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TO STUDY THE EFFECT OF WATER CONTAMINTED DUE TO PESTICIDES ON HUMAN HEALTH AT NAGAUR DISTRICT OF RAJASTHAN (INDIA).

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Abstract:

Pesticides are agrochemicals that are used to increase agricultural productivity. Pesticide use has also been associated with many direct and indirect negative impacts on human health and the environment. Their side effects can be an important environmental health risk factor. Pesticides in the drinking water supply are derived from agricultural fields and industrial wastewater runoff. The water-soluble pesticides were carried away by water molecules, especially during the precipitation event by percolating downward into the soil layers and eventually reaching surface waters and groundwater. Long-time exposure to the low concentration of pesticides had resulted in non-carcinogenic health risks. Some people receive emergency care annually for actual or suspected pesticide poisoning and are admitted to the hospital. The level of risk increases, when users are often illiterate, untrained, and do not possess appropriate protective equipment. The purpose of this study was to investigate the ideas, attitudes, and level of understanding of Nagaur district farmers regarding the benefits and risks of pesticide-related water contamination. The results clearly showed that Rajasthan farmers have poor knowledge about the management and handling of pesticides. However, many misconceptions like crop production increase with an increased number of spray, alcohol is an alternative for pesticides, vegetable can be preserved by spraying pesticides, pesticides mixed with fertilizers would destroy pests more effectively, and food products size would increase with the use of pesticides are prevailing in the mind of Nagaur district farmers. Pesticides have been reported to cause several adverse health effects which depend on the extent and duration of exposure. The health effects of pesticides range from mild allergies, eye irritating, breathing difficulties, and reproductive abnormalities to deadly chronic diseases like cancer. This challenge to food safety may be addressed by preventive strategies which include the use of alternative sustainable agricultural practices or mitigating strategies which are based on reducing pesticide exposure from food and water by different processing techniques. This work provides a comprehensive review of the occurrence of pesticides in drinking water and their possible treatment.

Key words: Pesticides, Farmer, Agriculture, Illness, water, human health.

1. Introduction:

Agrochemicals are used to increase agricultural productivity. In recent times, the effects of the commercialization of agriculture on the environment and human health have attracted the attention of both scholars and policymakers. The severity and risks of adverse impacts are higher in developing countries where users are quite often illiterate, untrained, and do not possess appropriate protective equipment's [1]. The emphasis on organic agriculture is the direct outcome of the increasing awareness of the adverse

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effects of the excessive use of agrochemicals. Environmental pollution is a global phenomenon and the risks and outcomes on human health are worrying factors. The present situation of pollution is a man-made calamity though the fact of benefit-risk ratio also needs to be weighed equally before complaining about the issue of pollution. Pesticides are designed to kill and because their mode of action is not specific to one species, they often kill or harm organisms other than pests, including humans. The world health organization (WHO) estimates that there are 3 million cases of pesticide poisoning each year and up to 220,000 deaths, primarily in developing countries. Pesticides result in the production of reactive oxygen species which in turn brings down the antioxidant levels and their defense against oxidative damage in the cellular system. Oxidative stress and reactive oxygen species induce long-term health effects such as carcinogenic, cardiovascular, respiratory, endocrine, and reproductive problems [2].

The occurrence of pesticides in the water body is derived from the runoff from the agricultural field and industrial wastewater. Despite the soil matrix that serves as a storage compartment for pesticides due to the high affinity of agrochemicals with soil, surface water resources like streams, estuaries, and lakes, as well as groundwater are susceptible to pesticide contamination because of the close interconnection of soil with water bodies. The low concentration of pesticides built up in the water can get magnified through the food chain and enter aquatic organisms that are hazardous for human consumption [3].

1.1 Type of Pesticide Pollutants in Water

Pesticides are categorized into several distinct groups based upon their target species, such as insecticides, herbicides, and fungicides being the most used in agricultural farmland. Herbicides are weed-killing compounds and are normally included in plant growth regulators. Insecticides are used in farmlands, food storage facilities, or home gardens to control insects. Fungicides prevent fungus infection in plants or seeds, which are usually applied before the fungus is present or after the fungus infects the plant species. Besides, the pesticide can be classified based on the mode of action on the pests such as destroying, mitigating, and repelling reagents [4]. According to an estimate, about 5.2 billion pounds of pesticides are used worldwide per year. The use of pesticides for pest mitigation has become a common practice all around the world. Their use is not only restricted to agricultural fields but they are also employed in homes in the form of sprays, poisons, and powders for controlling cockroaches, mosquitoes, rats, fleas, ticks, and other harmful bugs [5].

1.2 Classification of pesticides:

The most common and useful method of classifying pesticides is based on their chemical composition and nature of active ingredients. It is such kind of classification that gives the clue about the efficacy, and physical and chemical properties of the respective pesticides. The information on the chemical and physical characteristics of pesticides is very useful in determining the mode of application, precautions that need to be taken during the application, and the application rates. Based on chemical

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composition, pesticides are classified into four main groups namely; organochlorines, organophosphorus, carbamates, and pyrethroids. The chemical-based classification of pesticides is rather complex. In general, modern pesticides are organic chemicals. They include pesticides of both synthetic and plant origin. However, some inorganic compounds are also used as pesticides [6-7].

Table 1: Classification of pesticide based on target species.

Pesticides	Class: Substance
Insecticides	Organochlorine: Endosulfan Organophosphate:Diazinon,Malathion,parathion, Carbamate: Aldicarb, carbofuran, carbaryl Pyrethroid: Deltamethrin, Fenpropathrin Neonicotinoid: Acetamiprid, thiamethoxam
Herbicide	Triazine: Atrazine, cyanazine Chloroacetamide: alachlor, butachlor, dimethenamid, metolachlor
Fungicide	Benzamide: Fluopicolide, zoxamide Carboxamide: Boscalid captofol Chlorinated hydrocarbon: Hexachlorbenzene Organophosphate: Edifenphos, iprobenfos

The numerous negative health effects that have been associated with chemical pesticides include, among other effects, dermatological, gastrointestinal, neurological, carcinogenic, respiratory, reproductive, and endocrine effects. Furthermore, high occupational, accidental, or intentional exposure to pesticides can result in hospitalization and death [8].

2. Material and Methods:

2.1 Selection of study area:

The study was conducted in the agricultural area of the Nagaur region, Rajasthan. The villages were purposely selected to reflect the importance and scale of agriculture production in the study area.

The selection of the district was influenced by two factors. First, in this district, the cultivation of high-value crops namely cotton, millet, moong, and off-seasonal off-seasonal vegetables is being practiced since the late sixties and early seventies. Second, in this district, most people are dependent on agricultural practices [9].

2.2 Collection of Data:

A total of 370 farmers were randomly selected for interviews and questionnaires. Field surveys, group discussions, and questionnaire methods are used for data collection. Then, the data collected were tabulated and statistically analyzed using simple statistical tools like average and percentage to interpret the results.

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From these methods, information was gathered on the cropping system, type of vegetable, frequently used pesticides, diseases by pesticides, and farmer's knowledge, application, safety measure, and final disposal of a container.

The study is based both on primary and secondary data. The primary data were collected from the sample households using a pre-tested schedule through a personal interview method for the agricultural year 2021-2022. The data were collected on the following aspects: family size, educational status of the family, land utilization pattern, cropping pattern, symptoms due to prolonged exposure to pesticides; medicinal history, and expenditures incurred in treating the illness of farmers particularly impacts caused by use of pesticide; farmers awareness of the change in health condition. The secondary data were collected from the statistical outline of Rajasthan, 2021-22 on demographic features of the study area [10-12].

2.3 Field study of the selected areas of Nagaur district (Rajasthan):

The interview questionnaire was designed to elicit land ownership, the plantation where the farmer was currently working, exposure to pesticides, the use of pesticides, the commonly used pesticides, precautions taken, the farmer's source of information about pesticides, and signs and symptoms of illnesses related to pesticide exposure. The questionnaire was designed to probe farmers' concerns about pesticide use and its hazards.

Respondents will be sampled randomly from the population of farm workers in the villages.

(1). As the first step health or local government personnel familiar with the district will compile a list of workers involved in vegetable production in the village/district. The list will include all members of households aged 18 and above who work regularly as farmers. The list will comprise information on name, large or small farm, and gender. The number of households and people on the list will be noted.

(2). The main interview will be conducted either immediately or within a few days [13].

An interview questionnaire regarding Farmers knowledge, experience towards pesticide application, health problems and environment.

Questionnaire	Answer
1. Name of farmer/ Respodent	….....
2. Age	……
3. Gender	……
4. Address	……
5. Educational level of the farmer: (i) Less than elementary level (Illiterate) (ii) Elementary level (iii) Secondary level (iv) College level and higher	

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6. What is your marital status? (i) Married (ii) Unmarried (iii) None	
7. Is agriculture your main occupation? (i) Yes (ii) No	
8. What is main source of income in your household? (i) Agriculture (ii) Service (iii) Business (iv) Other	
9. Name of pesticides used by farmers during interview?	
10. Do you mix brands of pesticides? (i) Yes (ii) No	
11. Can this usage of pesticide cause any kind of long term or short term health effect? (i) No effect (ii) There is effect (iii) I don't know	
12. What application methods do you generally use when you apply pesticides?	
13. Do you read pesticide's labels before use? (i) Always (ii) Sometimes (iii) Never	
14. How do you mix pesticides? (i) With bare hand (ii) With stick (iii) Wear hand gloves, protective eyes goggles, and masks.	
15. Any health effect after pesticide application? (i)Least health hazard effects:- Headache, itching, tiredness, dizziness (ii)Moderate health hazard:- Dizziness, vomiting or blurred vision or skin sores (iii) Extreme health hazard:- long term illness and need to hospitalize. (iv) No health hazard	
16. Disposal of empty pesticide containers? (i) Incineration (ii) Burring (iii) Throw away on the farm or outside (iv) Reuse the empty container	
17. How many crops do you produce in one year?	
18. Have you ever heard about 'organic farming'? (i) Yes (ii) No	
19. How do you control weeds? (i) By burning plant residues after harvesting. (ii) By grazing through animals. (iii) By mechanical weeding (tillage, mowing and/or manual). (iv) By crop rotation and/or intercropping (v) By chemical herbicides	
20. Do you use any pesticides which you have used for one crop, but according to the label were prescribed for another crop? (i) Yes (ii) No	
21. Have you ever received basic training on safe handling and applying pesticides? (i)Yes (ii) No	
22. Have you ever heard or witnessed any of the pesticide-related accidents below in your local area? (i) Yes (ii) No	
23. How much risk do you think you are exposed to while using pesticides on this farm? (i) No risk at all (ii) Some small risks (iii) A medium amount of risk (iv) A large and significant amount of risk	

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(v) Dangerous and very toxic risks	
24. Do you keep pesticide bottles in the same place where you keep your medicine or food items? (i) Yes (ii) No	
25. Have you ever had any of the following symptoms after applying pesticides during the last year? (i) Eye irritation (ii) Fever (iii) Headache (iv) Convulsion (v) Dizziness (vi) Shortness of breath (vii)Vomiting (viii) Skin irritation (ix) Diarrhea (x) Other	
26. Did you take any medicine to relieve the symptoms or cure the diseases? (i) Yes (ii) No	
27. Did you go to a hospital or a health care centre? (i) Yes (ii) No	
28. What is the main disease causing due to pesticides?	

Results and discussion:

Table-2: Educational status of the farmers at the study area.

S. No.	Standard	No. of Farmers	Percentage of farmers
1.	Primary Level	75	20.27
2.	Secondary Level	120	32.43
3.	Sr. Secondary Level	115	31.08
4.	College Level	50	13.51
5.	Illliterate	10	2.70

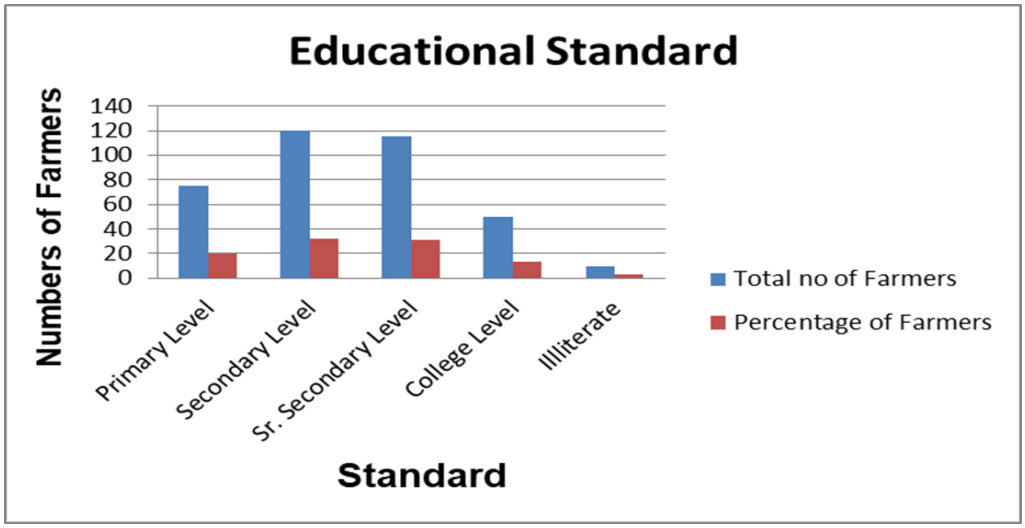

Figure-1: Illustration of the educational status of the respondents.

The information gathered through the survey of the respondents by education level indicated that 20.27 % of the farmer education up to primary level; 32.45% of the farmers had studied at secondary school; 13.51 % of the farmers had a college education and nearly 2.7% of the farmers were illiterates.

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Cultivation of crops:

It was found that 64.54 % of the farmers cultivate two crops per season; 24.16% of the farmers cultivate three crops and the rest of 11.3% of farmers cultivate four crops per season. According to observation, the average number of crops grown per season by the farmers was found to be around two crops in the study area.

Awareness about pesticides:

It was found during the survey that, 80% of the farmers do not know and care about the harmful residual effects of pesticides. The majority of farmers were not aware of recommended doses, pre-harvest intervals, and the harmful effects of these chemicals on human health. Only 20% of respondents' farmers followed safe methods while mixing or spraying pesticides on crops [14].

Figure-2: Pesticides Spray machine at Basani Village, Nagaur (Rajasthan).

Table- 3: Frequently used pesticide for selected agricultural area of Nagaur region of Rajasthan.

Pesticides	WHO Classification of hazardous	No of farmers	% of farmers
Malathion	(Class III) Slightly Hazardous	122	68.5
Methyl Parathion	(Class Ia) Extremely Hazardous	80	44.94
Chlorpyrifos	(Class II) Moderately Hazardous	45	25.28
Dichlorvos	(Class I b) Highly Hazardous	90	50.56
Dimethoate	(Class II)Moderately Hazardous	132	74.15
Monocrotophos	Class I b) Highly Hazardous	48	26.96
Profenofos	(Class II)Moderately Hazardous	97	54.49
Phorate	(Class Ia) Extremely Hazardous	38	21.34
Triazophos	(Class Ib) Highly Hazardous	70	39.32
Quinalphos	(Class II) Moderately Hazardous	11	6.179

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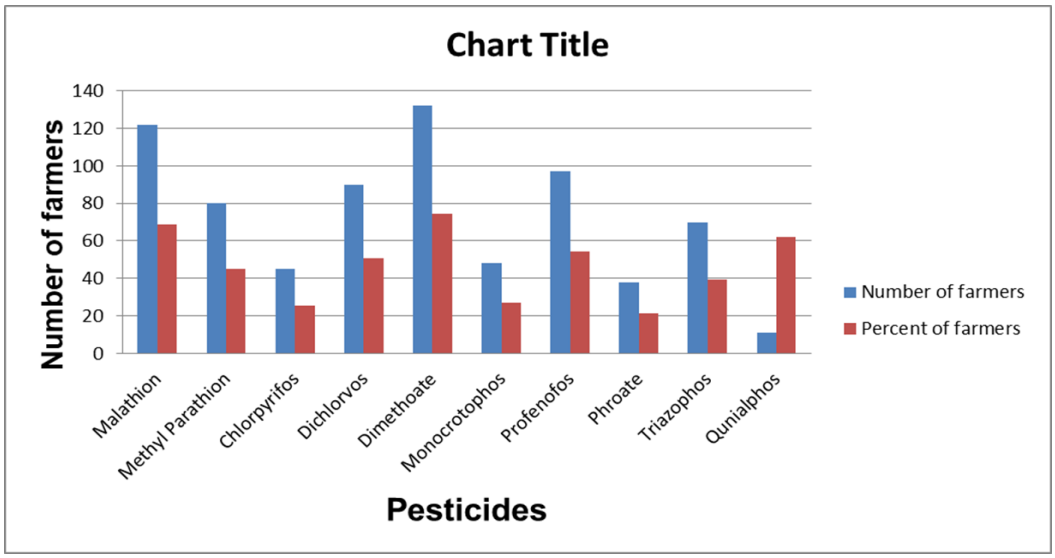

Figure-3. Illustration of the pesticides used by farmers at selected area of Nagaur region of Rajasthan.

Fig.3 shows that pesticides used by the most farmers are malathion, dichlorvos, and dimethoate.

Table-4 Consumption of pesticides among farmers for various agro products at study area.

s.no	Agro product	Total no. of farmers respondent	No. of farmer consuming pesticide	% of farmers consuming pesticides
1.	Cotton	278	240	86.33
2.	Wheat	200	175	87.5
3.	Mustard	150	140	93.33
4.	Millet	140	125	89.28
5.	Vegetables	135	110	81.48

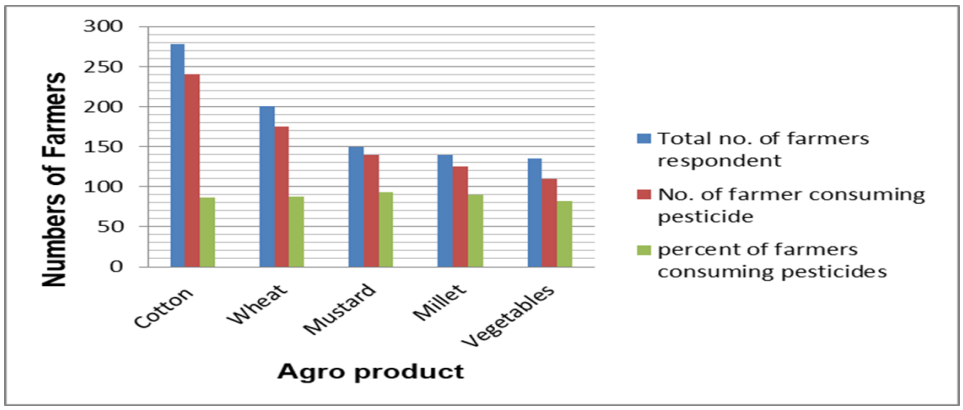

Figure- 4: Illustrationn of the percentage consumption pattern of pesticides.

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Table-4: The most commonly diseases due to pesticides and water contamination at study area.

S.No.	Diseases	No of Farmers	Percent of Farmers
1.	Eye irritation	30	8.10
2.	Skin irritation	45	12.16
3.	Head ache	65	17.57
4.	Back pain	35	9.46
5.	Vomiting	30	8.10
6.	Dizziness	25	6.76
7.	Asthma	65	17.57
8.	Bronchitis	50	13.51
9.	Kidney diseases	20	5.40
10.	Diabetes	40	10.81

Table 4 shows that the majority of the farmers reported having experienced acute illnesses due to pesticide exposure. Most of them opined that they had experienced eye irritation, fatigue, skin irritation, headache and back pain, vomiting, dizziness, and 1 percent eye discharge.

The clinic facilities were availed by 80 percent and 73 percent of the respondents after the illness caused by pesticide exposure in the Nagaur district of Rajasthan.

2.4 Pesticides dealers' survey to study the most commonly used pesticides at Nagaur district (Rajasthan):

The field study was conducted on the distributor of pesticides and the application of pesticides at farmers' fields in the Nagaur district of Rajasthan. A total of 20 distributors were interviewed.

A questionnaire was prepared considering relevant aspects including types of pesticides, awareness and technical knowledge about the uses of pesticides, training on safe and effective use of pesticides, and source of recommendations regarding time, application rate, and method of application [15].

Table-5: Dealers of seeds, fertilizers and pesticides at Nagaur region of Rajasthan.

S.N.	Dealers	Address
1.	Apni Bachat Ghar Yoj.Mahi. Sah.smi. Ltd.	Gogelav, Nagaur
2.	Bhadana G.S.S. Ltd.	Bhadana, Nagaur
3.	Bhati Beej Bhandaar	Gandhi chowk Nagaur
4.	Janta krishi seva kendra	Delhi gate Nagaur
5.	Krishi khad beej bhandar	Gandhi chowk Nagaur
6.	Sri Ram Agrosales	Gandhi chowk Nagaur
7.	Saraswati Agro sales	Nagaur city
8.	Sri Laxman Khad beej bhandar	Karnu, Nagaur
9.	Ramdev Krishi seva kendra	Fort road Nagaur
10.	Rahul Agro agency	Nagaur
11.	Pareek agency	Nagaur

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The major findings of the study are presented here under the following heads.

2.4.1 Organochlorine Pesticides:

The most widely known organochlorine pesticide is dichloro diphenyl trichloro ethane, i.e the insecticide DDT, the uncontrolled use of which raised many environmental and human health issues. Dieldrin, endosulfan, heptachlor, dicofol, and methoxychlor are some other organochlorines used as pesticides.

The general class of organochlorine pesticides has been associated with health effects, such as endocrine disorders, effects on embryonic development, lipid metabolism, and hematological and hepatic alterations. Their carcinogenic potential is questioned, but concerns about possible carcinogenic action should not be underestimated [16-17].

Figure - 5. Pesticides dealers shop at Nagaur district of Rajasthan.

2.4.2 Organo-phosphorus Pesticides:

Organophosphates, which were promoted as a more ecological alternative to organochlorines, include a great variety of pesticides, the most common of which is glyphosate. This class also includes other known pesticides, such as malathion, parathion, and dimethoate; some are known for their endocrine-disrupting potential [18]. This class of pesticides has been associated with effects on the function of cholinesterase enzymes, decrease in insulin secretion, disruption of normal cellular metabolism of proteins, carbohydrates and fats, and also with genotoxic effects and effects on mitochondrial function, causing cellular oxidative stress and problems to the nervous and endocrine systems [19]

2.4.3 Carbamate Pesticides:

Carbamate pesticides, such as aldicarb, carbofuran, and aziram, are another class of chemical pesticides that have been associated with endocrine-disrupting activity, and effects on cellular metabolic mechanisms and mitochondrial function (Wissem Mnif et al., 2011). Furthermore, it has been confirmed that carbaryl, which belongs to the category of carbamate pesticides, can act as a ligand for the hepatic aryl hydrocarbon receptor, a transcription factor involved in the mechanism of dioxin toxicity [20].

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Table-6: Showed the guideline value for a certain number of pesticides in drinking water issued by WHO aimed for a water quality that is suitable for long-term consumption. These guideline values were made available for the use of regulatory authorities.

Pesticide	Guideline Value (Microgram/L)	Pesticide	Guideline Value (Microgram/L)
Alachlor	20	Metolachlor	10
Aldicarb	10	Molinate	6
Atrazine	2	Pentachlorophenol	9
Bentazone	300	Permethrin	20
Carbofuran	7	Propanil	20
Chlordane	0.2	Pyridate	100
DDT	2	Simazine	2
Hexachlorobenzene	1	2,4,5-T	9
Isoproturon	9	Terbuthylazine	7
Lindane	2	Trifluralin	20

2.4.4 Other classes of pesticides:

The triazines, such as atrazine, simazine, and ametryn, are another class of chemical pesticides that have been related to endocrine-disrupting effects and reproductive toxicity. Moreover, it was found that there is a possible statistical relationship between triazine herbicides and breast cancer incidence (Chrysanthi Kotampasi et. al., 2016). Atrazine is the most known of the triazines, and it is a very widely used herbicide that has been associated with oxidative stress, cytotoxicity, and dopaminergic effects [21].

Synthetic pyrethroids, such as permethrin, and sumithrin, are considered to be among the safer insecticides currently available for agricultural and public health purposes.

Table – 7: The most common pesticides which are used in crops, and vegetables at Nagaur region of Rajasthan.

Pesticides	Class and substance
Insecticides	Organochlorine: Endosulfan Organophosphate: Malathion, parathion, Carbamate: Aldicarb, carbaryl Pyrethroid: Deltamethrin, Fenpropathrin Neonicotinoid: Acetamipride
Fungicides	Chlorinated hydrocarbon: Hexachlorbenzene Organophosphate: Edifenphos, iprobenfos
Herbicides	Triazine: Atrazine, cyanazine

2.5 Hospital survey in the Nagaur district of Rajasthan:

The survey of various hospitals of Nagaur district was done. Get information about different patients coming to the hospitals and received knowledge from the doctors about the diseases occured in various patients coming to the hospital.

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The collected information about various diseases caused by polluted water and around 20 hospitals were visited during the study, and during the survey, received information from doctors and health workers about various diseases caused by water contaminated with pesticides [22].

A study on water born disease is a qualitative study that used framework analysis to examine in-depth interviews among hospitalized patients, doctors other health conscious persons.

A pre-coded questionnaire was developed to obtain relevant information regarding socio-demographic status such as age, education, disease, health condition, dietary pattern, housing etc. We visited hospitals, which are located in the Nagaur city and nearby study area for the collection of data from the patient.

Figure – 6: Marwar hospital and Bhutra hospital at Nagaur district of Rajasthan.

A questionnaire's was developed by survey of hospitals to knowledge the diseases of indoor and outdoor patients.

Questionnaires	Answer
1. Name of Hospital:	
2. Name of respondent/ health worker:	
3. Address:	
4. Gender of respondent: (i)Yes (ii) No	
5. Total number of indoor patients per day	
6. Total number of outdoor patients per day:	
7. Total number of male / female patients per day:	
8. Is the hospital multispecialty? (i) Yes (ii) No	
9. Which disease patients come to the hospital the most?	
10. Do you come to the hospital for diseases infected with polluted water? (i) Yes (ii) No	
11. What are the diseases caused by contaminated water?	
12. How many patients of diseases caused by contaminated water come daily in hospital?	
13. What are the diseases caused by pesticides?	

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14. What is the main cause of water contamination in Nagaur region? (i) Excess use of pesticides in crops and vegetables (ii) sewage wastage (iii) industrial wastage (iv) All of above	
15. How would you rate the investigative diagnosis process that you underwent?	
16. What is the difference in the care provided by the hospitals available in your area?	
17. Is your primary health care physician able to conduct a swift diagnosis and prescribe medication? (i) Yes (ii) No	
18. Were the ambulatory staff quick to respond to your medical care request? (i) Yes (ii) No	
19. Did the radiology centre provide the scan reports on the same day? (i) Yes (ii) No	
20. Do cancer patients also come to the hospital? (i) Yes (ii) No	

We used statistical program for social science (SPSS) software for data analysis [23]. During the recruitment period (from December 2021 to May, 2022), there were 1144 individuals in the hospital studied both indoor and outdoor.

Among them 364 were water born disease patients. The subjects were randomly chosen. All participants were interviewed by using standard questionnaires that evaluated water contaminated disease. Among the water born disease, 10.3% were pneumonia and 6.2% asthma.

Table -6: Illustration of the number of indoor and outdoor patients.

Parameter	Frequency	Percentage (%)	Valid percentage (%)	Cumulative percentage (%)
Indoor	920	80.41	80.41	80.41
Outdoor	224	19.59	19.59	100
Total	1144	100	100	

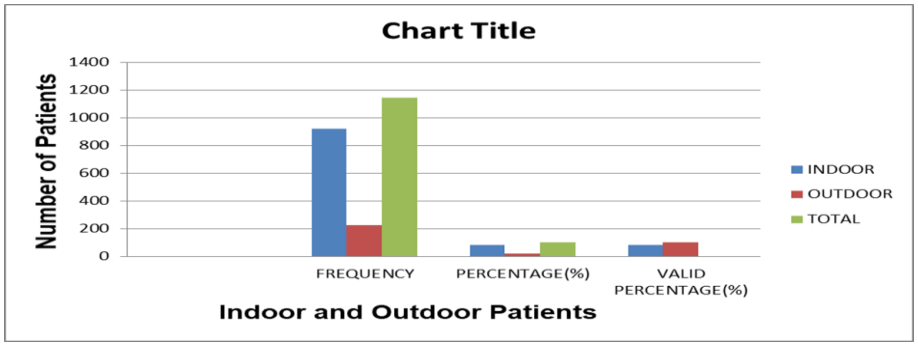

Figure- 7: The frequency of indoor and outdoor patients.

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Table – 8: Illustration of the number of male and female patients.

Parameter	Frequency	Percentage(%)	Valid Percentage (%)
Male	640	55.94	55.94
Female	504	44.06	44.06
Total	1144	100	100

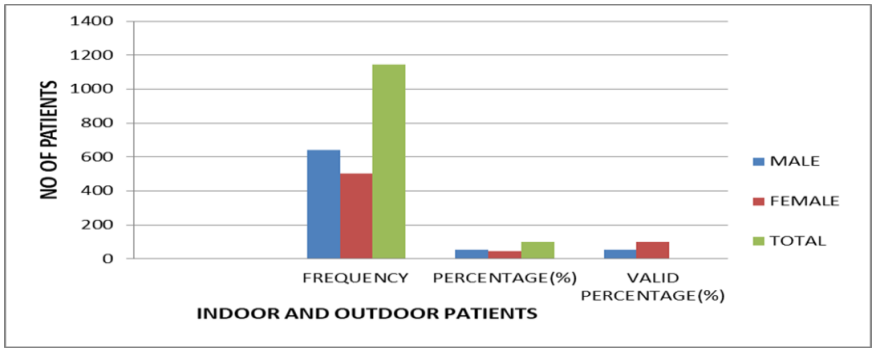

Figure-8: The frequency of male and female patients.

Table 9: The pattern of water born disease and medicine ward disease.

Parameter	Frequency	Percentage	Valid percentage
Allergy	120	10.50	10.50
Asthama	210	18.35	18.35
Vomiting	90	7.87	7.87
Cough	300	26.22	26.22
Diabetes	100	8.74	8.74
Diarrhea	98	8.56	8.56
Fever	450	39.33	39.33
Gastric	320	27.97	27.97
Headache	200	17.48	17.48
Heart	80	6.99	6.99
Hypertension	310	27.09	27.09

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Jaundice	**20**	**1.75**	**1.75**
Infection	140	12.24	12.24
Kidney failure	60	5.24	5.24
Cholera	20	1.75	1.75
Leukemia	38	3.32	3.32
Paralysis	3	0.26	0.26
Pneumonia	41	3.59	3.59
Sinus	5	0.44	0.44
Respiratory depression	81	7.08	7.08
Cancer	3	0.26	0.26
Typhoid	30	2.62	2.62
Skin itching	245	21.41	21.41
Eye irritation	325	28.40	28.40
Ear	30	2.62	2.62

3. DISCUSSION AND SUMMARY:

3.1 Responses of Farmers About Causes and Consequences of Pesticide Pollution:

The data for responses of farmers to the causes and consequences of pesticide pollution are plotted graphically in Figs. 1, 3, and 4. Most of the farmers were aware of the fact that pesticides are drained by rainwater and accumulate in water bodies. The pesticide may persist in water depending on the type of chemical and water bodies. Experimental studies have shown that pesticides may have mutagenic, carcinogenic, and teratogenic potential on long-term exposure [24]. In addition, consumption of pesticide-contaminated food may also damage the central and peripheral nervous system, liver, and kidney, or produce birth defects. In the present study, only two-fifth of the farmers knew that lindane and endosulfan in the body affect the nervous system and causes health problems [25]. The majority of farmers did not know that endosulfan not only affects the central nervous system but also causes hyperactivity, nausea, dizziness, headache, and severe poisoning resulting in death (Arun et al., 2006-07).

3.2 Responses of Farmers about the Remedies for Pesticide Pollution:

The responses of farmers to the remedies to pesticide pollution are plotted graphically. The majority of the farmers strongly affirmed that shifting to food grain and vegetable

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crops would reduce consumption of pesticides, that body should be covered properly at the time of spraying pesticides, and crop rotation would minimize pesticide requirement. Surprisingly, only half of the farmers (50%) were aware of the fact that switching over to organic farming would retard the use of pesticides while about two-thirds farmers (60%) thought that pesticide use could be reduced by switching over to genetically modified crops [26].

3.3 Strategies for Protection from Pesticides:

Methods carried out to rectify the problems associated with the entry of pesticides can be broadly classified into-Preventive and mitigating strategies.

Preventive strategies:

Alternative agriculture is viewed in the context of a healthier, environment friendly, and sustainable agriculture includes the use of non-chemical alternatives. In recent years, traditional techniques, including non-chemical alternatives are viewed as technology options that could help in decreasing the need for undesirable chemical inputs and create sustainable systems. Numerous models exist and have been advocated in this regard viz., Integrated Pest Management (IPM), Low External Input Sustainable Agriculture (LEISA), and Organic Agriculture [27].

3.3.1 Integrated Pest Management (IPM):

IPM approach is based on the integrated and appropriate use of biotechnology, information technology, and eco-technology. It is an ecologically based strategy that focuses on the long-term solution of the pests through a combination of techniques such as biological control, modification of agronomic practices, and use of resistant varieties. Pest control tactics, including pesticides, are carefully selected and applied to minimize risks to human health, beneficial and non-target organisms, and the environment [28]. It provides knowledge of the current pests, and helps select the possible combinations of pest management methods.

Use of botanical pesticides: Botanicals are generally less harmful to the environment because of their quick degrading property. These can be used as raw crushed plant leaves, extracts of plant parts, and chemicals purified from plants such as pyrethrum, azadirachta indica, tobacco, and garlic [29].

3.3.2 Low External Input Sustainable Agriculture:

LEISA is one of the most promising paradigms that have emerged for the benefit of small scale; resource-poor farmers ensure higher productivity and sustainability by optimizing, and maximizing the use of locally available resources, establishing a synergistic effect among the components of the farming system, such that they complement each other in the production of output [30].

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3.3.3 Organic Agriculture:

The organic farming system in India is not new, and is being followed since ancient times. It is primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment [31].

Direct impact on humans:

If the credits of pesticides include enhanced economic potential in terms of increased production of food, fibers, and amelioration of vector-borne diseases, then their debts have resulted in serious health implications to man and his environment. There is now overwhelming evidence that some of these chemicals do pose a potential risk to humans, and other life forms and unwanted side effects to the environment [32]. No segment of the population is completely protected against exposure to pesticides and the potentially serious health effects, though a disproportionate burden is shouldered by the people of developing countries, and by high-risk groups in each country (WHO, 1990). The high-risk groups exposed to pesticides include production workers, formulators, sprayers, loaders, and agricultural farm workers. During manufacture and formulation, the possibility of hazards may be higher because the processes involved are not risk-free. In industrial settings, workers are at increased risk since they handle various toxic chemicals including pesticides, raw materials, toxic solvents, and inert carriers. The magnitude of the toxicity risk involved in the spraying of methomyl, a carbamate insecticide, in field conditions was assessed by the National Institute of Occupational Health [33-34].

Impact on environment:

Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms [35].

4. Conclusion:

Pesticides are existing at more concentration that removed from drinking water for human safety. There is a need to maintain control on disposal of industrial waste or Agriculture waste in water bodies, and to bio-monitor the trace elements in the water and other eatables. It is recommended that there should be proper waste disposal system, and waste should be treated before entering in to water bodies. Pesticide containing agricultural runoff enters in aquatic environment, and harm to aquatic plants and animals. These technologies are recommended for field applicability and

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commercialization in the developing countries also where agriculture, urbanization, and industrialization are leaving a legacy of environmental degradation Iran must formulate appropriate agricultural policies at a national level to enhance the extension services and educate farmers to reduce fertilizer application for sustainable development [36].

Advances in knowledge at the genetic, molecular, cellular, and system levels can provide supportive evidence to back up human studies that can only infer or make correlations between pesticide exposure and a disorder or undesirable change in function. Literature has evidenced pesticides to be among the causative factors for respiratory, nervous, reproductive, hepatic, and renal abnormalities in the human body [37]. The adverse effects range from small health variations (like allergies, cough, irritation, wheezing, sneezing) to irreversible changes (like lung damage, mutations, infertility, cancer, and diabetes) slowly paving the way towards apoptosis and finally death of the individual. The primary need, at present, is the creation and implementation of sound policies that reduce exposure to pesticides by use of alternative strategies which do not rely on these chemicals for plant protection. The use of IPM and organic farming is a good attempt. Food processing can also be effectively used as a tool in addressing this problem of food safety at the household level. If such steps are taken, it is fully expected that the incidence of adverse health consequences for agrarian populations from pesticide toxicity will decrease [38].

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6. Conflict of interest:

The authors have no conflict of interest.

References:

[1]. Chikamso C. Apehcorr , Farmers' Perception of the Health Effects of Agrochemicals in Southeast Nigeria, Journal of health and pollution. 2018 Sep; 8(19): 180901. doi: 10.5696/2156-9614-8.19.180901.

[2]. R. Kaur, G.K. Mavi, S. Raghav, Pesticides Classification and its Impact on Environment, International Journal of Current Microbiology and Applied Sciences, ISSN: 2319-7706 Volume 8 Number 03 (2019). DOI: https://doi.org/10.20546/ijcmas.2019.803.224.

[3]. M. Syafrudin, R. Ayu Kristanti, A. Yuniarto, T. Hadibarata , Pesticides in Drinking Water—A Review, Int J Environ Res Public Health. 2021 Jan; 18(2): 46 Published online 2021 Jan 8. doi: 10.3390/ijerph18020468.

[4]. Md. Wasim Aktar,1 Dwaipayan Sengupta,2 and Ashim Chowdhury2 Impact of pesticides use in agriculture: their benefits and hazards, Interdiscip Toxicol. 2009 Mar; 2(1): 1–12, Published online 2009 Mar. doi: 10.2478/v10102-009-0001-7.

ISSN：1671-5497
E-Publication Online Open Access
Vol: 41 Issue: 10-2022
DOI 10.17605/OSF.IO/M6D9S

[5]. Michael C.R. Alavanja, Dr.P.H., Pesticides Use and Exposure Extensive Worldwide, Rev Environ Health. 2009 Oct–Dec; 24(4): 303–309. doi: 10.1515/reveh.2009.24.4.303.

[6]. I. C. Yadav, N. Linthoingambi, Pesticides Classification and Its Impact on Human and Environment, Environ Sci Eng, volume 6, 2017.

[7]. Ishwar Chandra Yadav, N. Linthoingambi , J. H. Syed, Zhineng Cheng, Current status of persistent organic pesticides residues in air, water, and soil and their possible effect on neighbouring countries; A comprehensive review of india. Science of the Total Environment, volume 511, 2015, publisher-Elsevier,

[8]. P. Nicolopoulou-Stamati, S. Maipas, C. Kotampasi, Panagiotis , Chemical Pesticides and Human Health: The Urgent Need for a New Concept in Agriculture, Front Public Health, 2016; 4: 148.

[9]. J. M. Deshmukh, V.G .Dhulgand & Sonali Vasudeo Kanade, book; Off Season Vegetable Production.

[10]. Ranjit Kumar, Research Methodology: A Step-by-step Guide for Beginners, 123 (Sage, London, 2005).

[11]. B.N.Ghosh, “Collection and Analysis of Data”, 24:4 JILI (1982).

[12]. Retrieved on 27.04.2020 from-https://bbamantra.com/methods-of-data-collection-primary-andsecondary-data/

[13]. C. A. Damalas, S. D. Koutroubas, Farmers’ Exposure to Pesticides: Toxicity Types and Ways of Prevention, Toxics 016 Mar; 4(1): 1. nline 2016 Jan 8. doi: 10.3390/toxics4010001.

[14]. M. F.A. Jallow , Dawood G. Awadh, Mohammed S. Albaho, Vimala Y. Devi and Binson M. Thomas, Pesticide Knowledge and Safety Practices among Farm Workers in Kuwait: Results of a Survey, International Journal of Environmental Research and Public Health,March 2017, ISSN: 1660-4601,

[15]. M. V. Satya Sai, G. Devi Revati, R. Ramya, Ann Mary Swaroop, Eswaran Maheswari, and Mudigubba Manoj Kumar, Knowledge and Perception of Farmers Regarding Pesticide Usage in a Rural Farming Village, Southern India. Indian J Occup Environ Med. 2019 Jan-Apr; 23(1): 32–36, doi: 10.4103/ijoem.IJOEM_121_18.

[16]. L. E. Lizarraga,a Jeffry L. Dean,a J. Phillip Kaiser,a Scott C. Wesselkamper, A Case Study on the Application of An Expert-driven Read-Across Approach in Support of Quantitative Risk Assessment of p,p’Dichlorodiphenyldichloroethane, Regul Toxicol Pharmacol. 2019 Apr; 103: 301–31. doi: 10.1016/j.yrtph.2019.02.010.

[17]. World Health Organization. Public Health Impact of Pesticides Used in Agriculture. England: World Health Organization (1990).

[18]. R. Jayaraj, P. Megha, Puthur Sreedev , Organochlorine pesticides, their toxic effects on living organisms and their fate in the environment, Interdiscip Toxicol. 2016 Dec; 9(3-4): 90–100. Published online 2017 May 17. doi: 10.1515/intox-2016-0012.

[19]. Fukuto TR. Mechanism of action of organophosphorus and carbamate insecticides. Environ Health Perspect 1990; 87: 245–254.

[20]. W. Mnif, A. I. Hadj Hassine, Aicha Bouaziz, A. Bartegi, O. Thomas, Benoit Roig, Effect of Endocrine Disruptor Pesticides: A Review, Int J Environ Res Public Health. 2011 Jun; 8(6): 2265–2303, Published online 2011 Jun 17. doi: 10.3390/ijerph8062265.

[21]. Sarka Klementova and Lucie Keltnerova, Book chapter- Triazine Herbicides in the Environment, December 2nd, 2015, DOI: 10.5772/60858.

[22]. Annual Report 2021-22, Department of Health & Family Welfare, Ministry of Health & Family Walfare Government of India, Nirman Bhawan, New Delhi – 110011, Website : mohfw.nic.in

ISSN：1671-5497
E-Publication Online Open Access
Vol: 41 Issue: 10-2022
DOI 10.17605/OSF.IO/M6D9S

[23]. SPSS Variable and Value totals: A quick tutorial.

[24]. C. A. Damalas, I. G. Eleftherohorinos, Pesticide Exposure, Safety Issues, and Risk Assessment Indicators, Int J Environ Res Public Health. 2011 May; 8(5): 1402–1419. doi: 10.3390/ijerph8051402.

[25]. H. C, Gaston CP. Effects of refining predicted chronic dietary intakes of pesticide residues: A case study using glyphosate. Food Addit. Contam. 2004; 21:857–864. [PubMed] [Google Scholar]

[26]. Animesh K. Mohapatra, Shilpa Roy, Pesticides Pollution: Perceptions of Farmers in Punjab , Nat. Env. Poll. Tech. vol. 9, 2010, ISSN: 0972-6268.

[27]. Seth, P.K., Raizada, R.B. Agricultural Chemical Use and Residue Management in India. Seeking Agricultural Procedure Free of pesticide Residues. Proceedings of an International Workshop held in Yogyakarta, Indonesia, 17-19 February 1998.

[28]. J.F. Karlik, S.A. Tjosvold, , Integated Pest Management(IPM) ,in Encyclopedia of Rose Science, 2003.

[29]. J.F. Brunner, Integrated Pest Management in tree fruit crops. in Encyclopedia of Agriculture and Food Systems, 2014.

[30]. Ibeawuchi, I.I; Obiefuna, J.C and Iwuanyanwu, Low External Input Agricultural Farming System for the Increase in Productivity of Resource Poor Farmers in Productivity of Resource Poor Farmers, Journal of Biology, Agriculture and Healthcare , ISSN 2224-3208 (Paper) ISSN 2225-093X (Online), Vol.5, No.2, 2015.

[31]. H. P. Parewa, L. K. Jain, Role of bio fertilizers and bio pesticides in organic farming, Advances in Organic Farming, 2021 [science direct].

[32]. Fenik J, Tankiewicz M, Biziuk M. Properties and determination of pesticides in fruits and vegetables. Trends in Analytical Chemistry 2011; 30 [6]: 814-826.

[33]. Delaplane K S. Pesticide Usage in the United States: History, Benefits, Risks, and Trends. The University of Georgia, Athens, Georgia 1996. http://ipm.ncsu.edu/safety.

[34]. Ecobichon DJ. Carbamate insecticides. In: Krieger R (ed). Handbook of Pesticide Toxicology. San Diego, CA: Academic Press; 2001. p.1087-1106.

[35]. Jokanovic M. Medical treatment of acute poisoning with organophosphorus and carbamate pesticides, Toxicology Letters 2009; 190: 107-115.

[36]. Reigart JR, Roberts JR. Recognition and Management of Pesticide Poisonings. 5ª Ed. United States EPA, http://www.epa.gov/oppfead1/safety/healthcare/handbook/handbook.pdf (Accessed 4 September 2014).

[37]. Wissem Mnif, Aziza Ibn Hadj Hassine, Aicha Bouaziz, Aghleb Bartegi, Olivier Thomas, Benoit Roig, Effect of Endocrine Disruptor Pesticides: A Review, Int J Environ Res Public Health. 2011 Jun; 8(6): 2265–2303, doi: 10.3390/ijerph8062265.

[38]. Vidsha tomar, Pesticide: An Appraisal on Human Health Implications, Proceedings of the National Academy of Sciences, India - Section B: Biological Sciences , ISSN- 0369-8211 Proc. Natl. Acad. Sci., India, Sect. B Biol.Sci. DOI 10.1007/s40011-014-0388-6.