



Impact on Farmers' Health Due to the Pesticide Exposure in the Agrarian Zones of Kashmir Valley: A Review

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Abstract

The antagonistic impact of pesticides on humans just as on other fauna has been surveyed and reported from various parts of the world. The exponentially growing human populace and its food requirements have prompted farmers to favour high yielding monocrops. The financial loss caused by pests has been compensated by the use of chemical pesticides by farmers; however, this causes a long-lasting adverse impact on various life forms and natural environment. Kashmir is an ecologically sensitive and biologically diverse place with its colossal floral and faunal diversity will have comparatively or much severe impact by the utilization of chemical pesticides. Most of the cultivated land in Kashmir is being utilized for different types of horticultural and agricultural practices that provide a livelihood for the growing population. The impact of widespread usage of chemical pesticides has made enormous effect on human health and has turned into a serious issue across the globe. The present study aims to make an assessment of the impact of chemical pesticides on human health in the Kashmir valley. These results will be utilized for creating awareness among farmers and the general public and to recommend the usage of biological control and biopesticides for safeguarding human life as well as conservation of biodiversity.

Keywords: Chemical Pesticides; Toxicity; Cancer; Farmers; Agriculture; Kashmir

Introduction

Global croplands are not unlimited and global population grows continually [1]. In order to ensure food safety around the world, it is important to build up all necessary measures to boost crop production [2]. A crop loss due to pests is the biggest challenge our agriculture sector faces today [3]. A Pest can either consume whole or ruin a large part of a crop. Without the utilization of pesticides, they would devour a higher volume and cause gigantic loses to productivity. Decreasing crop yield from pest damage is one of the significant errands to guarantee crop creation [4]. Due to pests, India faces an estimated production loss of over 42.66 million US\$ annually [5]. Pesticides assume an imperative job in boosting both the agricultural and horticultural profitability. The advantages of pesticides involve increased crop yield, expanded benefits for farmers and the counteractive action to crop diseases. Pesticides help the farmers to get a good deal on work costs by diminishing the measure of time required to physically expel weeds and pests from fields.

For protecting the crops, Mankind has used pesticides since 2000 BC. Basic Sulphur dusting was a prominent and a key element used in prehistoric times around 4,500 B.C. Till 15th century, toxic chemicals such as arsenic, mercury and lead were be-

ing splashed on crops to eliminate pests. During the 17th century, nicotine sulphate from tobacco leaves was extracted and used as an insecticide [6]. With the revelation of the insecticidal properties of DDT (dichlorodiphenyltrichloroethane) in 1939 by Paul Muller, synthetic pesticides started to progress in the market. In 1948, Paul Muller was granted the Nobel Prize for discovering the pesticidal properties of DDT [7]. DDT was imported for malaria control in India in 1948; this kick-started the utilization of pesticides. India began pesticide production with assembling plant for DDT and benzene hexachloride (BHC) in the year 1952 [8]. Currently, India is the largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides. Although the average consumption of pesticides is far lower than in many other countries, the problem of pesticide pollution is serious in India. Through the global exchange, pesticides may outreach nations that never delivered or utilized them [9]. In India, pesticide production is overwhelmed by insecticides and fungicides followed by herbicides, rodenticides (Figure 1). In spite of the fact that the normal utilization of pesticides is far lower than in many nations, the issue of pesticide contamination is alarming in India. The rise in the utilization of fungicides is high mostly as a result of their application in fruit and vegetable crops [10].

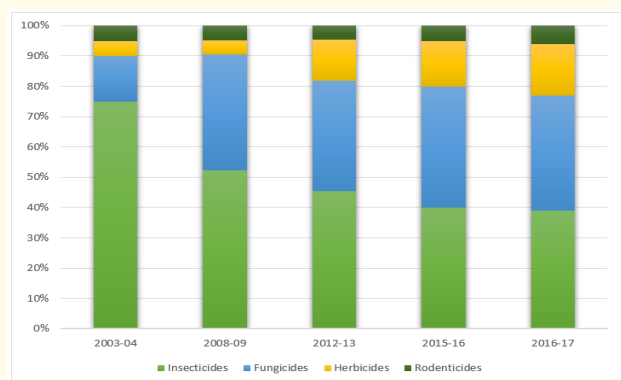


Figure 1: Share of pesticide groups in total pesticide production (technical grade).

Source: Ministry of Chemicals and Fertilizers.

Methodology

The present study aimed at compiling all long-term health reports conducted over the past 30 years that are available through global peer-reviewed literature databases. With that impact, we performed a search on the online Web of Science database using the keywords (health hazards) and (pesticide exposure) and (farmers) and (agriculture) which resulted in the total number of 155 publications. We selected surveys that considered all health-related issues faced by the farmers and farm workers around the world by the very much use of chemical pesticides and effects caused due to exposure while being utilized in the crop fields. Additional papers were obtained from the literature references. Finally, only surveys that reported changes in quantitative data over time were considered. Thus, this review covers 44 reports on health hazards due to pesticide exposure in the rural areas of Kashmir valley, India.

The agricultural and horticultural sectors of Kashmir

With varied dimensions of beauty, Kashmir acquired its name by unfathomable bounties of snow-clad mountains, forests, rivers, natural springs and large lakes. At a height of around 6000 ft., the valley is located in the chest of the western Himalayas and is encompassed by an unscathed chain of sky-scraping mountains [11]. Displays a fascinating morphology and the different locales on the paradigm of land design are the Valley Floor, the Karewas, the Side Valleys and the mountain ranges [12]. The valley of Kashmir has an adequate number of natural resources and the Agriculture sector of Kashmir has consistently been an imperative part of people's lives, straddling as it does even today, in the high to lowlands, vast forests and wastelands. Back in the sixteenth century, Kashmir's economy started to incorporate with the rest of the Indian economy, exposed Kashmiri's to different instruments utilized in agriculture during the extension of Mughal rule [13]. The agricultural sector is the backbone of the economy of Kashmir, almost 80% of people are directly or indirectly occupied with the agriculture and allied sectors. People in rural areas are busy in agricultural and horticultural fields throughout the year.

Rice is the staple food of Kashmir and the essential sustenance of its populace, and is an incredible article of income; the wealth of land is determined, not by its cash esteem, but by the quantity of proportions of rice it can deliver. Mostly, it was the fruits of the Valley which got attention from outsiders [14]. Extremely rich and

fertile alluvium helped by a favorable environment aided the production of walnuts, mulberries, peaches, apples, almonds, pears, plums, cherries, grapes and so forth. As years went on the rice was gradually supplanted by the cash crops like apple, pear, plum, peach, apricots and so forth because of more profit and generation of substantial income [15]. The Apples of Kashmir are very famous for their unique and delicious taste. Every year thousands of trucks export apples to almost every state of India. A dramatic rise has been recorded from the year 2001 to 2018 (Table 1) in the production of both fresh and dry fruits in Kashmir valley.

Year	Area (Hectares)	Production (MT. Tones)
2001-02	144992	1017492
2002-03	154181	1070045
2003-04	162028	1173484
2004-05	174906	1228694
2005-06	179220	1294686
2006-07	189614	1372600
2007-08	191321	1495941
2008-09	204800	1525618
2009-10	211298.32	1571737
2010-11	215305	2052311
2011-12	221950	1980312
2012-13	230187	1572044
2013-14	233948	1782812
2014-15	237598	1355000
2015-16	218283	2212892
2016-17	219723	1960974
2017-18	215172	2176895

Table 1: Area and Production of Fruit crops in Kashmir from 2001-2018.

Source: Directorate of Horticulture, Kashmir.

The expanding utilization of pesticides in the last three decades has ended up in the unflinching increment of apple production in the valley. The toxic chemicals are being utilized by the orchardists unpredictably without knowing any scientific recommendations and their adverse effects on the ecosystem in apple growing areas of Kashmir. The selection of synthetic chemical/brand inclinations is controlled by dealers and market functionaries [16], which results in the unlawful and unlicensed exchange of pesticides, consequently turning into a critical worldwide issue. In growing nations, as much as 30% of the pesticides don't meet universally perceived safety standards [17]. In India, for instance, the Ministry of Agriculture has verified that 33% of the pesticide tests analyzed do not conform to official standards [18].

Pesticide utilization in Kashmir

For better yield production, pesticide use is imperative. It was assessed that about 33% of the crop damage was prevented by utilizing pesticides [19] and without the use of pesticides, the damage by pests in fruits, vegetables and cereals may outstretch up to 78%, 54% and 32%, respectively [20]. About 45% of the total area of Kashmir is under Apple cultivation and other dry as well as fresh fruits. Almost 11.7 metric tons of apples were cultivated in Kashmir in the year 2016, which represented 71% of national generation. With the rising demand of fruit crops and chemical

pesticides, consistently million tons of toxic chemical pesticides like chlorpyrifos, mancozeb, captan, dimethoate, phosalone, etc. are being showered in the apple plantations of Kashmir. More than 30 fungicides, insecticides, acaricides, and so forth are being utilized by the orchard farmers and farmworkers in Kashmir (Table 2). Among other states in India, Jammu and Kashmir state has an average intensity level of pesticide application of 2.337/ kg/ha. Positive growth has been observed in Jammu and Kashmir, Andaman and Nicobar Islands and Tripura. The use-intensity has been found highest in Jammu and Kashmir, followed by Punjab and Haryana [21]. The authoritatively prescribed dithiocarbamate

fungicide (EU labelled carcinogen mancozeb) has been utilized in the apple plantations at a portion of 12.00 kg/ha twice in a season, which alone adds up to around 700 MT for each season. Mancozeb is being utilized all through the past 30 years in the Kashmir valley. Likewise, Captan, a dicarboximide fungicide, EU marked cancer-causing agent is utilized exorbitantly by the plantation ranchers than the prescribed dosages of 12.00 kg/ha; it is directly retained through the skin, inward breath ==and ingestion. Among organophosphates, the most utilized synthetic substances are chlorpyriphos (portion half, 4 l/ha) and dimethoate [22].

S. No.	Registered Name	Commercial Name	Chemical Class	WHO Class	Type
1,	Mancozeb	Dithane M-45, Mancozeb	Organosulphur	U	Fungicide
2,	Bitertanol	Baycor, Sibutol	Triazole	U	Fungicide
3,	Captan	Captaf, Captra	Phthalimide	U	Fungicide
4,	Hexaconazole	Contaf	Triazole	III	Fungicide
5,	Carbendazim	Safar, Shine	Benzimidazole	U	Fungicide
6,	Chlorothalonil	Roko, Ishaan	Organochlorine	U	Fungicide
7,	Difenoconazole	Score, Amrit top	Triazole	II	Fungicide
8,	Dodine	Superstar, Noor	Aliphatic Nitrogen	II	Fungicide
9,	Flusilazole	Nimahe	Organosilicon	II	Fungicide
10,	Kresoxim methyl	Ergon	Strobilurin		Fungicide
11,	Metiram	Clutch, Lurit	Dithiocarbamate	U	Fungicide
12,	Pyraclostrobin	Perido	Strobilurin		Fungicide
13,	Myclobutanil	Boon, Index, Fit	Triazole	III	Fungicide
14,	Penconazole	Fixer, Linker	Triazole	III	Fungicide
15,	Propineb	Antracol	Dithiocarbamate	U	Fungicide
16,	Trifloxystrobin	Navito	Strobilurin	U	Fungicide
17,	Tebuconazole	Indazole, Carapace	Triazole	II	Fungicide
18,	Ziram	Ziron, Star-27	Dithiocarbamate	II	Fungicide
19,	Zineb	Indofil M-45, Indofil Z-78, Avtar, Turf	Dithiocarbamate	U	Fungicide
20,	Copper oxychloride	Blitox, Coprus	Copper Fungicides	II	Fungicide
21,	Thiophate methyl	Roko, Secure	Benzimidazole	U	Fungicide
22,	Dithianon	Dithianon	Quinone	II	Fungicide
23,	Diniconazole	Gulin	Triazole	II	Fungicide
24,	Cymoxanil	CMZ-72, Moximate	Aliphatic Nitrogen	II	Fungicide
25,	Horticultural Mineral Oils	Arbofine Extra, HP, MAK, Servo			Insecticide
26,	Chlorpyrifos	Kohiban, Terminator	Organothiophosphate		Insecticide
27,	Dimethoate	Tafgor, Rogor	Organophosphates	II	Insecticide
28,	Quinalphos	Flash, Goldlux	Organothiophosphates	II	Insecticide
29,	Thiacloprid	Calypso, Alanto	Thiazolidine	II	Insecticide
30,	Dicofol	Colonel-S, Dumite, Rusfol	Organochlorines	II	Insecticide
31,	Ethion	Rusmite-50, Deltron, Samrat	Organophosphates	II	Insecticide
32,	Carbofuran	Furan-3G	Carbamate		Insecticide/ Nematicide
33,	Abamectin	Avid, Ornex	Macrocyclic lactone		Insecticide/ Acaricide
34,	Fenazaquin	Magister	Unclassified acaricide	II	Acaricide
35,	Fenpyroximate	Zolomite, Seagate	Pyrazole	II	Acaricide
36,	Hexythiazox	Maiden	Thiazolidine	U	Acaricide
37,	Propargite	Mitesik, Zeromite	Sulphite ester	III	Acaricide
38,	Spiromesifen	Oberon, Voltage	Tetronic acid		Acaricide

Table 2: List of Pesticides used by Farmers of Kashmir.

The Directorate of Horticulture Kashmir has recommended the following list of pesticides for the year 2018-019 and WHO has recommended the classification of Pesticides in terms of Acute Toxic-

ity Hazard as listed below: **Ia** Extremely hazardous, **Ib** Highly hazardous, **II** Moderately hazardous, **III** Slightly hazardous, **U** Unlikely to present an acute hazard.

Pesticides and human health in Kashmir

For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death [23].

The intemperate utilization of pesticides has made catastrophic concerns about the fatalistic consequences on human prosperity and a large number of pesticides are not actually degradable; they hold on in the soil, drain to ground and surface water and defile the more extensive environment [24]. For over 12 days, pesticides may thoroughly orbit the globe and particles will abide in the air for around seven days; at a height of 6 km, for 30 days; at a height of 30 km, for two years [25]. Pesticide use around the world has brought about various instances of acute and chronic poisoning, with impacts of proliferating peril on human wellbeing, from delicate effects to death [26]. Exposure to pesticides normally occurs while preparing the spray solutions and while showering the pesticides on crops. Proceeded with an introduction to sub-deadly amounts of pesticides for a protracted timeframe, may result in unending health-related issues among people [27]. Comparative health impacts are reliant upon the nature of the substance, the quantity received, course of the entrance, for example, intake by breath, ingestion or skin assimilation and individual perceptivity. Due to pesticides, there are possible incidences of a number of chronic diseases and disorders, such as cancer, diabetes, respiratory failures and fertility issues examined by several studies [28]. Different investigations have uncovered a connection between pesticide use and sarcomas [29], numerous myelomas [30], malignant growth of the prostate, pancreas, lungs, ovaries, the breast, gonads, liver, kidneys, alimentary tracts and brain [31]. Consistently because of the poisonous agricultural pesticides, around 250,000– 370,000 people lost their lives every year, making a disastrous health problem in the developing world [32]. As indicated by a 2018 European Food Safety Authority report, 44% of food samples conventionally produced contained one or more significant residues, on contrarily 6.5 % of organic samples contained quantifiable pesticide residues [33].

Farmers are routinely exposed to elevated amounts of pesticides, as exposure mostly happens during the preparation and spray of solutions [34]. An investigation uncovered that 90.04% (389 out of 432) patients were farmers, orchard inhabitants in Kashmir presented to the elevated amounts of various kinds of neurotoxic and carcinogenic (chlorpyrifos, dimethoate, mancozeb and captan) chemicals for more than 10–20 years [35]. Another study revealed that malignant brain tumours were more frequent in males and non- malignant brain tumours progressively basic in females in Kashmir. The most well-known side effect in the study was cerebral pain pursued by vomiting [36]. Many neurological dysfunctions in farmers are the cause of residual concentrations of these toxic chemicals [37-39]; however, the all-inclusive community is additionally influenced, for instance, because of defiled sustenance or consumer products or pesticide float from fields. Through various medical studies on brain, the chemical pesticides affecting brain are mostly organophosphates, carbamates and ethylenebisdithiocarbamates [40].

In addition, numerous individuals are poisoned while spraying pesticides on crops. The defensive attire is excessively costly,

not accessible, or unrealistic in hot and humid atmospheres. In a study in West Africa only a normal 2% of farmers wear guarded clothing when dealing with pesticides [41]. Security precautionary measures are frequently given in unknown dialects or are not comprehended for different reasons, particularly by uneducated yet additionally by the individuals who can peruse [42]. On pesticide containers, Pictograms are frequently used to notify farmers about the dangers of toxic pesticides splashed then to crops (Figure 2). In any case, an examination in South Africa had shown that numerous individuals who handle pesticides don't comprehend and confound the pictograms on pesticide labels (Figure 3) [43].

The utilization of pesticides must be functional, specific, and safe. The advantages of pest management have to outweigh the financial, well-being, and environmental expenses. Pesticides ought to be specifically toxic to insect pests contrasted with people and even relative with insect pollinators and valuable arthropods. The human food chain is also affected by the pesticide residues left in crops soil and water. Intake of pesticide residues in the body has been connected to birth imperfection, danger to an embryo, disease, hereditary deformities, neurotoxicity and endocrine disruption. Water bodies of Kashmir are at major risk as a recent study revealed the presence of organophosphate pesticide dimethoate in the Dal lake [44] which could pose danger not exclusively to the utilization of Dal waters for human purpose but also in addition to the economically vital plants and creatures also.



Figure 2: Pictograms for Communicating Pesticide Hazards and Safety Instructions.

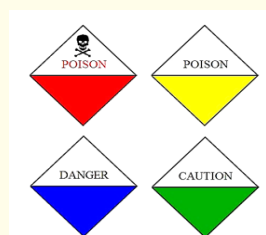


Figure 3: Toxicity label of Pesticides.

Discussion

Kashmir with its natural beauty and pollutant free environment has drawn the attention of national as well as international tourists over the years. The unique climate of Kashmir helped the farmers to cultivate specific cash crops which have been exported in the national and international markets. The use of high yielding varieties of crops and breeds has doubled the production, though the parallel growth of pests and their chemical control measures made

the farmers pay much directly and indirectly. The present study is a predictive message to the farmers and citizens of Kashmir about the dangers that they are going to face in the upcoming years especially by the future generations due to the excessive use of chemical pesticides.

The study shows the results of various side effects of pesticides on human lives as well as on the ecosystem. Many case studies are discussed wherein the usage of chemical pesticides has caused serious human diseases that affect all age groups. The victims are not only the primary users of these chemicals but the people who are exposed by other means. Farmers also get effected during various stages of crop production and by consuming pesticide residues present in fruits and vegetables. Kashmir being an ecologically sensitive location has its own carrying capacity for nullifying the effects of these pesticides. The pesticides are retained in nature for long periods like water bodies, soil, food and air. The rich bio-diverse location is facing many depletive effects in its natural resources that are unnoticed by the general public. The presence of pesticides in the rivers, streams and lakes of Kashmir is evidence of the growing danger that the coming generations are going to face. The rise in the number of cancer patients reported from Kashmir points to the immediate thorough analysis of the role of pesticides.

Conclusion

The present study predicts a dangerous future scenario in Kashmir valley. The usage of chemical pesticides has been proven repeatedly all over the world, about its hazardous effects on human and other life forms and the natural environment. If the application of chemical pesticides continues with such momentum, there will be a rise in cancer patients and other health disorders in Kashmir Valley which is alarming.

The study draws the attention of the people to the importance of alternative methods to solve the problem of the present and future generations. As proved by many the remedy to the problem is the usage of alternative methods like biological control and biopesticides. Kashmir being a biodiverse region, it has its own natural diversity which can be utilized for this purpose. The agents of biological control, as well as compounds for biopesticides, are to be comprehensively explored and utilized. The awareness of the local population especially the farmers is the first step towards this movement. The easy and cheap access to biological pesticides and biological control measures are to be studied and made available to the public through government and non-governmental organizations. The present study thus finds an important place in the process of human health management, conservation and protection of nature for the better development of Kashmir towards a bright future.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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