

## EXPOSURE TO DUST AMONG AGRICULTURAL WORKERS

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**Abstract:** The authors present results of studies of occupational exposure to dust in agriculture, conducted for the first time from the aspect of work site. Two work sites, typical of Polish agriculture, were considered: a tractor driver on a large state owned farm and a farmer on a private family farm. The studies covered all occupational activities performed within the annual work cycle. The results of the studies showed that the working conditions in agriculture were hazardous and exposure to dust was of a changeable character. This is due to the varied levels of dustiness according to the type of occupation and unequal distribution of working time.

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## INTRODUCTION

Studies concerning occupational exposure to dust among farmers are justified because of the insufficient research in this field; such study should approach the whole of a farmer's work from the point of view of the work site. Unlike in industry, exposure to dust at this work site takes place in changeable conditions - with respect to concentration and composition of dust, work post and daily working time - also during the prolonged work cycle which, in the case of plant production may even take a whole year [7, 11, 14].

Apart from high air temperature, vibration and noise, agricultural dust is considered by farmers themselves as an unfavourable factor which most often accompanies their occupation [2, 12]. Epidemiologic studies carried out among farmers indicate a clear relationship between the occurrence of dust-related pathologic symptoms, concentration of dust and its pathogenic components and the period of occupational exposure to agricultural dust; however, the lack of data concerning the exposure does not allow us to discover the relationship between exposure and health effects [1, 5, 6, 8, 17].

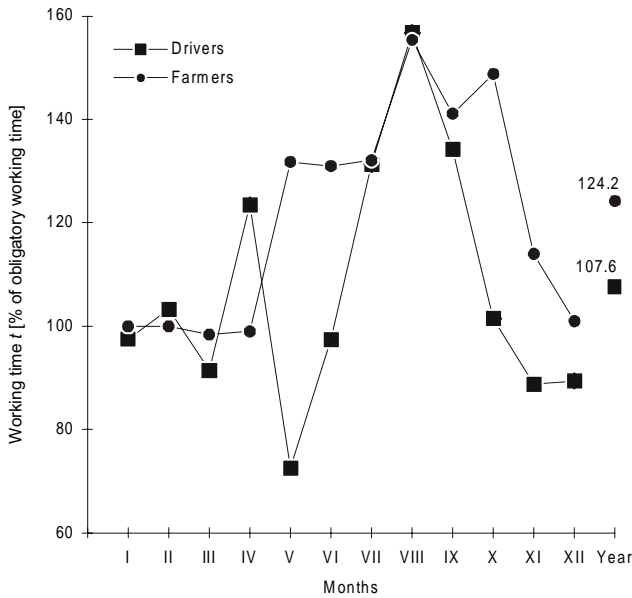
The results of hygienic studies conducted in Poland and other countries determine merely the dust risk while performing selected field or household occupations. These results do not constitute a basis for determining the actual exposure and, at the same time, health risk connected with work in agriculture [3, 4, 9].

The aim of this study was to evaluate the occupational exposure to dust in agriculture. The study covered two work sites typical of Polish agriculture: tractor and self-propelled machine drivers on large state owned farms, and the work post of a farmer on a private family farm.

## MATERIALS AND METHODS

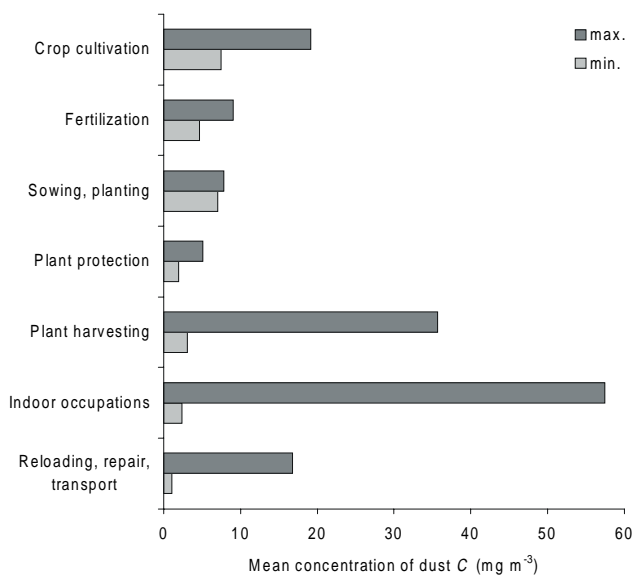
The sites of the studies were two agricultural concerns in the regions of Lublin and Chełm and seven private farms in the commune of Niemce in the Lublin region. The studies covered a group of 10 tractor drivers - males aged 30–51, and a group of seven private farmers - males aged 21–42.

The study covered determination of the concentration of total inhaled dust, concentration of free crystalline silica dust SiO<sub>2</sub>, and analysis of time schedule documentation. The

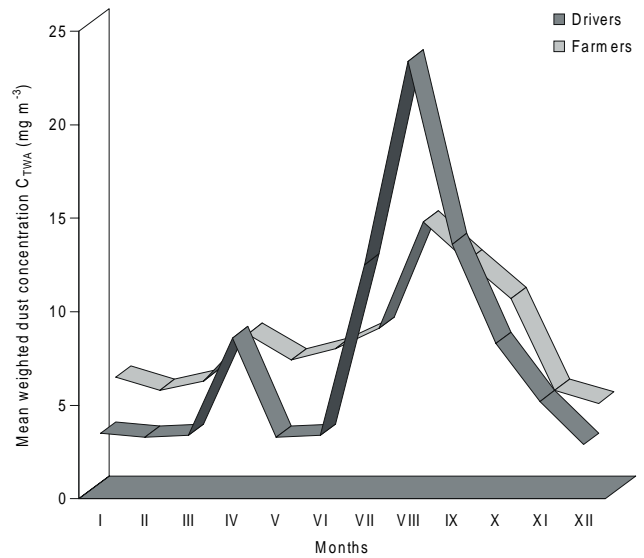


**Figure 1.** Distribution of working time in annual work cycle among drivers and farmers.

measurements of the level of total dust were carried out by filtration-weighing method, taking samples on polychlorovinyl filters within the farmer’s respiratory zone with the use of Polish-made AP-2 personal dust samplers [15]. Free crystalline silica was determined in samples of total dust by selective colorimetric method, eliminating silicates and amorphous silica. The method consists in slow crystallization of silica into a soluble sodium silicate and colorimetric determination of silicate ions [16]. The time schedule study was based on the documentation kept by the administration of the agricultural enterprises and the log-books kept by private farmers.



**Figure 2.** Levels of dustiness in individual groups of farming activities.



**Figure 3.** Distribution of exposure to dust in annual work cycle among drivers and farmers for all examined individuals.

The examinations covered all occupational activities performed within the annual work cycle. The exposure of a farmer to dust was assessed by comparing the mean weighed concentrations  $C_{TWA}$  (time weighted average) and the proper threshold limit value OEL (Occupational Exposure Limit), selected according to the level of  $SiO_2$  in the agricultural dust examined [18], with the application of the criterium of confidence interval of this mean.  $C_{TWA}$  was calculated according to the formula:

$$C_{TWA} = \frac{\sum_{i=1}^n C_i \cdot t_i}{8 \cdot N}$$

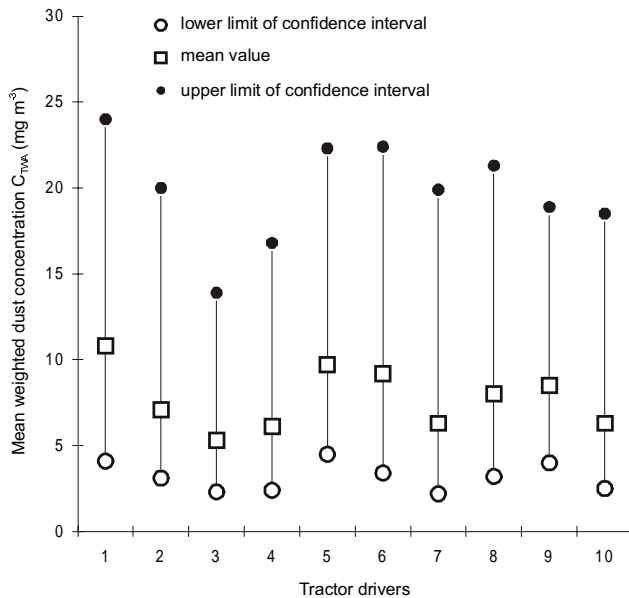
where:

- $C_i$  - airborne dust concentration for each activity in a full work cycle, [ $mg\ m^{-3}$ ]
- $t_i$  - working time for each activity, [h]
- 8 - eight hour shift, [h]
- N - number of obligatory work days in a full work cycle

Exposure to dust was qualified as harmful when  $C_{TWA}$  value was higher than OEL value, especially when the whole confidence interval was above the standard [5, 10, 13].

## RESULTS

**Working time.** An annual working time among the workers in the study exceeded the obligatory working limit of 2,104 hours by 7.6 % in the group of tractor drivers, and by 24.2 % in the group of private farmers. In both groups a monthly analysis showed that the work load varied during one year. The highest work load was observed during the period April-September, with maximum values noted in August - up to 160 % of obligatory working time on average (Fig. 1).



**Figure 4.** Annual mean level of exposure to dust in ten individual tractor drivers.

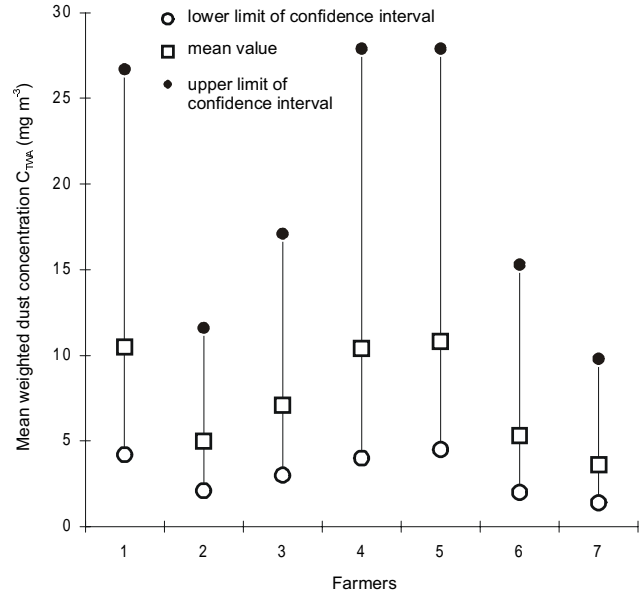
**Level of dustiness.** The level of dustiness varied according to the type of work. Among 42 types of occupation the highest amounts of dust were observed during threshing - an indoor occupation ( $57.5 \text{ mg m}^{-3}$  on average) and during combine harvesting of grain ( $35.7 \text{ mg m}^{-3}$  on average) (Fig. 2).

**Level of exposure.** A monthly analysis indicated an unequal distribution of the level of exposure during a year. The highest exposure was observed in August:  $23.4 \text{ mg m}^{-3}$  in the group of tractor drivers, and  $14.2 \text{ mg m}^{-3}$  among private farmers (Fig. 3). The calculated annual mean weighted values for the concentration of dust at the work site of 10 examined tractor drivers remained within the values  $5.3 - 10.8 \text{ mg m}^{-3}$  (Fig. 4), whereas for seven examined private farmers it was within the values  $3.6 - 10.7 \text{ mg m}^{-3}$  (Fig. 5). All these values were above the maximum allowable value of  $2.0 \text{ mg m}^{-3}$  and in the zone of hazardous working conditions.

## DISCUSSION

Due to the specific character of production processes in agriculture, workers employed in this sector of the economy are exposed to dust in changeable conditions, associated with a variety of work activities, variability of concentrations and composition of dust, work site and the daily time of exposure, as well as the duration of working cycle, which in plant production covers the whole year. Studies of the level of exposure to dust among operators of tractors and self-propelled machines, as well as private farmers, confirmed this changeability in all the aspects mentioned.

It was observed that the level of exposure at both workplaces varied during the year. This was due to the



**Figure 5.** Annual mean level of exposure to dust in seven individual private farmers.

technological distribution of occupations within the working cycle, their time consuming character and variations in the level of dustiness accompanying these occupations.

The variations in the level of dustiness were associated not only with the type of occupation, but also with the variability of conditions accompanying work, such as: weather and soil conditions, degree of humidity of the raw material harvested, the type of machines and equipment applied, or means of their utilization. An especially wide spread of results, which should be attributed to the conditions mentioned, concerned field work - e.g. the ratio between extreme values of dust concentration noted during ploughing was 1:40.

Unequal working time load during the year had similar dynamics of distribution for both workplaces; however, an annual summing-up showed that work on a family farm was more time consuming, compared to that on a state owned farm. In both cases the legal working time was exceeded: in the group of operators by 7.6%, and in the group of farmers - by 24.2% on average. This could be due to the time consuming manual occupations associated with the cultivation of crop and everyday care of breeding stock, which creates a type of background in the annual work of a private farmer. In the case of tractor operators, such a background may be ascribed to transport occupations, which are a permanent and basic component of working activities performed during subsequent months.

Mean weighted values calculated for the annual working cycle in 17 workers covered by the study, representing an average annual level of dustiness at workplaces of drivers and farmers, remain above the occupational exposure limit - within the sphere of hazardous working conditions. The span of the values obtained is noteworthy for both groups. In the case of state owned farms, a driver performs occupations

assigned by the work organizer, i.e. range and time distribution, and consequently the level of exposure to dust is of a random character and changes for individual drivers in subsequent years. For private farmers, the level of exposure is associated with the type of farm: type of crops, technologies applied, size of cultivated land, size of breeding stock, number of people cooperating in running the farm. Thus, the variations observed in this group result from the individual character of the farms in the study. Changes in exposure to dust among individual farmers during subsequent years depend on the changes within the quoted features of their own farms.

In the light of extant studies of dust in Polish agriculture and other countries [3, 4, 9], which merely concern dust risk while performing selected occupations, the results presented in this paper constitute the first attempt to recognize the exposure to dust at workplaces in agriculture during an annual cycle. The present study concerns workplaces typical of Polish agriculture: tractor driver and operator of self-propelled machines - a work site characteristic of large multiproduction state owned farms and private farmers, who are the core of the Polish agriculture. We should, however, expect evolutionary changes towards family farms of optimal economy.

The high level of exposure to agricultural dust containing components of confirmed pathogenic properties, noted among tractor drivers and farmers, was based on the studies of the total dust. A more comprehensive recognition of exposure requires further studies with the consideration of the respirable fraction and various conditions of this exposure. The evaluation of exposure creates a possibility to evaluate the health risk among the farming population, which to date has not been covered by legal regulations concerning health protection of the working population.

## CONCLUSIONS

The studies of occupational exposure to dust in agriculture, conducted for the first time from the aspect of work site in annual cycle:

- showed that the working conditions were hazardous;
- confirmed the changeable character of exposure;
- indicated the necessity for applying a special strategy in order to measure and evaluate the level of exposure in the agricultural working environment;
- indicated the necessity for farmers to apply technical prophylactic means.

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