

# *Rural workers' health related to the use of pesticides in developing and developed countries*

*Saúde do trabalhador rural relacionada à utilização de agrotóxicos em países em desenvolvimento e desenvolvidos*

Enilce Maria Coelho\*  
Fábio Cunha Coelho\*\*

This review aims to examine the issue rural workers' health and the use of pesticides in its various aspects, especially emphasizing how that is doing in developing and developed countries. We found that the rural workers pesticide contamination problems occur both in developing countries as in developed countries. We concluded that to ensure the rural workers' health when they use pesticides becomes necessary to increase the training of workers. It is also important to build political agendas and actions in the health of agricultural workers, with implementation of preventive health programs with greater oversight and monitoring on pesticide use.

Keywords: Worker safety. Conventional agriculture. Crop protection.

*Esta revisão tem por objetivo analisar a questão da saúde dos trabalhadores rurais quanto à utilização de agrotóxicos, especialmente enfatizando como se tem tratado essa questão em países em desenvolvimento e desenvolvidos. Verificou-se que os problemas de contaminação ocorrem tanto nos países em desenvolvimento quanto em países desenvolvidos. Concluiu-se que, para garantir a saúde dos trabalhadores rurais quando na utilização de agrotóxicos, torna-se necessário aumentar a sua formação. Também é importante estabelecer agendas e ações políticas relacionadas à saúde dos trabalhadores agrícolas, com a realização de programas de saúde preventiva com maior supervisão e monitoramento no uso de agrotóxicos.*

*Palavras-chave: Segurança do trabalho. Agricultura convencional. Defensivo agrícola.*

## **Introduction**

The indiscriminate application of pesticides affects both human health and natural ecosystems. The use of pesticides in agriculture can be justified by the need to increase agricultural production, but behind the use of these substances are the risks of occupational diseases confirmed by studies that focus primarily on specific types of substances (SILVA & SADI, 2006). The epidemiology of the use of pesticides in agriculture should be seen not only in terms of consumers, but in view of occupational hazard among farmers or rural workers.

\* D.Sc. Engenharia Agrícola pela Universidade Federal de Viçosa. Professora do Instituto Federal Fluminense, Campos dos Goytacazes, RJ – Brasil. E-mail: enilcecoelho@yahoo.com.br.

\*\* D.Sc. Fitotecnia pela Universidade Federal de Viçosa. Professor da Universidade Estadual do Norte Fluminense Darcy Ribeiro, Campos dos Goytacazes, RJ – Brasil. E-mail: fabiocunha@gmail.com.

In general, there is a false thought that in the developed countries there is no problem related to poisoning of farm workers by pesticides. According to the "Centers for Disease

Control and Prevention" of the United States, agriculture is the most dangerous industry for American workers, affecting mainly the younger ones. It was found that 76% of agricultural workers suffered fatal accident were under 16 years and worked in an agricultural family business that was exempt from child labor laws (CENTERS FOR DISEASE CONTROL AND PREVENTION. NIOSH, 2003).

Pesticides have been widely used to control pests and diseases related to agriculture, fisheries, forestry and food industry. Throughout history it was necessary to create laws that establish safety rules regarding the use of pesticides in order to reduce their impact on the environment and the health of farm workers. Leaflet and label are examples of this and are the main sources of information for rural workers, helping to prevent accidents and consequently poisoning (ZAMBRONE & CORREA, 2008).

This review aims to examine the issue rural workers' health and the use of pesticides in its various aspects, especially emphasizing how that is doing in developing and developed countries.

## ***Methodology***

We utilized the site periodic capes ([www.periodicos.capes.gov.br](http://www.periodicos.capes.gov.br)) and the key words utilized were: "segurança and agrotóxico" and "rural work and pesticide". The time was the last 10 years. We found 75 citations and selected 35 than talked about rural workers' health related to the use of pesticides. These 35 citations, 14 were in Portuguese language: 11 papers, 1 dissertation, 1 book and 1 technical bulletin and 21 were in English language: 18 papers, 2 books and 1 technical bulletin. We found mainly citations of the last five years (57.2% - 20 citations) and the most of the selected citations talked about Brazil (13) and United States (8).

## ***Results and Discussion***

### ***Rural workers' health and the use of pesticides in developing countries with emphasis on Brazil***

There are many problems related to contamination of farm workers due to the use of pesticides. In developing countries occur many cases of accidents due to the misuse of pesticides. As Brazil is the developing country that currently uses more pesticides certainly should be the country with the highest or with a lot of contamination of rural workers.

Brazil cultivated 95 million hectares in 2012, and Mato Grosso state was the major consumer of pesticides. PIGNATI et al. (2014) in their research, the database of the Agriculture and Livestock Defense Institute was consulted, as it records the prescribed agronomic data and place of use in sales invoices. The results reveal the average consumption of pesticides per hectare per crop: 12 liters for soy; 6 liters for corn; 4.8 liters for sugarcane; and 24 liters for cotton. The authors said that based on pesticide consumption, agricultural production and pesticide toxicity it is possible to ascertain health problems in Brazilian cities and establish prevention and surveillance strategies for the workers, the environment and the populations exposed to pesticides.

MASCARENHA et al. (2013) conducted a study about rural workers' health and the use of pesticides in Brazil through an integrative literature review of articles dated from 2005 to 2012. This study showed that most publications considers that the shortcomings of the applicator are the main boosters determinants of contamination by pesticides among residents of rural areas. According to NETO et al. (2014), pesticides are used abundantly driven by agribusiness, but it can cause damage to the environment and health and its use should be supervised by the society and sectors of agriculture, environment and health. Therefore, in order to identify and evaluate these actions the authors conducted interviews with managers and employees of the Municipal union leaders and workers and farmers, grain producing cities of Mato Grosso state - Brazil. They found in the discourse of managers and farmers the belief that pesticides are essential to agricultural productivity and do not generate impacts on health and the environment and identified no development of surveillance actions of pesticide use. The authors concluded that there is need to develop a model of sustainable agriculture, healthy and pesticide free and that organized society and the responsible institutions must build actions that meet the interests of the population living work in the field or consuming products harvested there, especially controlling risks and repercussions that can and should be avoided.

De ARAUJO-PINTO et al. (2012) in their research sought to identify the main risks to the health of farm workers and the environment associated with pesticide use in the Rio de Janeiro state - Brazil, based on analysis of official public documents and literature review applying force model driving-Pressure-State-Exposure-Effect-Action (DPSEEA) of the World Health Organization (WHO). They evaluated family farming in the mountain region and the monoculture of sugarcane in the plains. The results showed that most of the identified determinants are related to deficiencies in enforcement actions and monitoring of pesticide use as well as the lack of technical assistance provided by the public sector in Rio de Janeiro.

In developing countries the majority of workers have a hard time reading the safety instructions on the label of products due to their low level of education. So ZAMBRONE & CORREA (2008) evaluated the level of understanding of sharecroppers of tomato plantations in Sumaré-São Paulo/ Brazil about the first aid information contained in

the leaflet / pesticide label. Most of the respondents had incomplete primary education. The names of pesticides were unknown by 58.8% of respondents and only 32.5% had read label / pesticide label and, among those who found difficulty in reading and the presence of difficult words was the main reason the difficulty. LABINAS et al. (2010) performed work in order to convey to growers and rural workers, health information, safety, correct and safe use of pesticides. Trainings were conducted at 127 rural workers in Guapiara and Ribeirão Branco towns, São Paulo, Brazil. It was observed that 73% of owners had never participated in such training and that 34% of pesticide applicators did not know the meaning of the colored bands on product labels, indicative of toxicity, concluding that there is a lack of information from the rural workers in the region studied.

GEBLER (2007) points out in his article the importance of awareness among apple producers in Brazil about the risks of investing in inappropriate planning. He stresses the importance of planning the security, especially related to the use of pesticides, respecting the law and the environment, since the existing production systems for apples in Brazil, the main environmental risks directly linked to end pesticides. Similarly, the findings of the study in India of KUMAR et al. (2013) emphasize the need to educate agricultural workers regarding safe and adequate use of pesticides to prevent health and environmental hazards

SILVA (2008) conducted a study to establish the health profile of the elderly population of Cachoeira do Sul town – Rio Grande do Sul state - Brazil subject to direct or indirect exposure to pesticides. A questionnaire was applied in urban and rural areas, individuals of both sexes and above 60 years of age. They observed a positive correlation between exposure to pesticides and forgetfulness, constipation, leg pain, Parkinson's disease and diabetes mellitus. The need to implement the health surveillance of workers exposed to pesticides in the routine activities of the family health strategy has been shown in research by ARAÚJO (2012) in Chã Grande town, Pernambuco state, Brazil. It was found gradual increase of the pathologies that could result from pesticide contamination, such as neoplasms. The author emphasized the importance of implementing the educational work among the population.

According to TRAPE (2011) for occupational exposure to pesticides can occur through dermal absorption and respiratory tract and, depending on the duration of exposure, intoxication may be acute or chronic, making it essential to use individual protection equipment (IPE) that are intended to reduce the exposure, thereby minimizing absorption of pesticides, and therefore decreasing the quantity of product that reaches the targeted organs. On the one hand, TÁCIO et al. (2008) evaluated the potential dermal and respiratory exposure afforded to tractor drivers in pesticide sprays and the efficiency of two protective clothing and safety. These authors evaluated the use of 17 pesticides in guava crops in Vista Alegre town-São Paulo state - Brazil. The potential dermal exposure of the tractor by working conditions was 3807.3 mL

syrup / 7 labor hour and that the efficiency of personal protective set “Agro Light” was 96.7%, and the “Azeredo”, 96.2% and the potential dermal exposure in the most exposed areas of the body of the tractor spraying, in descending order, were the legs, arms, thighs + front-legs and the trunk behind. It was classified as safe three sprays of the 17 pesticides analyzed, seven with the use of personal protective clothing and the others were classified as unsafe.

ÁVILA et al. (2009) in their work investigated the use of pesticides in Campos Altos town Minas Gerais state - Brazil. A questionnaire was applied to 34 workers in the region. The results showed that among the pesticides used, the Dissulfan presents the greatest degree of toxicity. Only three respondents claimed to use all individual protection equipment (IPE) and three respect the grace period. The authors observed that the lack of information about the harmful effects of pesticides, the no use of IPE and disrespect the pesticide grace period are the determinants of poisoning cases and prevalence of symptoms. Also YANG et al. (2014) found in China, on Wei River catchment, that the majority of farmers never used any protective measures during pesticides spraying.

In order to characterize flaws in the protection of rural workers in the use of pesticides in areas of horticulture and horticulture in São João da Barra town, Rio de Janeiro, COELHO & COELHO (2008) found that the range of re-entry after application of pesticides was not respected and that farmers in this region also did not use signs of sprayed fields with pesticides. They also found that the number of training courses offered was short of demand and that they were not provided IPE, most of the time. They also noted that when IPE were supplied, workers were reluctant to use them, or used improperly, and many reuse empty containers of pesticides, not intended to receiving units.

SELMÍ & TRAPÉ (2014) evaluated the different methodologies to quantify the dermal exposure to pesticides that are used in the risk assessment process to the health of rural workers, among them the patches or full body in Brazil. The authors considered that various methods have limitation to the process, since they can't produces similar results due to differences in principles involved in the collection of samples. They also emphasized the importance of discussion about it and to highlight the need for actions that contribute to the establishment of a single methodology to quantify the dermal exposure of agricultural workers, for the harmonization of methodologies contribute to the achievement more safe and healthy working conditions, main for enabling to obtain more reliable results and thus establish, ensure and improve the process of preventing harm to workers' health.

SOUZA (2008) conducted a survey of rural workers in Sorocaba town, São Paulo. It was concluded that it is necessary an awareness of everyone involved as it is in the interest of the whole community, the countryside and the city, whereas the final product of agricultural production is consumed by all. Still, in his conclusion, he says

that despite the mission be difficult, it is quite possible to be achieved, provided there is integration of the organs of federal, state and municipal governments with regard to the effectiveness of worker protection policies through campaigns to respect the labor laws, especially the law Regulatory Standard 31 (NR-31), of the Ministry of Labor and Employment of Brazil.

ANDRADE-RIVAS & ROTHER (2015) made a study it aimed to understand workers' low IPE compliance (particularly workers who apply herbicides for Working for Water (WfW) – a South African invasive alien vegetation control programme) by analyzing their risk perceptions of herbicide use, working conditions and socio-cultural context. Interestingly, teams comprised of mostly women had the highest compliance rate. These findings highlighted that given the complexity of IPE compliance, exposure reduction interventions should not rely solely on IPE use promotion. Instead, other control strategies requiring less worker input for effectiveness should be implemented, such as elimination and substitution of highly hazardous pesticides, and altering application methods.

Neuropsychiatric disorders and increased suicide rates have been associated with exposure to cholinesterase inhibitors and organophosphates. WESSELINGET et al. (2010) evaluated symptoms of psychological distress, including suicidal idea, among banana workers in Costa Rica, previously exposed to a pesticide cholinesterase inhibitor. 78 workers were evaluated who had received medical attention for pesticide poisoning occupational 1 to 3 years previously. Of these, 54 had been exposed to organophosphorus, 24 to carbamate, and 43 and 35, respectively, had episodes of single and multiple intoxication with a cholinesterase inhibitor. In addition, they interviewed 130 randomly selected employees from company payrolls. The authors found that workers poisoned by organophosphate reported significantly more symptoms than non-poisoned. Trends significant increase symptoms with increasing number of previous poisoning were seen by somatization and obsessive-compulsives diseases, interpersonal sensitivity, depression and anxiety. This study demonstrated a relationship between acute occupational poisoning with organophosphates and psychological distress, including suicidal thoughts.

SUAREZ-LOPEZ et al. (2013) found lower Acetylcholinesterase activity associated with lower performance on attention, inhibitory control, and memory in boys in Ecuador. These are critical cognitive skills that affect learning and academic performance. The study enrolled residents of Pedro Moncayo County, Pichincha. This county has substantial floricultural activity, with a production area of 1800 hectares (5.3% of the county's surface area), and employs 21% of adults. Organophosphates are among the most frequently used insecticides in the Ecuadorian floricultural industry and account for a substantial proportion of intoxications in Ecuador. Children's parents and other adult residents were interviewed at home to obtain socioeconomic status, demographic characteristics, and pesticide exposure information of household

members. Their findings suggest that boys have greater sensitivity than girls for neurodevelopmental delays from subclinical pesticide exposures.

### ***Rural workers' health and the use of pesticides in developed countries with emphasis on United States of America***

Among the developed countries the United States of America is the most used pesticides, mainly due to its large agricultural production with predominance of conventional production system. Over 1 billion pounds (450 million liters) of pesticides are used in the United States each year (ALAVANJA, 2009). Developed countries, although they are developed, they also have serious problems with rural workers contamination by pesticides.

ROBINSON et al. (2011) investigated aspects of the safe use of pesticides experienced by rural migrant workers in North Carolina – United States of America (USA). Many rural workers reported lack of care pesticide safety standards where they worked. Only a third (34.8%) reported being provided by the supervisor of pesticides safety instructions, and 14.8% received the safety equipment to pesticides. About half workers used Individual Protection Equipment (IPE) when pesticides were applied (51.0%) and during re-entry interval (51.3%). About a quarter (25.2%) received the request of the employer to enter areas before the re-entry interval has run out, 16.0% worked in the fields when pesticides were being applied, and 28.0% worked in areas adjacent to fields in which the pesticides were being applied. Most (75.3%) had water available in the fields for hand washing, but only 44.3% had soap.

Migrant and seasonal farm workers are essential to the success of agriculture in North Carolina, USA. These farm workers provide the necessary manpower to plant, grow and harvest economically important crops, including tobacco, cucumbers, sweet potatoes, peaches, apples, and Christmas trees. Agricultural workers also immigrants are increasingly employed full-time, based on livestock and poultry, as well as cultures. Although essential to the financial success of agriculture, rural workers experience significant occupational and environmental exposures, deplorable living conditions, limited safety training and little regulatory support (ARCURY & QUANDT, 2009).

Whereas exposure to pesticides is a reality for migrant farm workers and, consequently, are exposed to numerous risks in the workplace. WHALLEY et al. (2009) performed work that described the security conditions and the safety behaviors of 255 rural workers during the 2007 harvest in eastern North Carolina, assessing the conditions required by federal and state standards. Most rural workers were Mexican men and about 20% had not received safety training to work with pesticides throughout the season and many of those who received such training not understood. Washing water was unavailable for about a third of workers; soap and towels were not available

for more than half. About 20% lived in households with more than eight workers shower and about 20% lived where not met the standard of 30 or fewer workers per washing machine.

RAYMER et al. (2014) studied 183 migrant farmworker camps in eastern North Carolina in 2010. Data and urine samples were collected from 371 men. Predictor measures included violations in six domains of housing regulations and non violation characteristics and personal behaviors that might impact urinary metabolites. The farmworker population in their study had exposures to multiple pesticides. The magnitude of the exposure in the home relative to the magnitude of the occupational exposure cannot be unambiguously defined in this study, but the evidence supports a chronic component of exposure via the housing, even if it is small relative to the total pesticide exposure.

In research conducted involving 200 immigrants and migrant rural workers of the horticultural industry in British Columbia, Canada, where about 10,000 workers are hired annually OTERO & PREIBISCH (2010) found that ethnicity and citizenship are important in health and safety at work. Immigrants are incorporated into the labor market as highly vulnerable workers. Rural workers from Mexico employees in Canada on temporary visas have their mobility restricted the labor market running out of the power to change it. According to the authors, language barriers, limited access to information and lack of knowledge of their rights are relevant factors to health and safety that are closely linked to the ethnicity of the people and citizenship.

In their review, YE et al. (2013) evaluated 193 references published on USA and Europe and identified a series of respiratory symptoms and diseases that have been associated with occupational exposure to pesticides. Some lung changes have also been observed among people occupationally exposed to pesticides. There is strong evidence of an association between occupational exposure to pesticides and asthma, especially in agricultural occupations. In addition, the authors found evidence suggesting nexus-causal relation to exposure to pesticides and chronic bronchitis or COPD (chronic obstructive pulmonary disease). However, they found no conclusive evidence for the association between occupational exposure to pesticides and lung cancer. It has been found that the best control practices and implementation of safety behaviors such as the use of individual protective equipment (IPE) at work with pesticides are critical to reducing the risk of developing symptoms and diseases related to pesticides.

On the other hand, MILLS & SHAH (2014) evaluated the cancer incidence in California (USA) farm workers, between 1988 and 2010. They found those farm workers experience proportionally more prostate, kidney and renal pelvis, brain, liver, stomach, cervix and leukemia and less breast, melanoma, and colorectal cancer than reference populations. A roster of farm workers was created and electronically linked to the database of the California Cancer Registry. Proportionate cancer incidence, stage, and age at diagnosis and histological subtypes of cancer were compared between the

United Farm Workers members and the Hispanic population of California as well as to the non-Hispanic whites. In this population of 139,000 farm workers in California, more than 3,600 cancer diagnoses were recorded between 1988 and 2010.

Although the effects of acute pesticide poisoning are well known to most pesticides currently used, there are few data on the health effects after exposure to low-dose long-term. The increased use of products other than organophosphate pesticides makes it even harder to find associations. In the study by HERNÁNDEZ et al. (2006), 106 intensive agriculture workers were evaluated twice during the period of a spray station. They were from a small village located within a large intensive agricultural area of plastic greenhouses on the coastline of Granada (southeast Spain). Modifications were analyzed in serum biochemistry, i.e., some enzymes it was evaluated that reflect the cytotoxicity: alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), creatine kinase (CK) and amino oxidase. Furthermore, they were evaluated other biochemical parameters such as nephrotoxicity marker (urea, creatinine) and lipid profile (cholesterol and triglycerides). Several criteria to estimate exposure to pesticides were used and the decrease in the concentration of cholinesterase proved the most important. The results showed an association with exposure to pesticides and AST changes (increased activity), LDH, and amino oxidase (reduction of activity) as well as the changes in serum creatinine and phosphorus (upper and lower levels, respectively).

Physical contact with branches, leaves, fruit or vegetables in previously treated crops is responsible for the transfer of pesticides to the worker's skin in agricultural tasks such as harvesting, pruning, thinning, cutting or sorting. BALDI et al. (2014) described levels of exposure and analyzed their determinants during re-entry and harvesting in vineyards in the Bordeaux area, France. Detailed information on the tasks was collected and dermal contamination was assessed using patches placed on the skin and hand-washing at the end of each working phase. For re-entry, the highest contaminations were observed during raising of wires and cutting of branches. During the harvest, the contamination was maximal for grape-picking. The delay since the last treatment and the rate of active ingredient per hectare played a role, together with other factors such as meteorological factors, crop and farm characteristics, gloves and clothes.

GIORGI et al. (2012) conducted a study in the province of Rome, Italy, on the effects on health of workers of exposure to organophosphate insecticides, analyzing residues in samples of different fruits like apples, pears, peaches, grapes, strawberries, citrus and fruit exotic. They found that there was a substantial decrease in pesticide residues without fruit samples, but the number of fruit with two or more wastes tripled from one year to the other in surveys conducted in 2008 and 2009. The chemicals most often found especially in crops peach, citrus fruits, grapes and strawberries are Chlorpyrifos and Dimethoate, which are insecticides, the organophosphate category with a dangerous neurotoxic activity.

However, another serious problem is the intentional suicide with the use of pesticides in rural areas. CHA et al. (2014) demonstrated through the national death and healthcare utilization data that the magnitude of acute pesticide poisoning in South Korea is higher than that in other developed countries. The majority of pesticide poisoning deaths were the result of intentional poisoning; in particular, elderly suicide by pesticide ingestion in rural areas was shown to be a serious social problem. Easy access to pesticides and the lack of management of suicide by pesticide ingestion in rural area are suggested as major factors related with the high rate of pesticide poisoning in South Korea.

Drift is the outward movement of the pesticide spray target, volatile compounds and contaminated dust. From 1998 to 2006, LEE et al. (2011) identified 2,945 cases associated with the switching of agricultural pesticides in 11 US states. Their results indicate that 47% were exposed to drift in the workplace and 14% were children (<15 years). The annual incidence ranged from 1.39 to 5.32 drift per million people over a period of nine years. The overall incidence (million person-years) was 114.3 for agricultural workers, 0.79 for other workers, 1.56 for non-occupational cases and 42.2 for residents in five regions of agriculture intensive in California. Soil applications with fumigants were responsible for the highest percentage (45%) of cases of drift. Aerial applications accounted for 24% of cases. Common factors contributing to the drift are the cases of weather conditions, inadequate seal the fumigation site and carelessness applicator close to non-target areas. The data were obtained by the authors of the National Institute for Occupational Safety and Sentinel Event Notification System for Health Risks program Occupational-Pesticides and the Department of the California Pesticide Regulation.

## ***Conclusions***

We concluded than the rural workers pesticide contamination problems occur both in developing countries as in developed countries. To ensure the rural workers' health when they use pesticides becomes necessary to increase the training of workers, improving the quality of individual protection equipment - IPE and the preparation of leaflet and label with safety instructions easier to understand, considering the low level of education of rural workers. It is also important to build political agendas and actions in the health of agricultural workers, with implementation of preventive health programs with greater oversight and monitoring on pesticide use.

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