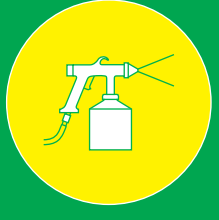
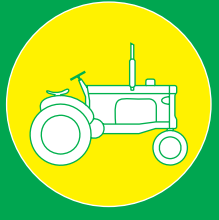
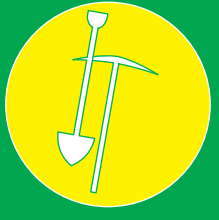
WHO Regional Publications, Eastern Mediterranean Series 25

Health of workers in agriculture







World Health Organization
Regional Office for the Eastern Mediterranean

WHO Regional Publications, Eastern Mediterranean Series 25

Health of workers in agriculture

Mostafa A. El Batawi

World Health Organization
Regional Office for the Eastern Mediterranean
Cairo
2003

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Agricultural workers frequently lack essential basic services that are available in other worker communities. Moreover, they are often poorly represented by government infrastructure and largely omitted in occupational safety and health legislation. With the expansion of agricultural technology there is growing concern that agricultural workers will face, in addition to traditional health risks, new occupational health and safety hazards.

Health and safety legislation usually takes many years to develop and implement. While efforts are being made in the legislative arena, education and training of agricultural workers, managers and health officials should also take place. In this manner, occupational health and safety risks in agriculture can be identified and reduced in the field, with immediate impact on health and safety of agricultural workers.

This is the background against which this manual on health of workers in agriculture has been produced. It is intended to serve as a handy reference for health officials and others concerned with the development and orientation of agricultural workers' health and safety programmes.

Hussein A. Gezairy, MD, FRCS
Regional Director for the Eastern Mediterranean

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Special attention is needed for the health problems of agricultural workers, who constitute some three-quarters of the world's working population. Agriculture is not a safe occupation. Agricultural workers face a large number of health problems, many of which arise from their work. In 1990, the National Safety Council of the United States estimated that agriculture was the most dangerous occupation, followed by mining/quarrying and construction [*1*]. Many new techniques and processes are being introduced to improve efficiency in agricultural production. However, they may also give rise to health problems that are not readily recognized either by health professionals or the workers themselves. It is therefore appropriate at this time to bring together in one publication relevant information on this problem. This will also facilitate the transfer of technical information often not readily available to health professionals.

This manual on health of workers in agriculture is intended for workers in both industrialized and developing countries. It is an example of the technical support that WHO offers in support of national efforts directed to developing health programmes for working populations.

The field of occupational health in agriculture is broad and involves many disciplines, including not only occupational health but also parasitology, toxicology, accident prevention and primary health care, among others.The purpose of this manual is to provide rural health practitioners and other public health officials with information relating to the major problems facing agricultural workers in health practice. Guidelines have been developed that will assist those concerned with improving health services to agricultural workers and identifying and controlling occupational health hazards in agricultural work.

Changing characteristics of agricultural work are presented in Chapter 1. The risk of injury, disability or death caused by an agricultural accident is reviewed in Chapter 2. Methods to prevent accidents in agriculture and the framework and specific activities of an injury prevention programme are presented.

Health hazards to workers from exposure to toxic chemicals are covered in Chapter 3, with special emphasis on the use of pesticides. Diagnosis and treatment of pesticide poisoning are discussed, and guidelines for the safe use of pesticides and other agricultural chemicals are presented. Biological hazards facing agricultural workers are discussed in Chapter 4. Certain diseases and parasitic infections that pose specific health risks to agricultural workers are described, and information on prevention and control of biological hazards is provided.

Chapter 5 covers the problem of worker exposure to organic natural dusts. A classification to exposure to vegetable dusts is provided, and control and prevention of associated diseases are discussed. Exposure of agricultural workers to environmental hazards such as heat, cold, noise and vibration is presented in Chapter 6. Information is provided on diagnosis, treatment and early detection and prevention of health disorders arising from exposure to these hazards.

Psychosocial factors in agricultural work are discussed in Chapter 7. Control and prevention of harmful effects of psychosocial factors on health and performance are outlined. Chapter 8 discusses the importance of rural health infrastructure in developing health and safety systems for agricultural workers. Fundamental principles in the development of an occupational health service are presented, with emphasis on the importance of the primary health care (PHC) approach.

Basic education and training needs in developing health programmes in agriculture are discussed in Chapter 9. Special attention is given to the needs of PHC workers and health education of agricultural workers. Priority research areas are also identified.

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The storage of grain in metal bins and similar facilities may be hazardous to workers because of the risk of exposure to fumigants and dust and of (grain) drowning.

Transport of goods and services in agricultural work is a major activity: moving equipment to and from the fields, collecting crops and moving them to market or storage areas. Operators of farm transport equipment may include not only the farmer but also family members.

Maintenance and repair are functions that necessarily accompany the use of mechanical equipment. Maintenance and repair demand significant effort in farm work. These activities are usually accomplished in off-season periods. Depending upon the type of equipment being used, work hazards include burns, electric shock, entanglements and falls.

Construction includes building roads, digging holes and drainage and irrigation ditches, clearing timber and erecting buildings. These activities can be hazardous for the untrained worker.

b) Scale

The problems faced by the subsistence farmer are different from those faced in a large-scale organized agricultural activity such as a plantation.

The subsistence farmer, most common in developing countries, often works irregular hours with no limit to the daily or weekly work regimen. Mechanized aids are rarely used. The work depends mostly on strength and demands heavy physical effort. There are no work standards and physical limits are self-imposed. The subsistence farmer often works alone or in small groups (often related by family) and has limited access to technological advice and health services.

Large-scale agricultural activity is characterized by the introduction of new mechanized and agricultural techniques. The worker becomes a member of a group and often is required to do limited tasks, and is usually provided with social services such as housing, health services and sanitation.

c) Use of new technology

Mechanization, automation, the use of chemical products and biological preparations have brought about essential changes for agricultural workers. This is especially obvious in industrialized countries, whereas in most developing countries agriculture has retained its traditional character. However, even in industrialized countries, some agricultural activities remain unchanged. Agricultural workers today face, simultaneously, traditional and new biological, physical and chemical hazards [*1*].

Working conditions, workload and the occupational health and safety problems in agriculture depend broadly on agricultural technology. The introduction of new technology brings with it the risk of new health and safety problems. Increasing use of tractors, chainsaws and other types of agricultural machinery may increase the risk from accidents. The use or misuse of agricultural chemicals may result in poisoning.

Exposure of workers to airborne dust in confined areas where animals are raised has been associated with respiratory disease, especially in the poultry processing industry. There is also epidemiological evidence of a higher incidence of respiratory symptoms (e.g. chest tightness, cough) and impairment of respiratory function in animal breeders in confined conditions [*1*]. Noise levels in pig breeding operations can reach 90 or 98 dB at the beginning of feeding and 100 to 118 dB during veterinary intervention [*2*]. Exposure of workers to these noise levels may lead to temporary or permanent hearing loss.

d) Agricultural workforce

In many parts of the world, women constitute a large proportion of farmers. Where adult labour is insufficient for the workload, children are often engaged in farm work. Because of their limited strength, knowledge and experience and the absence of statutory provisions regarding their employment, they present a particularly important health problem.

As countries move towards the production of more crops, increased mechanization and increased use of pesticides, the agricultural worker is required to acquire new knowledge and skill so that modern technology may be used efficiently and safely.

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Agriculture as carried out today is a dangerous occupation, with millions of workers sustaining injury and death throughout the world. Comparison between accident rates in different countries is difficult because the reporting systems for agricultural injuries and fatalities vary from country to country and in some countries may be absent entirely.

In industrialized countries data about agricultural accidents are readily available. In Australia, for instance, the fatality rate due to agricultural accidents was 19.4 deaths per 100 000 population per year for the period 1982–1984, with mobile mechanical equipment the main agent [*1*]. This figure was exceeded only by accidents in mining or quarrying.

In developing countries, data about agricultural accidents are not always available. It is often assumed that because less mechanized equipment is used, the frequency of agricultural accidents is also less than in industrialized countries; however, no data are available to support this view. A study in Punjab, India, in 1959 showed that the rate of disabling injuries in four villages was 116 per 1000 population [*2*]. Since agricultural work in villages covered in Punjab study was not mechanized, and since the majority of the population was engaged in agricultural activity, it seems probable that the accident rate in the traditional form of agriculture is at least as high or higher than in mechanized agriculture.

Even with the limited information available on agricultural accidents, it is clear that accidents in agriculture present a major health problem. Unless effective preventive action is taken now, this problem is likely to increase in magnitude and severity as mechanization increases. National and international efforts should be undertaken to standardize injury-reporting systems in farm work and to ensure adequate coverage of the total agricultural working population.

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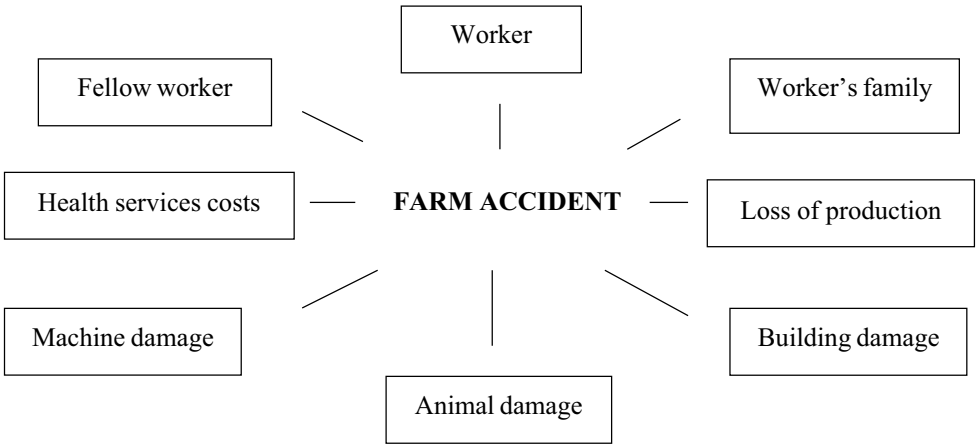
It is important to put accident statistics into proper perspective. The suffering to the individual who is injured is apparent; however, various other aspects of the problem need

to be considered. The widespread effects of a farm accident are shown schematically in Figure 2.1.

In small-scale farming, an injury to an agricultural worker may present severe and intolerable problems to the family. Not only must care be provided for the injured worker but care should be given to families. The normal routine of the family may be disrupted and its income drastically reduced.

On a national scale, agricultural accidents place a great burden on the economy. The efficiency of work is impeded and agricultural output is reduced. Moreover, in many cases the equipment involved in the accident may need to be replaced, often at considerable cost.

The burden on health services should not be ignored. The injured require treatment and the disabled require rehabilitation. A considerable proportion of national health resources may be utilized simply in dealing with the consequences of agricultural accidents. If the national health strategy places greater emphasis on accident prevention, this will be reflected in less demand being placed on the curative and rehabilitation aspects of the health system. Thus, there is a strong argument, based on economics and public health, for giving greater attention to safety promotion in agriculture.



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The pattern of injuries seen in agriculture depends to a great extent on the farming activities being carried out, the working method and the machinery or equipment used. Although more machinery is being used every year, the majority of workers, especially in developing countries, use a variety of hand tools or simple equipment.

The type and frequency of accidents in the agriculture sector depend on a variety of factors. The principal factors are noted below:

- type of agricultural work being done, e.g. cutting of sugar cane, animal husbandry, forestry work
- work technology, e.g. use of tractors, chainsaws, harvesters
- work environment, e.g. climatic factors such as excessive heat and humidity
- work habits, e.g. food intake, speed of work and rest periods
- knowledge of the equipment, e.g. how to safely use a chainsaw
- availability and use of mechanical safe guards, e.g. guards for moving belts, cutting blades
- availability and use of protective equipment and protective clothing, e.g. safety glasses or gloves.

A common type of injury is a wound caused by the cutting edge of implements such as axes, knives, sickles and machetes. Where preventive programmes are not available, or are not yet well developed, such injuries may well become infected. In addition, there is the risk of tetanus. Working barefoot and without hand and/or arm protection increases the risk of this type of injury.

In Japan, in a study of an agricultural area where there was increasing mechanization, 59% of all injuries occurred in the upper limb, mainly on the fingers [*3*]. The principal type of injury was contused wounds.

Eye injuries also occur frequently in agricultural work, where many hazards such as smoke, sawdust, chaff and insects are encountered. Perforating eye injuries occur frequently among forestry workers.

Muskuloskeletal problems are often reported in agricultural workers. A study in Finland showed that compared with a control population, farmers had twice as much incidence of musculoskeletal disorders [*4*]. A New Zealand study in 1980 showed that the two most common complaints among farmers were “pain in the joints” and “backache” [*5*]. Musculoskeletal disorders can result from repeated assumption of unusual postures during agricultural work or excessive demands placed on the musculoskeletal system in activities such as lifting, carrying, pushing or pulling.

A simple survey by questionnaire that can be used in assessing the extent of musculoskeletal disorders in farm workers is shown in Figure 2.2 [*4*]. In addition to this questionnaire, questions should be asked about working conditions, lifestyle and general state of health. Thus the frequency of health complaints can serve as a rough indicator of existing problems and help in identifying specific vulnerable groups or individuals.

To be answered by everyone	**To be answered only by those who had discomfort**	
Have you at any time during any the last 12 months had discomfort in:	**Have you at any time during the last 12 months been prevented from doing your work (at home or outside home) because of discomfort?**	**Have you had discomfort at time during the last 7 days?**
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Causes of agricultural accidents

Unsafe conditions and unsafe acts

Causes of accidents are commonly classified into two main categories: unsafe conditions and unsafe acts. Several examples of unsafe conditions and unsafe acts frequently encountered at the worksite are shown in Table 2.1.

Agricultural implements

Agricultural implements are defined as tools and instruments which are operated manually or are worked by animals such as oxen, as distinct from accessories used on machines, such as in earth cutting [*6*].

Table 2.1 Examples of causes of accidents from unsafe conditions and acts

Unsafe condition or act	Typical consequences
Unguarded roof openings	Falls
Tools that are improperly secured during work at elevated levels (i.e. roofs, ladders)	Tools falling from heights and injuring other workers
Agricultural machines that are not provided with safety guards	Clothing caught in belt or shaft resulting in injury of fingers, hands or body
Unsafe storage of flammables	Fire including spontaneous combustion
Allowing animals or tractors to move without direct control	Animal bites, kicks, tractor overturn and crushing of driver, injury of other workers
Using tools improperly	Cuts, amputations of hand or feet
Using badly maintained tools	Tools break during usage, injuring workers
Lifting a load which is too far from feet	Musculoskeletal disorders
Smoking or using open flames in potentially dangerous areas (hay lofts, solvent storage areas)	Fire, explosion
Touching overhead power lines while moving metal irrigation pipes or using metal ladders	Electrical shock resulting in severe burns or death

Although the use of machinery in agriculture is increasing, the majority of workers employed in agriculture, especially in developing countries, still make extensive use of agricultural implements. A few of the more common agricultural implements include hand tools used in land clearance, ploughs for seed-bed preparation and spades, rakes, forks and pick-axes used between rows of plants to kill weeds and loosen soil. Other implements such as sickles, scythes, cutlasses and machetes are used for cutting forage crops. Rakes and pitch forks may be used for chopping fodder, as well as fodder-knives or fodder-cutting rollers.

The main hazards in the use of agricultural implements are physical injuries from the cutting edges of implements such as sickles and machetes, and cumulative effects such as back problems from handling heavy or poorly designed implements. Agricultural work can be made easier and performed more efficiently if ergonomically designed implements are used [*6*].

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Because of the variety of machinery now in use in agriculture and because workers may be unfamiliar with both the machines and the precautions to be taken when using them, work in mechanized agriculture is recognized as a hazardous occupation.

As many countries lack reporting systems for injuries caused by farm machines, it is difficult to quantify the problem. In Japan, however, it has been estimated that some 40 000 to 50 000 persons a year are injured by farm machinery [*3*]. This is directly attributed to the increasing use of farming machines.

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The use of electricity has also increased in agriculture. Where large-scale farming enterprises are far removed from a power source, they may generate their own electricity. In others, electricity is brought to the farm, usually by overhead power lines. In either case there is a risk of hazardous exposure. If electrical wiring and equipment has not been installed in a safe manner, the risk of accidental contact with a live electrical source is increased.

) DOOV

Accidents resulting from falls are of two kinds. A worker may fall from a height or struck by a falling object. Additionally, a worker may slip and fall while walking, especially if the ground or floor is wet or oily.

Falls may occur from buildings, ladders, trees or poles, through floor openings, down stairways, through the open side of an unguarded stairway or from any overhead or raised workplace. Workers may also be struck by the collapse of insecurely stacked goods or by tools used by overhead workers. A common accident in excavation or trench work is the caving in or collapse of unshored earth walls.

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Part of the worker's life is spent in and around farm buildings and the home. The collapse of structurally unsafe buildings can result in injury or death to farm workers. Other conditions in farm buildings that pose a safety hazard include overcrowding, insufficient headroom, lack of fire precautions, unsafe stairs and ladders, unguarded walkways and slippery floor surfaces.

Many accidents occur in and around the house. Slips and falls both on ground level and from higher levels occur frequently. Working in and around the house under unsafe conditions and/or without regard to safe practices has given rise to many traumatic and in some cases fatal injuries.

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The prevention of agricultural accidents involves many disciplines. An effective injury and illness programme need not involve large costs nor require additional employees. Usually it can be integrated rather easily into other operations.

In any accident prevention activity, a survey of the environment should be made, potential hazards clearly identified and the appropriate preventive and control measures instituted.

While details may vary, there are several basic elements present in any effective occupational injury and illness prevention programme [*7*]. Regardless of the size or type of the operation, the following elements should be included to the degree necessary.

Leadership and assignment of responsibility

In terms of management responsibility, the supervisor(s) of workers are usually the key personnel in all operations.

Identification and control of hazards

To maintain a safe and healthy workplace, two things are needed. Current and potential workplace hazards should be identified, and procedures should be instituted to control or eliminate these hazards.

Worker and supervisor training

An effective injury and illness prevention programme requires proper job performance from everyone in the workplace.

- workers should receive instructions on safe use of equipment
- mechanical safeguards should be in place
- each worker is expected to report all unsafe conditions encountered during work
- any injury or illness suffered by a worker, even a slight one, must be reported at once.

Recordkeeping

Once the facts have been determined, causes of injury can often be identified and kept on record, and control procedures can be instituted to prevent a similar injury from happening again.

First aid and medical assistance

First aid and medical assistance should be available to deal with the probable types of injury that might be expected in a particular workplace. Special training of workers in first aid is essential.

Accident investigation

The purpose of accident investigation is to determine the factors, conditions and/or practices that contributed to the accident, so that proper action can be taken to prevent recurrence. A complete accident investigation includes gathering pertinent data and making an objective evaluation of facts, statements and related information.

During the accident investigation procedure many questions and factors must be considered. A useful list of these factors is provided below:

- What was the injured person doing at the time of the accident?
- Was the proper tool or machine being used for the job?
- Was there any ergonomically incorrect feature in the tool, equipment or job design?
- Was the person trained for the job and for the hazards involved?
- What was the physical condition of the area when the accident occurred?
- What long-term or permanent action could have prevented the accident?

Evaluation of an injury prevention programme

A few illustrative questions that may be asked for each of these evaluation concepts are noted below:

Relevance

- What major safety problems does the programme address?
- What would be the effect of not having the programme at all?

Adequacy

- Has the safety problem been adequately defined in terms of extent and severity?
- Are the targets quantified and measurable?

Efficiency

- What indicators are being used for increasing programme effectiveness?
- Has there been a reduction in the "target" safety problem?

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In the initial phase in the development of an injury prevention programme, activities should centre on three principal areas; enforcement, engineering and education. An overview of these areas is shown in Table 2.2.

Enforcement

This item is lacking in many developing countries. To adequately safeguard the safety of the agricultural worker, adequate safety legislation should be enacted and enforced.

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Such legislation should include in its provisions such topics as:

- regulations on the registration of machinery
- standards relating to agricultural machinery, e.g. safety frames in tractors, machine guarding
- standards relating to environmental problems, e.g. electricity and chemicals
- education for the use of protective clothing and equipment where indicated
- accident reporting system and the collection and reporting of the relevant statistics.

Engineering

General

A vital part of accident prevention is the introduction and implementation of good engineering and ergonomic principles. Included in these principles are measures such as proper maintenance of plant equipment, ensuring good housekeeping practices and adequate control of environmental conditions. Machines must be designed not only to maximize productivity but also to minimize hazards.

The main risk of using machinery is from contact with moving parts such as tools, shafts, belts, pulleys and gears. All such dangerous areas should therefore be protected by adequate guards or positioned so that neither clothing nor parts of the body can be caught in them.

Guards and safety design

Moving parts of engines and transmissions and all dangerous parts of machinery, including the point of operation, should be guarded. When machines in operation produce flying particles, the areas from which the particles are ejected should be guarded to prevent injury to the operator or bystander. Machines should be guarded even when not in use, unless they have been rendered inoperative, to prevent injury due to inadvertent start-up.

Although more agricultural machinery is being introduced into farm work, the majority of farm workers still use simple agricultural implements that are operated manually or by draft animals. These implements are produced in enormous quantities, and their design has not changed in many years.

Guidelines for machinery

a) Tractors*

All agricultural and forestry tractors should be equipped with a safety cab or frame to protect the operator and/or passenger from falling objects and from the tractor

* For more detailed information, see *Safe construction and operation of tractors*. Geneva, International Labour Organisation, 1976.

overturning in any direction. Such cabs should conform to recognized and approved national or international standards.

Shields, covers, and casings are stationary guards that may be used to cover moving parts, pinch points, etc., to prevent injury. A "moving" shield (spinner) may be used on the power take-off shaft if it will stop independently of the moving shaft that it covers in the event of contact with a person or clothing.

A guard or shield should be used to prevent inadvertent contact with such parts as the engine exhaust, manifold, or other host areas during normal operation. Such shields should be affixed, or made of such material, so as to prevent their becoming hot themselves.

Wheel guards should be so designed as to prevent contact with wheels, either by the operator or the passenger, when in motion. In some instances auxiliary equipment may serve as guards when wheels have to be removed so that auxiliary equipment may be attached.

Seating is important to the health and safety of the operator and passenger. Seats should have backrests, arm rests, hand holds and foot rests. When tractors are equipped with safety cabs or frames, seat belts should also be provided. The seat should be adequately cushioned to prevent undue vibration to the operator and be designed to conform to the size, weight and shape of a variety of drivers.

Tractors should have adequate brakes to stop the heaviest and bulkiest load hauled on the steepest gradient where work is anticipated. Service brakes, which are designed to operate separately for either the right or left rear wheel, should be equipped with a coupling device for road travel purposes, unless a third pedal is provided for this purpose.

Fueling a machine when hot or running can be dangerous because vapours may be ignited. The resulting fire will be destructive to the equipment and can cause serious injury to the person fuelling the machinery. Exhaust fumes are also dangerous because of the quality of toxic gases they contain, particularly carbon monoxide. It is important that the exhaust system of tractors or any petrol-fuelled engine be well maintained and, if used indoors, exhaust should be vented to the outside and away from the workers.

Guidelines for the safe operation of agricultural machinery have been published by ILO [*8*]. The guidelines that follow have been adapted from those published by the ILO for the type of machinery most commonly used in agricultural work.

b) Soil and crop preparation machines

It is desirable to choose implements which the tractor can pull even under the most rugged conditions that might occur.This implies that under normal operating conditions all the power of the tractor will not be necessary, and some will be held in reserve.

Ploughs should have some type of releasing device which operates when the plough strikes a fixed object in the soil. In order to function properly, the releasing devices must be adequately lubricated and maintained.

When a harrow is being used the driver should not allow anyone else to ride on the tractor or harrow.

In rotary cultivators the rotary "mill" should be protected by a hood. The handles of the rotary cultivator should be long enough to allow the operator to stay clear of the danger zone.

In manure spreaders which are driven by a tractor power take-off shaft, all of the revolving shaft should be properly guarded. The operator should always disconnect the power take-off drive before working on any of the spreader mechanisms. Disengaging the drive is not an adequate safeguard, as it can be inadvertently re-engaged.

In seed drills, the seed-feeding device at the bottom of the seed box may cause injury to workers reaching into the box. To prevent such accidents the inside of the box should be equipped with grating, iron rods or a similar type of guard to prevent hands from coming into contact with the feeding device.

c) Harvesting machines

The cutter bar on harvesting machines is very dangerous and has caused many accidents. No one should stand in front of a cutter bar unless the animals are unharnessed or the engine has stopped. Children should not be allowed near a harvesting machine. Most power-driven mowers have cutter bars that can swing out of the way. The releasing device for this purpose should be inspected regularly and should be kept in good condition. During transport of a mower the cutter bar should be securely locked in an upright position and the blade should be well guarded.

With rotary cutters employing high speed shearing or shredding tools, the operator must be thoroughly protected from flying stones, debris or pieces knocked off the whirling tools, as any of these could cause serious injury. The guards should, as far as possible, be constructed so as to protect not only the operator but also people nearby.

With combines, belts, pulleys and protruding shafts should be protected on both sides of the machine. The driver's seat should be comfortable and should have protection against heat and bad weather. There should be a properly designed backrest and access to the seat should be free from hazards. For example, a sheet metal guard may be fitted behind the rungs of the access ladder to prevent a foot from coming into contact with moving parts.

d) Threshing machines

Although threshers have largely been superseded by combines, some are still in use. They have caused a great number of accidents, usually due to unprotected transmissions

and drums. All accessible belt lines and shafts should be fully guarded regardless of size and position. The belt lines should be guarded with hinged shields which are securely held in position when in use but which can easily be opened for removing or changing a belt. Threshers with the feed opening on the top of the machine may cause severe injuries when the opening is unguarded or inadequately guarded. Grain fragments flying out of machinery and may cause eye injuries to the operator or other workers nearby. Workers exposed to such hazards should wear eye protection.

e) Rakes

There are many kinds of rakes or haymaking machines. A rake pulled by an animal should be equipped with a guard protecting the driver's foot. It should also have a rail that prevents the driver from falling forward if the machine stops unexpectedly.

f) Balers

These have a number of moving parts which, if not adequately protected or safely positioned, constitute hazards. Feet have been crushed by the plunger, hands or arms squeezed by the needles, and other injuries caused by the crank or the transmission. To prevent hands or fingers from being squeezed when the needle is threaded, a strong shield should be mounted at the side of the needle as close to it as possible.

g) Fodder preparation machines

Many types of machines are used for this purpose. Their component tools are usually blades, pegs or hammers mounted on wheels or cylinders, all of which can cause injury when workers accidentally come into contact with them. Material should never be fed into the machine in by hand. A suitable feeding device such as a hammer should be used, and the device should be chained to the machine to prevent it from being removed.

h) Hammer mills

These run at very high speeds and therefore must be of sturdy construction. The cover should be strong enough to prevent broken parts of hammerheads and other heavy objects from flying off.

i) Other machines

Crosscutting log saws should be held to the same standards as those for circular woodworking saws. To hold the log securely a feeding appliance such as a swinging frame or roller table should be provided. Crosscutting saw blades and ripping-saw blades have different types of teeth; each should only be used for the type of work for which it is designed. General purpose saw blades are also available.

Wood-splitting machines should have a grooved table on which the wood can be placed for splitting. A screen or other device should be in place to retain flying pieces of wood.

A brush-cutting saw is equipped with a circular blade and has the same hazards associated with any other circular saw. Because it is carried around by the operator it is dangerous to other people nearby. The operator running the saw is responsible for making sure that nobody is too near. The minimum safe distance from the saw is 5 metres. It is difficult to fit satisfactory guards on a brush cutting saw, but a shield behind the blade is used as protection for the operator.

Rotary lawn mowers should always be adequately guarded to avoid the hazards associated with a rotating blade or with objects shot out by the knife.

Centrifuges should be fitted with an interlock device on the lid which prevents the machine from being started while the lid is open and prevents the lid from being opened before the drum has come to a stop. It is also essential that the drum not be run at speeds higher than that specified by the manufacturer.

Ventilating fans have high speed fan blades, which are almost as dangerous as rotating knives. If a blower or a ventilator must be situated so that the blades are within reach of the floor or are easily accessible, it should be entirely enclosed, preferably with stout wire netting.

j) Farm buildings

Farm buildings such as barns, silos and garages should be safe and healthy places. Among the dangers and unhealthy conditions that can be found in farm buildings are disorder, overcrowding, poor drainage, accumulation of rubbish, neglected walkways, insufficient headroom, poor ventilation, floors uneven and in bad repair, lack of fire precautions and unsafe stairs and ladders.

When new farm buildings are planned and constructed, consideration should be given to the following.

- Buildings should be sited to avoid having a line of buildings in the direction of the prevailing wind, which would facilitate the spread of fire.
- All buildings, whether permanent or temporary, should be structurally safe so as to be free from the risk of collapse. Wherever possible fire resistant materials should be used in the construction of buildings. Access to upper floors and elevated workplaces in buildings should be, as much as possible, be by means of stairs rather than ladders.
- Floors and other walkway surfaces should be firm, continuous and even; they should also be non-slippery.
- Ladder-ways, stairways, hatchways and other accessible floor openings should be guarded on all exposed sides by permanent or removable railings or covers.
- Adequate lighting and ventilation should be provided and also, when required, heating.

- There should be adequate toilet and washing facilities, which should be kept in a sanitary condition.
- Where applicable, there should be protection against lightning.

Education and training

General

One of the aims of an occupational safety programme is to protect workers from accidents in the workplace. Therefore, safety programmes should include education and training elements. Education and training in this section are used in the context of acquisition of knowledge and skills, respectively. It is usual to consider this as a process involving three stages: provision of information; change in attitude in the recipient; and alteration in behaviour. These stages must be kept in mind when considering a health education programme in the agricultural industry.

Such a programme should be at different educational levels. Those planning the programme should consult with those for whom the programme is aimed about the course content, which should deal with issues directly relevant to work problems. Separate courses should therefore be arranged for rural health physicians, primary health care workers and agricultural workers.

The prime objective of such educational courses should be the provision of knowledge and alteration of attitudes. In addition, both national and community programmes should be developed and introduced to reinforce the information given in training courses and to achieve changes in behaviour. Such programmes should be concerned with specific safety problems which have been found to be prevalent in agricultural work.

Hand tools

All workers should receive education and training in the tools they are to use and the way in which they should be used. Many accidents are caused by using defective or inadequate hand tools or by using hand tools incorrectly. Workers must be trained to inspect tools before use and to repair or withdraw defective tools. In addition, workers need to be trained to use the correct tool for the job. Workers also should be taught how to use the tools correctly and informed of the dangers of incorrect use.

Agricultural machinery

The more sophisticated the machinery to be used, the more important it is to ensure that the operator is adequately trained in its use. For training purposes the following basic safety guidelines for operating machines should be stressed.

- No person should operate machines without the guards in place, or make the guards inoperative.

- Equipment should not be adjusted, lubricated, or cleaned while in motion.
- Machinery that has been stopped for maintenance or repairs should be rendered inoperable until such work is completed.
- Only competent persons who have been given adequate instruction should be entrusted with independent operation of such machines.

Protective clothing and equipment

Workers need to be trained to wear clothing that is appropriate for the task to be done. It is unsafe, for example, for workers using machinery to wear loose clothing which may catch in machines. If special clothing or equipment is necessary for a specific job, this should be explained to the worker, who should then be trained in its use.

Personal protective equipment includes all devices and garments of various kinds which protect the wearer against injury or disease. Generally, personal protective equipment is regarded as a second line of defence. Every effort should be made to use the first line of defence, which is the elimination of hazards by means such as built-in safety mechanisms, guards or the use of interlocks. However, in some agricultural work the safety of workers may depend on the use of personal protective equipment. In such cases workers should be thoroughly instructed in the purpose, use and limitations of personal protective equipment; they should also be persuaded of the value of using it.

Protection for the head may entail the use of hard hats, which provide protection against falling objects such as rocks, branches or tools. Protection against splashes of pesticides and other agricultural chemicals requires a different type of protective clothing and equipment (see Chapter 3, Chemical hazards).

Respiratory protection is necessary in situations where there is a risk of exposure to toxic fumes, dusts or vapours or where there is an inadequate supply of oxygen. Protective equipment includes respirators (including chemical cartridge, respirators), gas masks and supplied air equipment, the latter being either of the hose–mask type or the self-contained type of air supply.

For hand and arm protection there are a wide variety of gloves and arm protectors; for body protection there are aprons, special overalls and other types of protector. Foot protection includes safety boots with steel toecaps and/or insteps. Protective clothing for workers engaged in handling, mixing and applying pesticides or other dangerous substances should have long sleeves and should cover as much of the body as possible.

Certain tasks in agriculture require people to work high above the ground. In such cases safety belts or harnesses with lifelines should be used. The same applies to work in confined spaces such as wells, in places where there is a danger from contaminated air or in places where workers risk being buried in loose materials.

All personal protective clothing should be properly maintained and cared for. It is desirable for all the items to be looked after by one responsible person; this will facilitate inspection, cleaning, sterilizing and repair as required. Since the type of clothing material used for clothing varies considerably, it is important that the manufacturer's advice and recommendations be followed carefully.

Materials handling

Many musculoskeletal disorders result from excessive demands placed on the musculoskeletal system during routine agricultural activities such as lifting, pushing or pulling. If mechanical aids cannot be used in this type of work, farm workers should be trained on how to avoid such injuries.

If the load is lifted with the back bent, the intervertebral discs (layers of fibrocartilage between the vertebrae) become distorted into a wedge shape and overload at one edge, which can cause back pain.

The more the upper part of the body leans forward, the greater the load borne by the back muscles and the discs. If, on the other hand, the load is lifted with the back straight, the trunk bends from the hip joint, the disks are not pushed out of shape, the load is distributed evenly and the strain on the back is minimal. When the upper part of the body is kept straight, heavy loads can be lifted safely. If the trunk is bent forward there is a danger of injury, even with small loads.

To lift or lower heavy objects, the following techniques should always be put into practice:

- upper body straight
- back flat
- load near the body
- firm grip
- unrestricted movement.

Incorrect pushing or pulling of heavy objects has resulted in many musculoskeletal disorders. The force that is required for pulling or pushing heavy objects depends on the degree of friction between the objects and the ground (floor) surface, foot slippage, point of contact, body weight of the worker and strength of arms and legs.

For pulling an object, the body position should be the same as when pulling on a rope. To push an object safely, the back should be straight and flat against the object, and the movement should be done primarily with the lower and upper leg muscles.

Some general guidelines for materials handling are given below [*9*].

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Safe material handling will assist in preventing strain and stress injuries to muscles, ligaments and spinal discs.

Key factors to be used when lifting, lowering or positioning loads are:

- Position feet correctly, apart, with one forward and one back to gain balance, i.e. stand close to or astride the load where possible.
- Bend knees: when lowering the hands in lifting and lowering. When removing from or placing loads on shelves allow the leg muscles to lift or take the weight.
- Keep arms close to body in all handling procedures. Do not reach out to lift or place loads, but position your feet close to the object to be handled. Where it is impossible to stand close to the load, draw it to the body in a sliding movement prior to handling.
- Secure grasp: should always be taken using forearms, wrist, hand and fingers (not fingertips) where necessary.
- Raise the head at the commencement of all lifting procedures.
- Pulling and pushing of loads should be carried out by thrusting with the strong leg muscles and using the body weight correctly.
- Remember, when handling loads, **DO NOT**
  - keep your feet together
  - bend your back
  - reach forward to lift or position loads
  - lift beyond your capacity
  - handle loads with the fingertips
  - twist your back when handling weight.

Many accidents occur in and around the home. Frequently these accidents result in temporary disability, preventing the worker from performing his regular job. These accidents may also result in permanent disability or death.

Some general situations that can cause injury to workers, loss of time and earning capacity are noted below. *They are preventable*. They include the following:

- Falls on a level surface
  - spills, including water
  - grease- coated or oil-coated floor surfaces
  - floor covering that is not slip-free
  - objects left on the floor

- Falls from heights
  - – leaning out to clean a window with loss of balance
  - – walking downstairs with view obstructed because of material that is being carried
  - – running downstairs
  - – slippery stairs
  - – reaching to the side of the ladder for repair work rather than moving the ladder to a safer position
  - – use of unsafe ladders or chairs, boxes or tables for reaching
  - – stairs that are cluttered with objects.

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Development of a variety of chemicals such as drugs, industrial chemicals, household products and pesticides has greatly improved overall quality of life, but at the same time has created problems, particularly when these products are misused. In agriculture, chemicals have become both indispensable and a cause of concern for the health of workers.

To understand and diminish harmful effects of chemicals, many countries and international organizations have developed sophisticated regulations and guidelines for assessing risk and preventing harmful effects for man, animals and the environment [*1,2*].

It is impossible to list all the chemical agents which are capable of causing harm to agricultural workers. However, only several among them usually cause acute poisoning, and these deserve particular attention.

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A pesticide is defined as any substance or mixture of substances intended for destroying, repelling or mitigating pests. The term pest describes harmful, destructive or troublesome insects, rodents, nematodes, fungus, weeds, other forms of terrestrial or aquatic plant or animal life or viruses, bacteria or other microorganisms, except those living in man or animals [*3*]. Pesticides also include any substance or mixture of substances inteneded for use as a plant regulator, defoliant or desiccant.

The essential component of a pesticide is the active ingredient, which may include both organic and inorganic chemicals as well as bacterial, viral and other living pathogens of variable composition and function. All pesticides are poisonous substances and the possibility of acute and chronic adverse effects on humans following exposure is an inherent feature of many of these compounds.

However, although the potential for causing harmful effects is unavoidable in the course of development of a pesticide, every effort is made to prevent those chemicals

having irreversible detrimental effects on man, such as carcinogenicity, mutagenicity, teratogenicity and delayed neuropathy, from entering the market [*2*,*4*]. Therefore, in this book attention will mostly focus on preventable acute or chronic effects of pesticides on man.

The hazards associated with the use of a chemical depend not only on inherent toxicity but also on the circumstances surrounding formulation and use, such as concentrations used, method of application, absorption, distribution, elimination and detoxication of toxicants. Even pesticides of low toxicity may cause poisoning if workers handle them without precaution and are subjected to prolonged exposure.

Pesticides are used in many fields, but their use in agriculture is very specific, and there are a number of features which should be taken into account when assessing the dangers of exposure for humans. The amount of pesticides used in agriculture far exceeds that in other fields; however, the application of these pesticides is mostly in open spaces, which greatly mitages the extent of exposure. On the other hand, the use of pesticides in greenhouses and livestock housing may be hazardous to those who apply them. Possibly the greatest hazard arises from the use of aerosols containing toxic substances. Therefore, it is imperative that special attention be given to all aspects of safety, particularly in certain weather conditions when wind may cause drifting of a pesticide, resulting in exposure of unprotected persons and edible crops.

In contrast to the use of pesticides in public health, their application in agriculture is mostly undertaken by individuals and is rarely supervised. Application of highly toxic compounds is not uncommon and use of a variety of compounds in sequence is a normal procedure. In addition, seasonal and often poorly-trained workers are frequently engaged in such operations.

&ODVVLILFDWLRQ

Pesticides are commonly classified according to the pest they control and may be grouped mainly as follows:

- defoliants
- fungicides
- herbicides
- larvicides
- molluscicides
- nematocides
- plant growth regulators
- repellants
- rodenticides.

These classifications do not mean that these chemicals act exclusively within their category, as they may have other effects as well.

Pesticides can also be classified according to chemical groups. This is useful for determining their effects on man and animal and formulating antidotes where necessary. Major chemical categories of pesticides include carbamates, organochlorines, organomercury compounds, organophosphates, pyrethroids and biological agents.

Pesticides may be further classified by formulation (e.g. liquids, solids). However, the most important classification is according to the mammalian toxicity of the active ingredient. The most common classification of biologically active materials is into five groups according to oral median lethal dose value (LD_{50}), a statistical estimate of the number of mg of toxicant per kg of bodyweight required to kill 50% of a large population of test animals. However, this has proved inadequate because it reflects merely the innate toxicity of the active ingredient rather than the actual hazard posed by the pesticide. In recognition of the need to introduce a uniform classification system according to hazard, in 1975 the Twenty-eighth World Health Assembly adopted a classification for pesticides by hazard and recommended its use to Member States of WHO [*6*]. Provision has been made for the classification of a particular compound to be adjusted if, for any reason, the actual hazard to humans differs from that indicated by LD_{50} assessment alone. The classification distinguishes between more and less hazardous forms of each pesticide in that it is based on the toxicity of the technical compound and its formulations. In particular it takes into account the physical state of the pesticide preparation, differentiating lesser hazards from solids as compared with liquids. On this basis pesticides are classified as listed in Table 3.1.

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	LD_{50} for the rat (mg/kg body weight)			
	Oral		**Dermal**	
	Solids	**Liquids**	**Solids**	**Liquids**
,D ([WUHPHO KD]DUGRXV	RUGHUV	RUGHUV	RUGHUV	RUGHUV
,E +LJKO KD]DUGRXV				
,, 0RGHUDWHO KD]DUGRXV				
,,, 6OLJKWO KD]DUGRXV	2 YHU	2 YHU	2 YHU	2 YHU

Note. The terms “solids” and “liquids” refer to the physical state of the product or formulation

(IIHFWRI SHVWLFLGHV RQ KXP DQV

General

Although each active material in a pesticide preparation has a specific mode of action in mammals, most of these compounds have enough chemical and/or biological similarities to allow grouping. Thus, for instance, all pesticides having the property of inhibiting cholinesterases, regardless of whether organophosphates or carbamates, are known as anticholinesterases.

Anticholinesterases

Anticholinesterases are frequently powerful poisons for both insects and mammals. The primary effect of anticholinesterase pesticides is the inhibition of an enzyme, acetylcholinesterase, in the nervous tissue, which leads to the accumulation of acetylcholine [*5*]. Acetylcholine is an important chemical mediator of nerve impulse transmission and is found in synapses of the central nervous system, at various nerve junctions in the autonomic nervous system and in nerve endings of myelinated and parasympathetic nerves (motor endplates, glands, smooth muscles). Acetylcholinesterase and its substrate, acetylcholine, are in a delicate state of balance; if this balance is disturbed, complex nervous system functions no longer function normally. An excess of acetylcholine in the nervous tissue stimulates acetylcholine receptors longer than needed, impairing nerve impulse transmission and causing disturbance in cholinergic neuroeffector junctions (glands, smooth muscles, skeletal myoneural junctions) and in the brain.

The affinity of anticholinesterase compounds for acetylcholinesterase is based on their similarity to acetylcholine. Thus, the extent and duration of their inhibition of acetylcholinesterase vary from one class of compounds to another. In general, the higher the affinity the more toxic the compound and the longer the duration of enzyme inactivity, the longer the duration of clinical signs and symptoms.

There are two main groups of anticholinesterase pesticides, organophosphorus compounds and methyl carbamates. Organophosphorus compounds can be grouped into two categories: those which can act on cholinesterases directly without being changed, and those which first have to be transformed in the body and are therefore called indirect inhibitors. This difference is of great importance in the assessment of the hazard. After overexposure to direct inhibitors, signs and symptoms usually appear fairly quickly; indirect inhibitors produce a delayed and prolonged action, and when symptoms finally appear, although exposure might have ceased, they may develop further to cause a critical illness.

Carbamate insecticides are all direct inhibitors of cholinesterases. As a rule they are readily absorbed from the intestines, rapidly metabolized and rapidly excreted. The

inhibition of the enzyme by carbamates is very short, hardly exceeding several hours. Therefore, the symptoms of carbonate poisoning, although they may be more severe at onset, are shorter in duration than those of poisoning by organophosphorus compounds, many of which are indirect inhibitors.

Organochlorines

Organochlorine pesticides are more persistent in the environment than most other synthetic organic pesticides. Because of this fact and the frequent resistance of pests against this class of compounds, the use of these pesticides is steadily decreasing. They are efficiently absorbed from the gastrointestinal tract, but some are also readily absorbed through the skin [*7*].

Although the mechanism of action is not yet fully understood the major toxic action of this group of chemicals is on the nervous system, both the central and the peripheral. Some organochlorine insecticides also bring about a great increase in the activity of liver enzymes responsible for the metabolism of foreign compounds. Enhanced enzyme activity may result in either increased protection or increased toxicity, depending on what compounds are present.

Many of these pesticides or their degradation products are soluble in fat and can remain stored in body fat, apparently without effect. Generally, organochlorine compounds are much less toxic organophosphorus counterparts; however, their long persistence both in humans and in the environment is of public concern since in certain situations they may pose a health problem. In view of the extreme ranges of toxicity (i.e. DDT and endrin), it is dangerous to generalize.

On the basis of available data, a WHO study group has recommended the exposure limit for organochlorines as 20 mg/1 of blood plasma at the end of a working day [*1*].

Pyridyl derivatives

Paraquat is the best known and toxicologically the most important representative of this group of chemicals. At present this compound is widely used as a broad spectrum herbicide. Biologically it is very active, and in mammals the most striking pathological change observed is widespread cellular proliferation in the lungs regardless of the route of entry. Although ingested paraquat produces early and transient damage of the pharyngeal and gastrointestinal mucosa, the onset of serious pulmonary impairment is usually delayed up to two weeks and is sometimes not easily connected with the accident. However, from the occupational point of view, the most likely route of absorption is through the skin. In this case it also affects the lungs.

Nitrophenol and chlorophenols

Among dinitro compounds the most toxic is dinitro-orthocresol (DNOC), applied mostly as a winter wash for fruit trees. This and similar compounds are readily absorbed through the skin and gastrointestinal tract, and act as strong metabolic stimulators, having a common biochemical mode of action which affects energy formation at the cellular level, stimulating metabolic processes independently of the thyroid gland [*7*].

Increased basal metabolism leads to pyrexia, tachycardia, hyperventilation and dehydration, and ultimately depletes carbohydrate and fat stores. In the case of a single large exposure, symptoms develop rapidly; if death occurs, it generally takes place within 24–48 hours, with characteristically rapid onset of rigor mortis. High ambient temperatures may aggravate the hazards from exposure. In nonfatal cases recovery is complete, but the skin is stained yellow for an extended period.

Pyrethrins and synthetic pyrethroids

Pyrethrum is one of the oldest natural insecticides in use in the world today and has the best safety record among all insecticides. It is a mixture of several esters called pyrethrins, which are extracted from flowers belonging to the genus *Chrysanthemum*. Despite their long history of usage, their biological mechanism of action is not yet fully understood. Natural pyrethrins are unstable when exposed to light and therefore are not suitable for residual application, particularly in agriculture. This instability, along with a shortage of natural products, has led to the development of several classes of synthetic pyrethroid compounds which have high stability when exposed to light and high insecticidal activity.

The acute mammalian toxicity of most synthetic pyrethyroids is very low. However, due to the poor solubility of pyrethyroids in water, various solvents are used in toxicity testing, and these may produce markedly different results. It is known that the rapid metabolism of pyrethyroids in mammals accounts at least partly for the relatively low toxicity of most pyrethyroids.

Pyrethyroids are known to act on the nervous system. Among the limited number of pyrethyroids that have been tested there exist at least two distinct types: one acting mainly on the peripheral nervous system and the other acting on the central nervous system [*8*]. Convulsions have been seen in experimental animals and are almost certainly caused by action on the central nervous system.

Anticoagulants

Coumarin anticoagulants are widely used for controlling rodents. This group of chemicals has replaced several very toxic rodenticides and is generally considered to be safer for humans. The biological made of action of these chemicals is based on the

disruption of the coagulation mechanism through inhibiting the synthesis of prothrombin. After repeated ingestion by humans for several days, symptoms may include bleeding from the nose and intestine and blood in the urine.

A newer, stronger class of anticoagulant rodenticides does not require repeated ingestion to produce these symptoms in humans, and this may considerably increase the risk to exposed workers.

Fumigants

Fumigants are commonly used in large grain and food stores, disinfestation of bulk carriers, in farms for treatment of buildings, as soil fumigants and in greenhouses. The most frequently used and most toxic are methyl bromide, chlorpicrin, phosphine and cyanides. Due to their high volatility and high toxicity their application should be entrusted only to highly qualified and appropriately protected professionals.

Methyl bromide is biologically very active and its mode of action is not fully understood. It becomes attached to various protein molecules through sulfydryl groups, and interferes with a number of enzyme functions [*9*]. Inhalation results in pulmonary oedema and disorders of the central nervous system. Locally, it may produce burns of the skin.

Chlorpicrin is a powerful irritant that affects all surfaces with which it comes into contact. Since it produces strong irritation of the eyes, protection is needed even at a very low concentration in the air.

Phosphine affects primarily the gastrointestinal tract and central nervous system, causing nausea, vomiting and diarrhoea followed by convulsions and coma if a sufficient amount is inhaled [*2*]. The symptoms appear within 24 hours after exposure.

Cyanides which originate from hydrogen cyanide are readily absorbed into blood even through wet body surfaces. They prevent the transfer of oxygen from haemoglobin to the cells impairing energy metabolism. The action of cyanides is extremely fast, so that cellular asphyxia appears within minutes after exposure [*3*].

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Regulations

Pesticide poisonings can occur at all stages of the pesticide life cycle, from synthesis to usage and disposal. Most countries in the world now exercise some form of official regulation over the testing, production, formulation, transportation, marketing, disposal and use of pesticides, with international uniformity being encouraged and guided by WHO, the Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP) and similar bodies. Nevertheless, disparities

persist. In some countries these regulations are statutory; elsewhere they may be voluntary. Moreover, even where legislation exists its enforcement may be difficult, and in some countries numerous preventable poisonings occur daily despite good regulations. In general, cases of pesticide poisoning that are not associated with violation of precautionary measures are extremely rare.

Handling

Improper handling of pesticides will increase exposure risk regardless of how hazardous they may be. Handling concentrates requires particular care, and in the case of pesticides of moderate and high toxicity special protective equipment should be worn. Thus all workers (e.g. mixers, loaders, baggers) handling concentrates should wear rubber boots, impermeable aprons and rubber gloves, in addition to other general protective clothing such as long-sleeved shirts.

Opening containers, weighing and mixing the pesticide concentrates of high toxicity may require wearing special respirators. Once the material is diluted, general protective clothing (overalls, canvas shoes and hat) provide sufficient protection in most instances. The spray base (powder or concentrate) should be mixed carefully in a special container, first making a paste or emulsion by adding small quantities of water and then continuously mixing with a paddle, adding water as necessary. The mixture then should be poured through a strainer (to avoid blocking of the nozzles by clumps of material) into a sprayer tank, which should be filled to no more than 75% of its volume.

Workers carrying manual or power-operated sprayers on their shoulders are at risk of contaminating their backs. A piece of impervious material can be placed between the sprayer and the worker's back to provide protection. The material should be washed whenever soiled; however soiling can be largely avoided by checking the equipment for leaks.

Ambient temperature should be taken into account when planning spraying activities. For instance, it is recommended that dinintro-orthocresol not be used, particularly in greenhouses, when the ambient temperature exceeds 21°C.

Distribution and transportation

In many countries pesticides are treated as poisonous chemicals and their distribution and transport regulated by corresponding legislation. Thus in many countries the distribution of the pesticides belonging to WHO classes Ia and Ib is restricted only to those suitably qualified and registered with a competent authority.

The pesticide purchaser should be either known to the seller or should be able to produce identification. It is advisable that a register of sales be kept. Restrictions should be made on distribution of pesticide preparations to mentally handicapped persons or to those known to abuse alcohol.

Pesticides should always be distributed in the original packaging in order to avoid accidental poisoning. They should be transported only in suitable vehicles, guaranteeing the safety of the driver, other users of the vehicle and the general public. For this, it is essential that pesticides never be carried in the same vehicle or in the same compartment as food, especially highly absorbent food such as flour, sugar, etc.

Any pesticide spillage during transport should be considered an emergency requiring prompt and adequate decontamination, including clean-up and disposal of damaged or leaking containers.

Storage

If not stored adequately pesticides may deteriorate, resulting in financial loss for the owner. In some instances a more toxic product may be formed during the storage period. To diminish storage problems, only amounts sufficient to satisfy requirements in the immediate future should be ordered.

Pesticides should always be provided with separate storage. If large quantities of pesticides are involved, a separate building should be used for this purpose. For smaller quantities a self-contained section of a building may be used. The storage area should be located as far as feasible from domestic buildings, on land which is not prone to flooding, and if possible should be fire-proof with a concrete floor. It should be secured by a lock, the keys of which should be entrusted to only one responsible person. An adequate register of supplies in and out of storage should be maintained and steps taken to ensure that the oldest consignments of pesticides are used first.

Disposal

The safe disposal of unwanted pesticides and containers has grown more problematic with the introduction of synthetic and highly toxic compounds. Although a limited number of products are still commercially available in large returnable metal containers, this tends now to be the exception rather than the rule. Most pesticides are packed in non-returnable containers which become the property and responsibility of the purchaser. Some containers are attractive in shape and construction and may present a great hazard if misused. Each year, preventable poisoning outbreaks occur when people use such containers for food or water. It is very difficult to clean out a container adequately to make it safe for such use.

Before disposal, containers should be thoroughly emptied and then rinsed at least three times. The rinsings should be emptied into a spray tank to be used subsequently. Once the pesticide container has been rinsed it should be kept in a separate area to await disposal. This empty container enclosure should be properly delineated and kept under cover, away from unauthorized persons. Combustible material should be collected and stored in a waterproof container in the enclosure until burned.

Metal containers should be rinsed, perforated and flattened. Glass containers should be crushed. The remains should then be buried in an isolated but identifiable sites, away from water sources and out of flood zones, and covered with at least 50 cm of soil. Paper or plastic containers should be burnt in a furnace or in an open controlled area unless they have held certain chemicals which could explode or generate highly noxious fumes on ignition, in which case this information should appear on the label of the container.

Disposal of unwanted pesticides presents an even greater problem. It should be first considered whether the pesticide can be used for any of its recommended purposes. Pesticide surpluses can be avoided by ordering and using optimum pack sizes for a particular pest control operation and mixing only the required amount of ready-to-use material. Small quantities of unwanted pesticides may be disposed of in high dilution using dry disposal pits, located away from water sources. These disposal pits are also needed for disposal of other contaminated solids or liquids. The hole should be 50–80 cm deep, and at least 100 m away from water source. Water used for washing hands, cloth and equipment should also be poured into this pit. As soon as most of the water has soaked away, the pit should be filled. However, if water is in short supply, or if for any reason it is impossible to dig such a pit, the washings from one day can be used for pesticide dilutions on the next working day, assuming that the same pesticide is being applied. This water should be treated as a pesticide and containers should be clearly marked.

Large quantities of unusable pesticides may accumulate over several years due to inappropriate planning, late delivery, poor storage practices, etc. Their disposal may create problems for local authorities. The following measures may be considered.

- If possible, return the material to the supplier (formulating plant or manufacturer).
- Bury the material is an abandoned mining pit or cave, ensuring that unauthorized persons are unable to enter it.
- Bury the material in a big hole far away from both surface and underground water sources, placing layers of pesticide containers (drums, boxes, sacks) alternatively with 20 cm layers of caustic soda or lime. The top layer should consist of the latter and should be covered with 50 cm of soil. Protective equipment (including gloves) should be worn by workers during this process.

Personal protection

Personal protective equipment, when carefully selected, used and cared for, is a vital element of good practice in handling, mixing and applying pesticides and can minimize or eliminate a possible hazard. However, although the use of protective clothing and other safety devices offers considerable protection, it does not eliminate the necessity for other precautions.

Unfortunately, protective clothing and equipment that are cheap, effective, flexible and do not impede work are not available. Truly impregnable materials are usually thick, heavy, uncomfortable to wear and expensive. They may prove insufferable under hot and humid conditions, and it may be tempting to dispense with them. At the same time, wearing the wrong protective clothing or being careless in its maintenance and decontamination can increase rather than reduce the hazard.

The amount and type of protection needed are governed by the properties of the pesticide to be used, in particular its toxicity, concentration and formulation. Not all pesticides or techniques require the same degree of personal protection. The degree and duration of exposure as well as the technique of application should determine the utilization of the protective equipment. It is unwise to exaggerate the amount of protective equipment or to neglect the essential items.

All protective equipment, including clothing, hats, gloves, boots, aprons and face shields, should be thoroughly and regularly washed with soap and water. For work with pesticides in the moderate to high hazard class, a spare set of clothing should be available for each worker so that the worker can wear fresh clothes each day. This set should also be available as a spare in the event that pesticide is spilled on the clothing while it is worn by the worker.

Cotton overalls with long sleeves buttoned at the wrist constitute the minimum basic protection for every type of work with a pesticide. Light, comfortable overalls without pockets are preferred. Overalls should be removed at the end of the working day and washed regularly. Overalls soiled with pesticides should never be worn outside of work.

Chemically impermeable gloves are an essential part of personal protection. In many operations, such as mixing of concentrates, wearing gloves is mandatory. If there is no pesticide on the skin before gloves are put on and if the gloves are truly chemically impermeable, they will offer excellent protection.

Rubber or plastic boots should be used when handling concentrates and when working with highly toxic pesticides. Boots should be washed outside and inside. Overalls should be worn over the boots.

Face shields of transparent plastic which do not restrict vision or breathing are preferable to goggles. They must be light and comfortable so that they are not discarded by the operators. They should be washed with water at frequent intervals so that visibility is not affected.

A hat with wide brim is an essential personal protective item as it offers very good protection of head, shoulders and face when spraying pesticides. It should be washable and made of a light material.

An apron must be used whenever a concentrate is handled. When mixing an insecticide, a rubber apron of appropriate length should be used and should be washed at the end of the working day or whenever soiled with a concentrate.

A face mask, preferably disposable paper or gauze, is required for some types of pesticide application because it easily traps small droplets, preventing them from reaching the nose or the mouth. Masks should be changed several times during the working day.

A respirator is needed only in certain conditions, mainly during fumigation with highly toxic pesticides. In these instances it is important to follow instructions closely regarding the type and effective life of a canister or filter. It is equally important to adjust the equipment to fit the individual wearer.

Medical surveillance of pesticide workers

Consideration should be given to organizing a programme of pre-employment screening and periodic surveillance under the supervision of a physician, who will decide whether a person is fit for working with pesticides. The purpose of a pre-employment medical examination is to detect pre-existing conditions that might place the exposed worker at increased risk. In addition, it is important for establishing a baseline for future health monitoring. In the pre-employment examination it is prudent to exclude from any pesticide operation all juvenile and aged persons, pregnant women and nursing mothers, persons with psychiatric disorders, substance abusers and those incapable of undertaking significant physical exertion. Workers having abrasions of the skin in places likely to be exposed to pesticides should not be permitted to work with them. In all workers who are expected to work with anticholinesterase at any time, a pre-employment determination of blood cholinesterase activity is essential for obtaining pre-exposure reference values [*10*].

Rural physicians have a role to play in education and supervision of safe use of pesticides. In continuing medical supervision, the physician must be alert to the signs and symptoms specific to poisoning by a given pesticide.

Protection of other people

Whenever pesticide application is initiated, care should be taken that all unauthorized people are kept far from the area of application. This includes waiting for a specified interval of time after application, which may vary according to the type of crop and the type of the pesticide. In determining this interval, national regulations should be observed; where these do not exist, standard guidelines should be followed.

It is important to ensure that harvested crops do not contain pesticide residues harmful to the humans or animals who eat the crops. This can be achieved by using the pesticides in strict accordance with good agricultural practice [*11*]. This relates

particularly to the observance of established rules for the minimum interval between the last application of a pesticide and the harvesting of the crop to which the pesticide was applied.

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General

Some pesticides may produce characteristic symptoms that are readily diagnosed. However, in some cases diagnosis is difficult, particularly if unconnected with exposure. In the absence of clear evidence of exposure, illness is sometimes attributed to a pesticide solely on the basis of a clinical picture, which may or may not be unequivocal. Chronic poisoning is usually understood as an effect produced by small doses of a given pesticide absorbed over a prolonged period of a time.

The management of poisoning includes three essential procedures:

- alleviation of life-threatening effects
- removal of non-absorbed material
- provision of antidotal or supportive treatment.

Delay in the prompt initiation of treatment can prove fatal. Rapid implementation of first-aid measures, removal of the source of contamination and transport to a hospital, if indicated, may save a life.

The sequence of procedures which should be strictly observed is as follows:

1. Check respiration and made sure that the airway is clear.
2. Give artificial respiration if spontaneous breathing is inadequate.
3. Check need for decontamination and proceed if required.
4. Give antidote if available.
5. Collect evidence of exposure (e.g. empty containers, labels).
6. Transport to a medical care facility.

Emergency treatment in the field should be directed first towards alleviation of life-threatening effects. All efforts should be made to maintain normal respiration and a prerequisite for this is a clear airway. In cases of severe poisoning, the victim may be unconscious. The mouth and pharynx should be cleaned with a cloth or finger, or by suction in hospital, and the airway should be kept free. Any dentures or other objects in the mouth should be removed. The jaw should be supported and the patient placed in a prone position with head down and to one side and the tongue drawn forward. If spontaneous respiration is poor, artificial respiration should be started at once,

particularly if the patient becomes cyanotic. The cyanotic patient should not be transported unless artificial respiration can be applied during transport. Mouth-to-mouth respiration should be given through a cloth (except if cyanide has been swallowed).

Contamination of the eyes with an insecticide is also considered an emergency, and treatment should start in the field. Eyes should be irrigated immediately with a stream of water for at least 10 minutes while gently separating the lower and upper lids.

The worker suspected of being poisoned should not be allowed to drive a car even if the worker appears recovered; it is not possible to judge the severity of poisoning by the initial symptoms. Once poisoning is suspected, someone should stay with the patient until medical treatment is received.

Treatment of poisoning in a health centre is mainly supportive and symptomatic, since very few specific antidotes are available. Serious cases of poisoning should be admitted to intensive care units, where these exist, as such patients frequently need artificial respiration and close monitoring. In addition some patients may require acid–base regulation and water and salt repletion. Monitoring and prevention of cardiovascular, liver and kidney dysfunction and proper tissue oxygenation may save the patient's life. In intensive care units, persistent convulsions will be easier to control.

Large amounts of pesticides may be present in the intestine or on the skin, from which absorption may continue for days. If intoxication occurred orally and the patient is conscious, vomiting should be induced (e.g. by giving a teaspoon full of syrup of ipecac, followed by a glass of water). This manoeuvre should never be carried out an unconscious or semi-conscious patient, or on one who has difficulty in swallowing. Activated charcoal given by mouth may be useful to absorb what is left in the gastrointestinal tract, but only if it is given within an hour after ingestion of the poison.

If the clothing is contaminated with insecticide, or with insecticide-containing vomit, it should be removed at once. The exposed areas of the skin (hands, arms, face, neck and the parts covered by heavily contaminated clothing) should be thoroughly washed with soap and water. In an emergency, if no clean water is available then any source of water should be used.

If several active ingredients are mixed in the product believed to have caused the poisoning, treatment should target the most toxic ingredient or the ingredient present in highest concentrations, according to the predominant symptoms and signs.

Anticholinesterases

Following a single overdose, symptoms of poisoning generally occur soon after exposure, i.e. within 30 minutes after inhalation or within one hour after ingestion. There is a delay of at least 2–3 hours if the pesticide enters the body through the skin. Certain organophosphorus compounds are prone to storage in fatty tissue, which postpones the

occurrence of symptoms because the stored active material is released into circulation slowly. The onset of symptoms can be delayed for 24 hours or more following exposure to such compounds.

The first symptoms of intoxication are usually nausea, headache, exhaustion and weakness, often with mental confusion and loss of muscle coordination. Gradually headache, muscular weakness and fatigue become worse. Vomiting, abdominal cramping with diarrhoea, excessive sweating and salivation soon follow. One or both pupils may constrict due to a local effect following absorption through the eye mucosa, but this cannot be taken as a leading sign of systemic poisoning. However, blurred vision, caused by the affection of the ciliary body, is highly indicative of poisoning. As poisoning progresses, muscular twitching (fasciculation) begins in the eyelids and tongue and gradually involve other muscles. Tremor may also be present. Bronchial hypersecretion with broncho-constriction is a very typical sign of poisoning. At a later stage, pulmonary oedema may develop. In severe cases of poisoning paralysis may occur, and unconsciousness with convulsions may precede respiratory depression and, ultimately, coma and respiratory failure.

The onset and severity of signs and symptoms depend on both the rate and the degree of acetylcholinesterase inhibition. In the case of relatively rapid inhibition (within 30 minutes) signs and symptoms usually appear when the enzyme activity decreases to about 30% of pre-exposure activity [*12*].

Since headache and dizziness are almost invariably signs of poisoning, any of these signs appearing together with nausea, diarrhoea or increased perspiration within 24 hours of work with organophosphorus compounds should not be disregarded and should be brought to the attention of a medical professional.

Poisoning with organophosphates causes acute episodes in which the patient may either die or be well on the road to recovery by the time 24 hours have elapsed. There is no evidence of any residual effect of acute poisoning by organophosphate pesticides, with the exception of possible complications caused by lung oedema or hypoxia.

Basically, the symptoms of carbamate poisoning are indistinguishable from those found in patients overexposed to organophosphorus compounds. This is because carbamates also inhibit cholinesterase at nervous synapses. Some differences do exist, but these are more connected with prognosis and therapeutic procedures than with clinical signs and symptoms.

As a rule, signs and symptoms (headache, dizziness, nausea, vomiting, blurred vision, increased sweating, hyper-salivation, tremor, fasciculation, etc.) will appear more rapidly after overexposure to carbamates than after exposure to organophosphorus compounds. Since carbamates are readily absorbed and distributed in the body, and fairly quickly inhibit cholinesterases, the first symptoms occur soon after exposure. Since

headache usually is the first symptom, discomfort often makes the worker stop working, and therefore exposure ceases. In this case, further symptoms or signs do not develop at all, and the worker recovers completely within several hours. Because of this characteristic of carbamates, they are known as having a "built-in" warning system. However, if exposure is protracted or excessive most cholinergic symptoms, even the very pronounced, will develop very soon. Symptoms similar to those observed with organophosphorus compounds will develop fully but tend to disappear within a few hours, never lasting more than 24 hours. Treatment is needed, however, if symptoms are very pronounced or if there is a threat to the patient's life.

In cases of serious poisoning with anticholinesterase insecticides, atropine is the drug of choice, and should be given as soon as possible. As soon as the diagnosis of anticholinesterase poisoning is made, a first injection of 2–4 mg of atropine sulfate should be given intramuscularly, or intravenously in severe cases. Atropine intramuscular injections should be repeated as required until recovery or atropinization occurs (pulse rate over 140 beats per minute, dry mouth, flushing). The effects of intravenous atropine injection begin within 3–4 minutes and are maximal about 8 minutes after injection.

Atropine must be administered by injection. Whether non-medical personnel are to be entrusted with administering the atropine should depend on local circumstances. Automatic injectors loaded with atropine for intramuscular administration are available commercially.

After administration of atropine the patient must be kept under medical observation until symptom-free for at least 24 hours, as symptoms may recur and repeated injections are often required.

In cases of severe poisoning by anticholinesterases, the patient's breathing should be monitored carefully as it may stop suddenly. At the first sign of respiratory failure, artificial respiration should be started and should continue for as long as necessary.

Organochlorines

Acute poisoning after a short exposure to organochlorine compounds is extremely rare, unless the exposure is massive, or unless the compound is accidentally ingested. The only known action of this group of insecticides in cases of acute poisoning is on the nervous system, therefore the symptoms of overexposure reflect nervous system dysfunction. Rapid onset of signs and symptoms and rapid return to normal is very typical among those who survive.

Usually a few hours after ingestion, or following massive dermal absorption of highly toxic insecticides (endrin, aldrin) the following symptoms appear: apprehension and excitement with dizziness, headache, disorientation, vomiting, weakness, fibrillation

of skeletal muscles, tremors and epileptic convulsions. Typically convulsions, if they appear at all, do so suddenly and without warning, so that associated injuries such as bone fracture or tongue bites are not uncommon. Respiration is at first accelerated, but depression and apnoea supervene. This leads to cyanosis and may result in irreparable tissue damage.

Soon after ingestion, nausea and vomiting most commonly occur. However, all symptoms may be delayed for some hours, or even a day or two after exposure. This rather unspecific clinical picture may be even more confused in cases involving possible action of an organic solvent in which the active material of the insecticidal preparation is dissolved. When organochlorine insecticides are absorbed through the skin, apprehension, mental confusion and muscular twitching and tremors may be the only symptoms. Small doses of organochlorines may induce anoxeria.

Diagnosis can be confirmed by analysing blood or urine for a specific insecticide. However, the treatment should not depend on confirmatory tests. Detection of minute amounts of organochlorines in biological material does not indicate poisoning, merely exposure.

Workers poisoned with organochlorine insecticides should be transported to a hospital immediately due to the risk of convulsions. However, alleviation of immediate life-threatening effects and removal of nonabsorbed pesticide should be done without delay. In the case of convulsion, the patient's clothing should be loosened and something strong placed between his teeth to prevent the tongue from being bitten, and gentle restraint should be applied to the patient's limbs.

Although there is no specific antidote for poisoning with organochlorine pesticides, supportive and symtomatic treatment, including anticonvulsive therapy, may be life-saving. It is essential to establish a clear airway so that tissue oxygenation is maintained.

Pyridyl derivatives

In a concentrated form, pyridyl derivatives, particularly paraquat, act as a local irritant on mucous membranes and on the skin. Therefore splashes of concentrate left in contact with the skin or mucosa for any length of time cause irritation and inflammation. If corneal or conjunctival mucosa are affected, healing may be slow. However, the effect is typically superficial, even in severe cases, and recovery is usually complete.

Ingestion or inhalation also causes transient local effects. If large doses have been absorbed, signs of kidney and liver damage may appear. Pulmonary impairment may develop several days later, even without previous signs of local irritation.

Absorption of the bipyridyls though intact skin is limited, although fatal cases of poisoning have been recorded from occupational dermal exposure. Eye splashes require

immediate first aid irrigation followed by specific treatment prescribed by an ophthalmologist.

No antidotes presently exist, and any case of bipyridylium poisoning should be referred immediately to a hospital, where nonspecific supportive treatment can be initiated at once. Management of poisoning relies essentially on prevention of absorption and removal of absorbed bipyridylium from the body.

Oral administration of 1 litre of Fuller's earth (30%) or Bentonite (7%) should start immediately after swallowing of the poison and should be continued. In an emergency, use of common soil as an absorbent may be beneficial. Forced diuresis and any kind of haemodialysis are currently practised in order to eliminate the poison in an early stage. Administration of oxygen should be delayed as long as possible, since paraquat has greater toxicity in oxygenated lungs.

Nitrophenol and chlorophenols

Early symptoms of poisoning by nitro-and chlorophenolic compounds are fatigue, excessive and unusual sweating and thirst. Insomnia and weight loss occur in more protracted cases. The onset of acute poisoning is usually rapid and is signalled by a considerably increased body temperature, particularly in hot and humid weather. This is accompanied by nausea, restlessness, rapid respiration, increased heart rate and ultimately collapse [*13*].

No specific treatment is known for poisoning with these chemicals at the present time, and all that can be done is to apply general measures to address the symptoms as they arise. In the case of acute severe poisoning with nitro- and chlorophenolic compounds, it is essential for the patient to stay at absolute rest and as cool as possible (i.e. by means of cold compresses, ice, fan). Antipyretic drugs are ineffective.

Pyrethrins and synthetic pyrethroids

Since pyrethrins are insecticides of very low toxicity to mammals it is assumed that only high doses (above 15 g) may produce a serious hazard to adults. However, pyrethrum extract contains a common allergen and may cause contact dermatitis, mainly among workers handling raw material. Pyrethrins may be absorbed by ingestion, but skin penetration is unlikely. Symptoms, if they develop, would reflect stimulation of the central nervous system.

Synthetic pyrethroid compounds are a relatively new development and no cases of poisoning have been reported. There are several reports of laboratory and field workers who experienced transient periorbital sensations resembling that of a dental anaesthetic wearing off. This phenomenon is of short duration and requires no treatment.

Anticoagulants

Since anticoagulants are used solely in bait placed in inaccessible places, problems that may arise are primarily those of acute accidental or suicidal ingestion of contaminated food. Symptoms of poisoning occurring after repeated ingestion include bleeding from various sites. The principal diagnostic test for excessive repeated exposure to anticoagulants is markedly reduced prothrombin activity.

The mainstay of management of intoxication by conventional or second generation anticoagulant rodenticides is vitamin K_1 (phytomenadione), administered parenterally [*10*]. In severe cases of poisoning, transfusion of fresh blood or plasma is beneficial since in this way the missing clotting factors are quickly replaced. It has been shown that even 50 ml of cross-matched blood or plasma can be effective. If second generation anticoagulants are absorbed, repetitive therapy may be required since these chemicals are metabolized fairly slowly.

Fumigants

The risk of overexposure is present in all fumigation processes, with inhalation of vapours being the common route of entry of toxicants.

Methyl bromide, even in dangerous concentration, cannot be detected by smell or irritation. After small doses are absorbed, headache, loss of appetite and abdominal discomfort are the principal symptoms, and may be followed by disorders of the central nervous system. In more severe cases pulmonary oedema, delayed onset, is likely to develop and may prove fatal. There is no specific treatment. Rapid removal of methyl bromide from the skin will diminish its absorption. After inhalation, the patient must be kept at rest and under observation, preferably in the hospital.

Chlorpicrin, as a strong irritant, offers sufficient warning to avoid dangerous exposure. Irritative effects on the eye mucosa or in the respiratory tract should be treated symptomatically as no specific antidote exists.

Inhalation of phosphine causes nausea, abdominal pain, vomiting and diarrhoea. Possible delayed symptoms are related to disturbance of sensory organs (vertigo, hyperacusis). No specific diagnostic tests or specific therapy are available at present.

Cyanides, if absorbed in sufficient amounts, cause an immediate effect, with symptoms appearing within seconds of exposure. Dizziness, nausea, headache are typical initial symptoms and an experienced fumigation worker will recognize them easily. At this stage, a quick escape to fresh air will lead to full recovery. In more serious cases the patient becomes rapidly unconscious, breathing becomes rapid and immediate treatment is essential. The patient should be removed from the contaminated area. Nitrites should be administered at once (amyl nitrite by inhalation or sodium nitrite by injection), followed by an injection of sodium thiosulfate to counter the methaemoglobinaemia

produced by nitrities. Cobalt EDTA (kelocyanor) is an effective antidote when injected intravenously.

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By far the most hazardous fertilizer is anhydrous ammonia that has been contained under high pressure for application to soil. The alkali-generating properties of this gas render it extremely hazardous whenever it comes into contact with tissue. Anhydrous ammonia can cause burns of the cornea which are very likely to result in blindness. Injuries to the skin cause tissue damage similar to that produced by high temperatures, i.e. necrosis. An immediate supply of fresh water must be available at the work site to flush skin surfaces or eyes injured by anhydrous ammonia. This is the only measure that offers significant relief from tissue injury caused by anhydrous ammonia.

Workers using anhydrous ammonia tanks should take extraordinary care to avoid accidental breaks, leaks, and bursts of gas that occur when disconnecting at high pressure. Gloves should be worn when handling hoses, valves, and other mechanical parts where gas may escape. Goggles or a face shield are essential protection when making changes in hose connections or repairing the gas distribution system.

Solid nitrogen and phosphate fertilizers generally present little acute hazard to handlers although they are potentially serious pollutants of water supplies. Fertilizer run-off into wells may lead to high nitrate concentrations in water subsequently used by farmers and their families. These high nitrate concentrations may induce methaemoglobinaemia in humans consuming the water. Infants, in particular, are at higher risk because their metabolic potential for reversing methaemoglobinaemia is limited. Methaemoglobonaemia in infants is commonly known as “blue baby”. Proper well construction extending to a substantial depth represents the only practical protection from fertilizer pollution of well water.

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Substances commonly added to animal feed to enhance weight gain are of three classes: essential minerals, usually those in which the unfortified feed is deficient; antibiotics and antiparasitics, to suppress enteric organisms that compromise availability of nutrients to the animal; and hormones, to enhance metabolic conversion of absorbed nutrients to protein and fat.

It is unlikely that minerals or hormones are absorbed by exposed handlers in sufficient dosage to cause injury or illness. It is possible, however, that regular exposure to the many antibiotics given as feed additives modifies the spectra of natural respiratory and enteric flora of livestock workers to organisms that are resistant to antibiotic action.

This has the effect of exposing them to pathogens not readily controlled by antibiotics. However, there is no clear evidence that animal feed handlers are actually at additional risk as a result of this exposure.

Air filtering masks, if properly fitted, reduce inhalation exposure to dust formed from feed and feed additives. Disposable masks are available for this purpose and can provide reasonable protection to workers who must handle the feed regularly. Workers who become allergic to the dust should be assigned to other work.

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Several types of cleansing and disinfectant chemicals are used by dairies and food processing industries to ensure sanitary work sites. They include:

- alkaline salts, such as trisodium and disodium phosphate
- inorganic acids: phosphoric and hydrochloric acids
- organic acids: butyronic and citric acids
- chlorine-releasing substances
- phenols: ortho-phenylphenol
- iodine-releasing and quaternary ammonium compounds.

There is probably very limited dermal absorption of these highly ionic compounds. All are irritating to the skin, eyes and mucous membranes and some induce sensitization in a limited number of individuals. The iodine-releasing and quaternary ammonium compounds are most often implicated as sensitizers. Ingestion is likely to cause severe illness, mainly from corrosive effects on the gastrointestinal tract and injury to the liver and kidney.

Protective garments, gloves and face shields should be worn when using these compounds to minimize contact. Contaminated skin, eyes or mucous membranes should be flushed free of chemicals, using clean water, whenever accidental contamination occurs. There are no specific antidotes for poisonings and injuries by these compounds.

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Carbon monoxide (CO) causes many incidences of poisoning, a high percentage of which are fatal. Exhaust from internal combustion engines and space heating equipment is the most common source. Unfortunately, CO is colourless, odourless and nonirritating. For this reason, poisoning by it is usually insidious. Another feature of CO poisoning

which further increases the hazard of exposure is the depressing effect of the gas on mental processes: as poisoning increases in severity, the victim becomes less aware of the peril and less likely to escape from the hazardous environment.

Despite widespread knowledge about the hazards of operating internal combustion engine indoors, work facilities are still sometimes built without provision for disposal of exhaust gases. Equally hazardous are defects in once adequate exhaust systems which allow gases to leak into work areas.

Headache, dizziness, fatigue and mood changes among workers should arouse suspicion of CO intoxication, which causes impairment of oxygen transport to critical tissues, primarily the brain and heart muscle. Measurement of blood carboxyhaemoglobin concentration confirms CO poisoning, and can be used to measure severity. Treatment consists of removing the victim from the toxic environment, administration of 100% oxygen and, in cases of severe poisoning, cardiopulmonary resuscitation.

Protection against carbon monoxide poisoning has always depended mainly on education of the public and particularly of workers exposed to combustion effluents. Regular inspection of work sites for adequate exhaust systems and proper ventilation of work space is an important safeguard against poisoning.

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Petroleum products are widely used in agriculture. Various waste oils, including crankcase oil, kerosene and other fuel oils, are effective as non-specific contact herbicides. In addition, the active ingredients of most insecticides are commonly dissolved in petroleum distillates, then made into emulsions for application. All of these substances have the ability to cause dermatitis among exposed workers.

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Exposure to oxides of nitrogen may occur in high concentration in tower silos where nitrogen-rich silage has been stored. Carbohydrates in the silage produce acetic and lactic acids which combine with nitrites in the silage to produce nitrogen oxide (NO), nitrogen dioxide (NO_2) and carbon dioxide (CO_2). Both CO_2 and NO_2 are heavier than air and may be found in higher concentrations in cavities in the silage. NO_2 gas may also flow down the outer walls of the silo and fill unventilated spaces adjacent to the silo.

Farmers working around fresh silage must be aware of this serious hazard. With direct exposure to high gas concentrations in an unventilated silo, the worker may be overcome by NO_2 and CO_2 within two to three minutes. High concentrations of NO_2 may cause severe pulmonary injury resulting in pulmonary oedema. This specific disorder

has been referred to as silo-filler's disease. Without immediate and intensive medical treatment, such massive exposures will often result in death.

Prevention of silo-filler's disease depends upon recognition of the potential for massive NO_2 exposures. The silo should be adequately ventilated for at least 30 minutes prior to entry and workers should work in pairs and with a safety harness, entering the silo, if necessary, immediately following the last load and not after 24–48 hours, by which time NO_2 levels may be dangerously high.

Respirators may also be used but are expensive and usually necessary only for rescue operations. With attention to the preventive measures listed above, harmful exposure to NO_2 should not occur in a well informed agricultural worker.

$PSURUHG

With increasing use of anhydrous ammonia as a fertilizer for farm crops (see Fertilizers) comes increasing opportunities for spills of ammonia and acute exposure to ammonia gas among agricultural workers. Ammonia is a potent mucus membrane and respiratory irritant and causes conjunctivitis, rhinitis, pharyngitis and bronchitis at relatively low concentrations.

Workers frequently develop some tolerance to ammonia at low levels. Exposure to high concentrations of ammonia, however, which may occur with spills in confined spaces, can cause acute lung injury with pulmonary oedema. Vigorous and immediate medical attention must be provided in cases of exposure. Some workers who survive a major ammonia spill appear to progressively lose lung function over time.

Another source of ammonia exposure among agricultural workers is from liquid manure pits, which are increasingly being constructed underneath farm buildings in which livestock are confined. There has been a major shift towards animal confinement housing (poultry, swine and cattle) in the United States and other industrialized countries. Although this technology offers the advantage of industrial mass production and economy, it is also associated with occupational exposure to ammonia, hydrogen sulfide and respirable particulate (mainly grain dust and airborne faecal material containing high levels of endotoxins). This type of exposure is a strong irritatant to the respiratory system and results in a high prevalence of chronic bronchitis and asthma among those exposed. Because these confinement units are humid, absorption of ammonia onto respirable particulates is enhanced, which in turn allows ammonia-laden respirable particulates to penetrate distal lung cells.

Prevention of exposure to ammonia in agriculture is again dependent upon recognition of the potential risk. Therefore, whenever possible, working with ammonia tanks should be done only in well-ventilated areas. Similarly, adequate ventilation of

animal confinement units built over liquid manure pits can markedly reduce exposure. Alternatively, removal of the liquid manure pit to a location away from the work area will largely prevent this problem. Lastly, use of protective respiratory equipment will reduce, but not eliminate, exposure to ammonia gas and respirable particulates in animal confinement buildings.

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Exposure to methane gas (a fire and explosion hazard) and hydrogen sulfide gas in high concentrations has been documented when liquid manure pits, associated with animal confinement buildings, are agitated prior to pumping. Deaths have occurred among workers who have attempted to enter these pits to retrieve objects or to work on the pumping equipment. The cause of death in these instances has most commonly been from pulmonary oedema.

Prevention of acute toxic exposure to hydrogen sulfide gas in this agricultural setting is dependent on awareness of this serious hazard. Steps to be taken include avoiding entry of a confined space associated with liquid manure, using a safety harness, always working with a partner, and using a respirator if it is necessary to enter such an exposure area.

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Injuries and death due to snake-bite occur in most parts of the world, and especially in the tropics, where they may represent a real health problem. However, knowledge of their epidemiology is fragmentary, mainly due to lack of reliable statistical data.

Most snake-bites occur in rural areas, particularly in forests and fields. Snakes are generally most dangerous when they have been forced from their usual habitat by some natural event (flood or fire) or after a period of fasting when the venom has accumulated in the snake's glands due to inactivity. The site of the bite is often very painful with an intense burning sensation. The wound generally becomes discoloured due to subcutaneous extraction of blood and plasma. In addition there is oedema, which is a good prognostic indicator. The oedema can spread for up to 72 hours, but attains about 75% of maximum size by 12 hours. Final swelling of less than 3 cm in size, usually does not result in serious general phenomena; however, 30% of victims with a swelling of 4–8 cm are seriously poisoned, and all victims with a swelling of more than 8 cm in size have serious complications. The affected bite area may undergo necrosis in a small number of cases.

The generalized symptoms usually take a few hours to appear and initially include headache, vomiting and muscle spasms. Haematotoxic effects include haematuria, malaena, bleeding from the site of the bite, haemoptysis, haematemesis and haemorrhage of the vital organs. Neurotoxic effects include difficulty in speech, sommnolence, ataxia and muscle paralysis. Treatment consists of management of the site of the bite to prevent the spread of venom. This is usually done by the application of a light tourniquet so as to impede the flow of lymph while not impeding venous circulation. Suction can help in extraction of the venom from the site; however, in most bites the amount of venom injected is so great that suction cannot extract a sufficient amount and treatment with serum is still necessary. It should be stressed that preventive measures, tetanus vaccination and wound cleaning together with absorption delaying measures (immobilization, ice pack, abstention from alcohol) and the proper use of monovalent

and polyvalent serum, where existing and applicable, should be promoted. The most effective preventive measure for workers working in snake infested areas is to wear long trousers and boots.

$ UWKURSRGV

Insect stings usually produce one of two reactions: a local irritative reaction and an allergic reaction. The irritative reaction is due to the fluid injected by the insect, which is probably related to acetylcholine. The allergic reaction generally occurs as the result of sensitization from a previous sting, although sometimes reactions to subsequent stings are progressively weaker and natural immunity develops. The allergic reaction is usually caused by the protein fraction of the poison; however, pollen found on the stinger has also been incriminated in causing allergic reaction. The general symptoms of an allergic reaction may include headache, nausea, vomiting, dizziness, weakness, collapse and shock. The sooner such symptoms appear the more violent the reaction. If shock occurs it usually appears within five minutes of the sting.

In the case of an allergic reaction to an insect sting, treatment should be initiated immediately. The stinger should be extracted first, and if possible a light tourniquet should be applied above the point of the sting to minimize absorption of the poison. Local itching may be minimized by antihistamine creams, and appropriate medical therapy should be given depending on the severity of the reaction.

Prophylaxis consists of adequate desensitization of persons hypersensitive to insect stings. Desensitization is achieved by using a mixture of antigens to afford protection against a number of insects. This mixture should be given to persons who have suffered a general reaction as a result of an insect sting.

Spider bites are a relatively frequent occurrence. It is estimated that the average fatality from spider bites is approximately 4% and is particularly high among children. Death usually occurs within 12–24 hours after a bite, but it may be delayed up to a week. The poison often has a necrotic action, and may also act on the central and peripheral nervous system to cause muscle spasms. The black widow (*Latrodectus mactans*) is one of the most dangerous spiders; local symptoms from its bite include initial irritation at the site of the bite, developing later into severe pain which then spreads gradually. The severe pain is accompanied by muscle cramps, hypertension, nausea, vomiting, headache and sweating. These symptoms appear within a few hours, and may persist for several days if no specific treatment is available.

Scorpions do not attack human beings, but stings can occur due to accidental contact. The majority of scorpions produce a non-lethal poison, but several species of North African scorpions produce a neurotoxic poison which can be lethal. The sting from these species produces pain and a burning sensation in the wound, followed by general

neurotoxic effects. These symptoms appear early and last up to 48 hours. The victim usually becomes agitated and may experience epigastric pains and convulsions of the tonic type. The convulsions produced resemble those of strychnine poisoning and may be fatal if not treated in time. Localized treatment in the form of tourniquet and ice pack helps to delay absorption of the poison. The use of immune serum is the most promising specific therapy.

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The World Health Organization defines zoonoses as "those infections which are naturally transmitted between (other) vertebrate animals and humans" [*1*]. Patterns of disease transmission between humans and other animals are closely linked with the development of civilization and the domestication of animals. This section presents an overview of zoonotic diseases which have evolved as occupational diseases of agricultural workers.

An understanding of the epidemiology of zoonotic diseases is helpful to health officials, and can best be developed by examining the infectious agent as a part of the total environment, that is, by understanding the disease as part of an ecological system, or ecosystem. An ecosystem is a group of all plants and animals, their interactions, and the abiotic environment surrounding the organisms, in any given place at any specified time. With specific reference to disease, an ecosystem may be defined in a more limited way: a set of all vertebrate hosts; the invertebrate organisms, including infectious agents, that affect these hosts; the disease vectors; the abiotic environment that surrounds them all; and the interactions among the organisms and with the environment. Human activities encroach on disease cycles as they occur in the natural setting. Agricultural work is a specific type of activity that increases the risk for acquiring a zoonotic disease.

Risks for specific diseases vary with the particular type of animal production and geographical location [*2*]. For example, people who work with cattle are at risk for several infections, but risks for specific infections vary with the type of operation. Because of certain ecological factors, people working with dairy cows are particularly susceptible to milker's nodules, brucellosis, peptospirosis, Q fever and ringworm. People working with beef cattle, however, may be more at risk for rabies and leptospiroris. Those working with beef cattle in certain areas of Africa are at risk from Rift Valley fever. Agricultural workers who work among sheep are at risk from contagious ecthyma (orf) and infectious encephalomyelitis (louping ill).

Zoonoses are occupational hazards not only for people who raise and care for animals, but also for workers in agriculturally-related occupations who work with animals or animal products. Those at risk include veterinarians, packing plant workers,

poultry processing plant workers, rendering plant workers and hair and hide industry workers. These workers may contract diseases such as brucellosis, ornithosis, anthrax and contagious ecthyma [*3*].

Health officials can increase their ability to manage zoonotic diseases by consulting local practising veterinarians and veterinarians working for public health or agricultural sections of the government. Health officials must also develop an awareness of specific environments and agricultural activities typically responsible for contraction of these diseases.

The number of known zoonotic diseases is relatively large. Over 150 zoonoses have been identified worldwide, with at least 40 having significance as occupational diseases in agriculture [*4*]. Farmers in some regions of the world are at greater risk of contracting certain specific zoonoses as a result of consuming raw farm products such as raw milk from goats and cows infected with *Brucella melitensis* or *Mycobacterium bovis*. In some regions, human and animal excreta is used as manure for paddy fields, and may cause farmers to contract various parasitic infections.

Although exact numbers of zoonotic diseases occurring annually are not known, general trends in incidence can be traced. Zoonoses are responsible for widespread illness and death among humans, but is projected that the number of human cases of certain zoonoses, such as brucellosis and bovine tuberculosis, will continue to decrease in those countries having active control or eradication programmes. Vast epidemics are becoming less likely as countries continue to develop. However, natural or human-induced events that disturb ecological balances can have significant effects on disease patterns.

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In practical terms, zoonoses are best grouped according to the major population groups at risk (Table 4.1). Zoonoses most commonly occur where contact with animals is maximized.

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National plans and programmes for the control of specific zoonotic diseases must be established according to national priorities. The field measures for preventing or controlling zoonoses apply one or more of the following strategies:

- detection and treatment of cases in human beings
- interruption of the pathway of infection from animals to people
- interruption of the pathway of infection from wildlife to domestic animals
- interruption of person-to-person transmission.

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Occupational group	Infections
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- partial control, local or regional elimination of infection in its animal reservoir
- protection of areas free from specific zoonoses (including permanent defensive measures and emergency measures based on contingency plans).

National control programmes may vary from one country to another. It should be realized that the ultimate goal of a national programme is to control one or more of the zoonoses as required. The optimum objectives differ among programmes, but they broadly consist of:

- coordination of existing control activities in order to upgrade their functions and achievements
- establishment of surveillance programmes
- control of spread by animals
- control of spread by vehicles
- detection, prevention and treatment of disease in humans.

One of the simplest and most important components of the control programme is health education, particularly with regard to personal hygiene among high-risk groups. Two high-risk groups include livestock and poultry farmers and abattoir and meat processing plant workers.

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Prevalence

Ascariasis and hookworm infections are among the 10 most common infections in tropical countries. There are about one billion people infected with *Ascaris lumbricoides* and about 900 million infected with hookworms, either *Ancylostoma duodenal* or *Necator americanus*. Mortality due to hookworm anaemia in Africa, Asia and Latin America in 1997–1998 was estimated at between 50 000 and 60 000 cases per year; a further 20 000 cases in these regions die every year from ascariasis. These two major types of intestinal parasitosis are classified among 20 types of infection responsible for the highest global morbidity rates [*5*].

Ascariasis and hookworm infections are endemic among rural populations. However, epidemics may occur and very high prevalence rates may be observed around fields fertilized with raw sewage or in areas of intensive agricultural production where sanitation is deficient or night-soil is used as a fertilizer.

Hookworm anaemia was once well-known as "tunnel disease" in Europe, but disappeared when appropriate sanitary measures were introduced into working areas. Little information is available about the incidence of hookworm anaemia among agricultural workers, who can easily be exposed to polluted soil containing hookworm larvae, which are able to penetrate the skin. Hookworm infections are known to occur in some horticultural farms, and have been reported to be common among workers employed at plantations producing tea, coffee, mulberry leaves, sugar and cotton. The occupational character of hookworm infections seems to be overshadowed by high prevalence rates among rural populations as a whole.

Diagnosis and treatment

The diagnosis and treatment of ascariasis and hookworm infections is simple. Infections with adult worms can easily be identified by faecal examination. Anthelminthics such as pyrantel, mebendazole, albendazole amd levamisole are safe and highly effective in ascariasis. Treatment of hookworm infection requires higher doses of albendazole, mebendazole or pyrantel; treatment for hookworm anaemia should include supplementary therapy with iron. However, individual treatments do not contribute significantly to the control of these infections in communities or on plantations.

Control

Both ascariasis and hookworm infections can be controlled by sanitation and health education. In terms of sanitation, easy access to a toilet is important for work in the field.

Targeted chemotherapy on a segment of population most heavily infected can reduce the prevalence and intensity of infections in a short time. However, mass chemotherapy must be undertaken every 3 months for at least 3 years in order to achieve effective control of ascariasis in a given area.

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Prevalence

Endemic in 74 developing countries, schistosomiasis is also known as bilharzia, after its discoverer, Theodor Bilharz. There are three major types of this parasitic infection. Intestinal schistosomiasis caused by *Schistosoma mansoni* occurs in 52 countries in Africa, Middle East, Caribbean and South America. Intestinal schistosomiasis due to *S. japonicum*, or oriental schistosomiasis, is endemic in 8 countries in the WHO South-East Asia and Western Pacific regions. Urinary schistosomiasis caused by *S. haematobium* is endemic in 53 Member States in the WHO African and Eastern Mediterranean regions.

Schistosomiasis ranks among the most important health problems of agricultural workers in the tropics and the sub-tropics, and is recognized as second only to malaria in importance as a parasitic disease. Schistosomiasis is closely related to agricultural activities in all the 74 endemic countries. The majority of the 600 million people exposed to the risk of infection and the 200 million people infected are from rural agricultural communities.

Schistosomiasis is caused by people themselves. Humans contaminate the environment, causing infection in the snails, and then repeatedly reinfect themselves, families and neighbours in the course of daily activities involving contact with water, many of which are related to various agricultural practices.

Historically, schistosomiasis has been considered a major risk for agricultural workers and their families. New diagnostic techniques and effective, safe oral treatment, as well as an understanding of the dynamics of transmission and epidemiology, have modified the approach to its control. New drug treatments result in sustained low egg counts despite reinfection.

The epidemiology of schistosomiasis among countries varies widely, even in areas of endemicity [*6*]. Water resource development projects for irrigation and agricultural purposes can change an endemic area with seasonal and highly focal schistosomiasis transmission into one with intense, widespread and constant transmission.

Since the introduction of quantitative urine filtration techniques, a large body of data has become available from well-defined communities where *S. haematobium* is endemic. The peak incidence and intensity of infection generally occurs in children 10–14 years

of age. In general, 60%–70% of infected people are between 5 and 14 years of age; furthermore, about 75%–80% of people who have heavy infections (more than 50 eggs per 10 ml urine) are also in this age group.

Diagnosis and treatment

In children and adults, increasing levels of haematuria and proteinuria are associated with increasingly heavy *S. haematobium* infections. Cystoscopic, renographic and radiological changes of the urinary tract are associated with heavy infections in children.

There are now safe, effective and low-cost drugs available for treatment of all types of human schistosomiasis. Oral antischistosomal drugs, oxamniquine, praziquantel and metrifonate, are used on a large scale in most endemic countries, and treatment with these drugs is the first line of attack in schistosomiasis control programmes. These drugs can be used in endemic communities with medical supervision by paramedical personnel.

Oxamniquine is used exclusively to treat intestinal schistosomiasis in Africa and South America. Metrifonate has proven to be safe and effective for treatment of urinary schistosomiasis. Praziquantel is effective in a single oral dose against all forms of schistosomiasis.

Indiscriminate mass treatment for prophylaxis of populations in endemic areas is not recommended. Treatment of infected people is facilitated by simple low-cost microscopic detection techniques. The eggs of the parasite (*S. haematobium*) causing urinary schistosomiasis may be detected by filtration of urine through a plastic syringe filtration apparatus. In a small amount of faeces, the eggs of *S. mansoni* and *S. japonicum* can be observed microscopically under a cellophane film on a glass slide (Kato technique).

The prevalence of schistosomiasis in some agricultural irrigation schemes is proportional to the absence of latrines and sanitation. In *S. mansoni* endemic areas a small proportion (6%) of the infected population excretes at least 50% of the total number of eggs contaminating the environment. Most of these heavily infected persons are between 10 and 14 years of age. A high proportion of children with *S. mansoni* egg counts over 100 eggs per gram of faeces have enlarged livers and spleens. Heavy infections, such as those occuring among the canal cleaners of large irrigation systems or among the workers in sugar cane fields, can result in chronic and severe morbidity [*6–8*].

Individuals with heavy *S. japonicum* infections may also have enlarged livers or spleens. Central nervous systems involvement due to *S. japonicum* causes severe impairment.

Control

The strategy of morbidity reduction in schistosomiasis control endorsed by the WHO Expert Committee on the Control of Schistosomiasis offers a new approach to reducing the burden of schistosomiasis among agricultural workers.

- Health education. Health education is directed at raising awareness of people's role in schistosomiasis transmission.
- Diagnosis and treatment. New, low-cost drug treatment will result in elimination or reduction of worm burden, which will decrease the risk of development of disease.
- Water supply. Within the context of agricultural community development, water supplies should be kept separate from humans. Human contact with the water supply encourages contamination.
- Environmental management. This is an integral part of sound agricultural practices [*9*]. The agricultural worker can contribute to his own health by following guidelines for effective environmental management.
- Snail control. The only available means of achieving control of transmission is reduction or elimination of the snail host by molluscicide. The use of niclosamide requires specialized personnel for repeated applications. Chemotherapy may be supported by snail control but the cost of the latter must be carefully weighed.
- Health centres. Diagnosis and treatment of all incoming workers and their families should be required before employment. All previous residents in the area should also be examined and treated.
- Mobile teams. Mobile teams may effectively diagnose and treat workers in the workplace if necessary. Such teams permit rapid coverage of the target population.

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Plant dermatoses occur because of contact with certain plants that contain allergenic substances. These skin diseases are usually classified as irritant dermatitis, phytophoto dermatitis and eczematous contact dermatitis.

Irritant dermatitis is the result of contact with plants containing irritants; all persons coming into contact with these substances react. Phytophoto dermatitis is caused by the exposure of the skin to ultraviolet light after it has been in contact with certain plants. Eczematous contact dermatitis is an allergic response which appears after previous sensitization with the plant has occurred. Typical of this group are responses associated with contact with plants such as poison ivy, narcissus (lily rash), hyacinths, tulips, onions (bulb finger) and chrysanthemums and with pollens.

The amount of allergenic substance in a given plant will vary depending on its stage of growth; the allergen may be distributed throughout the entire plant or may only be concentrated in specific parts, such as flowers, roots, leaves.

If plant dermatitis has been correctly diagnosed and if the patient avoids further contact with the offending plant, then recovery is usually quick and the prognosis good. Desensitization is usually difficult and preventive measures consist of avoiding further contact with the plant.

Treatment for plant dermatoses depends upon the type and severity of the dermatitis; however, topical solutions or creams are usually suggested and antihistamines are often given.

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%DUERVD) 6 3 HUHLUD GD & RVWD ' 3 ,QFDSDFLWDWLQJ HIIHFWV RI VFKLVWRVRP LDVLV P DQVRQL RQ WKH SURGXFWLYLW\ RI VXJDU FDQH FXWWHUV LQ QRUWKHDVWHUQ %UD]LO ***$ P HULFDQ MRXUQDO RI HSLGHP LRORJ***

3 HUHLUD GD & RVWD ' 3 %DUERVD) 6 (VTXLVWRVVRP RVH HP WUDEDOKDGRUHV GD 8 VLQD & DWHQGH 3 HUQDP EXFR %UDVLO >6 FKLVWRVRP LDVLV LQ Z RUNHUV RI & DWHQGD 3 ODQW 3 HUQDP EXFR %UD]LO@ ***5 HYLVWD GH VD~GH S~EOLFD***

(QYLURQP HQWDO P DQDJHP HQWIRU YHFWRU FRQWURO LQ ULFH ILHOGV 5 RP H) RRG DQG $ JULFXOWXUH 2 UJDQL]DWLRQ RI WKH 8 QLWHG 1 DWLRQV) \$ 2 ,UULJDWLRQ DQG GUDLQDJH SDSHU QR

&KDSWHU

2UJDQLF QDWXUDOGXVW

*HQHUDO

Most agricultural workers are exposed to organic natural dusts. Grain, legumes, oil seeds and textile fibres all produce respirable dusts which may cause respiratory diseases among workers who harvest and process these products. Hence, two staple crops of developing and industrialized countries, cereal grains and natural textile fibres, are associated with these exposures. Other important sources of organic dust in agriculture are bird and animal danders common in agricultural settings [*1*]. The potential global population at risk from these exposure is probably quite large; however, no statistical information is available on the magnitude of the problem.

Vegetable dust may be defined as an aerosol derived from plant material, regardless of the nature of the dust particles or the circumstances of their emission into the air [*2*]. It is recognized that exposure to vegetable dusts is widely encountered in many industries, in agricultural work and in the general environment. The processing of agricultural products such as cotton, flax, hemp, grains, tobacco, paprika and tea is often associated with exposure to vegetable dust [*2*].

&ODVVLILFDWLRQ RI H[SRVXUHV WR YHJHWDEOH GXVW

Organic dust is recognized to be a complex mixture of vegetable particles and fragments, micro-organisms and their toxic products, insects and insect fragments, toxic chemicals and their residues, feed additives such as fish meal and antibiotics, and avian and rodent proteins. Depending on the specific exposure, any one or more of these individual components may predominate and thus influence the type of respiratory response. The clinical picture is made more complex because the respiratory response to the same or similar exposures varies among individual workers. Hence, an exposure to grain dust may cause occupational asthma in one worker and chronic bronchitis in the next.

The absorption of substances from vegetable dusts on the surfaces of airways or in the alveolae may lead to four main types of response.

- The first type is an allergic (atopic) response that occurs either in the upper airway (hay fever) or in the bronchi (asthma), or in both. Pollen allergies are undoubtedly the most important of the allergies, since they affect a large number of people.
- The second type of response is byssinosis, a disease with characteristic symptoms of chest tightness and/or shortness of breath on returning to work after an absence. Workers who suffer from byssinosis may eventually develop permanent respiratory disability. Byssinosis occurs among cotton and other textile workers all over the world. Exposure to flax dust in fibre processing shows particularly prominent manifestation of byssinosis.
- The third type of response involves immunological changes in the lung parenchyma, which may become irreversible after prolonged exposure. The diseases caused by this type of response are collectively known as extrinsic allergic alveolitis, or hypersensitivity pneumonitis. The best known and most widely studies are farmers' lung and bagasse pneumonitis.
- The fourth type of response is simple non-specific irritation in the respiratory tract. With prolonged exposure it may lead to nonspecific chronic obstructive pulmonary disease (COPD).

An attempt has been made to classify vegetable dusts according to the main response they evoke, and some examples are shown in Tables 5.1–5.4 [*2*].

7DEOH ' XVW FDXVLQJ DOOHUJLF DLUZD\ UHVSRQVH RFFXSDWLRQDODVWKPD

Dust type	Type of worker affected	Other effects
* UDLQ FHUHDOV DQG SXOVH SURGXFWV	* UDLQ KDQGOHUV IDUP ZRUNHUV PLOOHUV EDNHUV	&KURQLF REVWUXFWLYH SXOPRQDU\ GLVHDVH DQG H[WULQVLF DOOHUJLF DOYHROLWLV
: RRG UHGFHGDU LURNR	/ XP EHUDQG ZRRG ZRUNHUV	&KURQLF REVWUXFWLYH SXOPRQDU\ GLVHDVH DQG H[WULQVLF DOOHUJLF DOYHROLWLV
7HD	3URFHVVRUV EOHQGHU SDFNHUV	3RVVLEO\ FKURQLF REVWUXFWLYH SXOPRQDU\ GLVHDVH
7REDFFR	3URFHVVRUV FXWWHUV EOHQGHUV	7REDFFRVLV FKURQLF REVWUXFWLYH SXOPRQDU\ GLVHDVH

7DEOH ' XVW FDXVLQJ E\ VVLQRVLV

Dust type	Type of worker	Other effects
&RWWRQ	7H[WLOH ZRUNHUV JLQQLQJ ZRUNHUV	&KURQLF REVWUXFWLYH SXOPRQDU\ GLVHDVH P LOGHYHU
) OD[6RIWKHP S		

7DEOH ' XVW FDXVLQJ K\ SHUVHQVLWLYLW SQHXP RQLWLV

Dust type	Type of worker affected	Other effects
0 RXOG\ KD\ 0 RXOG\ VXJ DUFDQH	) DUP Z RUNHUV 6 XJ DUFDQH Z RUNHUV SDSHU ERDUG P DNHUV	2 FFXSDWRQDOODVWKP D

7DEOH ' XVW NQRZ Q VR FDXVH QRQVSHFLLF LLUULWDWRQ

Dust type	Type of worker affected	Other effects
6 LVDO - XWH + HP SV	7 H[WLOH Z RUNHUV URSH DQG WZLQH P DNHUV	%\ VWLQRVLV
& RLU FRFRQXWKXVN	%UXVK DQG URSH P DNHUV	%\ VWLQRVLV
. DSRN	* LQQHU Z RUNHUV EHGGLQJ P DNHUV	3 RVWLEOH RFFXSDWRQDODVWKP D
) OD[		%\ VWLQRVLV
& RUQ Z KHDWEDUQ\ DQG RWKHUJUDLQV	) DUP Z RUNHUV P LOOHUV JUDLQ KDQGOHUV EDNHUV	2 FFXSDWRQDODVWKP D DQG H[WUQVLF DOOHUJLF DSYHROLWV
5 LFH	) DUP Z RUNHUV P LOOHUV JUDLQ KDQGOHUV	2 FFXSDWRQDODVWKP D
7HD	3 URFHVVRUV %OHQGHUV SDFNHUV	2 FFXSDWRQDODVWKP D
& RIIHH	3 URFHVVRUV EOHQGHUV SDFNHUV	2 FFXSDWRQDODVWKP D

$ LUZ D\ REVWUXFWLRQ

The most common respiratory disorder to arise from dust exposure is airway obstruction, either the acute response i.e. asthma, or chronic airway obstruction, i.e. chronic bronchitis or non-specific airway obstruction.

There is a great deal of similarity among the health effects arising from this type of organic dust exposure. The principal difference is that some dusts appear to act as non-specific irritants, while other dusts contain specific allergens which will provoke an asthmatic response in sensitized individuals.

All vegetable dusts appear to be capable of producing both chronic obstructive pulmonary disease and occupational asthma, while only asthma (often with rhinitis) has been associated with exposure to animal dander and other animal proteins. However, the agricultural worker is usually exposed to a complex dust composed of inorganic dusts from the soil, vegetable dusts from crops and animal dander. Hence, agricultural workers are at increased risk of both asthma and chronic obstructive pulmonary disease.

+\ SHUVHQVLWLYLW SQHXP RQLWLV

The term hypersensitivity pneumonitis is applied to a group of allergic lung diseases which result from sensitization and recurrent exposure to a variety of organic dusts. The term extrinsic allergic alveolitis, rather than hypersensitivity pneumonitis, is commonly used in the United Kingdom [*3*]. Clinically, this disease presents as recurrent respiratory influenza-like illnesses or as insidious exertional dyspnoea. A wide variety of organic dusts may cause this disease, as seen in Table 5.5 [*2*].

7DEOH +\ SHUVHQVLWLYLW SQHXP RQLWLV FDXVDWLYH DJHQWV VSHFLILF GLVHDVH DQG WSH RI H[SRVXUH

Agent	Disease	Exposure
7KHUP RSKLOLF DFWLQRP \ FHWHV		
Micropolyspora faeni	) DUP HUV OXQJ	0 RXOGV KD\
Thermoactinomyces vulgaris *Thermoactinomyces viridis*	0 XVKURRP Z RUNHUV OXQJ	0 RXOGV FRP SRVW
Thermoactinomyces sacchari	%DJDVVRVLV	0 RXOGV VXJDUFDQH
Thermoactinomyces candidus	9HQWLODWRQ SQHXP RQLWV	&RQGP LQDWHG IRUFHG DLUV\ VWHP
) XQJL		
Cryptostroma corticale	0 DSOH EDUN VWLSSHUV GLVHDVH	0 RXOGV P DSOH EDUN
Aspergillus clavatus	0 DOWZ RUNHUV OXQJ	0 RXOGV P DOWV
Penicillium frequentans	6 XEHURVLV	0 RXOGV FRUN GXVW
Penicillium casei	&KHHVH Z RUNHUV OXQJ	&KHHVH P RXOG
Alternaria VSS	: RRG Z RUNHUV OXQJ	0 RXOGV Z RRG FKLSV
Pullularia VSS	6HTXRLRVLV	0 RXOGV UHGZ RRG GXVW
Mucor VSS	3 DSULND VSOHQGHUV OXQJ	3 DSULND GXVW
$ UWKURSRGV		
Sitophilus granarius	: KHDWZ HHYLOGLVHDVH	,QHVWHG JUDLQ
$ QLP DOSURWLQV		
$ YLDQ SURWHLQV	%LUG EUHHGHUV OXQJ	$ YLDQ GURSSLQJV

This disease occurs most frequently among agricultural workers exposed to mouldy materials, but may also be found among office workers exposed to contaminated ventilation systems. The most studied example of the disease is farmers' lung, which is the result of exposure to thermophilic bacteria in mouldy hay. The same disease occurs, but from a different antigenic exposure, among sugar cane workers (bagassosis), wood workers (maple bark-stripper's lung and sequoisis) and malt workers (malt worker's lung). All have in common microbial contamination of natural products with either thermophilic bacteria or fungal species. Two exceptions are wheat weevil disease, caused by sensitization to the granary weevil (*Sitophilus granarius*), and bird breeder's lung, arising from exposure to certain avian proteins, especially those of pigeons.

Clinically, the affected individual will often complain of a flu-like illness with fever and chills, dry cough, dyspnoea, malaise and fatigue beginning 4–6 hours after exposure. With light exposure to these antigents, the agricultural worker may not give a history of flu-like illness but may develop progressive shortness of breath over a period of a few months or a few years. Physical examination will reveal dry crackling rales among those with significant lung involvement.

Pulmonary function evaluation is variable but classically is a restrictive pulmonary defect with progressive loss in lung volume and hypoxaemia. Some cases, however, also have an obstructive component. This is especially common early in the disease and among workers who also smoke cigarettes. Chest radiography shows patchy infiltrates bilaterally in early stages, and profuse nodular and reticular opacities in later stages. Laboratory evaluation is helpful in demonstration of precipitating antibodies to the specific antigens by agar gel diffusion.

Hypersensitivity pneumonitis should be suspected whenever workers are exposed to mouldy materials. Specific microorganisms may be sampled and cultured; however, this is usually not necessary since serum precipitating antibodies are specific for these antigens. Routine medical surveillance is indicated in work areas where hypersensitivity pneumonitis is found. This should include a baseline chest radiograph and a standard respiratory questionnaire to assess respiratory symptoms, smoking history and occupational history. Pulmonary function evaluation before and after exposure may be used to correlate physiological changes with exposure. However, baseline assessment of serum precipitins, together with periodic reassessment, is the most specific screening test available [*3*].

3 UHYHQWLRQ

Prevention is best achieved through environmental control of dust exposure and prevention of contamination with bacteria, fungi, rodents and insects. Whenever vegetable material is harvested, care should be taken to store the vegetable material in a

dry and well-ventilated area to prevent bacterial and fungal contamination. When working with these organic dusts, one should always seek to provide ventilation which will remove the dust from the workers' breathing zone. This may be accomplished by natural ventilation, but is more effectively done with an exhaust fan.

Enclosure of certain dusty processes, which can be operated from outside the enclosure, is another efficient environmental control measure. Where these primary environmental control procedures cannot be employed effectively, dust masks or respirators may be used.

Unfortunately these devices do not eliminate all respirable dust even when they fit properly. In addition to problems with face fit, these devices are uncomfortable to wear and are not tolerated by workers for long periods. Several types of respirator are available which may be used for organic dust exposure [*4*]. Of these, the positive pressure full face piece respirator is the most effective, but is also expensive. The single half face piece disposable respirator will provide some protection from non-specific airway effects of organic dusts. For those workers who develop asthma from organic dust exposure, it often proves difficult to prevent this acute reaction even with good dust control and the most efficient respirator [*5*]. These individuals will often require transfer to another work area away from organic dust exposures.

The worker can minimize exposure by adopting proper work practices. These include attention to proper ventilation, avoiding exposure to mouldy vegetable materials, good housekeeping to prevent accumulation of organic dust in the workplace, and avoiding practices which create dust clouds in the work area. The worker must also be trained to understand the importance of proper ventilation and how to recognize when ventilation systems are not working properly. Lastly, the worker must understand how respirators work and when they should be used. Attention must also be given to ensuring that the respirator is properly maintained and stored.

Periodic medical surveillance is another preventive measure which may be employed among those exposed to organic dusts [*2*]. Pre-employment examinations may be done in order to detect workers with pre-existing respiratory diseases, multiple allergies, impaired lung function, or previous significant occupational exposures, as well as to obtain smoking and family histories. Periodic examinations can then be conducted utilizing a standard respiratory questionnaire and pre-workshift and post-workshift pulmonary function assessment in order to detect those individuals developing respiratory symptoms or functional abnormalities from organic dust exposure. It is important to fully inform workers of their medical findings and to maintain a complete file on each worker for both clinical evaluation and epidemiological evaluation of the individual workplace. Such medical surveillance data, when linked with environmental data, can be used for assessment as to whether environmental controls and other preventive measures are adequate to prevent respiratory disease in the workplace.

5HIHUHQFHV

/LQFRQ 7$ HWDO 2FFXSDWLRQDO DOOHUJ\ WR DQLPDO GDQGHU DQG VHUD *Thorax*

Recommended health-based occupational exposure limits for selected vegetable dusts *HQHYD : RUOG +HDOWK 2UJDQL]DWLRQ 7HFKQLFDO UHSRUW VHULHV QR

3HS\V - *Hypersensitivity disease of the lungs due to fungi and other organic dusts* 0RQRJUDSKV LQ $OOHUJ\ 1R %DVHO .DUJHU

A guide to industrial respiratory protection : DVKLQJWRQ ' & 1DWLRQDO ,QVWLWXWH IRU 2FFXSDWLRQDO 6DIHW\ DQG +HDOWK 7HFKQLFDO UHSRUW VHULHV QR

+HQGULFN ' HWDO 3URWHFWLYH YDOXH RI GXVW UHVSLUDWRUV LQ H[WULQVLF DOOHUJLF DOYHROLWLV FOLQLFDO DVVHVVPHQW XVLQJ SURYRFDWLRQ WHVWV *Thorax*

&KDSWHU

(QYLURQPHQWDOKD]DUGV

*HQHUDO

Most agricultural operations are performed outdoors and are subject to varying and uncontrollable climatic conditions. Today's agricultural workers face most of the same natural environmental health hazards as their forefathers did, but due to changing technology, many agricultural activities are also taking place in altered or controlled environments. Increasing mechanization exposes the agricultural worker to man-made physical hazards such as noise and vibration. This combination of natural and man-made hazards produces unique and sometimes unsuspected health problems.

While workers may carry out activities under varying seasonal conditions and at varying altitudes, temperature and humidity are the two major health concerns of outdoor work. Protection against excessive heat and cold is needed. Special attention should be given also to non-acclimatized migrant workers.

7KHUPDOFRQGLWLRQV

([SRVXUHWR KHDW

In agriculture, the temperature of the occupational environment is usually related to the natural environment in which the work is being done. Heat is normally produced in the body by metabolism of food which maintains body temperature. In determining the body's heat load, consideration must also be given to heat which may be added from man-made sources such as engines and mechanical equipment.

In many tropical communities, agricultural work is scheduled for early morning and in the evening, to avoid the hottest part of the day. If this custom is overridden by the need for utilizing the machines full-time, then the heat exposure of workers will increase substantially. Access to drinking-water must be made available, together with salt.

Replacement of salt lost by sweating must be done during the workday. It cannot be postponed until after work. Salt replacement can be accomplished by eating well salted foods, but the best method is to mix 0.1% NaCl (table salt) into cold drinking-water or fruit juice. The advantage of replacing salt with salted water is that it automatically adjusts to the amount of sweating. It also may irritate the stomach wall, though use of coated tablets will prevent this problem. There is no evidence that other electrolytes also

have to be replaced during the workday. Unacclimatized workers are particularly prone to excessive salt loss because their salt concentration in sweat is high. The salt concentration in sweat of acclimatized workers may be as low as 0.1%.

The main consideration for protective clothing in the cold is that the outer layer should be impermeable to wind and water. Underneath, there should be several layers of clothing so that during hard labour some layers can be removed, to be replaced during rest. Sweating during physical labour cannot be completely prevented in cold environments; however, it is important that underclothing be water-absorbent. There should also be an opportunity to dry socks and underclothing during rest periods.

In both heat and cold, short periods of rest (10–15 minutes) every two hours of continuous work are advisable. The worker should be clothed appropriatly and exposure (hours of work) should be limited during extremely adverse climatic periods or when new nonacclimatized workers are engaged. Adequate intake of water and salt must also be ensured during heat exposure.

Worker education information is available for the recognition and treatment of cases of heat illness and also for the prevention of heat illness. These guidelines are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). They can be used in worker training programmes especially for new workers with potential exposure to extreme heat.

In most agricultural communities certain work practices have evolved based on experience which protect the workers from excessive heat or cold exposure. Such practices, such as eating and drinking habits, may differ among communities but are usually based on sound reasoning, For example, spicy food stimulates drinking of fluids, which is advantageous in a hot environment. Hot fluids such as coffee, tea and soups, are useful for warming the body in cold environments. However, false notions that persist in some communities may result in harmful practices, e.g. “It is better to drink little water when exposed to heat”. It fact, for maintaining optimal physical fitness, it is best to drink exactly as much water as one is losing through sweating and normal body functions.

In a hot climate, human temperature balance is essentially maintained by the evaporation of sweat. Problems in temperature balance may be due to either inadequate sweat production, extreme environmental conditions or clothing which is not conducive to the evaporation of sweat. Heavy workloads may aggravate the situation since they can result in additional body heat [*1*].

The health problems of a hot environment result from fluid and electrolyte imbalance, cardiovascular dysfunction or a rise in body temperature above physiological limits.

Heat cramps

Heat cramps are usually due to loss of excessive sodium chloride from the body as a result of excessive sweating. It is usually seen among workers undertaking heavy work in a hot environment. The symptoms are those of painful muscular contractions which cease when the muscle spasm ends. In the acute phase, treatment consists of administering salt and water. Prevention consists of training workers in hot environments to ensure adequate intake of water and salt.

Heat exhaustion

Heat exhaustion is characterized by a dramatic fall in blood pressure when undertaking strenuous physical exertion in a hot environment. The syndrome is the result of excessive loss of salt and water due to profuse sweating without adequate compensatory intake of fluids, resulting in circulatory failure. The condition may manifest itself in acute collapse or go through a prodromal phase for a few days prior to acute collapse. Prodromal symptoms include headache, weakness, loss of appetite and giddiness. Severe vomiting may also occur, along with muscle cramp, tachycardia and moist damp skin. In severe cases there could be oliguria or anuria with proteinuria. The treatment in the acute phase depends on the severity of the condition. In mild cases, patient rest in a cool environment with increased fluid intake is adequate. In more severe cases, intravenous therapy is necessary to correct the fluid and electrolyte imbalance.

Heat stroke

This condition may follow heat exhaustion or may occur independently. It is usually the result of failure of the heat regulating mechanism in the human body. Basically the condition occurs when there is insufficient loss of body heat due to an overworked perspiratory system. Hence heat stroke is seen where there is prolonged exposure to hot environments. The symptoms include increased body heat, dizziness, headache, weakness, vomiting, hypertension and tachycardia. In more severe cases disorientation and unsteady gait may be observed. Death may ensue due to shock or rise in body temperature. A rectal temperature of over 40°C is a serious sign. The diagnosis is based on finding a high temperature in a patient in a comatose or pre-comatose state with a history of exposure to heat. On diagnosis, urgent treatment must be instituted by whatever means immediately available, i.e. immersion in ice, cardiac stimulants, etc.

Heat dermatoses (skin eruptions)

Skin eruptions are common in hot and humid climates, especially where people perspire constantly. Such eruptions are caused by blockages of the pores by keratin macerated by perspiration.

Secondary infections usually result from such conditions if this problem is not treated adequately.

([SRVXUH WR FROG

The effect of cold climates on agricultural workers may bring about a loss in body heat, depending on the insulation qualities of the clothing worn to maintain optimal body temperature. The possible effects experienced by workers in cold climates are frostbite, chilblains and hypothermia, but it must be appreciated that these conditions have rarely been reported as serious occupational risks in agricultural workers.

3 URWHFWLRQ IURP H[WUHP H WHP SHUDWXUHV

The protection of workers from the unfavourable effects of extreme heat and cold depends on the development of work regimens which:

- will not overexpose the worker to excessive temperatures that are life-threatening;
- provide adequate rest from heat or cold so that body thermoregulation can be maintained;
- provide adequate water and salt intake in heat along with periods of rest in a cool environment;
- provide adequate clothing in conditions of extreme heat or cold.

1 RLVH

Mechanization of agriculture through the introduction of self-propelled machines and tractors has added noise to the list of occupational hazards to which the farm worker is exposed. High levels of noise are also found in large-scale confined animal breeding areas.

Farm tractors and other agricultural machines constitute a source of variable intensity noise levels and frequency ranges. Exposure of workers to high intensity levels of noise causes temporary hearing loss after a relatively short time. If very prolonged exposure occurs, hearing loss becomes permanent. Other well known effects of noise exposure are: interference with communication; disturbance of sleep; cardiovascular, endocrine and neurological changes as part of a stress response; fatigue; and variable changes in performance [*2*]. General pathophysiological reactions of noise are not under investigation. It is an area which has not been thoroughly investigated and requires further research.

Noise-induced hearing loss occurs initially at high frequencies and high intensity, with a typical loss at around 4000 c/s. However, over a period of years it extends to other frequency bands. This is the result of damage in the internal ear at the Corti's organ. There is considerable variation in human sensitivity to the noise level and its duration. The hazardous nature of a noisy environment has been described in terms of "damage risk", which is expressed as the proportion of people exposed to that environment who are expected to suffer noise-induced hearing impairment giving appropriate allowance for hearing losses due to age and other causes. The level of 85 dB of intensity is commonly used as an acceptable exposure limit [*3*].

As a rule the most efficient action against excessive noise is the reduction of noise at the source. Noise control technology is available for resolving many noise problems arising from the use of agricultural machinery.

An effective hearing conservation programme should ensure that farm workers who face a risk of exposure to potentially hazardous noise levels are informed regarding the following: health consequences of excessive noise exposure; means of protection and the limitations of these means (e.g. ear plugs); and the need for periodic hearing examination as compared with pre-employment audiometric examination.

9 LEUDMRQ

Mechanization of agriculture through the introduction of propelled machines and tractors and power-driven tools has resulted in worker exposure to non-acoustic vibration. Vibration is transmitted to the body by contact with moving surfaces. For occupational health purposes, vibration can be classified as whole-body vibration (acting on the body of sitting or standing workers through supporting surfaces) and segmental or localized vibration (transmitted mainly through the hands and arms).

The overall frequency range of vibration of occupational interest ranges from 0–1000 c/s. Vibration can be described in respect to dimension, rotation, acceleration, velocity and displacement [*4*]. Several factors influence the extent to which vibration is transmitted to the body and include body size, posture and tension. The effects of vibration depend on the frequency, amplitude, duration of exposure, direction of vibration and clothing.

Sources of whole-body vibration exposure are encountered frequently in agricultural work, e.g. two-wheel walk-behind tractors, tractors and tractor-towed agricultural equipment, harvesters, threshers and combines. Power-driven tools, especially chain saws and branch cutters, are major sources of segmental vibration. Long-term worker exposure to whole-body vibration is associated with various types of histological, histochemical and biochemical alterations leading to dystrophic changes. The most

common effect is lower back pain, which is caused by various actions of vibration on the musculoskeletal system. In particular, whole-body vibration results in degeneration of the invertebral discs and damage to tissues and nerves. Discs can also be affected by long periods of sitting aggravated by vibration.

5HIHUHQFHV

Health factors involved in working under conditions of heat stress, Report of a WHO scientific group, Geneva, 29 August to 4 September 1967 * HQHYD : RUOG + HDOWK 2 UJDQL]DWLRQ

* ODVV ' & 5 HLP % 6 LQJHU - (%HKDYLRXUDOFRQVHTXHQFHV RI DGDSWDWLRQ WR FRQWURODEOH DQG XQFRQWURODEOH QRLVH *Journal of experimental social psychology.*

Noise * HQHYD : RUOG + HDOWK 2 UJDQL]DWLRQ (QYLURQP HQWDOKHDOWK FULWHULD VHULHV QR

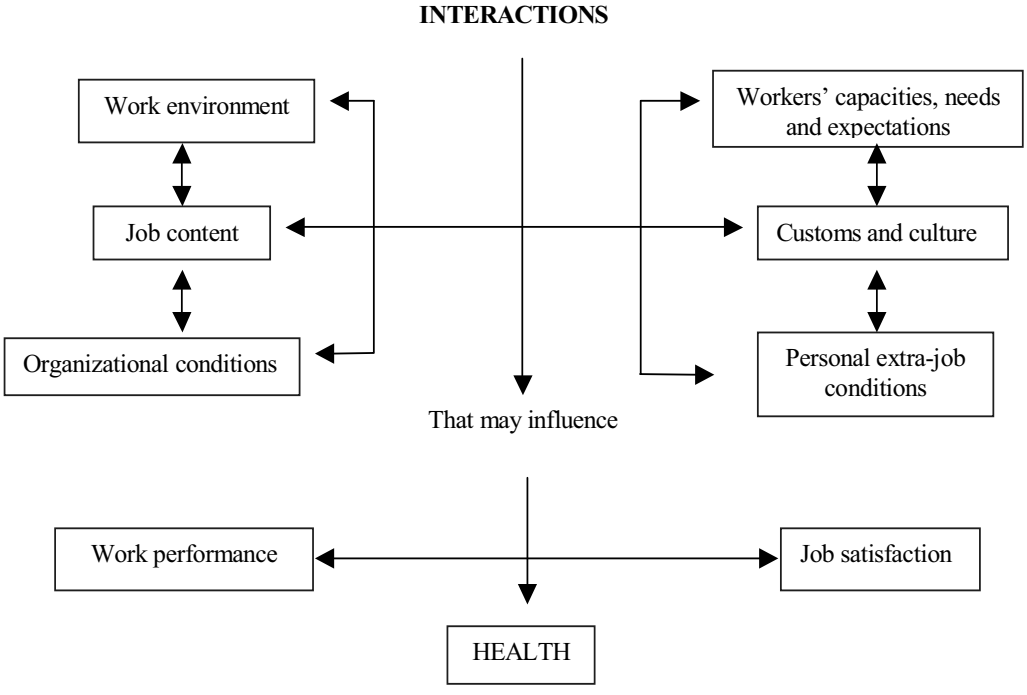
: DVVHUP DQ ' (7D\ORU 2 FFXSDWLRQDOLYLEUDWLRQ ,Q 5RQ : 1 HG *Environmental and occupational medicine* %RVWRQ / LWWOH %URZQ DQG &R

&KDSWHU

3V\FKRVRFLDOIDFWRUV

' HILQLWLRQ

Psychosocial factors at work refer to aspects of work such as environment, job content, organizational conditions, worker capacities and needs culture and personal extra-job considerations of workers that may influence health, work performance and job satisfaction, as illustrated in Figure 7.1 [*1*].



) LJXUH 3V\FKRVRFLDOIDFWRUV DWZRUN

Psychosocial factors in agriculture are complex and varying. Lines of production and work conditions vary to a large extent. Agriculture comprises occupations and tasks which may differ greatly from each other in basic psychosocial aspects. Many tasks are fundamentally different at different points of time because of seasonal variation. Moreover, psychosocial factors have different meanings in different social contexts. This must be taken into account in the application of any information regarding psychosocial factors in agriculture.

The aim of this section is to review trends in psychosocial factors in agriculture; outline the recognition of harmful psychosocial factors and their effects; describe factors affecting susceptibility of various population groups and individuals; and discuss possibilities for control of harmful psychosocial factors.

7UHQGV LQ SV\FKRVRFLDO IDFWRUV LQ DJULFXOWXUH

Traditional agricultural communities are stable with respect to the natural environment and the social networks and interaction among the farming population. These communities are characterized by a number of factors favourable for health and well-being.

- Human relations are stable in the family, and members of several generations usually interact within the family.
- Children have an opportunity to grow close to their parents and their workplaces.
- The community remains familiar to all of its members.
- Workers have a functional connection with nature and the opportunity to conceptualize their own work as a part of nature.

The agricultural community experiences a fundamental change during a period of industrialization. As farmwork is mechanized, the need for labour force decreases, and migration becomes a social problem. Farmwork becomes the responsibility of women, children and the aged in many countries during the first phases of industrialization, asmen are likely to seek jobs in industry.

Changes in production technology and work methods often create a tremendous demand for education in agricultural communities. Revision of traditional work methods and a change of attitudes may also be necessary in many developing countries because of insufficient crop production to satisfy national needs. This problem has been approached in India through applying psychological tests to identify the characteristics of people who may more readily adopt new farming methods [*2*].

Very little scientific information is available about work-related psychosocial factors in agriculture where traditional methods are still applied.

Weston and Cary investigated aspects of the working life of Australian farmers in two surveys in 1976 and 1978 [*3*]. The first survey took place during a period of severe depression in the food production industry and the second at the beginning of a business boom. The study showed the following links between agriculture and industry:

- Trend towards large-scale production.
- Growing need for capital, often forcing farmers to look for external sources of financing.
- Need for low production costs against rising demands regarding the quality and quantity of raw material.

These demands change the lifestyle of the farmers. The traditional farmer was self-supporting. The pressure for investments characteristic of the spirit of enterprise is a new challenge which requires a fundamental change of attitude.

As people move away from rural areas in an industrializing country, traditional social networks begin to break up. There may be no children at all in an elderly farmer's environment due to movement of young people to the cities. Current forms of intensive agriculture also change the physical environment; an effort to achieve greater production may lead to changing natural conditions in order to make them more favourable for agriculture. Additionally, urban expectations regarding standards of living also extend to rural areas, as people want modern facilities in their houses and amenities such as paved roads and television.

5 HFRJQLWLRQ RI SV\FKRVRFLDOIDFWRUV

3V\FKRVRFLDOVWUHVV IDFWRUV DWZRUN

Stress factors at work can, with certain limitations, be characterized by two main dimensions and their combinations: quantitative–qualitative and overload–underload: An example of quantitative overload in agricultural work could be extra work during the harvesting season. A qualitative overload could be caused by decision-making situations where the available information is insufficient. This may be the case when seeds and fertilizers must be selected. A quantitative underload of work might be experienced in northern grain farms during the winter. A qualitative underload of work does not provide sufficient challenge for worker or does not adequately stimulate the senses. This is characteristic of process control work in dairy production and in the processing of grain, where the main task is to observe routine procedures and to be prepared for occasional disturbances. Table 7.1 lists general aspects of work which may have psychosocial consequences [*4*].

7DEOH 6WUHVV IDFWRUV ZLWK GLIIHUHQWLDWHG SV\FKRVRFLDO FRQVHTXHQFHV LQ P HFKDQL]HG DJULFXOWXUH

	Nature-related	Technological	Ergonomic	Social	Economic	Organizational
6RXUFHV RI VWUHVV	&OP DWH IHUWLOLW\ RI VRLO HWF	0 HFKDQL]DWRQ	3K\VLFDO IDFWRUV	0 LJUDWRQ WR FLWLHV	/ RDQ SRQFLHV VXEVLGLHV	' LYLVRQ RI ODERXUL IDUP V
(QYLURQP HQWDO LQGLFDWRU RI VWUHVV	/ HYHORI VMP S HUDWXUH DP RXQW RI UDLQ	1 XP EHUDQG TXDOLW RI P DFKLQHV	/ HYHORI QRLVH YLEUDWRQ	8 QGHU VWDWHV WDWH LQJ VNHZ HG DJH DQG VH[GLVW UEXWRQ	$ WWLWXGHV WRZ DUGV DJ UFXO WXUH	%RXQGDULHV RI UHVSRQVLELOLW DQG Z RUN OBDG LQWHUSHUVRQDO UHODWRQV
7DUJHWV RI HIIRUW	$ JUFXO WXUDO SRSXOD WRQ	: RUNHU JURXSV	: RUNHU JURXSV	9LOODJ H IDP LO	$ JUFXO WXUDO SRSXOD WRQ	) DP LO HQWUSUMH IDUP V

7HFKQLTXHV IRUUHFRJQLWRQ RI VWUHVV IDFWRUV

A number of health-relevant psychosocial stress factors are related to changes associated with mechanization and industrialization. They must be recognized but any methodological approaches for their assessment are beyond the scope of this publication.

The basic techniques for the detection of psychosocial factors at work are interview and observation. Information about the subjective experiences of a farmer regarding work conditions can be gathered through an interview. This approach is feasible primarily in scientific investigations, as it may be too tedious in practical approaches for the assessment of psychosocial factors, such as in connection with other inspections at a farm. Observation can be applied for gathering of information independent of a farmer's own interpretations. Observation should preferably be based on a systematic checklist of the factors to be assessed.

For the determination of work-related stress factors, observation methods have been developed primarily for industry. The application of these techniques in agriculture is somewhat limited due to great seasonal variation in work. A list of common job stressors and indicators for recognition is shown in Table 7.2 [*4*].

7DEOH 5HFRJQLWLRQ RI ZRE VWUHVV DQG LWV DSSOLFDWLRQ WR DJULFXOWXUH Z RUN

Job stressor	Work characteristic in agriculture	Recognition
5HVSRQVLELOLWLHV IRU YDIHWV	: RUNLQJ Z LWK P DFKLQHV	1 XP EHURI P DFKLQHV
5HVSRQVLELOLWLHV IRUP DWHULDO YDOXHV	3 URFHVVLQJ RI JUDLQ P HDWP LON HWV	4 XDOLW GHP DQGV LQ SURGXFWRQ DJUHHP HQWV
6RODWLU Z RUN	: RUNLQ ILHOGV DQG Z RRGV	,VRODWLRQ RI IDUP
6WUHWUDUDUHWWLQJ	7DVN VWDWKDYH WR EH DQH D\ SHUFRUP HG LQ D FHUWDLQ Z D\ H J WHQGLQJ FDWWH	/ HYHORI P HFKDQL]DWRQ LQ GDLU IDUP V
+ DWH	+ DUYHWLQJ DQG VHHGLQJ WP H	6HDVRQV
& RP SOH[GHFLVLRQ P DNLQJ	+ DUYHWLQJ VHHGLQJ SODQQLQJ RI SURGXFWLRQ	6HDVRQV FKDQJHV LQ SURGXFWRQ QQH SURGXFWRQ DJUHHP HQWV
5HVSRQVLELOLWLHV IRUWKHU SHRSOH	,QFRP H RI IDP LV DQG YLOODJH	(FRQRP LF LQGHSHQGHQFH
5HSHWLWLYH WDVN	6RP H SKDVHV RI KDUYHWLQJ DQG VHHGLQJ	* UDLQ IDUP V VHDVRQV
' HP DQGV IRUDWWHQWLYHQHVV FRP ELQHG Z LWK IHZ VWP XO.	6RP H WDVNV LQ SURFHVVLQJ RI JUDLQ DQG FDWWH EUHHGLQJ	* UDLQ IDUP V KDUYHWLQJ VHDVRQ FDWWH IDUP V
' HP DQGV IRUSUHFLVH GLVFUP LQDWRQ	4 XDOLW FRQWROLQ SURFHVVLQJ JUDLQ	* UDLQ IDUP V

3V\FKRVRFLDOFDFWRUV DQG KHDOWK

Positive psychosocial factors at work enhance self-confidence, give satisfaction and promote well-being. Long-term stressful experiences often lead to disturbances that manifest themselves in psychosological functions and physiological functions and behaviour. [*5,6*]. Typical reactions are preoccupation, anxiety, irritability and fatigue. Consecutive changes in the physiological functions may cause aches and pains in various parts of the body and even physical disease and chronic psychological problems. The consequences may also be interpersonal, such as conflicts with co-workers or family members. Table 7.3 lists common psychological and behavioural outcomes of harmful psychosocial factors [*7*]. Stressful experiences can lead to constructive actions for the development of work conditions. However, a long-term chronic stress situation often increases passivity and reduces the likelihood of constructive efforts.

Elderly farmers often suffer from chronic health problems due to heavy work. These illnesses lower working capacity and may aggravate psychological problems [*8*]. Isolation of farms seems to be associated with feelings of powerlessness and alientation, which have been investigated among American farm workers [*9*]. The work of farmers depends on many phenomena that remain beyond human control. Feelings of

7DEOH 3V\FKRORJLFDOGDQGEHKDYLRXUDORXWFRPHV RI KDUP IXOSV\FKRVRFLDO IDFWRUV

(PRWLRQDOUHDFWLRQV

)HHOLQJV RI GHSUHVVLRQ ERUHGRP JXLOWSUHVVXUH DQ[LHWLHV VWUHVV LUULWDELOLW\ ZRUN VDGQHVV SHVVLP LVP KRSHOHVV YLHZ RI IXWXUH HYHQWV DSDWK\

' LVRUGHUV RI LQWHUHFWLRQDO IXQFWLRQV

5HVWULFWLRQ RI VFRSH RI SHUFHSWLRQ
/RZ HUHG DELOLW\ WR FRQFHQWUDWH
' LVWXUEHG P HP RU IXQFWLRQV
+HVLWDWLRQ LQ GHFLVLRQ P DNLQJ
&KDQJH LQ FRQWKQWRI WKLQNLQJ HJ FRQWDQWXP LQDWLRQ
/RZ HUHG FUHDWLYLW\

&KDQJH RI VHOI LP DJH

/RZ HUHG VHOI FRQILGHQFH

&KDQJHV RI EHKDYLRXU P DQLIHVWDWLZRUN

$EVHQFH IURP ZRUN DQG SRVWSRQHP HQWRI GXWLHV
/RZ HUHG ZRUN SHURUP DQFH TXDOLW\ DQG TXDQWLW\
,QFUHDVHG QXP EHUR DFFLGHQWV
,QWHUSHUVRQDO FRQIOLFW
5LVN WDNLQJ EHKDYLRXU

2WKHUFKDQJHV RI EHKDYLRXU

([FHVVLYH XVH RI FRIIHH QLFRWLQH
&KDQJH RI HDWLQJ KDELWV
' LVXUEHG VOHHS

2WKHUFKDQJHV RI EHKDYLRXU

/RZ HUHG VRFLDOSDUWLFLSDWLRQ DQG DFWLYHQHVV
$VVXP LQJ VLFN UROH LQFUHDVHG XVH RI RUQHJOHFWRI KHDOWK VHUYLFHV
&KDQJH RI JHQHUDOOHHVWOH
$FWQJ RXWDQWVRFLDOEHKDYLRXU
' LVUXSWLRQ RI LQWHUSHUVRQDOWHV DQG VH[XDOUHDWLRQVKLSV

powerlessness may generalize and carry over into areas outside work. Seasonal accumulation of work due to weather and crop conditions, with consequent time pressure, can be especially stressful.

,QGLYLGXDOVXVFHSWLELOLW\

Stressful experiences do not always lead to major disturbances. People differ in their responses to most types of situations, and some workers are more vulnerable than others in facing stress at work. Individual reactions may be related to the following types of factors:

- general life situation (recent changes, illnesses, losses)
- social support received from other people in the family or at work
- occupational skills (education)
- personality characteristics (e.g. flexibility, social skills)
- biological factors (e.g. age and sex).

Pressure to adopt new farming methods and new ways of economic reasoning are examples of current phenomena that farmers must cope with. Their success in coping with these challenges depends on intellectual abilities, occupational motives and also on the support they receive through interpersonal relations. Reactions to such challenges differ, for instance in considering investment in new fertilizers. A young farmer who views the farm as an enterprise, may see an opportunity, while an older farmer may perceive a threat to an entire way of life.

Attention should be paid to the importance of interpersonal factors as a resource. The emphasis on productivity in developing new agricultural methods has sometimes led to ignorance of interpersonal factors and consequent lack of approval or success. The support given by a community is of vital importance, especially in problem situations.

&RQWURO RI KDUP IXO SV\ FKRVRFLDO IDFWRUV

Traditions determine the organization of farmer's work to a large extent. This is particularly true in small family farms, but often in large farms as well, where machines may be highly developed and modern. Traditions and related ways of life involve factors perceived as safe and comfortable. At the same time, tradition may hinder the adoption of new work methods and favourable reorganizations. Introduction of new machines usually imply at least some changes in the distribution of labour and schedules. With proper planning and utilization of technology, even some of the seasonally-driven periods of inappropriate workload can be alleviated. However, caution is necessary. Methods that have been found effective in some places may not be suitable for other areas. The best solutions are usually found through collaboration between the farmer and a local adviser.

Through the improvement of the physical work environment, including ergonomic conditions and physical and perceptual loads, psychological well-being can be indirectly developed. Those who work at the farm may become used to problems that would be immediately recognizable to an outside observer. Ergonomic improvements in particular can often be implemented at low costs.

The general physical workload is heavy in traditional farming. Mechanization may also introduce new physical stress factors, such as vibration. These factors, along with others such as the application of chemical products, have implications for psychological

well-being [*10*]. It must be noted, however, that physical workload can also have a positive effect on muscular strength, leading to increased confidence and higher morale.

Person-oriented actions, which focus on the individual as a functioning whole, are the most common approach in dealing with the effects of harmful psychosocial factors. Preventive approaches to psychosocial hazards have been neglected. Deterious effects of psychosocial factors can be alleviated with a number of person-oriented methods that can be applied alone or in connection with actions in the work environment. Alternative possibilities for preventive actions are:

- education and training, job guidance (e.g. when elderly farmers must adopt new work methods)
- preparation for changes and systematic handling of related uncertainty and fears
- making use of physical activity at work to develop muscular strength and improve confidence and morale
- eliminating or reducing harmful environmental influences (e.g. temporary or permanent redistribution of labour in farms).

&RQFOXVLRQV

Agricultural work traditionally involves many positive psychosocial factors, foremost among which is the independence or freedom of a farmer. In addition, work is mostly varying and offers a wide range of challenges. Physical work can also lead to increased muscular strength and general well-being.

In recent years agricultural work has experienced many pressures for change. In developing countries intensification of farming has been necessary for solving food-production problems. In industrialized and industrializing countries, mechanization and decrease of the labour force have changed psychosocial conditions in agricultural work. Moreover, a number of psychosocially relevant factors are inherent in agricultural work, and thus remain beyond the control of workers.

Agricultural communities traditionally have had many resources for taking care of their members, and communal activities have a long history in agriculture. Transition to modern work methods may break traditional unifying social bonds. In problem situations, solutions sought from outside specialists can be regarded as alien to the community. Involvement of the members of the community is essential in resolving the problems caused by modernization of farms.

5HIHUHQFHV

3 VI FKRVRFLDO DVSHFWV RI UHFRJQLWLRQ DQG FRQWURO UHSRUWV WKH IMLQV// 2 : +2 &RP P LWWHRQ2 FFXSDWLRQDG+HDOK QIQJKVHVLRQ 6HSWMP EHU * HQHYD ,QWMUQDWLRQDO DERXU2 IILFH

6LQJK 1 5XUDORUDJULFXOWXUDOSV\FKRORJ\ IRUGHYHORSLQJ FRXQWULHV ***,QGLDQ-RXUQDO RI SV\FKRPHWU\ DQG HGXFDWLRQ***

: HVWRQ 5 (&DUU -: ***$ FKDQJH IRU WKH EHWWHU" 6WUHVV DWWLWXGHV DQG GHFLVLRQ PDNLQJ RI GDLU\ IDUPHUV WR*** 0HOERXUQH 8QLYHUVLW\ RI 0HOERXUQH 6FKRRO RI $JULFXOWXUH DQG)RUHVWU\

(OR $/ 9HKYLOlLQHQ 0 5 0HWKRG IRU KHDOWK FDUH SHUVRQQHO IRU HYDOXDWLRQ RI SV\FKRORJLFDO VWUHVV IDFWRUV DW ZRUN D VWXG\ RI UHOLDELOLW\ DQG YDOLGLW\ RI WKH PHWKRG ***5HSRUWV RI WKH ,QVWLWXWH RI 2FFXSDWLRQDO +HDOWK*** +HOVLQNL)LQQLVK ,QVWLWXWH RI 2FFXSDWLRQDO +HDOWK

(OOLRWW 5 (LVGRUIHU & HGV ***6WUHVV DQG KXPDQ KHDOWK*** 1HZ <RUN 6SULQJHU

/D]DUXV 5 6 ***3V\FKRORJLFDO VWUHVV DQG WKH FRSLQJ SURFHVV*** 1HZ <RUN 0F*UDZ +LOO

.DOLP R 5 $VVHVVPHQW RI SV\FKRORJLFDO VWUHVV ,Q .DUYRQHQ 0 0LNKHHY 0 , HGV ***(SLGHPLRORJ\ RI RFFXSDWLRQDO KHDOWK*** &RSHQKDJHQ : RUOG +HDOWK 2UJDQL]DWLRQ 5HJLRQDO 2IILFH IRU (XURSH

9RKORQHQ , HWDO 9LOMDQHQ\LGHQ WW\ MD WHUYH\ V >)DUPHUV ZRUN DQG KHDOWK@ ***)DUPHUV RI WKH 6RFLDO ,QVXUDQFH ,QVWLWXWLRQ*** $

0DUWLQVRQ 2 : LOOHQLQJ (3 5RGHIHOG 5)HHOLQJV RI SRZHUOHVVQHVV DQG VRFLDO LVRODWLRQ DPRQJ ODUJH VFDOH IDUP SHUVRQQHO ***5XUDO VRFLRORJ***

/HYLQ + 5RGQLW]N\ 5 / 0LFN ' $Q[LHW\ DVVRFLDWHG ZLWK H[SRVXUH WR RUJDQRSKRVSKDWH FRPSRXQGV ***$UFKLYHV RI JHQHUDO SV\FKLDWU***

&KDSWHU

2FFXSDWLRQDOKHDOWK FDUH IRU DJULFXOWXUDOZ RUNHUV

5XUDOKHDOWK LQIUDVWUXFWXUH

In developing occupational health and safety systems for agricultural workers, the rural health infrastructure must be involved and used to the greatest degree possible. Despite the efforts of agencies and other governmental organizations, adequate occupational health care has not been provided to agricultural workers. There are a number of reasons for this.

- Agricultural workers live in rural and sometimes inaccessible locations, usually dispersed over wide areas, where emergency and first aid services as well as medical facilities may be lacking or out of easy reach.
- In rural locations there are often limited or inadequate environmental services, including water supplies, sanitation and housing.
- Many agricultural workers are self-employed or work in family units.
- In many countries, agriculture workers do not belong to organized trade unions.

In addition to these socioeconomic factors, agricultural workers often face endemic diseases which are usually well-controlled in urban areas. This is particularly true of the zoonotic and parasitic diseases endemic in rural areas of many developing countries.

Despite these obvious problems and medical needs, occupational safety and health legislation has largely overlooked the needs of agricultural workers. In addition, independent farmers, who constitute the vast bulk of agricultural workers in developing and industrialized countries alike, are not specifically covered by many provisions of occupational safety and health legislation, and therefore may not benefit from educational programmes, inspections, labelling or record-keeping requirements or workers' compensation. Labour laws concerning the employment of women and children and work hours may not apply or be adequately enforced. Moreover, agricultural work is generally done by all members of the family, and child labour may constitute a legal problem. The omission of occupational safety and health legislation and health programme coverage for agricultural workers constitutes a major challenge in the

development of occupational health care systems for the agricultural sector. The initiative for improving occupational health care must come from national policy-makers.

2 FFXSDWLRQDONKHDOWK VHUYLFHV LQ DJULFXOWXUH

An occupational health programme aims to promote and maintain the highest possible level of health among the gainfully employed. Ideally an occupational health service in agriculture should constitute the following [*1*]:

- Medical examination, preplacement, periodic and special medical examination, including, where necessary, biological and radiological examinations
- Supervision of the working environment surveillance and advice on all factors which may affect the health of agricultural workers
- Supervision of the hygiene and sanitary installations for agricultural workers surveillance of the hygiene and sanitary installation (in liaison with appropriate bodies) of all facilities to ensure the healthful life of agricultural workers
- Health counselling advice to individual workers regarding any disorder that may occur or be aggravated in the course of work
- Accident prevention participation with other appropriate department or bodies in the prevention of accidents and the supervision of personal protective equipment and its uses
- First aid and emergency treatment
- Medical care; care of minor ailments or complete medical care for the worker and his family, depending on local circumstances
- Health education; education of the agricultural worker in the essentials of healthful living
- Maintenance of records and compilation of statistics; medical records with periodic review of statistical data concerning health conditions of the agricultural worker
- Research in occupational health; research or participation in such research in association with specialist services or institutions.

In some industrialized countries, such as Sweden, occupational health services of one type or another exist and cover the health needs of agricultural workers. In many other countries, particularly developing countries, the health services provided by rural health centres pay little attention, if any, to the occupational health problems of agricultural workers, so that these workers do not actually have any occupational health services.

$ SSURDFKHV WR RFFXSDWLRQDO KHDOWK FDUH

In order to cater to the needs for occupational health care of this important sector of the working population, the following recommendations of a WHO working group on primary health care and working populations in 1982 should be considered [*2*]:

> It is considered that the following three fundamental principles are basic to the development of an occupational health service.
>
> Firstly, it must be ensured that occupational health services be provided through the existing national health service system, by a process of integration.
>
> Secondly, the service must be for the total health of the workers and if possible their families.
>
> Thirdly and most importantly, the primary health care approach must be the chosen system for the delivery of such services. Having set these common guidelines which are universally applicable, it must be emphasized that the planning and implementation of the health system must necessarily vary among countries. All too often attempts are made to provide a single formula to resolve global health problems, particularly those of developing countries. This is done without realizing that often these countries cannot be considered as a single entity, in fact they may be far from homogeneous geographically, culturally or in stage of development. Having developed an overall policy, the strategy for implementation must be worked out within each country tailored for its special situation to achieve the target of providing occupational health services.

The primary health care approach will help to solve many problems relating to the availability of a trained occupational health workforce, facilities and financial resources.

3 UIP DU KHDOWK FDUH

The Declaration of Alma-Ata that emerged from the International Conference on Primary Health Care in 1978 emphasized that health, as a fundamental human right, requires the participation of many other sectors in addition to the health sector. It further stated that economic and social development are essential to health and that promotion and protection of health is vital to sustained social and economic growth. The Declaration emphasized that primary health care should address public health problems in the community ("as close as possible to where people live and work"), and that community members have both the right and duty to participate in planning and implementation of their health care. The principles of primary health care were re-endorsed by the World Health Assembly in May 2003, on the 25th anniversary of the International Conference on Primary Health Care. These principles clearly have practical applications in the provision of occupational health services in agriculture.

&KDUDFWHULVWLFV RI D KHDOWK FDUH V\VWHP IRUDJULFXOWXUH

An agricultural occupational health system based on primary health care would aim to provide balanced services that are relevant, accessible to everyone and fully supported and functionally integrated with higher technical echelons of the health system. It is also important that such services involve communities and representatives of the people as co-partners in the management of health services at all levels.

A system based on primary health care is characterized by cost–effectiveness. This means that resources are allocated in such manner as to achieve the greatest benefit at the lowest cost. This characteristic of primary health care implies a health care system that a country can afford.

The health care system based on primary health care has collaborative working relationships with other sectors at all levels. It is important for the health system to articulate with other sectors at the appropriate level. For example, a health centre responsible for a defined population would need to work closely with agricultural services in identifying nutrition problems and in finding appropriate solutions or in analysing seasonal interrelationships between agricultural labour demands and disease incidence and supply and distribution problems, or in mitigating and controlling occupational health hazards from resettlement programmes or irrigation systems.

6WUDWHJ\

Clearly such goals or characteristics will not be achieved without reforms and without a strategy to achieve these aims. Such a strategy was set forth in the WHO Global Strategy for Health for All, which identified primary health care as the key to the achievement of health for all [*3*]. Central to this strategy is the development of a primary health care infrastructure aimed at health promotion, disease prevention, diagnosis, therapy and rehabilitation. It calls for a commitment on the part of all groups in society beginning with the family unit and includes health professionals, community leaders and national leaders.

The implications of such a strategy for occupational health in agriculture may be summarized as follows:

- Occupational health services must be an integral part of or fully coordinated with community and national health services.
- The services provided must be for total health and not limited to occupational diseases.
- Participation of the worker must be a constituent part of the health services.
- Coordination with other sectors, particularly labour, is essential.

- Health system personnel must be developed and trained to support the primary health care services for the agricultural sector.
- All available health human resources must be mobilized to serve through the primary health care approach.

A plan of action should be adopted to develop and test this approach in a given area or country. Such a plan would include the following logical steps [*2*]:

- Develop a concept and identify resources and select pilot areas for study.
- Develop a system (organization, management, staffing and funding):
  - primary health care worker
  - committees (workers, employers, community)
  - support system
  - record system
  - application of primary health care to agricultural workers
  - economic assessment.
- Train personnel.
- Analyse results, evaluate and adapt.
- Enact relevant legislation.

The plan may take years to implement and evaluate. Nevertheless, there are now examples of such a system already at work, for example in Botswana, Sudan, Sweden and Thailand. Central to the application of primary health care to agricultural occupational health is selection, education and training of non-physician primary health care workers.

+ HDOWK FDUH Z RUNHUV

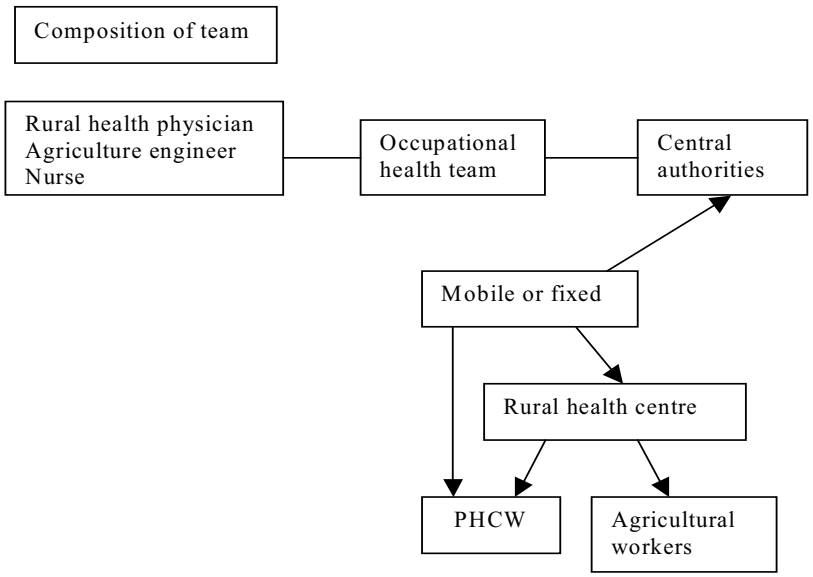
The skills and functions of the primary health care worker will clearly vary from country to country and community to community depending on local conditions. General functions which can be carried out by a primary health worker include the following:

- surveying workplaces using simple methods
- collecting biological or environmental samples
- identifying sources of injury in the workplace
- recognizing general health problems of workers, work-related or not
- referring patients when necessary to the appropriate unit in the health service
- educating and advising workers about health and safety problems
- administering first aid
- keeping simple records of individual workers, working groups and surveys.

In order to achieve the objectives of the occupational health programme within the primary health care system as economically and effectively as possible, primary health care workers will have to carry out certain prescribed functions. These workers will have to be trained in certain aspects of occupational health.

6SHFLDOL]HG PRGHOV RI RFFXSDWLRQDOKHDOWK FDUH LQ DJULFXOWXUH

Even in countries where the primary health care infrastructure is well developed, occupational health care in agriculture is often non-existent. However, several examples of such occupational health care services exist, particularly on plantations and in large-scale farmer cooperatives in some industrialized countries. In all cases it is important that the development of such occupational health services is closely integrated with existing community health and primary health care services.



3+&: 3UIP DUI KHDOWK FDUH ZRUNHU

)LJXUH 6LP SOLILHG PRGHORI SRVVLEOHLQWHJUDWLRQVKLSV LQ SUIP DUI KHDOWK FDUH DQG DJULFXOWXUDOZ RUNHUV

3 OD QMDMARQV

Health and safety services

Organized plantation occupational health and safety programmes represent a traditional approach to agricultural health services. Plantations offer many advantages which assist in the organization of such services. These advantages include a plantation community with many available basic services (water, sanitation, shelter) defined sources of information regarding the structure of the labour force (inventory of risk factors, knowledge of the type and incidence of illnesses and injuries in the plantation community), and a plantation records system for both production and occupational safety and health application. Such an occupational health care system is largely independent of other organizations, such as district health services, but is governed and guided by national or state legislation and regulatory programmes. Plantations are generally characterized by their comparatively capital-intensive agricultural methods that make use of advanced technology, including large amounts of agricultural machinery and chemicals.

Plantation community

Plantation communities comprise workers and their families, both from surrounding rural areas and from other areas of the country. The latter group of workers is known as plantation workers, while the former group of workers, from surrounding areas, may continue to practise subsistence agriculture or cash-cropping on a small scale. These two groups of workers are interrelated socially, biologically and occupationally. They are exposed to the same infectious diseases, chronic diseases, diets and natural disasters, all of which may profoundly affect their health and their working capacity.

Depending on the type of plantation, many of the workers may be migrants. Migrant workers may experience loss of family ties, changes in cultural traditions and values, and dietary and housing modifications. As a result, increased rates of alcoholism, narcotic addiction, venereal diseases, stress-related diseases, infectious and parasitic diseases, and nutritional diseases may be found among such workers.

These workers constitute a distinct occupational group. Their employers often utilize state-of-the-art agricultural technology with comparatively more agricultural machinery and more agricultural chemicals. However, plantations vary greatly not only in their agricultural practices, but also in the size and character of their workforces. Some employ thousands of workers while many are relatively small and hire only a few workers. Hence, the provision of occupational health and safety services may be similar to corporate occupational health and safety programmes for large plantations, or similar to small business occupational safety and health programmes for the small plantation.

Functions of a plantation occupational health service

The plantation occupational health and safety programme is similar to those of any other occupational health and safety service. Such services may be provided to plantation workers by extending the functions of plantation clinics and hospitals. Many of the personnel needed to operate an occupational safety and health service effectively are already employed in these facilities and involved in other public health activities on the plantation. With training in occupational safety and health, and the addition of agricultural safety engineers and agricultural extension workers who can provide environmental assessments, the role of an occupational health service may be incorporated into a plantation health service.

Cooperation with health activities and community leaders

Because of the vast size of many plantations, they often surround or border independent communities and therefore share a common environment with those communities, as well as the public health problems associated with that environment. The plantation may have a negative effect on the community, such as pesticide contamination of air and water or epidemic diseases among plantation workers. The plantations may also have a beneficial effect on the community, such as the development of water supplies and roads and the attraction of other businesses and services.

Mutual exchange of information between community and plantation health personnel may be beneficial for both public health and occupational health programmes. Because small communities often do not have health personnel trained in occupational safety and health, trained plantation personnel may provide not only community services but also community training on recognition, evaluation and control of occupational health and safety problems.

5 RO H RI I DUP HUV FRRSHUDWLYHV

A feasible means of achieving occupational health care for rural farmers may be the involvement of farmers' cooperatives. This kind of cooperation among farmers may create a framework of local bodies that are primarily concerned with technical problems of agriculture but that may also take an active interest in the creation of occupational health services for the farming population.

Preserving health mainly by preventive measures becomes an integrated part of the agricultural occupation. In developing countries, this concern by the farmers cooperatives might function as an incentive to improve primary health care. It is important that such services are closely coordinated with the primary health care system, but all activities taken to improve agricultural occupational health should be encouraged.

International agencies such as the International Labour Organisation and Food and Agriculture Organization of the United Nations provide technical and rural development expertise. The ILO aims to protect all workers through issuing special recommendations and conventions concerning working and living conditions which serve as a basis for national labour legislation.

5 RO H RI WDGH XQLRQV

Trade unions are becoming more involved in occupational safety and health and in certain industrialized nations they are employing occupational health professionals. In cooperative occupational health programmes, trade unions frequently make important contributions to the quality of the occupational health service through education and training, recommendations, participation in inspections, and participation in research projects.

5 RO H RI JRYHUQP HQW

Governments play an important role in shaping occupational health services throughout the world. Governments enact the laws, regulations and guidelines which are vital for promoting occupational health, enforcing and encouraging higher standards of occupational health, and providing sources of information, advice and consultation, particularly for those who do not have an organized occupational health service.

5 HIHUHQFHV

6 KDK 3 0 HG &KLOG OHERU D WKUHDW WR KHDOWK DQG GHYHORSP HQW * HQHYD : RUOG + HDOWK 2 UJDQL]DWLRQ

3 UP DU KHDOWK FDUH DQG ZRUNLQJ SRSXODWLRQV * HQHYD : RUOG + HDOWK 2 UJDQL]DWLRQ

* GEDOVWDWJ\ IRUKHDOWK IRUDOE\ WH\ HDU * HQHYD : RUOG + HDOWK 2 UJDQL]DWLRQ

&KDSWHU

(GXFDWLRQDODQG WUDLQLQJ UHTXLUHPHQWV IRUGHYHORSLQJ KHDOWK FDUH LQ DJULFXOWXUH

%DVLF LQIRUPDWLRQ

In order to achieve the goals of health care programmes in agriculture, it is necessary to educate agricultural workers (both unskilled and skilled), farm managers (junior, middle and senior managers) and the health officials concerned, including medical officers in rural areas, medical assistants, nurses, veterinarians, sanitarians and hygienists. Because of their varying levels of education and job demands, education and training requirements for each of these categories varies; however, there is certain basic information to be provided to all. Consideration should be given by governments to establishing educational programmes for rural health officers and agricultural workers. This basic information provided in these programmes should include the following:

- accidents in agriculture and means of prevention
- principles of chemical safety and health with an emphasis on pesticide use and prevention of chemical toxicity
- exposure to organic dust and biological hazards including zoonotic diseases and their prevention
- first aid in case of injury or acute illness
- occupational health laws and regulations
- community health problems, such as principles of sanitation with special attention to prevention of parasitic diseases particularly in the countries where they are endemic.

The suggested content of programmes for education and training of health care workers in agricultural health and safety is given in Annex 1.

For more details on content and methods of education and training of various levels of the occupational health team including the primary health care worker, the reader is referred to the eighth report of the Joint ILO/WHO Committee on Occupational Health [*1*].

3 UIP DU KHDOWK FDUH Z RUNHU

Non-physician primary health care workers should normally work at the interface between the specialized health care team and the workers. It is the primary health care worker who often best understands the problems faced by the workers and who can best communicate with the worker about measures to prevent illness and injury at work. It is therefore essential that the primary health care worker receive adequate education and training in certain aspects of safety and health. The primary health care worker should have a good working knowledge of agriculture, and ideally should have an agricultural background.

6 XSSRUWDQG UHIHUDO

In principle, support should be provided by a rural health centre if available. In this case, the rural physician should have more specialized knowledge of health in agriculture as well as access to specialized laboratories and units for referral and assistance in cases such as biological monitoring of workers exposed to pesticides, lung function studies in cases of exposure to dusts and evaluation of exposure to noise and vibration.

+ HDOWK HGXFDWLRQ IRU DJULFXOWXUDO SHUVRQQHO

The purpose of health education for agricultural personnel is to enhance awareness about the hazards to which they may be exposed and ultimately for them to take appropriate action to control hazards and prevent occupational accidents, intoxication and disease. This awareness may be created by:

- stimulating interest and educating individuals and the community through various media
- providing incentives for changing attitudes and habits
- providing practical guidance through participation of employers
- organization of educational programmes for workers in groups.

The specific learning needs of those engaged in agriculture vary greatly according to the ecological and agricultural patterns of the particular region. Small subsistence farmers have different learning requirements from those of progressive commercial farmers. There is a primary need for basic educational services for rural agricultural families in developing nations. In addition to basic education, rural agricultural dwellers need instruction in simple agrarian technology, particularly in the case of subsistence farmers. Literacy training for adults is essential for them to understand agrarian technology [*2*].

3 UIRULW UHVHDUFK DUHDV

There is a need for additional information on health of workers in agriculture. The following are research suggested priorities:

- Long-term effects of exposure to pesticides. There is evidence that exposure to certain pesticides may lead to cerebral damage as well as serious neuropathy [*3*];
- Health effects of exposure to vegetable and other organic dusts;
- Effects of combined exposure to heat and pesticides;
- Simple, practical, low-cost field equipment for the assessment of various hazards in agriculture.

5 HIHUHQFHV

Education and training in occupational health, safety and ergonomics eighth report of the Joint ILO/WHO Committee on Occupational Health * HQHYD : RUOG + HDOWK 2 UJDQL]DWLRQ 7HFKQLFDO UHSRUWV HULHV QR

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Short courses (one week to 10 days) for primary health care workers in agricultural health and safety are needed. Such courses could be held in association with other activities. Teaching materials with which to train the primary health care worker in his or her home country, state or community, should also be produced. The training objectives should include: 1) recognize health and safety hazards in agricultural work; 2) propose control measures in level of competence; 3) conduct and participate in training courses aimed at increasing awareness of health and safety issues; and 4) acquire competence in simple first aid. The course content should include the following subjects.

a) **Practical applications of health education and promotion in agriculture**

- communication with the agricultural worker
- importance and methods of "sensitizing" agricultural workers to make them more aware of occupational safety and health hazards
- the use of training tools and techniques including literacy primers, booklets and pamphlets, modular study kits, books, bulletin boards, audio aids (radio, records, tapes), visual aids (graphics, overhead projectors, films) and models or exhibitions; ideally some of these materials should be made available to the students for their later use or adaptation in their own countries or communities
- practical health promotion or wellness programmes including nutrition, exercise, sanitation and smoking cessation

b) Occupational health in agriculture

- respiratory hazards, health effects and prevention
- pesticide and other chemical hazards, health effects and prevention
- the zoonoses and parasitic diseases and their prevention
- the nutritional diseases and their prevention
- common dermatological diseases and their prevention
- recognition and evaluation of occupational safety and health hazards
- medical examinations, medical surveillance programmes and medical records and reports
- laws, regulations and other legal aspects of health effects and diseases among agricultural workers

c) Occupational hygiene, sanitation and safety

- sanitation in agriculture with an emphasis on control of parasitic diseases and pesticide or other chemical contamination
- principles of industrial hygiene including simple environmental measures, ventilation and proper work practices
- principles of agricultural safety with an emphasis on recognition of casual factors in accidents, safety devices and safe work practices
- use of personal protective equipment
- development of safety surveillance programmes and reports
- laws, regulations and other legal aspects of agricultural injuries and accidents

d) First aid

- cuts, lacerations and other soft tissue injuries
- fractures
- burns
- neurological problems or accidents involving loss of consciousness;
- ingestions and overdoses
- amputations and multiple trauma accidents
- cardiopulmonary resuscitation
- safe and efficient transportation to health care facilities