Risk assessment in plant nursery characterized by several working task with annual turnover

Pressiani, Sofia
E.L.A. S.r.l. Ecologia Lavoro Ambiente / Ergonoma / Strada Toasso n° 4 / 14100 Asti, Italia
+39 334 3465944/ pressiani@elasrl.it

ABSTRACT

Frequently, repetitive movements and awkward postures give rise to a risk injury. In some sectors characterized by several tasks with annual turnover, like in agriculture such as plant nursery, a specific identification and assessment of risk has to be developed. This paper provides risk assessment of the main ergonomics risks for every annual tasks, using OCRA Check list for repetitiveness, NIOSH for manual handling loads even considering awkward postures. The results are also weighted using a pre-assessed risk software (developed by Research Unit ergonomics of Posture and Movement EPM Foundation Don Gnocchi Onlus Milan - Italy), evaluating such factors as function of an yearly base exposure time and estimating an overall worker's risk level related with health effects.

Keywords
Ergonomics, repetitive tasks, annual turnover, risk assessment, plant nursery.

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.

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.

TASK ANALISYS 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.

Intrinsic upper-limb level of every task

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 wiste	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 pere	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

ANNUAL EXPOSURES 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

% Hours worked / month/ employee of the total hours workers/ year
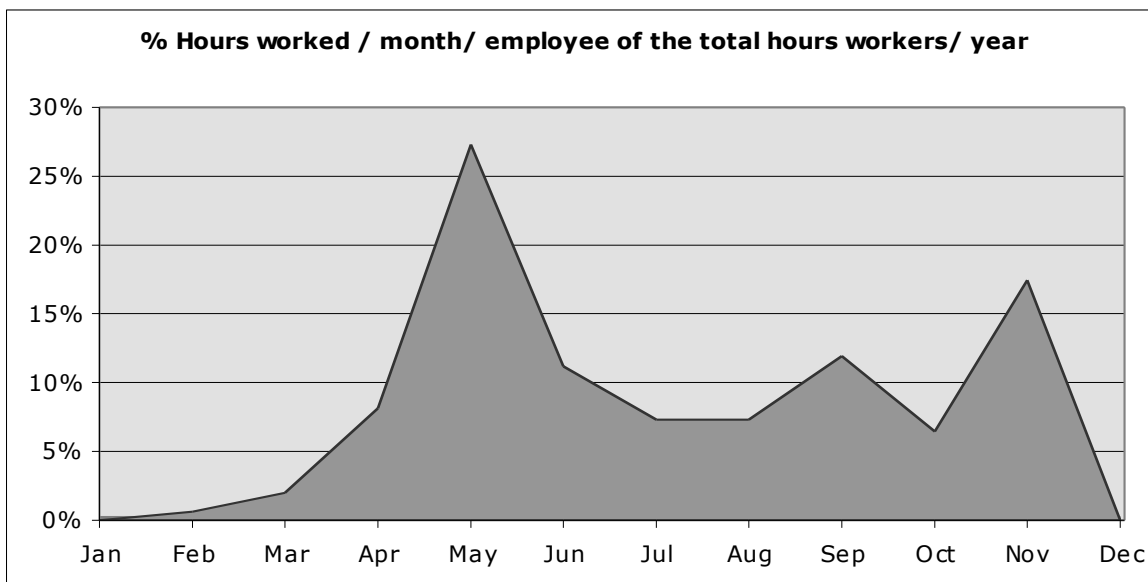
Annual exposure analysis

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.

ACKNOWLEDGMENTS

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