

CHEMICAL RISK IN AGRICULTURE - PRESENT STATE AND PERSPECTIVES

XII International Symposium on Ergonomics, Work Safety and Occupational Hygiene,
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The scientific programme of the XII International Symposium on Ergonomics, Work Safety and Occupational Hygiene covers the problems associated with chemical risk in agriculture, the present state and future perspectives. The programme consisted of a Plenary Session (6 presentations) and 4 Problem Sessions (32 presentations). The Problem Sessions covered the following issues:

- chemical plant protection and fertilization,
- risk associated with the application of pesticides and mineral fertilizers,
- preventive actions,
- effect of chemical agents on the human body, personal protection means.

During the Plenary Session, the activity of the Institute of Agricultural Medicine in Lublin was characterised on behalf of the improvement of work safety among the rural population. It was mentioned that the Institute was the first Polish research centre, which in the 60s of the 20th century undertook studies in the area of physiology of work in agriculture and forestry, and evaluated the severity of work in these sectors of production. At present, the priority directions of the Institute's research are: work safety and occupational hygiene, with particular consideration of private farming, development and implementation of the programmes and training courses in the field of work safety, ergonomics and occupational hygiene in agriculture, as well as health promotion in rural areas.

Further presentations at the Plenary Session discussed ergonomic achievements in agricultural engineering in the past 50 years, which meant an improvement, or in some cases, the transformation of an industrial product, introduction of new research methods practically in each area of engineering, standardisation of a product, equipment and methods, which would enable international industrial and scientific co-operation.

Due to an increase in common application of electronic devices in tractors, machinery, storage rooms and processing of food products, as well as computer software, the information load among operators in agriculture should be considered, and the consequences of the effect of this factor on man.

Attention was also paid to the tendencies of changes on the level of ergonomics and work safety in Polish forestry. The introduction of a mechanised, modern and ergonomic performance of forestry work activities in Poland encounters many barriers and difficulties (mainly financial); therefore, the majority of the work activities performed are characterised by a high level of work load, a relatively low level of safety and high risk of occupational diseases. However, within the perspective of more than 10 years we should anticipate an intensive development of mechanised performance of forestry tasks, and connected with it a considerable improvement in ergonomics and work safety.

At the Plenary Session, the problem of accident rates in private farming was discussed, which is still current with respect to the fact that the number of accidents remains high, whereas the financial and moral effects of these accidents are directly or indirectly suffered by the whole of society. The Symposia organised at the Institute contributed to increasingly wider understanding of the problem of work safety in agriculture, and attempts to find solutions.

The activity of the Agricultural Social Insurance Fund (KRUS), which is reflected in the promotion of safe products, greatly contributes to the prevention of accident risk in agriculture. While investigating the circumstances and causes of accidents in agriculture, the KRUS has the possibility to select machines and equipment which are the safest, and such products of Polish and foreign manufacture may be attributed the 'KRUS Safety Sign'.

Within the scope of problems concerning chemical plant protection and fertilization (the first Problem Session - 6 presentations), special attention was paid to the current directions in plant protection, environment and consumer protection, and regulations concerning fertilizers economy. The negative effects of the mass application of chemical plant protection products forced actions towards the control, or even total elimination, of the existing risk. A concept of integrated protection developed by the sciences was transferred to production technologies. The chemical industry synthesised and introduced new groups of compounds which are characterised by lower toxicity and application in low

doses, e.g. preparations of a new group of strobilurin fungicides or sulfonylurea derivatives. Also, the engineering industry designed new equipment for performing chemical treatment, characterised by high precision and safety for users. New methods of identification of agrophages and the need for chemical treatment were also developed, the systems of allowing plant protection products for placing on the market and admittance for use were expanded, also control systems were implemented covering, among other things, an analysis of residues and quality of plant protection products.

In Poland, the basic legal act concerning plant protection products is the Act on Plant Protection of 18 December 2003 (Official Journal, 2004, No. 11, item 94), and regulations concerning the scope of studies which should be conducted before an agent is allowed to be placed on the market and admitted for use, as well as detailed principles of evaluation of plant protection products.

Studies conducted in the form of a survey concerning the degree of pesticides use on private farms during the period 1999-2005, showed that in the case of agricultural crop-growing, herbicides are dominant for the protection of sweet corn against weeds, and the control of weeds in the cultivation of tricale and potatoes. On horticultural farms, the level of pesticides applied does not change greatly; however, changes are observed in the assortment of pesticides used.

Issues concerning the economy of fertilizers are regulated by the Act of 26 July 2002 concerning fertilizers and fertilization (Official Journal 2002, No. 89, item 991, and Official Journal 2004, No. 91, item 876), two Regulations by the European Parliament and of the Council (No. 2003/2003 of 2003, and No. 1771/2002 of 2002), the Regulations by the Minister of Economy and Labour (30 May 2001, 19 May 2004 and 13 May 2004), and the Minister of Agriculture and Rural Development (19 October 2004, 1 June 2001 and 27 June 2005).

The second important scope of issues discussed during the Symposium (second Problem Session - 13 presentations), was risk connected with the application of pesticides and mineral fertilizers. This covered the problems associated with environmental and health risk resulting from the application of plant protection products and the environmental effects of fertilization.

Environmental risk assessment is conducted according to SANCO, EPPO, and SETAC guidelines. The following factors contribute to this evaluation: dose of the agent, method of application, degradation rate of the active substance, number of applications during the vegetation season, and type of crop on which the product is applied. The next step in the risk assessment is determination of the hazard quotient - HQ (in case of bees and arthropods) and the value of TER (for the remaining organisms).

As confirmed, the application of pesticides in the protection of plants against various types of biocides simultaneously affects the quality of agricultural products in a definitely negative way. A part of the chemical

substances remains in agricultural products designed for consumption and processing and creates risk for consumers' health. The results of the studies showed that over 75% of chemical substances analysed were present in vegetable products. These were most frequently active substances classified into fungicides and acaricides in cases where main consumption portion were fruits, and herbicides, when plant roots or leaves were used.

Occupational exposure during the distribution of plant protection products evokes reservations in the private sector due to the fact that the places selling chemical preparations are most often located in housing buildings, where the hygienic and social base is insufficient.

In addition, the performance of chemical plant treatment, by increasing year by year the number of private farmers, creates a serious health risk because this treatment is not covered by any surveillance, farmers are insufficiently equipped in personal protection products, and the technical state of these means is insufficient.

It was confirmed that the application of a chemical preparation in the form of micro-capsules with suspension and the performance of treatment by a low value method allows the elimination of work activities most dangerous for workers and associated with the preparation of application liquid and the filling of the sprayer.

Based on literature review, chronic health effects associated with pesticides cover carcinogenesis, reproduction, development and immunological disorders. It is presumed that toxic effects are generally greater in children than adults.

Two presentations concerning the application of GIS techniques (Geographical Information Systems) and remote sensing in studies of the effect of pesticides contamination on the natural environment (including drinking water pollution) and public health evoked great interest. The sources of information may be cartographical (e.g. maps), remote sensing data (aerial and satellite imagery), ground measurements, and others. The usefulness of GIS as a tool was confirmed in studies concerning public health, which helped prevent an excessive and uncontrolled exposure to xenobiotics, including pesticides. Also, the application of the GIS technique and remote sensing allowed the evaluation of the effect of geophysical conditions (land slopes, distances between water sampling sites, ground waters, and orchards) on the contamination with pesticides of drinking water in the regions of intense agricultural production (orchards).

The evaluation of occupational risk on chemical substances present in the work environment (including pesticides) is based on the application of correct and precise analytic methods, which would allow the determination of the concentration of these substances in the air on the level of safe concentrations. Since 1980s of the 20th century, the Institute of Agricultural Medicine has developed methods for the determination of biologically active substances entering the composition of plant protection products. To date, 37 methods have been

developed at the Institute, and 29 standards for determination of pesticides in the air at workplaces developed, based on these methods, published by the Polish Standardisation Committee as the Polish Standard.

The second problem presented within the second Problem Session were hazards connected with the fertilization of plants. Recently, increasingly more attention has been paid to the effect of agriculture (fertilisation) on the state of the hydrosphere. In agricultural areas, a division is made between point contamination - introduced into water or soil at precisely defined sites, and area contamination - i.e. contamination which flows from the area of agricultural catchment as a surface runoff, or are transported into soil with water penetrating through the soil profile. As a result of the application in agriculture of mineral, natural, organic fertilizers, sewage and waste materials, an increase is noted in the contamination of agro-ecosystems with heavy metals, which leads to their accumulation in individual links of the ecological chain: soil-plant-man, even to toxic levels.

In agricultural areas located at a long distance from large habitation and industrial centres, and main roads roads, the primary sources of heavy metals accumulation are fertilizers and plant protection products applied. Phosphorus fertilizers, communal and industrial waste materials applied as organic fertilizers are the main source of lead and cadmium; therefore, the quantities of fertilizers applied will be - apart from the properties of soil - the primary factor deciding about the quantity of heavy metals in soils of agrocenosis. An increasingly greater role is also ascribed to natural fertilizers from farms where copper and arsenic compounds are used for fodder supplementation. In agriecosystems, metals are also introduced into the food chain as a result of animal grazing and cultivation of plants in the vicinity of industrial enterprises and roads with dense traffic. In previous years, plant protection products were important carriers of heavy metals. Recently, however, copper and zinc compounds are only present in fungicides for preventive effect.

The participants were also made familiar with special chemical hazards occurring on farms. Litter-free technologies in animal production lead to the production in dung tanks of toxic or oxygen replacing gases, which are dangerous for humans, as well as for animals. The following gases accompany the collection of dung and emptying of tanks: hydrogen sulfide, ammonia, carbon dioxide and methane. During the production of fodder in the form of silage, especially in gas proof storage silos - as a result of fermentation processes - the level of oxygen in the surrounding atmosphere decreases and is replaced primarily by carbon dioxide. Fermentation processes also lead to the production of nitric gases.

Relatively important but poorly recognized problems are agricultural hazards associated with the veterinary service. Common application of veterinary medicinal products creates risk for people who have contact with

these products or its ingredients (before administration, during drug storage and administration), and due to direct contact with the treated animals. This group covers doctors, animal breeders, care providers, pet owners, sheepshearers, workers in fodder mixing rooms who prepare medicated feeds.

The second source of risk for humans is possible exposure of the consumers of animal products to the residues of drugs applied to animals.

The third Problem Session (7 presentations), concerned prevention actions and covered such issues as pesticides wastes disposal, environmentally friendly spray application techniques, ecological farming and training in the safe and correct application of plant protection products. The problem of disposal of pesticides wastes is primarily a matter of disposing by a thermal method of so-called historical wastes, accumulated mainly during the period 1965-1985 in so-called thumbs (underground tanks). It is estimated that there are still 160 graveyards awaiting disposal (7,500 tons of wastes). It is planned that the disposal activities will be completed by the end of 2010.

The chief source of environmental pollution in plant protection are point contamination and spray drift. In field crops, the spray drift can be significantly decreased by the use of air-assisted booms, whereas in fruit-growing - tunnel sprayers. Safe application of chemical plant protection products is based on the application of proper procedures during spraying, ways of preparation of spray liquid, usage of protective clothes and principles concerning the procedures of the disposal of spray liquid residues, and management of empty packages.

Ecological farming is a panacea for the increasing contamination of the agricultural environment. Ecological farming is a system of production based on the usage of natural processes taking place within the farm. This system excludes the application of synthetic substances, such as synthetic fertilizers, chemical pesticides, growth hormones, etc. The state of contamination of soil and plants on ecological farms is constantly monitored.

Plant-related contamination of food with heavy metals may be decreased by proper selection of species and varieties cultivated on soils with an elevated content of these metals. In the case of moderate contamination of soil, agrotechnical measures are applied (liming, organic fertilization and phosphatic fertilization), which enable the reduction of bioavailability of metals from soil and decrease their contents in plants to the level which does not threaten consumers' health. The studies showed that due to the application of soil liming, it is possible to decrease the contents of lead and cadmium in vegetables (cabbage, beetroot, lettuce, leeks, celery) to 12% for cadmium, and 9.2% in the case of lead. A decrease in the levels of cadmium and lead was also obtained after fertilization with manure and green manure (*Phacelia*, *Vicia faba minor*).

In animal production (intensified swine breeding), the unfavourable effect on the environment is eliminated by

the application of so-called proecological technologies of production. Proecological, environment friendly solutions are those which limit the emission of so-called hazardous gas admixtures (ammonia, methane, nitrogen oxides and hydrogen sulfide). Currently, deep straw bedding and sloped floor pens are of the greatest importance among the systems. For litter-free swine farms, various methods of storage (reduction of the area of the deposition of excrements, separation of the liquid phase from the solid phase, quick removal) and utilization (anaerobic digestion and thermophilous stabilization) of dung are offered.

Agricultural advice plays an important role in the dissemination of safe application of pesticides. The low level of education among rural inhabitants is one of the important barriers in the acceleration of the process of reform in rural areas and agriculture in Poland. This also concerns safe and proper application of plant protection products (only about 120,000 farmers completed training courses in the area of pesticides application, and only about 50% of the 310,000 sprayers have a valid technical efficiency certificate).

The fourth Problem Session (6 presentations), was devoted to the effect of chemical agents on the human body and personal protection equipment. Dangers associated with the application of pesticides deserve special attention among health risks caused by chemical substances. Acute poisonings with pesticides are a serious problem for toxicological treatment. With the development of agricultural chemicalization in the end of the 1960s and 70s, a systematic increase was observed in the number of poisonings with plant protection products. In some years, pesticides occupied even the third position among factors causing acute poisonings, after alcohol and carbon monoxide. Throughout the 1980s and the beginning of the 90s, the number of acute poisonings still remained high, whereas a decrease was noted in the number of poisonings with organophosphorus compounds, and an increase in the number of poisonings with pyrethroids. Since the mid-1990s, a decrease in the number of poisonings has been observed (new legal regulations concerning the access to plant protection products). In recent years, over 100 cases of acute poisonings with pesticides have been registered.

Experimental studies on animals showed that pesticides are quickly absorbed through the alimentary tract and skin, causing defined morphological disorders. The

largest amount of pesticides reaches the organs, which are most active metabolically (liver, kidneys, lungs). A long-term presence of pesticides in the body results most probably from impaired detoxication in the liver and impaired excretion by the kidneys and lungs, which changes as a result of exposure to the pesticides examined. The disturbances of the processes connected with so-called 'oxygen burst' may consequently contribute to an increase in human morbidity due to contagious diseases and cancer.

Within this session, the presentation included an interesting discussion on the occurrence of toxic metals (lead and cadmium) in the blood of women at childbirth and in the umbilical blood of their newborns, as well as in the blood and hair of children and adolescents. It was noted that the allowable levels of lead and cadmium were exceeded both in children and adults.

Due to the lack of the possibility to totally eliminate risk in agriculture, there is a need to apply proper preventive actions consisting in the usage of means of personal protection equipment. The following personal protection equipment may be identified: devices for respiratory protection, protective clothes, gloves and boots. From the aspect of the application of the given group of personal protection means, the problem of their proper selection for the existing or anticipated risk is of the utmost importance.

120 researchers from Poland and abroad participated in the Symposium. The publication of the full versions of the presentations in the form of a monograph planned by the organizers of the Symposium will provide a better knowledge of the presented problems. We also express the hope that the publication will evoke interest among those who make decisions in the area of chemical risk in agriculture, and will furthermore contribute to the undertaking of proper actions in order to improve the state of the environment of life and work in agriculture.

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