. the splitting process is stopped if either manual control is released; and*
- *the wedge/pressure plate shall not return to the starting position if one manual control is in the "On" position; and*
- *it shall be impossible to start the splitting process inadvertently or to operate both manual controls simultaneously with one hand or arm or with other parts of the body (see 9.1 to 9.4 and 9.6 of EN 574:1996); and*
- *the controls shall be laid out in such a way that the operator has an unobstructed view of the splitting zone.*

From above it seems that:

1. the two-hands controls shall not totally conform to EN 574:1996 but shall only meet the requirements stated in 9.1 to 9.4 and 9.6 of the mentioned standard. These clauses refer to general requirements (ergonomic, environmental, etc.). Therefore, the

requirements referring to prevention of defeat defined in clauses 8.1 to 8.6 of EN 574:1996 seems to be not applicable as also represented in figure 1 which reproduces the same picture of the standard EN 609-1:1999, where an horizontal wedge splitter with fixed wedge is shown, and figure 2. In particular the two-hands controls depicted in those figures are clearly not compliant with clause 8.5 of EN 574:1996 "Prevention of defeat using one hand and any other part of the body (e.g. knee, hip)";

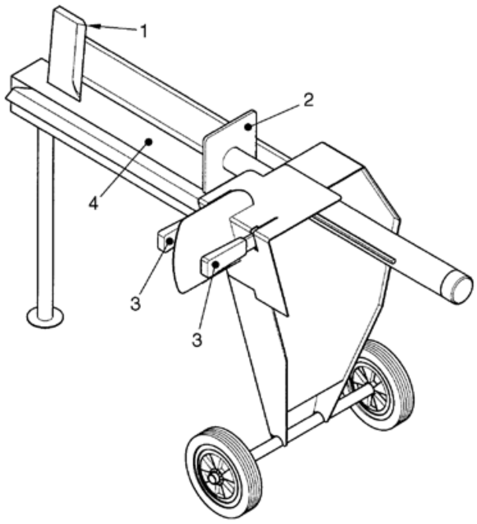

Figure 1. Horizontal wedge splitter with fixed wedge as shown in figure 2 of EN 609-1:1999

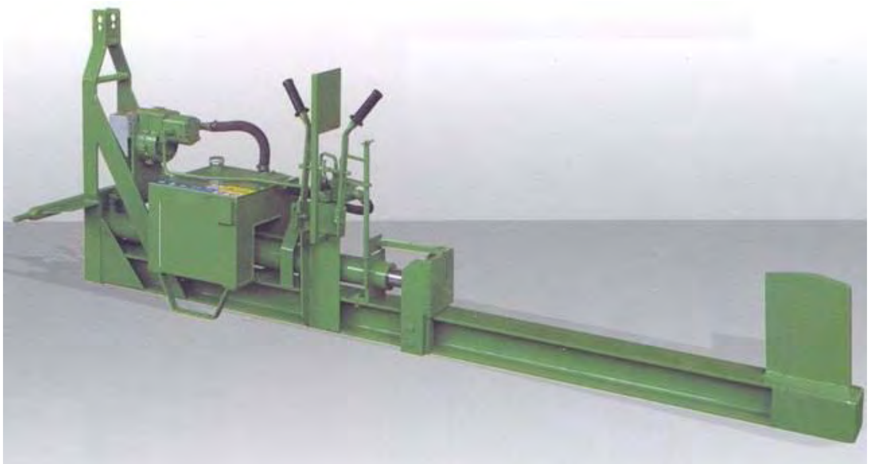

Figure 2. Example of an horizontal log splitters where the activation of two-hand controls used to start the splitting process could be made with parts of the body (hand, arm, etc.)

2. with reference to the simultaneous actuation of the two-hands controls, the standard EN 609-1:1999 states that shall be impossible *to operate both manual controls simultaneously with one hand or arm or with other parts of the body* and it refers again to clauses 9.1 to 9.4 and 9.6 of EN 574:1996. Thus, it seems that it should be

possible that the two-hands controls are designed to be simultaneously operated by means of:

- one hand and its own arm;
- one hand and other parts of the body;
- one arm and other parts of the body.

With reference to what above mentioned, in some working conditions it could be possible that the operator actuates the two-hand controls without simultaneously using both hands. As a consequence the free hand could be used within the dangerous zone, as already occurred in the two serious accidents previously mentioned. Thus, considering the two serious accidents occurred and the lack of any technical or economical impediment to install devices in order to fulfil the principles of prevention of defeat, which are essential in order to grant the safety level attained by the two-hands controls, ISPESL claimed to include the requirements referring to prevention of defeat defined in clauses 8.1 to 8.6 of EN 574:1996 in the revised version of EN 609-1.

EN 690 manure spreaders

For manure spreaders the relevant data of accidents occurred in Germany and in Italy showed that it is necessary to implement a safety device in order to prevent unintentional contact with the spreading devices while moving, during maintenance or cleaning operations. In figure 3 an example of spreading device with vertical axis is shown.

Figure 3. Example of manure spreader with vertical axes rotors rear spreading device

ISPESL encouraged a complete revision of the standard with particular reference to this issue. Thus, the actual draft of the standard provide that self-propelled manure spreaders shall have a system that prevents engagement of the spreading device moving working parts if the operator is not in the operator's work station and automatically disengages the power transmission of the spreading device when the operator leaves the operator's work station.
This requirement shall be also extended to mounted and trailed manure spreaders. In particular for trailed manure spreaders a system able to avoid the spreading device movement while tractor is not travelling shall be provided. If it is necessary to spread the manure while tractor is not travelling, it could be done by using an hold-to-run control from tractor driving position.

EN 709 pedestrian controlled tractors with mounted rotary cultivators, motor hoes, motor hoes with drive wheel(s)

Most of the several accidents occurred with motor hoes and pedestrian controlled had the same type of dynamic. In particular, the common feature was that the hold-to-run control

was by-passed by the operator. In fact, this was due to the matter that in the most part of the pedestrian controlled tractor with mounted rotary-cultivators or motor hoes, when the hold-to-run control is released, the engine of the machines switches off. This condition creates some restraints for operator who, in order to avoid repetitive stops in his working activity due to release of the hold-to-run control during turns and/or stop manoeuvres, excludes the safety device and locks it in the working position. Therefore, in case of an emergence, this device is not able to stop the motion of the operating tools, with serious consequences for the operator. The lock of safety device is not necessary if the hold-to-run control, when is released, does not switch off the engine but only interrupts the movement of the operating tools. This can be achieved by means of a inverted clutch, for example. In this case the operator is not induced to exclude the safety device.
ISPESL research activity on this kind of machines led to the partial revision of the standard EN 709 adding some important requirements. In particular:

- now releasing the hold-to-run control(s) shall not stop the engine but shall stop only the operating tools;
- the force required to maintain the hold-to-run control in the engaged position shall not be greater than 27,5 N when the hold-to-run control is located on only one handlebar. If the hold-to-run control is located so that it can be operated by either or both hands when they are holding the handle-grips, the force required to maintain the hold-to-run control in the engaged position shall not be greater than 35 N (see figure 4 for the location of the activation force).

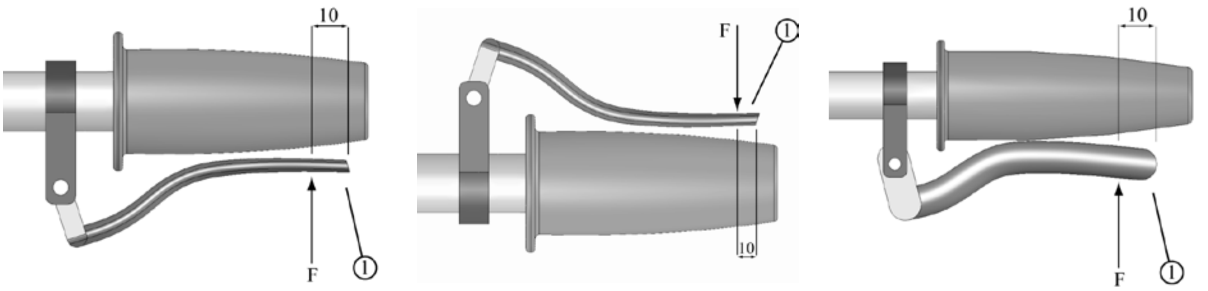

Figure 4. Location of the activation force: 1: end of the control, F: force required to maintain the hold-to-run control

- service and parking brake systems shall be provided to stop the pedestrian controlled tractor's motion in both forward and reverse directions if a force of more than 250 N, applied at the centre of the wheel axle and parallel to the slope, is required to hold the pedestrian controlled tractor, with the mounted rotary cultivator touching the ground, on a 30% (16,7°) slope.

Furthermore, the previous version of the standard did not provide for the risk due to the inertia of working tools, which continue moving after the hold-to-run control is released. The revision of the standard provides that the tools of pedestrian controlled tractors and motor hoes shall stop from their maximum rotational speed within 2 seconds after the operator releases the hold-to-run control. The last requirement added concerns the maximum travel speed. The previous version of the standard did not define the maximum travel speed of the machine compatibly with the pace of a driver on foot. Now, for pedestrian controlled tractors and motor hoes with drive wheel(s) with the power soil working tool mounted, the maximum travel speed shall not exceed 8 km/h in forward direction and 3,6 km/h in reverse direction.

EN 836 – ISO 5395-3 powered lawnmowers

The main concern refers to stability of self propelled ride-one lawnmowers. In fact the actual version of standard EN 836 requires that if the lawnmower is stable on a tilting table at 20° in the lateral test and 30° in the longitudinal one it is not necessary to fit a roll-over protective structure. Considering the recent fatal accidents occurred due to the roll-over of ride-on lawnmowers and that there are no technical difficulties, in the revision process of standard ISO 5395-3, which when finished will affect also the EN 836 according to the Vienna agreement, Italy asked to fit with a ROPS all the ride-on lawnmowers having a mass equal to or greater than 400 kg. Moreover, in order to reduce the risk of unintentional activation of the operator presence control (OPC) engaged by the seat or integrated into it, Italy asked to introduce a minimum activation force and a test procedure as follow:

- 350 N, if measured in the centre of a rigid circular plate of 350 mm of diameter placed on the centre of the seat; and
- 150 N, if measured in the centre of a rigid circular plate of 100 mm of diameter placed on the seat with the centre of plate vertically aligned with the centre of each sensor.

EN 1459 self- propelled variable reach truck

The main concerns refers to hazard related to travel movements without operator at controls. In fact, the actual standard EN 1459 specifies that it is sufficient to use the parking brake and the gear in neutral for fulfilling the safety requirement, thus it exclusively depends on the operator, despite of the presence of technical solution already used on other kinds of machines technically similar. Moreover, the same standard at point 5.1.2 *Unintentional movements* refers to point 5.9.5 of EN 1175 for battery powered trucks where it is specified that "*a separate and independent from the accelerator device shall automatically prevent the travel movement when the operator is not at the control, for example a switch under the seat…omissis…*". Thus, on the same kind of machines but battery powered a technical solution which does not depend on the operator has been adopted for reducing the risk. As a consequence ISPESL asked CEN, and obtained, to amend the standard EN 1459 concerning this safety requirement. So, the necessity of an operator presence control related to travel movement of self-propelled variable reach truck has been included.

Hydraulic backhoes

The main concerns refers to the unespected relative motion between tractor and the attached hydraulic backhoes which determines the risk of crushing for the operator while seating on the hydraulic backhoes (see figure 5 on the left). Actually, the safety devices used for not allowing this relative motion are not integrated with the machine itself. Thus, the application of these devices depends on the operator. Several fatal accidents in Italy are recorded related to this aspect. As a consequence ISPESL and the Italian manufacturer associated in Unacoma are involved in the development of a specific EN standard for this kind of machines in order to define, among the others, also the safety requirements related to the mentioned risk. In figure 5 on the right a possible solution regarding a integrated protective device is presented.

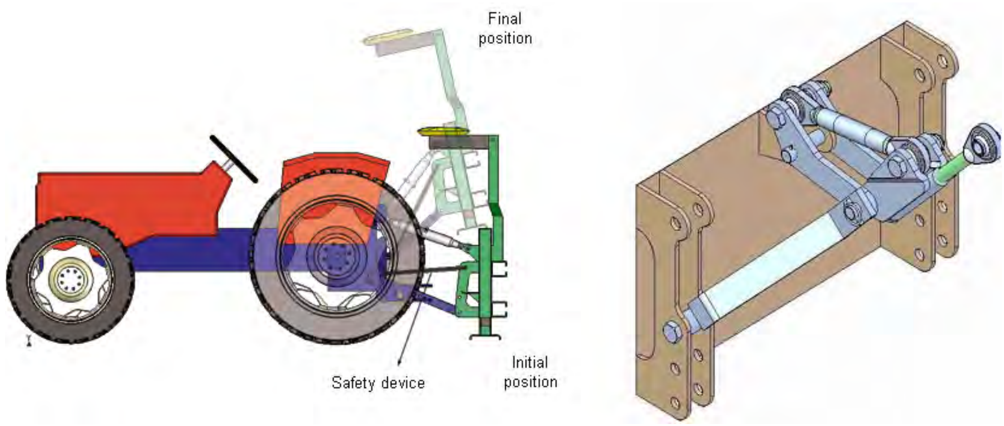

Figure 5. Example of hydraulic backhoes relative motion (on the left) and proposed safety device (on the right)

Roll-over risk for agricultural self-propelled machines

Agricultural self-propelled machines present roll-over risk without fitting a ROPS. Thus ISPESL is developing a research activity with the aim of evaluating the transversal and/or longitudinal roll-over risk in order to define the necessary safety actions for this kind of machines during their normal use. First of all the presence of proper roll-over protective structures on this kind of machines has been inspected. Thanks to some manufacturers, who placed technical drawings to ISPESL disposal, the resistance level of actual cabs has been investigated. In particular, finite element analysis has been developed on this cabs. The sequence of loads and the level of energy to be absorbed by the protective structure have been deduced from ISO 8082: 2003 and from the principal international standards for earth-moving machines (EN 13510:2002), because of the lack of a specific standard. In figure 6 a CAD model of a cab and the related FEM analysis results are reported as an example of the developed research activity.

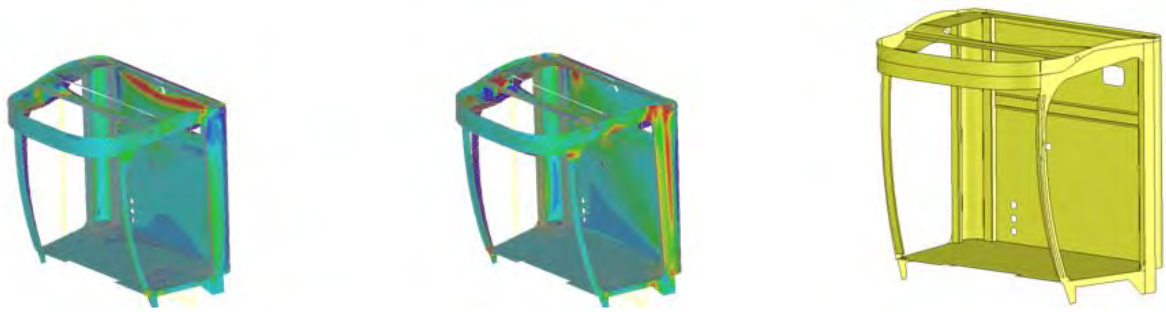

Figure 6. Example of finite element analysis on cab fitted on agricultural self-propelled machines

The results of these simulations revealed that the cabs actually mounted on this kind of machines have no mechanical properties such to preserve the safety volume of the operator in case of roll-over. In fact the plastic deformation of these structures were such to come completely inside the safety volume of the operator. Moreover the resistance properties were lower than the 30% of the minimum values stated by the international standards. In other words the cabs actually installed on self-propelled machines, which weight could reach the value of 20.000 kg during working operations, could guarantee the safety of the operator in case of roll-over only if they were installed on machines weighting at most 2.000 kg. Thus, it is possible to say that the technical solutions to reduce the roll-over risk of the agricultural self-propelled machines actually on market are not aligned with the state-of-the-art concerning technical knowledge adopted for self-propelled machines used in other working fields as for example earth-moving machines. Hence, ISPESL is involved into a CEN new working item for the definition of a standard on the protection against roll-over and tip over for this kind of machines.

Roll-over risk for passenger seat on agricultural or forestry tractors

Nowadays, agricultural and forestry tractors equipped with passenger seat do not ensure passenger protection against roll-over. For this reason CEN set a specific task force leaded by ISPESL for defining safety requirements and acceptance criteria with reference to this topic. At the moment a deflection limiting volume for passenger and its interaction with the operator clearance zone have been defined (see figure 7).

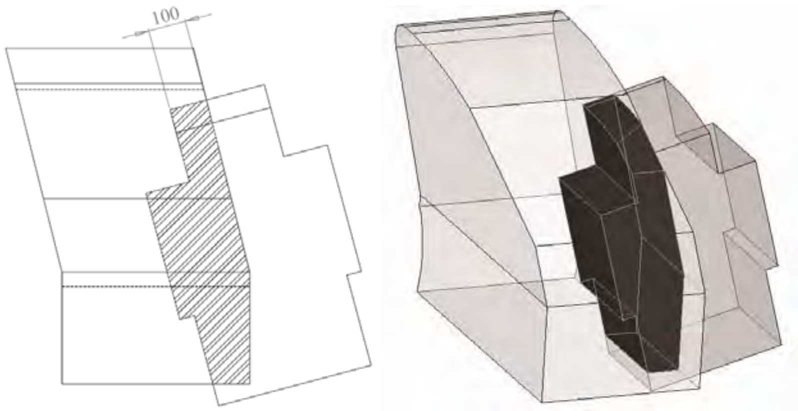

Figure 7. Passenger deflection limiting volume and its interaction with operator clearance zone

The testing procedure is going to be defined in order to complete the required task.

Conclusions

The examples herein reported reveal how the research activity joined to the market surveillance one are important for ISPESL standardization activity development. In fact, when amendments to a standard which is considered not to entirely satisfy the essential health and safety requirements which it covers is requested, it in necessary to deeply know the machine for the risk dealt and how it is technically possible to reduce it. Moreover, in several cases the raised issues result from accidents, sometimes fatal. Thus, facing the problem and forcing for improving the standard in order to define specific safety requirements and the related acceptance criteria has often a relevant social impact.

Safety and Prevention in Mechanised Forest Operations: a Tuscan Project

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Abstract
In the last years public and scientific debate about the reduction of polluting and CO2 emissions have intensified and the importance of renewable energies and fuel have increased.
At present many Italian logging companies produce substantial amounts of biomasses and forest operations are more and more mechanised. As a regard safety and prevention, the Tuscany Region has promoted in 2009 a project in order to provide specific guidelines to increase safety in logging operations and in particular in the use of harvester, chippers, cable yarders and other traditional machines.
Project partners are: CNR Ivalsa (National Council for research – Tree and Timber Institute), focusing on harvesters, processors and chippers; the University of Florence (DEISTAF Agricultural and forestry Engineering Dept.), for cable yarders; ISPESL (National Labor Safety and Health Agency) for general machine safety criteria and conformity of machines to European directives; the four provincial Health and Safety Agencies of Tuscany, for supervising the work and checking its applicability to Tuscan safety inspection programs. The primary aim of this project is to integrate the indications from the analysis of high mechanised forestry yards with the aspects of safety and prevention in forestry operations.

Keywords: biomass harvesting, high mechanisation level, risks profiles, best practices

Introduction

According to national Forest Inventory data (1998) Tuscany has a forest area of 1,086,000 hectares, representing 47% of the total territory of the region and over a tenth of the national one. The coppice exceeds the high forest, only in the mountain forests, particularly in beech woods, there was a strong increase (30%) of high forest. The privately owned is the type of ownership more frequent, with firms of small dimensions (70% of them have an average area less than 10 ha).
The forestry sector, directly and indirectly, involves about 9,000 workers (between technicians, operators, public enterprises, etc...). According to Chamber of Commerce Industry and Agriculture (CCIAA) data, in 2005 the wood enterprises were 1314but this number is underestimate because it doesn't include those that work primarily in other activities and occasionally in the forestry activities. According to ISTAT research, in 1990 the average number of permanent workers per forestry enterprises is between 1 and 2 units,

so it is estimated about 2500 permanent workers but it's impossible to estimate the number of fixed - term workers engaged in the forestry sector because there aren't specific data. The last Report on the State of Forests in Tuscany (RAFT 2008) reports that in 2008 there was a large increase in the number of forestry enterprises (8.7% compared to 2007); this phenomenon can be caused by the new legislation, too (Legislative decree 81 / 2008); in fact some employers could have led some of their workers to take the P.I.V.A. (value added tax) so reducing their liability for occupational accidents, diseases and controls.

The forestry worker represents a high-risk category with high percentage of fatal and serious accidents; often, the statistic data about the occupational forestry accidents are inaccurate and incomplete because the enterprises are included in the "Agriculture Sector".

A thorough analysis of the various risks present during the forest utilization it has been addressed in a previous regional project which culminated in the production of the publication "Guidelines for prevention and safety in the forestry operations in Tuscany."

Recently with the developing of forest-wood-energy chain some enterprises have increased their level of mechanization by introducing innovative and complex machines; in consideration of this trend the need has sort to analyse in detail the risks profiles of these highly mechanized enterprises by activating a specific project called "Promoting Safety in the Forest - Wood-Energy chain", to prepare appropriate safety guidelines for mechanised operations. The project focuses especially on cable yarders, harvesters, processors and chippers.

The specific major objectives of the project are:

- Highlight any risks in using forestry machinery introduced recently in the yards of forest use to make more competitive the Forest-Wood-Energy chain;
- Provide specific references for the development of safety and health in the Forest-Wood-Energy chain through the definition of procedures and best practices really applicable by forestry workers;
- Promote the dissemination of good practices and procedures between the operators and the various actors in the sector.

Materials and methods

The project included four main steps: 1) an analysis of existing materials on safety in mechanized operations; 2) interviews with mechanized operators working in Tuscany, in order to draw from their specific experience and to gauge their awareness of specific risks; 3) direct observation of risk-taking behaviour in selected mechanized operations; 4) drawing the guidelines and disseminating them.

The work started with a thorough and accurate analysis of existing publications on the subject, including manuals, guidelines, popular articles and scientific articles. Overall, about 70 titles were collected and studied.

Meetings were organized with all the partners in order to develop a most complete and comprehensive ergonomics and safety checklist, to be used for interviewing mechanized operators. Before starting with the interviews, a general test of the questionnaires was conducted by the complete study group in three plenary inspections of mechanized operations. All partners together were then able to check the effectiveness of the questionnaire, and to introduce appropriate improvements.

In the questionnaire were considered:

- the logging company identification;
- the company structure;
- the types of machines used and their general analysis;
- the usual working process;

- the main tasks;
- the presence of the safety equipment on the yards;
- the operators experience;
- the operators risk perception;
- the operators rating;
- the risk analysis in the past and the near misses;
- our evaluation of the safety and wrong behaviour.

So far, 30 operators have been interviewed. Upon arrival to the worksites, operators were informed about the project and its goals, and were asked if they could devote some time to an interview, possibly during the lunch break or any other pause in the work cycle. Participation was voluntary and no compensations were provided.
The operations were also observed during regular work and were specifically sampled for risk-taking behaviour, using a dedicated data-collection form.

Results
During the interviews, we obtained data about 1) machine compliance to safety and ergonomics rules; 2) perceived hazards; 3) past accidents and near misses; 4) risk-taking behavior during work.

Evaluation of the machines

Harvesters and processors
The reference standard is the EN 14861: 2004 *Forest machinery - Self propelled machinery - Safety requirements* (August 2004). This document is a type C[1] standard as stated in EN 1070 and deals with all common significant hazards, hazardous situations andevents of the following forestry machinery: fellers, bunchers, delimbers, forwarders, log loaders, skidders, processors and harvesters as defined in ISO 6814 and also multifunction versions of these machines, when they are used as intended and under the conditions foreseen by the manufacturer, see Clause 4.

The machines listed can be of the mobile, ride-on or self-propelled type or a combination of these types.

The following significant hazards are excluded:
- thrown objects, that may occur on a particular machine,
- noise,
- vibration.

In tab. 1 other reference standard for machinery for forestry

Tab. 1 - other reference standard for machinery for forestry:

[1] Type harmonised standard can be:
- Type A standards, standards giving basic concepts, principles for design and general aspects that can be applied to all machinery;
- Type B standards, standards dealing with one safety aspect or one type of safety related device that can be used across a wide range of machinery;
- Type C standards, standards giving detailed safety requirements for a particular machine or group of machines.

Standard	Type	Subject
ISO 6814: 2000	Machinery for forestry — Mobile and self-propelled machinery	Terms, definitions and classification
ISO 8082: 2003	Self-propelled machinery for forestry	Roll-over protective structures-Laboratory tests and performance requirements
ISO 8083: 2006	Machinery for forestry	Falling-object protective structures (FOPS) - Laboratory tests and performance requirements
ISO 8084: 2003	Machinery for forestry	Operator protective structures — Laboratory tests and performance requirements

The significant hazards associated with self-propelled, mobile and ride-on forestry machinery are:

1. Movement without a driver at the driving position
2. Falling or ejected objects;
3. Loss of stability/overturning of machinery
4. Objects falling onto or penetrating into the operator station;
5. Fluids ejecting from or rupture of unguarded pressurised hoses,
6. Slip, trip and fall of persons for lack, improper location or size of boarding means;
7. Contact with unguarded moving machine components, lack of clearance between moving parts;
8. Burns, scalds and other injuries by a possible contact of persons with objects or materials with extreme high temperature.

All checked machines complied with the main specifications for safety and were CE labeled, except for a very old chipper.
A main problem for excavator-base harvesters and processors was the coupling of head and carrier. In many cases, the manufacturer's handbook for the carrier did not specify the head types and models which could be fitted on the machine, which is a binding requirement of European safety law. Lacking such indications, owners should get their complete machine inspected and approved by ISPESL officials, which few had done.
Furthermore, windows on the excavators occasionally lacked suitable OPS. Where present, some of the OPS grates were too thick and impaired visibility.
As to machine self-evaluation, most operators were satisfied with the safety and comfort provided by their units. Negative appreciation only concerned the lighting and climatisation of excavator-base units. Old excavators often lack a functional air conditioning unit, and are only comfortable in winter time. A number of studies have documented productivity reduction in loggers exposed to the heat in warm climates (Smith et al., 1985, Hansson, 1968). Some operators reported that during the hottest summer days, the temperature inside the cabin can be so high that they cannot work without keeping the doors fully opened and taking frequent rest breaks. On the contrary, just one of the operators using dedicated harvesters complained about the inefficiency of the a/c system.

Chipper

All checked machines complied with the main specifications for safety (CE label), except for a very old chipper.

Chipper operators occasionally complained about poor lighting. Lowest scores were attributed to dust and noise, mostly for chippers without an enclosed cab.

The reference standard is the EN 13525:2005+A1 (may 2007) *Forestry machinery - Wood chippers - Safety*. This document is a type C standard and specifies safety requirements and their verification for design and construction of transportable, i.e. self-propelled, mounted, semi-mounted and trailed, wood chippers used in forestry, agriculture, horticulture and landscaping. The standard EN 13525 applies to chippers, used when stationary, which are manually loaded with wood through a horizontal or near horizontal infeed chute at the end of which mechanical infeed components (or chipping components acting as mechanical infeed components) draw the wood into the machine. The included wood chippers may be powered either by an external power source such as a tractor power take-off, hydraulics, etc or by an integral power source such as an internal combustion engine or an electric motor.

The standard does not cover hazards arising from mechanical loading and shredders/chippers with integral power source and with or without vacuum assisted collection which are designed primarily to reduce organic material to smaller pieces to be covered by EN 13683 - Garden equipment - Integrally powered shredders/chippers – Safety.

Cable crane

Wood harvesting in mountain areas is often particularly difficult, due to terrain morphology. Cableways are in these circumstances the best choice, and the couple cableway plus processor is becoming more and more frequent in Italian forests (Hippoliti et al., 2000)

At the moment few people have a direct experience of operating with cableways and the needs of training courses are still high.

The main problem concerning safety in cable crane extraction operation is due to the several factors and components that are involved in the whole production chain (Kanzian et al., 2003). Indeed independently of the types of machine used the components assembly of the cable crane is one of the most crucial steps of the process and wrong mounted cable crane systems often occur in our forest (Marchi 1997).

The coupling of the several elements should be provided by the manufacturer’s handbook.

Also for cableways the checked machines complied with the main specifications for safety and were CE labelled. As to machine self-evaluation, all the operators were satisfied with the safety and comfort provided by their cable system.

Perceived Hazards

Harvesters and processors

First results hint at a higher perceived safety for operators working from a cab. For most, the main concern is represented by co-workers operating in the proximity of the machine – which have been often indicated as the primary source of work hazard. Many operators also reported on the need for safe behaviour during machine maintenance.

Maintenance and repair work is generally performed by the operator in the forest, outside the cab, often in difficult terrain and/or in adverse weather conditions. The main problems reported for maintenance are related to: bad working postures; the need of great strength in handling heavy machine parts; the risk of slipping and falling associated with climbing up to and working on machines. Studies report that the accident rate for maintenance work is higher than that for machine operation, and nearly as high as in manual logging work (Vayrynen, 1984).

Chippers

Chipper operators using industrial machines generally work inside an enclosed cab, giving some protection against noise, dust and adverse weather conditions. Operators using small manually-fed chippers enjoy much less comfort and declare that they need to be very careful during feeding, because logs can "lash back" when they are engaged by the feed rollers. They usually wear tight clothes and use at least some of the prescribed Personal Protection Equipment (PPE), such as hearing protectors, gloves, goggles, and safety boots.
Chipper operators are particularly concerned with people entering the risk zone, and especially the loader swing area, the infeed area, the chip discharge area and the truck manoeuvring area. Many are also concerned with projection hazards, as the chipper can throw large wood chunks and occasionally metal parts, especially in case of mechanical failures. Preventive maintenance is carried out whenever the machines are stopped for knife changing.
Both harvester and chipper operators perform all maintenance work with the engine is off, unless this must be kept running for locating a failure.

Cable crane

In cableway extraction, the operators must identify:

- suitable stacking points;
- rack layout in relation to landform;
- the availability of spar and support trees especially in thinning operations.

A high hazard perception for the workers often occurs during loading and unloading operations under the line. Unloading is considered as the primary source of work hazard, but also maintenance and wire rope handling are often dangerous operation.
The main problems reported are related to the mounting and dismounting process of the cable crane, to climbing operations needed to prepare intermediate supports and to the risk of slipping on the forest ground during loading (Fabiano et al., 2001). Also bad postures were noticed during loading operations.
Moreover operators are particularly concerned with people entering the risk zone, and especially under the line during extraction and at the landing for unloading.
They usually use at least some of the prescribed Personal Protection Equipment (PPE), such as gloves and safety boots but the periodical use of the helmets in the risk area was noticed.

Direct observation of risk-taking behaviour

Very few real accidents have been reported, while some near-misses were described and commented.
So far, different operators were observed several hours each for risk-taking behaviour. Violations to safe working practice were characterized and annotated, obtaining a frequency distribution of different risk-taking behaviours, which can be related to time, number of events and output.

Harvesters and processors

With harvesters, the most frequent observed violation to safe working practice consisted of working with open doors, always pertaining to excavator-base machines and generally depending on the absence of an efficient a/c system. Some operators also stated that they preferred to work with open doors in order to obtain better visibility. All knew this is unsafe practice, but they deemed heat stroke and poor visibility to be higher risks. Many operators also did not use seat belts, although all machines were equipped with them. Finally, some operators mounted and dismounted by jumping, even if all machines were provided with suitable steps.

Chippers

Observation of chipping operations yielded similar results to those listed above, with the most common violations pertaining to open doors and lack in the use of seat belts. In one case, we also observed maintenance being conducted without gloves, which entails the risk of wounding and/or contamination with potentially hazardous fluids and chemicals.

Cable crane.

As regard cable crane systems the setting up and safe operation require a well trained working crew that is capable of recognising conditions that could potentially lead to failure, such as weak stump anchors, unusual line stresses etc. Technical guidance to avoid cable system failures is often available in the form of operating manuals. However, their application often depends on the knowledge and the skill of each individual crew. Using a specific data collection protocol the violations to safe behaviour were investigated.

In cableways extraction operations, the most frequent observed violations to safe working practice consisted of wrong cableways and bracing mounting and wrong loads hooking.
Some operators often work without Personal Protection Equipment especially at the landing and they usually don't pay a careful attention to the wire rope maintenance.

Discussion and conclusions

With the Legislative decree n. 81/2008 s.m.i in terms of prevention and worker safety all workers are required to attend specific training courses managed and defined by their companies.
None of harvester, chipper and cable crane operators have attended a formal training program, but just few days in coincidence with the delivery of the machine, by the manufactures. Most relied heavily on a combination of "on the job training" and experience gained in the logging or other similar previous works. This lack of training appears to be primarily due to the high daily production demands necessary to keep the operation profitable. Therefore, nobody is willing to leave his/her workplace for more than a week, because the missed income would be too significant.
Training is essential also to allow crews to efficiently operate cable systems. Focused training such as crew productivity training for entire crews, with emphasis on how the actions of individual crew-members may influence the productivity of the entire team.
Even experienced operators benefit from refresher training. It is important that the machine and system are equipped with ropes and components in a serviceable condition, that meet the manufacturer's recommended specification. The weight of the load must not exceed the manufacturer's recommended safe working load, which must be clearly stated on the machine.
Attention to work safety is motivated by a number of different considerations, deriving from ethics, self-preservation and legal obligations. However, it also has a further dimension in economics, because less accidents mean less lost workdays, and therefore less revenues for both the employer and the employee.
Safety and ergonomics are closely related, because an uncomfortable operator can get too tired and lose concentration, which makes he/she more prone to engage in risk taking

behaviour. At the same time, productivity also declines, with the increased risk of machine and product damage.
Most of the loggers interviewed during the study have a very clear perception of the risk inherent to their work, they may occasionally engage in risk-taking behaviour, as we observed during our study. Once asked about the specific events observed, most answered that they knew they were violating safety prescriptions, but they were confident in their own experience, and in their capacity to control the work process.

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Analysis of Accidents in Agriculture: Province of Ragusa – Year 2009

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Keywords: accidents

Objectives

In the Province of Ragusa, 37% of active companies belongs to the Agriculture sector and these companies will experience an average of over 20% of the total accidents.

The objective of this analysis is to know the where, the how and the who becomes the victim of workplace accident to highlight in what process and in what equipment you can possibly focus on prevention initiatives.

Second objective, but clearly not least, is to examine the epidemiological data that points out how in the Province of Ragusa occur the 26/30% of injuries to agricultural workers in the total of those recorded in the whole Sicily.

Methods

During 2009, the SPreSAL of Health Company Provincial Ragusa examined n ° 594 injuries occurred in farm workers in the Province. The record card, from wich are extracted the data, are those transmitted by INAIL to our service and are a percentage of '85-90% of total number of accidents occurred in the field. To obtain this result, for each accident was investigated the type of work with their place of work, location, type and severity of injuries, the type of equipment used and the type of worker.

Results

The results obtained are of course peculiar to our country where, alongside the wider cultivation in greenhouses Italy, coexist the work in open field, livestock and warehouses for processing of fruit and vegetables.

Investigation

The characteristic of farming in our province is the widespread cultivation in greenhouses. The statistic of accidents confirms this vocation to greenhouse crops: in this area occurs because 49% of agricultural accidents.

Interesting data that shows that 16% of accidents occur in warehouses for the processing of agricultural products.

Only 21% of injuries occur to the use of equipment, vehicles or machinery; much as 15% of all accidents occur on board means (car) in progress (10% provincial average).

The number of accidents reported, those on foreign workers are 20% but it is estimated that the actual number is larger. There is indeed a general phenomenon of complaint under of injuries focusing on agriculture and probably involves mainly foreign workers.

Living in our territory a few large companies many employees along with a myriad of small mostly family-run businesses.

In our province working farm is a very masculine type of work; large concentration of female workers is found in stores instead of fruit and vegetable processing where the number of accidents are 40% of all cases in which women are involved.

Accidents in the greenhouse are 49% of the total; inside the greenhouse accidents caused by using vehicles or equipment constitute only 11%.

The operation responsible for the increased number of accidents caused by using vehicles or equipment is handling/performance of coils sheets greenhouses (39%), resulting from the use of stairs (29%) - often used more for hedging / unveiling of the greenhouses - and use the handles for towel wrap (18%). It is clear therefore that the hedge/unveiling of the greenhouses

are, in various stages, a dangerous occupation (86% of accidents with the use of equipment or vehicles).
Be stressed that 14% of the events is caused by pump failures spraying of plant protection with potential exposure resulting in intoxication.
Injuries in the open field are 22% of the total; of these, accidents caused by using vehicles or equipment account for 28%.
The tractor has been confirmed as the most dangerous (52% of events), followed by use of chainsaws (29%) and brush cutters (16%). Fortunately limited to one event - fatal - injuries caused by round baler for haymaking.
Wanting to unify the work in the greenhouse with those in the open - remember that the large farms have mixed crops - verify how the hedge / unveiling of the greenhouses (coil + handle + scale) remains as the most dangerous phase of work (41%) followed by the use of tractors (27%) and the use of chainsaws (15%).
The storage of fruit and vegetable processing is clearly the place where the highest concentration of machinery and equipment. Indeed the use of these tools cause 34% of total accidents that occur in these workplaces. The female is involved in 20% of cases.
In order involving conveyors, handling of container boards, packaging machines and, ultimately, the movement of forklifts.
In cattle occur 12% of agricultural accidents. Are involved in these events mainly employers - 82% of the total. The female was hit in a rate of 5%. Only in 3 cases (5%) involved equipment (2 times the stairs - one time a container platform).

Conclusions
Cultivation in greenhouses is the type of work that, even for its widespread use in the province, is what is responsible for the increased number of accidents - 49% of the total.
Only 21% of injuries caused by use of means, machinery or equipment, while it is absolutely relevant, the percentage of commuting accidents - 15% - often fatal (10% provincial average).
20% of accidents on immigrant workers.
29% of accidents on self-employed.
The female is an overall marginal proportion - 7% - agricultural accidents.
Operations responsible for the greatest number of accidents refer to those related to covering / uncovering of the greenhouses (41%) followed by the use of tractors (27%) and chain saws (15%).
2) The epidemiological data points as in the Province of Ragusa occur on 26/30% of injuries to agricultural workers of the total of those registered throughout Sicily.
The Province of Ragusa is third in the Region as numbers of employees - 15.2% - and in first place as numbers of accidents at work - 26.6%; furthermore, in the province of Ragusa 23.4% of the working population is engaged in agriculture against 9.3% of Catania and 7.3% of Palermo, provinces which have a greater number of employees of Ragusa.
Looking at the tables it is clear that in the provinces of Agrigento, Catania, Messina and Palermo there is a phenomenon of complaint under of accident, especially agricultural ones, and then, like the provinces of Ragusa, in which the phenomenon of complaint under be relatively limited, comprising high percentages but obviously biased.

Survey on Mechanization and Safety Evolution in Forest Works in Italy

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Abstract

The work objectives were study the evolution from the 50s to 2009 of the forestry utilization companies in Italy, with particular attention to the level of mechanization and work safety in forest yards. The survey was conducted in the whole country, and implementing these data with research already carried out in the field whose results have been published in past. The study was based on responses given by forestry utilization companies as a result of questionnaires sending and taking into consideration a time period of about 60 years. Companies that answered were 292 on 3164 existing in Italy. In particular, this study has allowed to obtain a homogeneous vision of the Italian forestry utilization companies. The results of the survey show as the seasonal forestry work and then the low percentage of workers who can work continuously throughout the year represent a weakness of the sector thus requiring a scrupulous forest planning. The limited surfaces harvested annually highlights the difficulty for the forest firms to develop systems of work with high mechanization. Finally, most important, work safety, highlighted by the survey is a general lack of interest until at least 1990 for this important issue, from that time it will be clearly noted a growing commitment by firms in adapting to the safety laws, even though we are still far from complete transposition as required. However, our forestry work system is very weak as regards the level of training.

Keywords: forestry utilization, forest yards, work safety

Introduction

Working in forests is primarily characterized and influenced by the environment in which the work takes place. The tasks undertaken are extremely varied and require the use of machinery and equipment which, if used incorrectly, can cause serious injury to operators. Although there are a number of existing regulations regarding safety in general and the health and safety of operators in the workplace, in the forestry works, there is greater resistance as regards accepting the applicable legislative provisions, regarding both the owners of businesses and the machinery. The law n.° 626/94 represented an evolution at national level in the field of occupational safety, improving quality of life as well as encouraging a reduction in the social cost that accidents and occupational diseases represent, now another decrees (81/2008) have amended this "old" law. A new definition of prevention was given therein: "the whole body of provisions or measures necessary, also in terms of the special nature of the work, experience and technique, in order to prevent or reduce occupational risks as regards public health and the integrity of the external environment...". The aim of this study is to give an overview of the logging company throughout Italy, paying particular attention to the development of mechanization and especially to the field of risk prevention and safety work.

Material and methods

The investigation was conducted covering the whole country, and implementing the data with research already carried out in the forestry sector whose results have been published (Baldini et al., 2002, Baldini et al., 2006; Picchio et al., 2008) The study was based on responses from logging companies as a result of sending out specially created questionnaires which examined a time period of about 50 years. 292 of the 3164 logging companies surveyed completed the questionnaire (ISTAT, 2008 a; ISTAT 2008 b), approximately 9.2%. In particular, this insight enabled us to provide a more uniform overview of Italy from a geographical point of view, with an equal distribution of companies in the south, centre and north.

Data, results and discussion

Temporal distribution of forestry work

60% of the sample of companies studied (Fig.1) have predominantly seasonal work, with an average of 186 working days (Fig.2) per year. Only 40% have the opportunity to work continuously throughout the year. This is another clear factor of weakness in the industry which requires serious forestry planning.

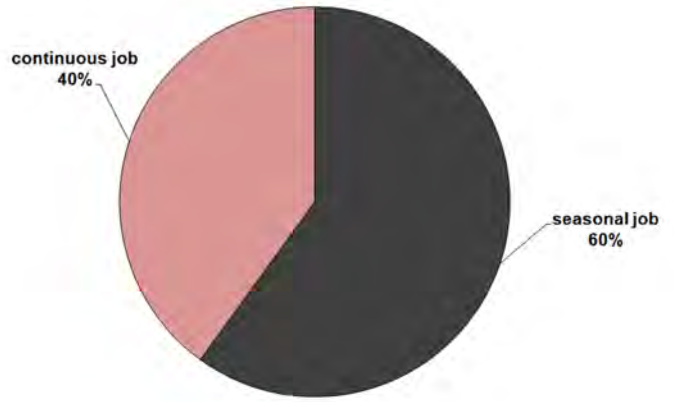

Figure 1. Job typology of the forestry companies (year 2009, 100% of the sample have given an answer)

Wood harvested annually

According to the investigation conducted, the average felling area for coppices is approximately 20.5 ha (Fig.3), while for the high forests, it is only possible to provide the average removal value of approximately 632 m^3/year (Fig.4). These values indicate that it is impossible for most logging companies to develop work systems with a high level of mechanization, as the volumes and working areas would not ensure adequate amortization of the expenses incurred.

Logging systems

The graph on the system for wood harvesting in the forest (Fig.5), shows how the tree length system accounts for 44% of the total, thanks to significant development over the last decade. The short wood system, with 38%, still holds a significant share of the sector. Furthermore, as much as 18% said they work equally with one system or the other depending on operational or market needs. This is a good adaptation index of company capacities. Nevertheless, with the current need to maximize stumpage, increase working productivity and prevent fire hazards, the tree length system appears to be a good opportunity, which we will gradually have to make more use of even in coppices. The waste material, consisting of branchwood and top end logs, will not be easy to place, but the current trend, the considerable use of biomass for energy purposes, seem able to find a useful place in the market for even this type of product.

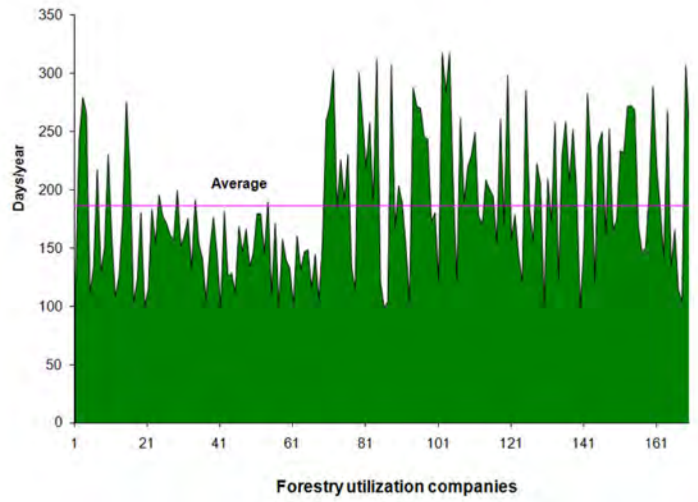

Figure 2. Annual average number of working days for every company (year 2009, 97% of the sample have given an answer)

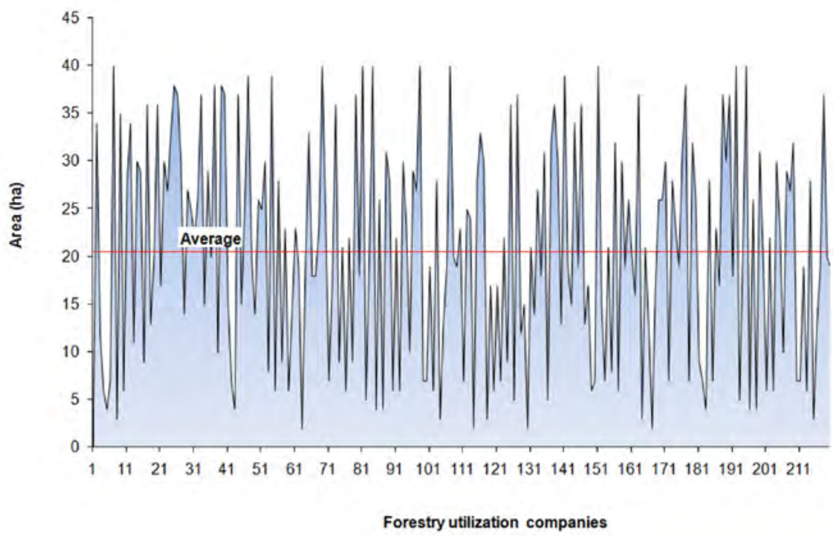

Figure 3. Average area of coppice wood harvested annually for every company (year 2009, 94,5% of the sample have given an answer)

Entering the mechanization sector, starting from the felling operation, in relation to the seven historical periods considered and as our investigation sample shows on the graph (Fig.6), we see that until 1970, manual systems, mainly manual saws and axes, were undoubtedly the most commonly used. The advent of the chainsaw in our country and, as a result, of semi-mechanical felling, began in 1960, leading to the demise of manual felling between 1980 and 1990. In 2000, the first harvesters began to be used and purchased and, confirming their targeted validity of use, within a decade, their presence doubled (from 4% in 2000 to 7% in 2009), still, though, leaving a 93% share for the chainsaw. A clear symptom of how the Italian forestry sector is still a long way off other European standards, due to orographic, technical and economic restraints.

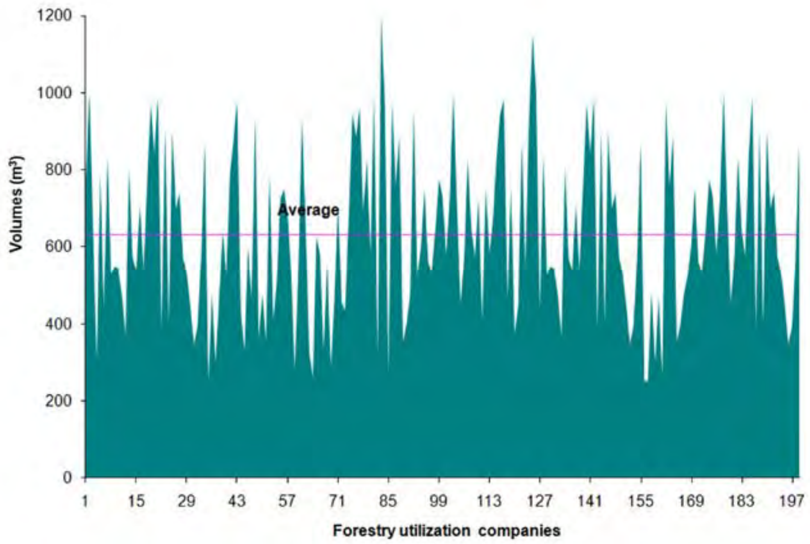

Figure 4. Average volume annually harvested for every company (year 2009, 63% of the sample have given an answer)

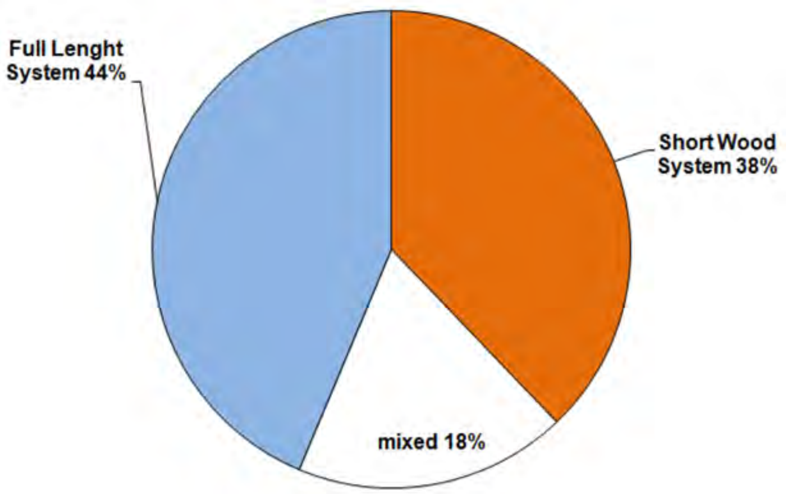

Figure 5. Forestry utilization systems. The full length system includes the full tree system and the full length system (year 2009, 91% of the sample have given an answer)

Forestry mechanization evolution

In the case of the processing operation (Fig.7), greater persistence is shown compared with felling in the use of manual systems. This should not be interpreted as a lack of evolution in this sector, but as proof of the actual usefulness of these systems. Furthermore, the use of advanced mechanization in this operation, especially in recent years, seems to be more marked compared with felling, above all on construction sites where processing at the landing is envisaged.

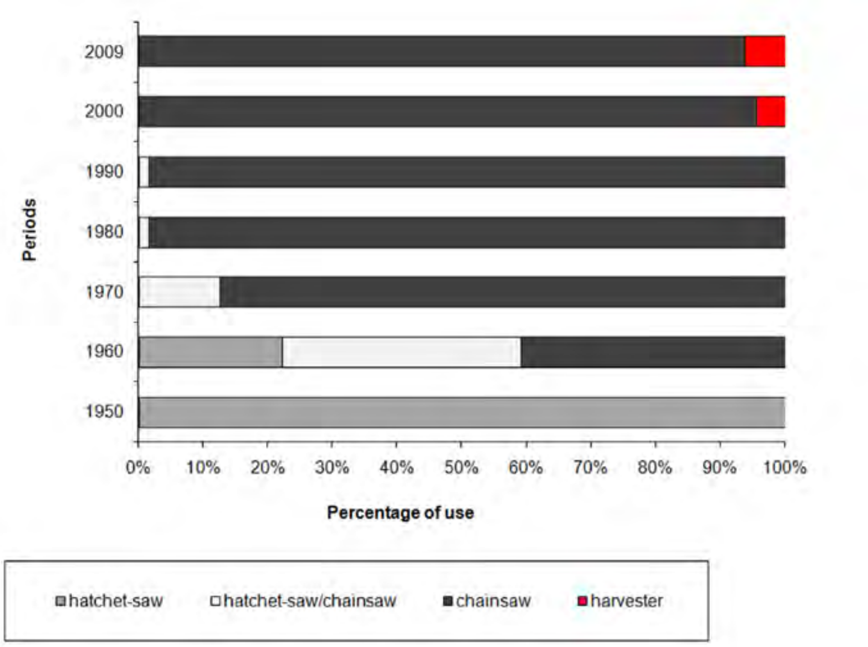

Figure 6. Felling methodologies used from 1950 to 2009. (97% of the sample have given an answer)

In the 1950s, the extraction operation (Fig.8) was done primarily using the strength of men and animals. In particular, sliding was carried out on "routes" which were both equipped (chutes) and non-equipped, while as regards animals, mules were mainly used in coppices, while horses and oxen were more commonly used in high forests.

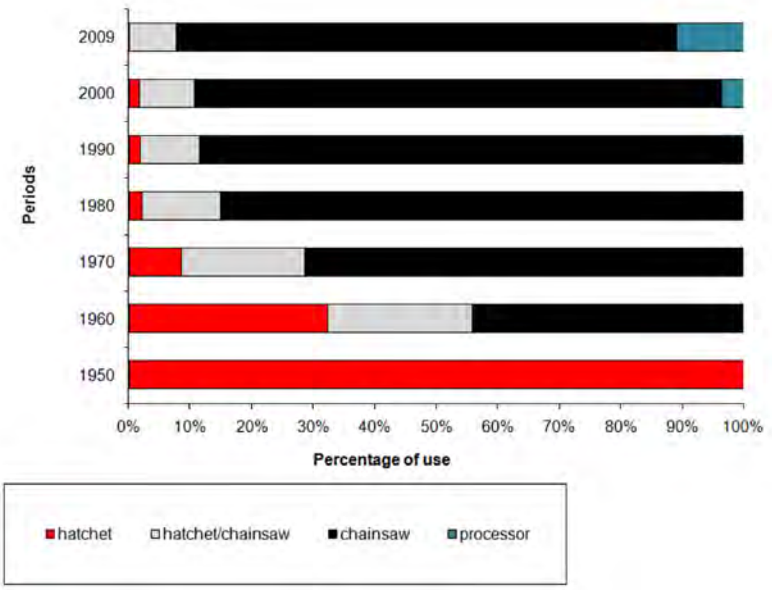

Figure 7. Processing methodologies used from 1950 to 2009. (97% of the sample have given an answer)

From 1960 onwards, the situation changed gradually. Extraction systems using animals or manual labour were increasingly integrated until they were replaced with mechanical equipment. The first mechanical use was mainly tractors for skidding and sporadic cases of recovery winch usage.

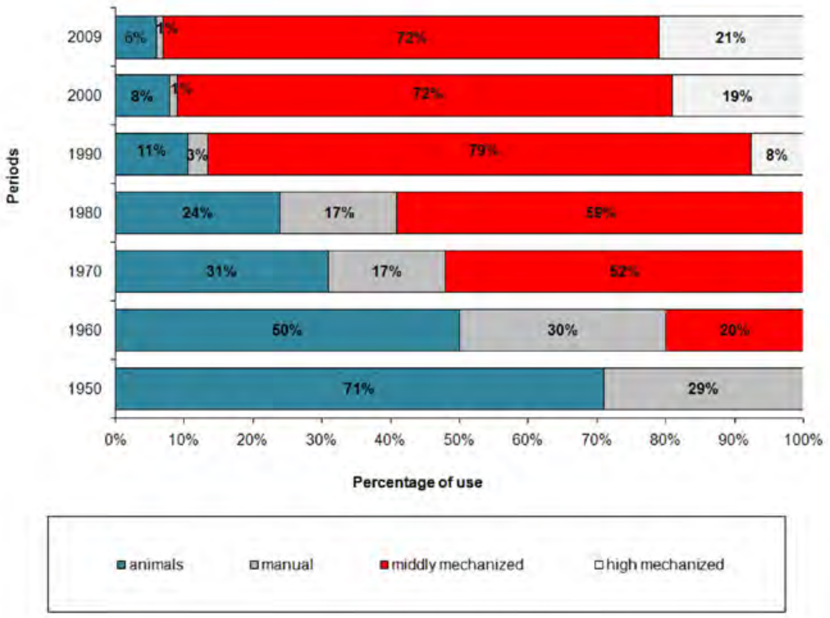

Figure 8. Bunching and extraction methodologies used from 1950 to 2009. (94% of the sample have given an answer)

From 1970 to 1990, the trend towards the replacement of human and animal strength with that of mechanical equipment became increasingly pronounced. Sliding was carried out less and less, unless on specially equipped routes using PVC or sheet metal (log-line) chutes. As regards animals, the use of oxen and horses was decreasing, while mules were still used in the most difficult and inaccessible areas. Tractors were most commonly used for skidding, although the first forestry winches were starting to be used.

From 1990 to the present day, the use of mechanical equipment has become paramount. Sliding now takes place using PVC or sheet chutes and the animals used are mules. Two types of mechanization are becoming more popular. One is less specialized, of rural origin, and is known as medium while the other, with a marked forestry specialization, is called advanced. Agricultural tractors, forestry-version agricultural tractors and forestry tractors are among the mechanical equipment used, with numerous accessories that enhance the usefulness of these machines, among them forestry winches, reverse hydraulic forestry grapples and cages located on the front and rear hydraulic lift on tractors.

Transport (Fig.9) during the 1950s and 1960s was mainly based on cable systems and to lesser extent on overland systems. The cable systems were made up of gravity cables and "Valtellina" model cable ways, while the overland systems were based on the use of animals, especially oxen and horses, tractors with trailers and, to a much lesser extent, lorries.

From 1970 onwards, up to the present day, cable systems have increasingly been overtaken by overland systems, and the use of animals is disappearing.

Over time, cable systems have undergone numerous modifications and changes. Gravity cables and cable ways have been entirely replaced by so-called yarders, supported by various types of stations, pylons, engines and log carriages. Overland transport is only carried out by tractors with trailers or, to a very small extent, by lorries or forwarders.

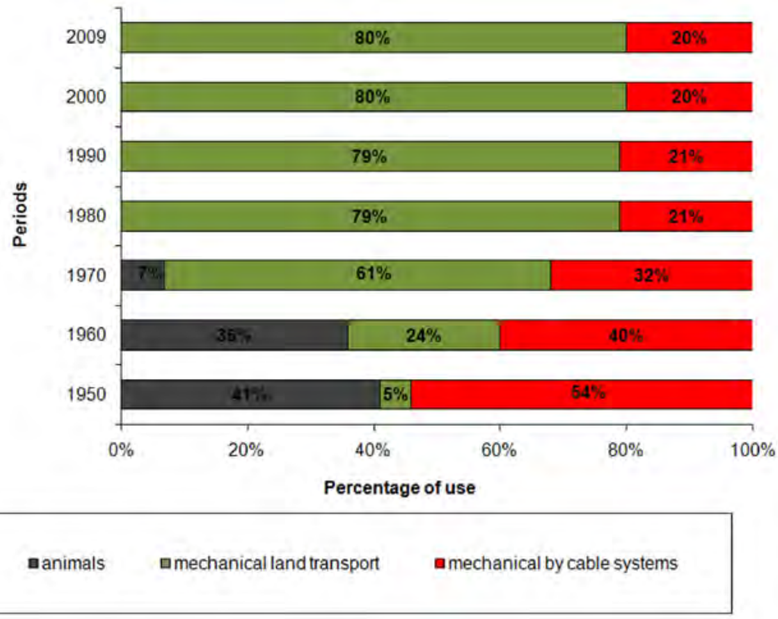

Figure 9. Extraction and transport methodologies used from 1950 to 2009. (95% of the sample have given an answer)

Work safety

Work safety (Fig.10) and the active and passive protection of operators is a fundamental issue.

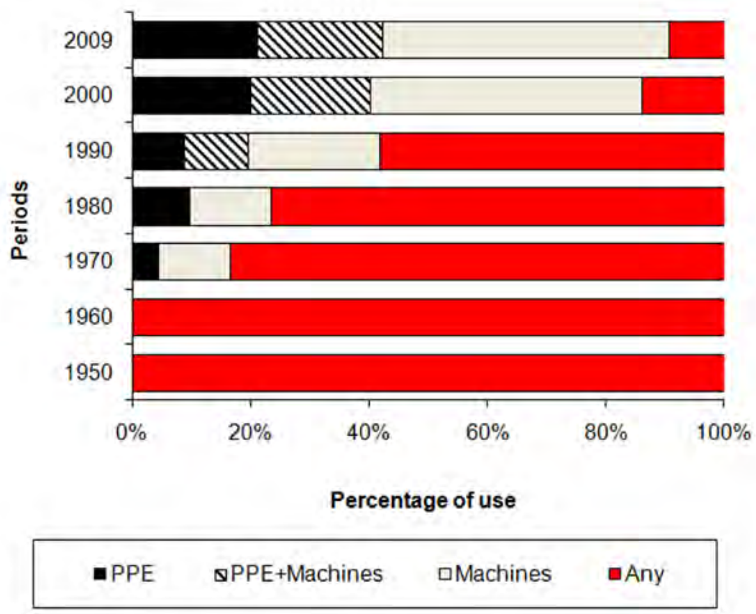

Figure 10. Use of the individual devices of protection and the safety machines devices in the forest yards from 1950 to 2009. (82% of the sample have given an answer)

Current industry regulations stipulate that when the risks can not be avoided or sufficiently reduced by technical prevention measures, collective protection, or by measures, methods or procedures for reorganizing work, a series of personal protective equipment must be used, where personal protective equipment refers to any equipment designed to be worn by workers in order to protect them from one or more risks which could threaten health or safety while at work. Nevertheless, upon examination of the results obtained from the investigation sample, it can be seen that only since the late 1990s has there been an active commitment by companies, but unfortunately even today, there are still instances of neglect regarding this important issue. It is particularly interesting to note that, in the face of increasing safety as regards the machinery used, personnel are still very reluctant to make use of personal protective equipment. As regards professional training, working in forests is primarily characterized and influenced by the environment in which the work takes place. The tasks undertaken are extremely varied and require the use of machinery and equipment which, if used incorrectly, can cause serious injury to operators. In order to work correctly and safely, proper theoretical training is therefore necessary, helping achieve the theoretical bases alongside practical training that involves the acquisition of manual skills and the ability to use vehicles and equipment safely. Combining theory and practice is essential, since theoretical training alone is not sufficient because forestry work requires a practical, manual ability. Training should not only be occasional, but must be continuous in order to go over topics already covered, providing information and refreshing skills. Once again, only in recent years (from the late 1990s onwards) has training registered its presence with a slight increase. The forestry sector still has serious shortcomings. In 2009 only operators from 20% of the sample of companies interviewed had participated actively in professional training courses for the forestry sector.

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Risk Perception and Health and Safety Measures in Work Environments: *effect of training on the pupils of two secondary schools*

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Abstracts
Industrial accident are a serious National issue. Despite recent government interventions this negative phenomena doesn't seem be improving. Italy needs a cultural change to improve risk management in the workplace. Education is a fundamental element in undertaking cultural change which is aimed at young people. We have studied the impact of education in the area of workplace safety in relation to the risk perceived by students from two technical secondary school institute. The questionnaire that was used both at the beginning and of course was the result of ISPESL's project "safety in the workplace" carried out collaboration with ARETES and ITI—IPIA "Leonardo da Vinci", a secondary school in Florence. The test group was made of 105 students of which 94 were male and 11 female. Upon first examination of the variations in answers between the beginning and the end of course, a marked increase in the number of virtuous answers. In particular, answers obtained to the questionnaire at the end of the course demonstrate the students have a concept of risk less fatalistic and more correlated to behaviour that is prevalent in the workplace. So the course has been useful for the student and has helped to change their idea about risk. Inevitably the result of this is an enhanced awareness of the probability of an adverse event occurring during behaviour adopted in everyday life.

Keywords: accident prevention, student, safety, behaviour

Introduction

Industrial accident are a serious National issue. Despite recent government interventions this negative phenomena doesn't seem be improving. Italy needs a cultural change to improve risk management in the workplace. Education is a fundamental element in undertaking cultural change which is aimed at young people. We have studied the impact of education in the area of workplace safety in relation to the risk perceived by students from two technical secondary school institute, with the aim to set up actions able to improve in the young people the risks perception.

Methods

In the school year 2007/08, the Prevention department of the Ragusa *Azienda Sanitaria Provinciale (ASP)* (Provincial Health Authority) began to promote health and security in the work place in two vocational secondary schools. The schools involved were the *Istituto per Geometri* (Institute for Surveyors) "R. Gagliardi" and the Ragusa *Istituto Tecnico Industriale Statale* (State Industrial Technical School). Fifth year students from the two schools took part in a 36-hour training course. It was decided to investigate whether the course influenced the behaviour of the students and if so which aspects of their daily lives were affected. 104 students were recruited from the two schools, 100 males and 5 females. They were given a questionnaire taken from the project "Safety in the Classroom" realised by the Florence ITI-PIA "Leonardo da Vinci" in collaboration with *the ISPESL* (Superior Institute for Prevention and Safety at the Work Place). The students filled in the questionnaires both before and after the course. 193 questionnaires were examined: 102 filled in at the beginning of the course and 93 at the end.

Results

Table 1 shows the main findings. Among the various parameters examined, it can be seen that there is a significant difference between the answers relating to risk perception given at the beginning and end of the course. The Odds Ratio calculation gave a value of 1.87, which indicates that the final data, despite the smallness of the sample, is different from that found in the entry questionnaire. This numerical evidence is also supported by the very positive comments made by the students in the appropriate section of the questionnaire – these cannot be reported here for reasons of space. As regards other questions a positive increase was found in 'virtuous' answers indicating a safer attitude at the end than at the beginning, even if this difference was not statistically different. Such questions include:

- Are you able to avoid risks to yourself? With an OR of 1.87;
- Are you able to assess risks? OR = 1.33.

Figure 1 presents the answers given to questions 15 and 16 of the questionnaire regarding the value attributed to behaviour (question 15) and behaviour adopted (question 16). The differences between the answers given at the beginning and the end are represented in yellow for question 15 and green for question 16. The values to the right of zero represent an increase in 'virtuous' replies at the end while the values to left of zero represent an increase in less 'virtuous' replies. It can be seen that the questions do not exclusively regard the work environment but cover all behaviour during daily life. Obviously the change in attitude varies according to the behavioural risk suggested by the question. In fact, while there was no increase in 'virtuous' answers relating to "not paying on public transport", there is a big increase in 'virtuous' answers regarding "listening to music at a high volume". This, in our opinion, indicates that even if risk perception changed as a result of the notions assimilated during the course, this does not influence all the forms of behaviour considered to involve risk by the questionnaire. A possible explanation of this result could be that the course was based on a series of concepts limited to explaining the main risks in the work place and how to assess and eliminate them. In our opinion, this explains why the course had less influence on behaviour such as "not paying for a ticket", which does not have a direct effect on the health of the student, than on other behaviour that had a direct effect on health, where the change was clearer.

Conclusions

In the light of the above and the data analysis presented, it can be concluded that the training received by the students of the two schools influenced the change in their risk perception. The enthusiasm shown by the students during the course is analogous to that noted in previous years. Finally, also legislators have noticed that Safety and Health in the work place training should be carried out at school and have provided for this with Legislative decree 81/08. *INAIL* (National Insurance Institute for Accidents at Work) has invested in this type of training for years even if the funding for it is not distributed uniformly throughout the whole country. Currently Health and Safety training for secondary school pupils is not regulated and depends on the individual initiatives of operators in the school or National Health Service sectors.

Graph.1 – Differences between high risk perception in exit test compared with modified behaviour at the end of the course. Difference between exit test (n° 91) and entry test (N° 102)