Introduction to ergonomics in forestry in developing countries

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FOREWORD

Ergonomics, which is the study of the efficiency of persons in their working environment, has been relatively neglected so far in developing countries. The reasons for this low priority are many, and relate not only to the lack of human and financial resources, but also, in the case of forest ergonomics, to the low status enjoyed by forestry work and the general belief that training in this field is a liability rather than a profitable investment.

This is regrettable as ergonomics is one of the essential elements in strategies aimed at reducing the costs associated with equipment downtime, suboptimal processing capacity, and the underutilization as well as overexploitation of forest resources, and the attendant problems.

Forestry work is in general physically demanding and, at times, dangerous. Additionally, high-energy food provision, health, medical and other services for forestry workers are often poor. All these, and many other deficiencies, point to the need for greater awareness, training, and extension in forest ergonomics.

This document is aimed at forestry instructors and trainers, particularly at technical and vocational level, for the development of education and training programmes. It is also meant to stimulate forestry teachers and researchers to study the varied work environments in forestry and how they affect the forestry worker in terms of his/her safety, health, well-being and efficiency.

Mechanization, and the steady increase in the use of expensive and sophisticated equipment, need to be paralleled with improved occupation safety and health, in order to make forestry work a productive and progressive occupation.

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1. INTRODUCTION

1.1 Introduction to Ergonomics

Working and living conditions for forest workers are generally poor in most countries all over the world; very often, work efficiency is also poor. Physically heavy work, inadequate working methods, working techniques and tools and equipment cause not only occupational accidents, diseases and unnecessary fatigue, but low productivity as well. In countries with available accident records, forestry appears to be one of the most hazardous occupations, with frequent and severe accidents and many diseases.

The improvement of safety, health, well-being and efficiency is a basic condition for prosperity, and ergonomics is a very important tool for this.

What is ergonomics?

The word ergonomics is rather new. It was coined about thirty years ago. Today, the term ergonomics refers to the study of workers in their working environment. Essentially, this means fitting the job to the worker and optimizing the man-task-environment system with due regard to efficiency and to the worker's safety, health and well-being. It also means "fitting the worker to the job", for example, by giving proper training for the job and providing adequate food and medical services. Other terms used synonymously include "human engineering" and "human factors".

The field of ergonomics is relatively young and the term ergonomics is still unknown by many. This does not mean, however, that the problems and their solutions in the field of ergonomics are new. Man has always striven to facilitate work. In fact, most of today's sophisticated machines have developed from yesterday's simple tools.

Very often, in the course of this development due regard has not been given to the worker's safety, health, well-being and efficiency. Instead, the machines and power tools used today are often designed without giving much consideration to the worker's capacities and limitations. Therefore, workers continue to put their safety, health and well-being at risk, as illustrated in Figure 1.

The alternative to mechanization is often to use the tools of yesterday, which have remained unchanged over the years although their design and method of use may not be optimal.

One reason for this is that force of habit prevents us from discovering the simple solution to a problem, for instance, in terms of minor changes in tool design and work method.

Instead of looking at present tools and methods to see if they can be modified, there is a tendency to accept things as they are because "that is how they have always been".

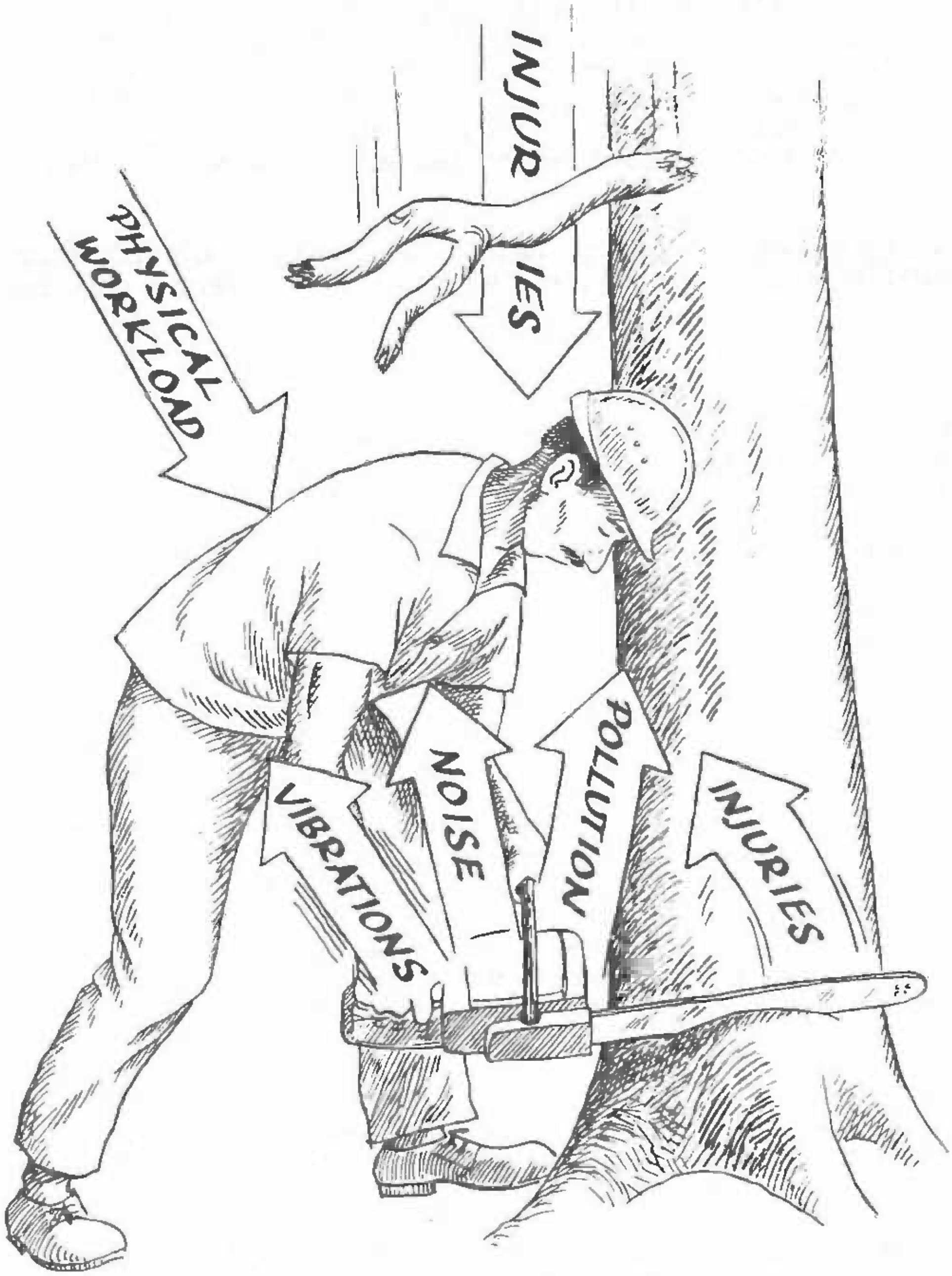

Figure 1. Machines and power tools in use today expose workers to many risks.

Elements of ergonomics

Ergonomics consists of two major elements, namely:

1) A technical part concerning the practical aspects of optimizing workplaces, machines, tools, etc., often called "Applied Ergonomics";

2) A human part concerning the description and knowledge of physical and psychological characteristics of man, e.g. in terms of measures, reactions, needs, capacities and limitations.

Accordingly, ergonomics is not a single science, but the application of many scientific disciplines such as anatomy, anthropometry, physiology, experimental and behavioural psychology, occupational medicine and hygiene, pathology, sociology, learning techniques and engineering, as well as economics.

In the beginning, ergonomics was defined as all steps and measures taken with the aim of adapting work to the individual's abilities and limitations. The term "work" here was used in its broadest sense. Besides the job task itself, it also included localities, work postures, and everything else in the working environment of importance for the worker. At a later stage, the definition of ergonomics was given an even broader coverage. Methods have been designed for analyzing and improving the whole man-task-environment system and the interrelation between different parts within this system. This is called systems-analysis or systems-ergonomics (see Section 4.4).

In the application of ergonomics there will also be a need to include the system's interaction with the existing social, economic and political systems.

To summarize, the main objective of all ergonomic efforts is to fit the work to man's needs, capacities and limitations by adjusting the technology and organization of work or to adjust man to the job, through proper training, information, and the provision of adequate food, health services, etc.

In evaluating whether or not a job task is acceptable from an ergonomic point of view, certain criteria have to be met. Examples of these criteria include:

a. Safety (protection from being injured in a work-related accident);

b. Health (absence of or protection from work-related diseases);

c. Fatigue and discomfort (physical and mental workload should be adjusted to factors such as worker's age, sex, nutritional status and physical fitness);

d. Security of employment;

e. Work satisfaction (e.g. finding one's work useful or interesting; having opportunities to use and develop existing skills and to learn new skills on the job);

f. Remuneration, social security and welfare;

g. Efficiency (quantity and quality of output).

The most important of the above-mentioned criteria are safety, health and fatigue. If the job does not meet the standards for these three criteria it cannot be regarded as acceptable from an ergonomic point of view. The criterion regarding efficiency should be met only within the limits of these three fundamental considerations. Fortunately, efficiency will usually improve when the job is performed in an ergonomic way, using proper tools and methods. A cost-benefit analysis, taking into consideration the whole economy of a country and not limited to the individual enterprise only, will usually show the advantages of the application of ergonomics in working life.

Sometimes the negative effects of forest work on health are indirect and therefore difficult to prove in an evaluation. Occupational diseases such as back disease and impairment of hearing usually take a long time to develop. In such cases it is more difficult to take protective measures.

The improvement of work efficiency as a result of applying ergonomics is also difficult to demonstrate in many cases. It is not easy to quantify the monetary benefits if, for example:

- the quantity of the work output is still the same, but the worker produces it with less effort, energy and risk involved;

- the quality has improved but is not measured;

- absenteeism caused by work-related accidents and diseases has decreased;

- work satisfaction has improved among the workers, leading to reduced labour turnover; or

- the image of the enterprise has improved and has led to the recruitment of good workers becoming easier.

Usually, there is a tendency to measure factors which are easy to measure, and also to put more emphasis on things which are measurable. This has often led to other factors, which also have a decisive impact on the result, being completely overlooked or given a much lower priority. This has been one of the major drawbacks in the promotion of ergonomics.

1.2 A Model for Ergonomics in Forestry

The most important goal for ergonomics is to adjust the working environment to the worker. The working environment can be defined as all the conditions, circumstances, and influences surrounding and affecting the worker.

The model given in this publication attempts to provide a structure for some of the most common and important factors. It is straightforward and easy to understand. Nevertheless, an example will be given to illustrate how it works.

In Figure 2, the "Affecting factors" are found on the left. The factors in their different combinations form the working environment. There is a fundamental difference between factors which originate from nature itself, such as tree dimensions, terrain or climate, and factors created by man, such as tools, machines, work methods and organizations. The factors originating from nature itself are usually more difficult to control. This is particularly true for forestry activities when the workers have to work out of doors.

Therefore these factors have been put in a separate box: (1) Biological and physical factors. The man-made factors are put in box (2) Technological and organizational factors. Examples of factors in each box are shown in Figure 3. Some factors may fit in both boxes (1) and (2), e.g. animals used for haulage form part of the method used; insects, bacteria and viruses are often results of poor sanitary conditions due to technical or organizational shortcomings. In spite of these and other examples, each factor has been put in only one box.

All the factors in boxes (1) and (2) will in one way or another affect the worker. This is indicated by the arrow. There is only one arrow from all the factors. It is essential to bear in mind that it is the combination of all the factors which make up the working environment. Certain factors may be rather harmless when considering the isolated effect of each one of them.

When combined with some other factors the result might be hazardous. For example, payment on a piece-rate basis could be advantageous in certain jobs, for both workers and employer. When the system is applied to a dangerous job, which requires much skill, experience and difficult decisions such as the felling of big trees with a chainsaw, the result will often be more accidents and worker fatigue.

Another example is that exposure to different air pollutants at the same time often results in new effects due to the combination of the harmful substances. The total effect could either be the straight sum of the individual effects of the different pollutants (1+1=2), or it could be greater than the sum (1+1=3). In the latter case, the effects of the harmful substances strengthen each other, which is called synergism.

The final effect on the worker also depends on different individual characteristics, such as age, sex, body size and health, just to mention a few. Many harmful chemicals will, for instance, have an even more harmful effect on workers who smoke!

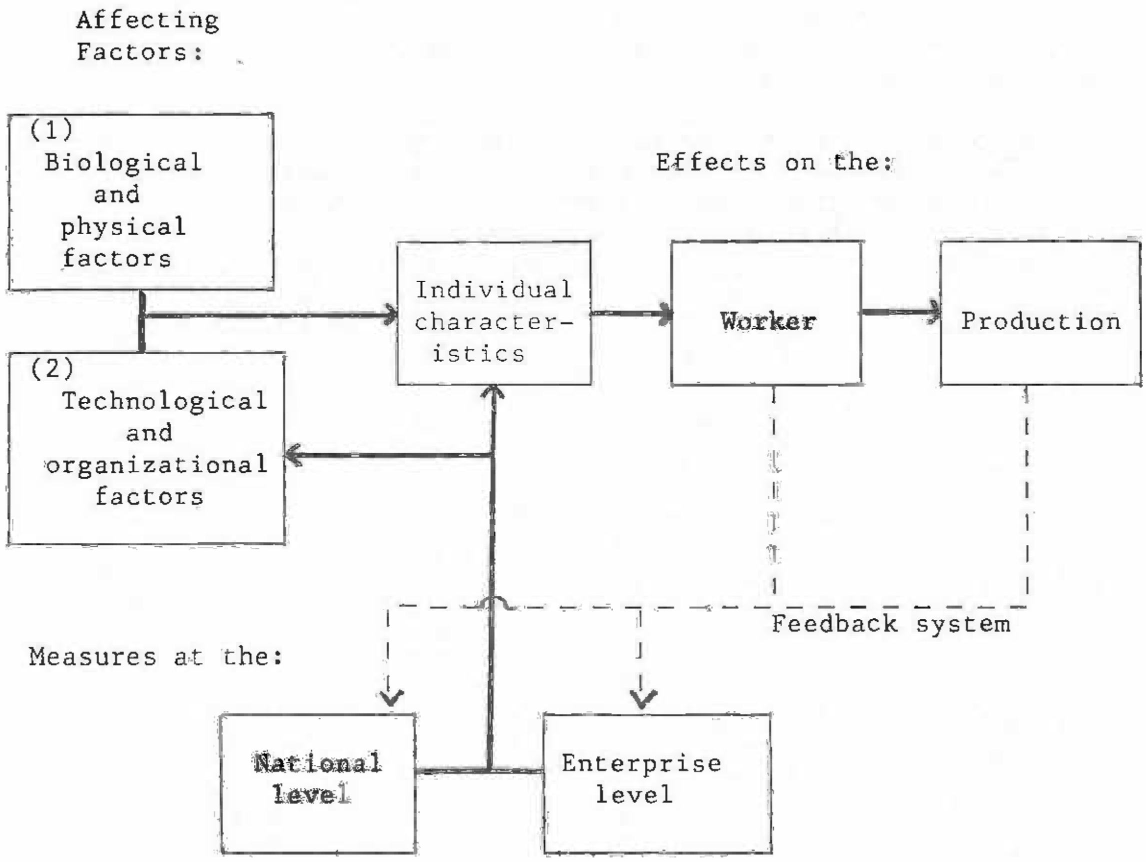

Figure 2. Model for Ergonomic Problems in Forestry Work.

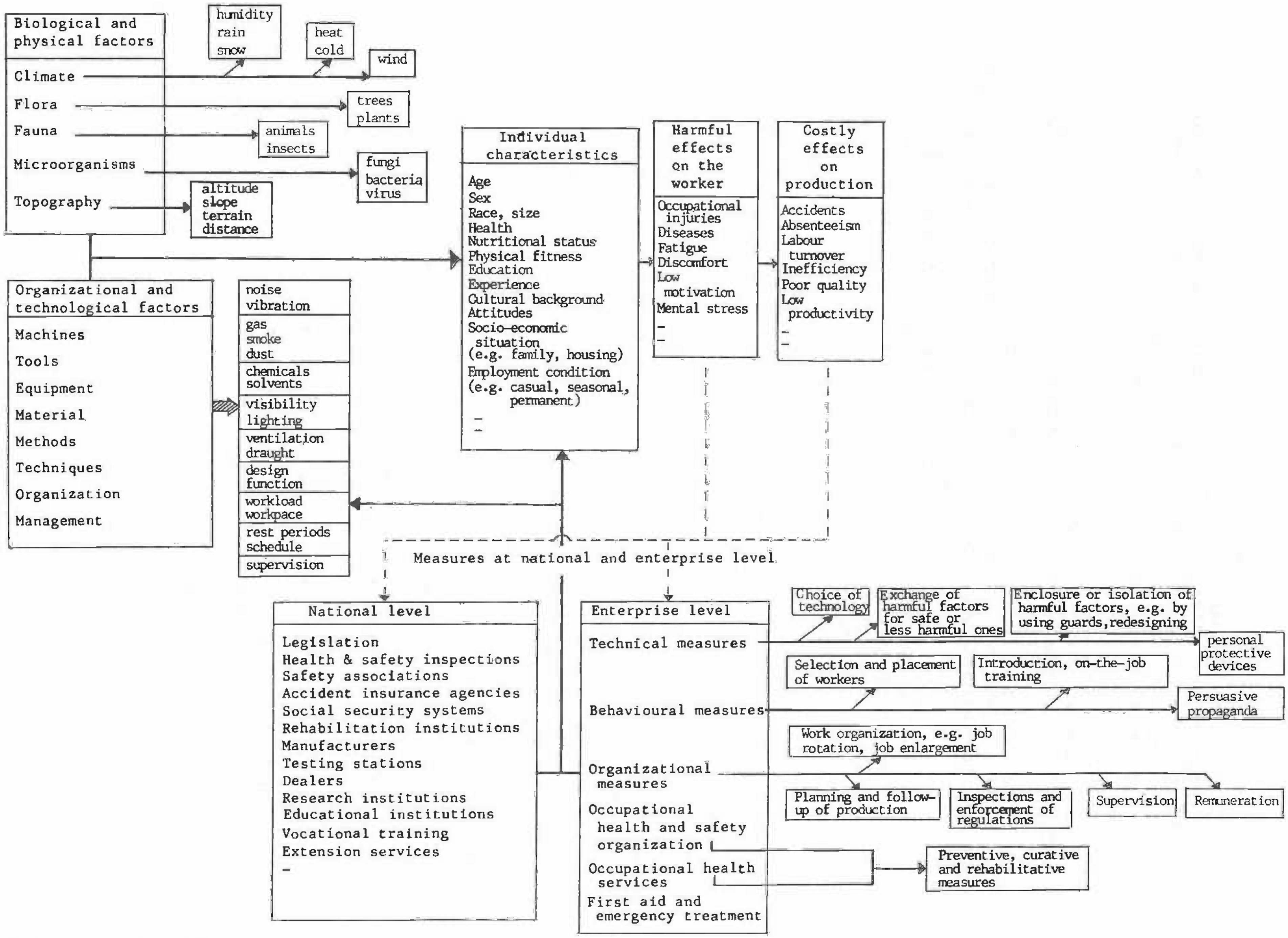

Figure 3. The model and some examples.

The effects on the worker could be of different degrees of seriousness, from a general feeling of discomfort to fatal. The effects on the worker will have effects on production. Most of these effects are very difficult to measure. It is also difficult to see the linkage between, for example, labour turnover, poor quality or inefficiency and fatigue or mental stress caused by technological or organizational factors.

To draw the conclusion that something which is difficult to measure is unimportant to study would be a big mistake. On the contrary, it is very important to study and control the effects of poor working conditions.

The model also has two boxes indicating measures for improvement of the working conditions. In the box to the left a number of measures to be taken at the national level are listed such as legislation, social security and education. In the box to the right measures to be taken at the enterprise level are listed, such as occupational health and safety organization, payment system and on-the-job training. Many of these measures are to be taken both at the national and at the enterprise level. Close collaboration between different governmental bodies, associations, educational institutions and the representatives of industry and different enterprises is necessary.

In the model in Figure 2 there is also an arrow marked with a broken line from the "worker and production" boxes to the "national- and enterprise-level" boxes. This arrow indicates that there is a possibility to obtain feedback from the affected workers on the working environment.

Most of the working environment is created by man, and can therefore also be changed by man. The arrow indicates how the workers, either individually or collectively, can have an impact on their own working environment.

In the following sections, almost all of these factors will be discussed. Some of the subjects will be only briefly discussed, as there is already a great deal of written material available on them. It would also take too much space to handle them in a meaningful way. Examples of such subjects are design, use and maintenance of tools and machines, felling techniques, and first-aid.

The chapters are not structured in the same way as the factors are structured in the model. It would not make sense to enumerate all the affecting factors, one after the other, without a simultaneous description of how they affect the worker and the production, and what the preventive measures are. For example, "organizational factors" will not be given a chapter on its own, but will be discussed, in a number of chapters whenever applicable, and often as examples of preventive measures.

The model can also serve as a teaching aid when introducing ergonomics for the first time to new groups.

2. THE WORKER AND THE WORK

2.1. The Human Body

For an understanding of the interrelationships between man, his work and the environment, it is necessary to have some basic knowledge of anatomy, which is the study of the form and structure of the body, and physiology, which deals with the life processes of the body. In this introduction to ergonomics some aspects of these subjects will be discussed very briefly, mainly those dealing with the skeleton, joints, muscles, and blood circulation and respiratory systems.

A. The skeleton

About 17% of the human body is made up of the skeleton, which consists of some 200 bones. Of the many different parts of the skeleton, it is particularly the spinal column which is exposed to physical strain during work. Generally speaking, every third person will suffer from back problems, at least once during his lifetime. Common back problems are sciatica (spasmodic or continuous pain of nerve situated in, or pertaining to, hip region) and lumbago (a painful rheumatic condition of the lumbar muscles).

The spinal column (illustrated in Figure 4) consists of 24 vertebrae. Between the vertebrae there are elastic cartilage-discs which serve as buffers and which also provide the necessary flexibility to make it possible to bend the back. The discs have a soft nucleus which is surrounded by a fibrous ring.

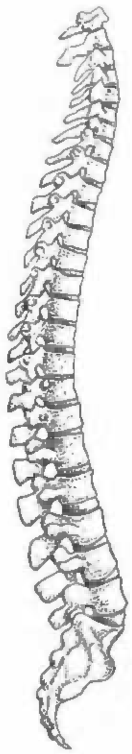

Figure 4. The spinal column.

When lifting or carrying a load with a straight back, the discs are slowly pressed together. The pressure on the back from the load is in this way distributed over a bigger surface and during a longer time. The discs eventually revert to their original form after the load has been removed (see Figure 5). The discs are more sensitive to pressure when the back is bent than when it is erect. If the pressure is too great or very frequent, the fibrous ring may wear and eventually burst and the gelatinous nucleus may partly come out. The person will then suffer from a slipped disc, which is very painful and causes long absence from work. When this rupture causes pressure on a nerve it will give rise to so-called sciatica. Ways of decreasing the risk of spinal injuries will be further discussed in Section 2.3 "Work postures".

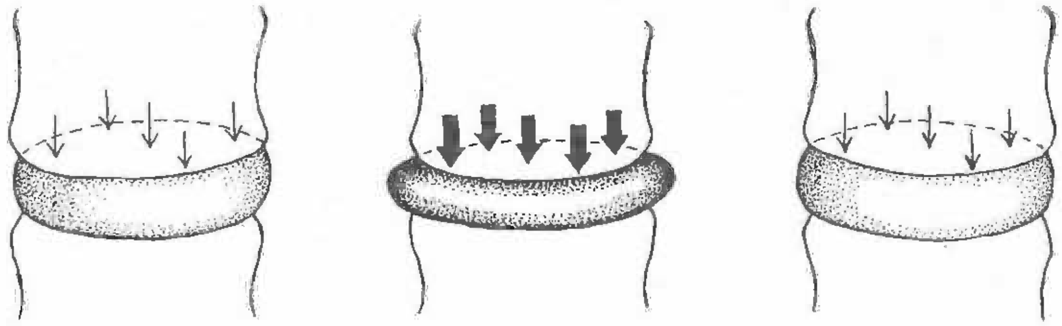

Figure 5. When lifting or carrying a load the discs are slowly pressed together. The pressure on the discs is in this way distributed over a bigger surface and during a longer time. The discs eventually revert to their original form after the load has been removed.

B. The joints

The joints make it possible for different parts of the skeleton to move. The end of the bones in a joint are covered with cartilage. As there are no blood vessels in the cartilage, it cannot regenerate easily. It may, therefore, get worn out if exposed to too much strain, which is often the case in heavy physical work such as forestry. The knee joints in particular are exposed to overload. The moveability of the joints usually decreases with age.

C. The muscles

There are a number of different types of muscles with various functions. Together, they make up about 40 per cent of the body weight. The so-called skeleton muscles, which will be dealt with here, are used for bodily movements. The muscles consist of elongated cells, fibres or threads. The capability of these to shrink or contract to as much as half their full length is the characteristic of the muscles. The working capacity of the muscle is directly related to its length and thickness (the number of cells).

In the muscles, chemical energy is converted into mechanical energy and heat is released. Oxygen and nutrients, particularly glucose, are needed for muscular work and are supplied by capillary blood vessels in the muscle. The blood vessels also take away carbon dioxide and other waste products such as lactic acid which result from the chemical processes. The muscle has very limited ability to store oxygen and nutrients and is, therefore, dependent on a continuous supply of these from the blood.

The number of blood vessels, the thickness of the muscle, and to a certain extent also its length, can be increased if the muscle is used frequently for a long time. Well-developed muscles will facilitate the work and also strengthen and support the spinal column and joints.

If the muscle contracts and relaxes in a rhythmic way, the work is dynamic. But when it is under tension for a long period of time, it is static. Static work is more tiring than dynamic work. When the muscle is under tension, the blood cannot flow through the muscle. The muscle will, therefore, not get a sufficient supply of oxygen and nutrients, neither will it get rid of waste products, such as the lactic acid which has a toxic effect on the muscle. The accumulation of lactic acid will cause local and painful muscular fatigue. The pain will not cease until the muscle relaxes and allows the blood to pass through it again. Examples static work are holding the hands above shoulder height, or holding a heavy load in the hand(s) for a period of time, for instance, a chainsaw, a basket with plants or a bucket with water. Examples of dynamic work are riding a bicycle, debarking a log with a long-handled barking spade, or walking in the forest.

When the work is dynamic and the supply of and need for oxygen and nutrients are in balance in the muscle, the work can continue for a long time without accumulated fatigue.

D. Blood circulation and respiration

Nutrients needed in the muscles are absorbed by the blood when it passes through the liver, and the blood is oxygenated in the lungs. It is the heart which pumps the blood out into the aorta (the great artery leading from the left ventricle of the heart). Blood pressure increases during heavy physical work. People with high blood pressure should be careful when engaged in heavy physical activity, otherwise the stress on the heart may be too great. Old people generally have higher blood pressure than young people.

When resting, the heart pumps between 3 to 6 litres of blood per minute, but in very physically fit people doing heavy muscular work it can pump over 35 litres per minute. The fit person's resting pulse rate may be less than 50 beats per minute, while for the average person it is somewhere between 60 and 80 beats per minute.

When a person is engaged in heavy physical work, the pulse rate will always increase, as well as oxygen consumption in the muscles. If untrained, the pulse rate will rise more, and faster, than if trained. It is therefore possible to use the pulse rate as a relative measure of a person's fitness and also to evaluate how heavy the workload is. This will be discussed further in Section 2.2 "Energy requirements and physical workload".

Apart from providing the muscles with nutrients and oxygen, and carrying away waste products, the blood also regulates the body temperature and its water and salt balance.

Oxygen is taken from environmental air to the lungs during breathing from where it diffuses to the blood when the blood passes through the lungs. At the same time, carbon dioxide is emitted. The "aerobic power", or the maximal oxygen consumption, is the person's maximal capacity to consume oxygen in the working muscles during exhaustive exercise.

When the muscles' need for oxygen is met, the work is called "aerobic". This means that sugar (1) together with oxygen (2) is converted into water (3), carbon dioxide (4) and mechanical energy plus heat (5), as follows:

Aerobic work: $C_6H_{12}O_6 + 6O_2 \longrightarrow 6H_2O + CO_2 + \text{free energy}$

(1) (2) (3) (4) (5)

When a too-heavy physical activity is performed, the supply of and requirement for oxygen are not in balance. The muscle will instead get the energy through "anaerobic processes". When the work is anaerobic, the small amount of oxygen stored in the muscle is very quickly used up resulting in an oxygen shortage. The sugar (1) without oxygen is converted into toxic lactic acid (2) and mechanical energy plus heat (3) as follows:

Anaerobic work: $C_6H_{12}O_6 \longrightarrow 2\,C_3H_6O_3 + \text{free energy}$

(1) (2) (3)

Static work is anaerobic and leads to a raised heart rate and a higher consumption of energy compared to dynamic and aerobic work. Longer rest pauses are also needed to restore the oxygen shortage. Static and anaerobic work is, therefore, uneconomic and should be avoided whenever possible. The most common reasons for static work are poorly designed workplaces, tools and equipment.

2.2. Energy Requirements and Physical Workload

The consumption of chemical energy through the intake of food, and the metabolic expenditure of mechanical energy, are both expressed in kilocalories (kcal) or joules (J). One kcal is equivalent to 4.18 kJ. One kcal is the amount of heat required to raise the temperature of one kilogram of water by one degree centigrade from 14.5 to 15.5 degrees. One kJ represents the energy involved when physically moving a one kilogram weight one meter by the force of one Newton. The use of kcal is now being replaced with the joule unit.

Metabolism

The term applied to the chemical processes which are continuously going on in the cells for the cells' survival and activities is "metabolism" and has been discussed briefly in the preceding chapter. These processes can be illustrated as in Figure 6.

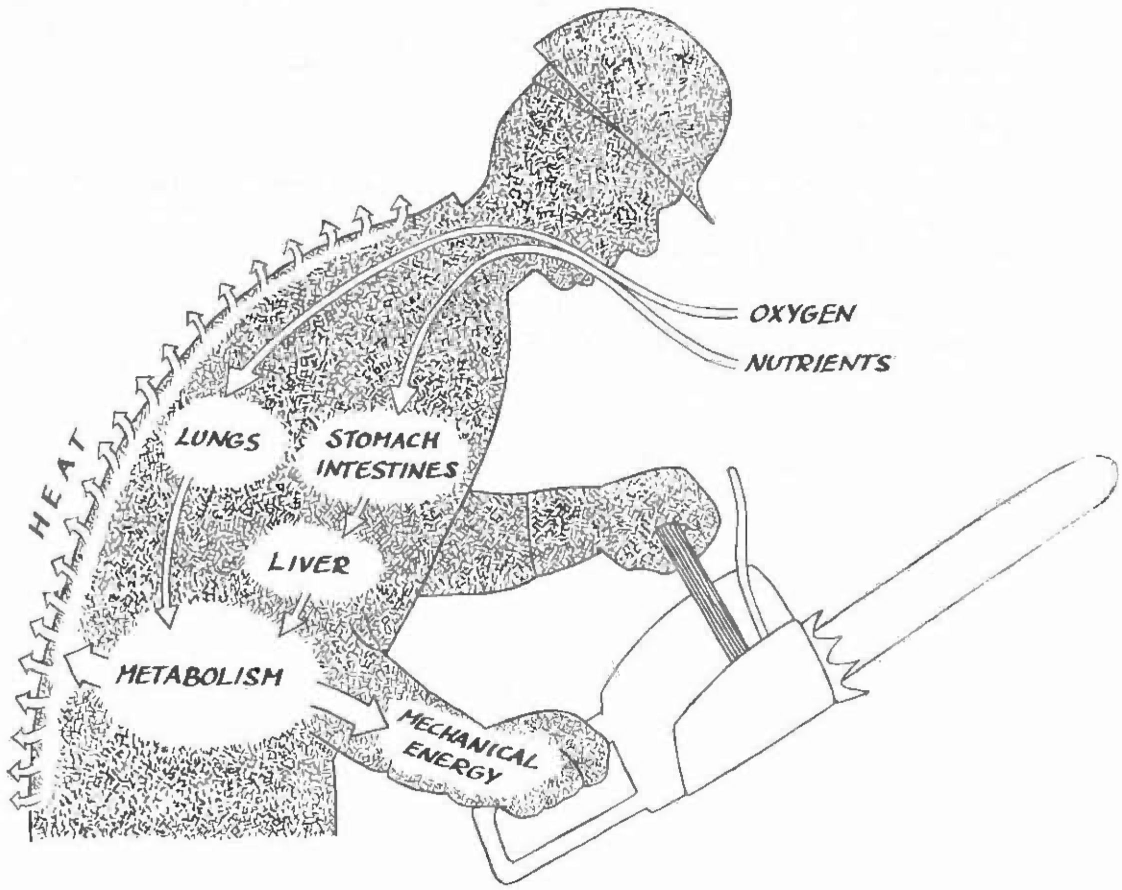

Figure 6. The term "metabolism" is used to describe the chemical processes which are continuously going on in the cells for their survival and activities.

Basal metabolism

When not performing any physical activity, but lying down, with an empty stomach, there is still a minimum need for energy for "basal metabolism". This means that energy is necessary for the maintenance of life processes such as pumping blood, respiration, cellular metabolism, glandular* activity and regulation of body temperature. The basal energy requirement depends on body size, sex, age, body temperature, environmental temperature, and pregnancy. It will vary between 4180-8360 kJ (1 000-2 000 kcal) for adults.

Work energy

In addition to the energy consumed for basal metabolism, the energy requirement will rise when performing any kind of physical activity. The increase will depend on how heavy the work is.

It is possible to measure, indirectly, the consumption of energy by measuring the consumption of oxygen. Each litre of oxygen consumed by the body is equivalent to 20.1 kJ (4.8 kcal) of energy, which is the "calorific value" of oxygen. When calculating the oxygen consumption, the difference of oxygen content between the inhaled (atmospheric) air and the exhaled air is what has been used, and this value is multiplied by the volume of exhaled air.

When discussing the physical workload it is sometimes useful to categorize jobs according to how much extra energy per 8-hour work day is required as follows:

< 4180 kJ (< 1000 work calories) per 8-hour day	light work
4180-6688 kJ (1000-1600 work calories) per 8-hour day	moderately heavy work
6688-8360 kJ (1600-2000 work calories) per 8-hour day	heavy work
> 8360 kJ (> 2000 work calories) per 8-hour day	very heavy work

These figures are very general and they depend on the person's aerobic capacity.

The figures apply to men and it is suggested that they be lowered by 25-30% for women.

Energy consumed for basal metabolism and activities outside working hours must be added so as to obtain the total energy consumption per 24 hours.

By studying energy consumption it is possible to learn about the physical effort of the work. Knowledge about energy consumption is useful when, for example, comparing the efficiency of tools and work methods, for the scheduling of rest pauses, and when assessing workers' nutritional requirements. However, it will not provide information on mental strain or other environmental factors affecting the worker.

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* gland: an organ or collection of cells secreting and extracting certain substances from the blood and transforming them into new compounds.

Leisure and energy

Life does not consist of rest and work only. Out-of-work activities also require energy which is sometimes referred to as "leisure calories". Figure 7 summarizes the different kinds of energy requirements. The figure is simplified and could give the impression that differences in daily energy expenditure are due only to work. This is not absolutely true and some people spend a considerable amount of energy on leisure. Also, many people spend their "leisure time" working within the informal sector.

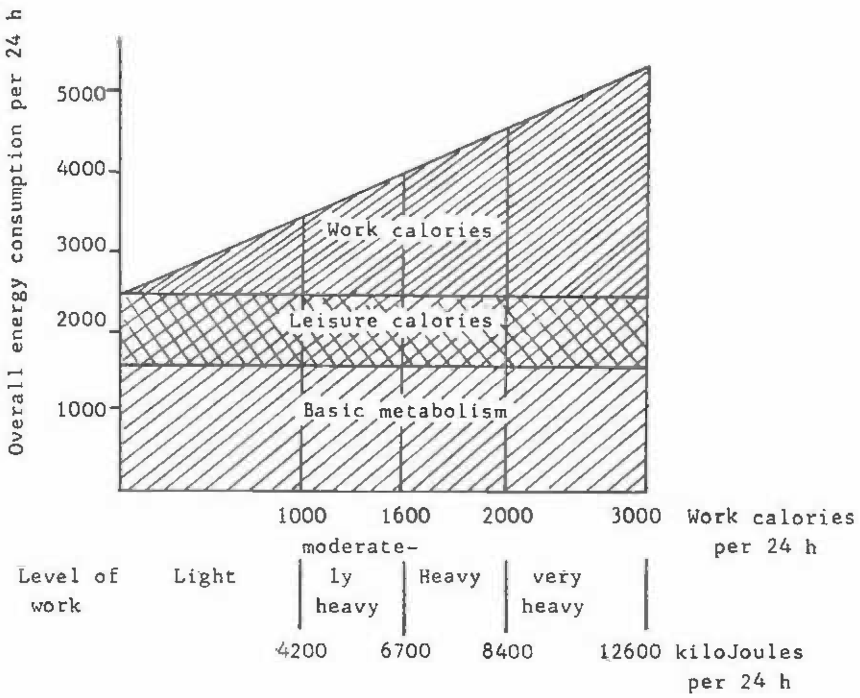


Figure 7. Summary of overall energy consumption of a man compared with his working consumption.
Source: Hettinger in Grandjean (1982).

Energy expenditure and physical workload

In Table 1 a number of physical activities, and the corresponding energy expenditure per minute, are listed, to give an idea of how the workload may vary between different activities. The figures shown should, however, be taken as approximate only, as they will vary depending on the person's body size, sex, age, fitness, work pace and what tools and working techniques are used.

Table 1. Energy expenditure in forestry work*

		kcal**/min/65 kg man Range	Mean
WORK IN FORESTRY NURSERY			
- hoeing			5.9
- weeding			4.7
- carrying load of weeds and dumping			4.2
PLANTING			
- digging drainage ditches with hand tools			8.0
- planting by hand		5.5 -11.2	6.5
- planting by machine			2.8
- tractor driving-harrowing while sitting		3.4 - 5.4	4.6
- tractor driving-harrowing while standing		5.6 - 7.5	6.6
WORKING WITH AXE - HORIZONTAL AND PERPENDICULAR BLOWS			
Weight of axe head	blows/min		
1.25 kg	20		5.5
0.65-1.25 kg	35	9.1 - 10.6	9.8
2.0 kg	35		10.0
FELLING, DEBRANCHING, ETC.			
- felling		6.8 - 12.7	8.6
- debranching		5.2 - 11.6	8.4
- debarking		5.2 - 12.0	8.0
- splitting wood		8.6 - 9.1	8.8
- dragging firewood		7.8 - 9.8	8.8
- stacking firewood		5.1 - 6.2	5.7
- carrying logs		9.9 - 14.4	12.1
- dragging logs		8.3 - 15.9	12.1
WORK WITH SAW IN FOREST			
- sharpening saw			3.2
- carrying chainsaw			6.5
- cross-cutting by handsaw		6.4 - 10.5	8.6
- horizontal sawing by handsaw		6.8 - 7.7	7.2
- cross-cutting by chainsaw		2.9 - 5.0	4.3
- horizontal sawing by chainsaw		3.6 - 6.4	5.4

* Source: Adapted freely from Durnin, J.V.G.A. and Passmore, R. "Energy work and leisure". Heinemann, London, 1967.

** for kJ multiply by 4.18.

The energy consumption when working with a tool or aid, such as an axe, handsaw, shovel or wheelbarrow, will vary considerably depending on the type, design and maintenance of the tool or aid. Figure 8 shows an example of this difference in energy expenditure per output of work, when using three types of saws for tree felling (sal). From this study, which was carried out in India, the bowsaw (Raker 2:1) was in the given circumstances a more economical alternative than the two-man crosscut saw (Raker 2:1) and the one-man crosscut saw (Peg-tooth) when comparing energy expenditure per square metre.

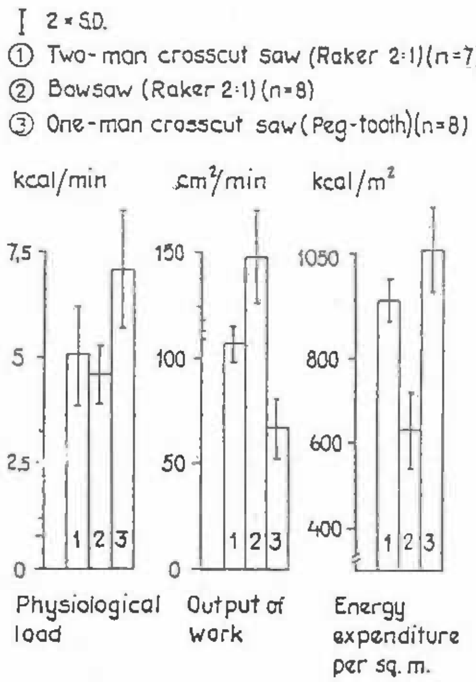


Figure 8. Comparison of three types of saw in felling sal trees in India. Source: Hansson, Lindholm, Birath (1966).

Figure 9 gives a further example from the same study, showing the significance of tool maintenance. The mean value of energy expenditure per square metre of sawn wood was 120% higher when using incorrectly maintained saws.

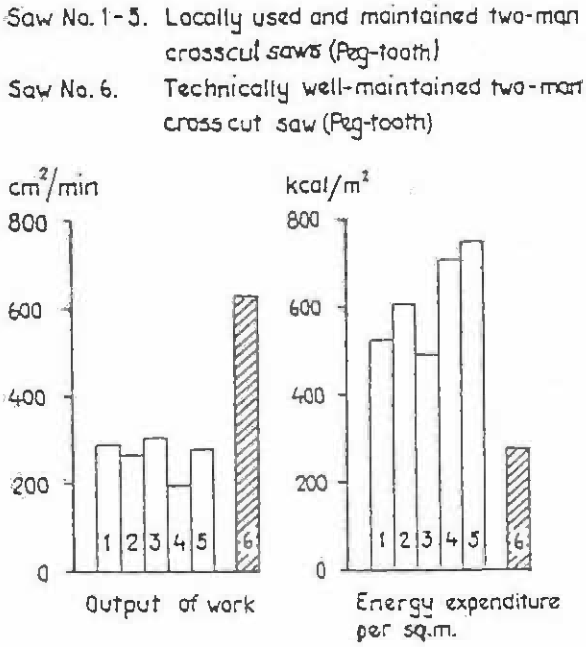


Figure 9. The significance of tool maintenance.
Source: Hansson, Lindholm, Birath (1966).

It was shown in another study how it was possible by redesigning or adjusting a wheelbarrow's wheel-diameter, tyre pressure (rubber tyres), height of handles above ground level, and distribution of the load between the wheel axle and handles to increase the loading capacity by 40% without increasing the physiological workload.

Efficiency

Sometimes the metabolism in the human body is compared to a combustion engine. This is because of the similarities between the two when it comes to the efficiency to convert chemical energy into mechanical energy. This is illustrated with two diagrams in Figure 10.

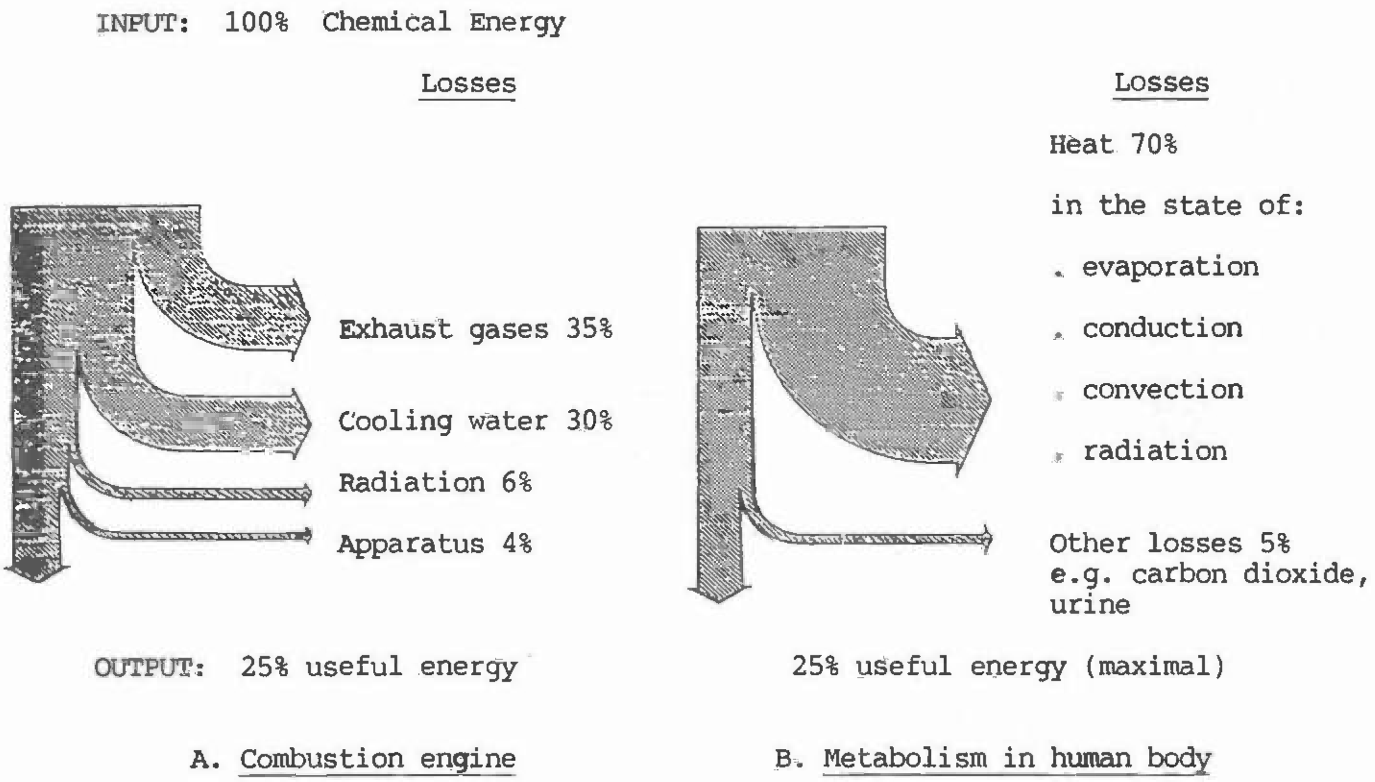


Figure 10. The energy-converting efficiency of the metabolism in the human body compared to a combustion engine.
Source: Ingemar Eile "Ergonomi". Hermods, 1973.

When comparing the energy consumption (input) with the measurable mechanical energy (output), it is evident that only a small portion is utilized. In the human body the heat losses amount to approximately 70%.

If work is carried out in the most efficient way, by using the large muscles in the legs, in dynamic movements and with a pace which allows the muscles to work aerobically, then it is possible to obtain 25% useful energy. Under less favourable conditions with entirely static effort the efficiency will be zero. Figure 11 gives some examples of the efficiency in different activities.

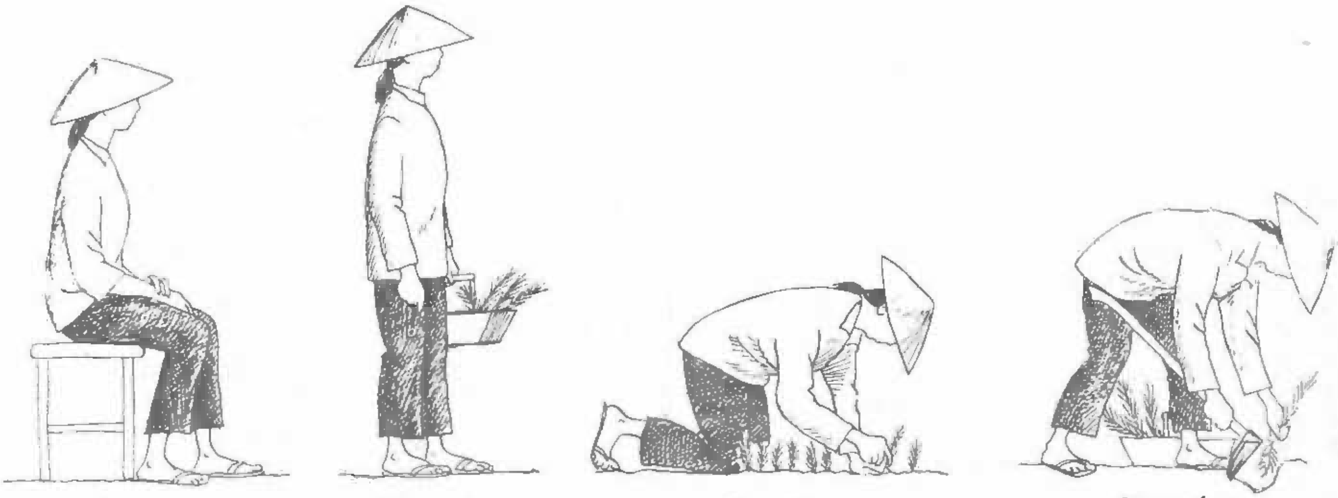


Figure 11 Relative increase in energy consumption in different postures.

For example, it can be deduced from Figure 11 that efficiency can be considerably increased simply by avoiding kneeling or stooping positions whenever this is possible (e.g. when filling plant pots with earth).

Considering the number of workers suffering from undernourishment and at the same time having to waste their scarce energy because of poor work postures, the importance of workplace arrangements and tools permitting ergnomically favourable working positions is evident.

Body temperature

The optimal temperature of inner organs of the human body is about + 37° C. It fluctuates from about + 36.5° C during the night to about + 37.5° C during the day. It is lowest during the early hours of the morning. A variation of the temperature between + 36° C and + 40°C is within the normal range. The temperature varies between different parts of the body. Under normal comfortable conditions it is, for example, only about + 30° C in the fingertips and toes, but about + 35° C in the trunk.

Heat production

At least 70% of the total input of energy is converted into heat as a result of metabolism in every living cell. When resting, most of this heat (70%) is produced in the bowels and the central nervous system, which have a high metabolism, and in the muscles (20%).

When carrying out physical activity, the production of heat will increase, mainly in the muscles. During very heavy physical work it may be ten times higher, or even more, compared to when resting.

Control of the heat balance

Basically, the human body follows the same general physical laws as any other object. The principle is that heat always flows from a warmer to a colder area.

There is a centre in the brain for the control of the mechanisms which regulate the body temperature. To maintain the temperature of the body, particularly in the inner organs, the excess heat produced there must be removed and emitted to the environment outside the body.

Most of the transport of the internal heat is carried out by the blood. The heat is mainly emitted through the dilated blood vessels in the skin. From the skin the heat partly leaves by the "dry" way, which is by radiation and convection, a minor part also by conduction, and partly by the "wet" way - by evaporation of water.

Air velocity and the difference in temperature between the air and the skin are the determining factors for convection. The decisive factor for radiation is the difference in temperature between the skin and the adjacent surfaces. Conduction of heat takes place when there is direct contact with a surrounding medium. From an ergonomic point of view, conduction is of less importance, apart from local conduction from/to the feet and hands. Out of the total evaporation, 2/5 of the heat leaves by the exhaled air and 3/5 by the secretion of sweat in the skin.

If the skin is heated, as, for example, when taking a hot bath, the heat transport will be the reverse.

The optimal surrounding temperature for human beings, if naked, is 28^{o}C. When resting at this temperature the heat produced by the metabolic processes will be in balance with the heat lost through convection, radiation and evaporation. About 75% leaves through convection and radiation and 25% through evaporation under such conditions.

The control of blood circulation and the secretion of sweat in the skin are the most important heat-regulating mechanisms of the body in cases of an increased heat load. There are about two million sweat glands in the skin. They are activated in a certain order, starting with the big surfaces on the legs and the trunk. If the sweat evaporates from the skin this will cool down the skin. When the whole body is wetted the cooling effect is most efficient.

To enable an increased transport of heat to the skin, the heart rate and blood pressure will rise. More blood will flow through the skin and lower priority is given to the blood supply to the muscles and digestive organs. This will lead to a reduced performance and efficiency of the muscles and a reduction of the digestive processes.

The effects of heat and other climatic factors on the human body and the capacity for work are further discussed in Section 3.1.1 "Climate".

Heart rate

Oxygen consumption is a measure of energy consumption which, under certain conditions, has a linear relationship with the heart rate as shown with curve D in Figure 12.

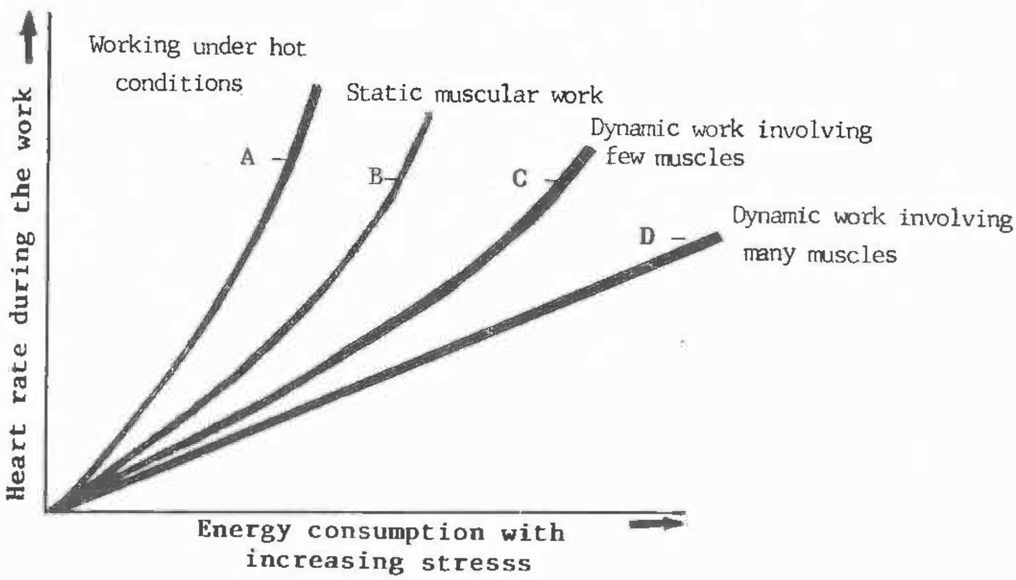


Figure 12. Increase in heart rate associated with various types of stress. Source: Grandjean (1982).

Sometimes, however, the oxygen (energy) consumption underestimates the stress on the heart, and the heart rate rises faster than the oxygen consumption. This will happen when, for instance, working in a hot environment (see curve A), when the work is static (see curve B), or when only a few muscles are involved in dynamic work (see curve C). Of course, the combination of these factors will increase the stress on the heart even more.

Measuring the heart rate (pulse) is, therefore, a useful way of assessing the real workload. It is also the simplest way to assess the strain on the worker.

When controlled for factors such as air temperature, muscles used, type of work, consumption of food, coffee, etc., or smoking just before study there is a relationship between workload, oxygen consumption, heart rate, lung ventilation and body temperature, as is shown in Table 2.

Table 2. Metabolism, respiration, temperature and heart rate as indicators of workload.

Assessment of workload	Oxygen consumption Litres/min.	Lung ventilation Litres/min.	Rectal temperature °C	Heart rate Pulses/min.
"Very low" (resting)	0.25-0.3	6-7	37.5	60-70
"Low"	0.5-1	11-20	37.5	75-100
"Moderate"	1-1.5	20-31	37.5-38	100-125
"High"	1.5-2	31-43	38-38.5	125-150
"Very high"	2-2.5	43-56	38.5-39	150-175
"Extremely high" (e.g. sport)	2.4-4	60-100	over 39	over 175

Source: E.H. Christensen in Grandjean (1982).

2.3 Work Postures

Static muscular work, back disease and worn-out joints caused by poor work postures have already been mentioned in Sections 2.1 and 2.2. These and other problems related to work postures will be further discussed in this section.

A. Handling of loads

Lifting

In forestry, manual lifting and carrying of loads is very common but should be avoided or limited as much as possible, particularly when the load is heavy and/or has to be lifted from a low level. It is difficult to give figures for the optimal or maximal weight of a load to be lifted, as there are so many other factors to take into consideration, such as shape, size, handles, lifting aids and the frequency of the lifting. In any case, the lifting of too-heavy loads must be avoided. Sometimes upper limits have been set for practical purposes.

If lifting is unavoidable, all possible precautions should be taken to facilitate the work so as to prevent painful back problems which may cause lingering absenteeism.

If the lifting is to be done frequently, the workplace can be equipped with a lifting aid such as a hoist or crane. In permanent workplaces, the load can be placed on a special ramp, so as to allow manual lifting from a convenient height. This should be at least 40 cm above ground level. There should be sufficient space for the feet under the ramp, so that the worker can stand near the load when lifting.

If the load does not have handles, the worker may use a harness or rope. For example, when lifting logs from the ground, the arms can be extended by the use of hooks and tongs, which will allow the back to be kept straight. See Figure 13.

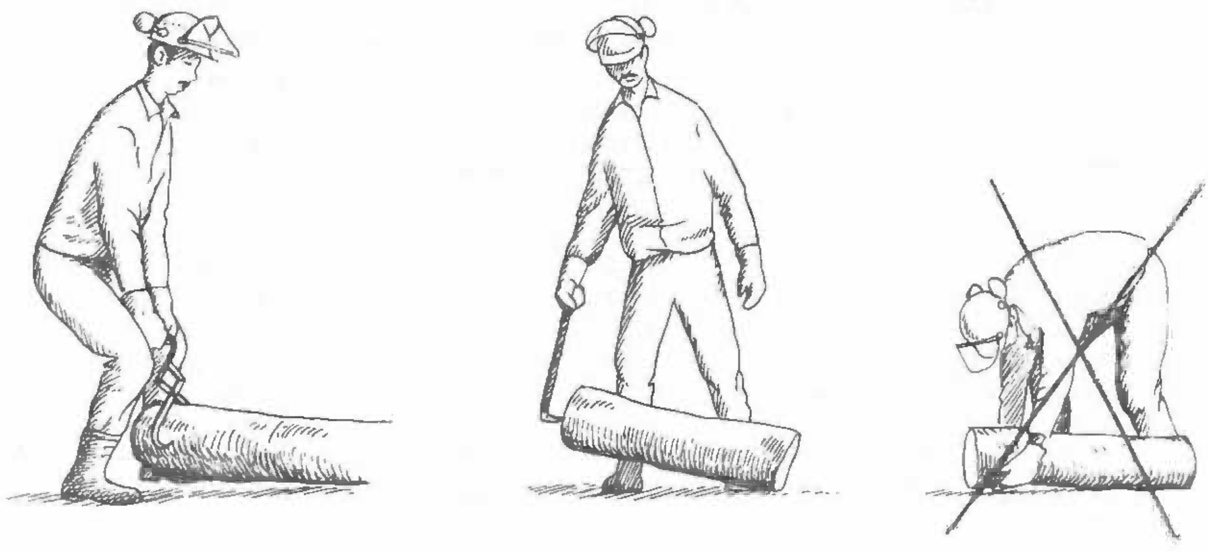


Figure 13. To allow the back to be kept straight when lifting a log from the ground, the arms can be extended by the use of hooks, tongs, etc.

Much back trouble can be avoided by the use of proper lifting techniques. When lifting with the back bent forward and the legs straight, as shown in Figure 14A, the pressure on the lower vertebrae will concentrate on only a small part of the discs. As the discs are very sensitive to uneven pressure, the risk of injury will be great.

Instead, the lifting should be done with:

* a straight back in an erect position
* the knees bent, and
* the feet a bit apart and with a good foothold; as shown in Figure 14B.

The pressure on the discs will in this way be distributed evenly and the risk of backache will diminish.

In addition:

- the load should be kept near the centre of the body. To hold 10 kg. at a distance 80 cm from the body is equivalent to the same load on the body as holding 50 kg. near the body;

- the body should be used as symmetrically as possible. To lift in a twisted posture in particular will increase the risks of causing injuries to muscles and joints.

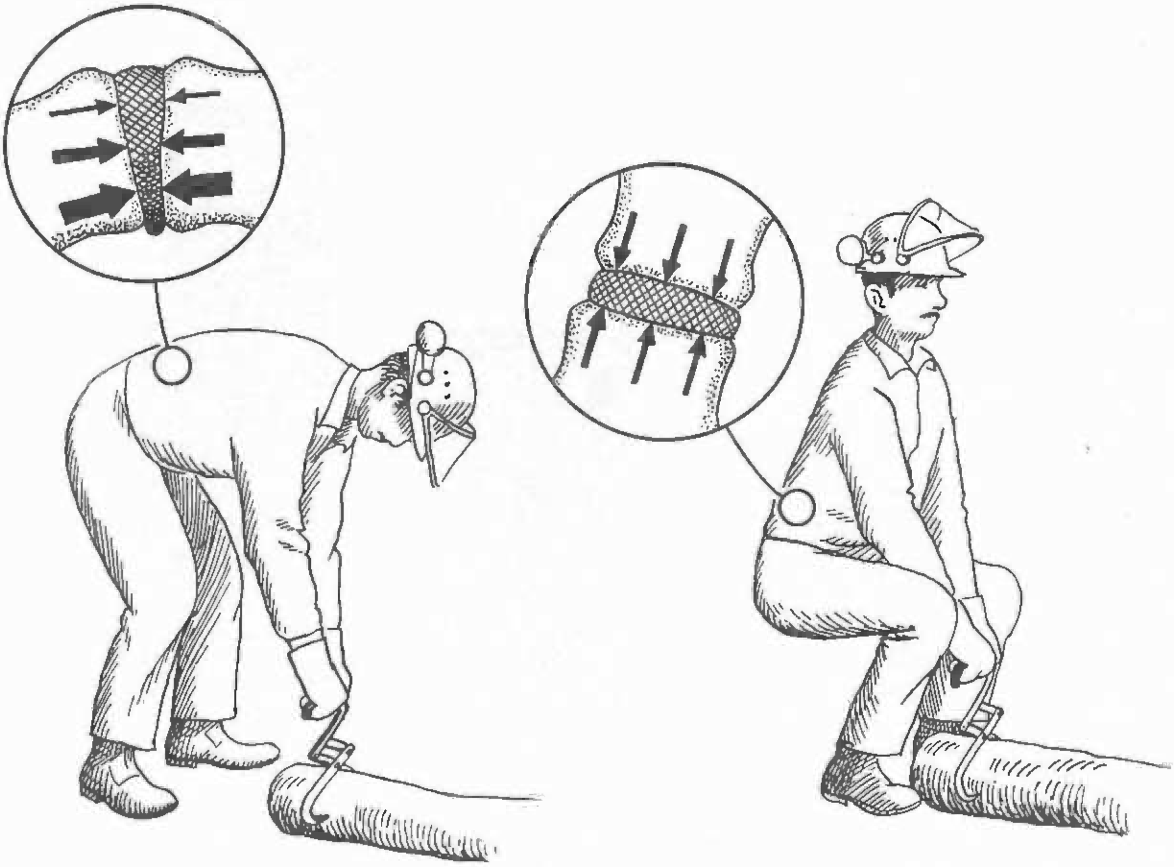


Figure 14. The distribution of the pressure on the intervertebral discs when lifting a load with bent back (A) and with straight back (B).

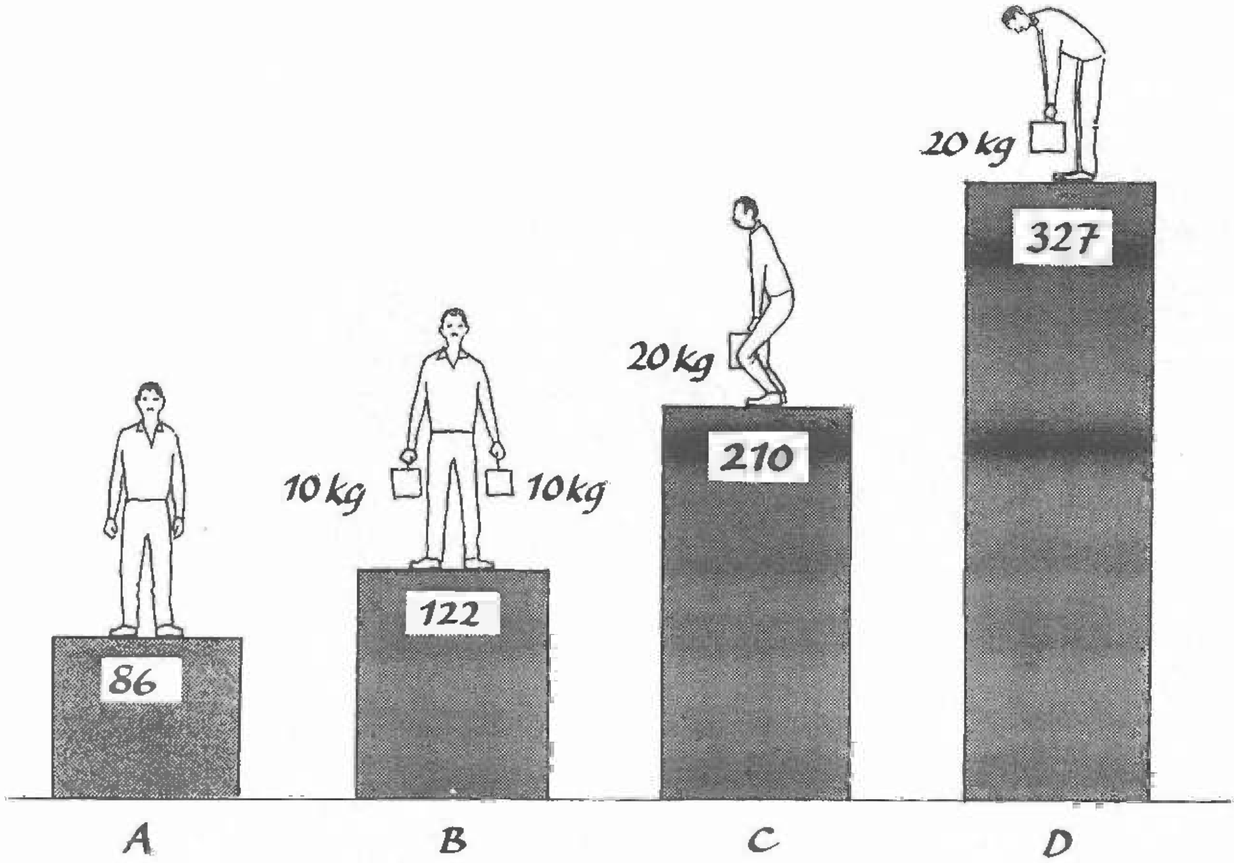


Figure 15. The pressure on the disc between the third and fourth lumbar vertebrae (in kg. per unit of surface) when lifting loads in different postures.
Source: Nachemson and Elfstrom in Grandjean (1982).

It is not only pressure caused by heavy loads but more often wear and tear on the discs from repetitive harmful movements which causes injuries.

As has been stated before, one in every three persons will suffer from back pain once during their lifetime. The absenteeism caused by back injuries is particularly high among workers engaged in physically active work as an unhealthy back will be more of a hindrance for them than for somebody who is not dependent on being physically mobile to carry out the job.

Carrying loads

Carrying of heavy loads is static work which produces local muscular effects, such as fatigue due to imparied circulation and lactic acid accumulation and, eventually, under extreme conditions, it may produce inflammation of the joints and other injuries.

Carrying a load on the back in a rucksack or with a harness designed for the purpose will decrease the physical strain and energy consumption as compared with carrying it on the shoulder or in one hand, which gives a high static load on the shoulder or arm.

Carrying loads using a yoke is usually less strenuous and less energy-consuming than carrying it by other manual means. A study showed that a person could carry 20 kg 4.5 km consuming 1045 kJ (250 kcal) if he used a yoke, as compared with only 3.9 km when carrying it on the back.

The lever principle

In the body, the skeleton bones serve as levers upon which the muscles work. To make use of levers also outside the body is particularly helpful when handling heavy loads.

When handling loads manually, considerable energy can be saved and efficiency can be gained by the use of very simple and cheap tools and equipment with an ergonomic design. Many injuries will also be prevented, leading to less absenteeism.

B. Standing or standing/walking

Many jobs are carried out in a standing or standing/walking position. It may be the only possible way to perform a particular job, or at least the most ergonomic way. Very heavy physical work is usually done in a standing position so as to get enough muscular strength to carry out the work.

If the work is not physically heavy and the worker can move around with a free choice of both the movements and the pace, and if the worker can sit down once in a while, the conditions are, from a physiological point of view, very favourable. Light, dynamic work is not, however, common in the forest and forest industries. In the forest, the dynamic work is often too heavy, and in forest industries many workers have to work in a more or less fixed standing position, coupled with repetitive and often one-sided movements of the arms.

When restricted to a standing position the blood circulation will decrease in the legs and cause increased blood pressure in the veins, which after some time causes pain. It may also cause diseases such as varicose veins (the veins become enlarged) if the person has to stand for long periods in the job.

Many parts of the body will be in a static state when standing, which is tiring, particularly for the back. The strain on the back can be considerably decreased if there is enough space to move one foot forward, and in this way change the centre of gravity of the body.

This is not possible, however, if one foot has to control a pedal, which will put the entire body weight on the other leg. The pedal may even be placed well above floor level, forcing the operator also to lift the weight of the leg each time the pedal is to be pressed down. Or the pedal may be placed too far from, or at a wrong angle to, the place where the hands are occupied. The result will then be a twisted or one-sided work posture, which is not only uncomfortable and tiring but also unhealthy. Figure 16 shows a worker in a somewhat acrobatic posture when operating an electrical crosscut saw in a plywood plant.

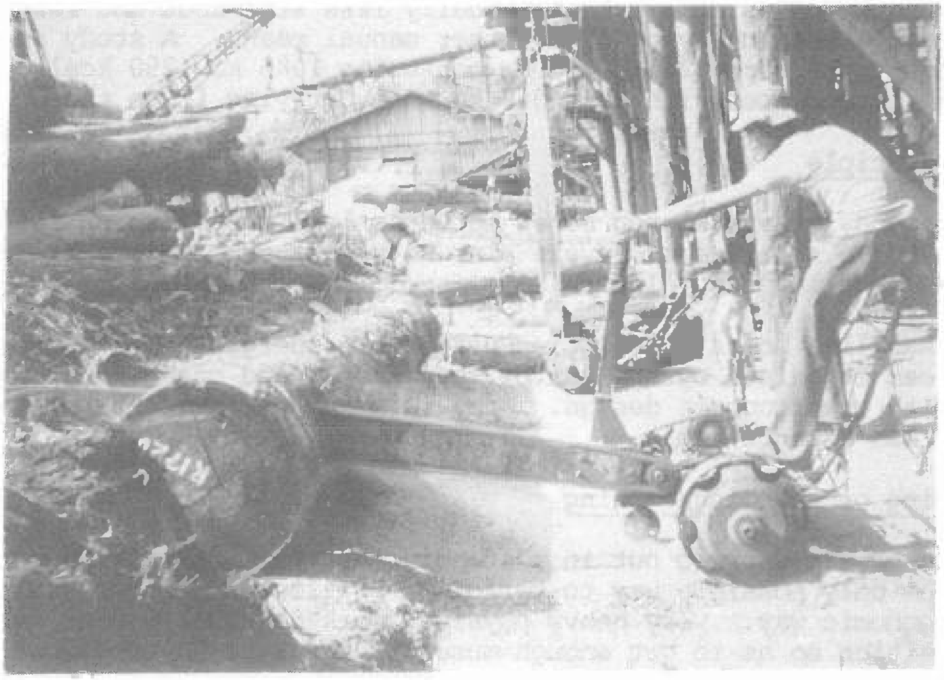


Figure 16. An operator of an electrical chainsaw in a plywood plant in an uncomfortable and dangerous posture.

When the worker has to work in a standing position, at least there should always be a chair within easy reach, to be used during pauses in the job.

C. Sitting or sitting/standing

Many jobs could be done, wholly or partially, in a sitting or sitting/standing position, after quite small changes of the workplace design.

A high stool allowing for a half-sitting posture can be a suitable compromise which will provide some relaxation of the tension in the legs and the back. The reach will still be fairly good and it is possible to stand up quickly when necessary for certain elements of the job or for safety reasons (see Figure 17).

Figure 17. A high stool allowing for a half-sitting posture.

The stool is, however, to be seen as an emergency solution for the otherwise continuously standing worker. A regular sitting position is preferable if the job does not require big muscular effort. A sitting position will take away much static work, provided that:

- the chair is of an appropriate height allowing the feet to rest on the floor with the knees bent in almost a right angle. The height of the chair should therefore be adjustable;
- there is enough space for the knees under the workbench;
- the chair has a backrest;
- the work object is at the right height, so as not to expose the arms and shoulders to unnecessary static effort, and to avoid sitting with a bent neck and back so as to see the object properly;
- the chair is functional. There is no such thing as the "ideal chair". The chair will only be ergonomically suitable if it functions well for the particular worker in the particular job.

D. Workplace design and anthropometry

Workplace design

When planning a workplace there are a number of simple rules related to workplace design which should be kept in mind, so as to protect the worker from uncomfortable, tiring, unhealthy and dangerous conditions. The first rule is that "no work posture is so good that it can be held for a long period of time without variation". Below is a list of the very basic conditions either to aim for, or to avoid:

To aim for:

a) a physically light and dynamic work which allows the worker to move freely and change between standing/walking and sitting positions;

b) a sitting position if the work is light but when the conditions under a) above are not possible to achieve;

c) an appropriate chair design, taking into account the size of the worker, the height of the place of the work object and the need for movements to the side or support for the arms and back;

d) a support, e.g. a stool, to provide a half-sitting position when the work has to be partially done in a standing position;

e) a chair within easy reach for any pauses which may occur, for jobs which have to be done in a standing position;

f) sufficient space for comfortable and safe movements;

g) placing of work object, controls, displays, etc., which are frequently used, within comfortable reach so as to avoid any awkward and tiring movements;

h) to have a clear and logical design and arrangement of displays so as to avoid mistakes.

To avoid:

- physically heavy work;
- twisted, unsymmetrical, crooked, repetitive or fixed body postures;
- a combination of demands for precision work and muscular force;

- static work e.g.:

  . to maintain a high level of effort for 10 seconds or more;
  . to maintain a moderate effort for one minute or more;
  . to maintain a slight effort (about one third of maximum force) for four minutes or more;

Common examples of such efforts are:

  . bending the back either forwards or sideways frequently;
  . holding things in the arms;
  . holding the arms stretched out horizontally;
  . holding the arms above shoulders height;
  . putting the weight on one leg while the other works a pedal;
  . standing in one place for long periods;
  . pushing and pulling heavy objects;
  . sitting erect without back support;
  . bending the neck excessively backwards or forwards;
  . applying an unnatural grasp of hand grip or tools.

(Adapted freely from Grandjean, E., 1982).

The solution may not always be as simple as indicated here, and a deeper analysis of the problem may be needed. If aiming to apply ergonomic principles when planning and organizing work, purchasing tools and equipment, etc., this will probably result in a significant reduction of occupational accidents and diseases, absenteeism and labour turnover and energy consumption, and an increase in work efficiency.

Anthropometry

To design and construct tools, machines and workplaces which will fit the worker requires knowledge of measurements and motions of the bodyparts which are decisive in the particular job. This study is known as "anthropometry".

When trying to fit e.g. the tools to the worker with the help of anthropometric data, the enormous variations in body size between races, men and women, and even between individuals of the same sex and race have to be taken into account.

To design a workplace to fit the average worker will in many cases have unacceptable consequences for either the taller or the shorter persons or both. This is illustrated in Figure 18.

Figure 18. To design a workplace to fit the average worker will in many cases have unacceptable consequences for either the taller or the shorter persons, or both.

Obviously, the workplace must in some cases be designed with the taller workers in mind and in other cases the shorter ones. It is for instance easier to provide a short person with an aid, such as a low stool to rest the feet on, than it would be to make a hole under the desk for the person with long legs so as to provide sufficient space for the legs under the desk.

As all people are different, the workplace should preferably be adjustable to fit workers of various size. In some cases this can be done, but very often it is not possible.

Manufacturers of tools, machines and equipment in industrialized countries design their products using anthropometric data of people from their own countries. The products may, however, be sold to and used by people in other countries of much different body size.

In forestry in developing countries the application of anthropometric data would above all be of use in cases of local manufacture of tools and equipment, for the design of workplaces in forest industry and when purchasing machines and tools from other countries.

Working techniques

Most of the heavy physical work in forestry is carried out in standing/walking or squatting postures, and preferably by moving the whole body so as to make use of the big muscles in the body. In some tasks such as sawing with a handsaw, planting with a planting hoe, debarking with a spade, or cutting with an axe, the proper working technique is to use wide, rhythmic and swinging body movements and the strong muscles of lower limbs as much as possible.

In the technique of a flywheel the kinetic (motive) energy of an object in motion is utilized. This principle can also be used in manual work, for example when throwing a heavy object from a lower level to a higher one. If the object is first set into a swinging motion and then at the right moment it is let loose, it will continue in its upward movement by itself, saving the worker's energy.

Another example is cutting with an axe. If pulling the weight of the arms and the axe down in the cutting movement by using the force of gravity on the body and axe, the result is a powerful blow without overstraining the arm muscles.

2.4 Nutrition

Nutrition is concerned with the food we eat and how the body uses it. Food is anything which will nourish us when taken into the body. The lack of food contributes to lower resistance to disease and leads to higher rates of accidents and absenteeism, as well as a lower work output.

Energy value

It is essential to know how much energy a worker requires to be able to carry out a particular job when discussing the worker's food intake. The energy content of the food eaten by the worker has a direct effect on the capacity to carry out muscular work. If the job requires, for instance 8,360 kJ (2,000 kcal) in addition to the approx. 8,360 kJ (2,000 kcal) needed in the basic metabolism and for off-work activities, the total daily requirement will be 16,720 kJ (4,000 kcal.). If the food intake provides only 12,540 kJ (3,000 kcal), this will affect the person's working capacity, as only 4,180 kJ (1,000 kcal) will remain available for the job. The worker will cope with the situation either by working at a slower pace or by reducing the effective working time, by taking more frequent and longer pauses, or a combination of these. If only 50 percent of the energy needed for the job is available, it is evident that the output will also be only 50 percent.

If the person does not adjust the work output to the available energy, the result will be a loss of body weight. Therefore, to adjust is a biological necessity for survival, and has nothing to do with low motivation or laziness. The energy expenditure and intake do not, however, have to be in balance each day, but over a period of time.

It is not only the amount of energy which is of importance and which will affect the worker's health and capacity to carry out physical work, but also the nutritive value of the food. There are six main categories of nutrients, which are all necessary for nourishing the body: to build up and maintain tissues, to supply energy, and to regulate body processes. They are:

1. Carbohydrates, which are the major source of energy. Carbohydrates are normally needed in the greatest quantities or in greater quantities than the others. They are usually found in the cheapest foodstuffs. Examples of food rich in carbohydrates are rice, maize, cereals, potatoes, cassava, tapioca, and breadfruit. Some of these also contain protein. Cassava contains very little protein, however.

Sugar is another source of carbohydrates. It is, however, often comparatively more expensive than other sources. Pure sugar gives only so-called "empty calories", providing no other nutrients than the energy itself, but as the body converts sugar very quickly into energy ready to be used, it can be important for workers engaged in very heavy physical work. Sugar is, however, harmful to the teeth, causing dental caries, which affect many forest workers.

The energy value of carbohydrates is ca. 17 kJ (4 kcal) per gram.

2. Fats and lipids, which have the highest energy value, ca. 38 kJ (9 kcal) per gram. Fats are important sources of energy and are particularly essential for persons engaged in heavy physical work and who therefore require large quantities of energy. Fat provides some of the energy in the diet without making it too bulky. Fats also stay longer in the stomach than carbohydrates or protein, and give prolonged satiation. Common fat sources are oils, butter, margarine, lard and nuts.

3. Protein, which has the same energy value as carbohydrates - ca. 17 kJ (4 kcal) per gram. The role of protein is to build up and maintain the muscular tissue. Besides being necessary as a body builder, protein is needed for the formation of essential body compounds such as enzymes, hormones and antibodies, and for the regulation of the water balance. Protein will eventually provide energy, if carbohydrates and fats are insufficient. This is, however, a misuse of expensive and valuable protein.

   Sources of animal protein include milk, eggs, fish, poultry and meat. Vegetable protein is supplied mainly by beans and other leguminous crops, which are cheaper and are the major dietary sources of protein for the bulk of the labour force in developing countries. The quality of protein in the diet is determined by its digestibility and amino acid pattern.

   The human body must be provided with protein daily. Generally, a sufficient protein intake for adults is 0.75 gram per kg body weight per day. Adolescents need more protein than adults.

   The intake of protein differs a lot between countries, depending on availability and socio-cultural and economic factors. People in several developing countries have a very low protein intake. Sometimes this lack of protein is coped with by means of a metabolic adaptation to the low intake. By adaptation a decrease of the breakdown of body protein will occur, so as to facilitate the maintenance of an equilibrium between protein intake and protein breakdown at the lower intake. In order not to disturb this delicate state of balance, persons who have adapted to low intakes will avoid heavy and prolonged muscular efforts. If these persons are put on heavy physical work, they must first for some time be provided with a diet rich in protein and energy.

4. Minerals, which are necessary for the body's normal functioning and growth. Examples are calcium and phosphorus, which are found in the bones and teeth. Calcium is also necessary for normal functioning of the nerves. Iron is a constituent of the blood haemoglobin, which transports oxygen in the blood. Iron deficiency may cause anaemia. There is evidence that iron-deficiency anaemia will reduce the person's maximal aerobic capacity. Workers suffering from malaria and some other tropical diseases, which also cause anaemia, will have an increased requirement for iron.

   The sources of minerals are milk, eggs, cheese, meat, fish, shell-fish and vegetables.

   Minerals do not have any energy value.

5. Vitamins, which are needed in small quantities as regulatory substances for life processes and good health. Deficiency of certain vitamins will cause diseases, for instance, lack of vitamin A will affect the eyes (in severe cases even causing blindness); cardiac, nervous and neuromuscular changes will occur due to beriberi, which is caused by vitamin B_1 (thiamin) deficiency. Of course, these diseases will also affect the person's work efficiency.

   Fats are carriers of the fat-soluble vitamins A, D, E and K The main sources for the water-soluble vitamins C and B-complex are fruit and vegetables, which should preferably be eaten raw or only lightly cooked so as not to destroy vitamin C. Vitamin C is particularly important as it improves the body's capacity also to absorb other nutrients from food.

   The requirement for the amount of vitamins does not vary with the heaviness of the work. The only exception is vitamin B which will be needed in bigger quantities by a person engaged in heavy work. Vitamin B deficiency is common in the Far East. This can partly be relieved by using undermilled, parboiled or enriched rice as the major staple food instead of the generally more appreciated white rice. Brown rice has a superior nutritional value compared to white rice in carbohydrates, calcium, phosphates, iron, potassium and also in vitamins. In addition, the fibre content of brown rice is much higher than that of white rice.

   Vitamins do not have any energy value.

6. Water, which is a major constituent of every cell in the body. Water is indispensable for a number of reasons: it is a solvent, a lubricant and a transporter of other nutrients and metabolic waste products, as well as assisting in regulating the body temperature. It is recommended for adults to consume 1 litre of water for every 4,180 kj (1,000 kcal) in the diet. Most of this will be covered by the food which contains a lot of water. The need for water is individual and is very dependent on the rate of perspiration. Heavy physical work and high temperature therefore considerably increase the need for water. This will be further discussed in Section 3.1.1. "Climate".

Water losses should be replaced by safe drinking water (boiled if necessary). Replacing moderate water losses partly by tea and coffee can be recommended in cases when the water is not safe to drink without having been boiled. Liquids should be taken not only at meal times or when thirst is felt, but more frequently, as thirst underestimates the body's need for water.

7. Alcohol. Alcohol consumption is harmful and should be strictly prohibited before or during working hours. Alcohol affects the functioning of the brain, decreases the speed of reaction and has a tiring effect. A person under the influence of alcohol may cause accidents and is a risk to him- or herself as well as to workmates. Alcohol itself has little nutritional value, and also dehydrates the body.

It is important that the diet be varied and well-balanced so as to prevent undernourishment (which means a less than optimal state of health and well-being and lack of energy resulting from the consumption of inadequate amounts of food), and malnutrition, (which means a relative deficiency or excess of one or more nutrients).

Undernourishment not only affects health and working efficiency, but may cause mental changes as well, such as depression coupled with a lack of drive and initiative.

Economic factors

There are many factors to be considered when discussing measures for improving the nutritional status of workers. The first are the economic factors.

The worker's wage can easily be compared with the cost of an adequate diet, calculated from the local food prices. This will give an indication as to whether the earnings are sufficient to cover the worker's and any dependents' daily diet. However, the budget has also to allow for other expenses such as housing, clothes, school fees and transport. Studies in developing countries have shown cases where workers in the low wage brackets, engaged in heavy physical work, do not earn enough to provide an adequate diet, even for themselves. Their only possibility to keep themselves fit for work is for basic foodstuffs to be grown by them or by their families.

In other cases, nutritious foods are simply not available. This is often the case for forest workers staying at the worksite for a period of weeks or even longer. They may be restricted to food which can be stored safely in the forest, often in a hot and humid climate, without any storage facilities. These may be rootcrops, maize and rice and other dried or canned foods. This diet may be supplemented with whatever edibles the workers can find in the forest, such as fresh roots, fruit, nuts and, in exceptional cases, birds, game or fish.

When wage levels are insufficient, the workers should be enabled to produce their own food near the forest camp or the village. Besides the provision of appropriate land, the working hours may also have to be scheduled so as to allow sufficient time for these activities.

Employers who have recognized the relationship between food and work efficiency have started workers' feeding programmes and have established canteens or non-profit-making stores at the workplace.

To provide, either free of charge or subsidized, a meal or substantial snack which is ready to be eaten by the worker at or near the workplace, is of course easier to arrange in concentrated large-scale forest operations than for workers scattered over wide areas. A lot can be done, however, by very simple means, to improve the food situation also for isolated forest workers. This is to a great extent a matter of organization. Work can be scheduled and organized so as to allow time during working hours for one worker to prepare an adequate meal for the rest of the group. An alternative is to hire a local person to cater for the group. Fresh and varied food can frequently be brought to the workplace by the use of transport such as log trucks. When part of the food is provided by the employer it should cover not only the necessary energy intake, but should in addition be composed in such a way that all nutritional needs are met. Besides simply providing adequate food to the workers, the objective should be to improve eating habits, to stimulate food production and to teach nutrition to the whole population. Forest enterprises, particularly in remote areas, may also benefit from starting agricultural and aquacultural production for the feeding of workers.

Socio-cultural factors

Apart from economic factors and the availability of food, socio-cultural factors also have a major influence on eating habits. Food has symbolic values and can be used for expressing social, economic, emotional, religious and cultural relationships. The way to select, prepare and consume food depends to a great extent on the role food plays in a given situation. The nutritional value of food is obviously nil until it is eaten by the worker. It is therefore necessary to consider local habits when providing food or when teaching nutrition, so that food is nutritional, but also acceptable and palatable from the worker's point of view.

Distribution of meals

The nutritional value of food depends not only on its composition and quantity, but on the distribution of the meals as well. Particularly with heavy physical work requiring large quantities of food, it will be necessary to distribute the intake over preferably four to five meals per day, so as not to disturb the digestive processes. Ideally, at least one quarter of the daily energy requirement should be taken at breakfast. After each meal both the blood sugar level and the efficiency of the muscles will increase sharply. It will thereafter fall steadily as time passes. After three to four hours it will reach a very low level, which is often accompanied by symptoms of fatigue. If a small meal or a substantial snack is taken every two hours the very low level will never be reached. The worker will stay on a higher and more even level of blood sugar and efficiency throughout the whole day.

Analysis of accident records and human errors have also shown a distinct increased occurrence just before lunch breaks and at the end of the working day. If a heavy meal is taken without allowing sufficient time to elapse afterwards for the digestive processes this will also lead to decreased efficiency.

Planning the distribution of food intake and rest pauses is one very important measure to prevent accidents. To distribute the food intake over 5 meals per day (3 main meals and 2 snacks) is ideal for health and efficiency. Here also, local habits have to be taken into consideration. But whatever these habits are, the worker should be encouraged to eat a substantial breakfast before work and never to work the whole day without at least one meal break.

Apart from the nutritional necessity of mealtimes, they also have a social value which should not be overlooked.

When workers eat only once or twice per day a normal work output cannot be expected. The worst case is when one meal only per day is eaten, after work. Under such conditions physical work is inadvisable.

2.5. Fatigue

Everybody will know intuitively and from experience what is meant by fatigue. When describing or trying to define fatigue it is possible to make a very long list of different types of fatigue. The chainsaw operator may think of fatigue in terms of pain in the back, arms and hands caused by static effort when handling a heavy chainsaw, by working in a bent posture and by the effects of vibration. The tractor driver may describe a feeling of general fatigue caused by the noise, vibration and heat in the cab, and the supervisor may be stressed and tired as a result of too many conflicting demands from chiefs, colleagues and workers and of long hours of travelling on dirty roads. The manager may have too great responsibilities or boring meetings, and the clerk may be mentally tired due to concentrated calculations, and the stress from knowing that any errors he makes may have far-reaching consequences. Somebody may also be tired after a day with too little or too monotonous work, and so on.

A very general definition of fatigue would be "weariness from bodily or mental exertion".

In many cases the feeling of fatigue is to be seen as a wholesome function and one way of the body to protect itself from overstrain.

Provided one gets the needed rest, it can be a rather pleasant feeling to be tired after a day's work. To avoid an unhealthy accumulation of fatigue, it is necessary to allow for time to recover in every 24-hour cycle. Most of the recovery takes place during sleep at night. Short and longer rest pauses during the work day may also be necessary for maintaining the balance between rest and effort.

Fatigue causes errors and accidents at the places of work. Many of these can be avoided if the workers are given sufficient rest pauses, and if the work is planned and organized in such a way as to avoid an accumulation of fatigue.

If fatigue is accumulated over a long period due to insufficient daily rest, the person will suffer from chronic fatigue. This is very often accompained by symptoms of illnesses such as headaches and digestive problems. Mental instability and liability to depression are other common consequences. Increased absenteeism and accident rates will eventually be the result.

In Figure 19 examples are given of factors causing fatigue, symptoms of fatigue and consequences which may follow if a person does not get sufficient daily rest.

Fatigue is a very complex phenomenon with no direct ways of measuring it. It is, however, possible to quantify it indirectly by measuring different indicators of fatigue such as quantitative and qualitative performances, electrical activity in the brain, and subjective feelings of fatigue.

2.6. Rest Periods and Scheduling of Working Hours

If accidents, illnesses, discomfort and low efficiency caused by accumulated fatigue at work are to be prevented, there must be possibilities to recover during the day. There are several ways to get some of the necessary rest apart from prescribing scheduled pauses of different length and frequency. For example, when unavoidable static effort located in only a few muscles is the main reason for being tired, the most efficient way to recover is not to sit down and simply do nothing but instead to carry out some dynamic movements. This will improve the circulation of blood, which will redress the balance of oxygen and nutrients in the muscles and remove accumulated waste products. In this physically active way the recovery will be faster compared to passive resting. Preferably the work should be organized in such a way that a sufficient amount of dynamic efforts is a natural part of the work.

In other cases, when fatigue is caused by a physical overstraining of the entire body, a complete rest either sitting or lying down will be necessary.

Reasons for rest pauses during the day:

Pauses during the day are needed for a number of reasons of which the most important are as follows:

a) static work - to restore the balance in the muscles of oxygen and nutrients and to remove waste products, particularly lactic acid;

b) heavy physical work - to recover respiration and circulation; to restore energy and to avoid a low level of blood sugar by spreading out the intake of food; also to remove lactic acid or pay the oxygen debt;

c) standing work - to restore the concentration of blood in the legs and feet and decrease the blood pressure in the veins;

d) work in hot climate - to cool down the body, to replace water losses regularly;

e) when exposed to vibration - to limit exposure time;

f) when exposed to high sound levels - to get rest in silence (see for more details section 3.2.2. "Noise");

Examples of FACTORS causing fatigue

A. Physical environment: temperature, lighting, noise, vibration, elevation, lack of oxygen

. Physical and mental workload: static work, heavy physical work, monotonous work, socially isolated work, concentrated mental work, work overstraining the eyes

C. Nutrition: undernourishment, deficiency of water, alcohol comsumption, digestive processes after food intake

D. Health: diseases, fever, pains, handicaps

E. Psychological troubles: anxiety, conflicts, obligations

F. Circadian rhythm: night and shift work

Examples of SYMPTOMS of fatigue

Objective symptoms:
- local muscular pain
- lack of or impaired attention, perception and alertness
- increased reaction time
- visual fatigue
- yawning

Subjective symptoms:
- to feel:
  - bored
  - unwilling to make any kind of effort
  - postural discomfort
  - weary
  - drowsy
  - sleepy
  - irritated

Examples of EFFECTS if worker is deprived of rest

Effects:
- errors
- accidents
- chronic fatigue

Symptoms of chronic fatigue:
- unwillingness to work
- depression
- illnesses, such as:
  - headaches
  - stomach pains
  - heart problems
- reduced resistance to disease in general

→ Increased: Absenteeism and Labour Turnover

Figure 19. Diagram of examples of factors causing fatigue, symptoms of fatigue and effects which will eventually result from insufficient rest.

g) repetitive and boring work - to break monotony;

h) isolated work - to provide for social contacts;

i) dangerous work - to prevent accidents caused by fatigue.

Studies have shown that it makes good economic sense to take well-planned rest pauses, as they have a positive effect on performance. The improved performance will compensate more than enough for the lost working time.

Different kinds of rest pauses

Generally speaking, it is preferable to let the workers control the workpace themselves so that they can take natural pauses when they feel the need.

It is particularly advantageous if the worker can freely change to other activities, such as maintenance of tools and machines, or consulting with workmates and supervisors. The worker can in such cases carry out this kind of light activity when in need of a light rest, as an alternative to ceasing work entirely. "A change of work is often as good as a rest" is a generally accepted truth. For old workers, who have impaired capabilities to cope with peaks in the physical workload, the freedom of controlling their own pauses and workpace can be decisive whether they will be able to go on with their jobs. If the work includes very heavy elements, e.g. carrying of logs, the work should be organized in such a way that continuous duration of such elements is as short as possible, and lighter work is done in between, so the peak of strain is kept lower and the need for recovery also.

Very often the workers get opportunities to rest during the day because of the nature of the work, its organization, or rather lack of organization. A machine breakdown may, for example, lead to long periods of passively waiting for the arrival of spare parts and the repairer, and the repair work to be done. These types of work-influenced pauses may, or may not, be an efficient way of resting, depending on whether they occur at the moment the worker needs a rest or not.

When it is neither possible to take natural pauses nor to rest by doing light work and also no work-influenced pauses can be expected, then the management should have prescribed scheduled rest pauses. The length and frequency of these pauses will depend on a number of factors such as physical workload, climatic conditions, workers' nutrional status, physical fitness and age, and the length of the working day.

Scheduling of rest pauses

Generally, the first part of any rest pause is far more efficient in terms of recuperation than the latter part. Therefore, taking many short pauses is a more effficient way of preventing an accumulation of fatigue compared to a few but longer pauses - even when the length of the short pauses taken together is the same as the long pause. Many investigations have shown that rest pauses tend to increase output rather than to decrease it.

If 50 percent of a person's maximal working capacity is required, which is common in heavy physical work in forestry, the time needed for rest will be about 20 percent of the total working time. This means that a break of about ten minutes per hour should be provided. If the work is lighter the pauses will be shorter or less frequent. If the work requires about 75 percent of the worker's maximal capacity (which is extremely heavy work), the time for rest pauses has to increase to 60 percent. To solve the problem of heavy physical work and poor working conditions by means of extra long or frequent rest pauses should always be the last way out. Considering that rest pauses more often than not are unproductive, it will be more efficient to change the work so as to reduce the needs for rest pauses to the minimum.

Even when the work is light and comfortable there will, however, always be a need for shorter breaks, as no work posture is so perfect that it is possible to remain the same during long periods of time without increasing discomfort. Even during sleep a change of posture is needed, and more frequently if the bed is uncomfortable.

For an eight-hour working day it is also advisable to have a longer break of about 15 minutes in the morning, and often also in the afternoon. Particularly if the work is heavy there will be a need to spread out the intake of food over the day so as to avoid overloading the digestive organs with only one heavy meal.

An additional meal break of about three quarters of an hour or an hour should also be provided. It is necessary to allow for about 15 minutes to elapse after eating a more substantial meal for the digestive processes.

If the work is physically heavy or dangerous or the worker is old or unfit, some scheduled pauses are essential. There is otherwise a risk, when the pauses are only optional, that the workers may decide to work throughout the day without stopping, to be able to leave work earlier. When work is paid on a piece-rate agreement, the workers may put in long hours without sufficient breaks. This will lead to accumulated fatigue, low efficiency and increased accident rates. Physically heavy work in a hot climate requires special considerations which are discussed further in Section 3.1.1 Climate.

Working hours per day

It is a common mistake to believe that there is a linear relationship between work output and the length of the working day, as is illustrated in Figure 20, curve A. Experience has shown that after some hours the output per hour will start to fall, illustrated by curve B. In many cases the output per hour is lower throughout the day, because the worker will automatically adjust to a lower work pace. This is often necessary to prevent overstraining because of lack of energy, illustrated by curve C.

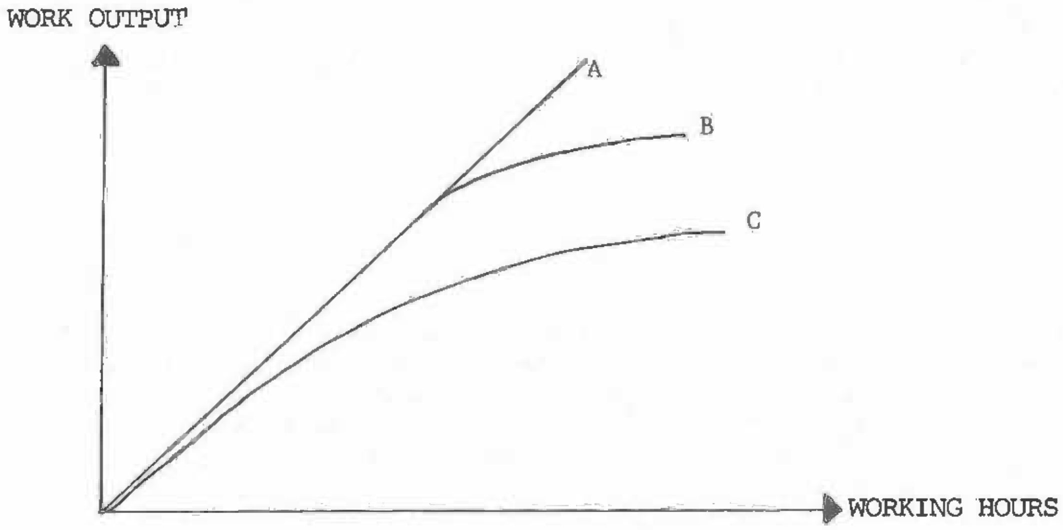


Figure 20. The relation between the number of working hours and work output. A. indicates a linear relation, which is an unrealistic assumption. B. and C. indicate what happens under actual working conditions.

Instead of frequently calling for overtime work, it would be more efficient to employ additional workers. Another reason for avoiding excessive overtime is that it leads to higher absenteeism caused by illness and accidents.

Working days per week and annual leave

Similar effects as have been described above have also been shown when changing the number of working days. At least one rest day per week should be provided, not only for reasons related to safety, health and efficiency, but also for social reasons. The same reasons hold good for the need for some annual leave. It should therefore be a policy to avoid payment for leave which has not been taken by the worker.

Night or shift work

Night or shift work is very unusual in forest operations in developing countries. It is more common in wood industries.

Night and shift workers usually complain of disturbed sleep during the daytime. Partly this is attributed to noise, which is usually greater during the day than at night. Other factors, according to many workers, are the feelings of restlessness when trying to sleep during the daytime, and that daytime sleep is not refreshing enough. It has been shown that on average, daytime sleep is distinctly shorter than night-time sleep. Most night and shift workers will, therefore, suffer from an accumulated deficiency of sleep or "sleep debt". The quality of daytime sleep is also impaired.

Both mental and physiological functions such as weariness, production of adrenalin (a hormone which is sometimes called "stress hormone"), heart rate, blood pressure, respiratory volume, body temperature and digestion, show characteristic fluctuations over a 24-hour cycle. This is called the circadian rhythm.

According to the circadian rhythm the readiness for work is at its peak during the forenoon and afternoon. Thereafter, it becomes poorer and declines even more at night, eventually reaching its lowest point in the early morning hours (between 2 and 4 o'clock).

Lower productivity and more frequent accidents and errors are consequences to be expected during night work. The conditions surrounding the worker at night are, however, usually so different from daytime conditions that any comparison of performance and accidents must be made with reservations. Examples of factors which often vary considerably between night and day are the number of people at work (fewer at night); workpace (slower at night); work tasks (many dangerous jobs such as maintenance and repair are only carried out in the daytime); and supervision (fewer supervisors at night). These are factors which of course have a significant impact on efficiency and safety, and may cover up ill effects of disturbed body rhythms among the workers.

It is well known that night and shift workers commonly suffer from bad health. Many have to give up shift work for this reason. Workers who remain on night shift can, therefore, be regarded as a "positive selection" of those having good health and great adaptability. Due to lack of other job alternatives or because night work provides monetary incentives, many workers on night shift secretly suffer from bad health.

Common ailments among night and shift workers are ulcers, nervous disorders, stomach troubles, intestinal disorders and chronic fatigue.

Over a period of years, people do not usually become accustomed to night work, but, on the contrary, they become increasingly liable to different diseases. Older workers with no previous experience of night and shift work should not be engaged in such work.

Closely related to physical health is social well-being. In many cases, complaints among shift and night workers regarding problems related to their social life are even more frequent than those regarding physical health. These problems mainly concern family life, child care, social isolation from friends and relatives, and limited or no participation in group activities.

Night and shift work should always be avoided whenever possible. If unavoidable, a great effort should be made to minimize the disadvantages it imposes upon the workers.

2.7 Mental Workload and Stress

Stress can be defined as "the state of physiological and mental arousal, which is caused by an imbalance between perceived environmental demands, and the individual's perceived capacity to meet those demands". Stress, then, occurs when an individual becomes badly matched to the environment.

Both psychological and physiological functions are affected by stress. Examples of "direct" measures of stress are heart rate, heart rate variability, levels of adrenalin and noradrenalin ("stress hormones") in the blood or in the urine. Disturbances of some of the functions may lead to psychosomatic disease (physical disease which has a mental origin), and heart and blood vessel diseases.

Stress factors (stressors)

In any job, there are a large number of environmental sources of stress such as the characteristics of the job itself, interpersonal relationships at work, the role of the worker in the workplace (e.g. as a supervisor), "climate" and structure of the work organization, and problems associated with the contacts between the organization and the outside world (e.g. working in a logging company which has poor relations with the local population may cause stress).

In the following section, attention will be focussed on stressors related to the job itself. Examples of job-related stressors are to have too much or too little work, time pressure and deadlines, too many or difficult decisions to make; fatigue from physical strain and from physical factors in the work environment such as noise, excessive travel, long working hours, coping with changes at work, and costs of making mistakes (monetary or dismissal).

Where there has been increasing mechanization and automation in forest industries, as well as the tendency to divide a job task into as many simple and limited operations as possible, jobs have become narrow, specialized and repetitive. In forest operations such as felling and transport this is not so much of a problem as in the wood-processing industries such as sawmills, veneer and plywood plants or pulp and paper mills.

The content of jobs in the latter industries is often prescribed in detail and allows little discretion. Sometimes the worker carries out only a single operation on a small part of the total end product, and at a pace predetermined by the speed of a conveyer belt. Consequently, this gives the worker little or no control over how the task is performed. The job has become monotonous and repetitive.

Both field studies and laboratory experiments have shown that monotonous and repetitive work under industrial conditions produce bad physiological and psychological symptoms. A study from a sawmill demonstrated that a group of sawmill workers who had jobs which were monotonous and repetitive, but at the same time demanding much responsibility, secreted much more adrenalin (a "stress- hormone") than other groups of sawmill workers. The workers also had a higher incidence of psychosomatic disease and more absenteeism.

Under-utilized physical and mental capacities characterize a state which is called "underload", while "overload" means having too much to do or doing a job which is too difficult (quantitative or qualitative overload). Both underload and overload situations relate to stress symptoms. On the other hand a moderate workload, which is when the demands of the job most closely match the capabilities of the worker, will give the least stress and the highest efficiency.

2.8 Individual Characteristics of the Worker

In the description in previous sections of the different aspects of the worker and the work, the workers have sometimes been referred to without considering individual differences in their capabilities and limitations. In this section, some of the most important individual characteristics of the workers will be discussed, namely: age, body size, and sex.

A. Age

Age affects a number of factors of importance for both the physical and mental working capacity.

Old persons

Some aspects of the working capacity decrease progressively with age due to:

- a lower maximal oxygen intake or aerobic capacity;
- a decreased mass of muscles. The peak for muscular power in both men and women is reached between the age of 25 and 35 years. Older people have considerably lower muscular power.
- a decreased adaptability to environmental heat;
- a decreased adaptability to changed sleeping pattern;
- impaired eyesight due to: a) less elasticity of the lens leading to impaired accommodation of the eye; b) need for a higher lighting level;
- an impaired hearing capacity, particularly the hearing of high frequencies;
- an impaired speed of mental operations and reaction time because the reflexes need a longer time to pass through the nerves;
- an impaired capacity to remember over a longer time what is recently learned. There is, however, only a small reduction, if any, in the capacity for immediate memorization.

All these may appear as a depressing picture, but there are redeeming features as well. The amount and variety of experience and memories will increase with age. In many situations this will compensate for the declined physical and mental capacity. Older people may for some time therefore be able to maintain the same performance as young people. Some people also age physically and mentally slower than the average.

The day will come, however, when the physical working capacity has declined to a level at which no heavy work should be done. The old worker should then preferably be transferred to a job which is physically light but still requires experience. The old worker can for instance provide experience and some degree of leadership and stability to groups of younger workers.

To transfer an old worker to a job with the task of handling a new machine may not be advisable if the worker has no previous experience of machines, even if the rationale is to provide a physically lighter job. The old worker may encounter difficulties in learning how to operate the machine safely and properly.

It is further very important for older workers to have the freedom to work in their individual rhythm and take pauses when needed. The peaks of physical workload should be avoided, as they may be the decisive reason why the old worker cannot stay on the job.

In most western countries the age of about 40-50 years is regarded as the age at which the working capacity starts to decline. For many workers in developing countries, who suffer from undernutrition, disease and a hot climate, this stage may be reached much earlier.

Recuperation time after diseases and accidents is also longer for an old person compared to a young one.

Young persons

Very young persons also call for special attention in their working life. Most countries have laws and standards regulating the minimum age for employment in industry. The age of 15 is a common minimum requirement for industrial employment, with a stricter requirement for the age of 18 if the work is physically heavy, dangerous, or involves the operation of machines. Additional standards regulating, for example, the maximum number of working hours per day or week, shift or night work, or maximum weight to be lifted and carried, also exist in several countries. The rationale for this special treatment of adolescents is to protect the young worker from occupational diseases and accidents. To overstrain the body before it is fully grown by doing heavy physical work may cause permanent injuries. The back in particular should be spared from harmful lifting and carrying of heavy loads.

It takes time to develop strength, skill and experience and it must be accepted that during this time the young worker cannot produce the same as an experienced and skilled adult worker.

Young workers should not be put under production pressure as they may take risks which can cause accidents, due to lack of experience and skill. They should be given extra close guidance and supervision when training for any job involving risks.

To enforce strict laws and standards for the young workers and to give a thorough introduction to the job, with much emphasis on safety aspects and working techniques, is a wise policy which will pay well.

Young workers need much guidance and understanding which in many cases can be provided by mixing older and young workers in the same crew.

B. Body size

The problems related to differences in body size between races, sexes and individuals when designing workplaces, tools and machines have already been mentioned in Section 2.3. "Work Postures".

There is some evidence from limited studies in a few countries that there is a close relationship between body weight and the capacity to carry out heavy physical work. An early study carried out in India (1966) gives an example of this relationship by showing that a group of Indian forest workers, whose weight was only about 70% of Scandinavian forest workers' weight, had a performance of muscular work which was correspondingly also about 65% of what the Scandinavian workers could perform.

Most literature and research reports on ergonomics are from studies carried out on people from western countries. When referring to "the average worker" in these studies this usually means a male worker, about 25-30 years old, and with a body weight of 65 kg. As the average body weight is, in general, lower in many developing countries, results from western countries are not always applicable to workers from other parts of the world.

C. Sex

In western countries the average woman has a 25% lower body weight than the average man. Her physical working capacity is correspondingly 25-30% lower. In many developing countries this relationship is, however, not the same.

Many countries have special laws for the employment of women in industry. In particular, special attention should be given to women who are pregnant or are breast feeding. They must not be exposed to harmful chemicals, air pollution, night work, heavy physical work, or lifting and carrying of heavy burdens. Women with small children may often need special working hours and arrangements for child care.

There are many examples of special laws, arrangements and standards said to be for the protection of women in general being abrogated under conditions when the women are needed to maintain industrial production, for example, during or just after a war which occupies the men. When the laws are introduced again they may serve more as a tool to keep women out of the better-paid jobs in industry.

In general, working conditions which are unhealthy and dangerous for the female worker are equally bad for the male worker. The goal should therefore be to improve working conditions so as to fit as many persons as possible whether they are men, women, young, old, large or small.

2.9 Socio-cultural Aspects

In most of what has been said so far the idea has been that all human beings have similar basic needs, requirements and limitations. In the last section (2.8) mention was made of some of the factors which, in spite of all the similarities, make it necessary to give special consideration to certain groups of workers, such as old workers, pregnant women, and very young workers.

Other aspects which often also have to be considered are the socio-cultural and economic aspects. For example, habits, beliefs, traditions, religions and socio-economic conditions may differ from one area to another in one and the same country. Individual workers or small groups of workers may have a divergent socio-cultural background. In many cases this will not cause any particular problems at the place of work. In other cases, it may be necessary to pay much attention to the consequences at the planning stage of any kind of forest operation. The list of examples could be very long, but mention will be made only of a few with direct ergonomic implications.

It is not unusual that the forest worker is both a wage earner and the cultivator of a small piece of land. The combination of getting some food at little expense from private agricultural work, and some necessary cash as a wage earner might very well be the optimal way of survival. If eight hours per day of regular work in the forest is introduced in this kind of society, it may interfere with the farming activities. The workers may then have to buy more, or all, of the needed foodstuffs at the market. This might affect the nutritional intake of both the workers and their families.

Another example, which also has to do with nutrition, is different eating habits. Workers may have the habit of taking only a cup of coffee or tea in the morning, before work, and waiting until evening for the main meal. As a consequence, their capability to carry out heavy physical work in the forest will be noticeably impaired. Their productivity, safety and health will suffer. It should then be a task for the employer to influence the workers to adopt better eating habits. A solution might be the provision of a free meal during the first half of the working day. This would be a very good investment in many developing countries regardless of what kind of eating habits the workers have.

Other habits may be difficult or impossible to influence. For example, those habits which are based on religious beliefs, such as long periods of fasting, or the refusal to remove a very special headgear in order to wear a safety helmet.

Often the cultural values are not so explicit as in the examples mentioned above. This can be illustrated by the following quotation regarding the interplay of cultural values among Filipino workers: "Values like utang-na-loob (debt of gratitude) to their employer, the strong kinship system or family ties and the bahala-na (come-what-may or faith-in-God) attitude might explain why the workers are contented with their working and living conditions". (Operational efficiency, work study and ergonomics in forestry. ILO, 1986).

It is beyond the scope of this publication to elaborate the unlimited socio-cultural aspects which have to be considered in forest management in various societies around the world. The message is rather to remember the importance of the socio-cultural and economic aspects in general. They may play the decisive role in whether a project becomes a failure or a success.

3. WORKING ENVIRONMENT

3.1 Biological and Physical Factors

3.1.1. Climate

Most forestry work is done out of doors, with very limited possibilities of protecting oneself against the weather.

From an ergonomic point of view the most important climatic factors are: extreme temperatures; high relative humidity; strong wind, heavy rain and snow. When one has to work under unfavourable climatic conditions it cannot be expected that the same performance will be reached as when the working environment is optimal.

To cease work, or adjust working methods, when the wind is too strong or the rainfall too heavy, so as to allow the work to be carried out safely is often more readily accepted than to take the same precautions because of extreme temperatures and humidity.

Hot climate

Normally it is easier to prevent discomfort arising from low than from high temperatures. The hot, or hot and humid, climate creates the biggest climatic problems in many developing countries and will therefore be given more space in this presentation than the cold climate.

Generally, the severe stress on the body caused by heat is overlooked, particularly when combined with humidity. This is most probably due to a lack of knowledge regarding the hazardous effects of heat stress.

Heat stress is not only a problem for forest workers in a hot climate but for forest fire fighters as well.

With some knowledge of the internal heat production, how the heat balance in the human body is controlled, and how man is affected by the climate, preventive measures could be taken so as to provide some protection indirectly. These measures could be of different types, such as adjustment of the working time schedule, working methods, clothing, availability of drinking water and shelter.

In Section 2.2. "Energy Requirements and Physical Workload" the mechanisms which regulate the body temperature were discussed, particularly the importance of sweating. A common problem in the tropics is that when the relative humidity of the air is high, less sweat can evaporate and the cooling effect will therefore be impaired.

Another important factor to consider, besides temperature and humidity of the air, is air velocity. In a hot and humid environment air movements will increase the evaporation of sweat. If the air temperature is lower than the temperature of the skin, the wind will also cool the skin by convection, and thereby reduce the amount of sweating.

Air temperature affects convection. The easiest way to measure air temperature is with an ordinary thermometer, which, however, should be screened if placed near any radiation. Digital and electronic thermometers are also available.

Air humidity. High air humidity reduces the evaporation of sweat and thus constitutes a thermal stress for the worker. It can be measured with a psychrometer. A psychrometer consists of two thermometers and a device to ensure ventilation of the thermometers at a minimum air velocity. The first thermometer is an ordinary one measuring the "dry" temperature. The other thermometer is surrounded by a wet wick, generally made from muslin, and gives the "wet" temperature. The difference between both thermometers is determinant for the humidity.

Air velocity affects both convection and evaporation. It is usually measured with an anemometer. Air velocity is generally difficult to measure because of its rapid fluctuctions in intensity and direction in time.

Radiant temperature is a result of the differences in surface temperature between adjacent surfaces. It can be measured with a black globe thermometer, which is an ordinary thermometer placed in the centre of a black globe made of thin copper.

Climate index

There have been many attempts to solve the problem of how best to combine the measurements of the different variables mentioned above, aiming at having only one figure for indicating the actual strain any particular combination has on the human body.

One of the most generally accepted of many existing indices is the WBGT (wet bulb-globe temperature) index. What most indices fail to consider is the metabolic rate of the human being.

Work

When the climate is very unfavourable (hot, humid, low air velocity) and/or the work is too heavy for the body to dissipate the excess heat, the heart rate will increase and eventually the body temperature will rise.

In Table 3 below a simplified example illustrates how air temperature and air humidity affect the working capacity.

Table 3. Relation between work capacity, air temperature and air humidity.

Air humidity	Air temperature	Work capacity over resting level
100%	25°C (77°F)	17 kJ/min (4 kcal/min)
100%	30°C (86°F)	6 kJ/min (1.5 kcal/min)
100%	35°C (95°F)	0 kJ/min

Source: Guide to Safety and Health in Forestry Work, ILO, Geneva. Fourth Impression 1979.

As shown in the table it is possible to perform quite heavy work when the temperature is about 25°C and the humidity reaches 100 per cent. At 35°C and the same humidity, the body cannot dissipate any more excessive heat than what is produced when resting. The alternative will be an accumulation of heat in the body.

Most people will start feeling sick when the body temperature rises and will automatically slow down their work pace. The lower work intensity which can sometimes be seen in countries with a hot climate is thus not a sign of laziness, but a physiologically reasonable way to cope with the strain.

If this were not done the temperature would continue to rise until it could no longer be controlled and the person would collapse. When discussing workload it is therefore necessary not only to discuss energy expenditure, but also to take the climate into account.

Replacement of water losses

When sweating, the body will lose considerable volumes of water. The water has to be replaced continuously so as not to cause dehydration of the body. The concentration of salt in the body regulates our thirst. Thirst, however, may be insufficient to cover the losses of liquid, especially in heavy work.

Inadequate replacement of water can be discovered by simply checking for weight losses. A reduced weight of 1-2 per cent caused by water losses will lead to an impaired working capacity. For each per cent dehydration of body weight, body temperature will rise about 0.2°C and the pulse rate will rise about 10 beats/min. If the body weight decreases by five per cent there is a risk of exhaustion and collapse. Preferably, the water should be replaced by drinking small quantities several times per hour. Sometimes 5-6 litres per work shift, or even more, can be required. Sweating also means a loss of salt, which has to be replaced. Water and salt can be supplemented by drinking 0.1 per cent salted water if larger quantities of water have to be replaced and the salt contained in food is insufficient. It should be observed that the salt should be taken together with liquid.

Heat stress disorders

Heat reactions are brought about by both internal and external factors and will not only result in physiological reactions but in psycho-physiological reactions as well, which may affect the working capacity and increase the risk of accidents. The mental performance may decrease and behavioural disturbances in the form of aggression, hysteria and apathy, or loss of normal social inhibitions might occur.

In the following, three major conditions are discussed according to their causes, symptoms and treatment, namely: heat cramps, heat exhaustion and heat stroke.

Elderly persons, overweight persons, alcoholics, chronic invalids and small children are in general more susceptible to heat reactions than others.

A. Heat cramps

Heat cramps occur when there is a deficiency of both water and salt, e.g. if the person has been sweating heavily and drinks large volumes of water but with no compensation for the salt loss. It is characterized by painful spasms in the skeletal muscles. The legs and abdomen are likely to be affected first.

First-aid treatment includes the following:

1. Give the victim sips of salt water - one teaspoonful of salt per glass - half a glass every 15 minutes, over a period of about one hour.

2. Exert pressure with your hands on the cramped muscles, or gently massage them, to help relieve spasm.

Heat cramps are often an early stage of heat exhaustion.

B. Heat exhaustion

Usually heat exhaustion is caused by either water loss or a lack of salt, or both. The body temperature can be normal or about 38°C. The victim is very weak and suffers from nausea, dizziness, and perhaps headache and cramps. The body tries to lose heat by excessive pooling of blood in the capillaries of the skin. This reduces the blood supply to the vital organs, such as brain, heart, and lungs.

The skin becomes white or pale, cool and clammy. The person may faint if standing, but will probably regain consciousness if his head is lowered and the blood supply to the brain is improved.

First-aid measures include the following:

1. Give the victim sips of salt water - one teaspoonful of salt per glass - half a glass every 15 minutes, over a period of about one hour.

2. Have the victim lie down with feet somewhat raised.

3. Loosen clothing.

4. Move the victim to a cooler environment or into the shadow and apply a cool, wet cloth and fan the victim.

5. Afterwards the victim should rest for several days and not be exposed to abnormally high temperatures.

Dehydration exhaustion is a form of heat disorder which may occur after several days of work in the heat. If water losses are not replaced daily, progressive dehydration can severely reduce work capacity.

C. Heat stroke

Heat stroke is the most serious of heat disorders and may be fatal. Heat stroke occurs when the body's heat controls fail.

The symptoms are hot, red and dry skin. The temperature is about 41° C and rising. The pulse is rapid and strong. There may be signs of brain disturbances, such as mental confusion, delirium, convulsions or unconsciousness. Heat stroke is an immediate medical emergency and the mortality rate is high. First-aid treatment should always be initiated immediately without waiting for transport to a medical facility.

First-aid treatment includes the following:

1. Cool the body quickly. However, prevent overchilling once the body temperature falls below 39°C.

   Whenever a person's body temperature reaches 40°C, the following first-aid measures should be taken:

- Undress and soak the victim continuously with cold water or rub with alcohol, or place him in cold water until the temperature is lowered.
- Increase evaporation and convection by fanning.
- Do not give the victim stimulants.
- Treat for shock (according to first-aid and emergency treatment).

Prevention of heat stress disorders

A hot and humid environment, with low air velocity, results in a limited evaporation of sweat. It is then necessary to avoid excessive heat stress by facilitating the performance of heavy jobs as much as possible. The solution is preferably not to decrease the number of working hours per day, but to reduce the physical workload, or increase periods of rest, or when possible organize for work in a cooler place during heat peaks.

Examples of how to fit the job to the worker with regard to heat are: scheduling of working hours, provision of shelter, availability of drinking water (and salt):

1. Provide shelter whenever possible, e.g. in nurseries so as to protect workers against the direct rays of the sun during work, or make use of natural shade, e.g. in natural forest leave a few wide-crowned trees as shelter for loading areas and future planting activities.

2. Allow frequent rest periods to allow the body temperature to decrease, preferably under shade near the worksite.

3. Make sure that drinking water is always available. The workers should be encouraged to drink small quantities frequently.

4. Organize the work pattern so that the heaviest work can be carried out in the early morning while the air is cooler, and change to lighter work in the heat of the day. In extreme conditions change to one single session with work only in the early morning or split session with work in the morning and later afternoon.

To some extent it is also possible to improve the worker's fitness for work in a hot climate through proper clothing, acclimatization and physical fitness.

- Clothing

Clothes will have another function and design in a dry climate with or without considerable radiant heat, than in a hot and humid climate, e.g. in the rainforest.

First, clothes should protect against the solar radiant heat but should not reduce evaporation and convection by isolation. Loose-fitting clothes, in bright colours, are usually recommended. The material should be lightweight. When carrying out heavy work it may, however, be better to wear thin and close-fitting clothes, which will be quickly soaked with sweat, and thereby increase the cooling by evaporation.

If the radiant heat load is low the principle is to wear as little clothing as possibe. When working in the forest or handling chemicals in the nursery, etc., clothes are, however, necessary for protection. Particularly in a hot and humid climate this may reduce the working capacity considerably and increase the risk of heat stress.

By making suitable clothes available, the employer can help the worker to adapt himself, as far as possible, to weather conditions.

- Acclimatization

Through physiological processes a person will also adapt to work under heat stress. These processess are called acclimatization.

The most important way for the body to give off excess heat is by sweating. During the first weeks and especially the first two to four days of work in a hot climate this ability will increase. The degree of acclimatization will thus be in relation to how much the person sweats.

The increased rate of sweating seems to occur when the sweat glands have got "trained" to start sweating. The sweat will also have a lower salt concentration when acclimatized. Acclimatization is also accompanied by decreased pulse rate and body temperature at a given work load in a hot climate.

After a break in the work of about two weeks the acclimatization will already be lost. This should be considered when e.g. a worker starts work again after a period of vacation or sick leave, and thus full production cannot be expected during the first week.

- Physical fitness

A physically fit person has a well-developed circulation capacity, as well as an increased blood volume and starts to sweat at lower body temperature, which are essential factors in regulating body temperature. The process of acclimatization is also faster for the fit person than for the unfit.

Health problems in the cardiovascular system or kidneys are supposed to decrease tolerance to heat. Overweight persons seem also to be more frequent victims of heat stress disorders, such as heat stroke.

Cold climate and snow

The other extreme which generally causes inconvenience to the forest worker is a cold climate particularly in combination with snow. Chainsaw operators, in particular, suffer from the cold, which provokes the symptoms of vibration-induced white fingers (see Section 3.2.3 "Vibration").

As already mentioned, the optimal air temperature for a naked human being is ca. 28°C. When the air temperature is lower the body will lose heat by convection and radiation to the environment. To decrease this transfer of heat the peripheral blood vessels, particularly in the fingers and toes, contract so as to reduce the blood flow. In this way the isolating effect of the skin can increase up to six times. Another effect is an increased metabolism caused by an automatic shivering of the skeletal muscles. As the mechanical efficiency will be zero percent, heat production is high. The metabolism may in this way increase three to four times compared to the basal metabolism.

The usual way to protect oneself against the cold when working is to wear proper clothing. The work should also be organized so as to avoid all unnecessary work in open areas when there is wind. The cooling effect is the same at 0°C and an air velocity of 5 m/sec. as at -8°C and no wind at all. Neither very light nor very heavy physical work should be carried out in very cold weather, but an optimal physical activity should be maintained. Work in deep snow should be avoided.

Clothing

Air is a poor conductor of heat and therefore an excellent isolator. Most of the efficient isolators consist of material which encloses air in small chambers. This is also the principle for clothes. The isolating capacity of a cloth depends on its thickness, which normally means the thickness of the layer of air. Between different layers of cloth there is also enclosed air. More layers will therefore increase the resistance to thermal transfer from the body.

3.1.2 Topography

This section will deal with the particular problems related to work at high altitudes, on steep slopes and in remote work places where timber has to be transported long distances to reach roads, waterways or railways, and also to work at a long distance from dwellings and social services.

High altitude

Aerobic power is diminished at a high altitude due to reduced oxygen pressure in the inhaled air. Reduced aerobic power means a decreased physical working capacity.

When a person living at sea level moves to a higher altitude his maximal intake of oxygen will decrease by about 5% or more at about 2,000 metres above sea level. At 3,000-3,500 m. it will be reduced by 10-15%. At 4,000 m., the aerobic capacity is reported by be reduced by about 30%. Individual variation is, however, considerable. Gradually one will acclimatize and the reduction will be only about half. The problem will remain for forestry workers who occasionally have to work at high altitudes, whilst still living at low altitudes. Forest work which is already very heavy under normal conditions will be extremely heavy for these workers, who are not adapted to the higher altitude.

Another problem may occur when the work is carried out in a hot climate and at a low air pressure. Up to about 3,000 m. above sea level the air pressure should not have any major influence on heat stress, but the competition between the demands for oxygen and heat transportation will be bigger when the oxygen concentration decreases (Axelson, 1979).

Steep slopes and difficult terrain

Working on steep slopes and in difficult terrain will very often increase energy consumption considerably, particularly if one has to carry heavy loads such as heavy tools, or pull winch cables.

Special tools and equipment may be needed, such as:

- Planting hoes with a shorter handle when planting on steep slopes.

- Seedlings should preferably be carried in a back pack instead of in baskets carried by hand.

- Footwear with a good grip should be used when working on steep slopes or if the soil is slippery.

There are many additional risks when working on steep slopes with animals such as horses, donkeys, mules and oxen for carrying or skidding timber or loads. When used for dangerous work in such terrain the animals must be well-trained and good-tempered and only led by experienced men. A safe distance from animal-hauled loads should be maintained.

When working with tractors on steep or rough terrain, there is a risk of overturning backwards or sideways. Often this kind of accident is fatal and should be prevented by all possible means. Only experienced tractor drivers with technical knowledge and skill should be employed on dangerous work, such as driving on steep slopes, particularly when the ground surface is slippery or loose and when driving with heavy loads.

If the tractor has a cab or frame strong enough to resist destruction when overturning, the driver's chances of survival will increase considerably. Many accidents could also be avoided by daily checks and regular maintenance of brakes.

Other particularly risky jobs on steep slopes or rough terrain when special attention to safety matters is called for are: felling timber downhill, the use of winches, installations for hoisting and haulage, and timber chutes. Only experienced supervisors and workers should have the responsibility of carrying out the most dangerous activities; good-quality material and equipment should be used; safety checks and maintenance should be regular and frequent; winches and cables must be clearly marked for maximum loads, and safety regulations at the workplace should be strictly followed.

The operations must be so planned that nobody is working in dangerous zones, e.g. no worker should work downhill from other workers when there is the risk of material rolling or sliding down.

Many operations require communication between the workers, but due to long distance or poor visibility the communication may be obstructed. Where this problem is not solved by radio communication, signals by motion of arms and hands and sound signals by whistle or horn are common. Many fatal misunderstandings can be avoided if a clear, simple signalling system known by all workers is employed. No workers should be engaged in such operations before they are familiar with the practical use of the system.

There are many additional difficulties and risks to foresee and prevent when working on steep and rough terrain. But it is beyond the scope of this publication to go into further details.

Work in remote areas

Many forestry operations involve transport over long distances. Workers have to move to remote logging or planting areas daily, weekly or for longer periods. When workers live close to the worksite it is common for them to use a considerable part of their working day for walking between their dwellings and places of work. This is not only time-consuming but also requires a lot of energy. It is common, as well, to travel on timber lorries not equipped or adapted for passenger transport. Many serious accidents occur during such transport. In Section 6.1 "Working and Living Conditions of Forestry Workers in General" problems related to staying in remote areas and in camps will be dealt with in more detail.

Heavy timber from remote logging areas has to be hauled in rough terrain to main roads, waterways or railways. The risk of accidents is high when setting heavy loads such as logs in motion under conditions which are difficult to control. Plenty of strenuous manual work is required, sometimes with the help of animals. The particular problems connected with transport and loading will be further discussed in Section 6.5 "Transport and Loading".

Also seedlings must be transported to remote planting areas. More about plantation work can be found in Section 6.3 "Planting Activities".

3.1.3 Harmful plants, wood, animals, snakes, insects, infections, etc.

Anybody spending much time working in the forest will probably encounter some problems in terms of injuries, infections or allergic reactions due to contact with plants with thorns and splinters, poisonous plants, insects and sometimes even animals. The type of problem will vary greatly with the climate, vegetation, conditions of living and standard of hygiene.

Because the conditions vary so much between different regions only the very general or very severe problems will be discussed in the following.

In general, workers living in the same area as they are working are familiar with the local conditions and know how to discriminate between harmful and harmless plants, animals, etc. and how to behave in case of insury. Workers from other regions or with an urban background have to learn this and adapt to the local conditions.

A. Harmful plants and wood

Not much has been written about the effects on forestry workers of harmful plants, either in terms of injuries from splinters, sharp edges and thorns or allergic reactions from contact with harmful plants.

Problems may arise when workers with no rural background, or from other regions, are recruited. Special attention should then be given to these workers so that they become aware of the risks and are able to recognize the plants, the symptoms of illness and learn about simple treatment. The supervisor may keep specimens and drawings accessible for the workers.

The most efficient way to learn to recognize a plant is to see it in its natural environment. Drawings or photographs, although they are poor substitutes, are widely used. The drawings should not only show the morphology and colours of the plant, but also its natural surroundings. Important seasonal changes should also be illustrated.

In addition, there should be a list of all the harmful plants, fruits and berries in the area. Poisonous mushrooms, berries and fruits are easily mistaken for edible ones.

Around forest villages and camps or other areas where workers (and their families) congregate, poisonous plants should, if possible, be destroyed. If they are burned, this should be done in an isolated place and contact with the smoke should be avoided, as toxic fumes may develop.

Most reactions from contact with poisonous plants are allergic. The reactions are characterized by itching, redness, rash, headaches and fever. Sometimes blisters and swelling will occur. The victim may be ill for several days, or even longer. The symptoms normally appear within a few hours, but may be delayed up to 24-48 hours. Exposed skin should be carefully washed with plenty of cold water. Clothing and tools which have been in contact with the poisonous plants should be washed with soap and water.

Very common types of injuries among forestry workers are cuts, puncture wounds, scratches or abrasions, due to touching or handling stinging plants, or plants which break into sharp splinters and edges or have thorns.

Well-fitting clothing of stout material with ends of trousers and shirtsleeves tied over shoes and gloves, or long gloves or leggings will protect the worker from accidental contact in areas with harmful plants. The first-aid kit should have forceps for the removal of splinters and thorns. When pruning and cutting thorny trees, suitable tools are also essential in order to avoid injuries.

In sawmills, veneer industries, carpentry, etc., residue of resin sap and other constituents of wood can cause allergic reactions after touching or breathing. Susceptible workers should be transferred to jobs with as little contact with the wood as possible. Workplaces should be well ventilated.

Exposure to toxic wood and wood dust is further discussed in Section 6.7 "Wood Processing".

B. Animals

Domestic animals

A number of animals are used in forestry for dragging and carrying loads, e.g. horses, mules, donkeys, camels, oxen, buffaloes and elephants. There is a great risk of accidents occurring if the animals are not treated with care. Only patient and calm persons with experience should be employed to take care of and work with the animals. Even well-trained and good-tempered animals can be spoiled in a short time if treated badly by a nervous and unbalanced person, and may thus create dangerous situations.

It should always be kept in mind to stay in a safe position and keep a line of retreat when near animals so as to avoid being pushed against a wall, or to be in the way of sudden movements of the feet or head of the animal. Particularly when the animal is annoyed by insects and heat, its movements will be unpredictable.

It takes considerable time, effort and experience to train animals for the difficult and hazardous tasks which are common in forest work. After lay-offs the animals should be approached with much care and patience when used in work again. Harnesses, saddles, bridles and other aids should be adjusted for both the worker and the animal, and these aids should be kept in good condition. Reins must never be wrapped around the wrist or body but held firmly in the hands.

When the animals are tethered, too much slack should be avoided as the animal might otherwise get entangled or come into contact with hazardous objects such as barbed or loose wires. As far as possible, the animals should be protected from insects.

Many domestic and wild animals spread diseases to men, such as brucellosis, tularaemia, spotted fever, malaria and rabies. The means of transmitting infection varies for the different diseases and could, for example, be through direct contact, bites from insects or from the animal itself, or consumption of infected food. Cleanliness is always one important preventive measure.

Wild animals

Large wild animals in the forest are generally rare and seldom create problems for forest workers.

Monkeys and apes can sometimes be dangerous, and their behaviour is often unpredictable. They can give nasty bites if irritated. There is a risk of infection in all animal bites, and there is also a risk of tetanus. Most monkeys and apes can be rabid and so it is unwise to entice them to visit campsites by feeding them.

Rabies

Rabies is an infectious disease caused by a number of animals in most parts of the world. Primarily it is transmitted by dogs, but several other animals can be affected and spread it, for example cats, cattle, rats, bats, mice, martens, foxes, wolves, skunk and deer. Rabies is caused by a virus in the saliva of the diseased animal. The virus can only enter the human body through the broken skin, lips and conjunctivae. The virus can be present in a dog's saliva two days before the dog shows any symptoms of rabies.

The virus will easily be destroyed by light, heat and disinfectants when outside the rabid animal or on inanimate objects. It is therefore not necessary to destroy clothing, etc.

The first symptoms appear two to five weeks after infection. The animal may change its behaviour entirely and may display unprovoked aggression. Later it will develop partial paralysis, have difficulties in drinking and will stagger about. Complete paralysis, convulsions and death will follow within a few days.

If bitten by an animal suspected of being rabid, the victim should wash the wounds immediately, with copious amounts of soapy water or detergent, so as to remove as much as possible of the rabies virus. Movements should be avoided until after medical care has been obtained. Medical advice should always be sought as soon as possible, as there is no cure once the final symptoms appear.

Snakes

Most people have a fear of snakes, but on the whole they cause few problems to forest workers. Mostly, snakes seek cover when disturbed. They usually only attack when touched, trodden on, or when they cannot escape.

Bites from even the most venomous snakes do not usually result in death. The mortality has been estimated at less than 10%, mainly because the snake is very seldom able to inject the full dose of venom. Venoms from different snakes affect the victim in different ways, such as effects on the nervous system, on the circulatory system, destruction of red blood cells and disturbance of the blood clotting. Snake bites normally occur on the limbs, especially on the feet and legs.

In areas with poisonous snakes the workers should wear high boots or leggings and the working group should be equipped with a snake bite kit. The employer should have anti-snake bite serum available.

When working in the forest one has to watch where to tread, especially in places where snakes could be resting, for example among rocks and logs, under timber stacks, or hidden by foliage. Stacked material such as lumber should only be moved with an appliance, e.g. a bar, and never with bare hands.

Some poisonous snakes live in trees and may attack men passing underneath, which is another reason always to wear a safety helmet in the forest.

Some knowledge of first-aid treatment is an advantage when someone is bitten by a snake. If possible, the snake should be killed and identified as poisonous or harmless. A careful examination of the bite may also answer that question: marks of two rows of contiguous teeth indicate that it was a harmless snake; two fang marks may indicate that the snake was poisonous. Sometimes there is only one fang mark, and sometimes three to four, depending on how many of the fangs have penetrated the skin.

If bitten by a poisonous snake, treatment is urgent and first aid should be given. The first-aid treatment aims at reducing the blood circulation through the bite, so as to slow down the absorption of venom. The victim should rest and not move the involved body part. The involved part should be in a lowered position, if possible below the level of the heart. The bite should be washed thoroughly with soap and water, or whatever liquid is available. Do not rub. Apply a slightly constricting bandage about 5-10 cm above the bite, between the bite and the victim's heart. The bandage should be snug but not too tight. Do not give the victim alcohol or morphine.

In general, it is not recommended to make incisions followed by suction. Often the incisions will be a bigger problem for the victim than the bite itself. It is better to take the victim to a hospital as soon as possible for an anti-venom injection.

Scorpions, spiders and leeches

There are different species of scorpions. Some can be dangerous. Their sting, by the tail, rarely causes death, but most often nausea, vomiting, abdominal pain, shock, convulsions and sometimes coma.
In a scorpion area it is good habit to "knock-out" the shoes before wearing them. The scorpions are usually concealed under stones and fallen branches etc. during the day.

Most spiders have poison glands, but very few are dangerous. The spider-like tarantulas give bites which are not poisonous, but result in severe wounds.

Leeches are often a problem for forest workers, especially in damp forests, near streams, or in marshy areas. Even when workers wear trousers, puttees and laced high boots, the small land leeches may find their way to the skin. The bites do not give a sensation of pain but will often bleed for some time. Because the bites may cause sepsis they should be treated with care.

If the leech is dragged or pulled from the skin its suction apparatus may be left and cause inflammation and suppuration. To get the leech off, salt or vinegar can be applied. A hot needle or lighted cigarette may also help.

Rubbing an insect repellent on the legs and clothes will prevent the leeches from biting.

Insects

Several diseases, particularly in warm climates, are spread by different insects. The insect can either play the role of a direct carrier of the disease: from man to man, or from animal to man; or it can be the host in which the causal organism multiplies or undergoes certain developments.

The direct transfer can be mechanical, e.g. the causal organism can adhere to the insect's legs or other parts of the body. The insect can then infect, e.g. the food. In the following table some important and common diseases and the insects spreading them are listed.

Table 4. Some examples of insects and the diseases they may spread.

Insects	Diseases
Mosquitoes:	
Anopheles	Malaria, Tularemi
Culex	Filariasis
Aedes	Yellow fever, Dengue fever
Flies	Loa-Loa African sleeping sickness (trypanosomiasis) by tse-tse flies Sandfly fever, Dysentery
Ticks	Relapsing fever, Tick typhus
Fleas	Plague (from rat to man)
Mites	Scabies, itch, scrub typhus fever
Lice	Epidemic typhus fever, Relapsing fever

One of the most important diseases among forest workers in many developing countries, particularly in the tropics, is malaria. Malaria is caused by certain mosquito species belonging to the tribe of the night-flying Anopheles. Since the late seventies the incidence of malaria has increased dramatically due to the parasite becoming resistant to many preventive medicines.

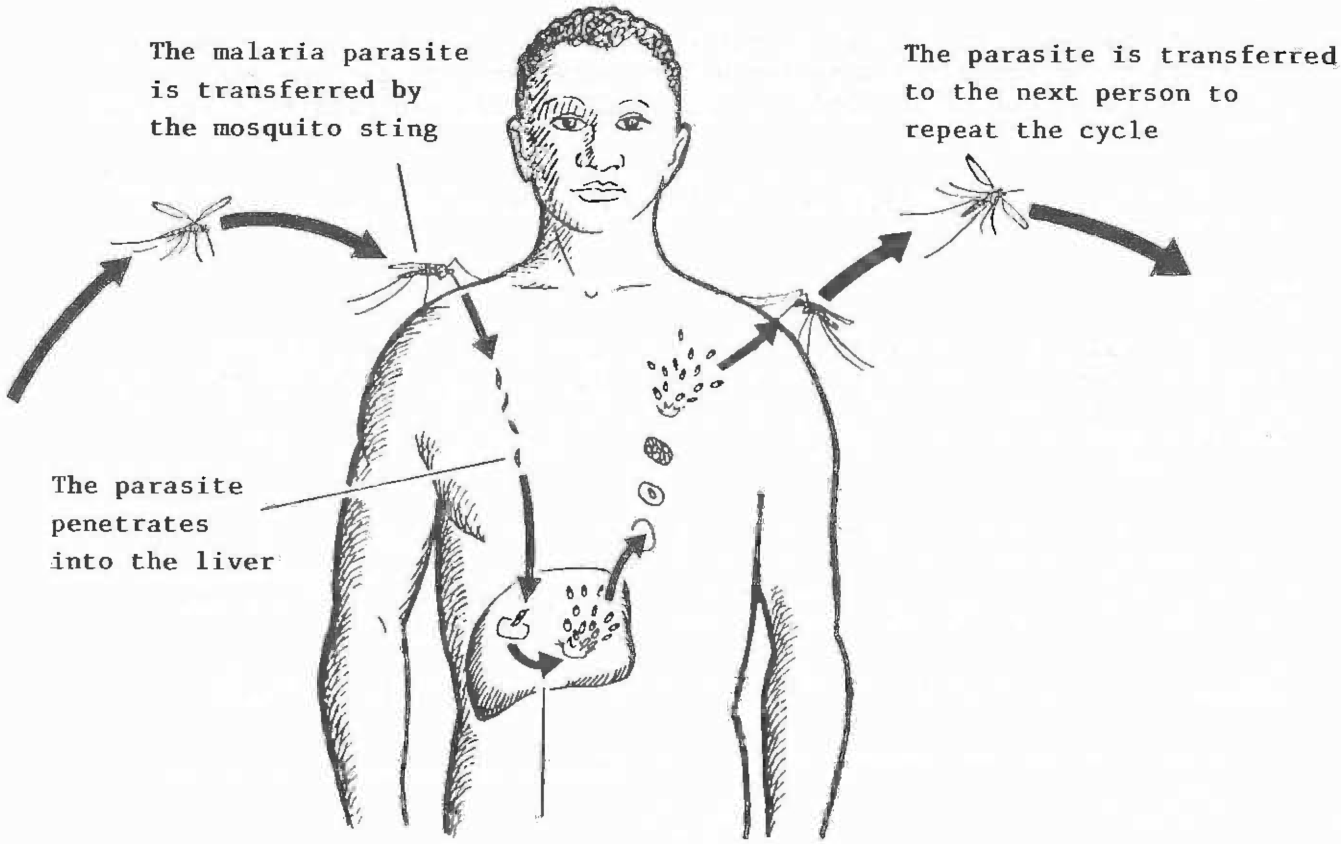


Figure 21. The three phases of the life cycle of the malaria mosquito.

The victim will have fever for some days, which occurs when the red cells burst and release their parasites (see the life cycle of the malaria parasite in Figure 21). Anaemia will follow the repeated loss of haemoglobin. The spleen will enlarge when taking care of the ruptured red cells. The victim may recover, die or survive but with a number of parasites left in the body causing ill health.

The symptoms of malaria are more or less the same as for many other fevers in the tropics. It is, however, easy to identify the malaria parasite by microscopic blood tests. The parasite can then be killed in the blood by anti-malarial drugs. The anti-malarial drugs can also be used as prophylaxis. Other preventive measures are: to use protective clothing between dusk and dawn, which is the time when the anopheline mosquitoes usually bite. The use of insect repellents and a mosquito net over the bed when sleeping are other measures which may be taken.

Of all the diseases spread by insects which trouble many forest workers, only malaria has been briefly discussed here. There are many other diseases spread by insects, not so widespread or common as malaria, but which are nevertheless a serious problem, locally or regionally. Forest workers, and other staff, should therefore be aware of and have knowledge about preventive measures and simple treatment.

Infections

Infections and poor health are common among forest workers in many developing countries, and the reasons are several. Living conditions are usually poor with insufficient sanitary and hygiene facilities, the diet often lacks proteins and vitamins, and the calorific content is generally low, the drinking water may be contaminated, medical services are very often poor, if any, and clothing inappropriate. Many diseases are endemic to the tropics. Forest workers may continously be suffering from poor health, which certainly will affect their efficiency and work output, and cause frequent absenteeism.

Common infections among forest workers are: fevers, e.g. malaria; respiratory tract infections, e.g. coughs, colds, tuberculosis and throat infections; intestinal infections and skin infections, e.g. boils and sting worm; and other diseases, e.g. tetanus and tropical ulcers, resulting from sometimes trivial injuries, such as abrasions and cuts.

Reservoirs, sources and ways of transmission of infections

Infection reservoirs, see Figure 22, are man, animals or soil. The reservoirs will above all serve as a guarantee for survival and multiplication in such a way that the causal organism can be transmitted to an appropriate host.

Sources of infections are man and animals which will excrete the causal organism, and contaminated objects, food, water, air, etc.

Ways of transmission are for example direct physical contact between the infected person (or animal) and the non-infected; indirect contact when the causal organism is spread via contaminated objects or a third person.

The length of time the different causal organisms can survive outside the host vary considerably - from, for example, a few hours to some months. Good hygiene, particularly hand-hygiene, is an essential preventive measure. Other means of transmission are via water, food or blood.

Examples of diseases spread by drinking water and food are typhus, paratyphus and amoebic dysentery. A disease, such as schistosomiasis (or bilharzia) is spread by worms in the water when bathing, or walking on wet grass. It may cause skin, liver or kidney problems.

The causal organism can also be carried by a vector, such as mosquitoes, flies and ticks. For certain diseases the vector also serves as the reservoir and not only as a carrier.

Finally, air is also a transmitter of infections, and then the infection is spread either by dust or aerosol. Preventive measures would be to keep a sufficient distance or through isolating the source of infection from susceptible persons.

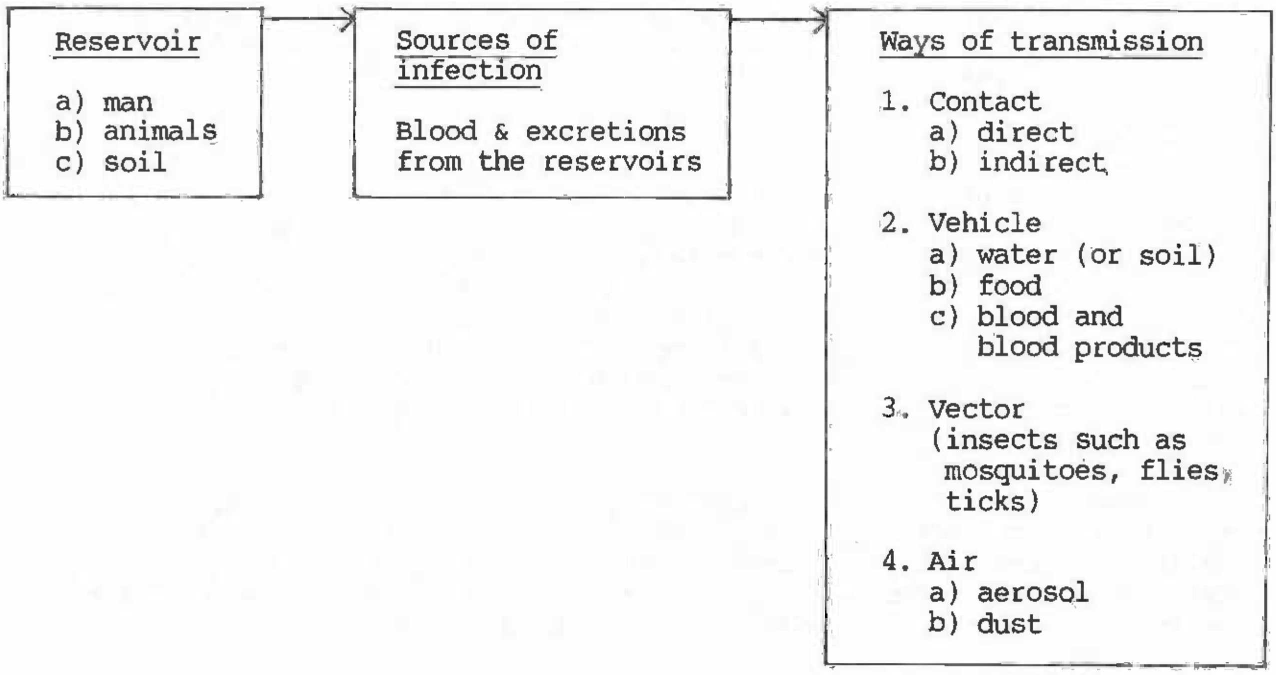


Figure 22. Reservoirs, sources of infection and different ways of transmission of infections.

Below is a list of the commoner diseases, with their causes and comments on prevention, etc. An estimate of their frequency is also included.

Disease	Frequency	Cause	Comments
Anaemia	Common	Poor nutrition. Folic acid destroyed by prolonged cooking. Lack of protein. Malaria: Destroys folic acid reserves. Blood loss: Hookworm and other parasites.	Education in nutrition Eradication of malaria Proper disposal of faeces - hookworm dropped in faeces enters through the feet of passers-by
Diarrhoea	Very common indeed	Bacillary dysentery: Amoebic dysentery: Contaminated water and food, flies. Food poisoning: Keeping cooked foods, reheating. Typhoid: Infected water supplies, direct contamination of food by hands. For all: Washing uncooked fruit and vegetables in contaminated water.	Proper latrines, washing hands Boiling drinking water Education in care of and cooking food Proper latrines, washing hands Boiling drinking water
Guinea worm	Common	Ingestion of infected cyclops (water flea). Rupture of skin and emergence of adult worm 12-18 months after infection. Worker incapacitated when worm becomes adult.	If worm dies or is broken during extraction, severe inflamation of the tissues (cellulitis), septicaemia or infective arthritis can result. Tetanus is a well-known complication of guinea worm
Hypertension	Very common in women, fairly common in men	Two types - the usual type is benign; cause unknown but it is thought that the carrying of head loads is a causative factor. (Very serious in young men in late teens or early 20's)	Never exceed the legal limit for head loads, particularly for young people
Malaria	Endemic - all workers affected	Anopheles mosquito bites infected human and carries the disease on.	Spraying of workers' houses, draining of stagnant water. Regular use of quinine drugs.
Muscular diseases	Fairly common	Climate is an important factor. Lumbago and general backache caused by climate and lifting.	Damp clothes should not be worn; when home, change to dry clothes. Emphasis on correct methods of lifting.

..../...

Disease	Frequency	Cause	Comments
Ochnocerciasis	Fairly common in tropical Africa & Central and South America	A chronic non-fatal disease caused by a nematode carried by the simulium fly. Fibrous nodules appear on the skin. Also causes blindness.	Occurs mainly from 10^{o}-20^{o}N in West Africa, in the savanna areas Avoid bites and control the vector
Respiratory tract infection	Very common indeed, esp. sinusitis and bronchitis	Climate encourages these diseases and tropical rain forest is ideal.	
Schistomoniasis (Bilharzia)	Common	A blood fluke which enters through the skin while victim is immersed in infected water. Sources: water infected by contaminated faeces and urine. Certain streams and pools are known reservoirs. There are many others.	Also a cause of anaemia through blood loss in stool and urine Prevention: Non-contamination of water. Limited time in and then a very brisk rub down with a rough towel of all body surfaces Health education
Tetanus	Endemic	Clostridium tetani. Reservoir is in infected animals and man. Immediate source of infection: soil, dust, animal and human faeces. Enters the body through injury, often trivial.	Of importance to forestry workers who are liable to punctures and other wounds and may well be in infected areas Prevention: Anti-tetanus toxoid and treatment if wounds contaminated with soil or faeces
Tropical ulcers	Common	Abrasions and cuts.	Abrasions should be cleaned and covered as soon as possible (provision of good diet, washing facilities and first-aid services has abolished tropical ulcers from labour forces of well-run estates)
Tuberculosis	Very common	Infection spread by droplets and contaminated dust and by coughing, spitting and poor housing (over-crowding - all one room).	Health education: coughing covered - avoidance of spitting. Treatment if chest complaint suspected. Massive eradication very difficult

Source: Oseni and Ward, 1972 in FAO, 1976: Harvesting man-made forests in developing countries.

3.2 Technological and Organizational Factors

In Section 3.1 "Biological and Physical Factors", the focus was on factors which mainly originate from nature itself. In this section, man-made factors, which are of great importance for the working environment in forestry, will be dealt with. In particular, the harmful physical effects of different common technologies such as the noise and vibration from chainsaws will be described. The work organization is (not in all, but in many cases) a result of the chosen technology. At least it is never independent of the technology. The organizational factors will, however, be only briefly discussed, primarily when the organization of work could be seen as an example of a preventive measure against health problems.

3.2.1 Design, use and maintenance of tools and machines

In Section 2, mention was made of the importance of appropriate design, working techniques and maintenance of tools as a means of reducing physical workload and energy requirements as well as avoiding static work postures.

Starting with the design, the first requirement should be a design which is both safe and efficient. There should not be obvious risks of accidents and work-related diseases, or unnecessary fatigue. We can take the simple example of a wooden handle of a tool, e.g. an axe or a planting hoe. To avoid accidents the following should be considered:

- the handle should be fitted to the axehead or blade in such a way that it does not fall off during work;
- the handle should have a knob at the end so as to give a better grip and to avoid slipping;
- the material should be strong enough to stand the stress and not break easily.

To avoid static work, uncomfortable work postures and inefficiency:

- the shape of the handle should fit the grip of the human hand, e.g. have an oval shape;
- the handle should absorb shocks which arise when the axe hits the tree or the hoe the ground. With an S-shape the shocks will only be partly transmitted to the hands or wrists;
- the length and weight of the handle should be appropriate for the type of work to be done and to the height of the worker.

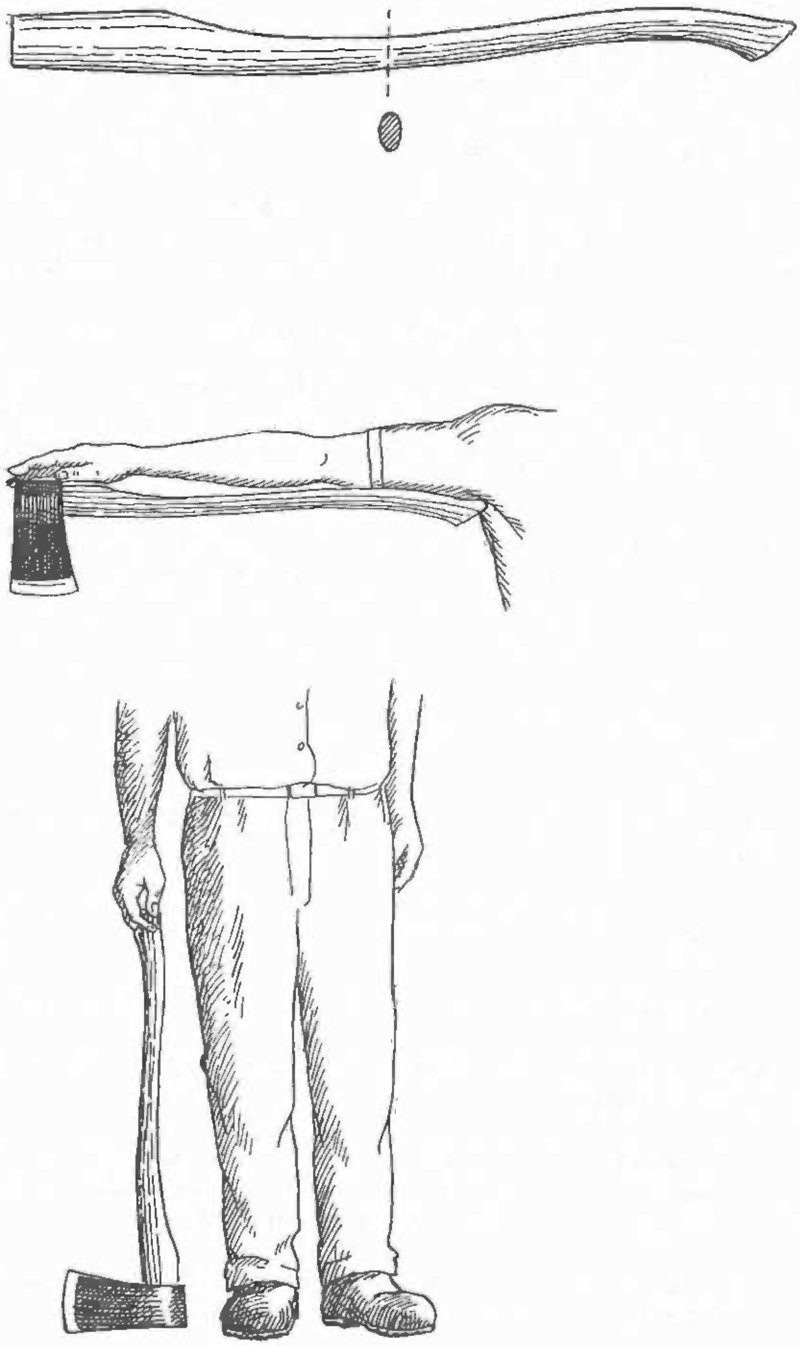


Figure 23. An ergonomic design of an axe handle: the S-shape will help to absorb shocks, the oval shape will fit the grip of the hand, the knob at the end will prevent slipping, and the length will be appropriate for the particular user.

Tools also have to be used in the proper way using the correct working technique. This will be discussed further in Section 5.2.1.A, Appropriate technology.

The same applies to maintenance. A tool which is both ergonomically designed and used by the worker with the correct working technique, will still be a poor tool if poorly maintained. A bowsaw with a blade which is not sharpened, or is sharpened in the wrong way, will require much more of the worker's energy and time than a well-maintained saw, when doing the same amount of work. In many cases a poorly maintained tool will increase accident risks and health problems as well.

It will not be possible to go into detail concerning the design, use and maintenance of the various tools, machines or other equipment used in different forestry activities. The intention at this stage is to stress the importance of these aspects and to recommend further studies and training in the subject. Good books on maintenance of tools exist, for instance, references 57 and 22.

3.2.2 Noise

The development of technology used in forestry has been accompanied by an increased number of noise sources and higher noise levels. In many countries, where mechanized logging methods have been introduced, noise is looked upon as one of the big problems in the working environment for forest workers.

The harmful effects of noise are related not only to a physiological loss of hearing, but to increased accident risk as well as psycho-physiological effects.

Individual reactions to exactly the same noise can vary between individuals depending on their different attitudes to the particular sound source. No matter whether the sound is appreciated or not, it may cause a loss of hearing when the level is too high and exposure too long. Therefore it is necessary to make objective measurements of the noise to know whether it is harmful or not and when preventive measures should be taken.

Sound

Sound is a mechanical disturbance propogated as a longitudinal wave motion in air or another elastic or mechanical media, such as water or steel.

Noise

In the following the definition used in ILO Convention No. 148 (1977) concerning the protection of workers against occupational hazards in the working environment due to noise, vibration and air pollution will be used: "the term "noise" covers all sound which can result in hearing impairment or be harmful to health or otherwise dangerous".

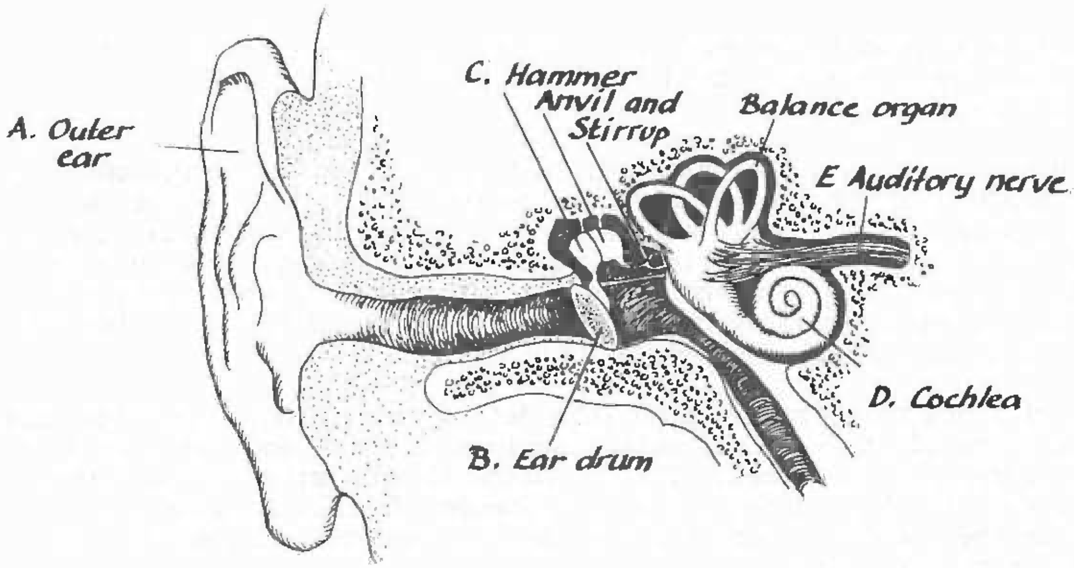


Figure 24. The human ear.

The human ear

Organs for hearing and balance are located in the human ear.

The sound waves are caught by the outer ear (Fig. 24A) and travel through the auditory canal. This canal is the inner part of the outer ear and ends with the ear drum (Fig. 24B). The waves start to vibrate the ear-drum. From the ear-drum the vibrations are led to the three amplifying ear-bones: hammer, anvil and stirrup (Fig. 24C). The vibrations pass through to the cochlea (Fig. 24D). The fluid in the cochlea affects the hair-cells. There are more than 20,000 hair-cells and they are the beginning of the auditory nerve (Fig. 24E). The auditory nerve transmits the signals to the brain and the brain interprets them as sounds.

When the hair-cells are exposed to very strong movements they might be damaged - temporarily or permanently. How noise affects the human being will be discussed later, but first something will be said about the physical characteristics of sound.

Physical Characteristics of Sound

There are two basic characteristics of sound, namely: sound pressure level, and frequency or pitch.

Pressure

Sound propagates as wave motions, e.g. in the air. The air particles nearest to the sound source are first set in motion. The motion is then spread to air particles further away from the source. In this way there will be small and regular fluctuations of the air pressure, which will affect the ear-drum.

These fluctuations of the air pressure are called "sound pressure" and can be measured.

To measure the sound pressure it is essential to describe the sound level. The measure for sound pressure (Pascal, Pa) does not, however, give the idea of how variations of the sound level are experienced by the human ear. Hearing follows a logarithmic curve of intensity, which is the case also for many other physiological sensations. Therefore a logarithmic unit, the decibel (dB) has been devised.

The number of decibels gives the sound pressure level, compared to a reference level, zero dB.

The scale is logarithmic. A sound with an intensity 10 times stronger than the reference level is said to be 10 dB. At 90 dB the sound pressure is 10^9 = 1,000,000,000 (one thousand million) times stronger than the lowest audible level.

The logarithmic scale raises problems when adding or subtracting different sound pressure levels. For example, if the number of noise sources is doubled, the pressure level will rise by +3 dB. If the number is increased 10 times, the pressure level will rise by +10 dB. Consequently, if a machine's sound pressure level is doubled from an original 70 dB, it will count 73 dB - not 140 dB.

Regardless of the initial sound pressure level, a change of e.g. 3 dB will have the same effect on how the human ear experiences the size of the change. An increase of 10 dB gives the subjective impression of approximately a doubling of the sound pressure level. Loudness is, however, a function of both intensity of the sound and the frequency (the number of vibrations per second).

Frequency

The number of fluctuations per second of the air pressure gives the pitch of the sound, and is expressed in herz (Hz). (Previously it was given in cycles/sec.)

Frequencies between 16-20,000 Hz are the normal hearing range. The human ear, when normal, can detect sounds within that range. Frequencies below 20 Hz are called infrasound, and above 20,000 Hz, ultrasound.

Normally, a sound is a mixture of many frequencies, and can be classified as wide-band (incorporating a wide range of frequencies), or narrow-band (incorporating only a few frequencies). The combination of frequencies is known as the spectrum of the sound. A sound of a certain volume is experienced by the human ear as less loud when the frequency is low.

Sound pressure levels are measured in dB, and sound levels are measured in dB(A), dB(B) or dB(C). The indices A, B and C show for which frequencies the sound pressure level has been weighted. It is weighted by the use of a filter on the measuring instrument, filtering out certain frequencies. When measuring noise at workplaces, the (A) filter is used, measuring the noise in a similar way to how it affects the human ear. The ear is, as mentioned earlier, less sensitive to certain frequencies.

The volume in dB(A) and the effect on human beings of some common sounds are shown in Table 5.

As shown in Table 5, the threshold for pain, with normal hearing, is in the range of 110-130 dB. Pain is not, however, a sufficient warning signal to avoid damage to hearing.

The critical level for hearing damage, when exposed 8 hours a day for several years, is 85 dB(A). Exposure to levels below 85 dB(A) will rarely lead to loss of hearing. At 85 dB(A), hearing may be damaged. For an estimated level of 90 dB(A) or more, damaged hearing is to be expected from a daily exposure time of 8 hours or less.

It is not possible "to get used to" noise, in the sense that a high noise level will not be harmful in the long term. Ears must be protected against noise, otherwise a loss of hearing will result.

Effect of Noise on Human Beings

Noise may affect human beings in a number of different ways, and not only their hearing capacity. The effects can be divided into three groups:

(a) effects on hearing capacity - temporary or permanent effects
(b) effects on other parts of the body - direct or indirect effects
(c) mental and social effects - effects on safety and efficiency.

(a) Hearing loss depends on the intensity of the noise, the frequency value and the duration of exposure

Hearing loss is the difference between the audibility threshold and the standard reference zero at each frequency as defined in International Standard ISO 389-1975. Impaired hearing is when the hearing loss exceeds a designated criterion - commonly 25 dB, averaged from the threshold levels at 500, 1,000 and 2,000 Hz.

When hearing loss is the result of prolonged exposure to noise, the hair cells in the inner ear have been damaged, and the injury is broadly speaking irreversible.

The hearing loss can also be the result of very intense, or explosive sounds. In such cases the eardrum can rupture. The structures of the middle and inner ear can also be damaged.

The hearing loss can also be temporary; a so-called noise-induced temporary threshold shift. A loss of hearing may occur from exposure to intense noise but the hearing capacity recovers after a period of time spent in silence. The extent of the hearing recovery varies, individual differences and the type of exposure are factors affecting the recovery.

Table 5. Sound levels and examples of noise sources and the effects on human beings.

Sound level in dB(A)	Example of source of noise	Effects on man
0	-	Threshold for hearing
10	Rustling of leaves	
30	Whispering	
50	Low conversation	
60	Normal conversation	
70	Private car	Speechmasking
80	Loud shouting - 1 metre	Threshold for physical discomfort
90	Framesaw	Damaged hearing (at 8 hrs exposure daily)
100-110	Chainsaw	Damaged hearing (at ca. 1 hr - ca. 4 min. daily exposure)
110-130	Propeller plane, wood chipping machine	Threshold of pain for normal ears
above 130		Risk of mechanical damage

(b) Effects on other parts of the body

Throughout the animal kingdom the sense of hearing is primarily an awake system. This basic function still remains also in human beings. When steepening the acoustic sense is a most effective awaken from sleep. Laboratory tests have shown that noise also affects the autonomous nervous system. Examples of such effects are: raised blood pressure, increased pulse rate, constriction of capillary blood vessels, increased muscular tension and dilation of pupils. The intestines and endocrine glands are also affected. These reactions are related to stress. They are examples of reflex responses aiming at preparing the organism for facing a possible danger by being ready for fight, flight or defence. These reactions are also influenced by social and cultural factors.

(c) Mental and social effects and effects on safety and efficiency

Other effects than reflex responses of the autonomous nervous system and loss of hearing are more difficult to prove. Effects such as fatigue, annoyance, non-specific health disorders and effects on mental health are aso influenced by social, cultural and subjective factors. The factors will affect individual reactions to the same noise. Not only is the level of sound important, but also other characteristics such as the content, e.g. whether the sound provides a message or not; if it is predictable or unexpected; and if it is a steady or non-steady-state noise. Noise with negligible small fluctuations of level during the period of exposure is steady. A non-steady-state noise shifts significantly, e.g. fluctuating noise, intermittent noise or impulsive noise. In particular, impulsive noise (i.e. noise of very short duration, at a level significantly above the background noise and separated by short intervals) should be taken into account as being harmful.

When the noise level hinders communication between workmates, it will lead to social isolation at work.

Investigations have shown that a reduction of noise is commonly accompanied by a decrease in errors, and an increase in production. The effects on efficiency are, however, difficult to measure and may vary with the situation, and subjective uncontrolled factors. Generally, noise is more disturbing, even at lower levels, when performing a mental activity rather than physical work.

Noise can also interfere with speech. When the speech level exceeds the noise level by 10 dB there will be no interference. When the difference is less, the voice must be raised, which is tiring and may lead to misinterpretation. When the noise level is so high that warning shouts or signals are masked it can lead to accidents.

Noise control

The general principle for noise control is that preventive measures should be borne in mind already at the design stage of a workplace, machine, tool or equipment. To make corrections afterwards is usually more expensive, less efficient and may even raise new problems in the production process.

The following are some ways of control:

Eliminate or minimize noise production by choosing alternative methods, designs, equipment and materials (e.g. use a bowsaw instead of a chainsaw when trees have small diameters). Before purchase, the noise level requirements should be discussed with manufacturers.

Prevent propagation, amplification and reverberation of noise. Many noise sources, such as motors in operation, not only produce airborne noise, but the noise can spread throughout the whole building, by taking different paths. Such noise sources should be installed with vibration-damping bases, isolated from the floor and walls. The prevention of propagation of air- and structure-borne noise should be taken into account in the planning and design of buildings, and in the spacing and distribution of workplaces. For example, noise sources which are unavoidable may be placed in an isolated room or area to minimize the number of workers exposed to them. Prevention of noise propagation should be done near the sources. The noise may be enclosed, completely or partially. Sound barriers, sound-absorbing linings or panels in the ceiling may be installed to reduce part of the noise, its reflection and echo effects.

A person working near a noise source is mainly affected by the noise coming direct from the source. Therefore, the most efficient way of reducing the noise is at the source itself.

Adequate maintenance of machines and equipment may also reduce the noise level considerably.

When all efforts to control noise by using alternative techniques and methods, appropriate design of buildings and equipment and proper installation and maintenance of machines, fail, or if these methods are not applicable, the workers needs constantly to wear ear protectors, and the duration of exposure to noise should be limited.

The latter two alternatives are the only means of protection for chainsaw operators. Today, all chainsaws have noise levels which far exceed 85 dB(A). This situation is likely to continue in the foreseeable future.

The length of time of exposure can be limited by modifying the work organization and applying job-rotation and job-enlargement. A silent environment should also be maintained during breaks from work and at mealtimes.

Audiometry - Measuring and Assessing of Hearing:

As already stated, the human ear is more sensitive to sound levels of certain frequencies. It is most sensitive in the 1,000-4,000 Hz range. This is also the most important frequency in interpreting human speech. A critical factor in interpreting speech is the correct perception of the consonants. Consonants are pitched at higher frequencies than the vowels, which are mostly pitched below 1,000 Hz.

It may take up to 10-15 years to develop hearing damage, unless the damage has been caused by, for example, an explosion or rifle shot near the ear. In the early stages of deafness caused by industrial noise, only the hearing of higher frequencies (in the 4,000 Hz range) is affected, and the individual will hardly notice the loss of hearing. It can, however, be measured. If the daily noise exposure continues, the progressive loss of hearing will eventually reach the lower critical frequencies. Difficulties in understanding a conversation will occur in the 300-3,000 Hz range.

The technique for measuring hearing - how the ear and brain perceive sound - is called audiometry.

Regular audiometric examinations should be carried out among workers exposed to daily high-level noise. The purposes of audiometric examinations are:

- to identify individuals showing signs of hearing loss;
- to get a screening of the hearing status of the workforce and its changes over time;
- to assess the effectiveness of noise control measures.

The audiometric measurements should preferably be part of a noise control programme and include detailed noise surveys of all workplaces as well as individual noise dose measurements (dosimetry). Assessment of noise conditions may lead to different measures being taken, applying engineering or administrative methods; provision of ear protectors and information to exposed workers.

3.2.3 Vibration

Vibration, like noise, is the transmission of mechanical energy from sources of oscillation. When talking about "vibrations" one usually means oscillation of such a frequency and amplitude that it is perceptible with the sense of feeling.

Vibration is described by its acceleration (m/s^2), its frequency (oscillations per second = Herz (Hz)) and type of vibration, e.g. sinus vibration.

Vibrations transmitted to the human body are generally divided into two groups: whole body vibration or local vibration (mainly hand-arm vibration), mainly depending on the point of transmission to the body and the frequency of vibration. It is, however, often difficult to distinguish where the border is between the two groups.

The effects of vibration on man can vary from feeling slightly sick (e.g. sea sickness, travel sickness) to severe physical injuries (vascular spasm, back trouble). The problems may start after even a short period of exposure. Vibrations with different frequencies cause resonance phenomena in different parts of the body.

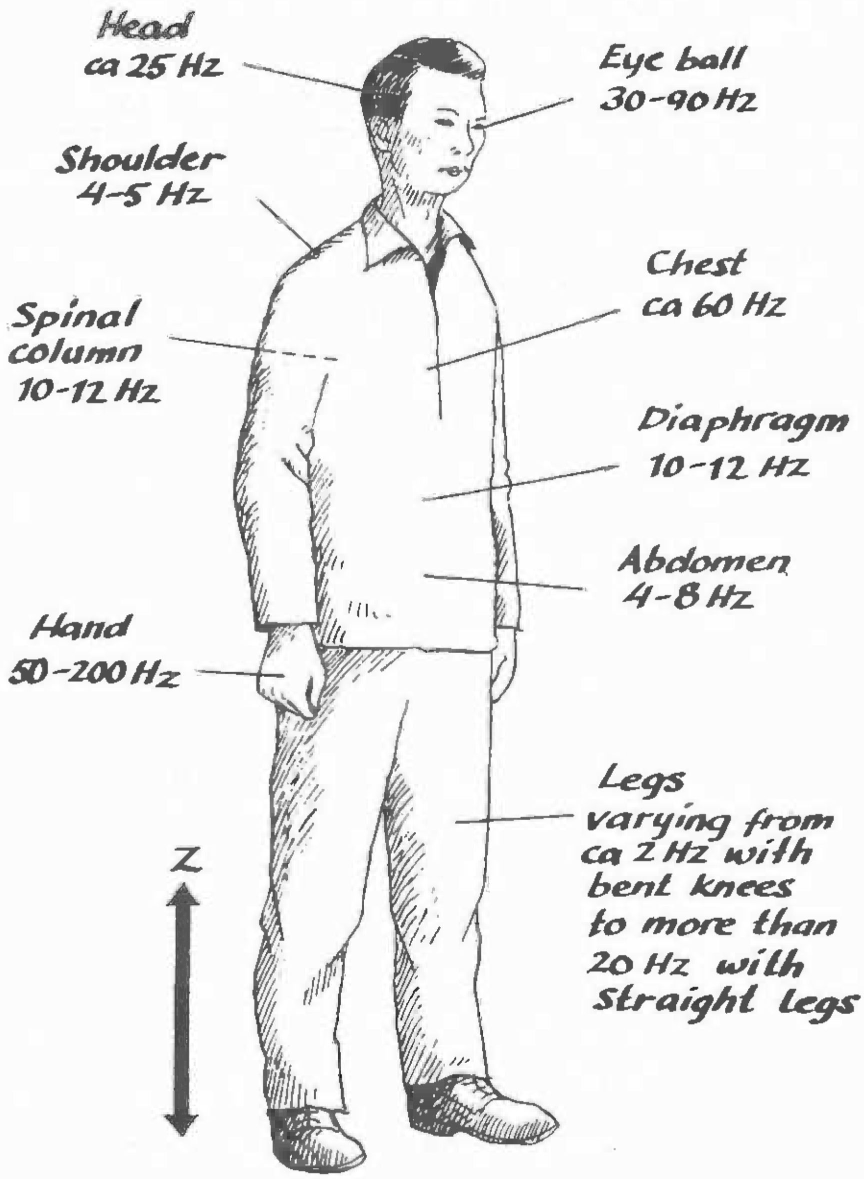


Figure 25. Frequencies for resonance in different parts of the body in Z direction.

Whole Body Vibration

At higher frequencies the vibration will cause more severe disturbances. The disturbances are often grouped in the following way:

- discomfort (physical and/or psychological)
- disturbances of functional capabilities
- injuries (reversible and/or irreversible)

Besides the physiological disorders vibration may also lead to tiredness and lower work output.

The nature and magnitude of the effects depends mainly on the vibration's frequency, intensity and direction, on the duration of exposure, body posture and part of body in contact with the sources of vibration.

Whole body vibrations may affect a sitting or standing person through the buttocks and feet, e.g. while operating a tractor or standing on a vibrating floor or foundation, for instance in a sawmill.

Vibrations between 1-20 Hz are particularly disturbing and tiring and these are also the frequencies which dominate in vehicles and industry.

The vibration will then pass through the whole body, with almost no lessening of intensity. This regardless of the vibration's point of application on the body. Frequencies of 4-5 Hz and 8-12 Hz also cause resonance phenomena which make them particularly harmful.

In forestry, machine operators frequently complain about back and neck troubles in connection with whole body vibrations. Other common complaints are pain in the chest and stomach, muscle cramps and breathing difficulties.

Exposure to whole body vibrations also affects the central nervous system and may disturb the metabolic processes and also increase energy losses of the organism. High levels of whole body vibration may also damage internal organs. Even sight may be affected.

Hand-arm-vibrations

Hand-arm vibrations are high-frequency vibrations transmitted to the worker from powerdriven handtools. In forestry this refers to chainsaws.

The vibrations affect the tactile sense of the fingers and hands. The phenomenon is known as "vibration-induced white finger" - VWF, with symptoms similar to Raynaud's phenomenon and Traumatic Vasospastic Disease - TVD.

The small intricate blood vessels in the skin contract and the blood cannot circulate. This causes a discolouring of the fingers and may also result in a temporary loss of the sense of touch in the fingers. Other types of vibration effects are injured nerves. This will appear as numbness and tingling feelings, often during the night. Bones, joints and even muscles can be affected. Bone injuries appear as small hollows in the bones of the fingers, and the injuries in joints and sinews appear as inflammations. Often it will take several years before the injuries appear.

The initial symptoms are trivial, starting with tingling and/or numbness in the fingertips. Later on, occasional blanching, with numbness and pain, will occur in one or more fingers, particularly during cold weather. In the later stages these attacks occur frequently, also when it is not cold.

The attacks during later stages are accompanied by a reduced ability to hold and control any object, such as working tools or the steering wheel of a car. Most individuals reaching the later stages have to give up any job or activity involving vibrating hand-held tools. In extreme cases ulceration may occur at the fingertips, sometimes accompanied by gangrene.

Usually the first sign of white fingers occurs after regular exposure to vibration for an extended period of time (from weeks to many years). Investigations show big individual differences in sensitivity, and that smoking habits may have an influence.

These symptoms can be graded according to a special scale shown below, for symptoms of Raynaud's phenomenon after Taylor and Palmear (1975).

VWF STAGE	CONDITION OF DIGITS	WORK AND INTERFERENCE
O	No blanching of digits	No complaints.
O_t	Intermittent tingling	No interference with activities
O_n	Intermittent numbness	" " " " "
1	Blanching of one or more fingertips with or without tingling and numbness	" " " " "
2	Blanching of one or more fingers with numbness. Usually confined to winter.	Slight interference with home and social activities. No interference at work.
3	Extensive blanching. Frequent episodes. Summer as well as winter.	Definite interference at work, at home and with social activities. Restriction of hobbies.
4	Extensive blanching of most fingers; frequent episodes in summer and winter.	Occupation changed to avoid further vibration exposure because of severity of symptoms.

Combatting Vibrations

As in the case of combatting noise, the prevention of harmful effects from vibrations will include different measures, which are mainly technical and organizational.

The first solution to try should always be the elimination of the vibrations, for example by choosing an alternative method, machine or tool, which does not generate vibrations.

When this is not possible, a reduction of the vibration at source should be tried by, for example, another design or better maintenance of the machine or tool.

Another alternative is to prevent the vibrations being transmitted from the machine or tool to man, by remote control, by absorption or by short-circuiting the vibration. The vibrations being transmitted to the worker can be reduced by different damping elements. In the case of chainsaws, damping (rubber) elements are placed between the engine unit and the handle unit. In addition, the handles should be covered with rubber.

Even in cases where measures have been taken to reduce the vibrations at the source of their transmission to man there may still be a need for the use of personal protective equipment.

Personal protective equipment, such as gloves (of good quality) can be seen as an additional, but insufficient, damping element between the handgrip and the worker's hand. In a cold climate it is also important to keep the hands warm and dry. (On some chainsaws used in cold climates, the exhaust gases are led into the handles so as to keep the hands warm.)

There is evidence that the introduction of chainsaws with anti-vibration systems has improved the situation greatly. In spite of this, no chainsaw available today (1987), regardless of anti-vibration systems, can be classified as "safe" as far as VWF is concerned. Because of this, but also because of the long-term nature of the disease, hand-arm vibrations will continue to be a problem for many chainsaw operators for a long time ahead.

The White Fingers disease has been well-known in the industrialized and temperate countries for decades. In spite of this, no information was available as to whether chainsaw operators in the tropics suffered from the disease. As cold is known to provoke the problem of VWF, the disease has been supposed to be a problem particularly for countries with a cold climate. A small study in the Philippines (1984/85) however, gave indication that this is a problem also in tropical countries.

Since there is a risk that available preventive measures including damping elements and gloves will prove inadequate, it may be necessary to apply a daily exposure limit. This has already been introduced in some countries, such as Japan, the Netherlands and Czechoslovakia. It may therefore be necessary to change working routines and to introduce job rotation to decrease the time of exposure.

When somebody is to be employed on a job where he or she will be exposed to a lot of vibrations, information about the risks should be given. Regular follow-ups should then be another measure to prevent problems.

Some advice to the user of vibrating machines:

- Use gloves (and keep the hands warm and dry in a cold climate).
- Let the tool do the work and apply as loose a grip as possible - but without losing control of the tool's movements. The chainsaw should, for example, rest as much as possible on the stem.
- Avoid or decrease the consumption of tobacco, as nicotine will diminish the blood flow to hands and fingers and thereby make the problem worse.
- Seek medical advice if attacks of white or bluish fingers occur or if long periods of tingling sensations or numbness in the fingers occur.
- Inform the supervisor in case of abnormal vibrations.

3.2.4 Harmful substances, e.g. chemicals, solvents, gases, smoke and dust

In this section an account will be given of how harmful substances in the working environment can affect man. Examples of such substances are chemicals, solvents, gases, smoke, fumes and dust. Every day new substances are introduced at workplaces. In most cases it has never been examined whether they are harmful or not. Often investigations begin only after the workers show symptoms of diseases. Therefore all such substances should be handled with the greatest care, bearing in mind that they might be harmful.

When the body is exposed to a harmful substance over a long period of time or when the concentration is too high, the body's capacity to purify them will be insufficient.

The effects can either be acute (disappear after a certain time) or chronic (lasting). Common symptoms of acute effects are headache, dizziness and vomiting. These can easily occur when using various solvents. Exposure to solvents can also have chronic effects on the nervous system, causing increased fatigue, impaired reaction time and memorization. Bigger amounts of the solvent will be stored in the brain, for example, when:

- the concentration in the air is high
- the physical workload is big (the air intake will increase)
- the solvent is readily diffused or suspended in air
- the exposure time is long.

There are three ways in which a dangerous substance can enter the body, as illustrated in Figure 26.

Inhaling   Skin contact   Ingestion

Figure 26. Three different ways a chemical can cause injury.

- it can be absorbed through the skin
- it can be inhaled
- it can be ingested.

The substance can then have either a local or a systemic (so-called organic) effect, which happens when the substance is spread by the blood further in the body where it may affect various organs.

Skin contact

Direct contact between the skin and a substance of a corrosive nature such as acid, ammonia or lye may cause caustic injury. In such a situation the skin should immediately be rinsed thoroughly with plenty of water. Other substances may not cause reactions so quickly. If the skin is exposed to e.g. solvents, detergents or coolants for some time, it may become irritated and a non-allergic eczema can develop. The skin becomes reddish and itches. It may become chapped and there may also be blisters and sores. The eczema may disappear if treated adequately or if the skin is no longer exposed to the irritant. The healing process may take a long time - up to several months.

Some people acquire hypersensitivity to certain substances. After only a short time of exposure (some weeks) or after many years, an allergic eczema develops. Once the allergic eczema has developed, the person will always get this reaction to the particular substance even when the quantity is very small. One can never tell who will get such an eczema or how long it will take for it to develop. Substances which may cause allergic eczema are: chromium (can be found in e.g. cement, leather and rust-proofing agents), nickel (can be found in many objects, e.g. keys, tools, coins which are nickelplated) and cobalt (e.g. in detergents and colour pigments).

If the eczema is of the allergic type the worker should not, in any way, be exposed to the harmful substance. If it is a non-allergic eczema, protective equipment may be sufficient.

Face-protection and gloves made of rubber should be avoided because rubber is a material which often causes allergic eczema. Plastic gloves will not cause allergic eczema.

At workplaces where substances which are known to cause allergic eczema have to be used it is important to have very good facilities for washing oneself and for cleaning the protective equipment after use.

Inhaling

The lungs as described in Section 2.1 take up oxygen and transfer it to the blood.

When there is not only oxygen but also harmful substances, for example gases, fumes and dust, in the air, these will also be inhaled.

The effects can be either local - affecting the lungs only - or systemic/organic - when the substances spread to different organs with the blood.

Dust, which is a common problem in the wood-working industries, can directly give only local effects. Sometimes, however, there are other substances in the dust which may enter the blood and give organic effects. Some wood species, particularly of the tropics, can cause allergic reaction of the lungs with coughing and breathing difficulties, similar to asthma or hay-fever symptoms.

The smaller the dust particles, the more dangerous they are. Only very fine dust can enter the airsacs in the lungs and remain there. It is also more difficult to protect oneself against small particles. They are not so irritating as larger particles and the person is usually not at all aware of inhaling them. The protective breathing equipment must then be of a high standard.

Chronic bronchitis may be a result of working in a dusty environment. The victim will suffer from heavy coughing in the morning. Particularly when combined with smoking, the problem can be severe. As a rule the problems of harmful substances become worse when combined with smoking.

Another example of dangerous substances in the air are harmful gases, for example ammonia and vapours from acids. They can be irritating and lead to coughing. The eyes will also be affected.

Ingestion

The third way for a substance to enter the human body is through the mouth. Dangerous substances handled by the worker, and left on the hands, can enter the body when eating or smoking. Personal hygiene should be emphasized and will require good washing facilities.

Some types of harmful substances

So far the discussion has mainly concentrated on how the worker may be affected by a substance, e.g. the effect is acute or chronic, it is local or systemic/organic, and how the substance can enter the body (through the skin, lungs or mouth).

To help recognize the risks at the place of work this section will be devoted to a description of the harmful substances and some of their characteristics. The substances can be divided into three main groups:

1) harmful substances suspended in the air, e.g. dust, smoke and gases;
2) liquids, oils and vapours, e.g. solvents, acids and bases;
3) metals, e.g. nickel, chromium and lead.

In the forest and wood processing industries most harmful substances are found in groups 1) and 2) e.g. dust, liquids, oils, exhaust gases and vapours. Group 3) is not covered in this publication.

1) Harmful substances suspended in the air, e.g. dust, smoke and gases

As already mentioned the human body can to some extent protect itself against injuries. This capacity depends on the particles' size, nature and concentration in the air and also on exposure time.

The particles - if not very small - can be rejected or filtered out already in the nose or bronchi.

Some particles are of a very dangerous nature and may cause severe damage to the inner organs. This is the case with some metals and metal alloys, e.g. lead and chromium. The concentration of the substance in the air as well as how long one is exposed to the polluted air are often decisive factors.

Dust

In the woodworking industries the main airborne particles causing health problems are wood dust of different sizes and species. Dust may cause allergic reactions, toxic effects, respiratory diseases and cancer. A more detailed discussion of dust as a health hazard will be found in Section 6.7 "Wood Processing".

Gases

Gases can affect the body in different ways. Some gases irritate the breathing organs or have a corrosive effect - irritant gases. Other gases are taken up by the blood and affect various internal organs.

For certain gases one gets a warning signal, when breathing, by the sharp and irritating smell of the gas, while other gases lack both smell and colour. These latter gases are particularly insidious as they gradually impair the awareness of the danger. One example of such a gas is carbon monoxide in the exhaust gases from motor vehicles and power chainsaws. When exposed to these gases under normal outdoor conditions with unlimited amounts of fresh air the worker is not so much affected. Under certain circumstances, e.g. when using the chainsaw in very dense forest with very little air velocity or in deep snow there is a risk of reaching high concentration causing effects such as headache and dizziness.

There are also other substances in the exhaust gases from the chainsaw which can affect the worker. Neither all the substances nor their effects are yet fully known. Also the chain oil gases contain harmful substances which are inhaled by the chainsaw operator.

2) Liquids, oils and vapours

At many work places solvents are used because of their ability to destroy and dissolve greases and fats. This is also the case in the forest and in forest industries. The solvent evaporates and the vapours are inhaled. Because of the solvent's ability to be dissolved in or to dissolve other substances it can be dissolved in the blood. The solvent can then be transported to different organs. Particularly the brain and the central nervous system, which contain a lot of fat, will attract the fat-dissolving solvents. The symptoms are dizziness, headaches, tiredness, impaired ability to understand and to react fast. All these symptoms could be factors increasing the risk of accidents.

Solvents with a low viscosity are more dangerous. They will spread faster in a closed room. The higher the concentration in the air the bigger are the risks and the risk will increase with time.

A heavy physical job leading to an increased intake of air will also increase the risk of injuries.

Solvents enter the body in different ways (see Figure 27).

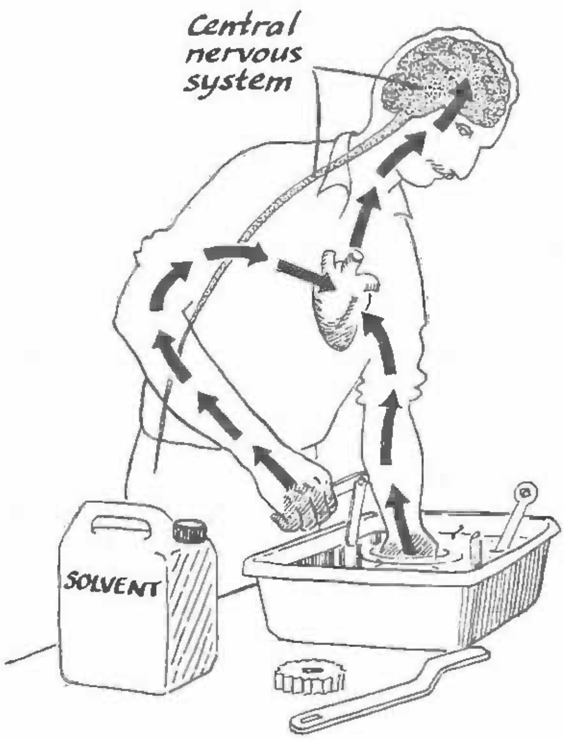


Figure 27. Solvents do not enter the body through the lungs only. They may also enter through the cells in the skin.

Other harmful substances belonging to this group (2) are acids and bases. They are of a corrosive nature and may damage the skin as well as the eyes if in direct contact. They can also, in the form of mist from the acids and bases, cause injuries to the lungs when breathing.

In forest industry a number of different oils such as hydraulic oils are used for greasing and other purposes. The oil can enter the body when breathing, in the form of mist, vapour or smoke, through swallowing if personal hygiene is poor and through direct contact with the skin. Oils may cause many different injuries to the lungs and skin. They may cause eczema, allergies and cancer. Also forest workers using power chainsaws, tractors and other machinery are exposed to different types of oils. It is particularly difficult for workers carrying out service and repair work to protect themselves and many develop eczemas and allergies.

There are therefore many reasons for avoiding contact with oils as much as possible. At many work places it is possible to use less harmful oils than is the case today. Work places or premises, machines, work methods and ventilation should also be arranged so as to avoid all unnecessary contact with the oils. The worker should never keep rags or cotton waste soaked with oil in the pockets. Washing facilities should be within easy reach and the workers should be informed about the necessity of washing hands and arms before meals or smoking and each time they get oil on their skin. Personal protective equipment should always be used when contact with oils is unavoidable. To take immediate care of small wounds or cuts is particularly important when in contact with oils so as to avoid inflammation.

There are also other chemicals used in forestry activities, such as pesticides, e.g. insecticides, herbicides and fungicides. Pesticides are often used in forest nurseries, in seedling treatment and for the preservation of unbarked timber.

Pesticides in forestry are usually used diluted with water or as spray powder (dust). The method of application is often a manual one using different types of portable devices, such as a sprinkling can, knapsack pressure sprayer, backpack power sprayer or mist sprayer. The pesticide tank is carried on the worker's back. (It is also possible to spread the pesticides from aeroplanes or by tractor-operated sprayers.) When using the manual methods the exposure will mainly be through the respiratory tract (the lungs) but sometimes through the skin as well. The use of tractor-operated sprayers will usually reduce the exposure.

Workers handling pesticides, particularly in manual methods of application, can be exposed to rather high concentrations. Examples of situations involving high risk of exposure are: when weighing out and mixing the pesticides with e.g. water and when filling the sprayer, the worker will be exposed to dust and splashes. During the application the risk is high of inhaling the pesticide vapour or of getting splashes on the skin. Even when protective clothing is used, the pesticides may penetrate the clothes when carrying the equipment. When using portable spraying equipment the worker comes very close to the harmful chemicals. It is very important that a correct working method is used as it will reduce the risks considerably. The risk of skin exposure is also high during repair and cleaning of the equipment unless appropriate protective devices and methods are used.

As mentioned above, pesticides can also be distributed in a powdered form. The powder (dust) can enter the body through the lungs. If the chemical is instead manufactured in cakes, pellets or granules, the risks through inhalation will be considerably reduced.

Many pesticides are slightly toxic. The risk of acute poisoning is known to be high for some pesticides. They may also cause toxic and allergic skin symptoms, as well as irritation of the mucous membranes. There is insufficient knowledge about long-term effects, such as cancer and genetic injuries. Experimental observations carried out on whether pesticides cause injury to the unborn child or affect pregnancy, call for caution, however. As many of the workers employed in nurseries and forest plantation are young women, it is wise to protect pregnant and breast-feeding women in particular from all exposure.

Preventive measures

At the national level

Some countries, e.g. USA, the Soviet Union and most European countries, have accepted hygienic maximum limits for chemicals in working life. The concentration of a dangerous substance in the air is not allowed to exceed a maximum permissible limit. The use of some dangerous chemicals (e.g. DDT) is totally prohibited.

Lower limits are stated for more dangerous substances. If the limits are exceeded there are big risks to the workers' health according to the scientific investigations these threshold limit values (TLV) are based on.

It should be the responsibility at the national level:

- to follow developments regarding the marketing of chemicals and other dangerous substances which are used in working life;
- to control manufacturers, importers and other deliverers of dangerous substances in the country;
- to spread and develop a register of chemicals and other dangerous substances present in the country;
- to investigate and document the risks to health and the environment of these chemicals and substances; and
- to give information to the end-users of products containing chemicals and dangerous substances.

Essential information to give to the end-users is:

- commercial name of the product;
- classification according to how dangerous the substance is;
- the risks to health of both short- and long-term exposure to the product;

. preventive measures to take;
. type of personal protective equipment to use;
. appropriate measures to take in case of an accident or other emergency situation, e.g. fire;
. handling of wastes;
. name of and concentration of the dangerous (active) substance(s) in the product;
. purpose of use; and
. name and address of the manufacturer or importer with responsibility for the information on product content.

At the enterprise level

The individual worker handling dangerous chemicals and other substances must receive information about:

. the risks to health;
. how to protect himself or herself e.g. what protective clothing and equipment to use, how to wear it and keep it clean;
. what to do in case of an accident or emergency;
. how to store and transport the substances; and
. how to treat wastes.

In addition to individual information, which should be both written (in easily understood language, with illustrations) and verbal, there should also be information at the workplace. It should be easy to find when working with the substances, e.g. posters and brochures.

The workplace should be equipped with all the necessary technical measures to eliminate or reduce risks, such as appropriate ventilation, washing facilities, medical service, and the workers should be provided with suitable personal protective equipment, e.g. gloves, shoes, aprons and respiratory protective devices.

The first and most important action to take will, however, always be to try to find out if the dangerous substance could be replaced by one which is less harmful.

3.2.5 Ventilation and draught

The need for ventilation and the occurrence of draught is not a problem in forestry in normal outdoor activities. It may, however, be a problem in e.g. the wood-processing industry and in tractor cabins. This section will therefore deal with technological factors. The outdoor climate was dealt with in Section 3.1. Biological and Physical Factors.

Ventilation

The primary reason for ventilating a room at the workplace is to ensure that the air in the room is of such quality as to avoid any adverse effects on the health, well-being or working capacity of the workers. The composition of the air in a room is affected by the people in the room and by the ongoing activities and processes.

The human being will, for example, consume oxygen, evaporate humidity, and may also spread bacteria and other microbes to the air from the air passages when sneezing, coughing and talking, and also from the skin, hair and clothes.

Other sources of air pollution are chemical or physical processes going on in the room. These processes will be decisive in how comprehensive the ventilation should be and how to arrange it.

Big glass windows facing the sun may also add heat to the room to the extent that ventilation will be necessary to cool the air. When a room is ventilated it is supplied with sufficient quantities of fresh air to bring about a sufficient dilution of the unhealthy or hot air.

Ventilation can be attained by natural movement of air using the differences between the indoor and outdoor air temperatures, and using windpower as the impelling force. The ventilation will then vary with the weather. During the summer or in a hot climate, the effects of the wind will be decisive. When constructing new buildings consideration should be given to the direction of winds when deciding which quarters of the building should be exposed to such winds. Different designs are used in order to make use of the natural draught often with some sort of channels in the ceiling.

Ventilation can also be attained by using mechanical fans for sucking in or blowing out the air. It is then possible to have local extraction. The contaminants are caught by the air moving into the extraction system the moment they escape from the process. This is often a necessity in industries using toxic substances. An extraction system must be inspected frequently (weekly or more often) and maintained by somebody who fully understands how it works. It is not unusual that systems without regular maintenance deteriorate to the point where they only provide a false sense of security.

Draught

Draught could be defined as a person's sensation of uneven cooling, which is caused by air velocity and/or radiation exchange with the environment. If the ventilation system has been incorrectly adjusted and the air is passing through the room too fast this will cause draught.

Cold windows and walls can also cause draught because the cooled air near the cold surfaces will stream down and at the same time suck up the adjacent air. The air streams resulting from this may cause discomfort.

Draught is not only unpleasant but may cause stiff muscles, rheumatic pain and similar problems.

When carrying out heavy physical work the air velocity ensures a decrease in the heat stress on the body. In Table 6 below the acceptable relation between air velocity and air temperature is shown.

Table 6. The relation between air velocity and air temperature.

Air velocity (m/sec)	0	0.2	0.4	0.6
Air temperature (^{o}C) (at 50% air humidity)	20	21	22.5	24-26

In reality this relation will also depend on what kind of work is carried out.

3.2.6. Lighting

In general, the lighting conditions in most forestry operations are sufficient. There are situations, however, when the daylight will not be enough, such as in very dense rainforest, where almost no daylight reaches the ground.

Poor lighting conditions are common in the wood-processing industry. Both poor lighting and visibility will often increase the risk of accidents and decrease productivity. Other effects of poor lighting or visibility can be fatigue, headache, smarting pain in the eyes, stress, uncomfortable workpostures and decreased capacity of focussing.

There are three factors decisive in vision, viz. the light (artificial or natural), the object and how it reflects light and colours and of course the eye and its capability to take in light, darkness, movement, colour, etc. These three factors interact in a system.

The eye

The eye is often compared with a camera. When the amount of light varies the eye will adjust. The pupil will close down when there is more light and open up when it is darker to allow more of the available light into the eye. The pupil can be compared to the diaphragm of a camera. This ability of the eye to adjust is called adaptation. The ability to see in darkness declines with increasing age due to the fact that maximal opening of the pupil will decrease.

The eye has a very good ability to focus on objects at different distances. This ability is called accommodation and also declines with fage. The impaired accommodation and adaptation of older people makes it particularly important to improve lighting conditions so as to fit each individual's requirements. Even when young the eye will get tired if it is forced to change its focus fast and often to objects at different distances.

Dazzle

When the eye has to look directly into a light which is brighter than what the eye is adjusted for, it is dazzled. Dazzling can also be caused by indirect light, e.g. when the light is reflected from a shiny surface, such as glass or a very bright surface. The phenomenon can also occur when the difference (contrast) between brightness and darkness is too great.

Dazzling makes it difficult to see and irritates the eye. Dazzling is very common and at the same time it is often difficult to put it right. It is therefore one of the most difficult problems related to lighting.

Some measures which can be taken to avoid dazzle are: provide lamp shades on lamps directly in the field of vision; paint ceilings and surfaces around windows with bright colours; avoid shiny surfaces.

Lighting requirements

There are a number of factors to consider when planning lighting in a workplace. The requirements for lighting will depend on, e.g. the nature of the work (less light is required in a sawmill than if the task is to carry out a surgical operation); the contrast between the object and the surroundings, the colours of the ceiling, walls and machines, the distance from the object, the worker's eyesight, etc. It is well known that lighting conditions have a big impact on production.

Usually it will be necessary to have both general lighting - illuminating the whole premises from lamps in the ceiling or on the walls, and local lighting - directed on the machine or object the worker is working with. Good general lighting can prevent too much contrast.

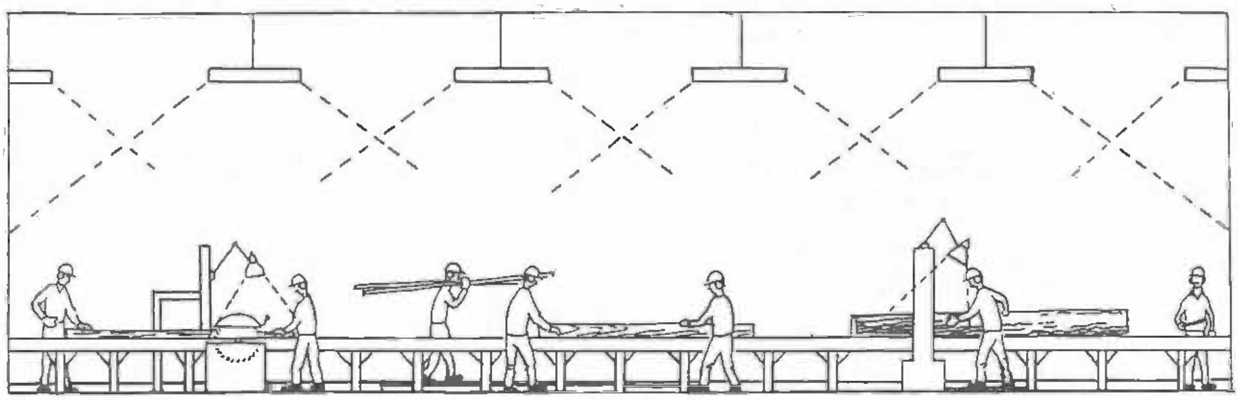


Figure 28. General lighting and local lighting of work area.

Types of light sources

As already mentioned, natural lighting (daylight) is the most efficient light - but as it will vary with the time of day and the season and weather, most industries depend on artificial lighting. The most common types of electrical lamps are the bulb (glow-lamp) with low effective power and short life. The bulb is best suited for local lighting. The other type is the flourescent tube with a much higher efficiency and also much longer life. The flourescent tube does not produce so much heat as the bulb, which is an advantage in countries with a hot climate.

Maintenance

Even after installing appropriate lighting it will be insufficient after some time if the dirt on lamps, fittings, surfaces of the room, reflectors and anti-dazzle devices is not removed. Particularly in the wood processing industries, where a lot of dust is produced, regular and frequent cleaning will be very effective. Also the instrument life of the lamps has to be checked regularly.

4. OCCUPATIONAL ACCIDENTS AND DISEASES

Occupational accidents

As stated in Section 1, the goal of ergonomics is to optimize the man-task-environment system from the point of view of the worker's safety, health, well-being and efficiency. One of the most obvious threats to safety and health is to be injured in an accident. The prevention of accidents is therefore a major task of ergonomics.

What is meant by an accident? One can find numerous definitions. To start with, the words "accident" and "injury" are often used interchangeably, which may cause some confusion.

An accident is an occurrence which is usually unexepected, unforeseen, unplanned and unwanted and interrupts or disturbs the progress of any activity and may result in:

- injury (to people)
- damage (to property) and/or
- delay (time).

An occupational accident could thus be described as: "An unexpected incident or external influence during work leading to injury, damage or delay."

There are many good reasons for striving to prevent occupational accidents. The basic reason is "survival" and maintenance of good health, but there are also other reasons such as:

- legal responsibilities
- social obligations
- economic advantages
- resource conservation.

An accident leads to different kinds of losses. These losses are not related just to medical treatment and compensation of costs for injuries, but also to losses due to reduced production caused by delays. Damaged property, repairs, spare parts or premature maintenance may also be costly. Absenteeism, training of somebody to substitute the injured worker, and lost goodwill are some other indirect costs.

Before one is able to start taking action to combat accidents, one should also know the answers to questions such as WHERE, WHY and HOW the most frequent and severe accidents occur. The following are helpful tools to use or analyze in order to provide answers to these questions:

(1) accident statistics
(2) special investigations carried out immediately after an accident
(3) near-accidents (or near-misses)
(4) systems-analysis (or systems-ergonomics).

A discussion of these tools will follow, but first a few words about the problem of occupational diseases.

Occupational diseases

It is well known that if one is exposed daily to harmful agents such as dust, noise, vibrations, exhaust emissions, chemicals, or to ergonomically unfavourable working postures, very heavy physical workload, etc., such exposure will cause different kinds of health problems - occupational diseases or occupation-related diseases. Examples of occupational diseases could be allergic reactions, vibration-induced white fingers, loss of hearing, and disorders in the muscular-skeletal system.

Most countries, however, lack reliable - if any - statistics on occupational diseases. There are many reasons for this lack of statistical information, such as insufficient regular health examinations of the workers and epidemiological surveys. For this, close liaison and contact between safety specialists and medical services is required - both parties also need a good knowledge of the actual working conditions of the workers. Further, the criteria for the diagnosis vary and so do the legal status and classification of occupational diseases. It may often be difficult to link a certain disorder to specific conditions in the work - particularly as it can often take a long time for the disorder to develop and for the symptoms to become evident.

In the case of statistics on accidents this kind of problem is less. Accident data are discussed in more detail below.

4.1 Accident Statistics

Accident statistics can, if accurate and carefully planned, give very useful information about what preventive measures to take, and also how to give priority to different measures.

The minimum requirements for accident statistics should be that they show how many, how often and how severe the accidents are. This information should be expressed in such a way that one can compare the situation in different forest undertakings and in different countries, and also between different periods. To be able to plan preventive measures the statistics should also allow for classification of the accidents in different ways.

Two types of indices are used to indicate the magnitude of the occupational accident problem. The two indices are frequency rate and severity rate, and both are usually related to the number of man-hours worked.

According to international recommendations the frequency rate for a specified period of time should be calculated by dividing the total number of accidents (multiplied by 1 million) by the total number of man-hours worked by all persons exposed to risk during the same period.

$$\text{Frequency rate} = \frac{\text{Total number of accidents x 1 million}}{\text{Total number of man-hours worked}}$$

Fatal accidents should be distinguishable from other accidents, as well as accidents leading to permanent total disability.

It can be misleading only to focus preventive efforts on jobs and workplaces with the highest frequency rate. The accidents might, for instance, be mainly minor wounds, etc. Therefore the frequency rate index must be complemented with an index for severity.

This other index, which shows the severity of the injuries, should according to the same international recommendations be calculated by dividing the number of lost working days due to injuries (multiplied by 1,000) with the total number of man-hours worked by all persons exposed to risk during the actual period.

$$\text{Severity rate} = \frac{\text{Total number of days lost x 1,000}}{\text{Total number of man-hours worked}}$$

In case of a fatal accident or an accident leading to permanent total disability, in some industralized countries the number of days lost is assumed to be 7,500 days. When the injury leads to permanent partial disability the severity rate can be calculated according to the scales for disability used in different countries. If permanent partial disability is expressed as a percentage, it follows that each unit of percent will be equivalent to 75 working days.

The severity rate for other injuries can be calculated on the basis of the number of sick days converted into working days by multiplying by 300/365.

If accident statistics are classified in different ways, this will make the records much more useful for the planning of safer work places and work methods. The following are examples of factors to consider in the classification of accidents:

- Kind of operation or activity (e.g. felling, cross-cutting, loading, walking in the forest)
- agency which is most closely associated with the injury (e.g. tool, machine, equipment)
- hazardous conditions (e.g. defects of agencies, lack of safety equipment)
- unsafe acts (e.g. negligence of safety regulations)
- type of accident (e.g. fall, knock or stumble against an object)
- nature of the injury (e.g. laceration, cuts, fracture)
- part of body injured (e.g. hand, fingers, eyes)
- personal characteristics of the victim (e.g. age, experience on the job, training, occupation)
- time (e.g. during the day in relation to the work schedule - hours after start of work or after meal; day of the week; season)
- other conditions contributing to the accident (e.g. weather, terrain, wage-system).

A warning: before starting to collect any data for very comprehensive statistics one should have a fairly detailed plan for both the analysis and presentation as well as the application of the statistics. Why do it, how to do it, when or how often to do it, who should do it and for whom ???

The information possible to gather is unlimited - but not its suitability for use. Particularly the availability of computers may lead to a superfluity of tables and cross-tabulations, while the hard and time-consuming, but absolutely necessary, work of data analysis and the act of taking preventive measures may still remain neglected.

When accident statistics are well-planned they can be an invaluable tool in efforts to create safer working conditions.

When one studies the accident statistics from industrialized countries one can see that, in most of these countries, forest work, compared to almost all other industries, has higher frequency and severity rates. And there is evidence that even these high rates are up to ten times higher in some tropical countries.

There are several reasons for this, some of which are listed below:

- workers in many tropical countries are often unskilled and not given appropriate training, if any;
- low awareness of safety risks among staff involved in forestry operations (and as a consequence poor and inadequate supervision and control);
- personal protective equipment is not available or is not used;
- poor maintenance of tools, chainsaws, machines and equipment;
- poor or inappropriate tools, machines, equipment and working methods and techniques;
- no first-aid available at the worksite (neither equipment nor trained personnel);
- long distances and poor transport facilities for medical treatment in case of injury.

These shortcomings, which are more of an organizational and technical character, are very often combined with other factors which will increase the risks, such as:

- undernourished and unhealthy workers;
- hot and humid climate;
- big trees;
- dense undergrowth;
- steep and rough terrain.

The statistics on accidents will help to uncover some of these factors, but not all of them.

4.2 Accident Investigation

The accident statistics may not be adequate to uncover the true causes of an accident. An accident is the result of some error(s) in the man-task-tool/machine/equipment-environment system.

The error(s) can either cause the accident directly or indirectly through a chain of events. The accident can also be the result of an accumulation of errors in the system.

To find the error(s) one has to analyze all parts of the system as well as their integration. This means that the factors involved could be e.g. technical, organizational, sociological, psychological and/or physical.

One way of reaching a better understanding of the actual situations behind the statistics is to carry out special investigations of the accidents. These should take place as soon as possible after the accident has occurred, when memories are still fresh and the motivation to adopt preventive changes (technical, organizational, behavioural, etc.) is probably higher - at all levels of the organization.

This investigation must not be mixed up with any investigation aiming at finding a scapegoat. Persons involved in the investigation must have complete confidence in the investigator.

Very often the cause of most accidents is believed to be "the human factor". Human behaviour is, however, determined by ergonomic factors such as work place characteristics, job instructions and information, situational and organizational factors, as well as individual factors. These factors often explain why people take risks on their jobs.

Careful analyses have often revealed 10 to 15 contributing factors behind an accident. Therefore one should not look for one specific cause or one main cause only, but instead look for as many contributing causes as possible. Probably it will not be possible to prevent all of them, but the prevention of some of them may reduce the probability of the accident occurring.

4.3 Near-Accidents

A near-accident (or a near-miss or a narrow escape) is "a sudden occurrence that might have resulted in injury". A Canadian study has shown that, on average, for each serious injury there were ten minor injuries, thirty property damage cases and six hundred near-accidents or incidents which, under slightly different circumstances, could have resulted in injury (see reference 29). A Swedish study showed that there is a high correlation between the causes of near-accidents and the causes of actual accidents (see reference 53).

So studying the causes of near-accidents instead of actual accidents might be a faster method of obtaining a large amount of material - enough for statistical analysis. Another benefit of the near-accident method is that people involved in the study will become more safety-conscious. When they are requested to report on each near-accident they have experienced for a certain limited period of time - including the causes - they have to start to analyze the working conditions and thereby become more aware of the risks.

4.4 Systems Analysis

The method emphasizes prevention rather than correction of problems. It is a method to be applied already at the early engineering design and organizational planning stage. All aspects, including accidents, of the planning, design, development, fabrication, test, installation, maintenance, operation, and overall evaluation of the man-task-environment system should be taken into consideration.

As accidents can be seen as the result of errors within the man-task-environment system, the analysis of errors is one more method of helping to prevent accidents. This approach has been called error-ergonomics.

Errors are looked upon as interaction phenomena - as failures in transaction between man and other parts of the system. It is therefore most often not possible to understand the errors, or accidents, by studying each component in the system separately. With this method one undesired event is selected. Thereafter, all of the possible happenings that could contribute to the event are analyzed in detail.

5. MEASURES AT THE NATIONAL AND ENTERPRISE LEVEL

To promote and facilitate daily occupational health and safety at work and the application of the ergonomic concept, measures have to be taken by a number of concerned parties and institutions. They must be taken both at the enterprise and the national level, as well as the international level. Some examples of this network of measures, concerned parties and institutions are: research, education and training in ergonomics, laws and regulations, health and safety inspections, accident insurance agencies, trade unions or worker's associations, safety committees, safety engineers, medical services, manufacturers and testing stations of tools and machines and international agreements and declarations.

Measures at the national and enterprise level will be discussed in detail in Sections 5.1 and 5.2 below, but first a few words about measures at the international level.

Different United Nations organizations, e.g. the International Labour Organization (ILO) and the World Health Organization (WHO) have drawn up international agreements, declarations and working environment programmes. Most countries have adopted them. Conventions from ILO and other international organizations have been signed by a number of countries - but not all signatories have observed them.

Other international bodies which also play an essential role are the FAO/ECE/ILO Joint Committee on Forest Working Techniques and Training of Forest Workers, the International Union of Forestry Research Organizations (IUFRO), and the International Organization for Standardization (ISO). These organizations' activities, in addition to national activities, in terms of legislation, standards, testing, and information to the end-users (to increase their demands) will make ergonomics more readily applicable in practice.

Transfer of technology from the industrialized countries to the developing countries is another aspect of the international measures to be considered. A lot has been achieved in the industrialized countries regarding ergonomics in forestry. These improvements have, however, had a tendency to remain in the industrialized world. The transfer of technology does not always mean also the transfer of ergonomics. Manufacturers frequently offer to developing countries machines, tools or equipment which do not meet existing safety and comfort standards in their own countries. Either the buyer may not be provided with information as to what the standards are and what is lacking on the version offered, or a machine is stripped of essential safety items because it sells better. Machinery should also have all instructions regarding use, safety and maintenance translated from the manufacturer's language to the local operator's language.

5.1 Measures at the National Level

In many cases, the division here into Measures at the National Level and Measures at the Enterprise Level will not be a very exact classification but will only give a rough structure to the discussion. At the national level the measures to be discussed are those which are planned and controlled by parties or institutions outside the enterprise, and which have a general function in the society, such as laws and regulations, institutions for education, training, research and extension, governmental bodies e.g. Ministry of Labour, Ministry of Health, health and safety inspection services, trade unions and safety associations.

Laws and regulations

Laws and regulations should provide a foundation and framework for preventive measures against occupational accidents and diseases. Examples are mandatory prescriptions concerning such matters as general working conditions; the design, construction, maintenance, inspection, testing and operation of machines and equipment; the duties of employers.

Inspection systems will also be necessary for the enforcement of mandatory laws and regulations.

- Many developing countries lack either part or all of the basics for implementing ergonomics by using legislative measures or collective agreements between employers and employees.

- Some countries, on the other hand, have the necessary national laws and regulations, but for various reasons these are not recognized in practice. One reason for this may be that they are a transcription of the legislation from an industrialized country with entirely different conditions and are therefore not relevant to the country in question. Another reason may be the lack of knowledge among those concerned as to how to enforce and follow the rules and recommendations.

- Some other countries have taken their laws, agreements and regulations with the basic intention and idea that cooperation between involved parties (employers and employees) is necessary to organize the health and safety work - with the employer being the one who is principally responsible.

Some kind of government-organized inspections for the enforcement of mandatory regulations will, as already mentioned, be part of the system. Many countries have a special health and safety inspection service.

Safety associations and accident insurance institutions

Safety associations are examples of institutions outside a company. These could handle ergonomic and safety matters that are of general interest to the industry, but which are expensive or difficult for a small enterprise to handle as regards standard and number, such as training resources, information material, etc. The safety associations could be financed, for example, from membership fees or through deduction of a percentage from compulsory accident insurance.

Accident insurance institutions can play the role of motivator and financial body of safety and health measures.

Manufacturers, dealers and testing institutions

Manufacturers, dealers and testing institutions of forest machines, tools and equipment should be mentioned as parties with a major impact on ergonomic conditions in forestry practice. Their involvement in ergonomic activities and projects has given very good results in some industrialized countries. Safety and comfort standards for tractors and chainsaws and the development of personal protective equipment have, for instance, improved considerably.

Education, vocational training and extension

Basically, education, training and extension are channels for sharing knowledge which is necessary to spread existing ideas, and also to generate new knowledge through research. The relatively rapid return on investment is a good reason for giving high priority to training in ergonomics.

Generally speaking, everybody undergoing training in forestry schools at various levels or working in forestry, or planning or administering other people's work, or in other ways directly affecting working conditions in the forest, should receive training in ergonomics as appropriate to their particular kind of work.

Initially, the lack of teachers and instructors familiar with ergonomics will be a constraint and the main obstacle to the introduction of the subject on a broad scale.

It is essential to concentrate on the practical aspects of training in ergonomics, and this implies a high ratio of instructors to students. Training of instructors and updating of their skills are two well-known and serious problems which are still not receiving adequate attention. If there is a scarcity of adequate training opportunities in ergonomics for trainers, there will be a scarcity of skilled human resources at the level of the enterprise.

In addition to the special training of ergonomics teachers, many other subject-matter teachers and instructors need basic training or upgrading in ergonomics to enable "ergonomization" of all appropriate forestry subjects.

The following broad levels of basic education are usually distinguished:

1. Vocational level: practical training of forest workers, machine operators and forest farmers - at vocational schools and in special courses for foremen and other people directly organizing and leading others.

2. Technical level: training of rangers, technicians and supervisors - at technical schools and in courses.

3. University level: professional education and postgraduate studies for people to be engaged in teaching, research, administration, design or management work, with responsibility for, e.g. developing and organizing practical work in large enterprises and organizations - at universities and colleges.

A factor to be considered in the training is the influence that the students will have, in their future occupations, on essential factors in their own and other people's working environment.

The specific objectives, and accordingly also the training programmes and methods, will vary between the different levels. For each course or each training programme within the levels, the objectives must be specified according to needs and practical experience, as follows:

1. At the vocational level the trainee should acquire the skills and knowledge which will prepare him for a job from which he can earn a living. He must therefore learn to:

- perform the job in an ergonomically adequate way;
- avoid risks, harmful influences, fatigue and errors;
- attain reasonable efficiency and quality.

Equally important for the trainee is to develop an attitude which makes him want to act in accordance with learned behaviour. The aim is that the trainee's concept of skill includes ergonomic practices as part and parcel of the work, because "a skilled worker is a safe(r) worker". The concern should include not only the worker's own safety and health, but also the safety and health of others, and the development of a safe working environment. The trainee should therefore acquire an understanding and general knowledge of different aspects of the working environment, such as effects and risks of different physical factors at the workplace (e.g. noise, chemicals, heat), and existing official regulations related to ergonomics. The worker should develop the practical skills so as to be able to assess and improve the actual working situation in order to avoid safety and health hazards. The worker should also be able to give first-aid. An ideal situation is that workers are able to get a basic education at vocational school and later on up-dating training in courses and on-the-job through skilful instructors. Therefore, the training of instructors should be part of vocational education.

2. At the technical level the student should, having completed his training, be able to assess the working conditions of other people and to detect ergonomic problems. He must know how to handle both physical and psycho-social environmental problems so as to be able to contribute to an ergonomic design of the workplace, machine organization and environment. In addition to a general knowledge of man and his working environment, the trainee must obtain practical knowledge. He should learn the basics of assessing, controlling and adjusting work environment factors, and gain practical skill in applying the principles of ergonomics as well as first-aid. Knowledge of laws and regulations related to safety matters at the worksite is particularly important in this category.

In many developing countries there are not sufficient training facilities at the vocational level. One important task for graduates at the technical level will therefore be to instruct workers in how to perform their jobs (on-the-job training). The very important skill of how to give appropriate job instruction, emphasizing safe and efficient working techniques and methods, should be given much more attention in training at the technical level. In order to be able to instruct others, the teacher must be able to do the job safely and efficiently. A change of attitude towards manual work among the trainees may be required, so that they will be open and prepared to learn how actually to carry out the same practical work as the workers. First-line or primary supervisors should also provide a good example to the workers, and will have a decisive influence on how safety regulations are observed at the workplace. It should be emphasized in the training that the function of a technician or supervisor is not to have a narrow approach to production, but to consider ergonomics and safety aspects as essential parts of the job. Even in cases where proper and safe working behaviour has been achieved during vocational training, it may not be sustained during normal production, because safety is looked upon as a subordinate function at the supervisory level. When unsafe practices are accepted by management, the worker too will come to accept unnecessary risks.

For both levels 1. and 2. the content of the training will be determined by its function, which is to acquire skills and knowledge that can be practised straight away.

3. At the university level, the future influence that the graduates will have on the development and implementation of ergonomic principles in education, research, design and management must be considered. Their positive attitude towards the subject, and motivation to promote ergonomics in the forestry sector are very important goals in the training.

In addition to a general knowledge of the concepts and philosophy of ergonomics, a deeper insight should be obtained into the interrelations between man, task and environment, applying a systems-analysis approach. Further, scientific developments in the field of ergonomics, specialized knowledge and skills concerning different ergonomic factors, methods and techniques for measuring, analyzing, assessing and controlling these factors, national and international legislation and standards, should be essential parts of the training.

Ergonomics should be taught not only in basic forestry education programmes, but also through extension activities and continuing education programmes, because:

- It will take too long for an ergonomic approach to be adopted in forestry practice before the first students who have been given ergonomic training during their basic education have graduated, been employed, and have started to introduce what they learned.

- Particularly in systems where hierarchy and seniority play an important role, it will take considerable time before newcomers, bringing new skills and ideas into the system, build up enough influence to be able to use these skills and introduce the ideas.

- Extension and continuing education courses can in such cases pave the way for new ideas and be a preventive measure against resistance caused by the threat to prestige or lack of knowledge in the system. It will give newcomers and those already working in the organization a common language.

- Ergonomic changes may interfere with production processes and may have some financial implications, and they might, therefore, meet resistance from management. There are educational needs and a need for attitudinal changes among employers and senior management in organizations, upon whom the responsibility for effective policies and programmes rests. This group must be made aware, on a continuing basis, of the concept of ergonomics, legislative requirements, and sources of information.

- If appropriate teaching methods are used, the efficiency of extension and continuing education will be high. Because of their practical experience in working life, the trainees will be in a good position to derive great benefit from such training.

The general aims of the training (all categories) are:

- the trainee should develop a positive attitude towards ergonomics, and an interest in and understanding of the concepts of the subject;

- the trainee should be made aware of the great ergonomic problems in forestry;

- the trainee should obtain sufficient information and knowledge, and be motivated for further studies so as to be able to contribute to the resolution of problems.

- the trainee should achieve the necessary skills for his/her level.

The overall objective should, however, be in the affective domain. To reach that very important objective, a change in the trainee's motivation and attitude towards technology, work and workers will often be necessary.

Certain topics are to be considered as basic in all ergonomic courses. Examples of such basic topics are: safety and first-aid, physical and psychological workload , energy expenditure, nutrition, workplace design, work environment hygiene, and applicable legislation. Certain theoretical topics must also be covered. All such topics should, however, be taught from the viewpoint of their relevance to practical situations.

Teaching methods

Design, methods and course content will vary depending not only on the different categories of trainee, but also on the different systems and environments within which they will eventually operate. Naturally, the availability of resources in terms of personnel, equipment and other training facilities will have a major impact on design, content and methods.

Teaching methods suitable for ergonomics training are lectures, demonstrations, laboratory work, excursions, field practice, seminars, group work, brainstorming sessions, self-study programmes, special assignments and case studies including practical problem-solving. These last would be carried out during periods of practical training and be presented and discussed subsequently in class. It might be possible to arrange such periods in extension activities, but it is usually difficult to include them in the basic educational system.

There are, however, other methods by which the trainee can be exposed to situations where theory is integrated with practice. The use of checklists is one method which has proved to be suitable in many cases. The use of checklists, supplemented by interviews with the workers and other involved parties, is an effective way of analyzing different jobs and workplaces. The exercise will open many an ergonomic eye. These practical parts of the training are particularly essential for students who have not had any actual exposure to and experience of forestry work. In general, better results will be obtained from the training if the students are encouraged to search for the knowledge instead of being restricted to passive listening. Whatever the method chosen, it is important that the material used in the training corresponds as much as possible to the actual conditions under which the student will later apply what has been learned.

The scarcity of suitable ergonomics textbooks, teaching notes, manuals, slide collections or films for forestry work in general, and for developing countries in particular, is a serious obstacle to introducing ergonomics into forestry training. There are a number of textbooks available on general ergonomics, which mainly discuss industrial problems. Material focusing on forestry ergonomics is usually prepared for industrialized countries having other socio-economic and cultural backgrounds. Furthermore, for the lower educational levels, the material should be in the local language.

In addition to textbooks on ergonomics, other material can be utilized in training, such as excerpts from labour legislation, national and international standards, threshold limit values, handbooks and manuals on tools and machines, checklists, models of designs and body parts, instruments for ergonomic measurement, tools and equipment for practising work methods and techniques.

It has already been stressed that, initially, the scarcity of trained teachers and instructors will most probably be one of the main obstacles. A way to overcome such an obstacle is to engage teachers from organizations outside the forestry educational system, but with a knowledge of special aspects of ergonomics, which are applicable to forestry. Examples of such external contributors are:

- physicians (preventive medicine, physical workload, physical stress diseases, rehabilitation, audiometry, etc.);

- nutritionists (nutrition, energy expenditure, etc.);

- first-aid instructors from the national Red Cross, Red Crescent or similar organization;

- physiotherapists (work postures, etc.);

- lawyers (labour and industrial legislation, social security systems, etc.);

- representatives from forestry enterprises representing management, supervisors, trade unions or workers' associations, safety and medical departments who can give information from their practical experience;

- representatives of relevant government authorities (Ministry of Labour, Ministry of Health, safety inspection board, etc.); and

- representatives of designers and manufacturers of tools, machines and equipment used in forestry.

When engaging external teachers who may be experts in a rather narrow field, the course leader must emphasize the necessity for them to deal only with the aspects which are relevant to the trainees. For resource persons without any experience of forestry work, a thorough briefing on working conditions in forestry is vital.

An additional measure to help reduce the problem of teacher shortage is to form teaching teams. One trained teacher can be assisted and supported by persons not having a formal teaching background. Such a team will prove useful, for example, during the practical sessions of an ergonomics course. Skilled workers or supervisors who have had some further training can assist the teacher by giving demonstrations, instruction and supervision to the students when practising appropriate working techniques and methods.

Private enterprises, machine and tool manufacturers, etc. may sometimes be involved in training in which ergonomic aspects are covered. They may provide short training courses for certain groups of employees and operators of particular machines and tools. Their objectives may, however, be too narrow to provide satisfactory skills and knowledge in ergonomics. With the assistance of forestry schools, training may be carried out in purpose-designed courses at private or State forest enterprises.

In other words, ergonomics as a teaching subject gains considerably from collaboration with forestry practice and with research. In industrialized countries, findings from ergonomic research and practical studies are used as very important teaching aids. In most developing countries, there is a marked absence of results from such research and studies.

Research

In many industrialized countries a considerable amount of ergonomic research has been carried out in various forestry activities for a long time. New legislation and stronger demands from employers as well as workers have further increased the amount and quality of ergonomic research and the application of its results. Examples of ergonomic problems where research efforts have been particularly significant are: causes of occupational accidents and their prevention in terms of technical measures (tool and machine design and function, personal protective equipment, etc.), organizational and administrative measures (payment systems, job rotation, etc.) and behavioural measures (training, information, motivation, etc.) chainsaw-related problems (noise, vibration, exhaust emission, etc.), epidemiological studies on specific occupational health problems, and rehabilitation and prevention of occupational diseases.

Examples of research carried out in various disciplines are:

- Technical research including investigations into the properties and characteristics of harmful materials, machine guards, design of machines, etc.

- Medical research including, in particular, investigations of the physiological and pathological effects of environmental and technological factors and physical circumstances conducive to accidents.

- Psychological research, i.e. investigations of psychological patterns conducive to accidents, motivational aspects, stress reactions, etc.

- Statistical research concerning occupational accidents.

Such research has usually been carried out in very close collaboration with forestry practice and education. State forest services, large and small-scale enterprises, physicians, employees' associations, trade unions, safety associations, government authorities, manufacturers, etc., have frequently been involved in the entire research process, from the planning to the dissemination and application of the results. Teachers and students have often taken an active part in the research. International collaboration through bodies mentioned earlier (ISO, IUFRO, FAO/ECE/ILO) has been extensive.

Many of the research findings from industrialized countries are of interest to developing countries; but due to differences between countries in the physical environment, technology, socio-cultural conditions, education, nutrition, endemic disease, etc., some of the experience gained in industrialized countries is not generally applicable. The very special ergonomics problems arising from working conditions in tropical countries are, to a great extent, unknown. Very little research has so far been carried out in the developing countries.

There is an enormous and immediate need for more information about the ergonomic situation in the developing countries. Data gathering and research projects must, however, be so designed as to conform with the countries' carefully analyzed needs and resources, in terms of objectives and research methods used.

A major obstacle, besides limited financial resources, is the lack of experienced and qualified research workers to carry out the studies.

To make ergonomics research possible in the near future by professionals at national level, more emphasis must be given to the subject at university level.

Ergonomics training of undergraduates should be designed, bearing in mind that it is from this group of trainees that the future experts will be recruited. There must be considerable flexibility in the educational system, allowing the students to specialize in different sub-topics, in accordance with their own interests, as well as the special requirements of the community. Special assignments, research work and development of postgraduate study programmes should be closely interrelated components of the education - research system. Recent scientific developments in the field of ergonomics; specialized knowledge and skills concerning different ergonomic factors; methods and techniques for measuring, analyzing, assessing and controlling these factors; and national and international legislation and standards, should be essential components of the training. Furthermore, the students should receive sufficient training in project planning and in the critical analysis and evaluation of research findings.

Postgraduate students and research workers should participate in international ergonomics courses, workshops and seminars for the exchange of experience and ideas. Initially, however, there is an immediate need for more training abroad in master's and doctor's degree programmes in countries with advanced ergonomics research and practice. More exchange of information, as well as of research workers and students from research organizations and universities in industrialized and developing countries, is of mutual benefit.

5.2 Measures at the Enterprise Level

5.2.1. Technical measures

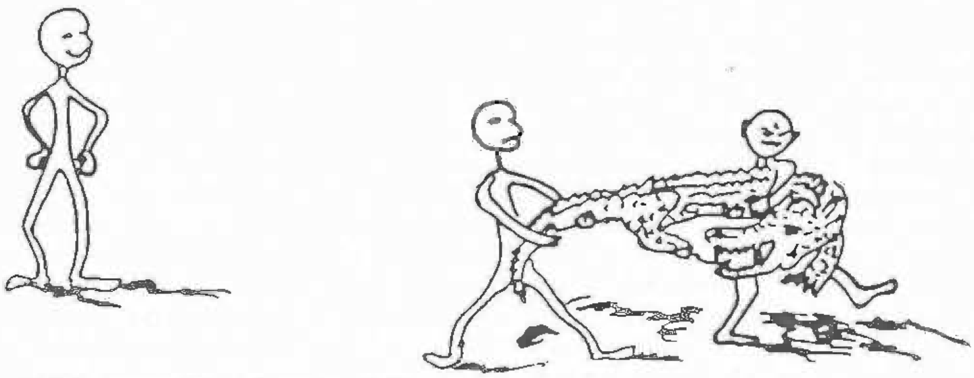
There are a number of alternative or supplementary measures which may be taken when facing an ergonomic problem in production. Figure 29 is an illustration of such alternatives, starting from the most effective measure to prevent accidents and diseases.

1. Take away the danger from man. One example is to replace the dangerous method, machine, tool, chemical, etc. by one which is safe(r) for the worker to use.

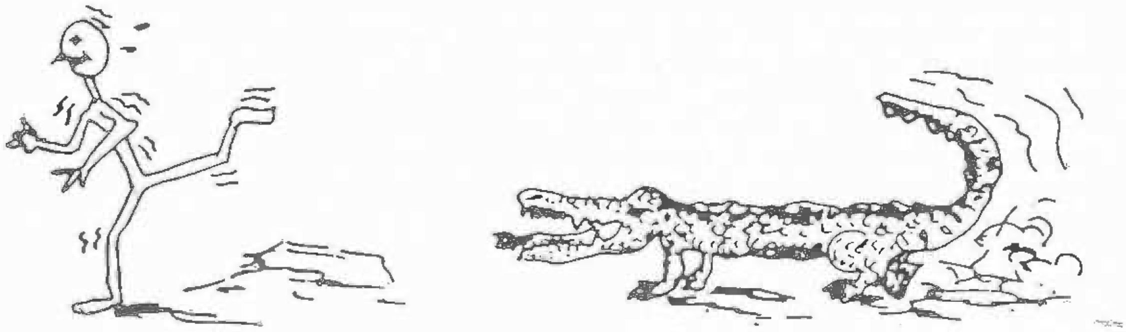
2. Take man away from the danger. One example is to organize the work or design the workplace so that no worker will stay within the zone of danger, e.g. being exposed to the risk of a load falling from a crane at one's workplace.

3. Enclose or isolate the danger. The use of safety guards is the most frequently applied preventive measure. However, it is often expensive compared to the safety aspects being taken into consideration and built into the machine when it is constructed. The safety effect may also be reduced, or even fail to appear, if it means that an additional effort will be expected on the part of the worker, or if it causes him some discomfort.

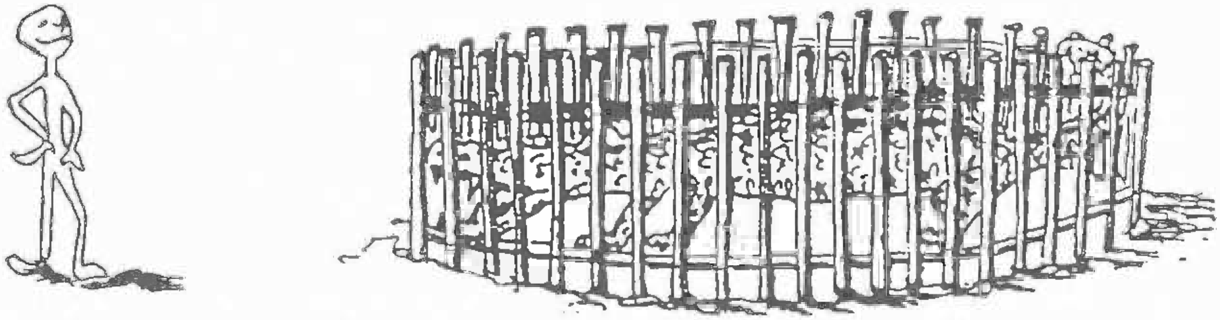
4. Enclose or isolate the worker. One example is to use personal protective equipment. This should always be the last solution to choose, when all other solutions have been investigated and found to be unsuitable. The use of personal protective devices will always cause some discomfort to the worker, and be a hindrance to his performance. Unfortunately this will in many cases, particularly in forestry operations, be the only alternative. (Different items of personal protective equipment will be discussed further in Section 5.2.1.B.)



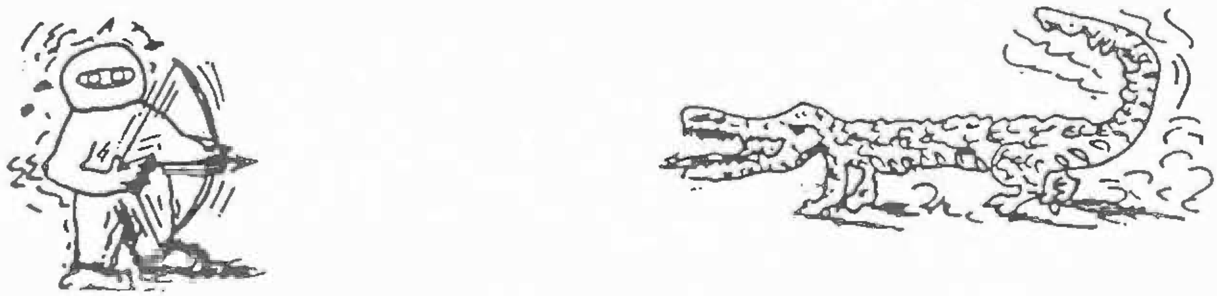
1. Take away the danger from man



2. Take man away from the danger



3. Enclose or isolate the danger



4. Use personal protective equipment

Figure 29. Measures to prevent accidents and diseases.

5.2.1.A. Appropriate technology

During the last 10-15 years expressions such as "basic technology" and "appropriate technology" have become common in discussions regarding choice of technology for different forestry operations, particularly in developing countries. In particular, the transfer of a too-sophisticated and capital-intensive technology from the industrialized countries has been criticized.

According to a (FAO, 1982) document, "the technology should be 'appropriate' with regard to local conditions and to the combined effect on:

- production, quantity and quality
- employment
- ergonomics, occupational safety and health
- socio-economic conditions
- ecology
- energy
- availability of tools and equipment."

The conditions mentioned above differ from country to country. In many developing countries the so-called basic technology will be the appropriate choice for many different forestry operations. "Basic technology" stands for a labour-intensive technology using manually-operated equipment. The utilization of traditional technology is often not efficient in terms of present-day standards. The upgrading of traditional technology has required a further development in line with the availability of new materials, designs etc. with the aim of reducing the expenditure of physical energy and improving productivity.

It is evident that the choice of technology has direct implications for the ergonomic conditions - consequently the choice of technology could be used as a tool to improve working and living conditions for forestry workers.

Training needs are usually recognized as important when introducing advanced technologies, but overlooked when introducing new forms of basic technology for the worker. Also manual tools, such as the bowsaw, will demand much training before the workers know the correct working technique and proper tool maintenance. No tool will be efficient if used the wrong way. Consequently it will be very difficult to convince any worker that the new tool and technique should be introduced, if not accompanied by proper training.

5.2.1.B. Personal Protective Equipment (PPE)

When all possible efforts to eliminate or control safety and health hazards at work have failed, the use of PPE must be considered. PPE plays an important role, particularly in the forest.

Analysis of accident records from logging have proved that the introduction of the compulsory use of appropriate PPE, and safety devices on chainsaws, can result in a large decrease of certain types of injuries and accidents.

There are a number of available varieties of personal protective items such as: helmets, gloves, ear, eye and knee-protectors, boots, safety leggings, etc. Some are of poor quality and design, while others are very good and should be of considerable help in preventing occupational accidents and diseases if used by the worker. There are, however, obstacles to overcome before the PPE is actually worn by the intended user.

PPE must be available to the worker. It normally represents an expense which the worker in many countries is unwilling, if not unable to bear.

For certain jobs or worksites, the safety regulations may clearly state the kind of PPE to be worn by the worker. One of the principal safety tasks of management is to make this PPE available, so that the regulations can be followed. PPE should preferably be provided to all workers and considered as part of the equipment necessary to be able to carry out the work. If not provided free of charge, it should be available at a reduced price. Management should also provide for regular cleaning for certain items of PPE, particularly when chemicals are handled or when equipment is shared by several people.

Even when PPE is provided free of charge, it is not always used to the extent that it should be. It is decisive that supervisors are well aware of the importance of PPE and are motivated to inform and persuade the workers to wear it. It should be part of the supervisor's responsibilities strictly to enforce the existing safety regulations.

Without doubt, one of the reasons for PPE not being readily accepted by workers is the design of the items. The best protection is provided by protective equipment which the worker will wear. Outfits which hinder the work or are in some way uncomfortable, are used with reluctance. Particularly in a hot and humid climate workers frequently complain about, for instance, helmets, earmuffs and gloves which cause discomfort such as headaches or eczema. Existing garments and appliances have to be used until a more appropriate design of PPE for a hot and humid climate is developed.

Safety Helmets

The top of the human skull is only a few millimetres thick. If a falling branch fractures the skull, the injury often leads to death. The appropriate PPE against falling or flying objects is a hard hat or helmet. When working in the forest, a safety helmet can normally be considered the most important item of the PPE.

Requirements of a safety helmet for forest workers are:

Shell

The helmet must meet recognized national or international standards regarding resistance to impact, penetration and fire.

Usually hats are made from polyethylene, a thermoplastic which is cheap and gives good protection against impact and penetration. When exposed daily to heat and sunlight it will eventually deteriorate and

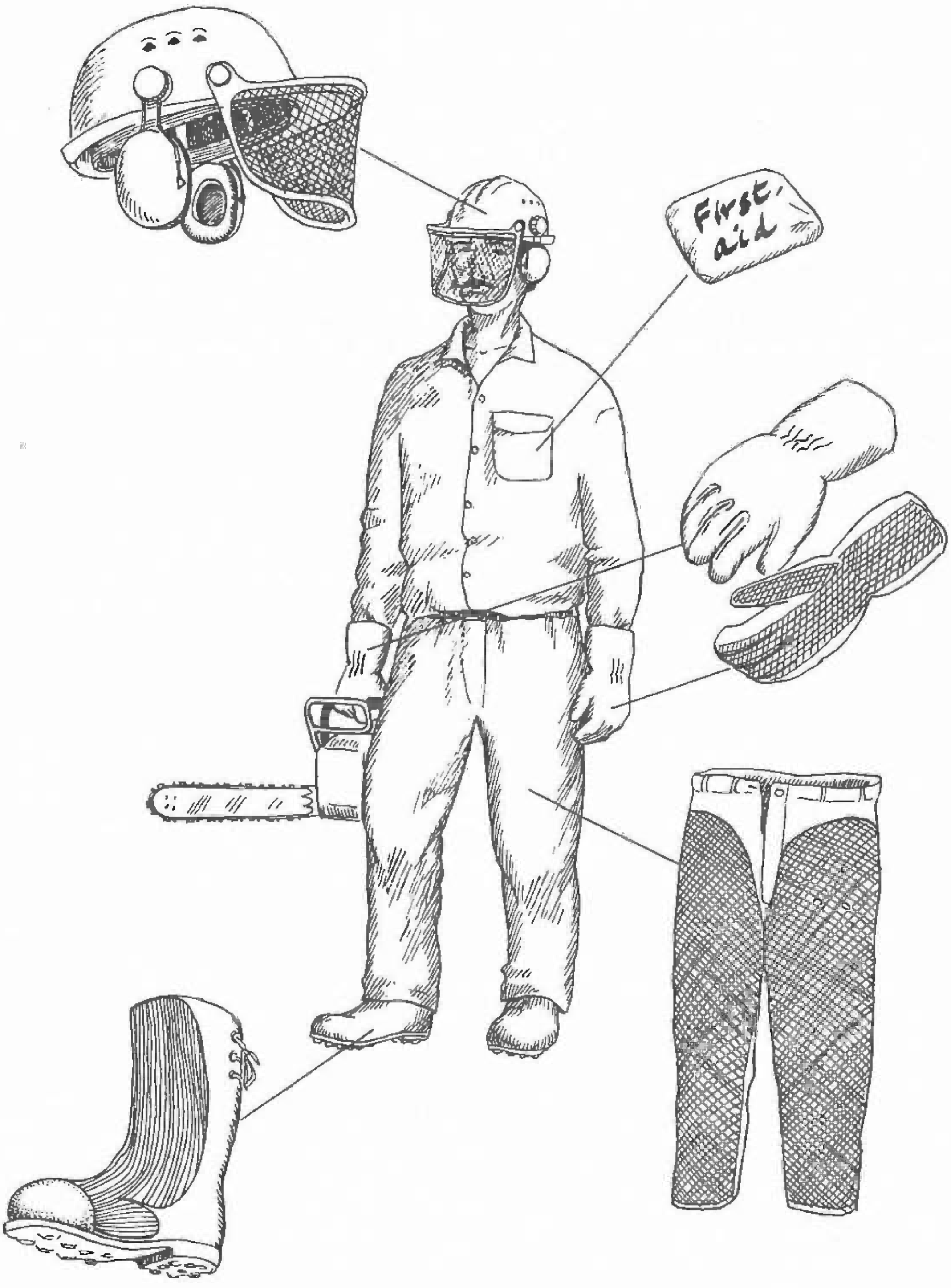


Figure 30. Personal Protective Equipment (PPE) for a chainsaw operator.

become stiff and brittle. Therefore it requires checking for craze pattern, dull colour and chalking. It should be replaced every 4 years. The hat is not suitable for use by fire fighters, as it softens at a high temperature.

Helmets made from fibreglass are resistant to heat and chemicals, but are usually rather expensive. They require inspection for cracking and signs of damage to the shell, e.g. deep scratches or dents.

Helmets may have a rain channel around the edge, at the sides and rear of the shell near the top of the helmet. There should be special holes for adequate ventilation incorporated in the design by the manufacturer. If the holes are made afterwards they will weaken the hat. The helmet should be designed so that it can be used with ear and eye protection.

Harness

The shell of the helmet is supported by a harness. Between the harness and shell there must be a clearance of about 2.5 cm to serve as a buffer in the event of impact. It should be possible for the user to easily adjust the harness to the size of head. The adjustment should be possible both vertically and laterally. The material in the headband should not give rise to skin irritation and should be proofed against shrinkage and changes in temperature and humidity.

Weight

The helmet should have a maximum weight of 300 gr. when complete with harness, but without ear and eye protection. Before getting used to wearing a helmet, the worker often finds it too heavy and giving rise to headaches, but even under tropical conditions these problems usually cease after some time, when the worker is used to wearing the helmet.

Hearing Protectors

If noise combat has failed, and the noise level exceeds 85 dB(A), the worker should wear individual hearing protection such as:

Disposable ear plugs:

These are the least expensive of the hearing protectors - and usually also the least effective. The material can be of acoustic fibre (a very fine glass fibre) or a putty-like substance that is moulded, when applied to the user's ear. An advantage of disposable plugs is that the problem of dirt causing ear infection is negligible. The use of plain cotton or even cigarette filter, which is sometimes seen, is ineffective.

Re-usable ear plugs

There are many different types available. A very effective type is made of expandable foam, which is designed as a small cylinder. Before insertion, the cylinder is pressed together between the fingers. It must be held in place in the ear canal for a minute to allow sufficient expansion.

The disadvantage with all reusable ear plugs is the risk of ear infection, if not kept clean and hygienic. Particularly when working in forestry or forest industries this may cause problems.

Ear muffs

In general, ear muffs are more effective than ear plugs. Unfortunately, they are also more expensive and may be uncomfortable to the user, particularly in a hot and humid climate.

Ear muffs are either mounted on a band for use over or behind the head, or mounted direct on the safety helmet. When attached to the helmet, this should be done in such a way that they can be easily retracted. The combined weight of ear pieces and headband, or helmet attachment, should not exceed 200 g.

The seal rings on the ear pieces should be made from soft and elastic material, and not give rise to skin irritation. Seal rings and sound-absorbing pads should be available as service parts and be easy to replace. All plastic materials, including the rings and pads, will deteriorate when used daily. They must therefore be cleaned and replaced regularly. To avoid unnecessary distortion of the seals, ear pieces should not be in contact with the helmet when in a raised position. In addition, the design and attachment of ear pieces should be such as to avoid branches or other obstructions getting caught in them.

Eye protectors

When working with chainsaws, or when pruning trees above eye level, or when working near woodworking machines, chips of wood and sawdust may fly into the eyes if adequate eye protectors are not being used. Mostly this does not lead to severe injuries but causes irritation of the eyes and disturbs the progress of work. There is, however, always the obvious risk of injuries, even very severe ones such as the loss of sight.

This can be avoided if a face shield or visor is used which is preferable to goggles or spectacles, as it will protect not only the eyes but also part of the face. The face shield can be made of steel mesh or plastic. Inconveniences when wearing a face shield are related to glare in sunshine and decreased visibility in rainy and dark conditions.

The face shield should be mounted on the safety helmet in such a way that it can be easily moved to and from the "in-use" position. The total weight of safety helmet ear and eye protectors should not exceed 600 g.

Other jobs where eye protection is necessary are welding, and sharpening tools on grinding stones. These and other jobs will require different types of eye protection.

Leg protectors

In forestry work, particularly when axes or chainsaws are being used, many accidents occur involving the legs.

Good leg protectors, which will prevent injuries from accidental contact between the leg and the chainsaw chain, should have as long a cut-through time as possible and also have a clogging effect on the chain. They can be made of a number of layers of nylon cord or another fabric.

Available leg shields do not give 100% protection, but will partly protect the user and reduce the risk of severe injuries.

The leg shields should be light in weight and flexible so as not to hinder movement of the legs. They should be sewn into the trousers or otherwise securely fastened. If not, they may slide round the leg, leaving part of the leg unprotected. Furthermore, they should be easy to wash and dry, and not shrink or change shape. They should also have a water-repellent surface.

The compulsory introduction of safety leggings for chainsaw operators in some industrialized countries has greatly reduced leg injuries.

Knee pads may be considered when working for long periods in a kneeling position and putting the body weight on the knee on a hard surface, e.g. in handsaw operations.

Safety Boots

Nobody should work barefoot in the forest or wood processing industry. Any kind of footwear is better than no shoes at all.

In many countries, however, adequate boots are too expensive for the worker to buy. Good footwear will prevent certain occupational accidents (e.g.slips and falls, cuts, snake bites and penetration of protruding objects) and diseases (e.g. infection from wounds and hookworms), which may cause long absenteeism. They will also reduce problems with leeches. Considering these factors, as well as the improvement of work efficiency, proper boots, subsidized by the employer, should be provided to workers.

To ensure satisfactory protection against rough surfaces, the penetration of sharp and protruding objects, impact, crushing, bruises and cuts, there are certain requirements the ideal boot should meet. A non-slip, impermeable and flexible sole is needed. The tread pattern should be deep and self-cleaning, so as to give a good grip.

If chainsaws or cutting tools such as axes are used, the shoe should have a steel toe-cap, and also a special lining to protect the front and as much as possible of the sides of the foot, from cuts and puncture. This lining can be made of impermeable material such as nylon or a special rubber mixture. Steel caps are also required whenever there is a risk of heavy objects dropping or rolling onto the feet, e.g. when loading and handling logs. Furthermore, the materials and design of good boots should allow sufficient ventilation and also be waterproof. The leg of the boot should be water-repellent. During the rainy season, rubber or leather coated with rubber, or other impermeable synthetic material may be used. During dry and hot periods, leather or reinforced canvas is preferable. The boots should not be too heavy. To give a snug fit, the width of the leg of the boot should be adjustable. The laces or straps should preferably be at the back.

In chainsaw work the height of the leg of the boot and the length of safety leggings should be such that no part of the leg is left unprotected.

The boots should preferably provide support of the arch so as to prevent back troubles.

Safety Gloves

Hands and fingers are the most frequently injured parts of the body. There are few jobs in forestry and the wood processing industry where gloves are not needed. However, different jobs need different types of gloves to protect the worker from cuts and scratches from wood and wires, splinters, thorns of trees and poisonous plants, harmful chemicals, dirt, vibrations, heat, cold and blisters. Even when workers are initially reluctant to wear gloves, the wearing of gloves should be strongly encouraged so as to reduce considerably occupational accidents and diseases.

For chainsaw operators the gloves should preferably be made of soft leather or reinforced canvas with seamless palms. In a cold climate, the gloves can be of full mitten-type design, but then the back of the left hand and fingers should be protected by an internal layer of protective material, e.g. nylon cord or rubber. The glove must be flexible enough to allow a comfortable grip of the front handle.

When handling chemicals, e.g. in nursery or plantation work or in the wood-processing industry, gloves made of rubber or plastic resistant to chemicals should be used. When handling wires and cables the gloves should have reinforced palms with internal protective layers of e.g. nylon cord. The material must be flexible to ensure a safe grip.

Other PPE

In this section, PPE necessary for some forestry jobs has been discussed. In forestry and the wood-working industry there are also, however, numerous tasks where other PPE is required. For example: workers on certain jobs in the woodworking industry and workers handling harmful chemicals should wear protective respirators and aprons; fire fighters need flame- and heat-resistant PPE such as helmets, eye protectors and gloves; in floating operations and in water storage of logs, life jackets should be worn.

5.2.2 Behavioural approach

- Propaganda and persuasion

Motivational campaigns, competitions, posters, etc. are examples of approaches to safety which are frequently used. As with all propaganda, it is difficult to assess how long the effects will last. Usually there will be a decrease in the rate of accidents, but the improvement may only be temporary. This does not mean, of course, that the method is unimportant - quite the contrary. A motivational campaign must, however, go beyond simply telling the worker to work safely - for example, by ensuring safer work practice and activating the workers so that they make proposals as to how to improve the working environment.

When using the approach of propaganda and persuasion, it is necessary to do so on a continuous basis. Old, faded, dusty posters on safety matters may have the opposite effect on the workers as they realize that safety is not given much attention by the management.

- Selection and placement of workers

No general criteria can be recommended for selection of applicants for employment. However, in order to reduce human errors, there is a need for special analysis of the particular job in question. Job requirements obtained from such analysis should also be validated as selection criteria. The "job demand profile" should be used together with a corresponding "capacity profile" of the worker. The principle for these profiles is to get a common language for the analysis of the worker's capacity and the demands of the job. If properly used this will ensure a better adaptation between the worker and the job.

Ergonomic evaluation of jobs requires a systematic and thorough analysis of the entire work situation. This may often consist of a complex of various elements and aspects to examine. There are several examples of how to carry out such an analysis in a systematic way. A simple diagram of the workplace and the operator can serve as a starting point for a systematic dissection of relevant ergonomic factors of the job. Another alternative is the use of a checklist (see Section 7).

- Training

An attitude towards safety should be built into the worker's mind during the basic training. The aim should be to train the worker so that his concept of the skill includes safe practices as part and parcel of his work.

In addition, workers should receive refresher training on safety aspects and proper working techniques. The training should be given at certain intervals, so that the workers do not revert to unsafe working habits. Updating training is also required when introducing new work methods or equipment. Well-trained instructors are very valuable for on-the-job training.

Introduction to safety is needed not only for new job applicants but also every time there is a transfer between jobs. This can be done through experienced workers or trained instructors assisting and supervising the newcomer. Newcomers should not be paid on piece rate until skilled enough to work safely.

Many studies have shown that the most common factor contributing to accidents is that the victim is newly appointed and/or unused to the job. The initiation into the new job should be well-planned and include a follow-up after a certain period of time.

It should involve, if available, the occupational health and safety organization, medical service, trade union or workers' association. Information should be given in a clear way about the workers' rights and duties.

The worker should also be given some basic training in first-aid during the introduction period.

5.2.3 Organizational measures

Organizational measures concern, for example, production planning, remuneration system, supervision, inspection and enforcement of mandatory regulations.

Prevention of accident risks through organizational measures is not effective if not well planned. In Sweden, for instance, the introduction of new safety regulations on felling, prohibiting the workers from using some very dangerous methods (e.g methods of taking down hung-up trees), did not significantly increase the use of less hazardous methods. A study showed that the main reason for this was that the forbidden methods were considered to be faster and demanded less physical effort. Saving time was equated with better earnings, because at that time the piece rate system was applied. The accident rate decreased, however, when a new wage system was introduced based on time worked, which encouraged the workers to use safer working methods and to help each other in hazardous situations, e.g. when taking down hung-up trees.

The traditional approach of accident prevention has been focussed merely on the worker himself, overlooking the importance of all the other contributing factors in the working environment, some of which have been discussed above.

5.2.4 Occupational health and safety organization

Safety measures in any enterprise should, as a principle, be part and parcel of the normal operations and should therefore not be handled as something separate.

The employer has the main responsibility for occupational health and safety measures. It is the duty of the employer to provide and maintain working conditions which conform to the existing legislation issued by the country's safety and health authorities. Normally these same authorities, or some other government services, also control law enforcement, by conducting inspections. In many developing countries no special legislation for the forest and wood-processing industries exists. Therefore, in these countries it should be the concern of the industries themselves and of the employers to take initiatives and leadership in safety and health measures. It is important that top management shows a sincere interest by actually taking visible measures. Many large enterprises have established their own regulations and services. The differences can be great between enterprises with high standards and those with inadequate standards.

In general, all safety and health measures require cooperation between management and workers. First, the employer must ensure that the workers are aware of and know how to apply any prescribed safety measures. The workers, on the other hand, are required to cooperate by following given prescriptions and reporting on unsafe conditions.

Cooperation will also be needed from other involved parties, such as foremen or supervisors, persons involved in design and organization of work and in the purchase of equipment, and other staff having an immediate influence on the working conditions.

There are some very special problems when organizing occupational health and safety services within the forestry sector. Due to the fact that the workers are often scattered in remote areas, and that many of the risk factors are related to nature itself, e.g. climate, terrain, vegetation, animals and insects, it is generally more difficult to find an efficient way to organize the safety and health services in forestry compared to most other industries.

<u>Objectives of occupational health and safety work</u>

The overall objective is to promote and maintain the workers' health, safety and well-being. To succeed in this it will be necessary:

- to identify the hazardous factors in the working environment which constitute a threat to the workers' safety and health;
- to analyze the hazardous factors, how the workers are affected and how to prevent the effects;
- to analyze the preventive measures to be taken to ensure that no new risks are introduced;
- to implement the needed improvements;
- to inform all concerned about risks and prevention; and
- to check thereafter that the measures taken have had the intended effect.

All the steps mentioned above aim at the <u>prevention</u> of any health hazards or injuries.

<u>Organization and function of the occupational health and safety work</u>

Although the health and safety aspects should be part and parcel of normal production, as mentioned previously, there is nevertheless a need for a separate organization within larger enterprises to handle these matters.

The individuals engaged in the health and safety services will become the experts, but they should at the same time be closely involved in everyday production. If not, there is a risk of the safety and health organization becoming an isolated activity in the total organization, with little power or influence on decisions affecting the working conditions.

One very important function of the persons involved in safety and health matters is to draw attention to these aspects and to provide information to the management as to what actions are needed.

<u>Individual responsibility</u>

It has already been emphasized that the improvement of health and safety conditions must be the concern of everyone in the enterprise. In the Introduction, the responsibilities of management were discussed. Here, some comments will be provided on the role and responsibility of the staff being appointed to care for certain health and safety aspects.

The organization of the health and safety services could vary between different undertakings depending on, for example, the total number of workers, the number on each worksite and the risks involved in production.

In any undertaking which is large enough, the following would be applicable:

1) Workers and their representatives

The workers must always be aware of what the risks are and how they can reduce the risks. It is the task of management to initiate and maintain this awareness and interest among the workers, regardless of the size of the enterprise. Preferably, a safety delegate should be selected from among the workers and have the main duty of working for safer conditions at the worksite. The safety delegate should serve as a model, motivate the workers to use safe and ergonomic working habits, check that safety regulations are followed and give support and assistance to newcomers regarding health and safety matters. In case of accident, the safety delegate should be involved in the investigation.

In order to be able to carry out these crucial activities at the worksite it will be necessary for the safety delegates to have support from management. Management should provide them with the information they may need, such as accident statistics, rationale behind new regulations, etc. They should also participate in any inspection of the conditions in the enterprise conducted by outside authorities such as national safety inspection services. The duties of the workers' safety delegates will require that they are given training on the basics of ergonomics. If the enterprise has work instructors, they should work in close cooperation with the safety delegates.

The safety delegates should be compensated for any income loss they may suffer due to their duties in addition to their ordinary work. The workers' safety delegate should also be a member of the safety committee, which will be discussed later on in this section.

2) Foremen and supervisors

The most common way of looking upon one's duties among foremen and supervisors is to give priority only to matters directly concerned with production. The health and safety aspects are usually considered as something not included in their responsibilities. To change this both dangerous and inefficient attitude will be decisive, if working conditions at the worksite are ever to be improved. It should be made very clear by management that health and safety matters are taken seriously and are given high priority.

The foremen, supervisors or work instructors and the workers' safety delegates should cooperate closely and have a consistent approach. If there are no work instructors in the enterprise, a very important task of the foremen or supervisors is to instruct and give newcomers on-the-job training. It will therefore be necessary for the foreman or supervisor to be able to carry out the job himself in a safe and ergonomic way and serve as a good example.

3) Safety specialist or safety engineer

In larger undertakings, management will need the assistance of an expert to organize and conduct the safety work. The safety specialist/engineer should be a member of the safety committee and should, as a rule, be supported by a safety department with sufficient resources to carry out all the duties, such as:

- preparation and evaluation of the safety committee's meetings;
- together with the other members of the safety committee make annual safety plans and evaluate the plans and activities at the end of the year;
- conduct safety inspections and follow up suggested corrections or improvements;
- cooperate in the planning of training programmes and the realization of the training;
- administer the accident statistics and investigate accidents;
- organize motivational campaigns, exhibitions, posters, information material, etc.;
- cooperate with and collect information from outside safety associations, accident insurance companies, governmental bodies, (e.g. Ministry of Labour, Ministry of Health), etc.;
- have a close collaboration with the technical departments, the medical department and the workers' association or trade union; and
- organize the purchase, distribution and inspection of personal protective equipment.

In order to succeed in all these and other duties the safety specialist or engineer must, in addition to high ergonomic and technical qualifications, also have the capability to cooperate with the foremen, supervisors, workers, etc. and the gift of convincing and motivating others - from management to the workman.

<u>The safety committee</u>

Enterprises employing 50 or more workers should form a safety committee. In principle, a safety committee should have an equal number of representatives from the employer's and the employees' side. It goes without saying that the workers' safety delegate, the safety engineer, a representative from management and the medical doctor and/or nurse from the company health service, if any, should be members of the safety committee. Other members could be part- or full-time safety officers and representatives of the foremen/supervisors. The chairman could be someone from top management to manifest the weight given to safety matters by management.

It is important that the committee hold regular meetings. The meetings must be meaningful and therefore they require careful preparation.

The safety committee has many purposes, such as:

- to streamline the safety and health work so that everyone will strive for common goals which are clearly stated in a safety programme;
- to provide a necessary opportunity to exchange experience, ideas and information between different departments and experts within the enterprise. The actual conditions in the enterprise will thereby be better known to all members;
- to plan joint activities to promote health and safety;
- to invite specialists from outside the enterprise as resource persons or consultants who could contribute to the solution of certain health and safety problems; and
- to handle special duties, such as safety inspections: to plan, conduct and evaluate safety inspections, and to make suggestions about measures to correct unsatisfactory conditions.

Safety inspections

These inspections can be of different types according to their purpose, e.g.:

a) general safety inspections, once or twice a year, which aim at an overall inspection of the general standard of the working environment;

b) detailed safety inspections can be carried out regularly but more frequently than the general safety inspection and aim to check the conditions within specific areas of the total enterprise; and

c) special safety inspections which are carried out when there is a specific problem or question to solve. Special safety inspections could, for instance, be conducted to get a picture of the problems related to noise, hand-arm vibration, work-schedules, handling of chemicals, etc.

Whatever type it is, the inspection must be carried out in a systematic way, usually with the help of a checklist. Careful notes should be made of the observations during the inspection, and of the measures suggested to correct the conditions. All notes, completed checklists and others should be kept. If a safety engineer is available this should be his task, and he should act as the committee's secretary.

5.2.5 Occupational health services

It is important, particularly in the forestry sector, for workers to have access to a company health service as they work in areas usually without (or with very poor) medical services.

In addition to all the common tropical diseases, of which many are endemic, forestry workers are exposed to a number of occupational risks which can affect their health and safety.

The functions of occupational health services

The tasks of the company health service are several and could be classified according to whether the measures will have a preventive, curative or rehabilitating effect.

Whatever the activity is, it is necessary to have close collaboration with the safety officers and other members of the safety committee.

In June 1985, the previous ILO Recommendation concerning Occupational Health Services was revised. In the new Recommendation 171 it is stated that:

The role of occupational health services should be essentially preventive. Occupational health services should establish a programme of activity adapted to the undertaking or undertakings they serve, taking into account in particular the occupational hazards in the working environment as well as the problems specific to the branches of economic activity concerned.

The following broad functions may be mentioned:

1. Surveillance of the working environment, which also implies that the occupational health services should:

   a) carry out monitoring of workers' exposure to special health hazards, when necessary;

   b) supervise sanitary installations and other facilities for the workers, such as drinking water, canteens and living accommodation, when provided by the employer;

   c) advise on the possible impact on the workers' health of the use of technologies;

   d) participate in and advise on the selection of the equipment necessary for the personal protection of the workers against occupational hazards;

   e) collaborate in job analysis and in the study of organization and methods of work with a view to securing a better adaptation of work to the workers;

   f) participate in the analysis of occupational accidents and occupational diseases and in accident prevention programmes.

2. Surveillance of the workers' health; which may include:

   a) health assessment of workers before their assignment to specific tasks which may involve a danger to their health or that of others. The physical and mental capacity of the worker should be compared with the job requirements so as to facilitate a successful placement of the worker.

b) health assessment at periodic intervals during employment which involves exposure to a particular hazard to health, for example regarding loss of hearing, lung symptoms or other diseases related to the job in question. Very young and old workers should be examined more frequently;

c) health assessment on resumption of work after a prolonged absence for health reasons for the purpose of: determining its possible occupational causes; recommending appropriate action to protect the workers; determining the worker's suitability for the job; needs for reassignment and rehabilitation; and

d) health assessment on and after the termination of assignments involving hazards which might cause or contribute to future health impairment.

3. Information, education, training, advice

These activities are of a preventive character. Some examples are:

- health and hygiene education of the workers in an endeavour to change behaviour and attitudes related to health, hygiene and feeding habits. This sounds like an easy programme but may include the following steps:

a) social diagnosis, e.g. living conditions including accommodation, sanitation, water reservoirs;

b) epidemiological diagnosis to find the health problems which may be linked to the social and working conditions;

c) behavioural diagnosis - which habits are epidemiologically linked to health problems? and

d) educational diagnosis - to assess what factors will facilitate or complicate health education, e.g. attitudes, knowledge.

- training and retraining in first-aid, and continuing training of personnel who contribute to occupational safety and health.

It is important that the staff at the company health service, e.g. the physician, nurse and physiotherapist, are familiar with the working conditions at the workplace. Regular visits to the field are decisive if they are to reveal the causes of injuries and work-related diseases. To be able to participate in the work of improving the conditions and suggest solutions to the safety committee, the actual conditions must be known in detail by the medical staff.

4. First-aid, emergency treatment and health programmes

ILO Recommendation 171 says further that: taking into account national law and practice, occupational health services should

- provide first-aid and emergency treatment in cases of accident or indisposition of workers;

- carry out immunisations and collaborate with health authorities in public health programmes; and

- engage in other health activities including both the workers and their families.

5. Other functions

Company health services may also, e.g.

- draw up plans and reports at appropriate intervals concerning their activities and health conditions in the undertaking. The employer, the workers' representatives and the safety and health committee should have access to these plans and reports;

- within the limits of the resources the company health service should contribute to research, by participating in studies or questionaires.

The organization of occupational health services

According to ILO Recommendation 171, occupational health services should, as far as possible, be located within or near the place of employment, or should be organized in such a way as to ensure that their functions are carried out at the place of employment.

In accordance with national conditions and practice, occupational health services may be organized by:

a) the undertaking or groups of undertakings concerned;

b) the public authorities or official services;

c) social security institutions;

d) any other bodies authorized by the competent authority;

e) a combination of any of the above.

Conditions of operation

Occupational health services should preferably be made up of multidisciplinary teams, e.g. technical personnel with specialized training and experience in such fields as occupational medicine, occupational hygiene, ergonomics, occupational health nursing and other relevant fields. They should, as far as possible, keep themselves up to date with progress in the scientific and technical knowledge necessary to perform their duties and should be given the opportunity to do so without loss of earning. The occupational health services should, in addition, have the necessary administrative personnel for their operation.

Within the framework of a multidisciplinary approach, occupational health services should collaborate with:

a) those services which are concerned with the safety of workers in the undertaking;

b) the various production units, or departments, in order to help them in formulating and implementing relevant preventive programmes;

c) the personnel department and other departments concerned; and

d) the workers' representatives in the undertaking, workers' safety representatives and the safety and health committee, where they exist.

5.2.6 First-aid and emergency treatment

First-aid is the immediate treatment given to someone who is injured or has suddenly become seriously ill when there is no qualified medical assistance available (e.g. physician, nurse or ambulance crew). First-aid includes not only physical treatment of the injury or illness but also psychological encouragement of the victim. The first-aider deals with the whole situation including both the injury and the victim.

Knowledge and skill of how to give first-aid treatment will increase the chances of survival in cases of serious injury, or it may mean a temporary disability only instead of a permanent one, or a speedy recovery instead of lengthy hospitalization.

First-aid knowledge will also develop a person's safety awareness and lead to safer working habits and thereby help to prevent accidents.

The benefits of first-aid are particularly evident in forestry operations which often include dangerous operations in remote areas without any medical services and with very poor transport. In such cases, and where many workers are employed, it is necessary to have well-trained first-aiders and comprehensive first-aid equipment.

At least two persons, e.g.the foreman or supervisor and one more person, with thorough knowledge and skill of first-aid should be available at the workplace or the forestry camp. In many situations the chances for successful first-aid treatment will increase if there are two first-aiders to cooperate, e.g. when artificial respiration is needed. These persons should be re-trained periodically and should also know the proper first-aid treatment of acute illnesses such as appendicitis, heart disorders, toothache, fever, etc.

At stationary work places and in logging camps there should be a first-aid room, and in the field a well-equipped first-aid box. The contents of the box should meet the needs specific to the workplace. The company physician or nurse should be consulted regarding with which items and in what numbers the first-aid box is to be supplied. The requirements will differ depending on: type of work carried out, the remoteness of the workplace, how many workers the box is intended for, or special dangers such as poisonous snakes.

All forest workers should be given basic first-aid training and regular re-training. Preferably, each worker should be equipped with a pocket-size first-aid kit. A minimum requirement is one first-aid kit in each group of workers working together or very near each other.

Preferably all motor vehicles should have a first-aid kit and if the vehicle is used for workers' transport the first-aid kit should be comprehensive. In all of the more well-equipped first-aid kits an illustrated first-aid guide should be included.

First-aid training is a most important activity for the company health service. First, the trainees must be motivated to learn. The usefulness and benefits of first-aid knowledge should be explained, e.g. how to treat minor injuries, how to put to bed or transport more seriously injured persons, and how to judge when an injury must be treated by a physician. All first-aid training should be directed towards practical skills. The treatment of such injuries as could be expected at the trainees' workplace should be emphasized.

Each trainee should be required to demonstrate his or her skills; passive listening or watching will not give the necessary skills. Regular re-training should be organized at least every second or third year. All foremen or supervisors should receive instruction from advanced first-aiders.

No further instructions on immediate first-aid treatment will be given in this chapter. The reader is strongly recommended to acquire knowledge and skills in first-aid treatment and to undergo special first-aid training. It would be an underestimation of the need for practice and thorough knowledge if only a few pages of summarized guidelines and illustrations were given here. The same is true regarding suggestions for the contents of the first-aid kits and boxes, which should be as custom-made as possible.

5.2.7 Work study

This section is based on two publications, namely "Introduction to work study", 3rd edition, ILO, Geneva, 1979 and "Forest work study nomenclature in Denmark, Finland, Norway and Sweden", The Nordic Forest Work Study Council. Bulletin No. 1, 1963. The content consists mainly of excerpts and paraphrases from these two publications. The aim of this section is to give the reader a brief introduction to the work study and its application in forestry work and to show the role of work studies as a useful tool in the framework of ergonomics. The interested reader is recommended to carry out further studies of the topic. Brief answers will be given to the questions: WHAT is work study? and WHY, WHEN and HOW can it be used?

Work Study is a generic term for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts, and which lead systematically to the investigation of all factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement.1/

Work study is systematic and objective both in the investigation of the problem being considered and in the development of its solution. Besides aiming at the most rational method of carrying out work, work study serves as a base of wage payment plans. However, to ensure the scientific integrity of work study it is of great importance to separate it from discussions on wage levels. There is a fundamental difference between work study and pricing of work. Pricing of work will not be further discussed here.

1/ The definition given here is that adopted in the "British Standards Institution: glossary of terms used in work study" (London 1969).

Most of the problems which are approached by using work study require a synthesis of measuring systems and also experience gained from ergonomic, technical, medical, climatological, sociological and other fields of research. So what then are the techniques - method study and work measurement - mentioned above in the definition?

Method study

Method study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs. The objectives are:

- to improve processes and procedures;
- to improve workplace layout and the design of plant, machines, tools and equipment;
- to economize on human effort and reduce unnecessary fatigue;
- to improve the use of materials, machines and manpower; and
- to develop a better working environment.

Work measurement

As mentioned in the definition of work study, method study was one technique used in work study. Another technique, also mentioned in the definition, is work measurement.

Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance.

So if method study is the principal technique for reducing the work involved, primarily by eliminating unnecessary movement on the part of material or operatives and by substituting good methods for poor ones, work measurement is concerned with investigating, reducing and subsequently eliminating ineffective time, that is, time during which no effective work is being performed, whatever the cause.

Application in forestry

In the industrial field, work study has been used to a far greater extent than in forestry. As to the pre-requisite of the jobs under observation and also the problems in respective cases, there is a great difference between industry and forestry. In important respects this also applies to measuring techniques.

Work study proper is often applied in industry to relatively short work operations, often in more or less automatized operations where the working conditions are stabilized and yet more easily influenced by management than in forestry. In forestry, the working conditions vary to a great extent both in time and space and the methods are also more dynamic. Method study used in forestry has, therefore, required other systems for work measuring. These are usually based on planned field experiments and statistical analysis. For ergonomic purposes, work studies should be combined with physiological studies.

Examples of studies in which work study has been used as a tool to evaluate the appropriateness of different technologies, tools, tool design and tool maintenance are "Choice of Technology in Forestry. A Philippine Case Study" (ILO, 1981) and "Men and Tools in Indian Logging Operations. A pilot study in ergonomics" (Hansson et al., 1966).

6. ERGONOMIC PROBLEMS IN DIFFERENT FORESTRY ACTIVITIES

6.1 Working and Living Conditions of Forestry Workers in General

In many countries, forestry work is regarded as a low status occupation. Salaries are lower than those of most other wage earners. Many forestry workers are casual workers without secure and permanent employment. Vocational training for forestry workers is rare in developing countries. A number of studies, carried out in different countries around the world, have confirmed that forestry work is among the heaviest in all industries. The provision of food of sufficient quantity and quality is therefore particularly important. Due to low salaries and remote, isolated and scattered workplaces in areas with poor infrastructure, many forestry workers have difficulty in getting sufficient food. They suffer from a too-low energy intake and often the nutritive value is far from optimal. To carry out dangerous and heavy physical work while being malnourished will very likely result in health problems.

Health, medical and other social services in the areas where forestry activities take place are usually poor or non-existent. When the circumstances are such as described here, which is more the rule than the exception, productivity is affected negatively. As a result of low productivity the salary will be low as well. In this way the forestry workers are caught in a vicious circle, as illustrated in Figure 31.

The poor working and living conditions also affect the families of the forestry workers. In many places the children are deprived of medical services and even schooling, which gives them small opportunity for a better life in the future. It is not unusual that labour unions or workers' associations, if they exist at all among forest workers, are disregarded. Where they are accepted there may still be hindrances in activities aiming at the promotion of the workers' working and living conditions.

The fact that the conditions for forestry workers and their families are so extremely poor in almost all countries, and that the improvements are so slow in the developing countries, must not be a reason to accept this state of affairs; quite the contrary.

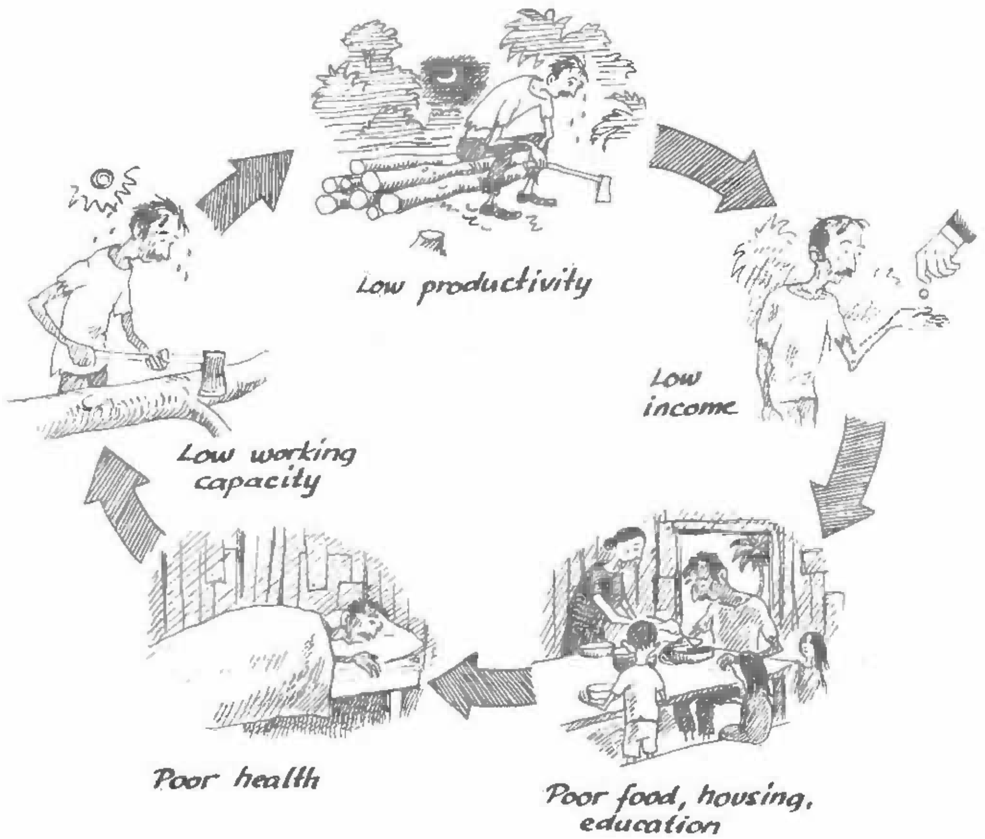


Figure 31. The vicious circle of low productivity and poor health.

6.2 Nursery Work

Nursery activities in general can be classified as physically light work and with small risk of serious accidents. In many countries it is common that much of the work is carried out by women. Nevertheless, there are some both heavy and dangerous tasks even in the nursery. Some of them are discussed here.

Preparation of the nursery

Even if the ordinary work in a nursery may be characterized as safe and light, this is not true for the preparation of the site for the nursery. The workers engaged for this work might be locally hired and with no experience of such work. It will often be necessary to remove standing trees and to uproot heavy stumps. This involves many risks, particularly when using machines such as tractors, bulldozers and winches, or when blasting. Also soil cultivation and the removal of small trees and undergrowth with manual tools may cause many accidents when the workers are inexperienced. Inexperienced workers may also not be aware of various risks, such as harmful plants, insects and snakes.

Careful planning, instruction and close supervision will be important. The use of good footwear and gloves, keeping a safe distance between the workers, proper maintenance of tools and the provision of shelter against wind, rain and sun are some measures to improve working conditions.

Fencing of the nursery is another activity which can be both heavy and risky work depending on the kind of fencing:

- Using barbed wire will require proper gloves, preferably of thick leather, and good boots. In particular, the stretching of wires should be done with great care and a safe distance must be kept when cutting a wire under tension. Wires and nails should not be left on the ground, otherwise there is a risk of stumbling or stepping on them.

- A stone wall is durable but takes a lot of energy to build. By using levers, wheelbarrows and sledges, the work load can be very much decreased. Gloves and good boots should be used.

- A bamboo fence combined with a hedge with thorns will not cause any big risk or heavy physical work if the worker is properly equipped.

Day-to-day nursery activities

Among the day-to-day activities in a nursery, certain jobs are heavy, such as moving material over short distances, particularly if not using proper equipment and tools.

- Plenty of soil and sand is needed, especially if growing seedlings in pots. Digging will be physically lighter when tools designed for the purpose are used. For example, when heaping loose forest soil in the nursery a plain spade will be the appropriate tool, but when loading hard material, such as stones, a shovel with a round mouth - or else with a pointed mouth or tip - will be better than a squared one. For certain jobs, a digging fork can facilitate the work: it is easier to drive into the soil than a spade. Footwear with good soles is needed when digging. The soil and sand must be transported from the source to the place where it will be used. This is preferably done using a wheelbarrow. Design and material may vary a lot. If the terrain is soft, a track made of narrow planks on cross stringers will make a path for a single-wheeled wheelbarrow. Other solutions might be sledges or yokes, if no animal power is available.

- Plenty of water is also needed in a nursery. In bigger nurseries the watering of seedlings can be done with, for example, a sprinkler system, flood irrigation or percolation. In small nurseries it is more common to do it by hand. Watering with a hose will require less effort than using a can.

- When producing seedlings in pots in nurseries there will be plenty of work moving the filled pots short distances. Again: wheelbarrows or sledges can facilitate the work considerably.

Besides all work involving short-distance transport of e.g. soil, sand, water or seedlings, much of the time in a nursery is spent on weeding, grading, transplanting and pot-filling. None of these activities is physically heavy but can be tiring due to poor work postures and/or lack of shelter against sun, wind and rain. The use of a low stool, instead of squatting, will give some relief for the back, legs and knees. If kneeling, a small soft rug or knee pads will protect the knees. A small, light and portable shelter against the sun could be an alternative or complement to a broad-brimmed hat (see Figure 32).

Even in the tropics, greenhouses are used for germination and rooting of seedlings. Temperatures may be very high unless good ventilation is arranged during working hours. Work rotation or long rest pauses outside the greenhouse may be needed.

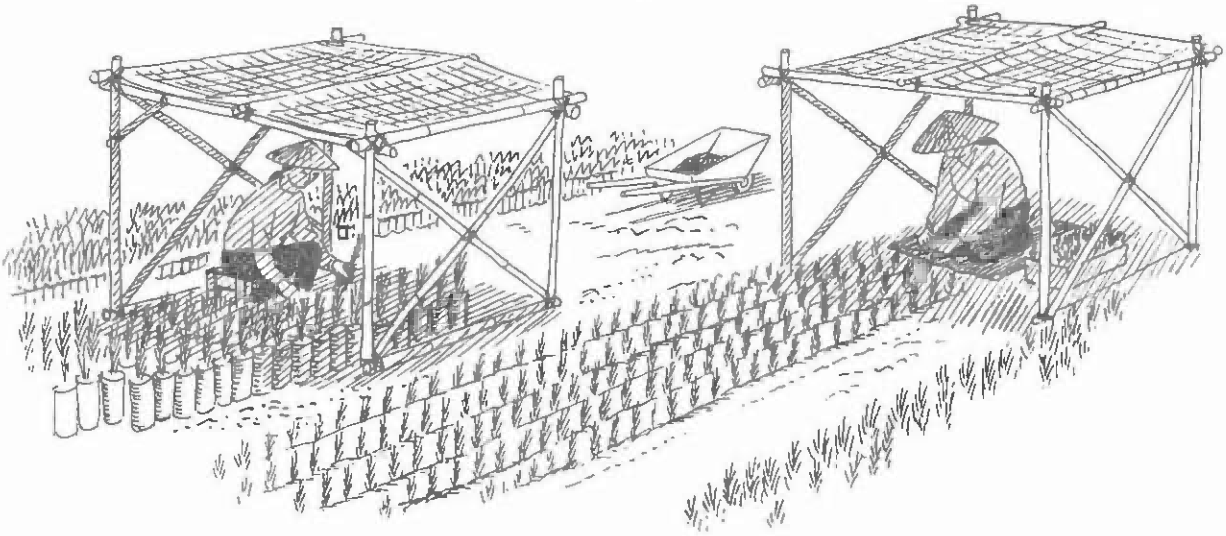


Figure 32. A low stool, a soft rug or kneepads, a shelter against the sun, and a wheelbarrow are examples of simple items which can facilitate work in the nursery.

Perhaps the most hazardous factor in nursery work is the handling of different chemicals. All pesticides are toxic. In nurseries pesticides such as fungicides, herbicides and insecticides are used against plant diseases, weeds and insects.

Often the pesticides are used only during short periods of time each year. It cannot be expected that uneducated workers in the nursery should be aware of the risks or remember all safety rules from one time of using to another. The supervisors will have the responsibility of ensuring that no workers are exposed to safety risks. Much has already been said on this topic in the sequence on "Harmful substances, e.g. chemicals, solvents, gases, smoke and dust" (3.2.4). In spite of this, a short repetition may be needed. The following is taken from the booklet "Village nurseries for forest trees - how to set them up and how to run them":

- Lock poison in a box or cupboard away from any food and out of the reach of children. Keep chemicals in their original containers. Never put chemicals in containers without labels. Make sure that the poison store has a clear label: POISON and also a sign which may easily be understood by illiterate persons.

- Make sure that when you use, store or throw away pesticides, you are following the laws of the country. Check the law about pesticides.

- Always read the label and follow the instructions on how to use the poison. Make sure all the workers understand how to use the poison. The label tells you what is in the poison, its uses, how much to use (the doses), and how often. It also tells you how to use the poison as carefully as possible. It tells you what to do before you use the poison. It also tells you about first-aid: what to do if something goes wrong. If the label is not clear, try to get a pamphlet about the poison. Never buy or use chemicals that come in sacks or bottles without labels.

- When the container of the poison is empty, make holes in it, flatten it, and bury it deep. Bury it in an area away from the village and fields, and away from any water supply. Do not use an empty container for any other purpose.

- Always use proper safety equipment and wear protective clothing when you use chemicals.

- Never smoke, eat or drink while you are using poison. Wash yourself with soap and water both before rest periods and when you have finished the job.

- Wash thoroughly all the spraying equipment and other tools with soap and water after you have used them. When you are washing, take the water to a safe place so that you do not harm the water sources.

- Be particularly careful with concentrated poison. When you mix pesticide solutions, try not to make splashes. If you spill some of the poison, soak it up with sawdust or soil. Then bury the sawdust or soil in a hole and cover it.

- If anybody develops symptoms of poisoning, remove him/her from the work area and call a doctor immediately.

6.3 Planting Activities

Tree planting is becoming a more and more important activity in forestry in many developing countries. To date, little interest has in general been shown when it comes to improving working conditions, methods, techniques, tools and equipment for tree planting.

Tree planting is generally manual work carried out with simple tools, often by women or unskilled labour. The incentives and benefits of improving tree planting operations are not always perceived by decision makers and management. In general, it is also difficult to mechanize the actual planting operation. But there is wide scope for improvement, in terms of quantity and quality. There are also a number of adjunct activities in addition to actual planting, many of which could be improved. Examples of such activities are: transporting seedlings from the nursery to the planting area, and then carrying them from the road to the actual planting site, clearing the planting area, marking planting rows, weeding and tending after the planting, and transplanting when necessary. In this section all but the first activity (transport of seedlings to planting area) will be covered briefly.

Very often the planting activities are conducted on land with difficult terrain and poor accessibility.

Workers may have to walk long distances to reach the planting area. They normally have to carry the seedlings on foot from the road to the planting site. When using potted instead of bare-root seedlings, big amounts of heavy soil are carried as well. The total weight to be carried during one working day can be considerable.

Improving the seedling carrier is one way to facilitate the transport work. When the seedlings are to be carried long distances, and particularly when the terrain is steep and rough, a back-pack model is preferable (see Figure 33), or a pack animal.

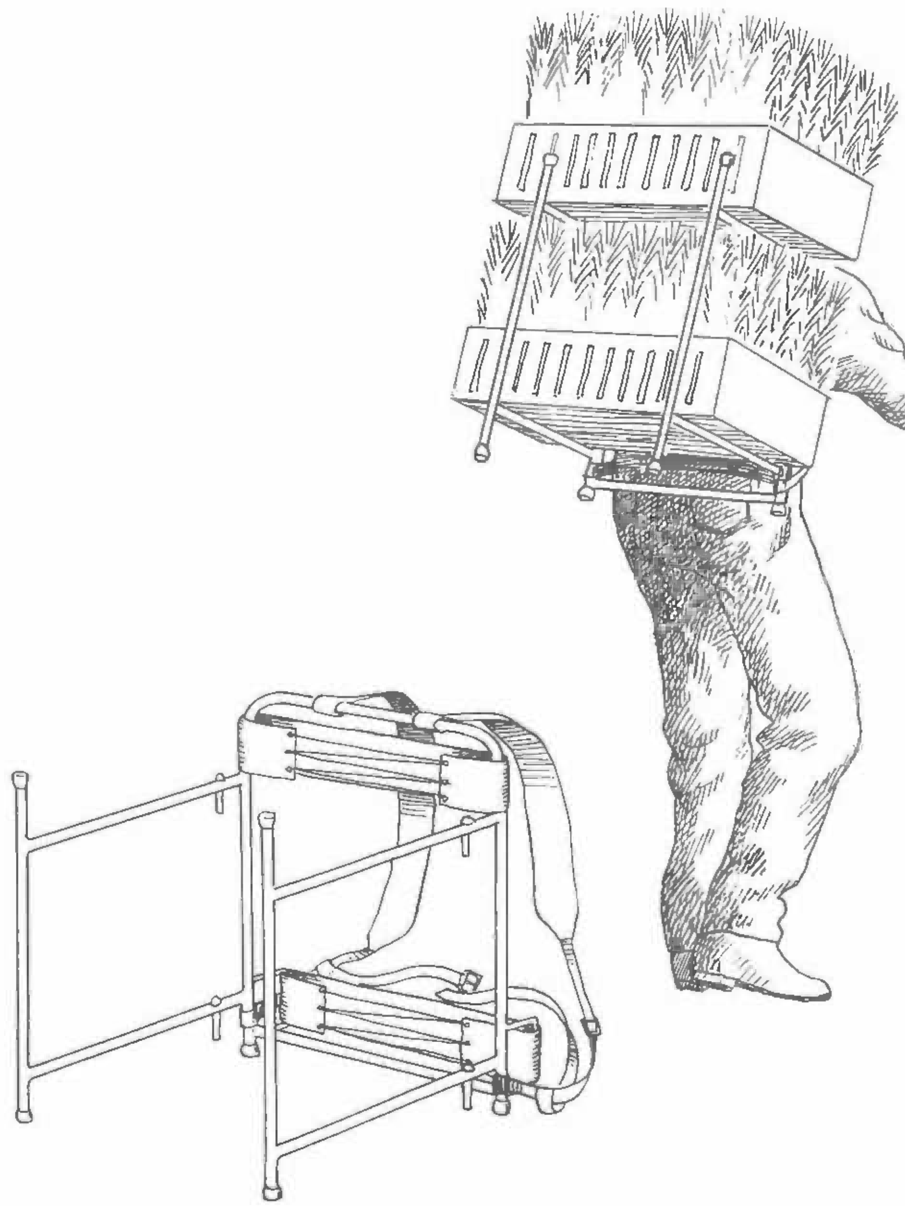


Figure 33. When the seedlings are to be carried long distances and when the terrain is steep and rough, a back-pack carrier will facilitate the transport work.

When it comes to the actual tree planting, the seedlings can be stored in a suitable plant tray which is carried in the hand between the plaa suitable plant tray which is carried in the hand between the planting sites and put down on the ground when doing the planting (Figure 34a), or in a shoulder-carried seedling container (Figure 34b).

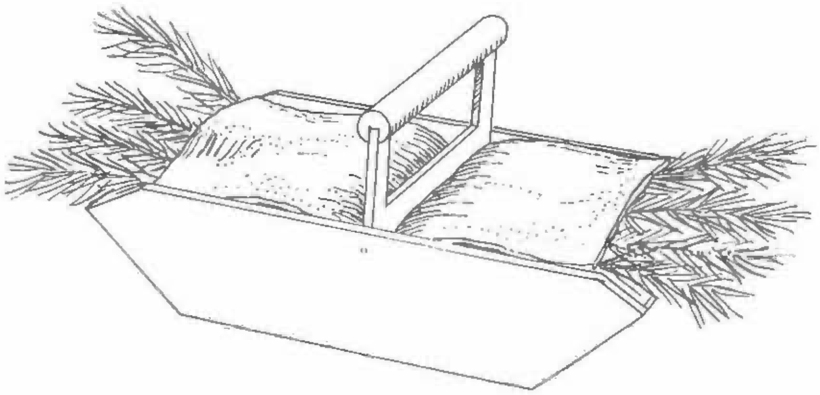


Figure 34a. A plant tray, carried in the hand between the planting sites and put down when planting, will also help to protect the plants from drying.

Figure 34b. A shoulder-carried seedling container.

Ideally, the workers should be equipped with a planting hoe of the appropriate type for the particular soil and terrain they are planting at the moment. For example, if the planting site is stony and very difficult, they should have a so-called "grubbing mattock" - see Figure 35 (ILO's Forestry Equipment Planning Guide, p.121), and if the planting site is on a steep slope the planting tool should have a shorter handle than when working on flat terrain. In the Philippines, different hand tools for planting (among other forestry activities) have been compared and evaluated in an ILO study.

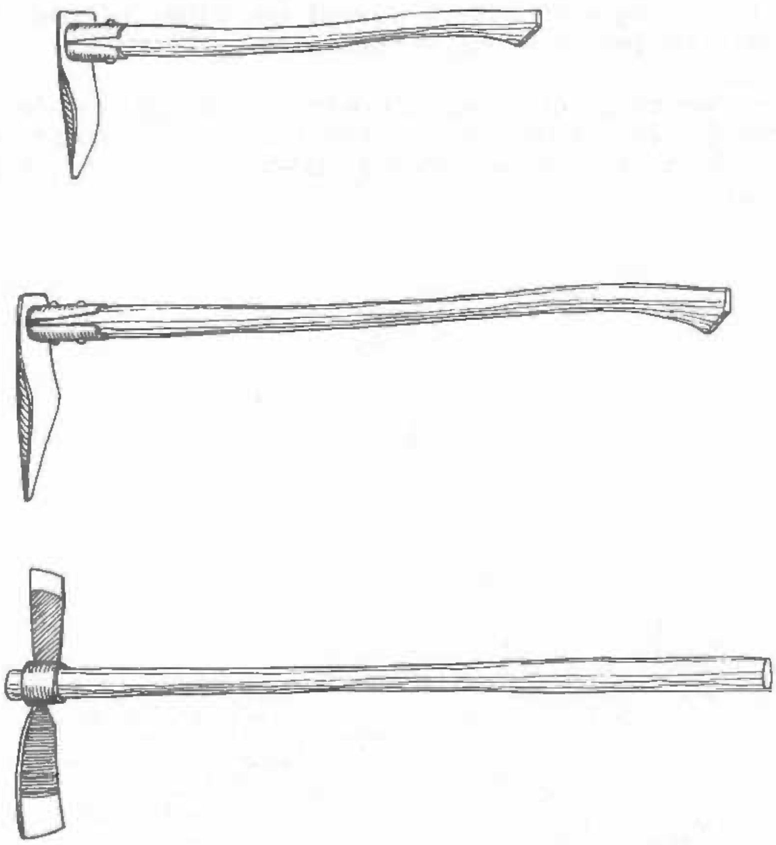


Figure 35. Different types of planting hoes designed for various terrain and soil. When planting on a steep slope a short-handled tool is preferable (upper hoe). When the planting site is stony and very difficult a "grubbing mattock" should be used (lower tool).

Two work studies were undertaken which dealt with tree planting in the context of an industrial plantation and a government reforestation project, respectively 1/. Both compared different hand tools for planting; one of them also evaluated the effect of using ordinary market baskets to augment the number of seedlings that can be carried from the roadside to the planting site.

The most satisfactory planting tool for general purposes was an oval-blade planting hoe (Figure 36). The oval-blade hoe penetrates the soil more easily than a blade with a straight edge. Unlike the wooden dibble (Figure 37), it does not leave an air pocket under the seedling, or compact the soil on all sides of the planting hole. Finally, the oval-blade hoe's cutting edge curves around the sides of the blade to facilitate patch clearing in dense grassland.

In the government reforestation project, the oval-blade hoe increased the planting rate by 22% above that of a military-type spade in easy terrain, and by 35% above that of the narrow-blade planting hoe in difficult terrain.

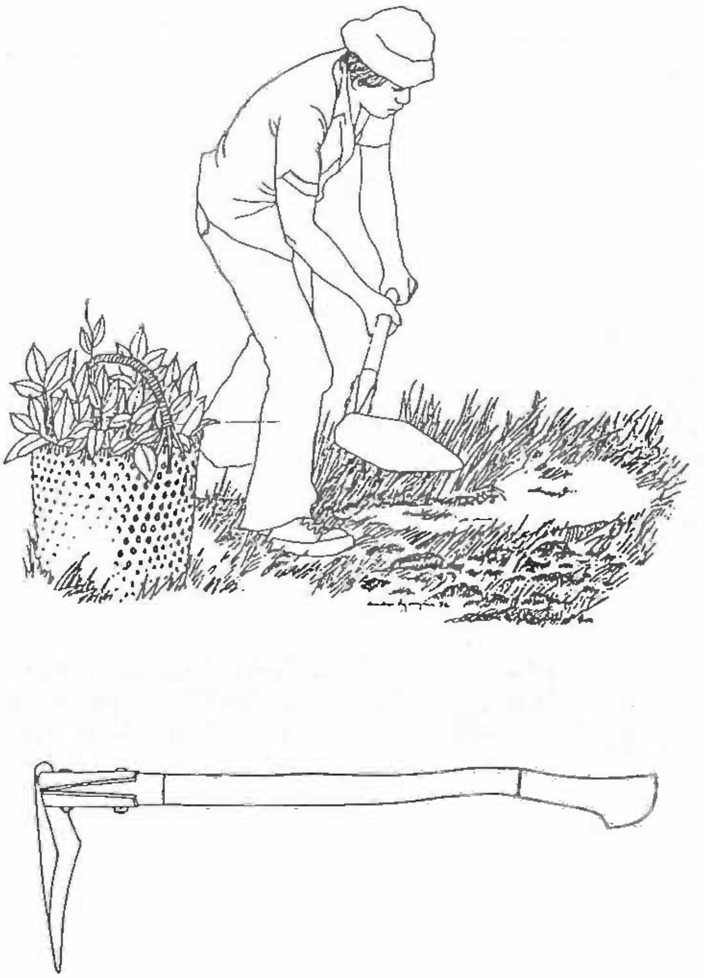


Figure 36. Removing the grass and humus layer with oval-blade planting hoe.

1/ Work Studies 6 and 7, Choice of Appropriate Technology in Philippine Forestry (1981).

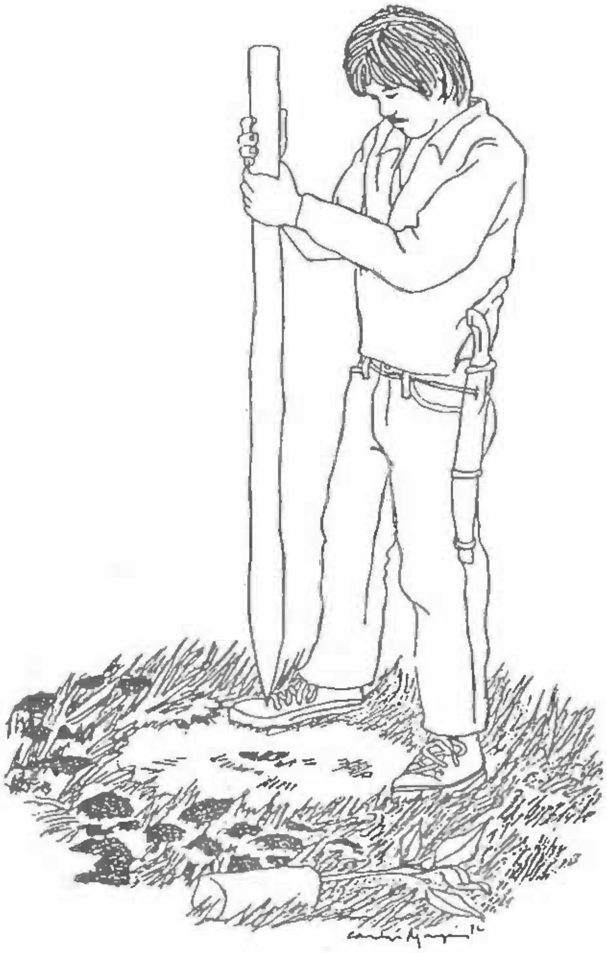


Figure 37. Tree planting with wooden dibble.

The clearing of the planting area, as well as the weeding and tending activites, could also be improved and facilitated by the introduction of appropriate tools.

The all-purpose machete, bolo or jungle knife, often made of material of poor quality, is the tool used also for the activities mentioned above. The short-handled tool must be used in a bent and inconvenient work posture.

Each separate task will in general be carried out with less effort, faster, better and more safely when using tools designed specially for the task. The workers themselves cannot afford three, four or even more different tools. But for the enterprise, the cost can usually be afforded, especially when considering the benefits.

Figure 38 shows some different tools used for cleaning, weeding and tending. Tools with a new and different design and a new way of functioning, when compared to the traditional tools the workers are used to working with, will need also a new working technique. It will be decisive for the acceptance of the new tools, as well as for production, effort and safety, that workers are given appropriate training on the use and maintenance of the new tools. This is often overlooked. The attitude that hand tools are so simple to use that no training is needed is far too prevalent.

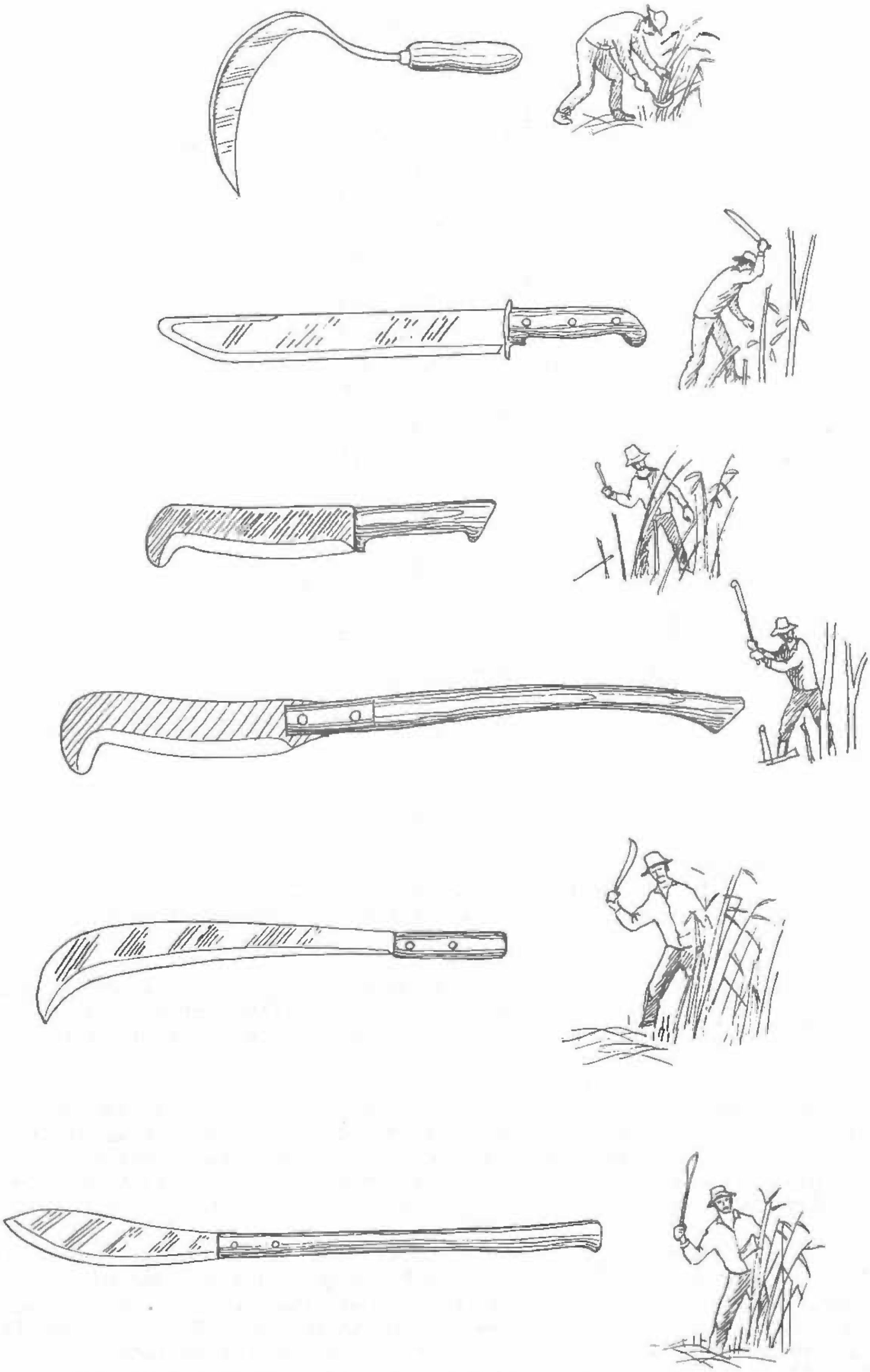


Figure 38. Different tools with varying design to be used for cleaning, weeding and tending.

Tree planting work is usually considered neither heavy nor dangerous, but steep and rough terrain, long walking distances, heavy loads to carry, and strenuous and unergonomic work postures due to poor tool design often make the planting work heavy. These working conditions, in combination with a hot climate and often direct exposure to radiant heat, increase the risk of heat stress. It is important to organize the work in such a way that this risk is avoided.

Shelters should be provided. Drinking water or other liquids should be available. Work during the hottest hours of the day should be avoided and work should preferably be concentrated in the cooler morning hours. Transport of the workers between dwelling and planting areas should be provided if possible, to save their energy. Workers should have appropriate footwear to help avoid falling, stepping on sharp objects, and snake bites. Tools should be properly maintained, e.g. sharpened and loose handles fastened. Workers should not work too near each other.

6.4 Logging Operations

Logging operations include a number of various work elements such as:

(1) Walking in the forest, with or without tools.
(2) Use of hand tools and chainsaws.
(3) Maintenance and repair of tools, equipment and machines.
(4) Clearing of paths, escape routes and the base of trees from undergrowth and other obstructions.
(5) Felling operations including taking down hung-up trees, debranching, cross-cutting and moving and bunching of logs.

The most hazardous tasks are felling and debranching, particularly when they are done by chainsaw.

(1) Walking

The workers are exposed to certain hazards when walking in the forest, and on arrival at or departure from their workplace, especially if they have to carry tools, a chainsaw or heavy loads. Walking for long distances in a hot climate and in rugged terrain should be restricted, as much as possible, so as not to cause unnecessary fatigue to the worker. The worker should not walk alone. At least one of the workers should have a first-aid box.

Paths and workplaces should be kept clear from obstacles in order to prevent stumbling and falling. The worker should wear appropriate boots to protect the feet from injuries, in case of stepping on protruding sharp objects, and to prevent slipping and falling. Good footwear will also provide protection from snake bites and leeches.

Frequently-used paths should be cleared of branches and plants which may strike the worker. In particular, plants which are poisonous or thorny should be removed.

A safety helmet must always be worn to protect the head if there is a danger of falling branches.

When sharp-edged or sharp-pointed tools are carried, they should be equipped with protective covers or sheaths. If not covered, the tool should be carried as safely as possible. Generally, it should be gripped near the cutting part and kept close to the body, with the sharp edge parallel to the leg, or pointing outwards.

When carrying a chainsaw, the engine should be stopped and the chainbar covered with a guard, except for short distances as during crosscutting and limbing, or when the distance between trees to be felled is very short.

Tools for chainsaw maintenance should preferably be carried in a tool belt.

In order to save energy and to free the hands, loads should, whenever possible, be carried on the back, e.g. in a rucksack.

(2) <u>Use of handtools and chainsaws</u>

A major part of injuries in forest work occur when handling hand tools and chainsaws. Many of these accidents are caused by direct accidental contact between the human body and the tool/chainsaw. The worker may, for example, strike himself with the bolo (machete), or axe because the tool slipped. Safe working techniques are crucial to avoid accidents and unnecessary physical strain. Below, only some very general precautions for using hand tools and chainsaws will be mentioned. Detailed guides on, e.g., the use and maintenance of chainsaws; proper working techniques for felling operations, are therefore recommended for further study. See nos. 4, 22, 37 and 39 in the reference list.

- Hand tools

The appropriate tool should always be used for the job. For example, an axe should neither be used as a wedge nor as a logpick. Whenever possible, dangerous tools should be replaced with less dangerous ones. A handsaw, for example, is safer than an axe when felling trees (and saves human energy and wood waste).

Dangerous cutting tools, such as axes, billhooks (bolos), saws and barking spuds should have as safe a design as possible. Knives, billhooks and similar cutting tools should have handles with a projection to prevent the hand from slipping onto the blade. A correctly designed axe handle is shown in Section 3.2.1, Figure 23.

The workers should be trained to use the tool or chainsaw in the right manner by using proper working techniques so as to avoid poor work positions, and reduce static work and harmful lifting. They should start under easy working conditions until they are skilled in its use. Safe behaviour should be emphasized, such as:

- never cut with a sharp tool towards the body;

- keep the stem between the tool and your legs, e.g. if debranching with an axe or chainsaw, or debarking with a barking spud, and always keep at a safe distance from other people.

- never throw a tool to another person, but always hand it over in a safe way;

- always keep tools in a safe place when not using them, so as to prevent stepping on, or falling over them. For the same reason tools, or at least their handles, should be painted in colours different from the surrounding environment;

- never use a tool or chainsaw if it is not in good condition; always use it following the manufacturer's recommendations, if any - this is particularly important when using a chainsaw.

- always use guards for sharp tools during transport and storage.

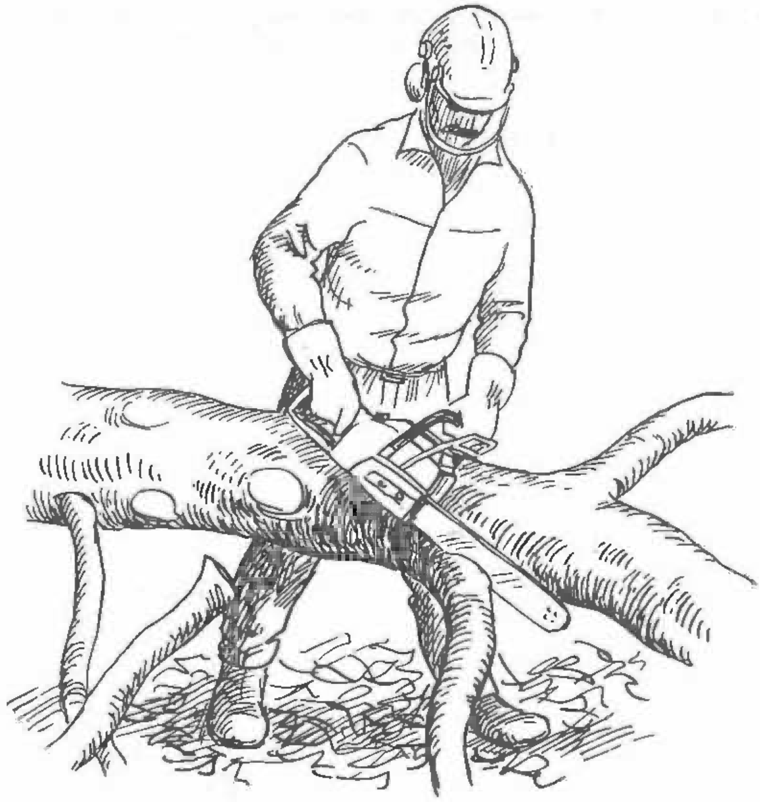


Figure 39. Work with the stem between the tool and yourself!

- Chainsaws

Chainsaws can cause both frequent and severe occupational accidents and diseases. Common hazards directly related to the chainsaw are:

- the worker cuts himself, usually on the hands, fingers, feet or legs;

- kickbacks, causing severe cuts or leading to indirect injuries, e.g. the worker falls because of the kickback and gets hurt by a sharp object;

- chain breaks, usually injuring the right hand, but separate loose cutters or links may also intrude on the body, leading to even fatal injuries. A well-maintained chain, properly sharpened, tensioned and lubricated, will considerably reduce the risk of a chain break;

- noise (see section 3.2.2).

- vibration (see section 3.2.3).

Before starting the chainsaw, it should be taken away from where it was filled up with fuel. It should be placed on firm ground before starting up to prevent it from slipping. The ground should be cleared of obstacles which otherwise might be caught by the chain and cause a kickback. No other person than the operator must be within a two-metre distance.

Figure 40a and b shows different starting techniques.

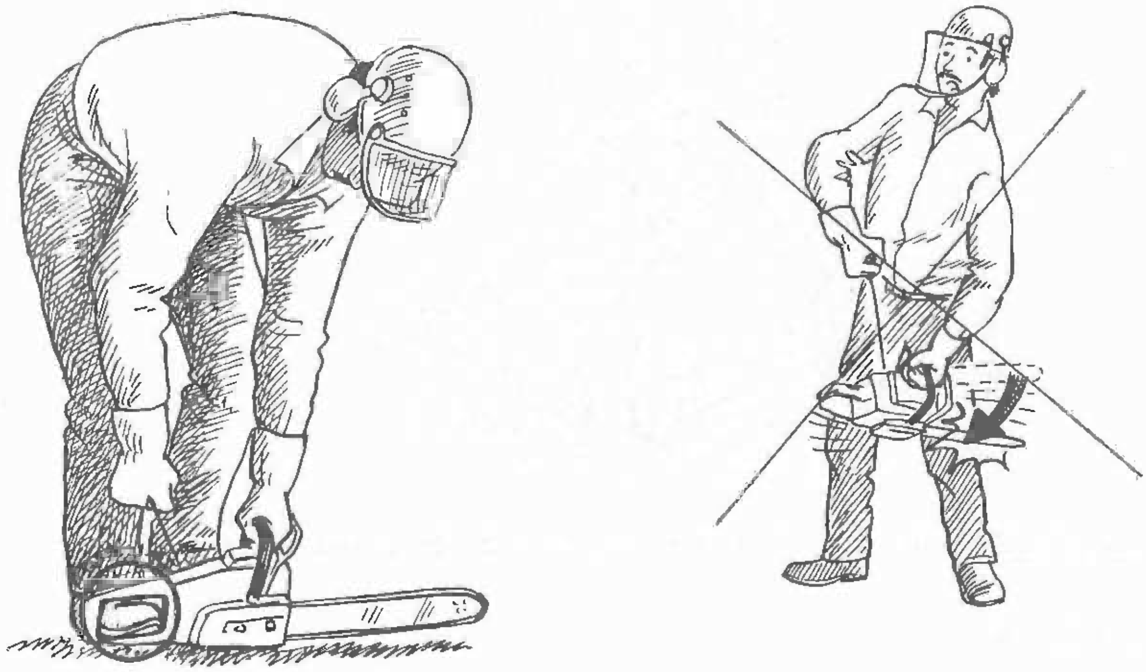


Figure 40a. How to start the saw when placed on the ground.

Figure 40b. How to start the saw when holding it between the knees.

The chainsaw operator should stand with the legs well apart and one foot forward when using the saw. A firm stand will reduce the risk of slipping, which is a common cause of accidents. The saw should be kept close to the body and be supported on the legs or tree (see Figure 41).

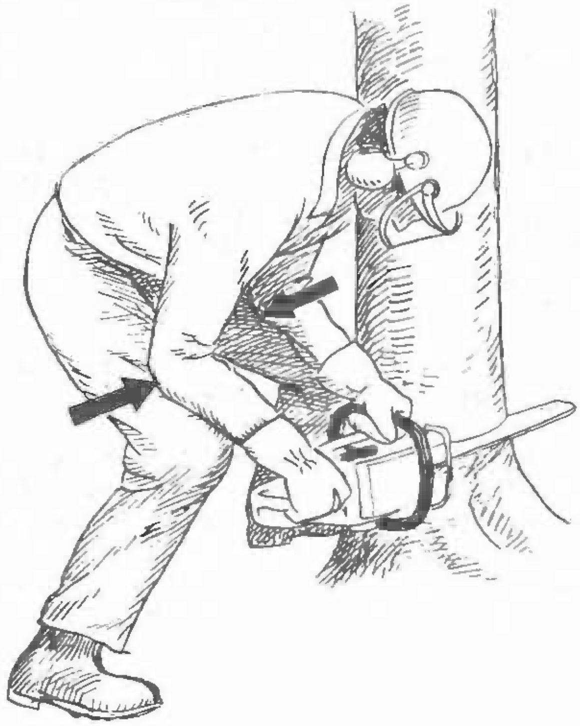


Figure 41. The saw should be kept close to the body and be supported on the legs or tree.

To reduce the risk of kickback, the upper part of the guidebar nose should not be used (see Figure 42).

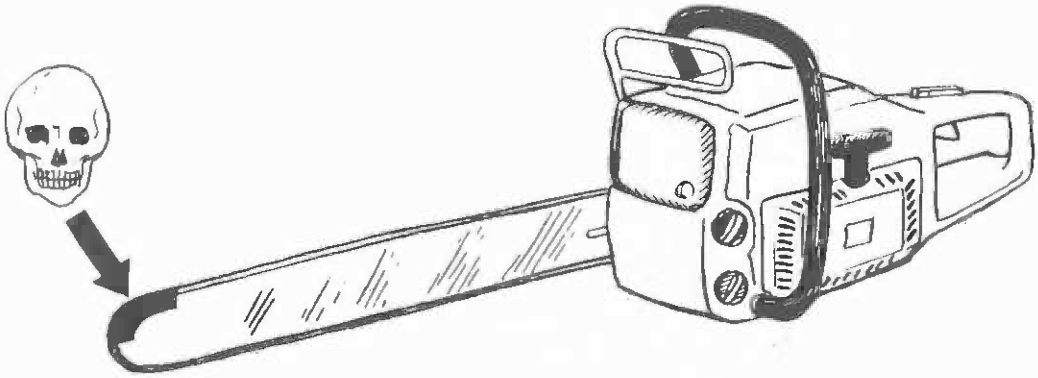


Figure 42. To reduce the risk of kickback, the upper part of the guidebar nose should not be used.

To prevent serious injuries, the chainsaw operator must wear a safety helmet with eye and ear protection, safety boots, gloves and leggings. A first-aid pocket kit should be included in the personal protective equipment.

(3) Maintenance and repair of tools, equipment and machines

Well-maintained tools and equipment are less likely to cause accidents, and cause less physical strain than those in poor condition. Inspections for general condition and sharpness should be carried out regularly. Broken or loose handles of tools should be replaced as soon as possible to avoid unnecessary, but common, accidents. Cutting tools should be kept sharp, so that the worker can rely on them and be able to use an efficient and safe working technique.

In an Indian study (Hansson et al., 1966), the significance of maintenance of two-man crosscut saws on the output of work and on energy expenditure was tested. The output of work, using a well-maintained saw, was more than 100% higher, and the energy expenditure was 120% lower, compared to the mean values of five badly-maintained saws.

Chainsaws should receive regular (daily and weekly) maintenance following the manufacturer's recommendations.

Each user of tools, chainsaws, equipment or machines should preferably be given sufficient training to be able to carry out maintenance and simple repair work. To do maintenance work for a while will give the worker on a physically heavy task a rest pause, while at the same time being productive. It will break monotony and make the workers more independent of repair and service organizations in their work.

After use, the tools should be carefully cleaned and put in a safe place. Responsibilities for maintenance, cleaning and repair should be made clear among workmen.

Many accidents occur during repair work. Situations will arise which often are new for the worker. Some reasons for frequent accidents in repair work are:

- lack of experience and awareness of safety risks;
- proper tools and aids are not available or not used;
- time pressure.

(4) Clearing paths, escape routes and base of trees to be felled of undergrowth and other obstructions

This can be physically heavy work, particularly if carried out in a hot climate, in rugged terrain and with dense undergrowth. The worker will be exposed to the same hazards as mentioned under (1) and (2).

To protect themselves from leeches, snakes, poisonous plants and those causing allergic reactions when touched the workers should wear clothes of stout material, with long sleeves and leggings. Boot-tops and trousers should overlap. Gloves should be used to protect the hands from sharp splinters from plants, sharp edges, thorns and the like.

The workers should be informed about local dangerous plants, animals and insects, how to identify them, and how to apply first-aid, if affected.

(5) Felling operations, including taking down hung-up trees, debranching, cross-cutting, and moving and bunching of logs

Whatever tool or machine is used for felling operations and related activites such as debranching and cross-cutting, the worker must be given sufficient training, under close supervision, in safe and efficient working techniques.

Tree fellers have one of the most, if not the most, hazardous jobs in forestry. Tree felling causes frequent accidents each year. Many of them are severe or fatal. This is true regardless of mechanization level, climate, terrain and other relevant working environment factors.

A skilled worker who is aware of safety risks, who uses well-maintained tools (and when using a chainsaw, is equipped with safety devices), and who wears appropriate personal protective equipment is less likely to suffer from severe occupational accidents and diseases. Common types of accidents are, e.g. that the tree falls in the wrong direction or backwards. This is often caused by sawing through the felling comb or by a poor notch. It is also common that the butt end of the tree is thrown upwards, hitting the worker. This is usually because the worker is standing too close to the tree after finishing the felling cut, or due to poor escape routes.

It is also common that fellers suffer from pain in the back, neck and certain joints caused by their heavy and strenuous work. In many cases the worker would be helped by applying the correct technique for lifting and carrying loads. The use of levers, hooks and logpicks facilitates the work when felling small-diameter trees. (Figure 43).

Figure 43. In many cases the worker would prevent work-related pain in the back, neck and joints by applying a better technique when lifting and ....(see next page)

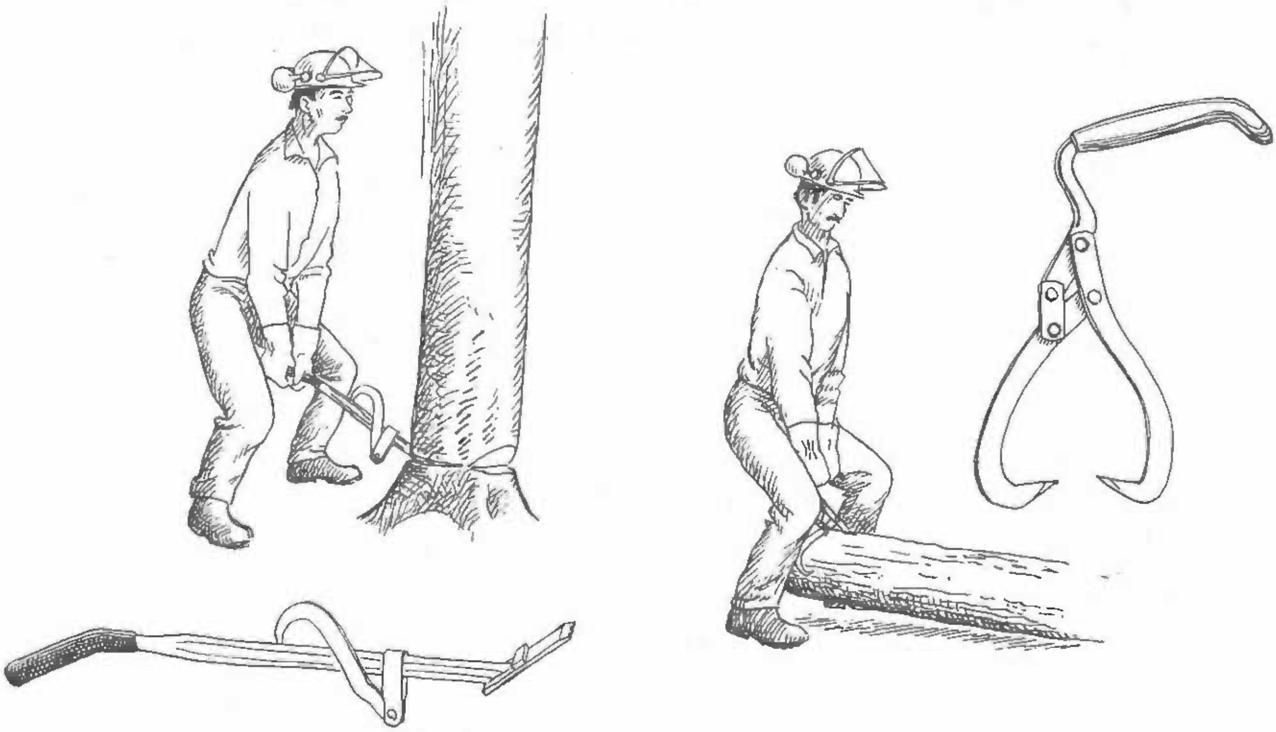
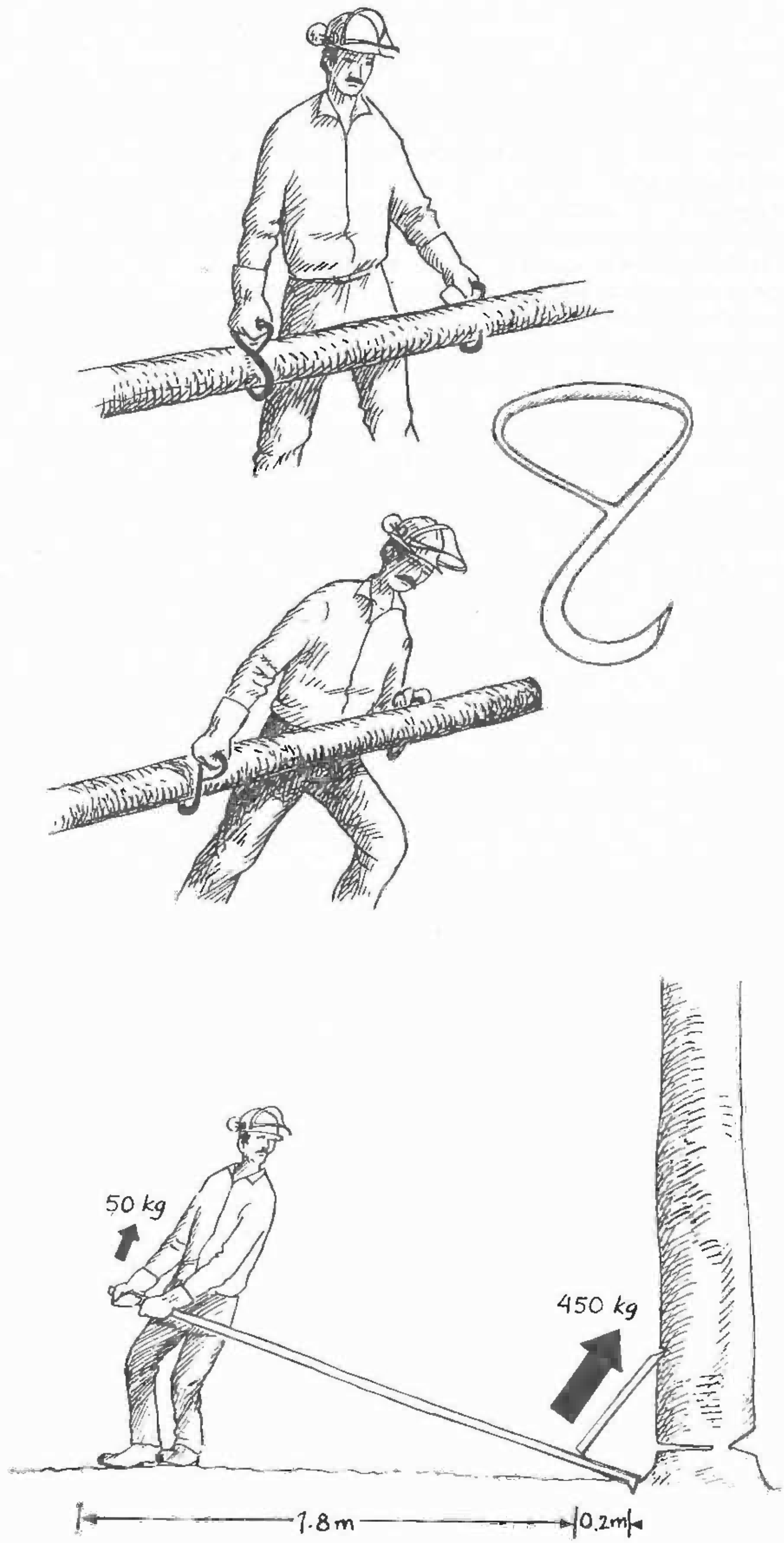


Figure 43 (cont'd.)...carrying loads. The use of levers, hooks and log-picks also facilitates the work.



Taking down hung-up trees is the most hazardous job a feller has to do. It should be given much attention during the training of forest workers.

A hung-up tree left hanging is a fatal trap and every attempt should be made to take it down, without delay. Many forest workers have suffered severe or fatal accidents because of using unsafe methods when taking down lodged trees, such as:

- felling the tree in which the hung-up tree is caught;
- felling another tree onto the hung-up tree;
- cutting short pieces of the lower part of the hung-up tree.

These methods are usually practised because when they work they are faster than other, safer methods. However, they may not work, but result in a fatal accident instead.

A lodged tree is always extremely dangerous. The work of taking it down should only be started after the situation has been thoroughly evaluated, so as to decide on the safest method to be used. The proper method may be one of the following. After cutting any remaining branches, preferably with an axe:

- roll the tree free by using tools such as lifting hooks, felling lever (with cant hook), turn-line or cant hook - if the tree is small. (Figure 44).

- with the help of a sulky, lift the tree up from the stump and pull it down. (Figure 45).

- pull the butt end backwards, using a push pole - if the tree is small. (Figure 46a).

When the tree is bigger, a draught animal, a tractor-mounted winch or portable winch may be the solution. (see Figures 46 b, c and d).

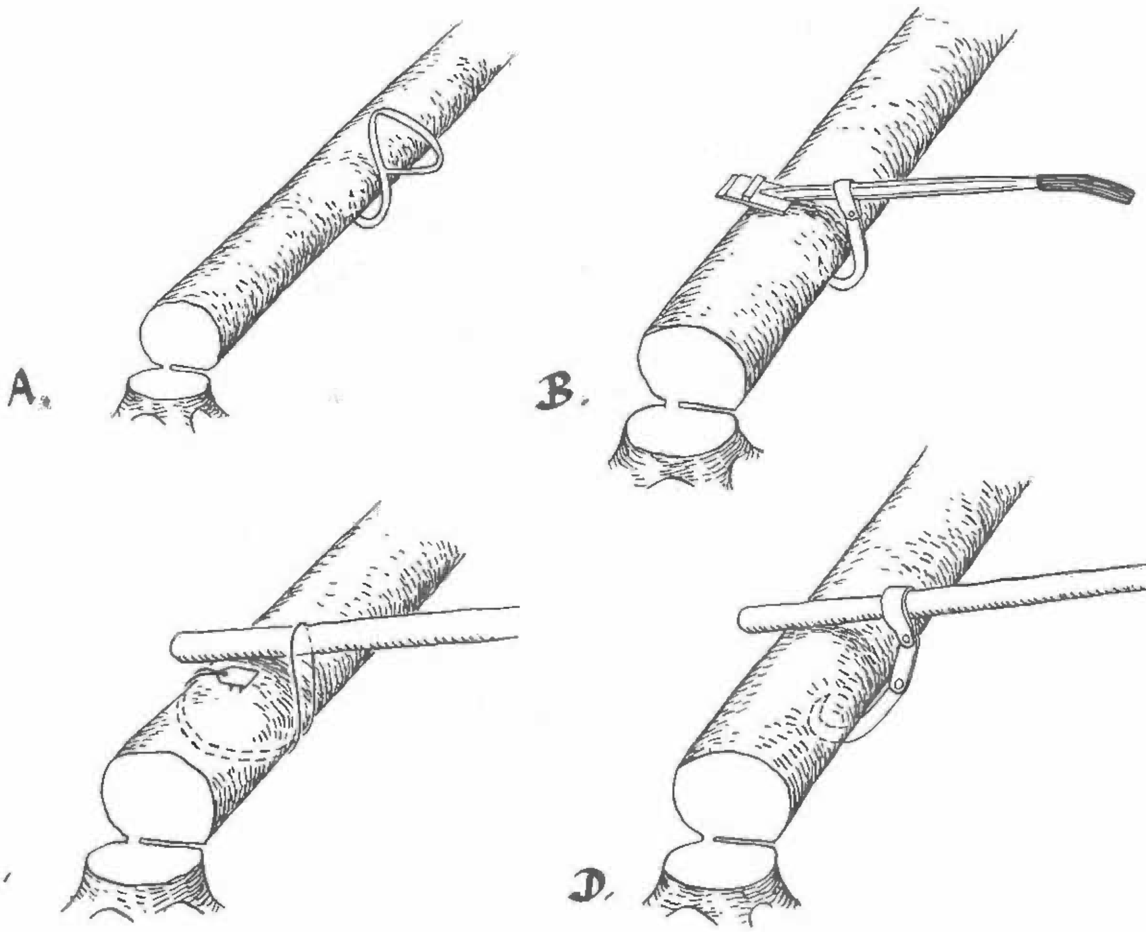


Figure 44. Different tools which can be used for rolling small trees.
A. Lifting hook; B. Felling lever; C. Turn line. D. Cant hook.

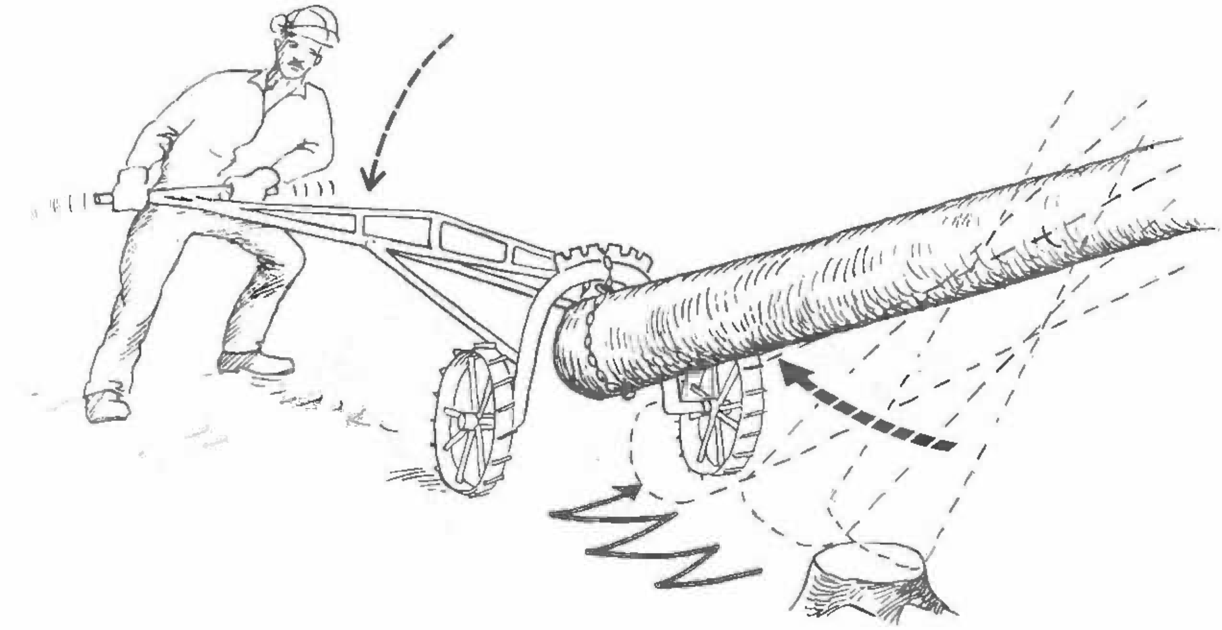


Figure 45. A hang-up sulky for freeing of lodged trees.

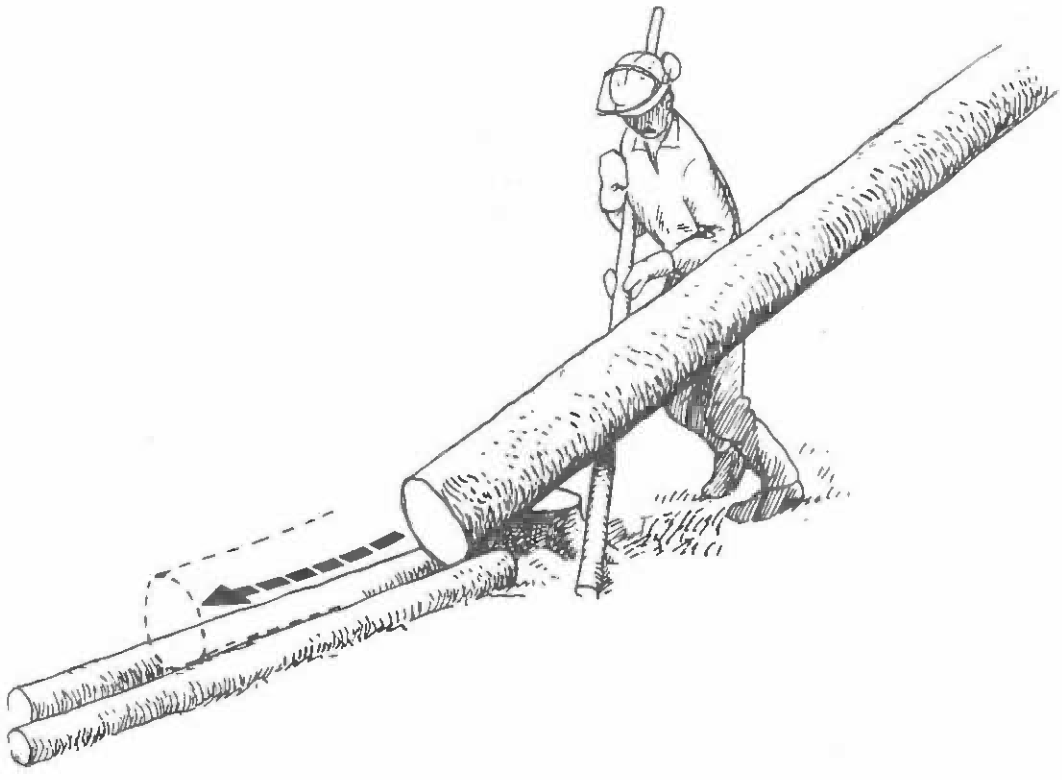
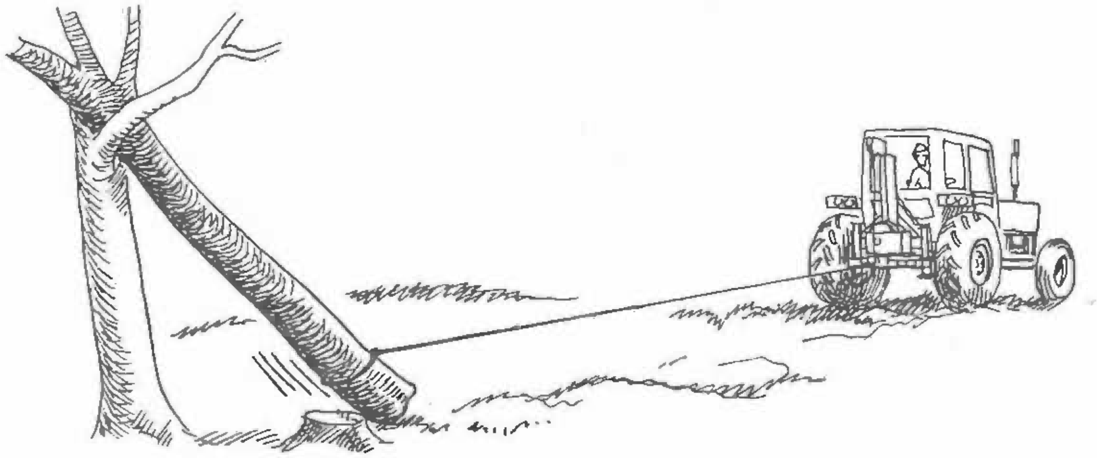
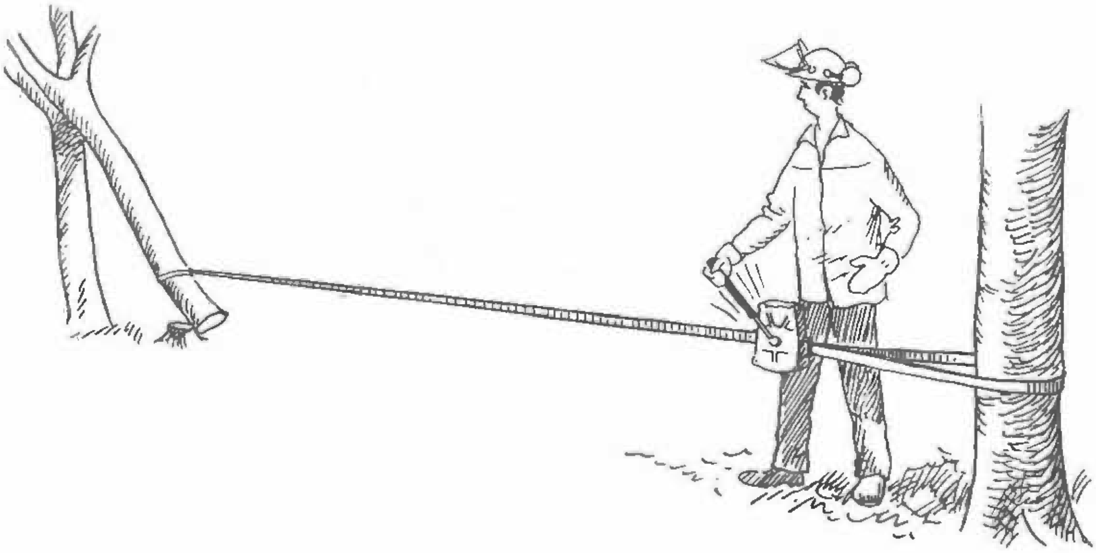


Figure 46 a. When the tree is small: use a push pole and pull the butt end backwards.





Figures 46 b and c. When the tree is bigger, use a tractor-mounted winch or portable winch.

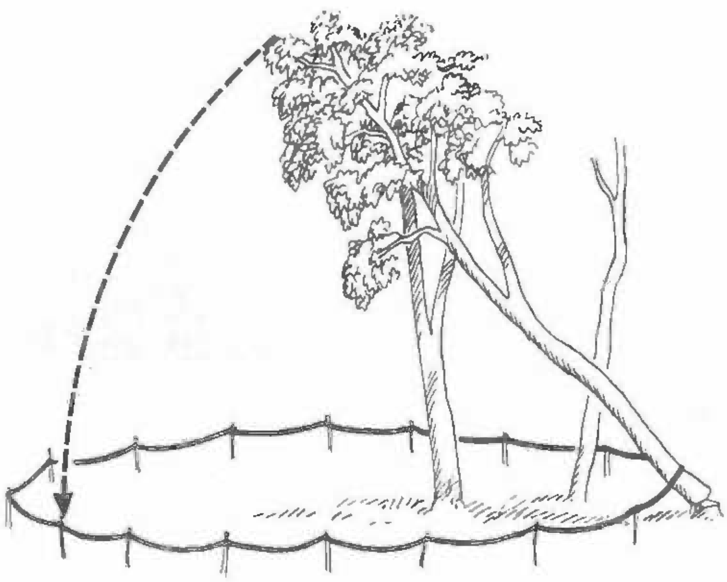


Figure 46 d. Never leave a lodged tree without marking the danger area clearly.

The following are tools which are needed for safe and efficient work:

- a bolo (or machete) with protective cover
- wedges of soft metal or wood
- hammer to drive wedges into big trees
- axe with protective cover
- cant-hook
- felling lever with cant-hook) - for small
- hooks and tongs) trees

The chainsaw should have safety devices such as:

- front handle guard with chain brake to protect the left hand and to stop the saw in case of a kickback (1),
- chain catcher to catch the chain if it breaks (2),
- rear handle guard to protect the right hand if the chain breaks (3),
- throttle control lock out to prevent the chain from running accidentally (4),
- anti-vibration devices, to reduce vibration being transmitted to hands (5),
- guide bar cover to prevent injuries (cuts) during transport, storage or walking with chainsaw (6) (see Figure 47).

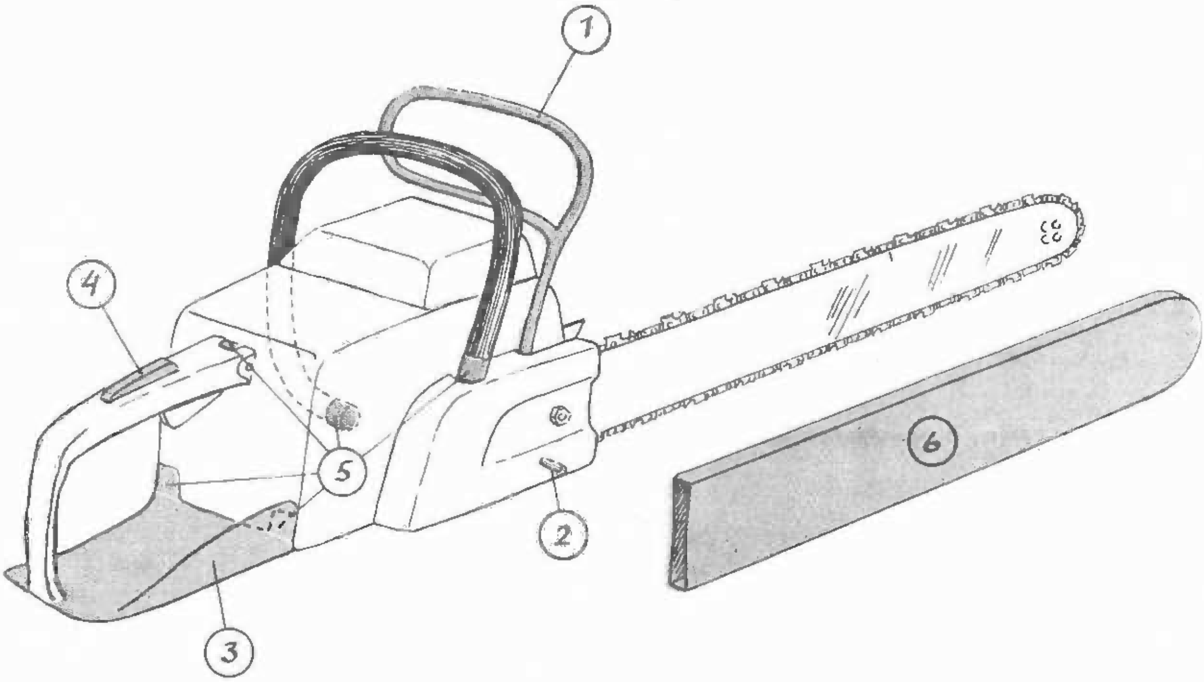


Figure 47. Safety devices on the chainsaw. (1) Front handle guard with chain brake, (2) Chain catcher; (3) Rear handle guard; (4) Throttle control lock out; (5) Anti-vibration devices; (6) Guide bar cover.

6.5 Loading and unloading

Manual bunching, extraction, loading and unloading are heavy and dangerous activities with obvious risks of occupational accidents and diseases.

Common causes of accidents are slipping, falling and stumbling over obstacles. Paths and timber yards should therefore be kept clear of obstacles, holes, overhanging branches and the like. The workers should wear proper boots.

Other causes of accidents are the tools and aids used, or not used, or used in the wrong manner. The use of adequate tools and equipment and appropriate working techniques (e.g. straight back when lifting) will facilitate the work and decrease the risk of back trouble, muscular strain, bursitis, unnecessary fatigue and waste of energy, whereas using inappropriate tools for the job, such as using an axe for pulling or lifting, or using tools in poor condition (a blunt rather than a sharp tool, tools with broken handles) will lead to accidents (such as cuts in the leg or foot, or load dropped onto the foot, due to tool slipping).

Manual handling of heavy loads should be avoided whenever possible, particularly when working in a hot and humid climate, being exposed to radiation, working long hours, or if workers are malnourished or under-nourished. Instead, mechanical aids for lifting, loading and unloading should be used. When organizing the work, efforts should be made to facilitate the work by means of scheduling of working hours and breaks, manpower planning and job rotation in cases where it is not possible to entirely avoid manual lifting and carrying (see Figure 48).

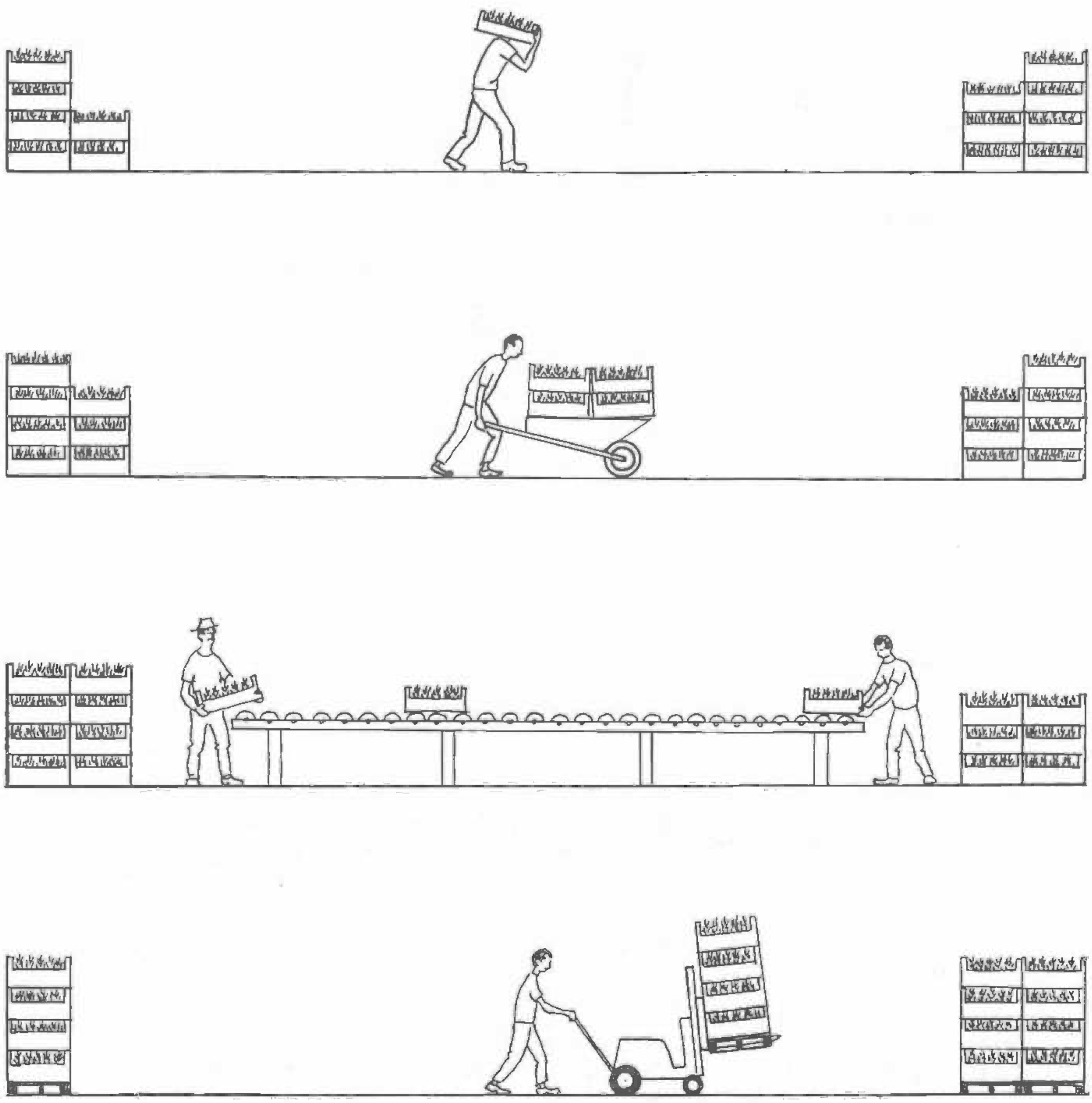


Figure 48. Different ways of loading, unloading and moving loads.

Although mechanical loading and unloading will considerably decrease the physical workload and the risk of occupational accidents and diseases for most workers, new risks of serious accidents will occur for certain tasks. Accidents caused by loss of stability and component failure are particularly common. Mechanization of almost any job requires more training of the workers, more planning by supervisors and management, and a strict enforcement of safety regulations, e.g. a safe distance between loading/unloading operations and persons not directly involved must be ensured. No load must pass over any person. Landings must have sufficient space and be kept clear to ensure safe operations.

All workers at the workplace must be aware of the signal system practised. Equipment which may cause an accident when worn out, damaged or failing to run normally should always be treated as a safety risk, and never be trusted as safe.

Equipment must be checked regularly for wear and damage. Responsibilities for keeping equipment and materials in safe working condition must be clearly stated. For instance, the anchoring of winches, the condition of brakes and handles on winches, and other materials such as wire ropes, chains and chokers must be checked regularly.

Transport

When a number of workers carry logs together, the working technique and signals used for lifting and dropping the load, or walking and stopping walking should be specified before starting the work. New crew members should be made aware of the signals. Signals should be given by the worker furthest to the rear of the load.

As already stated, manual handling of heavy loads like logs should be restricted. However, skidding sulkies are a reasonable solution for manual transport over shorter distances.

For terrain transport, animals may also be a good solution.

Tractors and trucks of various levels of mechanization and with different equipment are frequently used in transport operations in forestry. The physical workload is generally moderate to low for the machine driver. A helper may, however, consume up to five times as much energy as the driver, when required to pull the cable from a tractor-winch over long distances in rough and steep terrain to reach the logs. The work of the driver involves many safety and health hazards which do not exist in manual work. Noise, vibration, heat and exhaust gases are some common ergonomic problems accompanying mechanization.

Maintenance and repair work are particularly dangerous and cause a considerable number of accidents in machine operations. Besides risks of accidents affecting the operator, the risks for other persons working near the machine and equipment will often increase when an operation is mechanized.

When operating a tractor, the driver should be protected in case the tractor overturns or if falling logs, branches, flying lines, or other obstacles come into the cab from above, or from the side. A cab with frame, roof and windows with metal grating of sufficient strength to resist impact will decrease the risk of injury from such incidents. Furthermore, it should be easy to get on and off the tractor by means of anti-slip steps, platforms and handholds, with sufficient cab space and correct placement of the seat. When the operator has to work both inside the cab and on the ground, e.g. if operating a winch, and therefore is frequently climbing in and out, easy access is important. It is also necessary for safety in emergencies, e.g. fire caused by the machine.

The seat should be comfortable and safely anchored. It should absorb oscillations of different frequency. Seat, pedals, controls and instruments should be so designed and placed as to give the operator a comfortable work posture, with possibilities for adjustment to suit most of the people likely to operate the machine.

The controls' resistance to being moved should match the working position and muscular mass involved to prevent fatigue and over-strained muscles.

The instruments should be of a suitable type giving all necessary information.

Poor visibility from the operator's position over the working area may cause accidents. It may also cause fatigue and pain if the operator is forced to get into awkward positions in order to obtain better visibility.

The operator should be sufficiently trained to be capable of not only operating the machine safely and efficiently, but also carrying out maintenance and minor repairs. Condition of brakes, winches, cables, ropes, transmission, clutches and other parts must be checked regularly. Proper tools and equipment for this must be readily available.

The worker should also be trained to plan his various tasks and be familiar with the use of simple checklists in order not to overlook any factor. At work the operator should wear a safety helmet, hearing protectors, boots with anti-slip soles, tight-fitting clothes, and gloves if handling wires, cables and ropes. Injuries to the hands caused by broken wires may lead to blood poisoning.

Passengers for whom there is no safe seat should not be allowed on the tractor or trailer. Log trucks used for long distance transport on public roads must comply with national requirements regarding such items as lights, warning and signalling devices.

6.6 Other Activities in Forestry

In Sections 6.1 to 6.5, some of the most common forestry activities have been discussed from an ergonomic point of view. Forestry does not comprise these activities only, but a number of other operations as well. Some of them involve very special risks, for example, forest fire fighting and timber floating, which will be briefly dealt with here.

6.6.1 Forest fire fighting

Forest fire fighting is extremely demanding work. Forest fires often have to be fought in remote and isolated areas and in rough terrain, where conditions may be very poor and where *ad hoc* solutions (such as medical care) must be found for emergency situations.

Only workers who are healthy and physically fit should be selected for this job. They will need physical training as well as specialized first-aid training in which the particular risks in fire fighting are stressed, for example: burns, thermal overload, heat stress, dehydration, carbon monoxide poisoning, and also learn how to recognize such behaviour of their workmates which could indicate that they are affected in a harmful way by e.g. heat, carbon monoxide or fatigue. They should be aware of the importance of rest periods and sufficient intake of liquids and food to maintain a sustained working capacity.

The workers should be trained in the understanding of the basic principles of forest fire behaviour. They should be well aware of what the conditions and factors are which can lead to sudden changes of the behaviour of the fire. It is often the sudden changes which cause the accidents (also the fatal accidents) and the near-accident situations.

Clothing

Forest fire fighters should wear clothes and equipment which will provide some protection against fire and heat. The cloth should be cotton, wool and/or canvas when special flame-resistant clothing is not available. Synthetics and cloth of mixed material should not be worn if they contain more than 15 percent nylon or polyester. There is always the risk that such cloth will melt and cause burns. Oily clothes must never be worn. Shirts should be long-sleeved, and the legs of the trousers should reach the top of boots, so as not to leave any part of the arms and legs unprotected. The safety helmet should be made of heat-resistant material as well as the footwear. Gloves are recommended.

Organization

Fire control organization has to be effective and requires experienced and safety-minded personnel. Escape routes for everyone and safety islands should be planned and they have to be made known. Special lookouts should be posted whenever there is a risk of great danger. All communication should be prompt and clear and be checked that it has been understood - misinterpretations can be fatal. Crew leaders should be familiar with the terrain, which is particularly important when there are steep slopes, narrow valleys and gullies. This type of topography can create dangerous situations as the fire can speed up very fast and trap the firefighters. Other conditions which can give rise to very unpredictable, and therefore dangerous, behaviour of fire are when the fire is burning in highly inflammable areas, and when there are variable winds. The risk of heat stress disorders and carbon monoxide poisoning should also be taken into account when organizing fire control.

Heat stress

In Section 3.1.1. "Climate", heat stress disorders have been described and fire fighters were mentioned as a high-risk group.

Thermal overload has a much shorter lapse than heat stroke (described in that section), but can lead to the person being totally incapacitated within less than a minute. Under such strenuous conditions the work organization should be adapted, e.g. in the form of a rotation system of the workers in the most exposed positions.

Carbon monoxide

The rotation system is particularly important to avoid carbon monoxide poisoning. The effets of carbon monoxide are insidious and the workers themselves will not be aware of how their mental capacity deteriorates.

It is essential that the crew leaders be experienced and well aware of the very special risks involved in the work of controlling forest fires.

6.6.2 Timber floating

In many countries, waterways have long been used for the transport of timber. Different methods and techniques are used when floating loose timber or bundles of logs (rafts) on rivers, lakes or sea.

Some workplaces are permanent, such as log-pond landings. Others are mobile, such as raft building on land alongside the waterways and in the water, or the actual floating and guiding of loose timber or rafts. The working and living conditions are diverse.

All workers engaged in timber floating - both those at the permanent workplaces and those who are mobile - should know how to swim and how to give artificial respiration. They should never work out of hearing and sight of other workers.

The workers should wear safety jackets and footwear with non-slip soles.

Boats should be in good condition and be well-maintained and operated only by experienced workers.

The maximum number of persons and load allowed should be clearly stated and never be exceeded. There should be suitable life-saving equipment and the workers should be trained in how to act when someone falls overboard. They should know what to do if the boat capsizes, e.g. take off any heavy items such as heavy clothing and boots. It is usually safer to hold on to the boat or other floating objects than to try to swim a long distance, particularly in rough or cold water or with a current.

Other constructions, e.g. booms, bridges and gangways, should be designed in such a way as to allow the work to be carried out safely. There should, for example, be enough space for safe movement and for two workers to pass each other, surfaces should be even without protruding objects, there should be supports to hold on to at dangerous spots, and sufficient life-saving equipment should be within easy reach at strategic places.

6.7 Wood Processing

Ergonomic matters which are briefly discussed in this section will refer mainly to sawmilling, wood-based panel industries, carpentry, joinery and furniture making.

A wide range of technologies are used in wood processing, including the most advanced large-scale wood-based panel industries, different sizes of modern sawmills as well as small pit-saws, and artisans using only

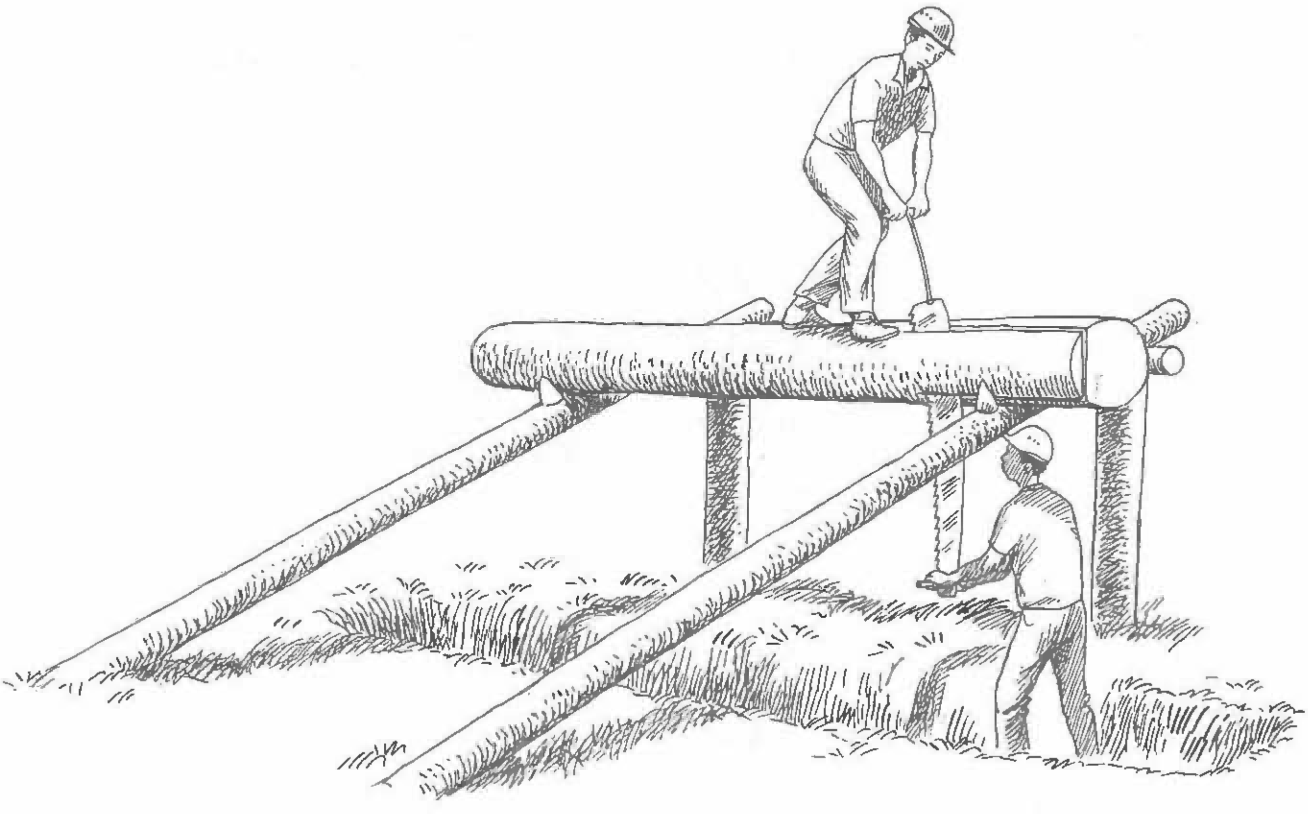


Figure 49. Pit-sawing.

handtools in furniture making. The ergonomic problems discussed below will by no means be a complete list of hazards in all these industries, but will serve as examples of some common safety and health problems.

Besides frequent accident risks, many jobs in the processing industries involve risks of serious occupational diseases. For example, the use of glues, paints and chemicals in wood industries involves health hazards. Also dust and other toxic constituents originating from the wood give rise to possible risks. Growing attention in industrialized countries is being paid to related occupational diseases. But in many countries there is still an apparent lack of awareness of these problems.

6.7.1 Accident risks and preventive measures

Woodworking machines

Woodworking machines constitute one major agent of occupational accidents in the processing industry, causing about one-third of all injuries (Philippines, 1977-1981).

The majority of injuries occurring in woodworking concern a few basic machines, namely circular saws, bandsaws, spindle moulders, planers and chainsaws.

1. Circular saws

Accidental contact between hand and saw and kickback of wood are possible, resulting in serious accidents, if sawblades are inadequately guarded.

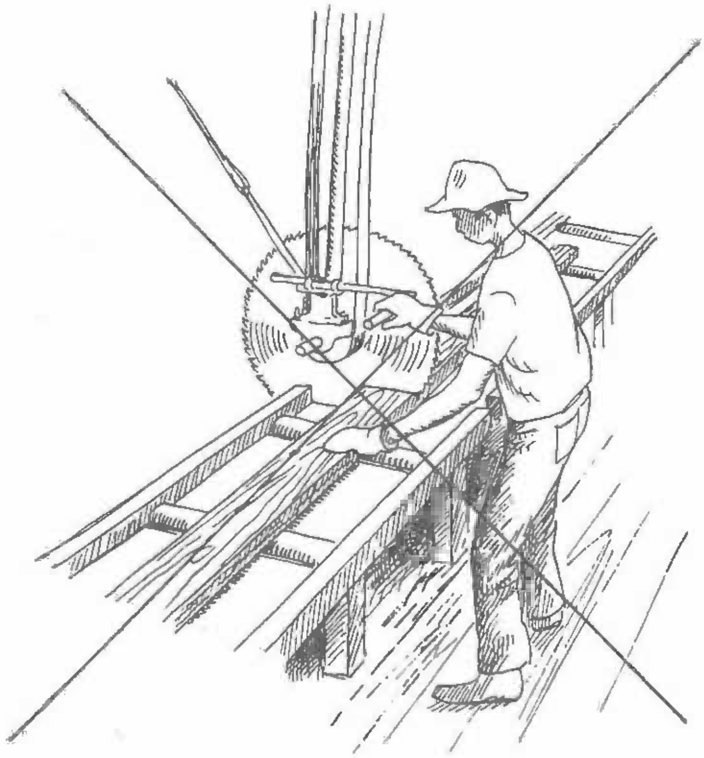


Figure 50a. The sawblade must not be unguarded.

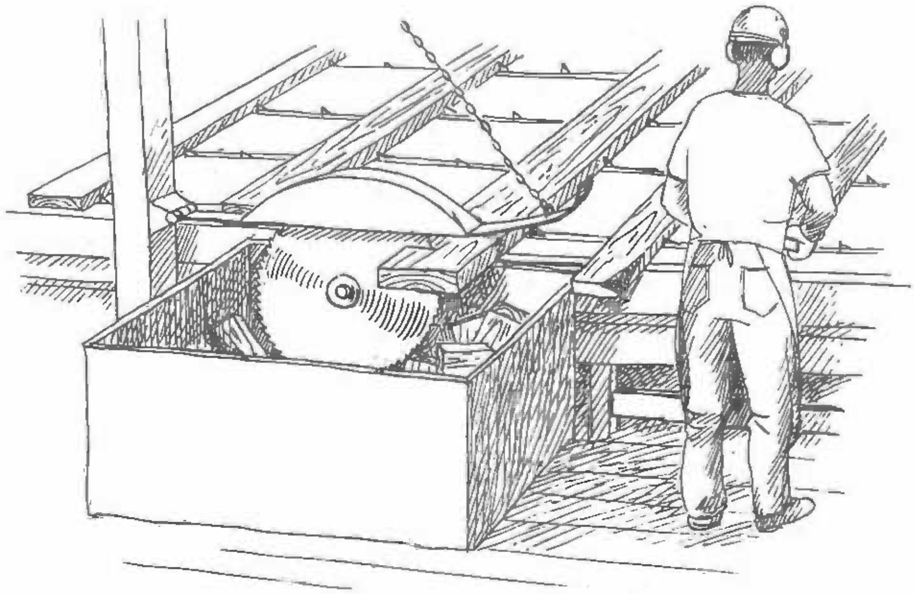


Figure 50b. The sawblade should always be guarded.

For length sawing (rip-sawing) machines, the saw blade cover should be adjustable. The saw blade should have guards also under the table to prevent accidental contact with the saw. Handles, pedals and steering wheels should be at a minimum distance, of at least half a metre, from saw blades and feed rollers.

Proper saw blade maintenance and feed speed will also improve safety. The most common type of cross-cutting saw is the pendulum saw mounted above the saw bench. The saw blade should be covered with a self-adjusting guard. After cross-cutting, a counter weight should return the saw blade to a safe position behind the guide fence. Start and stop controls should be within easy reach, but at a safe distance from the saw blade.

2. Band saws

Safety rules are very much like those for circular saws. Both upper and lower band wheels should be covered, as well as the rear side of the blade. Guides should be adjustable in height and the cover should follow the height adjustment. A brake, to stop the blade after the power is switched off, should be available within easy reach. Maintenance and frequent checks for any defects of saw blades are important preventive measures.

3. Spindle moulders

The purpose of using spindle moulders is to shape wood edges to patterns of varying designs. The cutter works at very high speed and should therefore be enclosed, to prevent worker's contact with the tool and exposure to wood dust or chips. The machine should also be equipped with protection against kickback of wood. A brake, to stop the cutter after the power is switched off, should be within easy reach.

4. Planers

The most dangerous planers are the hand-fed surface planers. An adjustable table guard should protect the hand from contact with the cutting tool.

General comments

There are numerous other wood-working machines not mentioned here. However, the general safety rules that should be considered are the following:

- moving or projecting parts must be provided with guards;
- a brake, to stop moving parts after the power is switched off, should be within easy reach in case of emergency;
- the importance of proper maintenance of tools and fittings, proper tensioning and sharpening should be recognized, as well as the importance of operating machinery at appropriate speeds;
- only persons who are properly trained and familiar with the machine should be allowed to operate it;

- new operators should receive adequate training from skilled and safety-minded persons;
- maintenance and repair should be carried out only after the power has been switched off and when no parts are moving;
- maintenance and repair should only be carried out by qualified personnel, using proper tools;
- proper personal protective equipment such as gloves, hard hat, eye and ear protection, apron, boots and other equipment should be used where appropriate.

<u>Plant layout, materials handling and housekeeping</u>

A high percentage of accidents are related to the handling of goods and transport of material. "Falls", "stepping or striking against", and "struck by falling objects" are common immediate casues of accidents. But the real causes of such accidents usually originate from poor layout of worksites or storage places, or poor housekeeping.

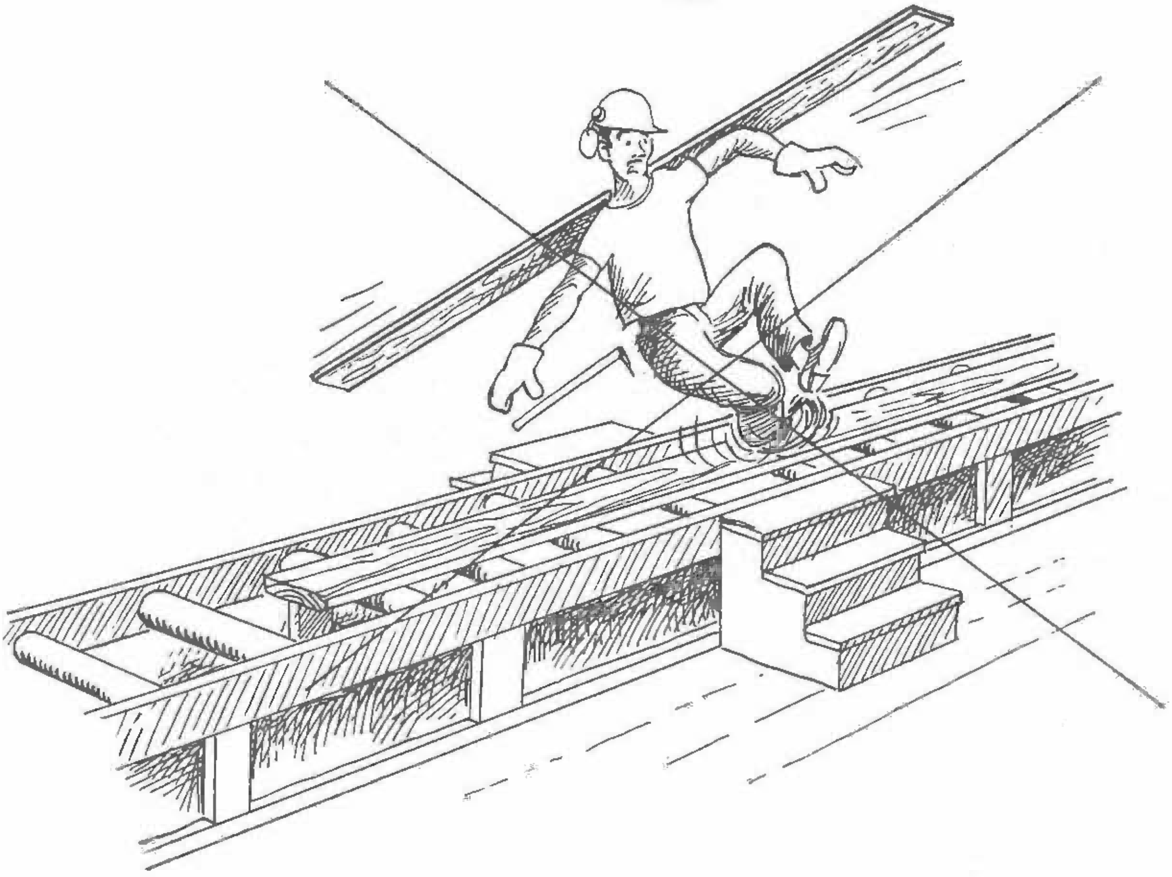
To attain a safe and smooth workflow, the succession of work operations must be carefully planned. All work operations should be ensured sufficient space. Plant layout should allow people and vehicles, or other means of transportation of material, to move freely and without risks of collision. These movements should be separated from each other. When this is not possible, warning signs should indicate transport lanes, and vehicles should have back-up alarms to cover the driver's blind spots. Lifting equipment should have maximum loading signs.

All tools, equipment and machines used for materials handling should be regularly inspected for damage or wear and tear, and must be properly maintained.

To avoid slips and falls, stairs, cross-overs, walkways and ladders should be kept clear. The measurements of stairs and walkways and handles should be such as to allow adequate space for feet and body movements and firm body position. The floor should be made of non-slippery material and should be kept free from obstacles.

The work area should be kept clean and free from loose boards, offcuts, shavings, sawdust and grease. Housekeeping must never be left to chance but responsibilities and organization for this should be well-planned and strictly followed. Good housekeeping is an inexpensive way of preventing accidents as well as to improve productivity. Other areas where housekeeping and careful planning will improve safety and productivity are in log and lumber yards. For instance, piles must be stable to avoid logs rolling or lumber falling.

Also for the avoidance of fire, good housekeeping is necessary. In all wood-processing industries there is a risk of fire, particularly in particles such as wood dust, shavings or chips. In these materials there is a risk of self-igniting due to internal overheating. Engines may also get overheated if covered with dust. Strict rules should be followed regarding housekeeping, smoking, the use of open fires or highly inflammable chemicals and materials.



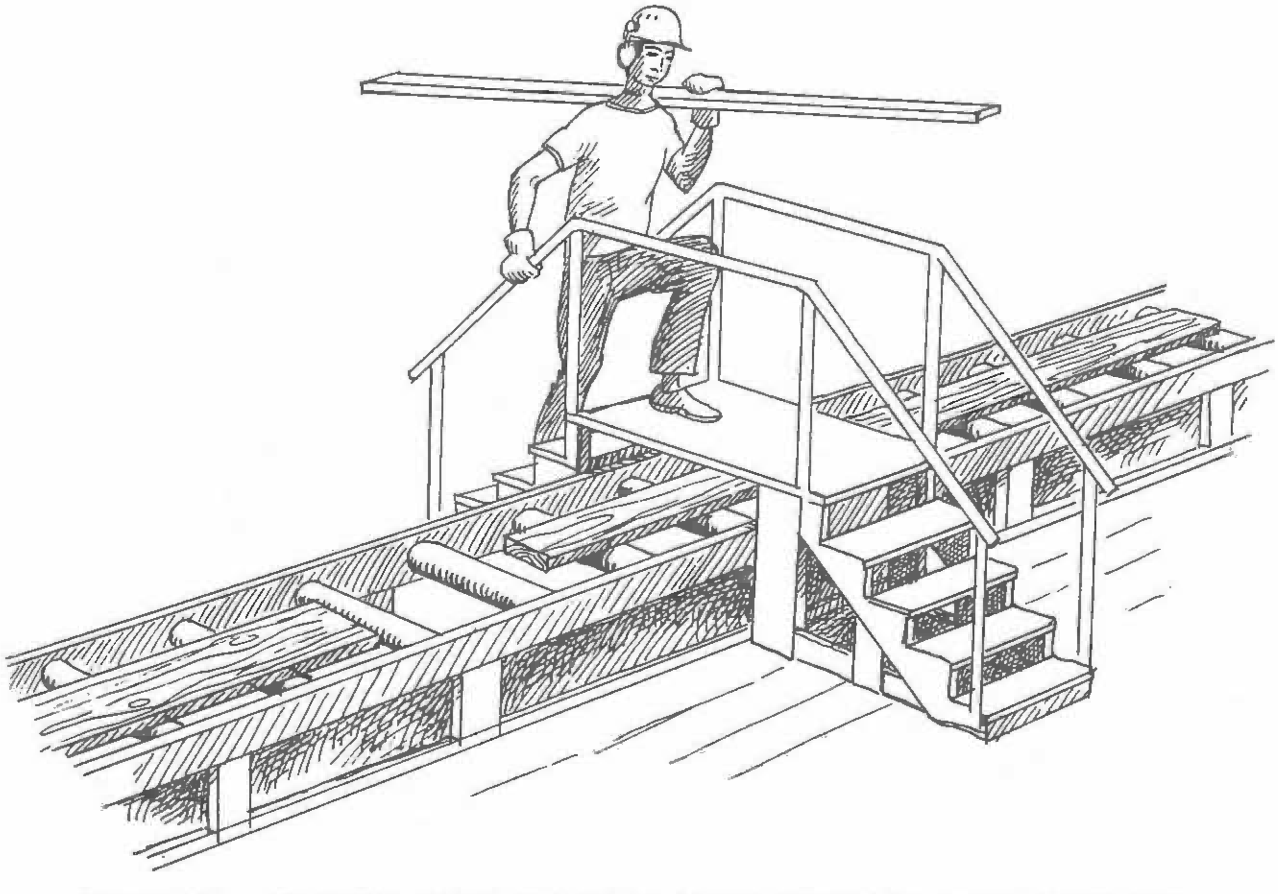


Figure 51. To avoid slips and falls there should be cross-overs and walkways at strategic places.

The organization of fire fighting should be thoroughly planned as regards employees' training and responsibilities, location and regular checks of fire fighting equipment.

Installation, maintenance and repair of electrically-powered woodworking and other machines, equipment, wiring and cables should be carried out by qualified electricians.

Nature of injuries and parts of body injured

According to statistics from the Philippines, the predominant injuries are lacertions (in more than 50 percent of cases), bruises and haematoma (in almost one-third of the cases). Injuries were mostly to fingers, feet and head. About 40% of the injuries affected fingers, hands and arms, about 25% feet, toes and legs, and more than 10% the head. If appropriate personal protective equipment, such as gloves, boots and helmets had been used, a considerable part of these 75% of the accidents might have been avoided entirely, or at least the injuries may have been less severe.

6.7.2 Health risks and preventive measures

Based on statistics available from different countries, occupational diseases are much less frequent than occupational accidents in the processing industry. On the other hand, according to the same sources, they are more serious. However, this does not necessarily represent the true picture of actual conditions. Definitions of occupational diseases are usually vague and varying and very often the relationships between a disease and certain environmental factors are still unknown. It also takes longer to develop an occupational disease.

Noise and vibration

Impaired hearing caused by noise has a clear definition, and can easily be attributed to a too-high sound level at the place of work. Hearing impairment is also the most frequent occupational disease in the wood-processing industries, according to statistics in many countries.

Most woodworking machines produce a very high sound level. High-speed cutting tools usually produce harmful, high-frequency noise. There are also many other sources of noise such as transport systems, falling planks, hard materials clashing together, vibrating plates, ventilation systems and compressors.

Hand-arm vibration diseases do not seem to be a very common problem in the wood-processing industry. When chainsaws are used there will, however, be a risk of vibration inducing white fingers. Whole body vibration is reported to be a problem for many sawmill workers. The most commonly found vibration is in the range of 1-20 Hz and may cause dizziness, nausea and headache. The combination of a standing job-posture and vibration may lead to varicose veins.

In Sections 3.2.2 and 3.2.3, occupational diseases caused by noise and vibration and their prevention are described more thoroughly.

Wood dust and toxic wood constituents

As already mentioned, wood dust increases the risk of fires and explosions. It may also cause skin irritation, allergic reactions, toxic effects, respiratory diseases and cancer.

- Skin irritation is mainly caused by mechanical reaction. The reaction may be caused by sap, oils, resins, turpentines, bacteria or naturally-occurring fungi. If dust comes into contact with the eyes, nose or throat, it may give rise to tears, sneezing or asthma-like symptoms.

- Allergic reaction may appear after repeated exposure, causing reactions similar to those mentioned above, or itching throat and nose, high fever and headache.

- Toxic effects, such as local skin and eye irritation, may be the result of contact with woods containing certain poisonous substances. Severe health effects from inhalation of sawdust from such wood are anaemia, liver disease, depressed heart action, nausea and vomiting. Most of these woods are of tropical origin.

- Respiratory diseases are particularly common among employees in the furniture industry. Very fine dust, which is extremely irritant to the respiratory tract, is produced in large quantities when wood is sanded. The exposure to a variety of wood dusts may cause diseases such as bronchial asthma and fibroid lung.

- Cancer of the lung, tonsils, tongue, nasal passages and larynx, most probably due to exposure to wood dust, have been reported primarily in the furniture industry.

Preventive measures are dust collection and efficient systems of exhaust ventilation at wood dust-producing machines or operations. When this is not possible the worker must wear personal respiratory equipment. Employees exposed to wood dust should have regular medical examinations.

Chemicals, glues and solvents

A large variety of chemicals are used to preserve wood from being destroyed by moulds and insects. These chemicals may be applied by brushing, spraying, immersion, osmosis or injection. As the use of these chemicals involves different health risks, direct contact with them should be avoided. Irritation of the skin and eyes, bronchitis, allergic reactions, and even severe poisoning have been reported as affecting the workers handling these chemicals. The application of chemicals should always be done in enclosed systems. Even when an enclosed system is used, there is still the possibility of contact between the worker and chemicals due to leakage of vapour or mists, or spilling from defective containers.

New chemicals are introduced to the market every year. Very often the effect of these on health is not known. Such chemicals should all be treated with the greatest care.

Another factor causing health problems, particularly in veneer, plywood and particle-board manufacture, is the use of glues, particularly artifical ones. Most of them are made of synthetic adhesives based on formaldehyde and the neoprene adhesives. Besides skin diseases, allergic reactions, and chronic eczema from direct contact, these glues may cause systemic intoxication. At low concentrations of formaldehyde in the air, the eyes and upper respiratory tract will be irritated. If concentration increases, the problems become more severe. The eyes, nose and trachea will burn and the eyes start watering. The exposed person will have difficulty in breathing and may get severe spasmodic coughing. If high concentration is inhaled it may be fatal.

Where glues, paints and varnishes are used in the processing industries, there will also be the use of various solvents such as alcohols, ethers, glycol derivatives, turpentine, etc. Irritation of mucous membrane and skin are common problems. Some solvents also lead to allergic reactions and eczema, and may even affect the central nervous system. Benzine, tetrachlorethane and carbon tetracholoride are examples of highly toxic solvents which should not be used.

Preventive measures to protect workers from occupational diseases caused by toxic chemicals can be carried out by:

- changing the dangerous chemicals for less hazardous ones to the health;
- enclosing processes where harmful substances are in use;
- installing effective ventilation and washing facilities.

All workers who may be exposed to dangerous chemicals should be given proper information, instructions, and training on how to handle the chemicals, and on the necessity of using personal protective equipment, personal hygiene, and emergency treatment in case of accidental exposure. Personal protective equipment such as protective clothing, rubber boots, aprons and gloves, face shields, respiratory masks or anything else which may be appropriate, should be worn. The provision and maintenance of personal protective equipment, such as cleaning and regular checks for damage or leakage, should be organized. First-aid equipment and treatment should be available and exposed workers should have periodic special medical examinations.

Work postures and movements

Workers in the wood processing industry usually have to work in standing or walking postions, very often without any chance to sit down even for a short while. Many jobs, particularly in small or old plants, are physically heavy. But even when jobs are not heavy, they may lead to severe occupational diseases such as tenosynovitis (inflammation of tendons). Due to short work cycles with rapid, repititive movements, in unergonomically designed workplaces, tenosynovitis occurs frequently in the hands, wrists and forearms. Low back pain and headaches are other common problems.

Another inflammatory effect is bursitis. Here, the parts of the body that are most commonly affected are the elbow and knee joints due to repeated pressure on joints. If frequently carrying heavy loads, such as timber or lumber, workers may get bursitis in their shoulders.

Ergonomically designed workplaces with suitable work heights, well-placed controls and panels, enough space, and the availability of appropriate tools, machines and other aids can solve many of these problems.

6.7.3 Other ergonomic factors

Lighting

Insufficient lighting is common in the wood-processing industries. Besides too-low lighting levels, glare from unshaded lamps or poor location of lamps and windows may trouble the worker. Very often the worker himself is not aware of poor lighting being the cause of his fatigue, headaches and inability to concentrate. Unsuitable lighting may result in low quality and quantity of work and increased accident risks. Such a simple measure as regular removal of dust from lamps and windows may improve lighting conditions considerably.

Climate

Ventilation may be necessary to reduce heat stress when the climate is hot and humid. Drinking water should always be within easy reach so that the workers do not have to wait until longer breaks for drinking.

Stress and mental workload

Monotonous, repetitive jobs with no possibilities for the worker to control his own work pace or work method; limited contacts with colleagues due to noise, distance, work pace or because the workers are tied to their individual work places; and night or shift work are some of the factors in the wood-processing industry which may cause "psychosomatic problems". Changes of work design and work organization may help to improve the psycho-social effects from the work environment.

7. THE USE OF ERGONOMIC CHECKLISTS

7.1 Background and Objectives

A checklist is not a substitute for knowledge, but proves to be more valuable the more experienced the user is. No matter how experienced and knowledgeable a person is, a checklist is indispensable for ergonomic evaluation and analysis. The use of checklists will prevent the risk of overlooking any ergonomic aspect of importance for the evaluation. It will also provide comparable data from studies and analysis conducted by different persons, at different times and of different objects.

A checklist will prove useful when:

- assessing new design of tools, machines, equipment, etc.;
- assessing new work organizations and techniques;
- assessing entire workplaces, including tools, machines, equipment, work organization, methods and techniques;
- purchasing tools, machines, equipment, etc.;
- conducting safety inspections;
- teaching ergonomics.

For certain analyses, it will be necessary to carry out supplementary measures, applying more sophisticated methods and instruments, for instance when analyzing noise exposure, physical workload or nutritional conditions. Very often, however, well-prepared and well-designed checklists, including interviews, will provide sufficient information about the working conditions to be evaluated.

The objectives of an ergonomic checklist, when used for problem surveys, or in the planning and design process, are:

- to ensure a logical and systematic study of the problem to be solved;
- to maximize the chances of gathering only the relevant and important data and background information;
- to minimize the risk of missing any of it;
- to assist in the decision process, whenever possible.

For operational management, a checklist is used as a tool for gathering qualitative rather than quantitative data. The objective is, then, not to get material sufficient for statistical analysis, but to get a general overview of the working conditions, enabling the user to pin-point critical conditions. The conditions identified as unacceptable, or sub-optimal, should then become the object of further studies. It might be necessary to consult experts for conducting further studies, and finding solutions to the problems.

Generally, all checklists should include interviews with involved parties. The studied worker and supervisors are persons who should be considered as experts on their own working conditions. If the interviews are carried out carefully with a respectful and open mind, they will always prove to be an invaluable source of information. They will also prevent misinterpretation of data gathered using other methods and techniques.

7.2 Required Conditions

To get the best out of a checklist study, the following requirements should be met:

- the user of the checklist should be knowledgeable, experienced and well-prepared;
- the user of the checklist should aim at objectivity and preferably have an independent relationship with involved parties;
- a thorough introduction should be given to everyone concerned, or to representatives of e.g. management, employees, safety and medical departments, regarding background, objectives and procedures of the study, e.g. methods to be used, how findings will be presented and utilized, if and how the study will be followed up;
- the approval of all parties should be obtained before the study starts;
- the attitude of persons who might not agree to participate in the study, particularly in an interview, should be respected and fully accepted;

- sufficient time should be allowed for observations and interviews, and for making additional notes, comments, photographs or sketches related to items covered in the checklist;

- a quiet environment and a relaxed atmosphere during the interviews should be ensured;

- no listeners or onlookers should be present during the interviews;

- the interviewer and interviewee should preferably speak the same language so as to avoid the presence of a third person, an interpreter, during the interview;

- after the interview is completed, the interviewed person should be provided with a contact address, in case he/she would like to change or add to anything said during the interview;

- any follow-up or feedback activity promised, e.g. during the introduction or the interview, must take place. Future cooperation from involved parties cannot otherwise be expected;

- sufficient time should be set aside for the analysis of the information as soon as possible after it has been gathered. Notes, sketches, etc., and particularly notes from interviews, should always be interpreted by the person who produced them;

- group interviews should only be conducted by persons with experience of such, as group interviews always involve a risk of getting only the official opinion, or the opinion of the "leader", which is not necessarily the opinion of the group as a whole.

As mentioned earlier, an ergonomic checklist can also serve as a useful teaching aid in ergonomics training. Preferably, the checklist will be used towards the end of the training. The exercise will provide the trainees with an opportunity to apply learned theories and practices under realistic conditions. The exercise will also serve as a check-up, for both trainer and trainees, of what has been learned or perhaps misunderstood. It will give an indication of what kind of further training is needed.

An example of an ergonomic checklist, originally developed for training purposes, has been included in this handbook.

The checklist is fairly comprehensive and may therefore also be appropriate for other purposes, mentioned earlier. It can be used by following the general "instructions" discussed in this section. Some additional "instructions" applicable to this particular checklist may, however, be useful.

7.3 How to use the Checklist

The checklist is designed to be used for only one worker/job at a time, as each worker, with a specific job, is unique. So there must be one checklist for each worker/job to be studied.

Before starting to fill in the checklist:

- make a schema of the total process flow. Indicate where the different workplaces are located. The schema will familiarize the checklist user with the production process, as well as being useful for the reporting of the study;

- make a simple drawing, or take photographs of the studied worker and his workplace.

- photographs taken of work postures, tools, aids, etc. may also prove useful.

- write a job description for the studied worker.

- before each question, indicate whether the question can be answered solely by observations, if the observations should be completed with an interview, and when the question has to be answered by the information given during the interview.

The symbols used are:

ID = interview desirable to complement observations

IN = interview necessary

- Start with the observations, answering all unmarked questions. This should preferably be done without disturbing the worker. Continue thereafter with the interview and answer all questions marked ID and IN.

- In most cases the entire checklist can be used, as the items which are not applicable will drop out when following the instructions saying "if NOT, see...." or "if YES see ....".

- Additional information will always be necessary from, e.g. management, medical and safety departments, representatives of trade unions or workers' associations.

- After each section there is a space for "Comments" which should be used for any remarks and information of relevance to the subject of each particular section. Improvements and changes which are needed or desirable should be noted down. Unusual or new solutions to problems which have already been successfully applied may be cited as good examples.

- Mark each item for which measures should be taken to improve the conditions. Circle the number of the item. Items for which measures are urgent should be marked in a very distinct way, e.g. by marking with a noticeable colour.

7.4 Ergonomic Checklist for Workplaces

TASK: ....

ENTERPRISE: ....

WORKPLACE: ....

MAIN ACTIVITY: ....

WORKER'S NAME: ....

WORKER'S AGE: ....

NAME OF CHECKER: ....

DATE: ....

No. of employees	Male	Female
Office		
Production		

DRAWING OF WORKPLACE
(Provide a simple drawing of the workplace under study. Mark the position of the worker and point out the position of machines/equipment/materials.)

DESCRIPTION OF TASK
(List activities performed by the worker under study and estimate time in percentage spent on different activities.)

LEGEND:

|ID| = Interviews desirable to supplement observations

|IN| = Interviews necessary

1. WORKING POSTURES	YES	NO
1.1 Sitting		
1.2 Sitting/standing (changeable)		
1.3 Standing		
1.3.1 Can the job be done sitting or sitting/standing? (specify)......................		
1.3.2 Is a chair available during short breaks? . .		
1.4 Standing/walking		
1.4.1 Is a chair available during short breaks? . .		
1.5 Chairs:		
1.5.1 Is the chair well-designed (regarding height, seat, arm- and back-support)?		
If not, comments		
....		
1.5.2 Is the chair adjustable?		
1.5.3 Is a footrest available?		
1.6 Does the job imply:		
1.6.1 Free choice of working position?		
1.6.2 A fixed position?		
1.6.3 Static muscle work?		
1.6.4 One-sided and unsymmetrical movements?		
1.6.5 Frequently-repeated movements without variety?		
1.6.6 Complicated work patterns?		
1.6.7 Uncomfortable or tiring movements (e.g. working with arms above shoulders or head, twisting, bending, stooping)?		

|IN| 1.7 Suggestions for improvement (related to items 1.1-1.6)

....

....

2. TOOL(S) AND EQUIPMENT

		YES	NO
2.1	Are any tool(s)/equipment used by the worker?		

If NO, continue at 3.

If YES, reply to questions 2.2-2.8.

2.2 Which tool(s)/equipment are used and for which task(s)?

....

....

|ID| 2.3 How frequently is/are the tool(s)/equipment used (continuously, often, occasionally, rarely)?

....

....

		YES	NO
|ID| 2.4	Are the tool(s)/equipment appropriate for performing the task?		

If not, state why (e.g. too heavy, inappropriate design, etc.)

....

....

		YES	NO
|ID| 2.5	Are tools fitted with adequate handles?		
|ID| 2.6	Are tools properly maintained?		
|ID| 2.7	Can the job be performed more easily/more efficiently by using any additional/other tool(s)/equipment? . .		

If yes, which tool(s)/equipment and for which task(s)?

....

....

|IN| 2.8 Suggestions for improvement (related to items 2.1-2.7)

....

....

3. CONTROLS AND DISPLAYS

		YES	NO
	3.1 Are any controls or displays used by the worker? . .		

If NO, continue at 4.

If YES, reply to questions 3.2-3.9.

3.2 Which:

controls? ....

displays? ....

|ID| 3.3 How frequently are the controls/displays used?

....

....

		YES	NO
|IN|	3.4 Is it easy to operate the controls?		
|ID|	3.5 Has the function of the controls/displays been clearly indicated, and is it understandable?		
|ID|	3.6 Is the operator adequately informed about the function of the controls/displays?		
|ID|	3.7 Have the controls/displays been set up logically and conveniently?		
|ID|	3.8 Can the job be performed more easily/more efficiently by using any additional/other controls/displays? . .		

|IN| 3.9 Suggestions for improvement (related to items 3.1-3.8)

....

....

4. PHYSICAL WORKLOAD (should preferably be supplemented by measurement)

	YES	NO
4.1 Is the work physically very heavy most of the time?		
4.2 Not very heavy most of the time, but with peaks of very heavy work?		

4.3 Mention the heaviest work elements:

....

....

	YES	NO
4.4 Light work most of the working time		

|IN| 4.5 Worker's opinion of the physical workload (4.1-4.4)

....

....

|IN| 4.6 Suggestions for improvement (related to items 4.1-4.5)

....

....

5. MANUAL LIFTING, CARRYING, PULLING AND PUSHING

5.1 Does the job imply:

	YES	NO
5.1.1 manual lifting?		
5.1.2 manual carrying?		
5.1.3 manual pulling?		
5.1.4 manual pushing?		

If NO, continue at 6.

If YES, reply to questions 5.2 and 5.3.

|ID| 5.2 Give a brief description of the burdens:

weight: ....

shape: ....

frequency of handling (per hour): ....

distance of handling: ....

|IN| 5.3 Suggestions for improvement (related to items 5.1 and 5.2)

....

....

6. VISIBILITY AND LIGHTING

		YES	NO
|ID| 6.1	Is visibility adequate (regarding work posture, safety, fatigue, efficiency)?		

6.2 Is the workplace lit by artificial or natural light?

....

6.3 What kind of artificial light source?

....

6.4 If the workplace is lit by (a) lamp(s), is the worker disturbed by:

		YES	NO
|ID|	6.4.1 flickering of the lamp?		
|ID|	6.4.2 too much contrast?		
|ID|	6.4.3 fluctuation of bright and dark in his visual field?		
|ID|	6.4.4 glare or reflection?		
|IN| 6.5	According to the worker, is the workplace well lit? .		

|IN| 6.6 Suggestions for improvement (related to items 6.1-6.5)

....

....

		YES	NO
7.	NOISE (should preferably be supplemented by measurement)		
7.1	Is the worker exposed to noise?	☐	☐
	If NO, continue at 8.		
	If YES, reply to questions 7.2-7.11.		
|ID| 7.2	What is/are the source(s) of the noise?		
	....		
	....		
|ID| 7.3	For how long per day is the worker exposed to noise?		
	.... hours/day		
7.4	Is the noise continuous or intermittent?		
	....	YES	NO
7.5	Is there noise of impulse-type?	☐	☐
|IN| 7.6	Is the noise disturbing, according to the worker? . .	☐	☐
	If yes, in what way?		
	....		
	....	YES	NO
7.7	Can the noise source(s) be eliminated?.	☐	☐
	If yes, how?		
	....		
	....	YES	NO
7.8	Can the noise source(s) be isolated?	☐	☐
	If yes, how?		
	....		
	....	YES	NO
7.9	Does the worker wear ear protectors?	☐	☐
	If yes, what kind?		
|IN|	If no, why not?		

YES NO

|ID| 7.10 Are there any audible warning signals or other audible communications necessary to perform the job? ☐ ☐

|IN| If yes, can the worker hear them? . . . . ☐ ☐

|IN| 7.11 Suggestions for improvement (related to items 7.2-7.10)

....

....

8. VIBRATION

YES NO

8.1 Is the worker exposed to vibration? . . . . ☐ ☐

If NO, continue at 9.

If YES, reply to questions 8.2-8.8

8.2 What kind of vibration:

YES NO

8.2.1 hand-arm vibration? . . . . ☐ ☐

8.2.2 whole-body vibration? . . . . ☐ ☐

8.3 What is/are the source(s) of vibration?

....

....

|IN| 8.4 For how long per day is the worker exposed to vibration?

.... hours/day

YES NO

|IN| 8.5 Is the vibration disturbing, according to the worker? ☐ ☐

If yes, in what way?

....

....

YES NO

8.6 Can the vibration source(s) be eliminated? . . . . . ☐ ☐

If yes, how?

....

....

	YES	NO
8.7 Can the source(s) be isolated?		

If yes, how?

....

....

|IN| 8.8 Suggestions for improvement (related to items 8.2-8.7)

....

....

9. DUST, SMOKE, GAS, CHEMICALS, ETC.

	YES	NO
|ID| 9.1 Is the worker exposed to:		
9.1.1 Dust? source:		
9.1.2 Smoke? source:		
9.1.3 Gas? source:		
9.1.4 Chemicals? namely:		
9.1.5 Other dangerous substances? namely:		
|ID| 9.2 Is ventilation adequate?		
|ID| 9.3 If the worker is exposed to sawdust, is it adequately removed from the workplace?		
|IN| 9.4 If the worker is exposed to gas, does the worker wear a mask?		
|IN| 9.5 If the worker is exposed to chemicals, does the worker wear protective clothing (gloves, shoes, apron) or a gas mask?		

|IN| 9.6 Is the worker suffering from any health problems related to sawdust, saw-vapour, gas, chemicals (i.e. skin irritation, irritation of the eyes, rough voice, eczema, asthma)? . . . . YES ☐ NO ☐

If yes, specify what: ....

....

|IN| 9.7 Suggestions for improvement (related to items 9.2-9.6)

....

....

10. CLIMATIC FACTORS

|IN| 10.1 Is the worker exposed to:

	YES	NO
10.1.1 Cold?		
10.1.2 Heat?		
10.1.3 Humidity?		
10.1.4 Draught?		

|IN| 10.2 Suggestions for improvement

....

....

11. STRESS, MENTAL WORKLOAD

|IN| 11.1 Is the work pace controlled by the worker? . . . . . YES ☐ NO ☐

If YES, continue at 11.2

If NO, is the pace controlled by:

	YES	NO
11.1.1 The machine the worker is operating?		
11.1.2 Other machine(s) or worker(s) (after or before the worker in the production process)?		
11.1.3 Other factors		

If yes, describe: ....

....

		YES	NO
|IN| 11.2	Can the worker determine when to take short breaks?		
11.3	Is the job task very repetitive?		

How frequently does the same work element occur during a 10-minute period?

....

		YES	NO
|ID| 11.4	Can the worker determine which tools, techniques and methods will be used?		
11.5	Is the worker closely supervised?		
|ID| 11.6	Does the job task imply social interaction or co-operation with other people?		
11.7	Is the worker isolated most of the working day (except during longer breaks)?		

If yes, explain nature of isolation:

....

		YES	NO
|IN| 11.8	Does the worker rotate between different tasks? . .		

|IN| 11.9 Suggestions for improvement (related to items 11.1.1-11.8)

....

....

12. WORKING TIME

12.1 Does the worker work:

		YES	NO
12.1.1	Only day-time (not before 6.00 a.m. and not after 6.00 p.m.)?		
12.1.2	Two-shift work?		
12.1.3	Three-shift work?		
12.1.4	Other scheduling of working hours (e.g. when changing shifts)?		

12.2 When does work:

start? .... hours

finish? .... hours

12.3 Work extends over:

how many days per week? .... days

how many months per year? .... months

|IN| 12.4 Does the worker take (a) meal break(s)? . . . . . . YES ☐ NO ☐

If yes:

From .... to .... (hours)

From .... to .... (hours)

Where is the meal break taken? ....

|IN| 12.5 Does the worker take any other breaks? . . . . . . YES ☐ NO ☐

If yes,

How often? ....

How long each time? .... minutes

Where are the breaks spent? ....

|IN| 12.6 Suggestions for improvement

....

....

13. GENERAL SAFETY AND HEALTH ASPECTS

|IN| 13.1 Has the worker experienced any accident(s) on the job? . . . . YES ☐ NO ☐

If yes, give details:

....

....

....

			YES	NO
|IN|	13.2	Does the worker recall fatal accidents or accidents leading to loss of work among his fellow workers? .		

If yes, give details:

....

....

....

			YES	NO
|IN|	13.3	Is the worker exposed to any obvious accident risk?		

If yes, which:

....

....

			YES	NO
	13.4	Does the worker expose other persons to accident risks?		

If yes, how and which:

....

....

			YES	NO
|IN|	13.5	Do safety regulations exist for the job?		
		If yes, are they adequate?		
|IN|	13.6	Is adequate first-aid equipment available?		
|IN|	13.7	Has someone at the work site been trained in first aid?		
|IN|	13.8	Does the worker suffer from health complaints? . . .		

If yes, give details:

....

....

....

YES NO

|IN| 13.9 Does the worker recall that fellow workers have given up employment because of health complaints? [ ] [ ]

If yes, give details:

....

....

....

YES NO

|IN| 13.10 Is the worker exposed to any obvious health risks? [ ] [ ]

If yes, which:

....

....

YES NO

|IN| 13.11 Has the worker access to adequate medical care?. . . [ ] [ ]

|IN| 13.12 Comments and suggestions for improvement

....

....

14. PREMISES AND FACILITIES

		YES	NO
14.1	Can the worker enter and leave the workplace safely and easily?		
14.2	Are passageways clearly marked with warning signs? .		
14.3	Are there sufficient auxiliary supports, e.g. steps, handles, railings?		
	If yes, is their design and placement adequate? . .		
14.4	Are cabins, platforms and other constructions safe?		
14.5	Is the working floor free from obstructions and risk of slipping?		
14.6	Is there sufficient working space to move freely and safely?		
14.7	Are dangerous moving parts of machines adequately guarded?		

	YES	NO
14.8 Is fire equipment adequately located and in working order?		
14.9 Are there adequate sanitary and hygienic facilities (toilets, washing facilities)?		
14.10 Is adequate housekeeping provided (proper storage of tools, raw materials and products, cleaning, disposal of waste, maintenance of premises and equipment)?		
14.11 Are machines and equipment regularly maintained and inspected?		
14.12 Are electrical installations safe and regularly maintained and inspected?		

14.13 Other observations:

....

....

|IN| 14.12 Suggestions for improvement (related to items 14.1-14.13)

....

....

15. PERSONAL PROTECTIVE EQUIPMENT

Equipment	Not needed	Needed	Not used	Used	Not provided	Provided	How often is equipment replaced?
15.1 Safety helmet							
15.2 Ear protectors							
15.3 Eye protectors							
15.4 Safety gloves							
15.5 Safety leggings							
15.6 Safety boots							
15.7 Gas/dust mask							
15.8 Protective clothing							
15.9 Other personal protective equipment Please .... specify..........							

|IN| 15.10 Is the personal protective equipment properly cleaned and maintained? . . . . YES ☐ NO ☐

If yes, by whom? ....

how often? ....

|IN| 15.11 Suggestions for improvement of personal protective equipment

....

....

16. AID TOOLS FOR SAFE FELLING, DEBRANCHING AND CROSS-CUTTING OF TREES

Aid tools	Not needed	Needed	Not used	Used	Not provided	Provided
16.1 Felling levers type:						
16.2 Wedges type:						
16.3 Lifting devices (e.g. hooks, tongs) type:						
16.4 Aid tools for taking down hung-up trees type:						
16.5 Other aid tools type:						

|IN| 16.6 Suggestions for improvement of aid tools

....

....

17. SAFETY DEVICES ON CHAIN SAWS |ID|

Safety devices	Not available	Available	Not functioning	Functioning
17.1 Front handle guard				
17.2 Rear handle guard				
17.3 Automatic chain brake				
17.4 Chain catcher				
17.5 Throttle control				
17.6 Anti-vibration system (e.g. dampening elements)				
17.7 Spiked bumper				
17.8 Guide bar cover				

|IN| 17.9 How is maintenance organised (schedule, responsibilities, place)?

....

....

|IN| 17.10 Suggestions for improvement of chain saw safety

....

....

18. INFORMATION ABOUT SOCIAL SECURITY, WORKERS' WELFARE AND NUTRITION

18.1 What is compensation in case of accident?

....

....

18.2 What is compensation in case of sickness?

....

....

18.3 What is compensation in case of invalidity?

....

....

18.4 What is compensation in case of retirement?

....

....

18.5 How many days paid annual leave is the worker entitled to?

.... days

18.6 How many days maternity leave is the worker entitled to?

.... days

		YES	NO
|IN| 18.7	Is housing provided?		

If so, what kind?

....

		YES	NO
|IN| 18.8	Is transportation to and from work provided?		

If so, how is it organised?

....

|IN| 18.9 How far, and for how long, does the worker walk daily to and from the worksite?

....

		YES	NO
|IN| 18.10	Is adequate shelter provided at the worksite (from rain, heat, wind)?		
18.11	Are camping facilities provided?		
	If yes, are they adequate?		

|IN| 18.12 What are the worker's main activities outside work?

....

|IN| 18.13 When and where does the worker have his main meals?

....

|IN| 18.14 Who prepares the food?

.... YES NO

18.15 Is any food provided or subsidised by the employer? [ ] [ ]

If so, what kind of food? ....

how much? ....

how often? ....

|IN| 18.16 Does the worker eat the following food items daily? weekly?

Food item	Daily	Weekly
Rice, maize, bread, cassava, potatoes or other carbohydrates		
Fish, meat, eggs, dairy produce, beans		
Vegetables, fruit		

|IN| 18.17 What is the availability and quality of drinking water?

....

|IN| 18.18 Suggestions for improvement (related to items 18.1-18.17)

....

....

....

....

19. WORKER'S BACKGROUND

19.1 Time worked with the enterprise: .... years

19.2 Time worked on present job: .... years

19.3 Type of employment (permanent, seasonal, casual)

....

|IN| 19.4 Education:

19.4.1 How many years has the worker spent in school?

.... years

	YES	NO
19.4.2 Can he/she read and write?		

19.5 Training:

	YES	NO
|IN| 19.5.1 Was initial instruction provided when the worker started on his/her job?		

If yes, please describe

....

....

	YES	NO
19.5.2 Are instruction manuals necessary?		
If yes, are they available and understood by the worker?		
|IN| 19.5.3 Has the worker received basic training for the job?		

If yes, please describe

....

....

	YES	NO
|IN| 19.5.4 Has the worker practical experience/training in other jobs?		

If yes, which ones?

....

19.6 How are wages paid:

	YES	NO
19.6.1 Based on time?		
19.6.2 Based on task?		
19.6.3 Piece rate?		
19.6.4 Based on time plus production bonus?		

|IN| 19.7 Trade union:

	YES	NO
19.7.1 Is the worker a member of a trade union or a workers' association?		

If yes, which one?

....

	YES	NO
19.7.2 Has the trade union negotiated a collective agreement with the worker's employer? . . .		

|IN| 19.8 Suggestions made by the worker for <u>any</u> kind of improvements

....

....

....

|IN| 19.9 What does the worker like <u>best</u> about the job?

....

....

|IN| 19.10 What does the worker like <u>least</u> about the job?

....

....

19.11 Comments

....

....

....

REFERENCES

1. Anon. Advanced First Aid and Emergency Care. 1973. The American National Red Cross. First Edition. Doubleday & Company, Inc., USA.

2. Anon. 1977 Bullerbekämpning. Principer och tillämpning. Arbetarskyddsfonden. (In Swedish).

3. Anon. 1973 Preservation of personal health in warm climates. The Ross Institute of Tropical Hygiene. Published by E.G. Berryman & Sons Limited. Greenwich, London, U.K.

4. Anon. 1982 The Chainsaw - use and maintenance. The National Board of Forestry. Sweden.

5. Apud, E., Elgstrand K. and Teljsted, H. 1972 An Outline for the Initiation of Activities of Ergonomics and Occupational Health within Chilean Forestry. Department of Operational Efficiency. Research Notes no. 53. Royal College of Forestry, Stockholm, Sweden.

6. Axelson, O. 1974 Heat Stress in Forest Work. An Attempt to Evaluate the Physical Work Capacity of Forest Workers as Influenced by a Hot Climate. FAO, Rome, Italy.

7. Bostrand, L. and Frykman B. 1975 A short review of behavioural research in the field of forest operations in the Nordic countries. Vik T. II. A short review of ergonomic research in forest operations carried out in the Nordic countries in the years 1969-1973. Royal College of Forestry. Department of Operational Efficiency. Research Notes 83. Garpenberg, Sweden.

8. Bostrand, L. 1978 Women in Forestry. FAO 8th World Forestry Congress. Jakarta, Indonesia, 16-28 October 1978. Royal College of Forestry, Garpenberg, Sweden.

9. Bostrand, L. 1979 Adaptation of forestry work to man's qualifications. The Swedish University of Agricultural Sciences. Department of Operational Efficiency. Report No. 128. Garpenberg, Sweden. (In Swedish with English summary).

10. Bostrand, L. 1984 Production techniques and work environment - A study on forest machine operator's work conditions 1969-81. The Swedish University of Agricultural Sciences. Department of Operational Efficiency. Report No. 159. Garpenberg, Sweden. (In Swedish with English summary).

11. Bostrand, L. 1986 Living and working conditions for forestry workers in Vietnam: a follow-up report. SIDA, Sweden.

12. Brown, D.B. 1976 Systems Analysis & Design For Safety. Prentice-Hall International Series in Industrial and Systems Engineering. Auburn University, USA.

13. Davidsson, H. & Nilsson G. Ergonomi för jordbruk, skogsbruk och
1985 trädgård. LT's förlag. Stockholm, Sweden (In Swedish).

14. Durain, J.V.G.A. and Passmore, R. Energy, work and leisure.
1967. Heinemann, London.

15. Edholm, O.G. The Biology of Work (Arbetets biologi Människan
1967 och arbetsmiljön). Aldusuniversitetet. 1967. (In Swedish).

16. Eile, I. Arbetsmiljön. Arbetarskydd - Ergonomi - Arbetshygien.
1977 Liber Läromedel. Malmö. (In Swedish).

17. FAO Nutrition and Working Efficiency. Freedom from Hunger
1962 Campaign. Basic Study No. 5. Rome, Italy.

18. FAO Employment in Forestry. Report on the FAO/ILO/SIDA
1974 Consultation on Employment in Forestry held in Chiang Mai, Thailand, 10 February - 1 March 1974. FAO/SWE/TF 126. Rome, Italy.

19. FAO Annex to the report of the FAO/ILO/SIDA Consultation on
1974 Employment in Forestry. Chiang Mai, Thailand. 10 February - 1 March 1974. FAO/SWE/TF 126. Rome, Italy.

20. FAO The feeding of workers in developing countries. FAO Food
1976 and Nutrition Paper No. 6, Rome, Italy.

21. FAO Harvesting man-made forests in developing countries. Rome,
1976 Italy.

22. FAO/ILO Chainsaws in tropical forests. FAO Training Series No. 2.
1980 FAO and ILO. Rome, Italy.

23. FAO Appropriate Technology in Forestry. Report of the
1982 Consultation on Intermediate Technology in Forestry held in New Delhi and Dehra Dun 18 October - 7 November 1981. FAO Forestry Paper No. 31. Rome, Italy.

24. FAO Basic Technology in Forest Operations. FAO Forestry Paper
1982 No. 36. Rome, Italy.

25. FAO Technical and Vocational Forestry and Forest Industries
1986 Training. Introduction to Forest Fire Management. Training Manual prepared for the Government of Burma by FAO and UNDP based on the work of J.G. Goldammer. FO:DP/BUR/81/001. Field Document No. 6. Rome, Italy.

26. FAO A systematic model for identifying research, training and
1986 extension needs in ergonomics by B. Frykman. Rome, Italy.

27. FAO/ECE/LOG. Symposium on Ergonomics Applied to Forestry.
1971 Volume 1 A. Joint Committee on Forest Working Techniques and Training of Forest Workers. FAO/ECE/LOG 243. Geneva, Switzerland.

28. FAO/ECE/ILO. Occupational Health and Rehabilitation of Forest
1986 Workers. Proceedings of the Seminar on Occupational Health and Rehabilitation of Forest Workers held at Kuopio, Finland, 3-7 June 1985. The Joint FAO/ECE/ILO Committee on Forest Working Techniques and Training of Forest Workers. Helsinki, Finland.

29. FAO/ECE/ILO Ergonomics Applied to Forestry. Proceedings, 17-22 October
1983 1983. Vienna and Ossiach, Austria. Economic Commission for Europe.

30. FTP Sawmilling in developing countries. Proceedings of the
1980 Seminar on Sawmilling for Developing Countries, 15 September - 3 October 1980, Kotka, Finland. National Board of Vocational Education. Forestry Training Programme for Developing Countries. Helsinki, Finland.

31. Grandjean, E. Fitting the task to the Man. An ergonomic approach.
1982 Taylor & Francis Ltd.

32. Hanlon, J. Does A.T. walk on plastic sandals? New Scientist, 26 May.
1977

33. Hansson, J.E., Lindholm, A. and Birath, H. Men and Tools in Indian
1966 Logging Operations - A pilot study in ergonomics. Department of Operational Efficiency. Research Notes No. 29. Stockholm, Sweden.

34. IFBWW Documents: Health and safety in the building, wood and
1984 forestry industries. Geneva, 14 - 18 May 1984. International Federation of Building and Wood Workers. (IFBWW).

35. ILO Guide to Safety and Health in Forestry Work. Geneva,
1968 Switzerland.

36. ILO Safety and Health in Forestry Work. ILO Codes of Practice.
1969 Geneva, Switzerland.

37. ILO Selection and Maintenance of Logging Hand Tools. An
1970 illustrated training manual for foresters, loggers, foremen and workers. D 9. Geneva, Switzerland.

38. ILO Protection of workers against noise and vibration in the
1977 working environment. 1977. ILO Codes of Practice. Geneva, Switzerland.

39. ILO Safe design and use of chain saws. Geneva, Switzerland,
1978

40. ILO Introduction to Work Study. Third (revised) Edition.
1978 Geneva, Switzerland.

41. ILO Technology to improve working conditions in Asia. Geneva,
1979 Switzerland.

42. ILO 1980 Fraser, T.M. Ergonomic Principles in the Design of Hand Tools. Occupational Safety and Health Series. No. 44. Geneva, Switzerland.

43. ILO 1981 Laarman, J., Virtanen, K. and Jurvelius, M. 1981. Choice of Technology in Forestry. A Philippine Case Study. Geneva, Switzerland.

44. ILO 1981 Tool Brochure. Catalogue of appropriate tools for Philippine labour-based forestry. Geneva, Switzerland.

45. ILO 1981 Field Handbook. Choice of appropriate technology in Philippine forestry. Geneva, Switzerland.

46. ILO 1981 Equipment planning guide for vocational and technical training and education programmes. Geneva, Switzerland.

47. ILO 1981 Programme of Industrial Activities. Employment promotion and vocational training in the timber industry, with particular reference to developing countries. Report III. Geneva, Switzerland.

48. ILO 1981 Programme of Industrial Activities. Occupational safety and health problems in the timber industry. Third Tripartite Technical Meeting for the Timber Industry. Report II. Geneva, Switzerland.

49. ILO 1983 Occupational safety and health in the wood and wood products industries. Sectoral Working Paper Series. No. 9. Sectoral Studies Branch. Division for Industrial Studies. Geneva, Switzerland.

50. ILO 1985 Working, Living and Social Conditions in Forestry. Programme of Industrial Activities. Forestry and Wood Industries Committee. First Session. Report III. Geneva, Switzerland.

51. ILO 1985 Operational Efficiency, Work Study and Ergonomics in Forestry. Proceedings of an International Workshop held at Olmotonyi, the United Republic of Tanzania, 14-27 January 1985, Geneva, Switzerland.

52. IMF 1980 Better working environment. IMF - The Joint Industrial Safety Council. Stockholm, Sweden.

53. IUFRO 1971 Methods in Ergonomic Research in Forestry. IUFRO Seminar. Silvifuturum. Hurdal, Norway. September 1971. IUFRO Division No. 3 "Forest Operations and Techniques". Publication No. 2

54. IUFRO 1974 Ergonomics in Sawmills and Woodworking Industries. Proceedings of IUFRO Joint Meeting, Division 3 and 5. Symposium in Sweden, 26 - 30 August, 1974.

55. IUFRO 1976 XVI World Congress. Division III. Proceedings - Referate - Exposés.

56. IUFRO XVIII World Congress. Division 3. Forest Operations and
1986 Techniques. Yugoslavia, 7 - 21 September. Proceedings. Referate - Exposés.

57. Kantola, M. and Virtanen, K. Handbook on Appropriate Technology for
1986 Forestry Operations in Developing Countries. Part 1. Tree felling and conversion clearing of forest plantations. Forestry Training Programme. Publication 16. National Board of Vocational Education of the Government of Finland.

58. Larsson, S.G. Advanced training and education in ergonomics and safety
1976 at the State College for Forest Engineers. Special paper prepared for the International Colloquium at Baden near Vienna, Austria 17 - 20 May. Report No. 1.

59. Loon, J.H.van, Staudt, F.J. and Zander, J. Ergonomics in tropical
1979 agriculture and forestry. Proceedings of the Fifth Joint Ergonomic Symposium organized by the Ergonomic Commissions of IAAMRH, CIGR and IUFRO. Wageningen, Netherlands, May 14-18, 1979.

60. Magnusson, M. and Nilsson, C. Att arbeta pa obekväm arbetstid.
1979 Arbetarskyddsfonden. (In Swedish).

61. Martinez, G.R. Understanding the Filipino People. Instruction
1982 Department of Social Sciences CAS, UPLB Laguna, Philippines.

62. Nilsson, M. The Farm Tractor in the Forest. The National Board of
1984 Forestry, Sweden.

63. Nordenborg, M. Arbetskunskap. LT's förlag. Stockholm, Sweden
1974 (in Swedish).

64. Pettersson B., Aminoff S., Gustafsson L., Lindström K-G and
1983 Sundström-Frisk, C. Enhanced Safety in Forestry - a Campaign of action for one branch of industry. The Logging Research Foundation. Bulletin No. 14, Stockholm, Sweden.

65. Sharkey, B.J. Work, Rest and Fatigue - A review of factors
1980 influencing performance and fatigue during prolonged work. USDA. Special report. Missoula, Montana, U.S.A.

66. SIDA Swedish forest techniques with possible applications in the
1983 third world. A project sponsored by SIDA. Forest Operations Institute. Stockholm, Sweden.

67. SIDA Village nurseries for forest trees - how to set them up and
1984 how to run them. SIDA. Swedforest Consulting AB, Stockholm, Sweden.

68. SIDA A Handbook on basic logging and transport methods adapted
1986 to typical conditions in India. A project sponsored by SIDA. Forest Operations Institute. Stockholm, Sweden.

69. Sjøflot, L. Design of the Work Environment. International
1976 Symposium on Ergonomics and Safety in Education and Training in Agriculture and Forestry. Baden, Austria, 17-20 May, 1976.

70. Taylor and Palmear
1975

71. USDA Protect Your Hearing! Equip. Tips. Revision No. 2. USDA.
1979 U.S. Department of Agriculture - Forest Service Equipment Development Center. San Dimas, California, U.S.A.

72. USDA Hardhats... use, care, replacement. Medc '80. Project
1980 record. Forest Service. U.S. Department of Agriculture, Equipment Development Center. Missoula, Montana, U.S.A.

73. Woodson, W.E. Human Engineering Guide for Equipment Designers.
1956 University of California Press. Berkeley, Los Angeles, U.S.A.