

Farmers and Formulations – Rural Health Perspective

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Summary

Conventional farming demands excessive use of chemicals in the form of synthetic fertilizers and pesticides, confirming to the norms of Green Revolution. Farmers in general, specifically in the developing countries resort to injudicious and excessive use of pesticides which is linked to the illiteracy and poverty of the rural farming community. Their overriding concern for profitable agriculture, has rendered the health of the farmers at a greater risk of developing dreadful maladies including various type of cancers, reproductive disorders, respiratory, dermal, and neuropsychological problems etc. The possible means of reducing the health risks are discussed, including the global effort to regulate the manufacture, transport and use of highly toxic pesticides. Slow and programmed transition to alternative agriculture and strengthening of farmers' knowledge on health, ecosystem and environment will prove effective.

Key Words: Pesticides, Cancers, Genotoxic, Insect resistance, Integrated pest management, Organic farming.

Introduction

The world population is projected to be 9 billion by the year 2050 and the demand for food supply will further intensify. The world's worst recorded food disaster happened in India during 1943, known as Bengal famine, an estimated four million people died of hunger. According to FAO's latest estimate, there are 815 million undernourished people in the world, 777 million in the developing countries, 27 million in the countries in transition and 11 million in the developed market economies. During the first 35 years of chemical intensive green revolution, global grain production doubled; greatly reducing food shortages, but at a high cost of environment and human health. The modern farming methods totally rely on synthetic fertilizers and an array of pesticides, that generate resistant pest populations, farmers need evermore fertilizers and pesticides to achieve the same result or even less, still at the cost of environment, soil and

human health. Nearly 85 percent of the 2.6 million metric tons of active ingredient of pesticides produced annually is used in crop production. The average frequency of application of the most used insecticide and fungicide products on the most intensively treated crops was between 10 to 20 times per year¹.

To quote one example of the adverse impact of chemical depended agriculture is that the modern farming practices have significantly reduced the levels of beta-glucan in the foodstuffs. This beta-glucan, which is present in many plant products especially in mushrooms, potentiates and modulates the immune response primarily through the activation of macrophages, dendritic immune cells, B- lymphocytes, natural killer cells and suppressor T-cells². There may be several such pesticide induced factors both in plants and in human beings that may result in severe immune dysfunction.

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Impacts of pesticides

Farmers in the developing countries heavily rely on the use of chemical pesticides to get rid of their pest problems. In this process, a large quantity of these toxic chemicals remain in the environment and cause irreparable human health hazards, and the symptoms may vary from headache to cancers. Pesticides are a major source of occupational injury and illness to which farmers are exposed, typically associated with poverty and illiteracy. Such health effects are dependent upon the nature of the substance, the dose received, the route of exposure such as inhalation, ingestion or skin absorption and individual susceptibility. The chronic effect usually occurs following repeated low dose exposure over an extended period of time. Exposure to pesticides normally occurs while preparing the spray solutions, loading in the spray tank and while applying the pesticide.

Cancers

Different types of occupational exposures to pesticides play a crucial role in the development of various cancers. Compared to all other workers, farmers and pesticide applicators are at a definite risk of developing cancers. Epidemiological studies in humans indicated that there is a possible association between pesticide exposure and infertility, testis, breast, prostate and ovarian cancer³ and also hematopoietic and nervous system cancers⁴. Among the male farm workers over 50 years of age, the use of chlorinated pesticides and methyl bromide were significantly associated with prostate cancer, the second most common cancer in men, after lung cancer⁵. Among herbicides, significant associations were found for glyphosate and 4-chloro-2-methylphenoxyacetic acid⁶. Renal cell carcinoma has been widely reported among male farm workers who were exposed to pesticides and herbicides⁷ organic solvents and copper sulphate⁸. Epidemiological studies conducted in Gaza concluded that the introduction of and heavy use and misuse of pesticides are suspected to correlate with the growing incidence of cancers. Lung cancer, lymphomas, leukemia, cancers of urinary bladder, prostate, brain, colon, stomach and liver were the most abundant among males, while breast cancer, leukemia, lymphomas, cancers of the brain, uterus, lung, thyroid gland and liver were the most abundant in female⁹.

Farm women contribute and take part in more than 70 percent of the farm related work, from planting to harvest, including mixing and transporting the spray fluid. There is a significant association between the

number of acres of crops planted and the mortality rate from breast cancers¹⁰. Blood analysis of breast cancer patients indicated the presence of significant level of organochlorin pesticides in the blood, irrespective of age, diet and geographic distribution¹¹.

Reproductive health hazards

Occupational exposure to pesticides also implicated in the impaired semen parameters among male farm workers¹² and conception delay among green house workers with high pesticide exposure¹³. Epidemiological studies have confirmed increased risk of conception delay associated with occupational exposure to pesticides, and also an increased risk of spontaneous abortion among wives of exposed workers¹⁴. Maternal exposure to pesticide may contribute to still births, congenital malformations, miscarriages, low birth weight, and preterm delivery¹⁵ and the risk of giving birth to a child with limb defects¹⁶. Infants born to women exposed to pesticides such as phenoxyacetic acid derivatives, organophosphates, ureas, triazines, and synthetic pyrethroids in first and second trimester had birth weight lower by 189 grams than that of infants of non-exposed women¹⁷. The risk of congenital malformations to infants such as orofacial cleft, birth marks in the form of haemangioma, as well as musculoskeletal and nervous system defects.

Genotoxic effects

Exposure to pesticides also causes genotoxic effects. The micro nucleus test performed in farm workers directly exposed to pesticides showed a higher mean number of binucleated cells with micro nuclei¹⁸. In Costa Rica where the pesticides use is high round the year, the genotoxic effect among the women workers in banana packaging activities for 5 to 15 years, revealed the damage to single stranded DNA¹⁹. Chronic occupational exposure to mixture of pesticides may also result in the increase in the number of sister chromatid exchange²⁰. Blood analysis of farmers who engaged pesticides spraying revealed more DNA damage, a significant decrease of neutrophils and a decrease of red blood cells²¹.

Respiratory disorders

It has been found that herbicides paraquat, atrazine and alachlor; organophosphate pesticides such as parathion, malathion and chlorpyrifos, and thio carbamate pesticide S-ethyl-dipropylthiocarbamate are associated with wheeze²². The farm workers with various job experiences such as supervisors,

technicians and spray persons were found to be remarkably suffering from reduction in pulmonary function and frequent complaints of respiratory symptoms that could possibly lead to chronic respiratory health problems²³. The study conducted in United Arab Emirates on the pesticide induced dermo-respiratory symptoms revealed that, most of the farmers were illiterate or poorly educated and used heavy pesticides and even mixtures of pesticides. These farmers had a very high prevalence of chronic dermo-respiratory symptoms, particularly cough, pharyngitis, bronchitis, asthma, respiratory insufficiency, pneumonia, dyspnea, nasal catarrh, sinusitis, pharyngeal irritation, nasal irritation (dryness, sneezing and secretions), ocular irritations, cutaneous pruritis and contact dermatitis²⁴.

Skin diseases

Skin is the most exposed organ while spraying the pesticide on fields. Unprotected spraying of pesticides may result in frequent skin contact especially on the hands and face leading to hand dermatitis, pigmentation and thickening of hands and fungal infection of skin. Farmers were most frequently sensitive to fungicides such as captfol, folpet and captan²⁵. Farmers exposed to arsenic pesticides are at risk of skin cancer, multiple cell carcinomas and squamous cell carcinoma²⁶. In Panama, contact dermatitis related to pesticide exposure is a significant health problem among the farm workers in banana plantations, who were exposed to propiconazole, maneb, chlorothalonil, dithane, dalaphon, ametrin and gramoxone. It was found that hands were the most frequently affected areas (82%), followed by thorax and abdomen (9%), leg and feet (5%) and genital area (4%). The most frequent reactions were to the fungicides chlorothalonil (51.4%), thiabedazole (12.8%) and aluminium hydroxide(10.2%). The majority of the cases were related to exposure to fungicides²⁷.

Parkinson's disease

It is a common and disabling neurodegenerative disease marked by progressive motor dysfunction, which results from selective degeneration of nigrostriatal pathway. Epidemiological studies indicate that exposure to pesticides, rural living, farming and drinking well water are associated with an increased risk of developing Parkinson's disease²⁸. A study conducted in Hawaii indicated that exposure to pesticides are associated with an increased risk of Parkinson's disease in later years²⁹. In addition, pesticide can also inhibit mitochondrial I complex,

which may result in oxidative stress and increase the susceptibility of neurons to excitotoxic death. Epidemiological studies among the patients with idiopathic Parkinson's syndrome indicated that the chemical 1-methyl-4-phenyl-1,2,3,6-tetra hydropyridine (MPTP) has been associated with the disease.

The other major occupational health hazards of pesticides include end- stage renal disease³⁰, depressive symptoms and anxiety among the farm residents as result of acute pesticide poisoning from organophosphate compounds, independently of other known risk factors for depression³¹. Long term exposures to pesticides in vineyard workers engaged in mixing and spraying fungicide suffered from neuropsychological performances⁶. Pesticide formulators and pesticide applicators suffer from peripheral neuritis, psychiatric manifestations, electroencephalographic changes and hepatorenal dysfunction³². High pesticides exposure has contributed significantly to the peripheral nervous system effects among the farmers in Ecuador, who used frequently organophosphorous, carbamate insecticides and dithiocarbamate fungicides³³. Prolonged pesticide exposure also resulted in the reduced activity of blood enzymes such as delta-aminolevulinic acid dehydratase, superoxide dismutase and plasma cholinesterase³⁴. Thyroid function impairment was also reported with the male pesticide formulators exposed to dust and liquid formulation of endosulfan, quinolphos, chlorpyriphos, monocrotophos, lindane, parathion, phorate, and fenvalerate³⁵. Retinal degeneration was also related to the prolonged and unprotected use of organochlorine or carbamate insecticides³⁶.

The Paradox

There is an increasing global awareness for environmental protection and human health care. Silent Spring, Rachel Carson's landmark challenge to the abuse of synthetic pesticides was published in 1962, and initiated a movement toward agrochemical regulations. Modern and advanced health care studies now, confirmed Rachel Carson's prophetic words "for the first time in the history of the world, every human being is now being subjected to contact with dangerous chemicals, from the moment of conception until death". Recently World Resource Institute has estimated the annual world pesticide production to the value of 30 billion US\$; and 62% of the sales is in developed nations such as United States, Western Europe and Japan. It is reported that during 1997-2000, the United States had exported 3.2 billion pounds of pesticide

products to other countries. Nearly 65 million pounds of exported pesticides were either forbidden or severely restricted in the United States. The exported pesticides include, as designated by World Health Organization (WHO) "extremely hazardous" (89 million pounds), pesticide associated with cancer (170 million pounds) and pesticides associated with endocrine disrupting effects (368 million pounds), mostly to the developing countries³⁷.

Possibilities and Priorities

Farmers and farm laborers are fully involved in all farm operations and hence are maximally exposed to the various farm chemicals both directly and indirectly. Globally farmers are less educated except in some rare situations where precision and organic farming are practiced. In general, farmers' knowledge concerning the health hazards of pesticides is not sufficient to change their behaviors. Their prime concern to protect the crop from economic loss and not health³⁸. The recurrent suicide among marginal cotton farmers in Andhra Pradesh, India may be due to the injudicious application of pesticides which aggravated the secondary infestation of pests such as White flies *Bemisia tabaci*, a devastating sucking pest of cotton. In addition, their economic sustainability, social and political factors also contributed to such tragedies³⁹. The young farmers and farm laborers must be imparted periodically with specialized trainings on pesticides, environment, ecology and human health⁴⁰. In Nicaragua the farmers trained in integrated pest management (IPM) field school used minimum pesticides, spent less money, however they made higher net returns. In addition, the cholinesterase level was not affected in IPM trained farmers compared to the conventional farmers who are frequently exposed to organophosphate insecticides⁴¹. The farmers must be introduced and persuaded to adapt the integrated pest management (IPM) components in its entirety. Recent studies conducted in Philippines indicated that spontaneous abortion occurred significantly more often among the conventional pesticide users households than among the IPM households. A dramatic drop in breast cancer mortality in Israel has been linked to the banning of carcinogenic pesticides.

Use of biocontrol agents such as bacteria, fungi and viruses should widely be introduced among farmers. Biopesticides which are safe to environment and human health should become more important tools in pest management along with transgenic crops⁴². It is reported that occupational exposure to *Bacillus*

thuringiensis (Bt) based biopesticides, has not impaired the gastrointestinal system, despite the presence of Bt in the fecal samples of the workers⁴³. Even aerial spraying of biopesticide based on Bt had no adverse effect on human health, including respiratory problems⁴⁴.

Developing countries are at risk because of their intensified use of more toxic pesticides which have been banned in industrialized countries. In addition the developing countries have a limited capacity to regulate pesticide use and enforce health and safety measures. The governments should enforce strict pesticides regulation policy. Worker protection standard should be enforced and followed with the objective to reduce the risk of pesticide poisoning and injuries among farmers. It is reported that, despite farmers' knowledge about adverse health impact of pesticides, the use of protective measures was poor⁴⁵ not only among less educated farmers of developing countries but also among the educated farmers in developed countries⁴⁶. The government and voluntary health organizations may conduct pesticide safety training and intervention programs on the use of personal protective equipments, decontamination procedures and emergency medical assistance to farmers.

Another important thrust area is to train the agricultural extension workers periodically on environmental crop protection in the modern pest management practices. Effective network of extension system need to be evolved, one that of Training and Visit system widely practiced in Israel. A survey of Tanzanian agricultural extension workers indicated that the training of agricultural workers in health aspects of pesticide exposure is an important task for adequate provision of service to farmers with regard to safe use of pesticides⁴⁷.

Occupational safety involves protection and promotion of the farm workers health, periodical medical examination of farm workers for detecting possible health impacts and maintaining the proper medical records related to various health problems of the farmers⁴⁸. Another important area need to be strengthened is the research that should focus on simple methods for surveillance of exposure and on surveillance of acute illness and its causes in order to develop and evaluate rapid local interventions. Strict pre-marketing product evaluation and post-marketing risk assessment and risk preventive measures should be taken both by the industry as well as the government⁴⁹.

CONTINUING MEDICAL EDUCATION

Each country should develop an adequate National plan for prevention of pesticide risk with different roles and tasks at the federal, regional and local level. International collaborations must be encouraged to address the global health problem. The success of Food Systems 2002 in Canada, best illustrates the national effort to reduce the pesticides use by 50 percent. Pesticide use increased by 46 percent from 1973 to 1983. From 1983, the base line year for Food System 2002, to 1998, pesticide use decreased by 38.5 percent. The reduction in pesticide use and risk were primarily on maize and tobacco, the crops with highest pesticide use in 1983⁵⁰.

It has been proved experimentally that alternate farming methods combined with good agricultural practice can yield as much as that of conventional farming, with minimum health and environmental impacts. A study conducted among the sugarcane farmers in Fiji revealed an interesting observation that the average production of sugarcane was markedly higher among pesticide users and also the average annual medical expenditure compared to the non pesticide users⁵¹. However, the net return was high

among the non pesticide users with minimum health impact.

To conclude, the farmers who are the vital force in sustaining a nation's food security, must be secured from the havocs of pesticides. A real concerted effort on the part of the government's world over is warranted, to effectively reduce the production of toxic chemical and exporting to the third world countries needs human consideration. The farmers should be persuaded continually by well qualified and dedicated agricultural extension workers to slowly shift to non-chemical farming. Concerted research efforts are needed, to develop eco-farming methods with better yields. Detailed epidemiological studies are needed to identify the causes of various farm related illness and formulating the strategy to mitigate such problem in the early stages. Different parameters, conditions, early diagnostic symptoms, treatments related to pesticide exposure should be properly documented. The permanent solution to the problem can be, the farmers themselves should understand the reality and transform towards healthier farming practices.

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MCQ'S : Farmer's and Formulations - Rural Health Perspective

1. The major factor affecting the health of rural farmers
 - A. Malnutrition
 - B. Food habits
 - C. Exposure to hazardous chemicals
 - D. Psychological stress due to crop failure
 - E. Hypertension

2. Farmers' knowledge on the negative impact of pesticides is generally
 - A. Inadequate
 - B. Adequate
 - C. Very minimal
 - D. Reasonably good
 - E. Misconceived

3. Pesticide toxicity in human beings is closely related to
 - A. Nutritional status
 - B. Age
 - C. Dose and duration of exposure
 - D. Ethnicity
 - E. Gender

4. The major priority in the pesticide toxicity management is to
 - A. Create awareness among farmers
 - B. Ban on pesticide sales
 - C. Promote pesticide regulations
 - D. Develop safer molecules
 - E. Establishing rural health centers

5. Chronic pesticide poisoning affects only
 - A. Digestive system
 - B. Reproductive system
 - C. Renal system
 - D. Respiratory system
 - E. All major systems