PAN INDIA

PAN ASIA PACIFIC

Highly Hazardous Pesticide Series

STATE OF CHLORPYRIFOS FIPRONIL, ATRAZINE & PARAQUAT DICHLORIDE IN INDIA

A. D. Dileep Kumar

Highly Hazardous Pesticide Series

State of Chlorpyrifos, Fipronil, Atrazine, and Paraquat Dichloride in India

February 2022

Author : **A. D. Dileep Kumar** MSc., PGDPRM (UCT, South Africa)

Editor : **Dr. Meriel Watts,** Director, Science and Policy, PAN Asia Pacific.

Layout : **Jino V Babu**

About PAN India

Pesticide Action Network India (PAN India) is a public interest research and advocacy non-profit organisation formed in 2013. PAN India is a national independent organization in India, working closely with the PAN Asia Pacific and PAN international community. PAN India's objective is to help communities and governments to reduce dependence on toxic chemicals for pest control in agriculture, household as well as public health and to increase the use of sustainable alternatives. PAN India is committed to safe farming, safe living, and safe working place. PAN India is working to make India a world leader in Agroecology by empowering farming communities to keep away from toxic pesticides and agrochemicals, and to take up non-chemical methods of farming practices that champion traditional knowledge, biodiversity, and farmer participated research in attaining food sovereignty.

About PANAP

PAN Asia Pacific (PANAP) is one of five regional centers of Pesticide Action Network, a global network dedicated to the elimination of harm upon humans and the environment by pesticide use, and to the promotion of biodiversity-based ecological agriculture. PANAP's vision is a society that is truly democratic and culturally diverse, based on social and gender justice, fair distribution of productive resources and environmental safety and sustainability.

Contact

Pesticide Action Network (PAN) India

10/233/3, 1st Floor, Sarangi Complex, Chiyaram Post

Thrissur District, Kerala, India - 680026

Phone: +91 487 2253737 | www.pan-india.org | admin@pan-india.org

Contents

PREFACE

The Indian agricultural sector is grappling with low incomes, shortage of natural resources, increasing pest incidence and low public investments in research and extension. Pest attacks are increasing. Previously unknown pests are attacking crops. Farmers, indebted as they are due to various market mechanisms, are finding it hard to protect their crop investments. Thus farmers are pushed into the conundrum of pesticide usage by pesticide markets and companies. Pesticide usage in India is increasingly becoming a regulatory problem.

Regulation has not been effective in the face of such challenges. Scientific expertise on pesticides is often subsumed in the policy trade-offs that, in the ultimate scenario, encourage production and marketing of HHPs. Expert Committee reports, which are recommending withdrawal of certain HHPs, are not being acted upon. Lobbying by pesticide companies has seriously impaired the basics of governance. Amendment to pesticide legislation has been pending for the past 15 years or more. A comprehensive pesticide regulatory law and related mechanism of effective implementation still remains unfulfilled.

Highly hazardous pesticides are being used, as companies are pushing their products through advertisements and sales networks. Often, farmers are misled and influenced into using pesticides that are not recommended for the purpose. Farmers are led to believe that pesticides are the easy choices for the problems they are facing in crop production. HHPs are being pushed as technical answers to social problems such as labour shortages. Herbicide usage, as studies show, is linked to the perception that its better to use these hazardous products than manage local agricultural labour. Negative consequences of such usage are not recognised by the farmers. Farmers who are aware of the hazardous impacts of herbicides and pesticides feel there is no other way. Its Hobson's choice.

Pesticide poisoning is causing ill-health in rural communities and chronic impacts on the health of, particualry, children and women. Sociological groups such as farm labourers and small farmers have become extremely vulnerable to the poisonous effects of pesticides. The persistence of these chemical contaminants in water, soil and air is perpetuating the problem, unseen and unnoticed.

This is where the need for proper agricultural extension services is felt. However, governments have been withdrawing from providing extension services, forcing farmers to depend on advice from the sales persons at local shops for agricultural inputs. Financial linkages also force the farmers to heed advice from these sales persons. Agri-inputs shop owners allow farmers to purchase agriculture inputs (seeds, fertilisers and plant protection chemicals)

without over-the-counter payment, and the shop owners deduct it later from the harvest payments or, farmers pay after the market sales. Thus a financial bondage is established. This bondage has become a tool for pesticide companies to push their wares.

PAN India in collaboration with PANAP is working on various initiatives to get rid of these HHPs and reverse the harm caused by them. A study of four pesticides – two insecticides namely chlorpyrifos and fipronil as well as two herbicides, atrazine and paraquat dichloride – is part of these initiatives. Education and awareness on pesticides is required. Farmers and consumers need to understand the long-term consequences of pesticides that are primarily designed to kill life. Scientists have to do more research on harmful impacts of pesticides. Policy makers also need to increase their awareness and focus on regulating these pesticides, and put the welfare of the farmers and their communitites before the profits of the pesticide companies. Pesticides have been identified as one of the major factors in causing climate change, through their destructive characteristics. Banishing pesticides is one of the options for conservation of Earth and its biodiversity.

Dr. Narasimha Reddy Donthi
Policy Expert & Steering Committee Member
Pesticide Action Network India

ACKNOWLEDGEMENT

First of all, I would like to thank PAN AP for supporting the study. I wholeheartedly thank C. Jayakumar, and J. Shyam Krishnan, Board of directors, PAN India for enabling me to take up this study, and also for guidance. I gratefully remember Dr. Narasimha Reddy Donthi, honorary director of PAN India and Policy Expert, for guidance, technical support, and mentoring throughout this work. Heartfelt thanks to Dr Sharadini Rath, S. Ushakumari, and Sarojeni Rengam, Steering Committee members of PAN India for their constant encouragement as well as guidance in this study. Thanks to Dr. Meriel Watts, Director, Science and Policy, PAN Asia Pacific for valuable suggestions on this work as well as editing the report. Thanks also to Dr. Silpa Satheesh, and Dr. Adithya Pradyumna (Steering Committee Members of PAN India) for providing guidance.

Heartfelt thanks to all the coordinators and volunteers in seven states who helped and facilitated field data collection: K. Nagarjuna in Andhra Pradesh, Sugunakar Reddy in Telangana, Prashant Varma, Diwan Negi and Trilock Kumar in Himachal Pradesh; Bhairab Saini and Soumik Banerjee in West Bengal; Jayakumar Arockiasamy in Tamilnadu, Mahesh Chandra Guru in Karnataka; Sharat Singh and Joseph Hill in Jharkhand. I appreciate their sincere effort and patience in gathering field data for this study.

I express my deep sense of gratitude to all the respondents – farmers, farmworkers, pesticide retailers, and agriculture officers in the study area – who spent their valuable time for interviews and sharing relevant data, which formed the basis of this report.

I would like to place special thanks to Team Thanal for their moral support and encouragement for taking up this important work. PAN India is grateful to Thanal for facilitating and supporting this research.

And finally, I gratefully remember the continuing support from my family members and friends for undertaking this work.

A. D. Dileep Kumar

EXECUTIVE SUMMARY

This report presents the ground reality of use of the four pesticides – two insecticides namely chlorpyrifos and fipronil as well as two herbicides, atrazine and paraquat dichloride. Pesticide Action Network has recognised these four agrochemicals as highly hazardous pesticides, because of the fact that they pose severe acute as well as chronic harms to human health and environment. In this light, the current study attempted to document usage scenarios of these pesticides in India.

For the study, both primary and secondary data were used. Primary data was gathered from seven Indian states - Andhra Pradesh, Jharkhand, Himachal Pradesh, Karnataka, Tamilnadu, Telangana and West Bengal.

The ground reality of use of the four pesticides – chlorpyrifos, fipronil atrazine, and paraquat dichloride – in India, reveals shocking facts. Chlorpyrifos was approved for 18 crops/uses, fipronil was approved for 9 crops/uses, atrazine was approved for one crop, and paraquat dichloride was approved for 11 crops/uses. However, numerous unintended and/or illegal uses have been reported in this study. Pesticide use recommendations given by State Agriculture Departments/Universities, as well as pesticide manufacturers covered more crops than their approved uses, indicating non-compliance with the national regulation as well as promoting illegal use. Field data gathered from 300 respondents, including farmers, farm workers and retailers shows unsafe and risky practices. Use of the insecticides chlorpyrifos and fipronil was reported in 23 and 27 crops respectively. Use of the herbicides atrazine and paraquat dichloride was reported in 19 and 23 crops respectively. Use of pesticides for non-approved crops has implications for food safety as the Maximum Residue Level (MRL) regulations developed in India are based on approved crop-pesticide combinations. Hence, any use beyond the approved ones would result in farm produce not being adequately monitored for pesticide residues and thus posing risk to consumers, in addition to environmental damages.

Lack of proper training and access to the right information was noted in the study, as reported by many of the farmers and farm workers interviewed, indicating denial of critical information on pesticide use and safety for pesticide users. Additionally, the poor pesticide labelling practices recorded in the study reveal only a minimum of information on some aspects of pesticide use, while being silent on other critical information, such as required dosage, PPE requirements, disposal methods, etc. Various practices noted in the study, such as storing pesticides in the vicinity of homes, use of leaking faulty spraying equipment, and pesticide usages coupled with non-availability of recommended PPE, could lead to exposure to the toxic pesticides which are inherently harmful and able to cause serious

health problems.

Inadequate retail practices recorded in the study, including not selling the recommended PPE along with pesticides, decanting and repacking of pesticides, and poor advice given to buyers, would also be contributing to unsafe and illegal use practices. The inadequate labelling practices for some pesticide brands, such as small font size, lack of proper information on dosage and PPE use, crop recommendations for non-approved crops, and empty container disposal, are serious issues to be addressed. Moreover, misleading advertisements with unscientific statements were also recorded.

Thus, the overall pesticide use scenario recorded in the study, that violates national regulatory requirements as well as the International Code of Conduct on Pesticide Management, indicates major gaps in regulation and accountability, which points to an anarchic situation with regard to toxic agrochemicals that are inherently harmful to people and environment. Contamination of food commodities and environmental samples, and unintentional / occupational poisoning and death in farming communities, as noted in the recent past in India highlights the outcome of poor pesticide governance in India. Ignoring the ground reality of illegal usage and unsafe practices in pesticide application will be having unintended, deleterious, and irreparable effects on the socio-economic system. While farmers and farm workers are often blamed for indiscriminate, injudicious and unsafe use of pesticides, it needs to be realized that safe use of hazardous pesticides can never happen given the agroeocological conditions and tropical climate of India. Therefore, the field reality recorded in this study provides ample evidence of the need for effective and stringent regulation of pesticide use so as to protect the farming community and consumers of India from the undesired harmful effects of pesticides, as well as preventing contamination of the environment and destruction of biodiversity. It is high time that India strengthened regulation of pesticides, not to allow production, export/import and use of highly hazardous pesticides – and especially chlorpyrifos, fipronil, atrazine, and paraquat dichloride – which are proven to be dangerous for human health and environment.

MAJOR FINDINGS

- ✓ There were 48 different brands of chlorpyrifos, 19 brands of fipronil, 12 brands of atrazine, and 21 brands of paraquat dichloride reported in the study areas.

- ✓ The insecticides chlorpyrifos and fipronil and the herbicides atrazine and paraquat dichloride are being applied in crop fields beyond the uses approved in India.

- ✓ About 79% of respondents reported use of chlorpyrifos-based insecticides in 23 crops, but it was approved for 18 crops/uses.

- ✓ About 74% of respondents reported use of fipronil in 27 crops, but it was approved for eight crops and non-agriculture termite control.

- ✓ About 47% of respondents reported use of atrazine-based herbicide products. Atrazine use was noted in 19 crops, while it was approved for weed control in only one crop, maize.

- ✓ About 68% of respondents reported use of paraquat dichloride based herbicides in 23 crops, but it was approved for weed control in 10 crops.

- ✓ Information gathered though the provisions of Right to Information Act, 2005 reveals that the State Agriculture Departments have given recommendations for use of the four pesticides for several crops that include non-approved uses.

- ✓ About 21% of farmers were trained and instructed on pesticide use and safety measures to some extent, whereas none of the farm workers were trained on pesticide use; and 90% of them were not trained on PPE use as well.

- ✓ The major sources of information on pesticide use for farmers were pesticide retailers and agents of pesticide manufacturers/distributors. Some respondents reported agriculture officers/staff and peer farmers as sources of information.

- ✓ A considerable section of respondent farmers (18.94%) reported lack of access to instruction leaflets, and 5.28% of respondents reported that some of the pesticide products they bought did not have labels, which means that they did not have access to the critical information that should be available on them.

- ✓ Many of the respondents (29.26%) did not read labels or information leaflets because, either the details given in them was in very small font size that they are unable to read, they do not know the language, are unable to comprehend the in-

formation, or are illiterate.

✓ Many practices that lead to exposure to pesticides and poisoning were reported in the study, including pesticide storage, spraying equipment, lack of washing, lack of or inadequate PPE, inappropriate application time and working in sprayed fields without protective measures.

✓ None of the respondents (both farmers and workers) reported use of recommended PPE while working with pesticides or working in sprayed fields, though some sort of safety measures were reported which include use of hat, mask, towel, cloth, raincoat, trousers, shoes, etc.

✓ Pesticide exposure due to spillage and spray mist was reported by 20% farmers and 44.19% of farm workers; they reported ill effects such as abdominal pain, breathing problems, blurred vision, cough, diarrhoea, giddiness, headache, itching, loss of appetite, muscle/body pain, nausea, nose irritation, numbness, skin burn, and vomiting.

✓ None of the retail points assessed had a stock of recommended PPE, and about one third had some sort of poor quality safety gear.

✓ Product label analysis of 37 brands belonging to 24 manufacturers revealed that labels did not contain proper information on pesticide use including dosage, PPE use and disposal methods for most of the brands. Further, crop recommendations given on the label revealed that atrazine was recommended for three non-approved crops; chlorpyrifos formulations were recommended for 14 non-approved uses; fipronil formulations were recommended for nine crops (all were approved uses); and paraquat dichloride was recommended for 13 uses out of which three were non-approved.

✓ Pesticide advertisements contained misleading information and unscientific statements.

✓ Labelling, sales, marketing, recommended use and actual use of these four pesticides (chlorpyrifos, fipronil, atrazine and paraquat dichloride) breach provisions of Insecticide Act, 1968 and Insecticide Rules 1971, as well as the International Code of Conduct on Pesticide Management – and the obligations of the government of India and the pesticides industry under that Code – in a number of ways.

RECOMMENDATIONS

This study results in the following Recommendations:

* Ministry of Agriculture and Farmers Welfare, Government of India, immediately takes measures to ban production/ import/export and usage of the four pesticides – chlorpyrifos, fipronil, atrazine, and paraquat dichloride – considering their inherent toxicity as well as the unsafe and non-approved uses occurring in the field.

* The Central Sector Scheme, Monitoring of Pesticide Residues at National Level, should focus on monitoring residues of the four pesticides – chlorpyrifos, fipronil, atrazine, and paraquat dichloride – both in farm products and environmental samples across India to understand the level and extent of contamination, as a number of non-approved uses have been found. Further, residue monitoring should be expanded to reveal other non-approved uses of pesticides.

* Ministry of Agriculture and Cooperation, initiates legal actions against the respective State Agriculture Departments/ Universities and pesticide manufactures for recommending the four pesticides – chlorpyrifos, fipronil, atrazine, and paraquat dichloride – for crops that are not approved by the Central Insecticides Board and Registration Committee.

* The Central Insecticides Board and Registration Comittee urgently increases its compliance monitoring of the sales and marketing of pesticides in India.

* State Agriculture Departments/Universities immediately take measures to stop sales and usage of the four pesticides – chlorpyrifos, fipronil, atrazine, and paraquat dichloride – for crops not approved by the CIBRC, and promote non-chemical farming methods.

* The pesticide industry must immediately cease sales of, and withdraw from the market, pesticides with labels not in compliance with the label requirments in India.

* Ministry of Agriculture and Farmers Welfare entrusts and assists the National Center for Organic Farming to identify, develop and promote non-chemical farming approaches, options and methods that best suit agro-climatic and agro-ecological scenarios in India, to remove the apparent need for these four hazardous pesticides.

* The Ministry of Agriculture fosters a paradigm shift with adequate policy change to eliminate use of all toxic pesticides that are acknowledged to present severe health and environmental risks and boost wider adoption of alternative non-chemical farming based on agroecology.

1 INTRODUCTION

India is the fourth largest global producer of pesticides with an estimated market size of around $4.9 billion in the 2017 financial year, after United States, Japan and China[1]. Statistical Report 2016, by the Department of Agriculture, Cooperation & Farmers Welfare, shows pesticide usage in India was 47,020 metric tonnes technical grade in 2001-02. This has jumped to more than 62,000 metric tonnes in 2017-18. According to statistical data released by Directorate of Plant Protection, Quarantine and Storage (PPQ&S) under the Ministry of Agriculture and Farmers Welfare, consumption of chemical pesticides in India in the year 2017-18 was 62,183 metric tonnes technical grade, which is higher than that of previous years (PPQ&S, 2019a). However, this dataset lacks consumption data from four Indian states and Union territories, therefore, in reality, the total consumption would be more than this figure. In contrast to the increased pesticide consumption, the area under cultivation using pesticides in India has shown drastic decline, indicating increasing intensification of use. During the 2017-18 period, the area under cultivation with pesticide usage was reported to be 62,247 thousand hectares, while in the previous year (2016-17) it was 104,037 thousand hectares (PPQ&S, 2019b). There has been an increase in pesticide consumption, especially herbicides, throughout India in commercialized production in irrigated- or borewell- dependent systems.

In India, paddy accounts for the largest share of pesticide consumption (26%-28%) followed by cotton (18%-20%). Insecticides have the major market share (60%), whereas fungicides account for 18%, herbicides 16%, and the rest 6%. According to Credit Analysis & Research Limited (CARE Ratings, 2018), players across the industry have fairly steady credit profiles exhibiting steady revenue growth and profitability irrespective of the monsoon failures, mainly on account of a diversified revenue profile (Care Ratings, 2017). Approximately 50% of the demand comes from domestic consumers and the rest from exports. During the same period, domestic demand is expected to grow at 6.5% per annum and exports at 9% per annum, presuming that the Indian agrochemicals market will be driven by growth in herbicides and fungicides, contract manufacturing, and export opportunities (FICCI, 2016). According to a TechSci Research[2] report the pesticide market in India is forecast to surpass $5 billion by 2026.

[1]Outlook of Indian Pesticide Industry, Ratings Department, Care Ratings, May 31, 2017.

[2]India Pesticides Market By Type (Insecticides, Herbicides, Fungicides and Others), By Application (Cotton, Paddy, Plantation, Wheat, Fruits & Vegetables and Others), By Region, Competition Forecast & Opportunities, 2012-2026 https://www.techsciresearch.com/report/india-pesticides-market-by-type-insecticides-herbicides-fungicides-and-others-by-application-cotton-paddy-plantation-wheat-fruits-vegetables-and-others-by-region-competition-forecast-opportunities/1028.html

Declining productivity due to soil degradation, health problems emerging from the use of chemical pesticides and the insufficient land entitlements of small and marginal farmers and tenant farmers, were diagnosed as critical problems for Indian agriculture. More than 60% of the farmers were of the opinion that input costs had doubled over the last decade or so, while 10% of the farmers were of the opinion that input costs had become three times more (IGSSS, 2017). The increase in input costs was because of increased rates of both cost and use of fertilizers and pesticides and an increase in wages. As the cost of inputs increased, the returns from agriculture also reduced substantially. Sri Lingaraj Pradhan, Convenor of the Paschima Odisha Krushak Samanwaya Samiti, and a well-known farmer leader in the Odisha state, says that the rate at which the cost of inputs like seeds, fertilizers, water, labour and pesticides have increased, has not been matched by the selling price of paddy.

An occasional paper released by NITI Aayog identified five issues that need attention in order to improve the livelihoods of farmer households. The five issues are: increasing agricultural productivity, remunerative prices for farmers, focus on land leasing and land titles, risk adaptation and mitigation, and a geographical focus on the eastern region. Increasing agricultural productivity, as per official narrative, is invariably linked to the usage of pesticides. However, a compilation by the Government of Gujarat[3], of 101 success stories of farmers, shows that almost all of them avoided chemical pesticides, or reduced their usage through better crop monitoring and efficient systems of operation.

Economic, environmental and social problems created by technologies introduced by the Green Revolution, such as the use of pesticides and fertilizers, have not been sufficiently acknowledged by proponents of industrial agriculture. Almost all of the scholars have ignored the potential of pesticides, including insecticides and herbicides, to disrupt economic well-being, physical and mental health of the farmers, causing economic distress of its own.

Hybrid seeds, synthetic fertilizers and pesticides became, and continue to be, the foundation of modern agricultural companies, and also the common inputs of all farmers who committed suicides. However, the role of these three factors, especially pesticides, has been grossly ignored.

Changes in insecticide applications resulting from the adoption of Bt cotton in India have been the subject of numerous studies. An analysis showed that Bt cotton introduction in India significantly reduced insecticide usage initially (2002-2006 period), but it increased infestation of some pests later necessitating intensive application of insecticides (Kranthi K. R 2014). It is quite clear that genetically modified seeds of commercial crops have not reduced the usage of agrochemicals significantly. In fact, farmers continued to use insecticides on Bt crops, since they believe that targeted pests are not eliminated by Bt toxin technology.

[3]101 Success Stories to Double the Income of Farmers, Department of Agriculture and Cooperation, Government of Gujarat, 2017.

For a number of reason – including farmer's beliefs, practices, advertisements by seed and pesticide companies, failure of seeds and the development of pest resistance – agrochemical usage has increased (Radhakrishnan S. and K. Kuruganti, 2012). Thus, both agrochemical and seed companies have benefitted enormously in the last decade or so.

There has been a vast expansion of pesticide use, throughout India, both in small-scale farms as well as small and large commercialized productions in irrigated systems. The lack of appropriate regulatory capacity surrounding pesticides, including growth in imports, indiscriminate use of pesticides, and lack of post-registrational compliance monitoring is causing public and environmental health issues in rural areas, which largely remain unrecognised and un-documented in the current inadequate governance regime.

Reduced reliance on external inputs such as fertilizers, pesticides and seeds can help in reduction of production costs. Producing high yields, without usage of such external inputs, is an important step towards achieving economically viable farming systems. Replacing expensive synthetic pesticides with non-chemical methods will also eliminate their associated health and environmental risks.

This report is part of a Highly Hazardous Pesticide study series undertaken by PAN India. This study addressed four agrochemicals (which are Highly Hazardous Pesticides according to Pesticide Action Network), to assess their usage patterns in India. A major drawback is that State-wise consumption levels of each of the agrochemicals are not available for all the States. However, herbicide usage has increased tremendously in the last few years due to labour shortages, higher wages and changing lifestyles of farmers. This study picked popularly used herbicides, atrazine and paraquat (glyphosate is not included in this report as PAN India recently published a separate report on it). Atrazine was selected because it is a herbicide used on most of the US corn (maize) crop and is the subject of on-going controversy, with increasing documentation of its potentially harmful health and environmental impacts. Paraquat was chosen because of its usage pattern, as per a previous study by PAN India. Two insecticides, chlorpyrifos and fipronil, were included in the study based on anecdotal evidence of their heavy usage in India. Fipronil is widely used in India on crops, animals and at homes. Moreover, residues of chlorpyrifos have extensively been reported in food items in India.

2 OBJECTIVES, MATERIALS AND METHODS

OBJECTIVE

The objective of this study is to unravel the use and regulation in India of four pesticides: chlorpyrifos, fipronil, atrazine and paraquat dichloride. This study analyses approved uses of these pesticides, recommended use by State Agriculture Departments, production and consumption, various formulations used, field level uses, and various implications of actual use in the field. Apart from use and regulation, this study attempts to gather details such as companies involved in importing and manufacturing these pesticides, including Indian firms and multinational players. It also aims to provide information on factors that affect the risks from these pesticides, such as training in pesticide use, access to information, application equipment, use of PPE, working in sprayed fields, exposure routes, health impacts, access to washing facilities, storage, disposal of containers, etc.

SCOPE OF THE STUDY

This national level field study helps in understanding the ground reality of use of toxic pesticides such as chlorpyrifos, fipronil, atrazine and paraquat dichloride. Central government, State governments, agriculture and other departments, as well as policymakers, can use the report as a tool for informed decision-making processes in policy development towards achieving sustainable agriculture development without harming public health and environment.

METHODOLOGY

The study relies on primary and secondary data sources. Surveys were used to gather primary data from the study area. A structured questionnaire was administered to the respondents. The participants in the survey included three categories of respondents: farmers (227), farm workers (43) and retailers (30). Surveys were conducted among farmers and farm workers to understand the use of the pesticides on farms. Additionally, surveys were conducted among retailers to understand their involvement in field level use of the pesticide and to know more about famers' decision-making.

The study area was finalized based on preliminary exploration and secondary data. Seven out of the 29 States in India were selected based on known usage of the four pesticides for undertaking primary data collection: Andhra Pradesh, Jharkhand, Himachal Pradesh, Karnataka, Tamilnadu, Telangana and West Bengal.

SAMPLING

A purposive sampling method was used to select the respondents. A total of 56 villages in 14 blocks from 11 districts from the seven states selected for the field study. Villages were identified based on the perception of pesticide usage, secondary information, anecdotal evidence and previous field experience where farmers use the four pesticides that are being studied. The field researchers then identified farmers through purposive sampling. Farm workers involved in the application of the pesticides being studied were also identified in the similar manner from the same villages. Retailers who were available within (or nearby) to each of the selected block/villages were selected for the study. Apart from purposive sampling, the snowball-sampling technique was also used to identify study participants within each category of respondents.

TOOLS OF DATA COLLECTION

A stuctured questionnaire was used to collect field data. A separate questionnaire was used for farmers, farm workers and retailers. Further, a questionnaire developed as part of the Community Pesticide Action Monitoring (CPAM) of Pesticide Action Network Asia and Pacific (PAN AP) was used to collect information on pesticide labels.

SECONDARY DATA

Relevant secondary data on approved uses, recommended uses and statistics of pesticides was gathered from various official sources. The relevant information available on the web sites of Central Government Institutions and Agencies such as Directorate of of Economics & Statistics and Directorate of Plant Protection Quarantine & Storage, under the Ministry of Agriculture and Farmers Welfare, Government of India (https://eands.dacnet.nic.in, http://ppqs.gov.in/divisions/cib-rc/registered-products, and http://ppqs.gov.in/divisions/cib-rc/major-uses-of-pesticides) as well as the Indian Council of Agricultural Research (https://icar.org.in) was gathered and used for the study.

Approved formulations and approved uses of pesticides in India were compiled from such datasets available in the web site of Directorate of Plant Protection Quarantine and Storage (PPQ&S). Production and consumption data were gathered from the information made available on the website http://ppqs.gov.in.

Provisions of Right To Information (RTI) Act, 2005, were also used to gather important data. Through the provisions of this Act, applications were filed with all the State Agriculture departments in India to collect data on State level recommended use and consumption of pesticides. Of the 14 States that provided information on RTI applications, 10 States have given data on recommended uses of pesticides. The State Agriculture Departments (SAD) have recommended the four pesticides for several crops, which includes those approved as well as not approved by Central Insecticide Board and Registration Committee.

DATA ANALYSIS

The field data collected by interviewing re-

spondents with the questionnaire was recorded in Microsoft Excell spreadsheet. The data was analysed using descriptive statistics and presented as percentages. Information provided on the product labels of pesticides was assessed within the framework of the questionnaire developed as part of the Community Pesticide Action Monitoring (CPAM) of Pesticide Action Network Asia and Pacific (PAN AP).

STUDY AREA

Primary data collection for this study was conducted in seven Indian states namely Andhra Pradesh, Jharkhand, Himachal Pradesh, Karnataka, Tamilnadu, Telangana and West Bengal. A brief profile of the States where the field study was conducted is given below.

Andhra Pradesh is the south-eastern State of India. The total population is around 53 million. Its economy is mainly based on agriculture and livestock rearing. Farming is the main occupation and 60% of the population is engaged in agriculture and related activities. The major crops are rice, cotton, wheat, sorghum, pearl millet, maize, many varieties of pulses, oil seeds, sugarcane, vegetables, and oil crops such as peanuts and sunflower. From Andhra Pradesh, 13 farmers and five farm workers, from Padidempadu village and two pesticide retailers from Kurnool area were interviewed from Kurnool District (Kurnool block) for this study.

Jharkhand is an eastern Indian State, which accounts for 40% of the mineral resources of India. The total population is around 32 million. Nearly 30% of the total population belongs to tribal communities. Agriculture is the primary employment and income generating activity for 80% of the rural population of the state. The agricultural economy of the Jharkhand state is characterized by dependence on nature, low investment, low productivity, and mono-cropping with paddy as the dominant crop. Other major crops are sugarcane, cotton, jute, tea, vegetables, etc. Twenty-four farmers and four farm workers and 11 pesticide retailers were interviewed from Bero Block (Bhauwardah, Kesa, Mukumda, Bhainsadon, Karanji, Tengariya and Punapani villages) in Ranchi District, and Bhitha village of Bhandra Block in Lohardaga District for this study.

Himachal Pradesh, the north Indian state, is a mountainous region that lies in the lap of Himalayas. The total population is around 7 million. Agriculture, including horticulture and animal husbandry, is the main occupation of people in this State. Wheat, barley, paddy, maize, potato, apple, ginger, and vegetables are the major crops in this state. Fifteen farmers and five farm workers were interviewed from Mandi District (Chalharg village in Joginder nager block; Suja, Baggi, Chauntra in Chauntra block; and Padher villages in Padher block) and Kangra District (Bhara Gra, Bir and Madher villages in Baijnath block; Khoti Khor village in Multhan block; and Bandia, Palmapur, and Kandbari vilages in Palampur block) in Himachal Pradesh for this study.

Karnataka is a state in southwest India with an Arabian Sea coastline. The population in

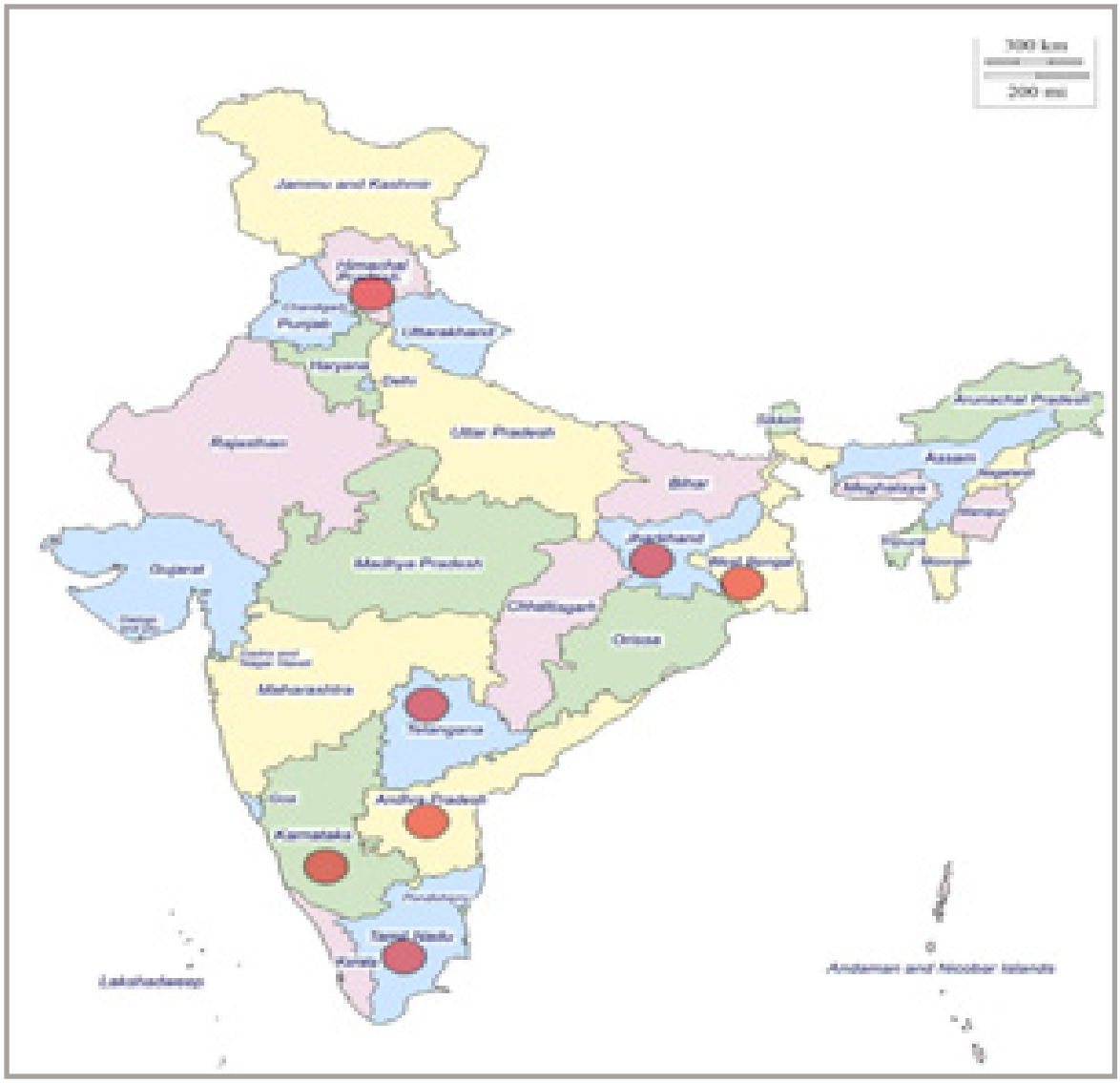
Karnataka is around 65 million. For many rural residents of Karnataka, agriculture is the major occupation. A total of 123,100 km² of land is cultivated in Karnataka, 25.3% of the total geographical area of the state. The main crops grown here are rice, ragi, jowar, maize, and pulses (Tur and gram) besides oilseeds and a number of cash crops such as cashew, coconut, areca nut, cardamom, chillies, cotton, sugarcane, and tobacco. Karnataka is the largest producer of coarse cereals, coffee, raw silk, and tomatoes among the states in India. Fifty-one farmers and ten farm workers were interviewed from Shettahalli, Mikkere, H H Koppalu, Sujjaluru, Kyathanahalli, Shettahalli, Ragibommanahalli, Kyathanahalli, Nelamakanahalli, Nagegowdanadoddi, villages in Malavalli block; Annur, Byadarahalli, Bharathinagar villages in Maddur block; and Bhookanakere, Vitalapura, Alambadikaval, Vitalapura, Bellenahalli, villages in K. R. Pete block from Mandya District.

Tamilnadu is the southernmost part of peninsular India along the coast of Bay of Bengal. The population is around 68 million. Agriculture continues to be the most predominant sector of the State economy, as 70 percent of the population is engaged in agriculture and allied activities for their livelihood. Cereals, millets, pulses, vegetables, and fruits are the major crops grown in Tamilnadu. Fifty four farmers were interviewed from Karur District (Nachalur, Inungur, Oonthampatti, Koilmedu, Akkad, Seplapatti villages in Kulithalai block; Kallai and Kavalkaranpatti villages in Thogamalai block) and Trichy District (Kalingankadu, Kalingapatti, and Sunnmbukaranpatti villages in Srirangam block) for this study.

Telangana is a south Indian State with a population of around 37 million. The majority of the population is dependent on agriculture and allied sectors for their livelihood. Rice is the major food crop. Other important local crops are cotton, sugar cane, mango, and tobacco. Recently, crops used for vegetable oil production, such as sunflower and peanuts, have gained favour. Twenty farmers, four farm workers, and six pesticide retailers were interviewed for this study from Jangaon District (Basireddypalli, Laxmapur, Kesireddypalli, Kodavatoor villages in Bachnnapet block) and Rangareddy District (Kummari guda and Urella villages in Chevella block) in Telangana.

West Bengal is located in the eastern part of India and is the nation's fourth-most populous state. The total population is around 91 million. Agriculture is the leading occupation of the people in West Bengal. Rice is the principal food crop in the State and other major crops are potato, jute, sugarcane, wheat, and oil seeds. Tea is also produced commercially in the northern districts. Fifty farmers, 20 farm workers, and six pesticide retailers were interviewed from Bankura District (Belua, Basia, Iccharia, Bidyadhar Pur, and Rapat Gange villages in Sonamukhi block and Chanuya, Gouranga para, Merja pur, Tantulmuri, Uttar Ghos Para villages in Kotulpur block) for this study.

STUDY AREA MAP



3 OBSERVATIONS

Observations from this study are presented in the following section. It starts with distribution and demographic details of respondents, followed by a brief account on the use of the four pesticides. The following sections presents brief profiles, national regulation, statistical data on pesticides, use of pesticides and use scenarios as reported in the field study, respectively from famers, workers and retailers, and observations on pesticide labels and pesticide advertisement.

DISTRIBUTION AND DEMOGRAPHIC DETAILS OF RESPONDENTS

For this study, data has been collected from a total of 300 respondents (227 farmers, 43 farm workers and 30 retailers) from eleven districts across the seven states. State-wise distribution of respondents is given in table 1.

Table 1 State wise distributions of respondents

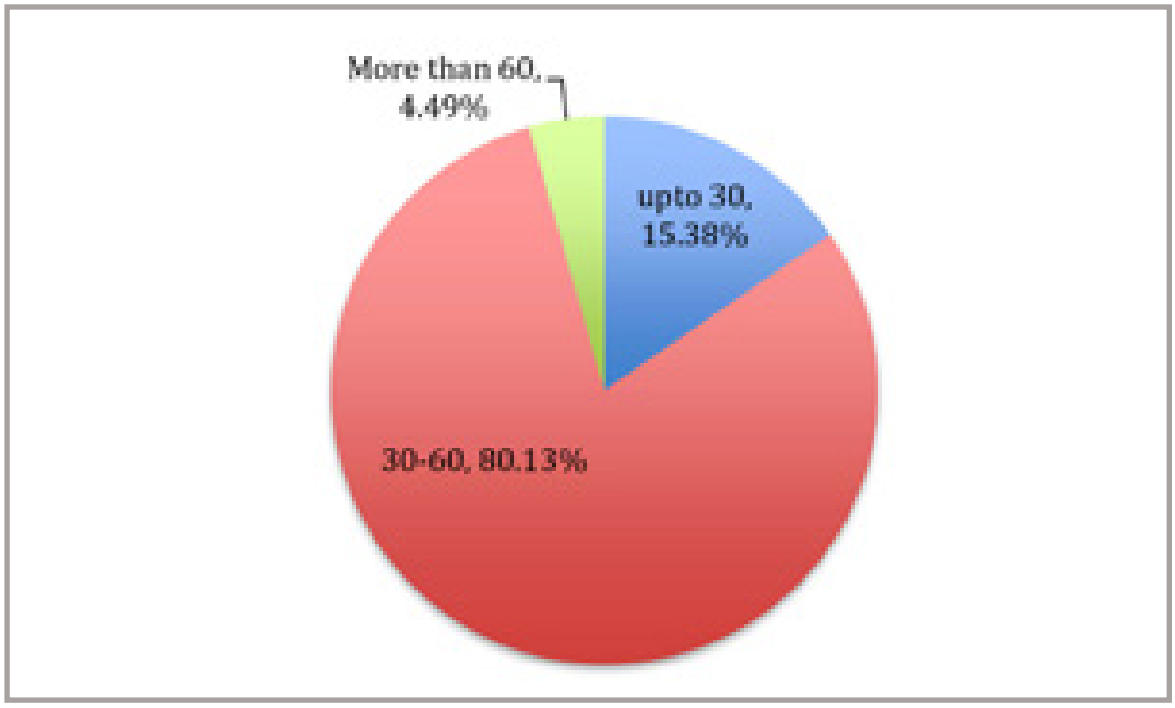
#	States	Farmers	Farm workers	Retailers
1	Andhra Pradesh	13	5	2
2	Jharkhand	24	4	11
3	Himachal Pradesh	15	-	5
4	Karnataka	51	10	-
5	Tamilnadu	54	-	-
5	Telangana	20	4	6
6	West Bengal	50	20	6
Total respondents		**227**	**43**	**30**

Demographic Details of Farmers

For all of the 227 respondents (219 were men and 8 were women), farming is the major source of income. More than a third (38.32%) of the respondents are small-scale and marginal farmers, with landholdings less than a hectare. About 43.65 % of the respondents have a landholding between one and two hectares, and 14.98% of the respondents have a landholding more than two hectares. In addition to growing crops o n their own land, many of the small-scale farmers also cultivate crops on leased land as well.

Farmers were growing a number of crops: paddy, maize, ginger, beans, black gram, tomato, cucumber, potato, mustard, corn, rajma, radish, beats, soybeans, cabbage, cauliflower, okra, vegetables, ground nut, jasmine, sugarcane, leafy vegetables, banana, red gram, cotton, jower, sunflower, marigold, onion, bitter gourd, chickpeas, broad beans, foxtail millet, pearl millet, etc.

Chart 1 Age wise distribution of farmers/labourers working with pesticides



They have been using pesticides for many years in their farm. Most of the farmers, except for those with landholdings more than two hectares, utilise family labour in many of their farming operations, with minimum hired workers. A quarter of the respondents have been using pesticides for about 10 years and the rest have been using them for more then 10 years.

An analysis of the highest educational attainment in the farming households revealed that 12.77 % have family members with education completed up to matriculation; 25.55% have passed matriculation; 27.31% have passed intermediate and 26.43% have completed graduation, and the rest (7.94%) did not answer the question.

Brief Profile of Farm Workers

As part of this study, a total of 43 farm worker from five states – Andhra Pradesh, Jharkhand, Karnataka, Telangana, and West Bengal – were interviewed to assess their pesticide use practices. All were males and working as daily wage labourers. 39.54% have been in agricultural work for about 10 years and the rest more than 10 years. They have been involved in pesticide mixing and application in farm fields.

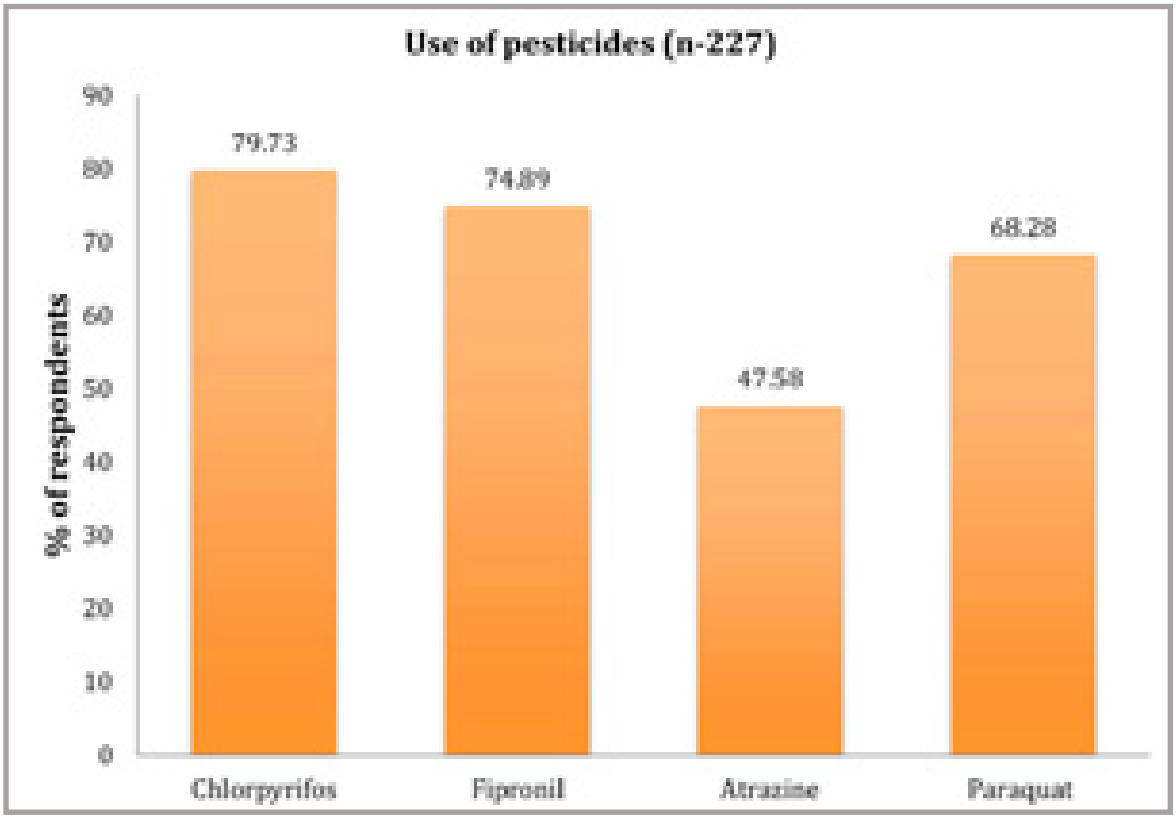
Brief Profile of Retailers

A total of 30 retailers were interviewed from the study area in all states sampled, except for Karnataka and Tamilnadu. All of them were males and their age ranges from 22 to more than 60. About 36.67% of retailers were in the business of pesticide trade for about 10 years, 50% of traders for more than 10 years and the rest did not respond to the questions. When asked if they have a licence to sell pesticides, nearly 70% of retailers said they had obtained a licence from the government, but they seemed to be hesitant to show it. However, 6.67% of retailers said they don't have a licence and the rest (23.33%) did not respond to the question.

USE OF THE FOUR PESTICIDES IN INDIA

This study documents field level actual use and practices of use of the insecticides chlorpyrifos and fipronil and the herbicides atrazine and paraquat. Chlorpyrifos is used by 79.73% of the respondents, fipronil by 74.89 %, atrazine by 47.58%, and paraquat by 68.28 %. A number of uses are reported in this study. Pesticide wise details of field use are presented in the following sections.

Chart 2 Use of the four pesticides reported in the study



LEGAL FRAMEWORK OF PESTICIDE USE IN INDIA

In India, pesticides are regulated by various government agencies. The Agriculture Ministry regulates the registration, manufacture, sales, transport and distribution, export, import, and use of pesticides through the Insecticides Act, 1968, and the Insecticides Rules 1971. In effect, pesticide regulation is governed by two different bodies namely the Central Insecticides Board and Registration Committee (CIB & RC, under the Ministry of Agriculture) and the Food Safety and Standards Authority of India (FSSAI, under the Ministry of Health and Family welfare). The Central Insecticides Board is responsible for advising the Central and State governments on technical issues related to manufacture, use and safety of pesticides. The Registration Committee (RC) is responsible for registering pesticides after verifying the claims of the manufacturers or importers or formulators related to the efficacy and safety of relevant pesticides. The Registration Committee also gives approval for the use of pesticides for specific crop-pest combinations. Further, State Agriculture Departments, Commodity Boards, and agencies give recommendations for the use of pesticides through crop advisories and extension services.

A farmer showing the pesticide Regent (Fipronil),near to his farm. Photo from West Bengal, credit-Bhariab Saini for PAN India

I CHLORPYRIFOS

BRIEF PROFILE

Chlorpyrifos (CAS number 2921-88-2) is an organophosphate cholinesterase inhibitor that is used as an insecticide. It is a chlorinated organophosphorous compound, and is one of the most widely used broad-spectrum insecticides in the world. It has been used for numerous agriculture as well as non-agriculture applications. It is used as an acarcide and nematicide as well. It is being applied on a variety of food and non food crops for pest control as well as for controlling termites in both agriculture and buildings (Watts, M. et al., 2014, NCBI, CIB&RC, 2016).

Chlorpyrifos is a contact insecticide designed to be effective by direct contact, ingestion, and inhalation (Tomlin, 2006). It affects the normal functioning of the nervous system of insects upon contact (USEPA 1999). Chlorpyrifos affects the nervous system by inhibiting the breakdown of the neurotransmitter acetylcholine (ACh) (Smegal, 2000). When insects are exposed to chlorpyrifos, it binds to the active site of the cholinesterase (ChE) enzyme, and prevents breakdown of ACh in the synaptic cleft. This results in accumulation of ACh in the synaptic cleft and causes overstimulation of the neuronal cells, which leads to neurotoxicity and eventually death (Karanth, 2000; USDHHS 1997). Studies have shown that the mode of action of chlorpyrifos is similar both in target organisms and in non-target organisms. It can interact with the enzymes cholinesterase, carboxylesterases and A-esterases in mammals (Reigar and Roberts, 1999; Blodgett, 2006; Christensen, K. et al. 2009).

According to the Safety and Hazards data provided in the PubChem database based on Globally Harmonised System Hazard Statements, chlorpyrifos is a dangerous chemical (NCBI, 2018 a).

- It is toxic if swallowed (danger acute toxicity),
- Fatal if inhaled (danger acute toxicity),
- Very toxic to aquatic life with long lasting effects
  [Warning: Hazardous to the aquatic environment, acute hazard and long term hazard].

The World Health Organisation (WHO) has classified chlorpyrifos as a Class II - moderately hazardous pesticide (WHO, 2020). However, Pesticide[4] Action Network (PAN) considers it as a Highly Hazardous Pesticide (HHP) as it meets the reproductive toxicity criterion; and is a PAN Bad Actor[5] chemical. It has been identified as one of the 20 most Highly Hazardous Pesticides that cause harm to children. Chlorpyrifos can cause cholinesterase inhibition in humans; that is, it can over

[4]Highly Hazardous Pesticides means pesticides that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment according to internationally accepted classification systems such as World Health Organisation (WHO) or Globally Harmonised System (GHS) or their listing in relevant binding international agreements or conventions. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous.

[5]PAN Bad Actors are chemicals that are one or more of the following: highly acutely toxic, cholinesterase inhibitor, known/probable carcinogen, known groundwater pollutant or known reproductive or developmental toxicant https://www.pesticideinfo.org/resources/data-detail-definitions.

stimulate the nervous system causing nausea, dizziness, confusion, and at very high exposures (e.g., accidents or major spills), respiratory paralysis and death (USEPA, 1999), as well as a range of chronic health impacts, such as endocrine disruption and neurodevelopmental impacts (Hazarika, et al., 2020; Bruke, et al., 2017). It is known to cause foetal damage leading to neurodevelopmental disorders. It has been reported that chlorpyrifos is implicated in various hazards in children such as derailed development, brain damage, impaired immune function, hormone disruption, triggering obesity, diabetes, cancer and reproductive problems later in life (Watts, M. et al. 2014).

Occupational and non-occupational poisonings have been reported from many countries. Exposure to chlorpyrifos results in development of symptoms such as tearing of the eyes, runny nose, increased saliva and sweat production, nausea, dizziness and headache. Signs of progression of poisoning include muscle twitching, weakness or tremors, lack of coordination, vomiting, abdominal cramps, diarrhea, and pupil constriction with blurred or darkened vision. Severe toxicity includes increased heart rate, unconsciousness, loss of control of the urinary bladder or bowels, convulsions, respiratory depression, and paralysis. Psychiatric symptoms may include anxiety, depression, memory loss, confusion, stupor, bizarre behaviour, and restlessness. (Reigart and Roberts, 1999; Thompson and Richardson, 2004; Wagner, 1997). Chlorpyrifos has been banned/not approved in at least 35 countries, and restricted in four countries (PAN consolidated list of Bans, 2021; CIB&RC, 2015).

Residues of chlorpyrifos have been found in human cord blood and meconium, cervical fluid, sperm fluid, cord blood, meconium, breast milk, and maternal and infant hair. Biomonitoring in the US showed that 94% of people had chlorpyrifos in their bodies in 1999-2000. Residues have been reported globally in food commodities such as in fruit and vegetables; in dairy products, nuts, cottonseed, wheat and wheat-based products such as bread and pasta, rice, maize, chickpeas, fish, muesli, jam, olive oil, pizza, hamburgers, raisins; also soft drinks and drinking water (Watts, M., et al. 2014).

In 2021, chlorpyrifos was nominated by the European Union for inclusion under the Stockholm Convention on Persistent Organic Pollutants (POPs) for global phase-out; and in January 2022 the POPs Review Committee found that it meets the Convention's criteria for a POP.

REGULATION OF CHLORPYRIFOS IN INDIA

Chlorpyrifos was registered in 1977 and approved for use in both agriculture as well as non-agriculture applications. Chlorpyrifos is one of the most commonly used and recommended insecticides in India (Bhushan, C. et al, 2013). According to the approved uses of Registered Insecticides in India, chlorpyrifos has been approved for use on 16 crops (both food and non food crops) and for termite control in cropped areas and non-cropped areas – pre- and post- construction treatments in buildings, as well as forestry. Waiting periods and MRLs have been set for only a few of the approved crops. In the State of Bihar, chlorpyrifos has been banned for use on green gram. The State Government of Kerala has restricted the use of chlorpyrifos. The Anupam Varma Committee constituted by the Agriculture Department in 2013 reviewed 66 pesticides banned elsewhere and still used in India recommended use of chlorpyrifos to be continued and to be reviewed in 2018. Chlorpyrifos was included in the draft ban notification issued by the Indian Government in May 2020; however the final ban notification is yet to come.

Chlorpyrifos formulations and approved use in India

A total of nine formulations of chlorpyrifos have been approved for use in India. Seven are approved for agriculture use (some of them are approved for termite control as well) and the rest are approved for public health and household use. Chlorpyrifos 10% G has been approved for only one crop, while 20% EC has been approved for 12 food crops, two non-food crops as well as for termite control in four crops and for building and forestry. Chlorpyrifos 50% EC has been approved for rice and cotton as well as for termite control in the construction sector. Chlorpyrifos 1.5% DP has been approved for paddy and Bengal gram.

Of the three combination products, two are approved for both paddy and cotton, while the rest are approved for paddy only.

The formulations Chlorpyrifos Methyl 40% EC and Chlorpyrifos 2% w/w are approved for non agriculture use, the former is for mosquito vector control and the later is for controlling wood termites and borers in households.

[6]Seventeeth POPs Review Committee, Geneva http://chm.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC17/Overview/tabid/8900/Default.aspx

[7]http://www.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC17/Overview/tabid/8900/Default.aspx

Table 2 Approved uses of Chlorpyrifos in India

Sl. No	Formulations	Approved crops	Waiting period
1	Chlorpyrifos 10% G	Rice	30 days
2	Chlorpyrifos 20% EC	Apple, ber, beans, brinjal, cabbage, citrus, gram, ground nut, mustard, onion, Paddy, sugarcane. Tobacco, cotton. Termite control: Barley, gram, wheat; soil treatment for sugarcane and wheat; Building and forestry.	Waiting period has not been provided even for food crops.
3	Chlorpyrifos 50% EC	Rice Cotton Termite control: buildings (pre- and post- construction)	15 days 30 days
4	Chlorpyrifos 1.5% DP	Paddy, Bengal gram	7 days
5	Chlorpyrifos 50% + Cypermethrin 5%EC	Paddy Cotton	15 days 15 days
6	Chlorpyrifos 16% + Alphacypermethrin 1%	Cotton	15 days
7	Chlorpyrifos 20%EC + Acetamiprid 0.4%	Paddy	10 days
8	Chlorpyrifos Methyl 40% EC	Non-agriculture use. Approved for adult vector mosquito control.	
9	Chlorpyrifos 2% w/w	Non-agriculture use. Approved for household use, for protecting wood from termites and borers.	

Source: Compiled from approved uses of Pesticides (Insecticides), CIBRC, as on 31.10.2019

Waiting Period

The CIB&RC has given waiting periods for pesticides with respect to different crops and formulations. It is the time interval to be observed in any crops between the last pesticide application and harvest.

Different waiting periods have been noted for various crops for which these formulations have been approved. While Chlorpyrifos 10% G has a waiting period of 30 days in paddy, the same has not been set for Chlorpyrifos 20% EC. It is to be noted that the formulation Chlorpyrifos 20% EC has been approved for 14 food crops, but the waiting period has been set for none of them. In the case of Chlorpyrifos 50% EC a waiting period of 30 days has been given for cotton, while only 15 days has been set for rice. Seven days is the waiting period given for Chlorpyrifos 1.5% DP for paddy and Bengal gram, while 15 days has been given for two combination formulations (Chlorpyrifos 50% + Cypermethrin 5%EC, Chlorpyrifos 16% + Alphacypermethrin 1%) for cotton and paddy; and 10 has been given for Chlorpyrifos 20%EC + Acetamiprid 0.4% in paddy.

Chlorpyrifos residues in agriculture Commodities and Environmental samples

The annual progress report of the monitoring of pesticides at the national level in India revealed that residues of chlorpyrifos (among a number of other pesticides) have been detected in a number of samples of farm produce across India during 2017-18 (FSSAI, 2019). Of the 29 commodities in which residues of chlorpyrifos were detected, only 10 were approved uses. A great majority of the residues were found in commodity/crops for which chlorpyrifos was not approved, indicating widespread non-approved use in the country. Chlorpyrifos residues were reported in water samples as well.

Table 3 Commodities in which residues of chlorpyrifos have been detected in India

Pesticides	Approved crops	Commodities in which residues detected
Chloropyrifos	rice, paddy, beans, gram, cotton, ground nut, mustard, brinjal, cabbage, onion, apple, citrus, tobacco, Bengal gram and ber.	cauliflower, coriander leaves, green peas, pointer gourd, pigeon pea, green gram, capsicum, rice, okra, bitter gourd, cabbage, green chilli, apple, wheat, tomato, spinach, beans, cowpea, cucumber, red gram, beetroot, mustard leaves, radish, basmathi rice, fenugreek leaves, broccoli, black gram, and board bean. And also in water samples

Source: Compiled from the Survey report, Status of Pesticide Residues in India Monitoring of pesticide residues at National Level, 2017-18. https://www.fssai.gov.in/upload/advisories/2019/10/5da705b31ca78Letter_Report_Pesticides_MRL_16_10_2019.pdf

Importers and indigenous manufacturers of chlorpyrifos in India

As per the approved sources of import and indigenous manufacturers, Chlorpyrifos Technical 94% minimum and Chlorpyrifos Methyl Technical 96% minimum are approved for import and indigenous manufacture (Table 4). For Chlorpyrifos Technical 94%, five companies are approved as sources of import, including the Dow Agrosciences, while 28 companies are approved for indigenous manufacture. Only one company – Dow Agrosciences UK – is the approved source of impor;and De-Nocil Crop Protection Ltd., Mumbai is approved for indigenous manufacture of Chlorpyrifos Methyl Technical 96%.

Residues of chlorpyrifos detected in breast milk from Punjab

A 2014 report, "Monitoring of Pesticide Residues in Human Breast Milk from Punjab, India and Its Correlation with Health Associated Parameters", showed the presence of chlorpyrifos, among other pesticides, in breast milk. This study analysed 127 milk samples and residues were found in 25% of the samples (Anupama & Pooni, 2014).

Farmer spraying without safety measures

Table 4 Sources of import and indigenous manufactures of pesticides for chlorpyrifos

Common Name	Approved Source for Import	Indigenous manufacturers
Chlorpyrifos Technical 94% min.	1. Dow Agrosciences LLC, USA 2. Dow Agrosciences LLC, UK 3. M/s ADAMA Makhteshim Ltd. Israel. (formerly known as Makhteshim Chemical Works, Beer Sheva, Israel, P.o. Box 60, Industrial Zone, Beer Sheva, 8410001, Israel. Through Supplier: Same as Manufacturer (Validity of the source 11.12.2021) (By- M/s ADAMA India Pvt. Ltd.,) 4. FMC Corporation, USA 5. Cheminova Denmark A/s, PO Box 9, DK-7620	1. De-NOCIL Crop Protection Ltd., Mumbai 2. Excel Crop Care Ltd. Ltd., Mumbai 3. Gharda Chemicals Ltd., Mumbai 4. Montari Industries Ltd., Delhi 5. Siris India Ltd., Hyderabad. 6. Vantech Industries Ltd., Hyderabad. 7. GSP Crop Science Ltd., Ahmedabad (RC 305) 8. Sabero Organics Gujrat Limited, 9. India Pesticide Ltd, Lucknow 10. Punjab Chemicals and Crop Protection Ltd, Chandigarh 11. Rotam India Limited, Mumbai 12. Heranba Industries Limited 13. Insecticides India Ltd., 14. Shivalik Rasayan Ltd., New Delhi 15. Bonagri Life Science Ltd, Hubli. 16. Coromandel International Ltd. 17. Hyderabad Chemical Products Pvt. Ltd. 18. Cheminova Inida Ltd., Gujarat 19. Netmatrix Ltd. Hyderabad 20. Megmani Organics Ltd., Ahmedabad 21. Bharat Rasayan Ltd., Delhi 22. Gujarat Insecticides Ltd. Ankleshwar 23. Sudarshan Chemical Industries Ltd., Pune 24. Bhagiratha Chemicals & Industries Ltd.

		25. HPM Chemicals & Fertilizers Ltd., 26. Jubilent Life Sciences Ltd., Gajraula, Jyotiba Phule Nagar, UP 27. Best Crop Science LLP, Gajraula, UP 94.0% min. 9(4) 28. Hemani Industries Ltd., 94.0% min. 9(4) 29. Integrated Pesticides (P) Ltd., ., 94.0% min. 9(4) 30. Sujanil Chemo Industries, Pune., 94.0% min. 9(4) 31. Coromandel Agrico Pvt. Ltd., New Delhi, 94.0% min. 9(4) 32. M/s Oriya Organics Pvt. Ltd.,94% min., 9(4), In 386th RC 33. M/s Krishi Rasayan Exports Pvt. 94% min., 9(4), In 386th RC
Chlorpyrifos Methyl Technical 96% min.	Dow Agrosciences LLC, UK.	De-Nocil Crop Protection Ltd., Mumbai

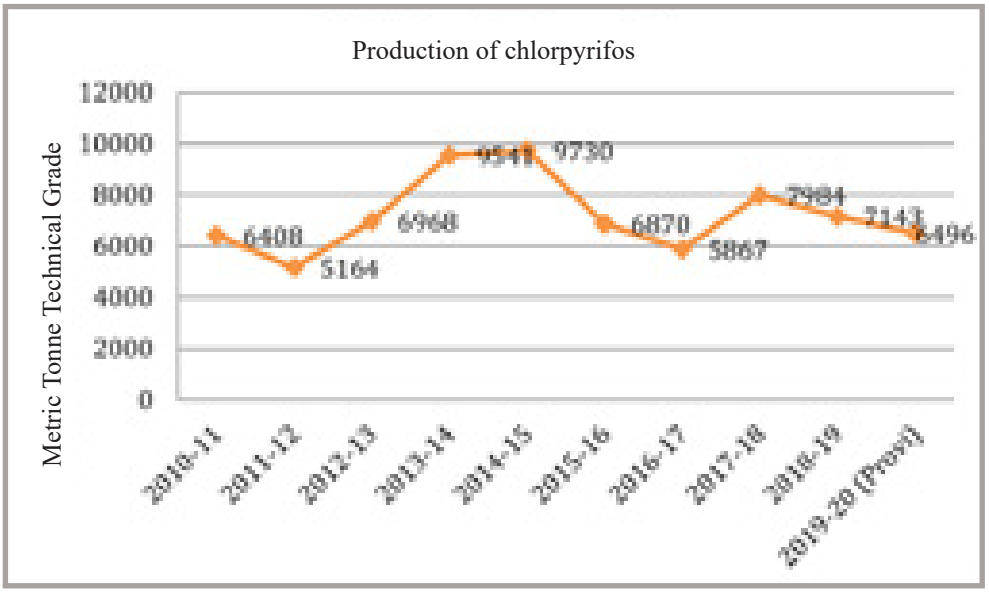
Source: Source of import and list of indigenous manufacturers of Insecticides, dated 31st October 2019, CIBRC.

STATISTICAL DATA ON CHLORPYRIFOS IN INDIA

Production of Chlorpyrifos

Over the past nine years, production of chlorpyrifos shows an increasing trend until 2014-15, thereafter a decreasing trend has been noted until 2019-20.

Chart 3 Production of chlorpyrifos

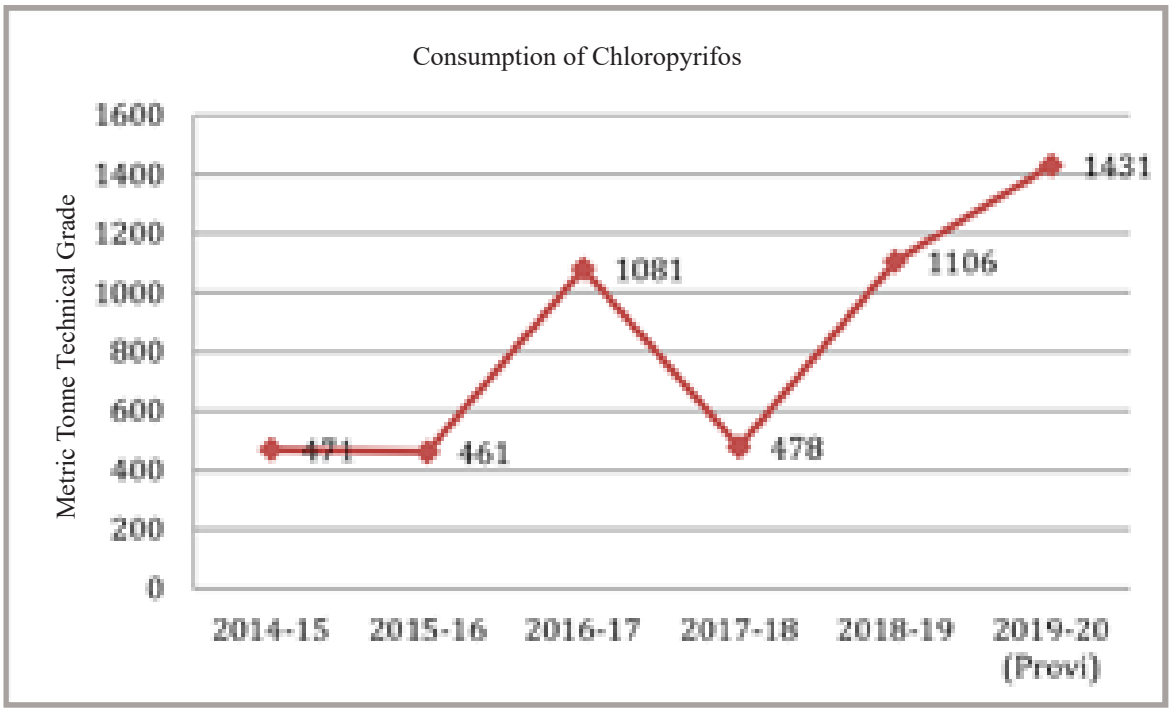


Source: Compiled based on the statistical data provided in web site PPQ&S

Consumption of Chlorpyrifos

Both indigenous and imported chlorpyrifos are used in India, but the major contribution is from indigenous production. For the year 2019-20, though provisional data, consumption of chlorpyrifos was 1431 metric tonne technical grade, the highest over the past five years.

Chart 4 Consumption of chlorpyrifos in India



Source: Compiled based on the statistical data provided in web site PPQ&S

The gap between production and consumption data indicate possible export of a considerable proportion of chlorpyrifos; however, statistical data is not available for that. It is also possible that the actual consumption data is not captured properly.

Producers of Chlorpyrifos

According to information obtained through a RTI response from the Department of Chemicals and Fertilizers under the Ministry of Chemicals and Petrochemicals, 10 companies produce chlorpyrifos.

Table 5 Chlorpyrifos producers in India

1	Bharat Rasayan
2	Sudarshan Chem ltd. Pune
3	Dow Agrosciences (I) Pvt. Lt.d (De-Nocil Corporation)
4	HIL Rasayani
5	Excel Crop Care Ltd
6	R3 Crop Care Pvt. Ltd (formerly Rotam India Ltd)
7	Hyderabad Chemicals Ltd
8	Bharat Rasayan Gujarat
9	Insecticides India Limited
10	Meghmani Orgnanic Chemicals

Source: Compiled from responses obtained from SAD through the provisions of RTI Act.

Recommended Uses

The responses obtained from SAD through the provisions of RTI Act shows that SAD has recommended chlorpyrifos for 11 uses; however, it is not approved for use on maize, wheat, potato grape and vegetable crops except for brinjal, cabbage and onion.

Table 6 Different brands of chlorpyrifos used in India

Blaze, Calban, Chlori dust, Chloroban, Chloroguard, Classic, Coroban, Deviban (devidayal), Dhanvan (NML), Drint, Durmet, Dursban (Dow agrochemicals), Eldrin (Crystal crop science), Fantom, Force, Hamla, Heraban, Hexaban, Hilban, Hiltor, Hyban, Inband, Integer, Intizer, Kartoos, Krishan (Krishi rasayan), Ladrint (Jayasree rasayan udyog), Lantrek, Lethal (Insecticide India), Massban, Megaban, Nuklor, Predator, Quinhit, Radar, Robon (Romcides), Rusban, Sacban, Strike, Tafaban, Tagbann, Tarshak, Tekban, Tricel, Trisul (HPM), Varhan,

Source: Compiled from the responses obtained from SAD through the provisions of RTI Act.

USE OF CHLORPYRIFOS AS OBSERVED FROM THE FIELD STUDY

Chlorpyrifos use was reported in all seven states from which field data was collected. A total of five different formulations were reported. About 79 % of respondents reported use of chlorpyrifos in a variety of crops. State-wise analysis shows that all the respondents interviewed from Andhra Pradesh, Himachal Pradesh, Karnataka and West Bengal have been using this insecticide, whereas in Jharkhand, Tamilnadu and Telangana, 75%, 48.14% and 40% of the respondents respectively have been using it. Respondents reported that chlorpyrifos is used to control aphids, borers, white fly, jassids, thrips, caterpillars, earth worms, beetles, etc. Up to a litre of chlorpyrifos is used to cover an acre of cropped area. Many respondents reported mixing of biopesticides, fungicides and other pesticides, and micronutrients, as well as adhesives to improve stickability to plants, while applying chlorpyrifos.

According to the field data, chlorpyrifos is applied about four times during a crop season on average and, especially in vegetables, it is applied at 15 day intervals. Different waiting periods between last application and harvest were reported, ranging from 24 hours to more than two weeks.

Brands reported in the study, and crops on which they are used, are given in Table 7. Twelve brands were reported for chlorpyrifos 20%EC and they have been used on 11 crops. Chlorpyrifos 50%EC was reported in seven brands and also used on 11 crops. The most widely used formulation was a combination product, Chlorpyrifos 50% + Cypermethrin 5% EC, reported in 27 brands. It was used on 16 crops. The fourth one is also a combination product, Chlorpyrifos 16% + Alphacypermethrin 1%. This formulation was found in two brands and used on three crops – cotton,

paddy and pulses. Chlorpyrifos 1.5% DP was the fifth formulation reported in the study. Only one brand was found for this formulation and it was used for sugar cane and jasmine. In addition to the these five formulations, two brands, of Chlorpyrifos 48%EC named Sulban and Pyrifos are also reported from the study area. However, these formulations were not listed in the approved uses of insecticides in India and it needs to be verified whether they are illegally traded in India.

Table 7 Chlorpyrifos brands, manufacturers and crops applied to

S. no	Brand name	Manufacturer	Crops applied on
I. Chlorpyrifos 20% EC			bitter gourd, brinjal, cabbage, capsicum, cauliflower, chilli, jasmine, leafy vegetables, okra, paddy, and snake gourd.
1	Chloro Ultra	Saga Pesticides Ltd	
2	Chloro 20	Gujarat Pesticides	
3	Classic 20	Cheminova	
4	Clear Out	Anu	
5	Dursban	Dow Agrosciences	
6	Eldrin	Crystal	
7	Lethal	Insecticides India	
8	Nagpyripos	Multiplex	
9	Ramban	National Pesticides & Chemicals	
10	Shriram Chlor 20	Shriram Farm Solutions	
11	Tagban	Tropical Agrosystem	
12	Terminator	Ramsree Chemicals	
II. Chlorpyrifos 50% EC			
1	Bouncer	Anmol, Saga Pesticide	bitter gourd, capsicum, chilli, citrus, cotton, ground nut, okra, Paddy, potato, sugarcane and snake gourd.
2	Bouncer	Anmol	
3	Ecoguard	Gharda Chemicals	
4	Nagraja 505	Crop Chemicals India	
5	Ramsree		
6	Tafaban	Tata Rallis	
7	Transformer	Ichiban	
III. Chlorpyrifos 50% + Cypermethrin 5% EC			banana, beans, bitter gourd, black gram, brinjal, cabbage, cauliflower, chilli, cucumber, jasmine, maize, okra, paddy, peas, potato and snake gourd.
1	Action 505	Tropical Agrosystem (India)	
2	Aflatoon	Insecticides India	
3	Anth	Krishi Rasayan	
4	Bilbo B505	Bharath Insecticides	
5	Blaster 505	Khublal	
6	Canon	Nagarjuna	
7	Combo Plus	Vimax	
8	Eurocombie	IndoBohger	

9	Fightar	-	
10	Hamla 550	Gharda chemicals	
11	Judwaa	Sulphur mills	
12	Jupiter	JU	
13	Koranda 505	Tata Rallis	
14	Leader 505	Khublal	
15	Lethal Super 505	Insecticides India	
16	Mashal	Super Agro India	
17	Noorani 505	Anu Products	
18	Spine	-	
19	Strike 550	Universal Agrochemical Industries	
20	Super 505	-	
21	Transformer	Ichiban	
22	Turbo	Matrix India	
23	ULD 550	United Phosphorous	
24	Ulka 505	MS Biostadt	
25	Yorker	Anmol, Saga Pesticide	
26	Yujo	IFFCO	
IV. Chlorpyrifos 16% + Alphacypermethrin 1%			cotton, paddy and pulses.
1	Anth Super	Krishi Rasayan	
2	Dangal	Ichiban	
V. Chlorpyrifos 1.5% DP			sugar cane and jasmine.
1	Hindol	HPM Chemicals & Fertilizers Ltd	

chlorpyrifos (6) WB

Chlorpyrifos_20__EC_ClearOut_AnuProducts

Chlorpyrifos_20__EC_Dursban_DowAgroSciences

Chlorpyrifos_20__EC_Dursban_DowAgroSciences

Chlorpyrifos_20__EC_Tagban_TropicalAgrosystem

Chlorpyrifos_50__Cypermethrin_5__EC_ Blaster_505_KhublalAgroChemicals

2 FIPRONIL

BRIEF PROFILE

Fipronil (CAS number – 120068-37-3) is a broad-spectrum neurotoxic insecticide. It belongs to the chemical group phenylpyrazole. It is a systemic insecticide and is widely used for agriculture as well as household insect control. It is a nervous system disruptor effective on contact or ingestion. Globally it has been used for pest control in a variety of food and non-food crops as well as for non-agriculture applications such as pest control in pets and livestock, and for termite control.

Fipronil is a new generation contact insecticide. Its toxicity is manifested either through contact or ingestion (Tomlin, 2006). Its mode of action is more or less the same in both target and non-target organisms with differential affinity. Fipronil acts on and blocks GABAA-gated chloride channels in the central nervous system. Disruption of the GABAA receptors by fipronil prevents the uptake of chloride ions and results in excess neuronal stimulation, neural excitation and convulsions causing death of the target insect (Cole, et al., 1993; Ratra, and Casida, 2001; WHO, 1997). The primary biological metabolite of fipronil – fipronil sulfone – is reported to be twenty times more active at mammalian chloride channels than at insect chloride channels (Zhao, et al., 2005). Fipronil sulfone is reportedly six times more potent in blocking vertebrate GABA-gated chloride channels than fipronil, but demonstrates similar toxicity to the parent compound in mammals. Fipronil desulfinyl, the primary environmental metabolite (photoproduct) of fipronil, is 9-10 times more active at the mammalian chloride channel than the parent compound, reducing the selectivity between insects and humans when exposed to this metabolite (Hainzl, et al., 1998; Hainzl and Casida, 1996; Jackson, D., et al. 2009).

As per the Safety and Hazards data provided in the PubChem database, based on Globally Harmonised System Hazard Statements fipronil is a dangerous chemical (NCBI, 2018b).

- It is toxic if swallowed (Danger Acute toxicity, oral),
- Toxic in contact with skin (Danger Acute toxicity, dermal), Toxic if inhaled (Danger Acute toxicity, inhalation),
- Causes damage to organs through prolonged or repeated exposure (Danger Specific target organ toxicity, repeated exposure),
- Very toxic to aquatic life (Warning Hazardous to the aquatic environment, acute hazard), and very toxic to aquatic life with long lasting effects (Warning Hazard ous to the aquatic environment, long-term hazard).

Fipronil belongs to Class II – moderately hazardous category of the World Health Organisation's classification of pesticides

based on acute hazard (WHO 2020). According to PAN International, fipronil is a highly hazardous pesticide. The United States Environmental Protection Agency (US EPA) has classified fipronil as a Group C, Possible Human Carcinogen. Residues of fipronil have been reported in farm produce as well as in honey (Watts, M. 2012). Fipronil can disrupt thyroid function and interferes with regulation of cell metabolism by decreasing plasma concentrations of thyroxine hormones. It may also cause adverse reproductive effects[8].

Exposure to fipronil can cause symptoms such as sweating, nausea, vomiting, headache, vertigo, abdominal pain, dizziness, agitation, weakness, shaking, paresthesia, seizure, confusion, slurred speech, tingling and stiffness of hands, muscle weakness, diarrhoea, tachycardia, palpitations, fatigue, sore throat, difficulty in breathing, upper respiratory pain, cough, wheezing, skin rash, irritated and painful eyes, blurred vision, and tonic-clonic seizures (Jennings, 2002; Chodorowski, et al., 2004; Watts, M. 2012). According to PAN's Consolidated List of Bans, fipronil is banned in at least 36 countries, including China, the European Union, UK, Vietnam and a number of African countries.

REGULATION OF FIPRONIL IN INDIA

Fipronil is registered for use in India for both agriculture and non-agriculture purposes. According to the approved uses of Registered Insecticides in India, fipronil is approved for six food crops, one non-food crop as well as for termite control in pre- and post- construction. Though waiting periods have been set for the crops approved for its use, MRLs are not set.

Fipronil formulations and approved uses in India

A total of 13 formulations including nine combination formulations of fipronil are approved for use in India. Twelve formulations are approved for agriculture use and one formulation, Fipronil 2.92% EC, is approved for non-agriculture use: termite control in pre- and post- construction buildings. Fipronil 5% EC has been approved for five crops, 0.3% GR is approved for three crops, 80%WG is approved for four crops. The combination formulations are approved one crop each.

[8]Fipronil. Chemical Watch Factsheet. Beyond Pesticides

Table 8 Approved uses of fipronil in India

S no	Formulations	Approved crops	Waiting period
1	Fipronil 5% SC	Cabbage Chillies Rice Sugarcane Cotton	7 days 7 days 32 days 9 months 7 days
2	Fipronil 2.92% EC	Non-agriculture use: termite control in pre and post construction buildings.	NA
3	Fipronil 0.3 GR	Rice Sugarcane Wheat	32 days 9 days 91 days
4	Fipronil 80% WG	Rice Grapes Onion Cabbage	19 days 10 days 15 days 15 days
5	Fipronil 18.87% w/w SC	Cotton	21 days
6	Fipronil 0.6% w/w GR	Rice	Not given
7	Buprofezin 22% + Fipronil 3% SC	Rice	32 days
8	Buprofezin 23.1 % + Fipronil 3.85% w/w SC	Rice	30 days
9	Emamectin Benzoate 1.5% + Fipronil 3.5% SC	Chillies	3 days
10	Fipronil 40% + Imidacloprid 40% WG	Sugarcane	296 days
11	Fipronil 4% + Acetamiprid 4% W/W	Cotton	30 days
12	Fipronil 4% + Thiamethoxam 4% w/w SC	Rice	45 days
13	Fipronil 7% + Hexythiazox 2% w/w SC	Chilli	7 days

Source: Compiled from approved uses of Pesticides (Insecticides), CIBRC, as on 31.10.2019

Waiting period for Fipronil

Wide variations have been noted among the waiting periods given for various formulations of fipronil for different crops. A waiting period of seven days is given for cabbage, chillies and cotton for Fipronil 5%SC, but 32 days are given for rice and nine months for sugar cane. Waiting periods of 32 days for rice, 9 days for sugarcane and 91 days for wheat are given for fipronil 0.3GR, while 19 days in rice, 10 days in grapes and 15 days for onion and cabbage are given for Fipronil 80%WG. Fipronil 18.87%w/w/SC has a waiting period of 21 days in cotton, whereas no waiting period has not given for Fipronil 0.6% w/w GR for rice. Three of the nine combination formulations, viz, Buprofezin 22% + Fipronil 3% SC, Buprofezin 23.1 % + Fipronil 3.85% w/w SC, Fipronil 4% + Thiamethoxam 4% w/w SC are approved for rice and waiting period is given as 32 days, 30 days and 45 days respectively. Whereas, a waiting period of 296 days is given for sugarcane for Fipronil 40% + Imidacloprid 40% WG; and 30 days for cotton for Fipronil 4% + Acetamiprid 4% W/W. Emamectin Benzoate 1.5% + Fipronil 3.5% SC and Fipronil 7% + Hexythiazox 2% w/w SC are approved for chilli; a waiting period is not given for the former, but the latter has 7 days.

Importers and manufacturers of technical grade Fipronil in India

There are three companies, with two of them belonging to BASF, approved as sources of import for Fipronil Technical 90% and 92%, whereas 15 companies are approved for manufacturing these indigenously. Bayer SAS, Bayer Environmental Science, France is the source of import for Fipronil 0.03% gel and 0.05% gel; there are no indigenous manufacturers for these. Bayer Crop Science LP, USA, and Bayer Crop Science Ltd., Mumbai, are approved as sources of imports and indigenous manufacture respectively.

Pesticide kept open at the wall of house. Photo from West Bengal, credit-Bhariab Saini for PAN India

Table 9 Sources of imports and indigenous manufactures of fipronil.

Common Name	Approved Source for Import	Indigenous manufacturers
1. Fipronil Technical 90% and 92% min, 2. 95%min., 3. Fipronil 0.03% gel, 0.05% GEL 4. Fipronil 80% WG	1. BASF Agri. Production SAS, Elbeuf, France (90%). {Previous Source name was Bayer Crop Science S.A. Lyon, France which was changed in 273 RC (Name of previous source is M/s. Aventis Crop Science S.A. Lyon, France this was changed in 230th RC)} 2. Bayer Crop Science Hangzhou Co. Ltd., No. 5 Road, Hangzhou Economic & technological Development Zone, Hangzhou, 310018, China (90%). 3. Anhui Huaxing Chemical Industry Co. Ltd., Changjing, Mid. Rd. Hefei, Anhui, China 4. Zhejiang Hisun Chemicals Co. Ltd. 97, Waisha Road, Jiaojiang China (By M/s Hilfil Chemicals Pvt. Ltd) 5. Bayer SAS, Bayer Environmental Science, 16 rue Jean-Marie Leclair 69009, Lyon – France 6. Bayer Crop Science LP, USA, St. Louis supplied by Bayer Crop Science AG, Germany and Bayer Crop Science, LP, USA, St. Louis 7. M/s Bayer SAS, Bayer Crop Science Industrial Operations Marle, France.Through Supplier: M/s- Bayer SAS, Bayer Environmental Science, Lyon, France. Fipronil 0.05% GEL, FI/9(3). (M/s Bayer Crop Science in 408th RC)	1. Gharda Chemical Ltd., Mumbai (TIM) 2. Insecticides India Ltd. 3. Bhagiratha Chemicals & Industries Ltd. 4. Punjab Chemicals and Crop Protection Pvt Limited 5. PI Industries Limited 6. Coromandal International Ltd., 7. Bharat Rasayan Ltd., New Delhi (92% min.) 8. Hyderabad Chemicals Products Ltd., Hyderabad 9. Pest Control India (Pvt) Ltd, Mumbai (92% min.) 10. Atul Ltd., Valsad 11. Meghmani Organics Ltd., Ahmedabad 12. Tagros Chemicals India Ltd., Chennai (92%) 13. Rallis India Ltd. 14. HPM Chemicals & Fertilizers Ltd., 15. Best Crop Science LLP, Gajraula, UP 16. Sujanil Chemo Industries, Pune 92.0% Min. 9 (4) 17. Excel Phosphorus (P) Ltd., 92.0% Min. 9 (4) 18. Sahib Pesticides, Karnal, 92.0% Min. 9 (4) 19. M/s Synergia Science Pvt. Ltd. 92.0%, 9(4) in 342th 20. Anu Products Ltd., New Delhi, 92.0% Min. 9 (4) 21. Bayer Crop Science Ltd. Mumbai. 22. M/s Bonageri Crop Science Ltd., 92% min ,9(4), in 386th RC 23. M/s Crimsun Organics Pvt. Ltd., 92.0% Min. 9(4) in 397th RC.

Source: Source of import and list of indigenous manufacturers of Insecticides' dated 31st October 2019, CIBRC.

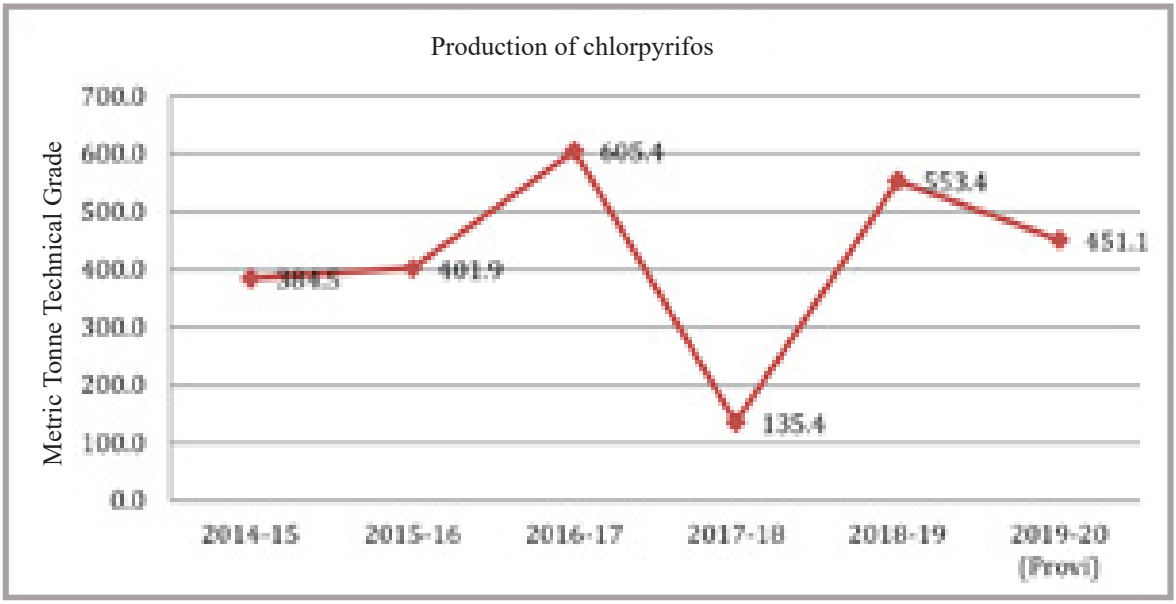
STATISTICAL DATA ON FIPRONIL

The production and export data for fipronil in India is not available in the public domain, though consumption data is available and is given below.

Consumption of Fipronil in India

Consumption data for fipronil over the past nine years shows both indigenous and imported formulations are used in India. The major contribution to the consumption is from indigenous production. For the year 2018-19, 180 metric tonne technical grade fipronil was sold.

Chart 5. Consumption of fipronil in India



Recommended Uses

SAD has recommended fipronil for 10 uses. While the crops recommended by SAD are approved by CIB&RC, uses for pest control generally in grains and as a household insecticide are not approved.

Table 10 List of crops/uses recommended by SAD for fipronil

Paddy, sugar cane, chilli, cotton, cabbage, onion, grapes, control sucking pets, Grain pest control, household pesticide.

Source: Compiled from the responses obtained from SAD through the provisions of RTI Act.

Fipronil residues in agriculture commodities

As per the annual progress report of the Monitoring of Pesticide Residues at the National Level in India, residues of fipronil were reported in samples of two commodities namely grapes and green chilli, and all fall in the approved use category.

Table 11 Residues of fipronil reported in India

Pesticide	Approved crops	Commodities in which residues detected
Fipronil	Rice, cabbage, chillies, sugar cane, cotton, grapes and onion.	grapes, and green chilli

Source: Compiled from the Survey report, Status of Pesticide Residues in India Monitoring of pesticide residues at National Level, 2017-18. https://www.fssai.gov.in/upload/advisories/2019/10/5da705b31ca78Letter_Report_Pesticides_MRL_16_10_2019.pdf

Brands of fipronil reportedly used in States (obtained through RTI application)

Table 12 Different brands of fipronil used in India (27 brands)

Assirwaad (HPM), Avtar, Corofip, Crigent (Crystal crop science), Devigent Plus, Fax, FIL (Plant Rem), Fipro, Frazor, Harina G, Harina, Heranil plus, Hexanil, Janbaaz 0.3G (Biostadt), Janbaaz SC, Jump, Mahaveer, Phiprox, Rafree, Regent (Bayer India), Rusdol, Salvo SC, Sargent GR , Sergeant, Sunil, Tagagent, Urgent G (Cristal PL)

USE OF FIPRONIL AS OBSERVED FROM THE FIELD STUDY

Except for Himachal Pradesh, use of fipronil was reported in the other six states. Use of fipronil is noted among 70.48% of the respondents. A state-wise analysis shows that all the respondents interviewed from Karnataka and West Bengal were using this insecticide. While 70% of the respondents were using fipronil in Telangana, for Tamilnadu it was 57.41% and for Jharkhand it was 54.17%. Fipronil is mainly used to kill pests such as aphids, jassids, white flies, corn worm, beetles, caterpillars, cut worm, root worm, termites, etc. Four different formulations, including a combination product, were reported from the study area. Half a litre to one litre (or kilograms in the case of granules) of fipronil was generally applied per acre of crop field; however, more than 5kg granules per acre was also noted in some cases. It was noted that micronutrients, growth promoters, fungicides and adhesives are mixed together with fipronil.

Use of fipronil was reported in a number of crops (Table 13). The formulation Fipronil 5% SC was used on 19 crops. The granular formulation Fipronil 0.3%GR was used on 17 crops. Another granular formulation, Fipronil 80%WG was used for two crops, paddy and sugarcane, whereas the granular combination formulation, imidacloprid 40% + fipronil 40% w/w WG was used on five crops.

A minimum of three and maximum of 10 applications of fipronil were noted in different crops. Some farmers have been following a calendar spray, which is once in every 15 days.

Table 13 Fipronil brands, manufacturers and crops applied to

S. no	Brand name	Manufacturer	Crops applied to
I. Fipronil 5% SC			banana, bitter gourd, black gram, brinjal, capsicum, carrot, chilli, French beans, ground nut, jasmine, leafy vegetables, onion, okra, paddy, radish, snake gourd, sugarcane, sunflower, tomato.
1	Biltop SC	Bharat Insecticides Ltd	
2	Elegant	Sudarshan	
3	Fine	Agrolife Science corporation	
4	Regent	Bayer	
5	SonicFlo	TATA Rallis	
6	Tag Agent	Tropical Agrosystem	
II. Fipronil 0.3% GR			banana, bitter gourd, brinjal, cauliflower, chilli, cucumber, ginger, jasmine, maize, okra, paddy, pea, potato, radish, snake gourd and tomato as well as or floriculture.
1	Ashirwad GR	HPM Chemicals and Fertilizers	
2	Aghadi	ADAMA	
3	Fipronil	JU	
4	Janbaaz	Biostadt	
5	Regain	IndoBohger	
6	Regent	Bayer	
7	Sargent	Insecticides India	
8	Shinzen	IFFCO	
9	Urgent	United Pesticides	
III. Fipronil 80% WG			paddy and sugarcane
1	Hooter	Bharat Insecticides Ltd	
2	Jump	Bayer	
IV. Imidacloprid 40% + Fipronil 40% w/w WG (80 WG)			bitter gourd, chilli, ground nut, snake gourd, okra, etc.
1	Deed	Bharat Insecticides Ltd	
2	Lesenta	Bayer	

Workers having food in between spraying - Photo from West Bengal, credit - Bhariab Saini for PAN India

fipronil 5_sc

fipronil 5_sc

fipronil 5_sc

Fipronil_0.3__GR_Fipronil_JU_front

III ATRAZINE

BRIEF PROFILE

Atrazine (CAS Number - 1912-24-9) is a selective, pre-emergence and early post-emergence synthetic herbicide. It belongs to the chemical group triazine. Though atrazine is banned in the European Union, still it is one of the most commonly used herbicides in the world. It is mainly applied for controlling broad-leaved weeds and grasses both for the agricultural and non-agricultural sectors. Its use is controversial due to widespread contamination of drinking water and its association with birth defects and menstrual problems in humans, even when it is consumed unintentionally at concentrations below government standards (Marquez, E., 2014).

Atrazine is a systemic herbicide and its principle mode of action seems to be the inhibition of photosynthesis in higher plants. It inhibits the Hill reaction and its associated noncyclic photophosphorylation taking place with in chloroplasts in plant cells. (Richard H. S., 1969). Thus it shuts down the photosynthetic process in plants. Inhibition of photosynthesis could result in a slow starvation of the plant; however, the plant experiences a more rapid death that is believed to be due to the production of secondary toxic substances (UMES 1999). It has been widely detected in surface water as well as in ground waters (WHO, 2009). In animals, atrazine may have a neuroendocrine mode of action and cancer mode of action as well as related reproductive and developmental effects, and these may be relevant in humans as well (USEPA, 2003).

Most formulations of atrazine are restricted use pesticides. Atrazine belongs to the Class III-Slightly Hazardous classification of the World Health Organisation (WHO, 2020).

The Safety and Hazards data provided in the PubChem (NCBI, 2018c) database based on Globally Harmonised System of Classification's Hazard Statements shows that atrazine,

- may cause an allergic skin reaction (warning: skin sensitization),
- causes serious eye irritation (warning: serious eye damage/eye irritation),
- causes damage to organs through prolonged or repeated exposure (warning: specific target organ toxicity, repeated exposure),
- is very toxic to aquatic life (warning: hazardous to the aquatic environment, acute hazard),
- very toxic to aquatic life with long lasting effects (warning: hazardous to the aquatic environment, long-term hazard),

Atrazine irritates eyes and skin and, if ingested, irritates mouth and stomach. Human

exposure to atrazine is linked to a number of serious health effects.At extremely low doses atrazine interferes with hormonal activity in animals and humans. The human health risk and ecological risk assessments for atrazine indicate risks of concern and reproductive effects as the most sensitive effects observed in atrazine toxicity tests (USEPA, 2013). Atrazine has been categorized as a Highly Hazardous Pesticide by Pesticide Action Network. It also qualified as a PAN North America Bad Actor chemical. It is also a ground water contaminant and has been reported in drinking water. Atrazine is listed in the PAN AP's Terrible 20 (T20) list of pesticides that cause much harm to children[9]

Acute poisoning by atrazine may cause coma, circulatory collapse, renal failure, and gastric bleeding. Atrazine residues had been detected in cord blood, neonate plasma, breast milk, urine, house dust, food, and drinking water. In children, atrazine could cause potential developmental effects, immunotoxicity, neurological effects endocrine disruption, cancer later in life, and male reproductive problems (Emily Marquez, 2014). Atrazine is slightly to moderately toxic to humans and other animals (EXTOXNET, 1996).

An Indian Expert Committee under the Chairmanship of Dr. Anupam Varma that reviewed atrazine, observed that it has been reported to be persistent in soil and water bodies. PAN's Consolidated List of Banned Pesticides (PAN, 2021b) shows it has been banned in at least 41 countries including in the EU and a number of African countries.

REGULATION OF ATRAZINE IN INDIA

Atrazine was registered in India before the Insecticide Act 1962 came into effect, and is considered as a 'deemed to be registered pesticide' now. According to the approved uses of Registered Herbicides in India, it is approved to control weeds in maize only. A Maximum Residue Limit (MRL) and waiting period have not been set for it. Atrazine was banned in the state of Kerala in 2011. The Dr. Anupam Varma Committee, constituted by the Agriculture Department to review 66 pesticides banned elsewhere and still used in India, submitted its report in 2015 and recommended use of atrazine to be continued and to be reviewed in 2018. Atrazine was included in the draft ban notification issued by the Indian Government in May 2020; however the final ban notification is yet to come.

Approved use of atrazine in India

Atrazine is approved for use in India for only one crop, maize. There is only one formulation, Atrazine 50%WP, and it is approved for controlling nine weeds in maize crops. The per hectare approved dosage is 1-2 kilograms, to be used in 700 litres of water.

[9]Terrible 20 pesticides. PAN AP. http://panap.net/2015/11/20-terrible-pesticides-toxic-children/

Table 14 Approved use of atrazine in India

Atrazine 50% WP		
Approved Crop	**Weed Species**	**Waiting period / PHI between last application & harvest (days)**
Maize	Trianthama monogyna Digera arvensis , Echinochloa spp Eleusine Spp. Xantheium strumarium Brachiaria sp, Digitaria sp, Amaranthus viridis , Cleome viscose, Polygonum spp	Not given

Source: Compiled from approved uses of Pesticides (Herbicides), CIBRC, as on 31.10.2019

Room where pesticides are stored - Photo from West Bengal, credit - Bhariab Saini for PAN India

Waiting periods

The available information shows that a waiting period has not been set for atrazine.

Importers and manufacturers of technical grade atrazine in India

Seven sources of import and nine indigenous manufacturers are approved for technical grade atrazine of 80%, 92%. Details of the companies are provided in the table given below.

Table 15 Sources of import and indigenous manufactures of atrazine herbicides

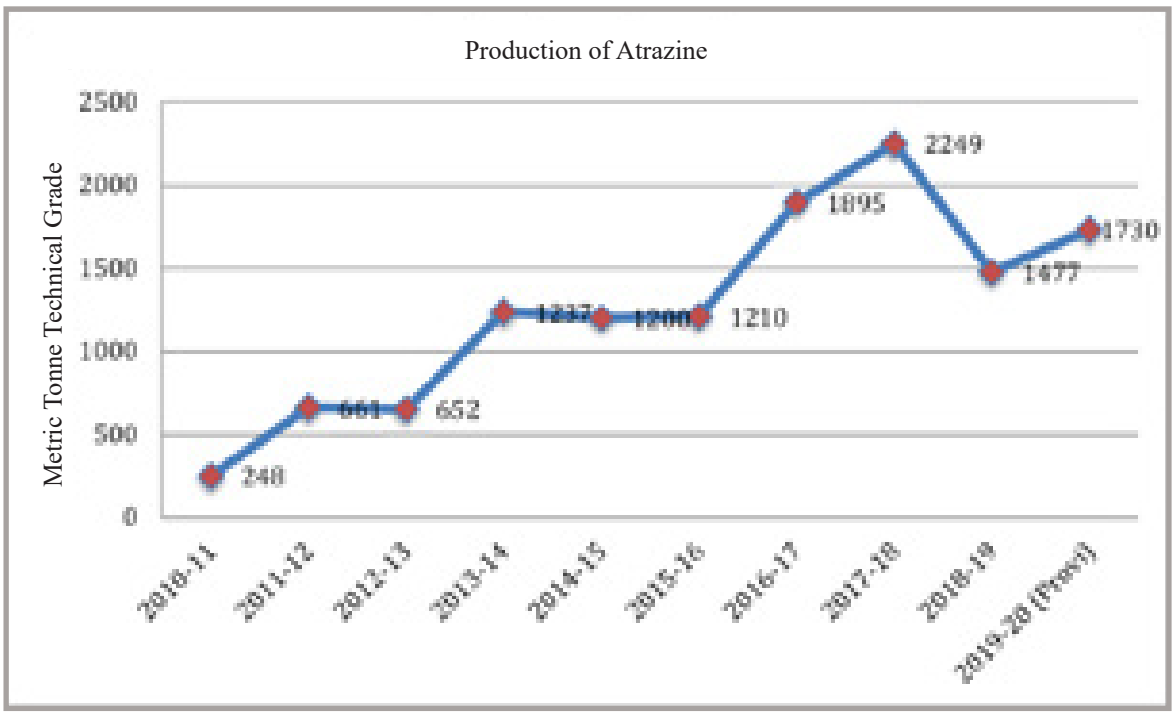
Common Name	Approved Source for Import	Indigenous manufacturers
Atrazine Technical 80%, 92% min. and 95% min.	1. Agan Chemical Mfrs. Ltd., Israel 2. Makhteshim Agan Beer-Sheva, Israel. 3. Intrachem, SA, Switzerland 4. Fisons Ltd., Houston, UK 5. Oxon Italia, Italy. 6. Zhejiang Zhongshan Chemical Industry Group Co., Ltd. Zhongshan, Xiaopu, Changxing, Zhejiang Province, 313 116, China. (for 95%min) Supplier: M/s. Hebei Bestar Commerce and Trade Co. Ltd., 6-3-203 No. 66 Dianda Street, Sinhua District, Shijiazhuang, China 7. Shandong Qiaochang Chemical Co. Ltd., South of Xinyongshen Road, Binbei, Bincheng District, Binzhou City, Shandong, China Valid upto 06th Aug.2018 (by M/s Krishi Rasayan Export Pvt.Ltd.)	1. Rallis India Ltd., Bangalore 2. Pesticides India, Udaipur 3. Nagarjuna Agrichem, Hyderabad 4. GSP Crop Science Pvt. Ltd. Ahmedabad 5. Insecticide India Ltd 6. Megmani Industries Ltd. 7. Best Crop Science LLP, Gajraula, UP 8. Maheshwari Biochemicals Pvt.Ltd.. 95.0% min 9. HPM Chemicals & Fertilizers Ltd., 95.0% min, 9(4).

Source: Source of import and list of indigenous manufacturers of Insecticides' dated 31st October 2019, CIBRC.

STATISTICAL DATA ON ATRAZINE IN INDIA

Production: The production data for atrazine in India shows an increasing trend until 2017-18 and then a decreasing trend. Though the data is provisional, an upward trend is noted for the year 2019-2020.

Chart 6 Production of atrazine in India



Source: Compiled based on the statistical data provided in web site PPQ&S

Chart 7 Consumption of atrazine in India

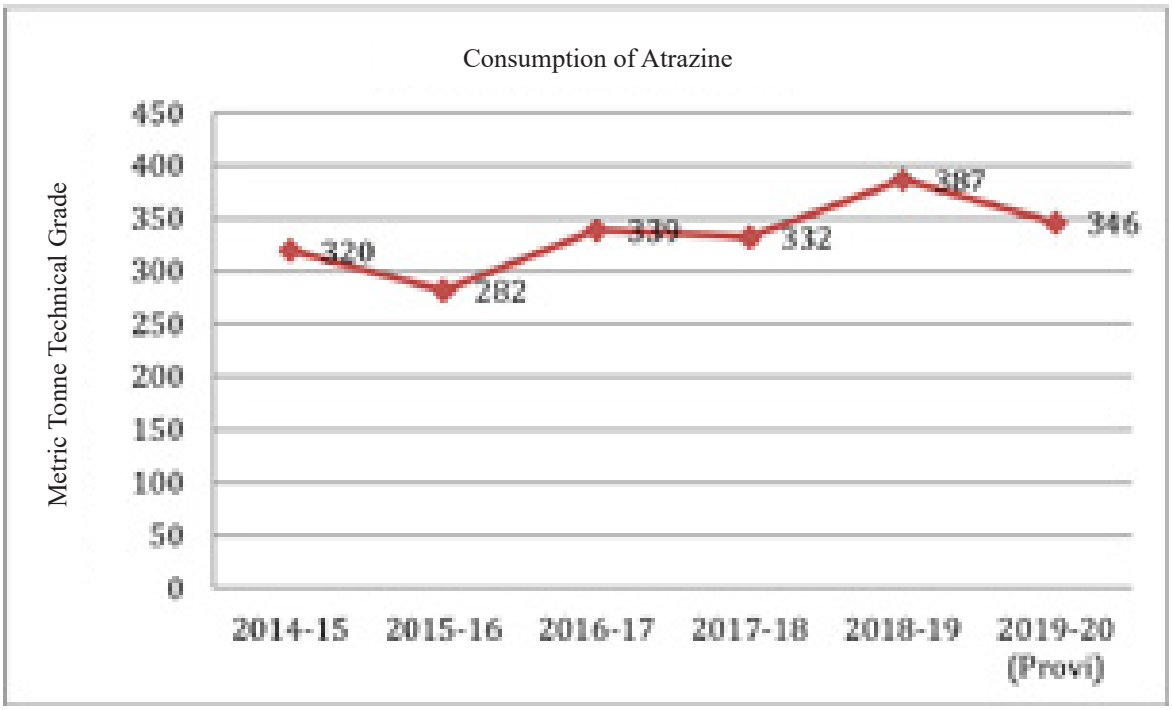


Table 16 List of Indian producers of atrazine

1.	Meghmani industries Ltd Gujarat
2.	Insecticides India Ltd Chopanki
3.	Insecticides India Ltd Dahej

Source: Compiled from the responses obtained from SAD through the provisions of RTI Act

Recommended uses of atrazine in India

According to the RTI response from the States, atrazine is recommended for weed control in the crops such as jower, maize, pearl millet, potato, sugarcane; one State has reported that it is used for weed control in 'crops'. However, the CIB&RC has approved atrazine for weed control only for maize. More than five non-approved uses are noted from the recommendations of SADs in India.

Various brands of atrazine reportedly used in States

A total of 35 brands of atrazine were reported in RTI responses obtained from 14 states, as given in Table 17.

Table 17 Different brands of Atrazine used in India

Agrovin, Alter, Anilotop, Asatrus, Atracel, Atrafil (Indofil), Atrafine, Atrakal, Atrasoul, Atrataf 50W (Rallis), Atratech, Atratop, Atrazine 50% WP, Atrazine, Atria, Attack (Devidayal), Azadi, Crozin, Dhanizine, Dhanusine, Dhwansh, Masstox, Milzin, Milzine 50, Polar, Raszine (Jayasree Rasayan), Rsasyanzine, Ruszine, Soloro (Pesticide India), Soltaf, Srizon (Cristal PL), Tagtaf (Tropical AS), Traxx, Ultrakem, Zinguard.

Source: Compiled from the responses obtained from SAD through the provisions of RTI Act.

USE OF ATRAZINE IN INDIA AS OBSERVED FROM THE FIELD STUDY

Use of atrazine was reported by 47.58% of respondents. Eleven different brands of atrazine were reported. Except for West Bengal and Andhra Pradesh, atrazine is used in all other five states where the field study was conducted. In Himachal Pradesh and Karnataka, all the respondents interviewed were using atrazine; in Jharkhand and Telangana 50% of respondents and in Tamilnadu 37.04% respondents were using it. Atrazine was found to be used for general weed control in cropping fields as pre-emergence and post-emergence control as well as for controlling broad-leaved weeds and plants. Generally, half to two kilograms of atrazine are used per acre, mixed with 10-20 times the amount of sand and broadcasted in the field.

Mainly it was applied before sowing or planting crops, as well as two or three times post- emergence. Atrazine use was reported in 19 crops including vegetables, banana, sugarcane, groundnut, cotton, paddy, black gram, etc. A list of brands of atrazine, their manufactures and the crops in which atrazine was used are provided in table 18. A total of 12 brands of atrazine were reported from the study.

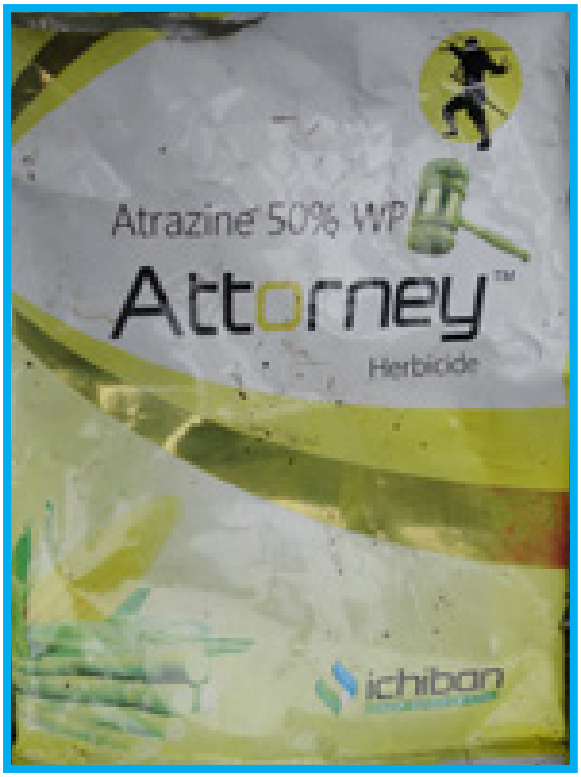
Table 18 Atrazine brands, manufacturers and crops used on

S. No	Brands	Manufacturers	Crops used on
1	Atari	IFFCO-MC crop Science	Barley, banana, bitter guard, black gram, chilli, corn, cotton, groundnut, leafy vegetables, maize, okra, paddy, potato, snake guard, soybeans, sugarcane, tomato, and wheat as well as for floriculture.
2	Atrahit	Hindusthan Insecticides	
4	Attorney	Ichiban	
5	Atranex	ADAMA	
	Atrataf	Tata Rallis India	
6	Dhavans	Biostadt, India Ltd,	
7	Dhanuzine	Dhanuka Agritech	
8	Hexazine	Coramandal International Ltd	
9	Masstaf 50%	Pioneer Pesticides	
10	Shriram	Shriram Fertilisers and Chemicals	
11	Strike	Insecticides India	
12	Solaro	PI Industries	

Source: compiled from field study

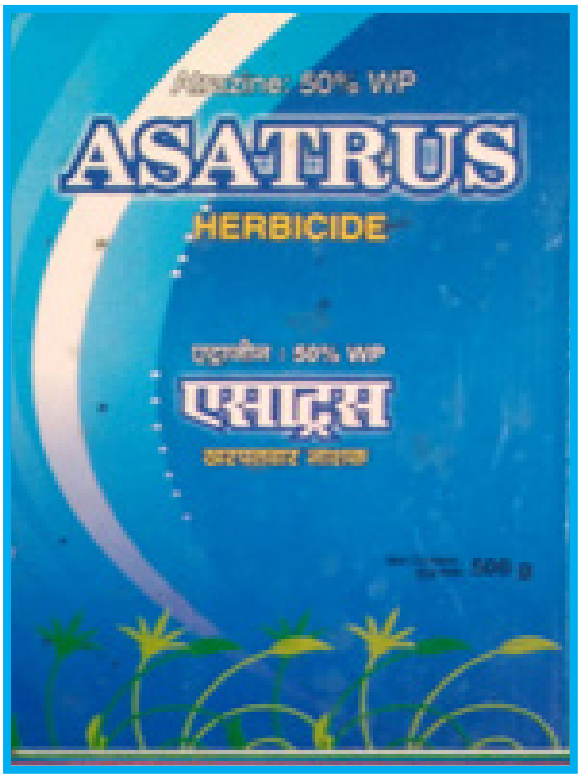
Atrazine from Himachal Pradesh-Photo Trilock Kumar for PAN India

Atrazine_50__WP_Attari_PlantRemediesPvtLtd



Atrazine_50__WP_Attorney_Ichiban

Atrazine_50__WP_Attari_PlantRemediesPvtLtd



IV PARAQUAT DICHLORIDE

BRIEF PROFILE

Paraquat dichloride (CAS number 1910-42-5) is the most highly acutely toxic and one of the most used herbicides in the world. Paraquat is a poisonous dipyridilium compound used as contact herbicide. It is used on large and small farms, plantations and estates and in non-agricultural weed control. It is used to control broad-leaved weeds and grasses, in a wide range of agricultural applications and for general weed control.

Paraquat destroys green plant tissue on contact and by translocation within the plant. It is absorbed by the foliage, is fast-acting, and is a non-selective herbicide. It destroys plant tissue by disrupting photosynthesis and rupturing cell membranes, which allows water to escape leading to rapid desiccation of foliage (Dinis-Olivera, et al. 2006). Paraquat is known to act on the photosynthetic membrane system called photosystem I, which produces free electrons to drive photosynthesis. The free electrons from photosystem I react with the paraquat ion to give the free radical form. Oxygen rapidly reconverts this free radical and in that process produces super oxides. Chemically highly reactive, the super oxides attack unsaturated membrane fatty acids, rapidly opening up and disintegrating the cell membranes and tissues[10].

It can also be translocated within the plant, increasing the likelihood of residues (Watts M., 2010).

As per the Safety and Hazards data provided in the PubChem database, based on Globally Harmonised System Hazard Statements (NCBI, 2018d), paraquat dichloride is a dangerous chemical.

* It is toxic if swallowed (danger acute toxicity, oral),
* Toxic in contact with skin (danger acute toxicity, dermal), causes skin irritation (warning skin corrosion/ irritation),
* Causes serious eye irritation (warning serious eye damage/eye irritation),
* Fatal if inhaled (danger acute toxicity, inhalation),
* May cause respiratory irritation (warning specific target organ toxicity, single exposure; respiratory tract irritation),
* Causes damage to organs through prolonged or repeated exposure (danger specific target organ toxicity, repeated exposure),
* Very toxic to aquatic life (warning hazardous to the aquatic environment, acute hazard), and
* very toxic to aquatic life with long lasting effects (warning hazardous to the aquatic environment, long-term hazard).

According to the Chemical Assessment Summary of the Integrated Risk Information

[10]Paraquat Information centre, http://paraquat.com/faq#t8n57

System (IRIS) of the United States Environmental Protection Agency, paraquat is a possible human carcinogen (USEPA). Paraquat is also reported to have links to reproductive problems and Parkinson's disease.

The WHO classified paraquat as a Moderately Hazardous (class II) pesticide (WHO, 2020). It is a PAN North America Bad Actor chemical and one of the original Dirty Dozen pesticides (Barbara D., 2004). Paraquat shows high acute toxicity and it qualifies as a Highly Hazardous Pesticide using the Pesticide Action Network criteria (PAN, 2021a). Paraquat can cause life-threatening effects on the lungs, gastrointestinal tract, kidney, liver, heart and other organs. Pulmonary effects represent the most lethal and least treatable manifestation of toxicity. Toxicity in the gastrointestinal tract is manifested by swelling, oedema and painful ulceration of the mouth, pharynx, esophagus, stomach and intestine. Ingestion has been reported to cause cerebral oedema and brain damage. At necropsy, brain damage was found in the form of moderate neuronal depletion. Contact with concentrated solutions causes irritation of the skin, cracking and shedding of the nails, and delayed healing of cuts and wounds. Early symptoms and signs of poisoning by ingested paraquat are burning pain in the mouth, throat, chest and upper abdomen due to the corrosive effect of paraquat on the mucosal lining. Symptoms include acute respiratory distress, shortness of breath and rapid heartbeat; loss of appetite, abdominal pain, thirst, nausea, vomiting, and diarrhoea; giddiness, headache, fever, muscle pain, and lethargy; burns to the mouth, nose bleeds, skin fissures, peeling, burns and blistering; eye injuries, and nail damage including discolouration and temporary nail loss (Watts M., 2012). Diarrhoea, which is sometimes bloody, can also occur . Paraquat crosses, and accumulates in, the placenta, and can cause acute poisoning including death of the foetus or chronic effects that can persist for the lifetime. There is no known antidote for paraquat (Gawarammana, I. B., & Buckley, N. A, 2011) and a systematic review shows that it has higest acute poisoning case fatality rate (Moebus & Bodeker 2021).

According to the PAN Consolidated List of Banned Pesticides (PAN, 2021b), paraquat is now banned in at least 48 countries, including in the European Union, South Korea, Vietnam, UK, Switzerland, which is Syngenta's home country, and a number of African countries, because of its adverse health effects. The US Environmental Protection Agency had announced its proposal to further restrict the use of paraquat and, among other measures, prohibit application from hand-held and backpack equipment as well as to restrict the use to certified pesticide applicators only. Additionally, many labelling organisations such as the Fair Trade International, the Forest Stewardship Council, the Rainforest Alliance, and food corporations like Chiquita, or retailers like Migros and Coop in Switzerland, have all voluntarily prohibited paraquat (Isenring, 2017). Recently, the US EPA has identified

potential human risks related to mixing, loading, and applying of paraquat; and also post aplication risks to workers and bystanders from spray drift. Additionaly, ecological risks to mammals, birds, terrestrial vertebrates and plants, aquatic plants and aquatic invertebrates were identified; and hence the proposed stringent mitigation measures (USEPA, 2021).

REGULATION OF PARAQUAT DICHLORIDE IN INDIA

Paraquat dichloride was registered before the Insecticide Act 1962 came into effect, and is considered as a 'deemed to be registered' pesticide now. It has been approved for wuse in both agriculture as well as for non-agriculture purposes. In the agriculture sector, it has been approved for both pre-emergence and post-emergence applications on food and non-food crops. For non-agriculture application, it has been approved for aquatic weed control.

The South Indian State of Kerala stopped the use of paraquat in 2011 based on health concerns. The waiting period and MRL were set for only a few of the approved crops.

The Anupam Varma Committee, constituted by the Agriculture Department, Government of India, to review 66 pesticides banned elsewhere and still used in India, submitted its report in 2015, and recommended use of paraquat dichloride to be continued.

Approved uses of Paraquat Dichloride

Only one formulation of paraquat, Paraquat dichloride 24%SL, is approved for use in India. It has been approved for 10 crops, as well as for aquatic weed control. Tea, potato, cotton, rubber, coffee, rice, wheat, maize, grapes and apple are the approved crops.

Table 19 Approved uses of paraquat dichloride in India

Sl.No	Formulations	Approved crops	Waiting period
1	Paraquat dichloride 24% SL	Tea	Not provided
		potato	100 days
		cotton	150-180 days
		rubber	NA
		coffee	Not provided
		rice	Not provided
		wheat	120-150 days
		maize	90-120 days
		grapes	90 days
		apple	NA
		aquatic weed control, water ways, ponds, etc.	NA

Source: Compiled from approved uses of Pesticides (Herbicides), CIBRC, as on 31.10.2019

[11]NPIC, http://npic.orst.edu/RMPP/rmpp_ch12.pdf

[12]Pesticides used in India before the Insecticide Act 1968 came into force are considered as 'deemed to be registered'.

Waiting period for Paraquat Dichloride

There are wide variations in waiting periods for paraquat dichloride. Of the 12 crops approved, waiting periods are given for only seven. A waiting period of 270 days is given for sugarcane, 150-180 days for cotton, 120-150 days for wheat, 120 days for sunflower, 90-120 days for maize, 100 days for potato and 90 days for grapes. For some crops such as tea, coffee, rice, and apples, a waiting period is not provided.

Importers & Manufacturers of Technical Grade Paraquat Dichloride in India

Only one company is approved to import paraquat dichloride Technical 40% minimum, where as two indigenous companies have approved for manufacturing it. For paraquat dichloride Technical 42% minimum, two companies including the multinational giant Syngenta are approved as sources of import to India, where as a subsidiary of Syngenta – Syngenta India – is approved to manufacture it indigenously.

Table 20 Sources of import and indigenous manufactures of paraquat

Common Name	Approved Source for Import	Indigenous manufacturers
Paraquat dichloride Technical 40% min, 42% min	1. Comlets Chemical Industrial Co. Ltd., Taiwan 2. Syngenta Limited, Huddersfield, West Yorkshire HD2 1FF, United Kingdom (by Syngenta India, Mumbai) 3. Sinon Corporation, Regd. Office 1 FL., No. 23, Sec 1, Mei Chuan W. Rd., Taichung, Taiwan, ROC. (Valid up to 25.07.2023). Factory address 101, Nanrong Rd., Ta Tu District, Taichung City, 43245, Taiwan, Taiwan (Supplier: Sinon Corporation)	1. Crystal Phosphate Ltd., New Delhi 2. United Phosphorus Ltd., Mumbai
Paraquat dichloride Technical.	1. Syngenta Ltd, United Kingdom 2. Sinon Corporation, Taiwan, Supplier : Sinon Corporation, Taiuchung	1. Syngenta India, Mumbai

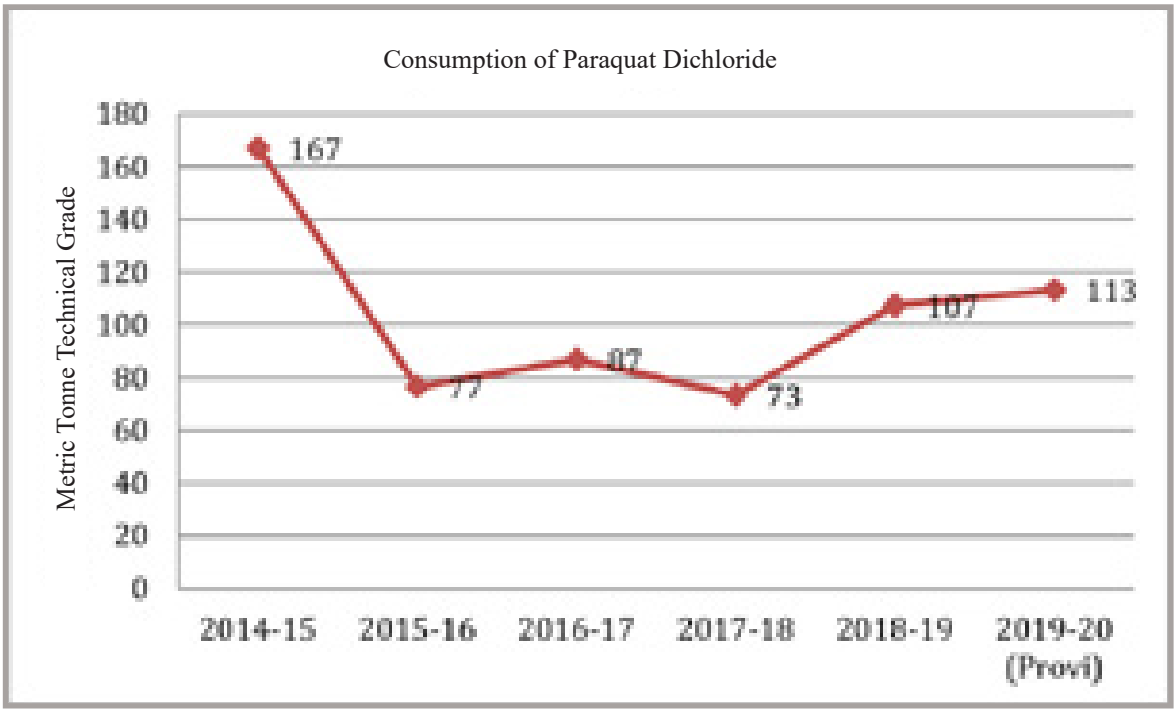
Source: Source of import and list of indigenous manufacturers of insecticides' dated 31st October 2019, CIBRC.

Statistical data on paraquat dichloride in India

Consumption of paraquat dichloride

For the year 2019-20, though data is provisional, the consumption of paraquat dichloride was 113 metric tonne technical grade, an increase on the previous 4 years.

Table 19 Approved uses of paraquat dichloride in India



Source: Compiled from statistical data provided in web site PPQ&S

Recommended use and brands

Paraquat dichloride is recommended for several crops by industry. It has been recommended for weed control generally in all crops before cultivating barren lands, in potato, cotton, wheat, tea; post emergence weed control on grassy grounds, to control annual grasses and dicot weeds in fruit trees; used on cotton to bring maturity at the tome of last picking, and generally used as a desiccant. Some of these uses are not approved by CIB&RC.

Table 21 List of crops/uses recommended by SAD for Paraquat dichloride

Potato, cotton, wheat and tea. And all crops before cultivation of barren lands; used on cotton to bring maturity at the time of last picking, desiccant, post-emergence weed control on grassy grounds, to control annual grasses and dicot weeds in fruit trees.

Source: Compiled from the responses obtained from SAD through the provisions of RTI Act.

Various brands of paraquat dichloride reportedly used in States

A total of 24 brands of paraquat dichloride was reported in the responses received on the RTI applications, and are given in the table below.

Table 22 Different brands of paraquat dichloride used in India

Paraquat dichloride (24 brands)
Airawat, All Clear (HPM), Allquit (Cristal PL), Anuxone (Anu), Crezil, Dectron, Fire (Jayasree Rasayan udyog), Firestorm, Gramoxone (Syngenta India), Heraquat, Kitkat, Ozone, Parachute, Paragreen, Parakh (Bharat IL), Paralac (Rallis), Paraplus, Parasac, Parq, Quilt (Crystal crop science), Spyker, Swat, Uniquat, Weedex,

Source: Compiled from the responses obtained from SAD through the provisions of RTI Act.

USE OF PARAQUAT DICHLORIDE AS OBSERVEDFROM THE FIELD STUDY

Paraquat dichloride use was reported by 62.28% of respondents in five states - Jharkhand, Karnataka, Tamilnadu, Telangana and West Bengal. All the respondents interviewed in Karnataka and West Bengal were using this herbicide, whereas in Jharkhand, Tamilnadu and Telangana, 70.83%, 62.96% and 15% of the respondents respectively were using it. It was used for both pre- and post- emergence weed control. The majority of the respondents reported that paraquat is applied to kill weeds in farmland either before ploughing or before planting saplings or sowing seeds. It was found that 200ml to 1.25 litre of paraquat is applied per acre. Common salt, urea and some adhesives are mixed in while applying paraquat in the field.

The use of paraquat was reported on 23 crops such as in vegetables, cereals, pulses, sugarcane and cotton as well as for general weed control, and only five are approved uses. Most of the respondents who use paraquat reported that it is applied once or twice a year to control grass and broad leaved weeds in crops and sometimes non-cropped area.

A number of brands of paraquat dichloride were noted in the field study. A total of 21 brands belonging to Indian manufacturers and transnational corporates were being used for weed control in various approved and non-approved crops.

Table 23 Brands of paraquat dichloride, their manufacturers and crops applied on

Sl. No	Brand name	Manufacturer	Crops used for
1	All Clear	Hindustan Insecticides	banana, beans, black gram, cabbage, capsicum, chilli, cauliflower, corn, cotton, cucumber, finger millet, ground nut, jasmine (floriculture), mustard, maize, okra, paddy, peas, potato, radish, sugarcane, and wheat.
2	Clear	Plant Remedies Pvt Ltd	
3	Crezil	Vimax Crop Science	
4	Ginny	Anu Products	
5	Gramoxone	Syngenta	
6	Herbuscone	Ankar industries	
7	Kabuto	IFFCO	
8	Kapiq	Krishirasayan	
9	Milquat	Insecticides India	
10	Ozone	Dhanuka Agritech limited	
11	Para Flame	Khublal Agro Chemicals	
12	Parajet	IndoBohger	
13	Parakh	Bharat Insecticides ltd	
14	Paralac	TATA Rallis	
15	Paranex	Makateshim-Agan India	
16	Parawin	SDS Ramcides Crop science	
17	Parq	Ravi Crop Science	
18	Pogo	Excell Biotech	
19	Rhino	Nagarjuna	
20	Uniquat	United phosphorous Ltd	
21	Wilquat	Willowood crop science	

paraquat (2)

paraquat (3)

paraquat (8)

paraquat (9)

paraquat (10)

paraquat (13)

Paraquat_Clear_PlantRemedies

Paraquat_Gramoxone_Syngenta

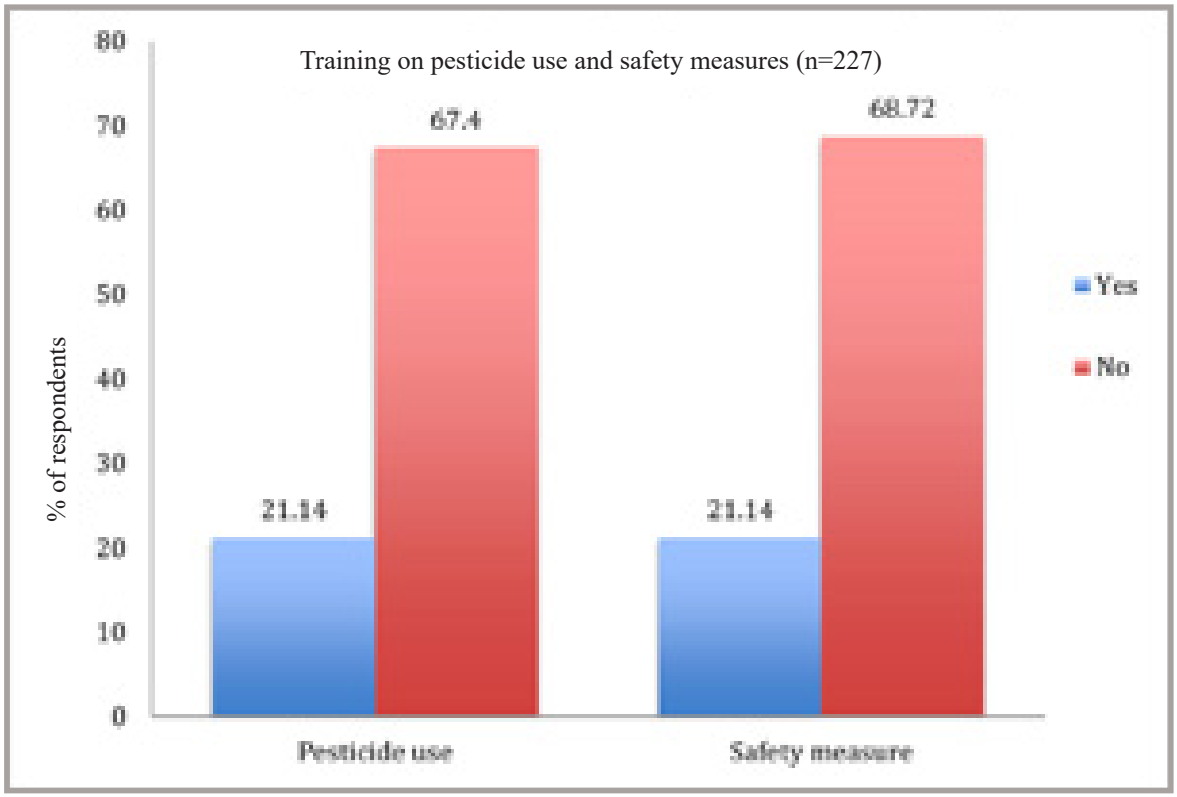
V PESTICIDE USE SCENARIO IN INDIA

OBSERVATIONS FROM FARMERS

Training and Awareness on Pesticide use and Safety Measures

To a question asked of respondents, on whether they have had received any training or instructions about handling and application of pesticides in the field as well as on the provision of safety measures and personal protective equipment (PPE), most of them said 'no'. Only 21.14% respondents reported that they were trained and instructed on pesticide use and safety measures to some extend. This was mainly reported from the study areas in Andhra Pradesh, Himachal Pradesh and Karnataka where such awareness programs were reportedly organised by agriculture offices in the area. However, respondents did not provide further information on how long the training was given, what were the topics covered, etc.

Chart 9 Training obtained on pesticide and safety measures among farmers



Sources of information on pesticides use

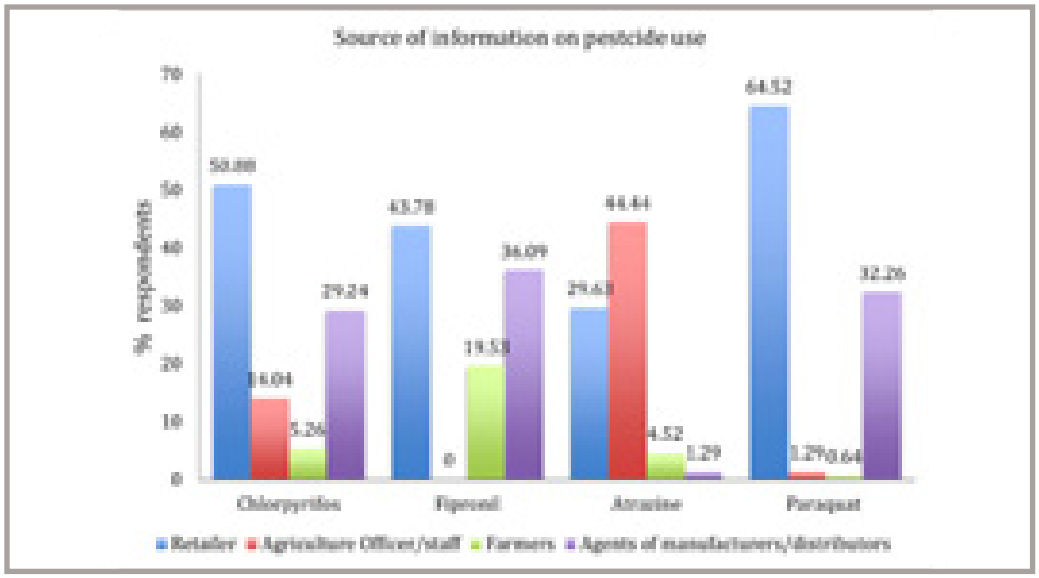
Different sources of information and advice on pesticides and their use were reported from the field study. These were retailers, agriculture offices, farmer peers, as well as agents of distributors and/or manufacturers. This study has revealed that the majority of the respondents are depending on the advice from retailers and agents of companies or distributors, though a small percentage is dependent on agriculture officers.

Nearly half of the respondents (50.88%) who use chlorpyrifos reported that retailers are the major source of information for them, while 29.24% reported agents of manufacturers and/or distributors are the sources of information on chlorpyrifos. 14.04% of the respondents are dependent on agriculture officers. All of these sources of information recommended use of this deadly insecticide on a number crops.

Respondents reported that they get advice on the use of fipronil products mainly from retailers (43.78%) and agents of manufacturers and distributers (36.09%), and always they recommend using their products on all the crops. None of the respondents reported getting information from agriculture officers. However, 19.53% of respondents were using fipronil as per the information provided by other farmers.

Among the respondents who had reported use of atrazine, 44.4% (n=108) responded that they obtained information and advice on its use from agriculture offices. 29.63% of respondents reported that they get the same information from pesticide retail points. Only a few of the respondents reported to have been dependent on the advice of peer farmers and agents of manufacturers and or distributers. It was reported that agriculture officers and retailers have been recommending atrazine for several crops, though it is approved for weed control only in maize.

Chart 10 Sources of information on pesticide use

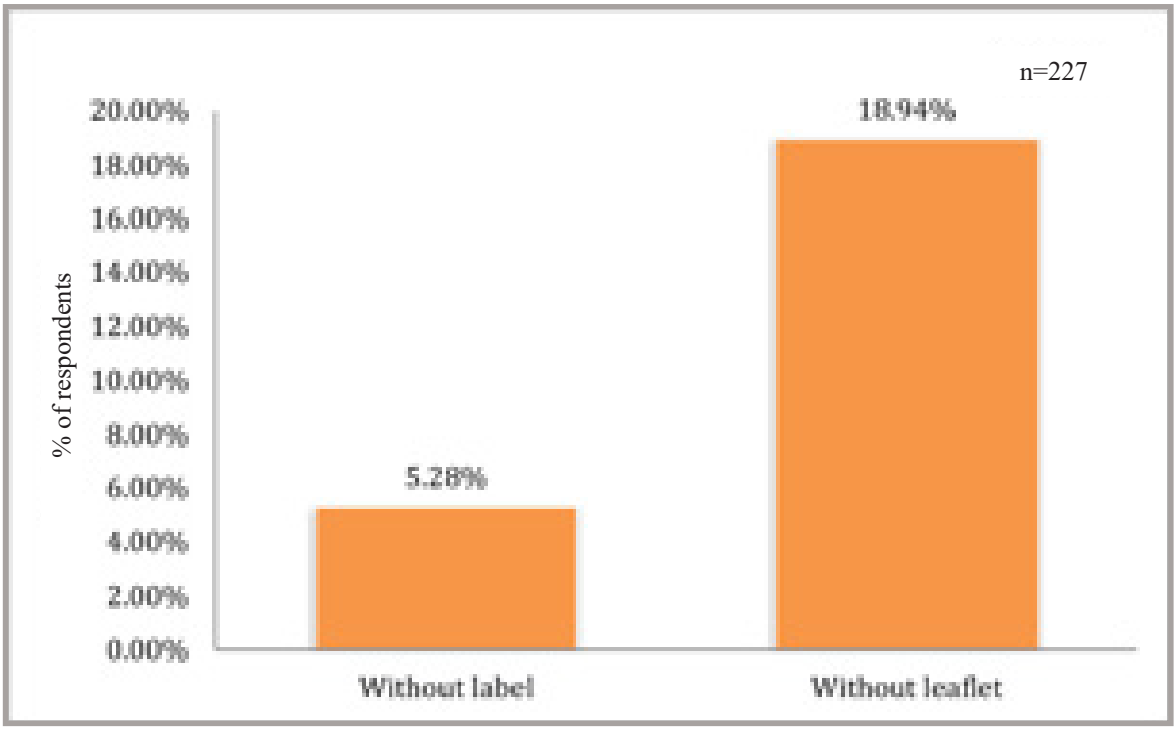


64.52% of the respondents who have been using paraquat reported that they get information about its use mostly from retailers; 32.26% reported that they get information from agents of distributors or manufacturers. They recommend paraquat for general weed control as well as for weed control in all the crops. Only 1.29% of respondents are actually depending upon the advice of agriculture officers, and they recommended paraquat use for chilly and other vegetables.

Access to information on labels and leaflets

A considerable percentage of respondents reported buying some of the four pesticides without labels and information leaflets: 5.28% reported that they bought pesticides that did not have product label and 18.94% reported that they did not get an instruction leaflet. The absence of label and leaflet was mostly reported from West Bengal and the rest from Andhra Pradesh, Jharkhand and Karnataka. Many of the respondents did not remember brand names. Some of the brands reported by respondents that instruction leaflets were not provided for were Yorker, Transformer, No Weed, Ultra 505, Crezil, Clear, Safal, and Manik.

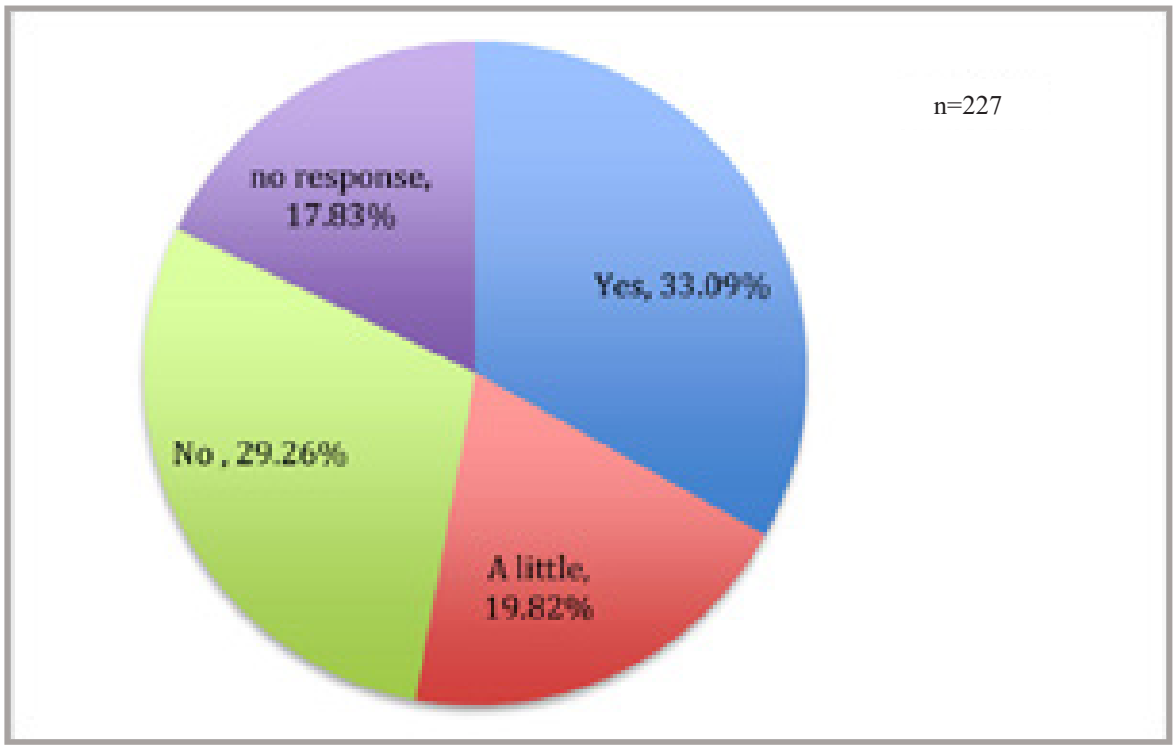
Chart 11 Purchase of pesticides without product label and leaflet



About 33% of respondents reported that they are able to read and understand labels or instruction leaflets. Respondents said that they try to follow instructions given on labels and leaflets, such as keeping pesticides out of reach of children, using on the crops specified, use

of gloves and face mask, etc. About 19.82% of respondents reported that they are able to read but understand 'a little' or unable to comprehend.. Many of the respondents (29.26%) did not read the labels or information leaflets because, either the details given in them was in very small font size that are unable to be read, they do not know the language, were unable to comprehend it, or are illiterate. 17.83% of respondents did not respond to this question. Some of the respondents (6.5%) reported that the labels and leaflets contained information in the local language in addition to English and Hindi.

Chart 12 Response to a question on ability to read and understand labels/leaflets



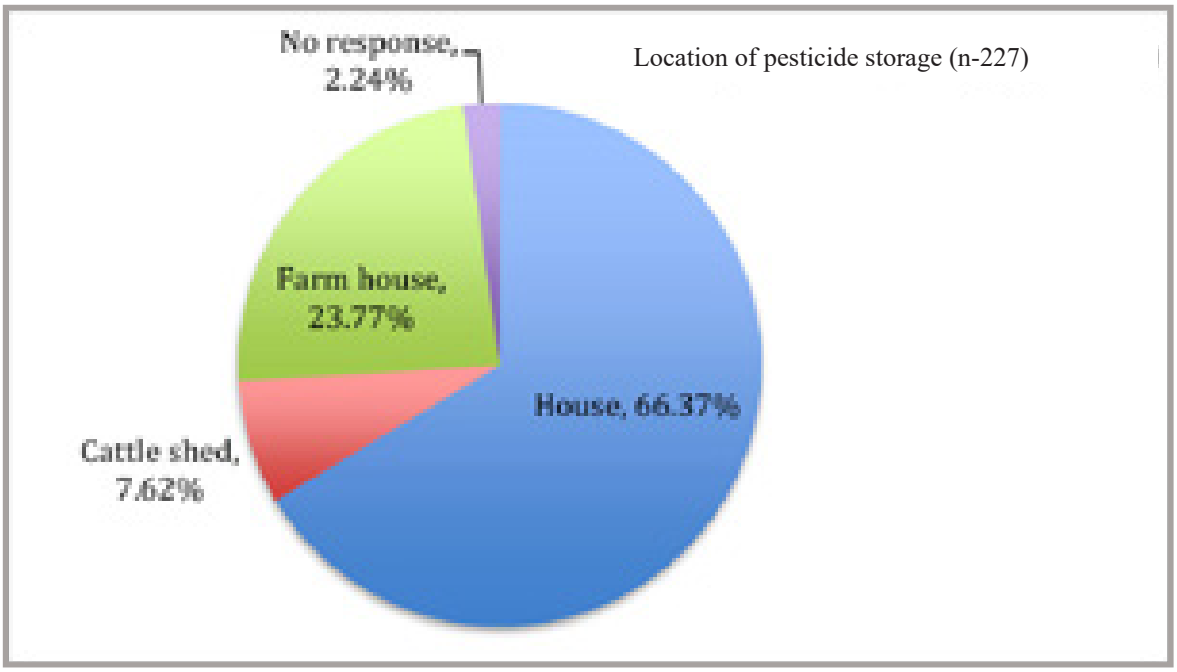
Practices Leading to Exposure and Poisoning

A number of factors can lead to exposure to pesticides and results in poisoning. To avoid exposure and poisoning, government and industry provide certain precautionary measures to be followed. However, field data shows that such precautionary measures are not followed. This section of the report focuses on various practices by farmers that can lead to exposures and poisoning such as storage, spraying equipment, washing, use of PPE, application time, working in sprayed fields, etc.

Storage site of pesticides: Different storage sites, such as house premises, cattle sheds, and farm sheds, were reported in the study, with the majority of the respondents storing pesticide containers in their home premises. About 66% of the respondents stored pesticide containers within house premises (kitchen, wall shelf, veranda, near the window, store room, etc.),

while 23.77 % stored them in the farm shed, 7.62% in the cattle shed, but the remaining respondents did not answer the question. The majority of the respondents (73%) said that they store pesticides in places where children cannot reach them.

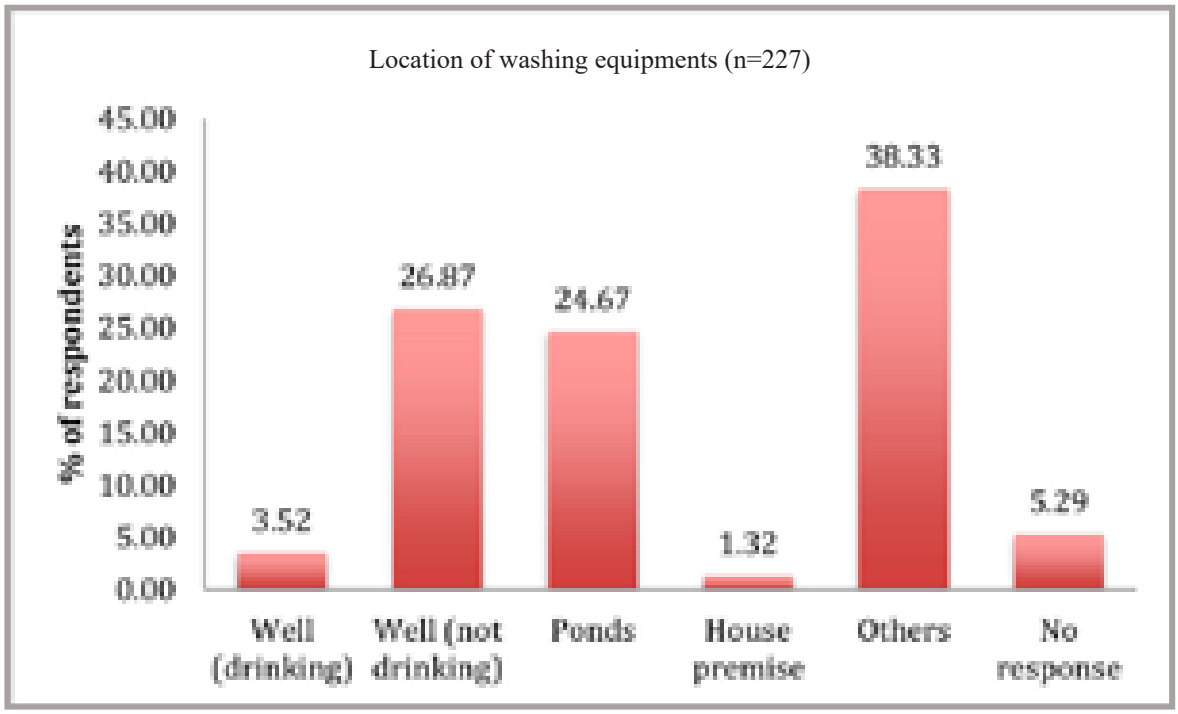
Chart 13 Location of pesticide storage



Type of spraying equipment and condition: The majority of the respondents were using backpack sprayers for pesticide application. Common manual backpack sprayers, battery powered backpack sprayers as well as petrol-fuelled backpack sprayers were reported. Less than a two percent of respondents were using a manually operated rocker sprayer. Among the respondents, 34.36% were working with faulty sprayers that were leaking occasionally or frequently. Many of them were unable to repair the sprayers themselves, so continued to work with them. Only a few of them reported that they get their faulty sprayers repaired after the spray or just before the next spray schedule.

Location of washing equipment used for pesticide application: respondents reported different locations used for washing of spraying equipment. 3.52% of respondents were washing the equipment near to wells used as the source of drinking water; 26.87% of respondents wash at wells usually not used as sources of drinking water, 24.67% of respondents wash them at ponds, 1.32% of respondents wash equipment at their house premise, and 38.33% of respondents reported that they wash spraying equipment either in the farm itself, drainage streams, and or river, and the remaining 5.29% did not respond to the question.

Chart 14 location of washing equipments used for pesticide application



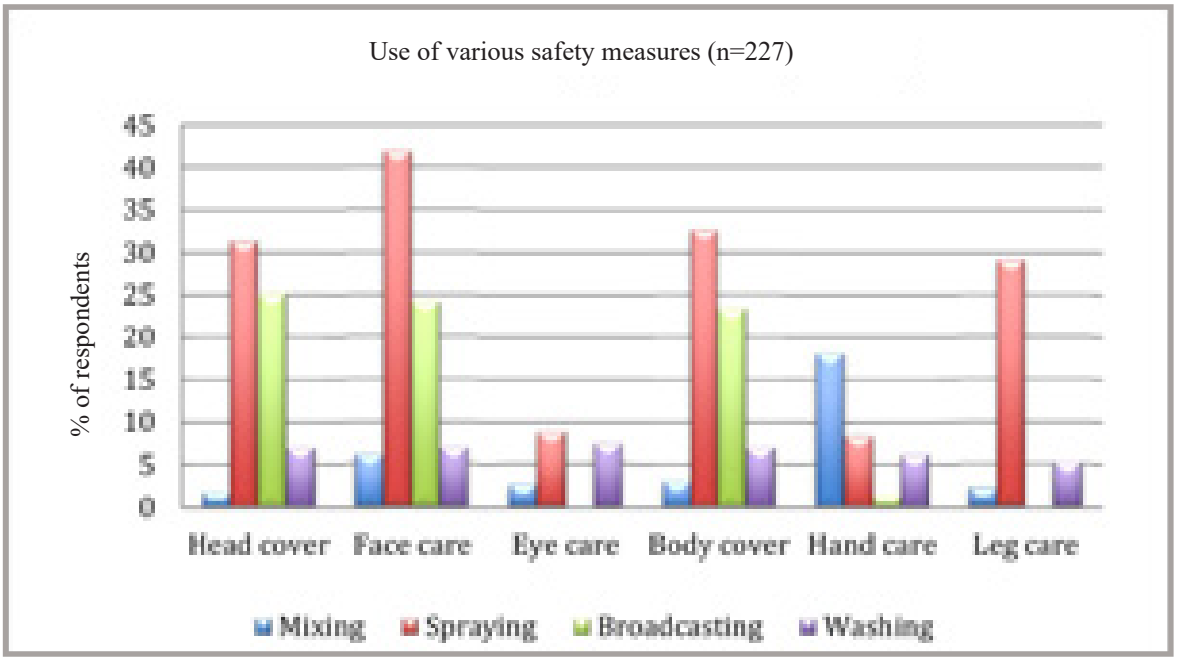
Activity roles:

As the majority of the respondents are small scale and marginal farmers, the various activities involved in pesticide use such as mixing, spraying, broadcasting/dispersing and washing the equipment used, are mostly done by farmers themselves or family members. However, about 18.83% of respondents have hired workers for such activities. The age of those who are involved in these various activities (whether it is farmer himself or herself, family member or hired labourers) ranged from 23 to 67 years. 1.43% of respondents reported participation of women in the activities, mostly involved in mixing of pesticides and washing the equipment, while others did not answer the question.

Use of personal protective equipment (PPE)

When asked whether they use PPE while working with pesticides, only 10.57% of respondents said "yes" and mentioned some kind of protective measures, and the rest said "no". A detailed further enquiry revealed that they were using some sort of protective measures, but not the actual recommended PPE. They use hat, towel, cloth, etc. as a head cover; mask and cloth wrapped around mouth and nose as face cover, some sort of specs or goggles for eye care; raincoat or cloth as body cover; gloves, plastic sheet and full sleeved shirts as hand/arm care; and full length trousers and shoes as leg care while mixing, spraying, broadcasting/dispersing and washing the equipments. However, the least protection has been noted for eye, hands and legs.

Chart 15 Use of various safety measures reported from the field



When asked about the availability of protective equipment in villages, 44.05% respondents reported that some sort of low quality gloves and goggles were sometimes available in some of the retail points, but not always. 23.79% reported that it was affordable. They further said that such items got damaged after being used a couple of times and did not last for even a year. On further enquiry about whether they asked for PPE from retailers, agriculture officers, agents of distributers and or manufacturers, some of the respondents (28.65%) said yes, and these persons mentioned 'it is good to use PPE and can avoid health implication'; however, they didn't say what were the PPE items required and where good quality equipment was available. A few respondents mentioned that they got some gloves and goggles when demanded of a retailer.

Pesticide application time and precautions on wind direction: field data shows that 93.83% of respondents were applying pesticides mostly during the morning and evening, although some of them also reported that they had to spray during noon and afternoon to finish spraying the entire field. The rest of the respondents did not respond to questions on this. The data also shows that 74.45% respondents considered wind direction while spraying, with the majority reporting that they sprayed along the direction of wind to avoid spray blowing back onto their face, whereas 22.1% of respondents did not consider wind direction while spraying.

Re-entry to sprayed field: a varying period of re-entry to sprayed fields was reported by the respondents. Field data shows that 25.11% of respondents entered a sprayed field immedi-

ately after spraying. Entering the sprayed field some time after the spray and the next day was reported by 38.33% of respondents; 31.72% of respondents reported that they entered a sprayed field after two days, and the rest of respondents reported a week's re-entry period.

Increasing dose in successive applications: 35.34% of respondents reported having used an increased dose of pesticides in successive applications. They reported several reasons for this practice, including increased incidents of pest infestation over the years, use of more pesticides would give more yield, pests were not dying with the dose used earlier, higher doses were used if low dose has not given a good result, etc.

Exposures and Health Effects

When asked if farmers know the dangerous side effects of pesticide use, 74.44% respondents responded 'yes'. Further interaction with them revealed that they are aware that some pesticides can cause headache, asthma, body pain, breathing issues, nausea, abdominal discomfort, cancer and may result even in death. They further said that they continue to use these deadly chemicals, as no other options are available to save their crops.

This study has observed exposures and adverse effects among farmers due to the pesticides. Respondents reported that they were exposed to pesticides while working in the field. Most of the exposure happened because of a sudden change in wind direction while spraying. Other reasons for exposure reported from the field were: pesticide spilled when opening the lid of container; spilled on hands while mixing; and spilled on body while loading the sprayer. About 18% of respondents reported exposures with pesticides and health effects, presented below by pesticide active ingredient.

Table 24 Exposures and illness reported

#	Pesticides	% of respondents who reported exposures	Illness reported
1	Chlorpyrifos	10.55	skin burn, blurred vision, nose irritation, cough, abdominal pain, nausea and vomiting
2	Fipronil	2.35	eye irritation, breathing problems, body pain, headache and vomiting
3	Atrazine	3.7	itching on fingers, hands and numbness
4	Paraquat dichloride	1.29	breathing problems, diarrhoea, giddiness, headache, loss of appetite, muscle pain, abdominal pain, nausea and vomiting

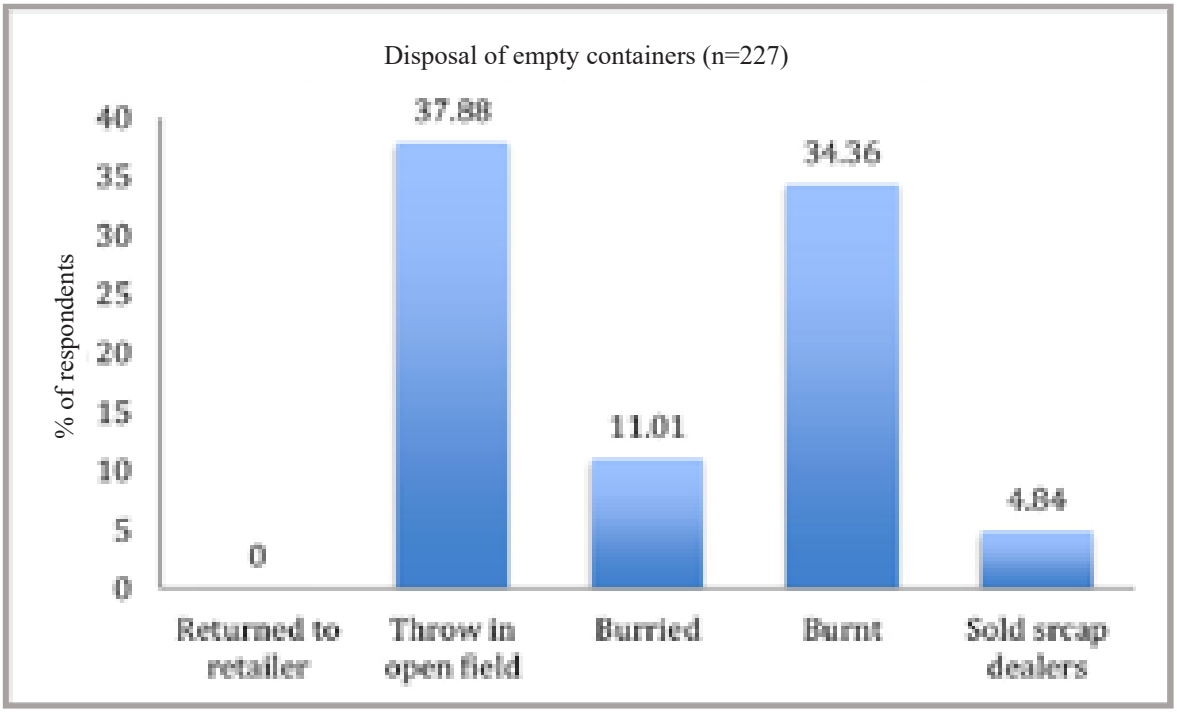
Re-use of Pesticide Containers and Disposal

A proper container disposal method was not reported from this field study. About 15% of respondents were using empty pesticide containers for household uses such as to store seeds, used as night lamp fuelled with kerosene, used as vessels in toilets and bathrooms, used to store kerosene and oils.

The majority of the respondents (37.88%) reported throwing out the containers in open fields while 11.01% of respondents buried them; 34.36% of respondents reported that they burned empty pesticide containers; and 4.84% respondents sold the containers to scrap dealers.

No one reported that the containers went to a proper government or industry container collection mechanism or were returned to the retailer.

Chart 16 Pesticide container disposal methods



OBSERVATIONS FROM FARM WORKERS

In addition to farmer respondents, this study gathered field data on pesticide usage from 43 farm workers who work in small and marginal farms as daily wage labourers. The major of observations from the farm workers are presented below.

Training on pesticide use and Safety Measures

None of the farm workers had received training on the use of pesticides. Most of them were using backpack sprayers that operate either manually or were powered by battery or petrol. Further, 90.68% of workers reported that they did not have training on the use of personal protective equipment (PPE) or safety and precautionary measures to be followed while working with pesticides. The rest of the respondents said they were informed about using PPE while spraying. Nearly 40% of the workers said that they were not aware of the health hazards of using pesticides, while the remaining workers reported that they know pesticides are poisons.

Crop Specific use of Pesticides as Informed by Workers

Field data from farm workers shows that they had used the four pesticides focussed on in this study on several crops, as listed in the table below. The crops range from non-food crops, such as cotton and floriculture, to food-crops such as millets, cereals, oil seeds, pulses and vegetables.

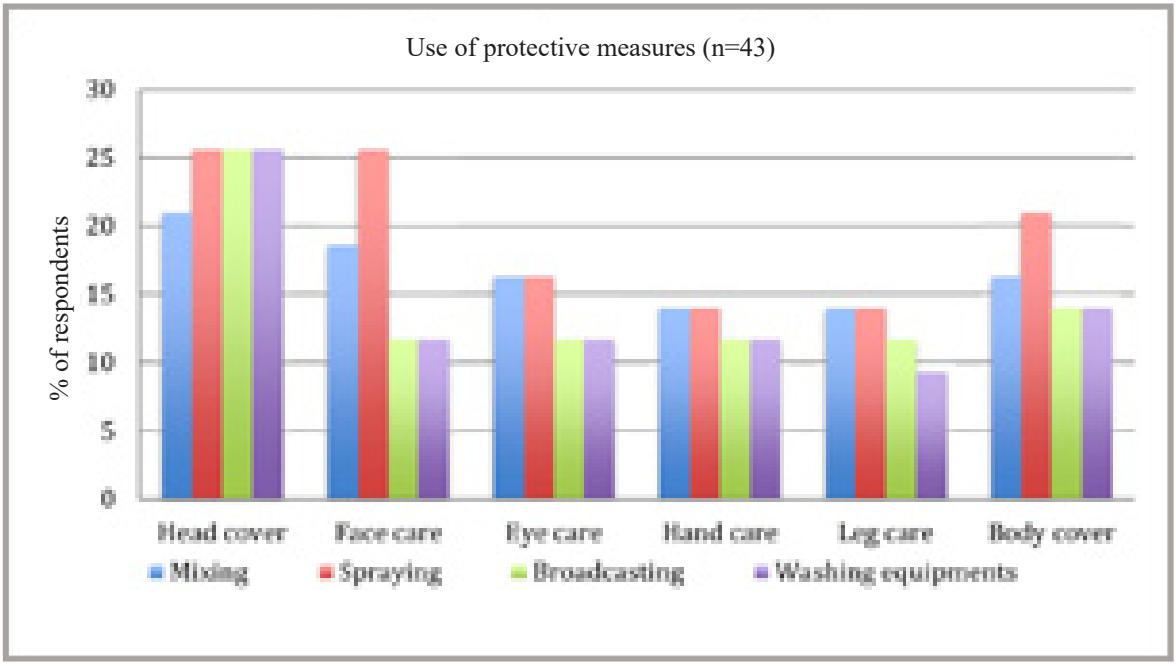
Table 25 Crops on which pesticides used

Chlorpyrifos	Fipronil	Atrazine	Paraquat dichloride
cotton, paddy, sugarcane and vegetable crops such as brinjal, chilli, cauliflower, onion, capsicum, etc	cucumber, green chilli, tomato, sunflower, and floriculture, etc	floriculture, sugarcane, tomato	cabbage, finger millet, cucumber, etc.

PPE use

Use of PPE is very important to minimise the intensity of exposure to pesticides while working with them. The field data shows that workers did not obtain training on the use of PPE and precautionary measures. Data reveals that the recommended PPE was not in use; however, 32.55% of workers reported use of certain kinds of precautionary measures such as gloves, goggles, masks, cloths to wrap around head and nose, and casual clothing (see chart number 17). Therefore, these workers have higher chances of exposure to pesticides. Further, working with pesticides continuously for three to four days without the proper PPE further aggravates risk of exposures.

Chart 17 Use of protective measures by farm workers



Farm worker respondents also reported that they had to work in sprayed fields as well, sometimes immediately after the spray, the next day or over the following days. Fertilizer application, inter-crop cultivation, harvesting, watering, etc. are the general work undertaken in this way. 46.51% of workers said that they usually entered and worked in a sprayed area immediately after spray or on the same day. They further reported that, apart from casual clothing, they did not use PPE while working in sprayed fields. However, about 32.56% of workers reported that occasionally they used some cloths to wrap around their nose to avoid irritating smell and used shoes in such working conditions.

Exposure and Health Effects

There are multiple factors that contribute to exposure to pesticides. These include the time spent working with or applying pesticides, working in a sprayed fields, and absence of PPE and precautionary measures. The time spent working with pesticides (mixing/application) varied considerably among the workers. Some of the workers (23.25%) reported that they work with pesticides at least half a day, while others reported that sometimes they may have to work a full day spraying pesticides, and sometimes continuously for three to four days during peak spraying season. They further reported that, on an average, usually they spray about 5-20 days in a crop season.

Spillage and exposure: Pesticide spillage and accidents are the other factors contributing to exposure to pesticides. Pesticide spillage, inhalation of spray mist and contact exposures

were common among the farming community. Some of the workers (39.53%) reported that they were exposed to pesticides while spraying, which was mainly because of spillage or using faulty spraying equipment. A few workers reported pesticide spilt on leg, hand, etc. while mixing and spraying, and said they felt burning sensations and irritation.

Health effects: 44.19% of farm workers complained about experiencing certain ill effects after being exposed to the pesticides as mentioned above. Thirst, nausea, vomiting, loss of appetite, body pain, head ache, irritation, rapid heart rate, difficulty in breathing, etc. were the prominent symptoms reported. Those who have worked with atrazine reported headache, giddiness and irritation on body parts. Skin allergy, nausea, and vomiting are the symptoms noted from workers who have worked with paraquat. Workers, who have sprayed chlorpyrifos, reported symptoms such as eye irritation, irritation in nose, nausea and vomiting, whereas those who worked with fipronil reported headache, skin irritation and vomiting.

Container disposal and reuse

Throwing out in open field was the most common method of container disposal noted among farm workers. However, 25.58% of farm workers reported that they used empty pesticide containers for household activities, such as in toilets, for storing kerosene oil and cooking oil, as kerosene lamps, etc.

OBSERVATIONS FROM RETAILERS

This study gathered field data from pesticide retailers in the study area. A total of 30 retailers were interviewed to gather relevant information on retail practices and the observations are presented below. Different formulations of the four pesticides were observed at the sales points. Some of the formulations were available in different volumes such as 100ml, 250ml, 500ml, one litre and five litres.

Location and Type of Sales Points

Pesticide sales points recorded in this study were from both villages and small towns. 16.67% of them were from villages and the rest from semi-urban areas. Most of them were farm supply stores where they sell inputs such as seeds, fertilisers, and pesticides (insecticides, fungicides, weedicides and plant growth regulators), while the rest were market stalls or roadside stalls. About 33.33% of the sales points were located near to a medical facility, 16.67% located near to schools, 20% located near to food item stores, 10% located near to an eatery and the rest 20% were close to agriculture fields. Vegetables, cotton, corn, paddy, sugarcane, soybean, wheat, mustard, garlic, etc. were the major crops grown in the area where the pesticide sales points were recorded.

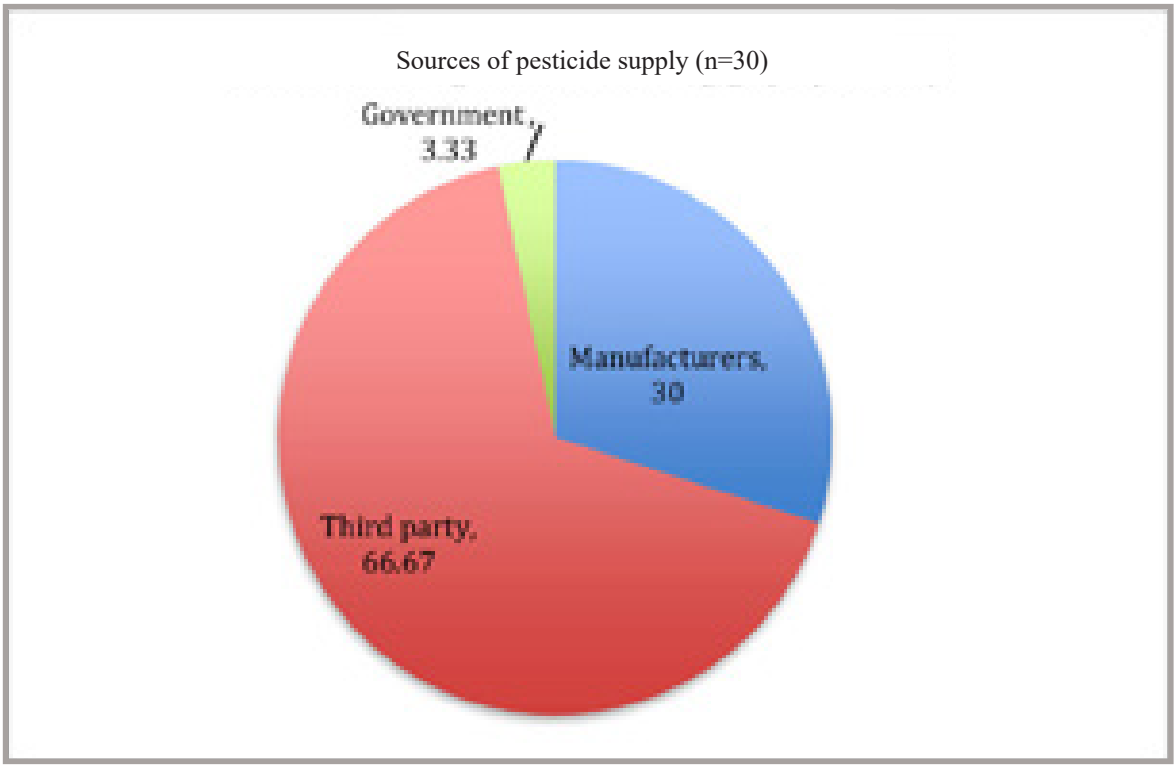
Availability of PPE in the Sales Points

None of the sales points had a stock of all the recommended PPE. About 66.67% of sales points did not have any of the protective equipment, but the rest had some PPE such as gloves, facemasks, goggles, etc, although it seemed to be of poor quality.

Sources of Pesticide Supply

Three different sources of pesticide supply were reported: manufacturers through their agents, third party suppliers like distributers, and supply through Government Agriculture Department. The predominant source was third party suppliers, as reported by 67.67% of the retailers, followed by manufactures (30%). Government Agriculture Department as the source of supply was reported by 3.33% of the respondents.

Chart 18 Pesticide source of supply



Training Received by Retailers

It was reported that retailers received some sort of training related to pesticides and marketing. Retailers reported that agents of pesticide companies and distributors, as well as government agencies such as Agriculture Departments organised training programs once or twice a year. Seminars and field demonstrations were the usual modes of training. About 66.67% of retailers said that they attended training programs on pesticides, mostly organised by pesticide companies or distributors, and also by Agriculture Departments. Some retailers reported that

the training or seminars covered topics such as crops for which pesticides can be applied, precautions to be followed, storage and disposal, health and environmental aspects.

Decanting and Repackaging of Pesticides

Almost all the retailers have responded 'no' to a question about whether they decant or repackage pesticides in the shops. However, it was noted that about 10% retailers (reported from Andhra Pradesh, Himachal Pradesh and West Bengal) were decanting pesticides for farmers who requested smaller quantities such as 50ml or 100 ml. Usually, most of the farmers in this area are small-scale and marginal farmers and they require small quantities of pesticides to be applied on the crop grown in a small area. Here retailers stock pesticides in large containers, normally of five litres or kilograms, decanted and sold to farmers as per their needs. Plastic carry bags and soft drink bottles were generally used. Labels or instruction leaflets were not provided along with the decanted/repacked products.

Advice Given to Buyers

Data collected from retailers showed that they 'advised' farmers as and when new products were made available. About 36% of retailers said 'yes' to a question asked on this. This advice was mainly on the crops for which the pesticides can be used and dosage, but as suggested by agents of companies or distributors. Further, when asked if any advice is given on disposal of pesticide packages and containers, many of them said that they tell the buyers to burn or bury them or to sell to scrap dealers. Little advice was given on PPE and safety measures.

Paraquat applied vegetable field Photo from West Bengal, credit - Bhariab Saini for PAN India

OBSERVATIONS ON PESTICIDE LABELS

As part of the study, the information provided on the labels pasted on various pesticide containers was analyzed to get a sense of the labeling practices being followed by manufacturers. For this exercise, one of the study areas - Jharkhand - was selected because the highest number of brands was recorded from this state. A total of 37 brands of the four pesticides focused in this study, belonging to 24 manufacturers, were recorded in Jharkhand. That included four brands each of atrazine and fipronil, 22 brands of chlorpyrifos and seven brands of paraquat dichloride. Information provided on the product labels of all these pesticides was assessed within the framework of the questionnaire developed as part of the Community Pesticide Action Monitoring (CPAM) of Pesticide Action Network Asia and Pacific (PAN AP). Observations on this exercise are given below.

Table 26 List of manufactures recorded from Jharkhand (based on field data)

Sl. No	Manufacturers
1	Acme Organics, Sikanderabad, UP
2	Anu Products Ltd, Faridabad, Haryana
3	Anu Products, Samba, J&K
4	Bayer CropScience, Himatnagar, Gujarat
5	Crystal Crop Protection Ltd, Jammu/ Haryana
6	Dhanuka Agritech Ltd, Gurgaon, Haryana
7	Dow AgroSciences India, Vikhroli, Mumbai
8	Hindustan Chemicals and Pesticides, Kurla, Mumbai
9	Ichiban Crop Science Ltd, Khushkhera, Rajasthan
10	Insecticides (India) Rajasthan, J&K
11	JU Agri Sciences, Sikandrabad, UP
12	Khublal Agro Chemicals, Kanchanpur, Nalanda
13	Krishi Rasayan Exports
14	M/S Biostadt India, Mumbai
15	Matrix India Crop Care, Mumbai
16	Multiplex Agricare, Tumkur, Karnataka
17	Plant Remedies Pvt Ltd, Hazipur
18	Ravi Crop Science, Samba, J&K
19	S S Crop Care, Govindpura, Bhopal
20	Saga Pesticides Ltd, Deoghar, Jharkhand
21	Saraswati Agro Chemicals (India), Jammu
22	Syngenta India Ltd, Pune
23	Tropical Agrosystem (India), Chennai
24	Vimax Crop Science Ltd, Gujarat

Label Languages and Font Size

English and Hindi were the prominent languages on the labels of all the 37 brands recorded in Jharkhand. Additionally, two to four other languages were also noted on the labels of some brands. The state language in Jharkhand is Hindi, therefore in this instance as label information was provided in Hindi as well, it can be considered that the label info was given in the local language. The label information provided in 45.45% products was reported to have been in very small font size that made it difficult to read.

Hazard classification

Hazard classification and precautionary statements are very important information for pesticides. All the brands observed in this study had a hazard classification 'colour code' on their labels, marked with a yellow[13] triangle for chlorpyrifos, fipronil and paraquat dichloride formulations, and blue triangle for atrazine formulations.

Instructions to be Followed and Safety / Precautionary Measures

Instructions or directions on proper usage and safety measures to be followed are critical information for minimising the inherent risks of pesticide use. 97.73% of the brands contained no information on how to use the products, while 2.27% contained minimal information on use. All the brands stated 'read the leaflet'; however, only a few products had an instruction leaflet attached to them. None of the brands provided the crucial information with regard to the application dosage.

Warning statements, some safety instructions, or precautionary statements were recorded on the labels of all the brands. These include the following information: keep out of reach of children, keep away from foodstuffs, animals food, mouth, eyes, skin, avoid inhalation, do not eat or drink while using, wash after using, wear protective clothing, etc.

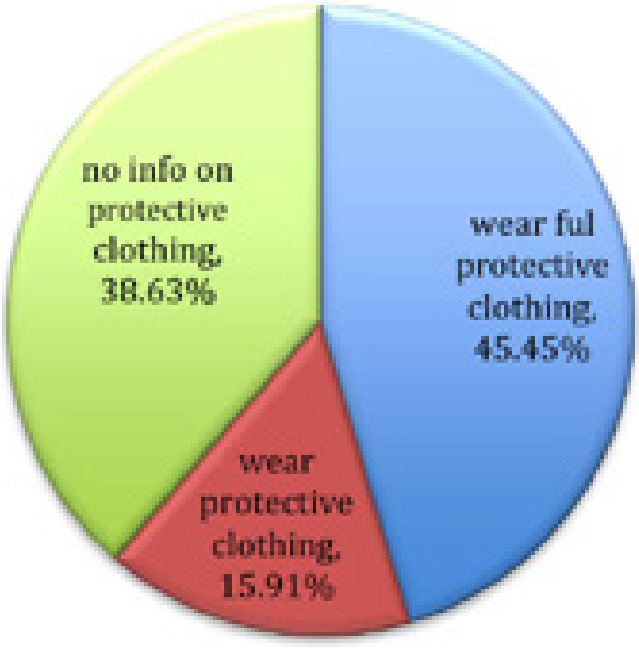
Information on PPE Use

None of the brands contained proper information on the use of PPE on their labels. Some brands (45.45%) provided minimal information on PPE, such as 'wear full protective clothing' and 15.91% brands merely stated 'wear protective clothing' on their labels. However, details of what protective clothing is required, or what full protective clothing is, were not given. The remaining 38.63% brands did not have any information on protective measures on their labels.

[13]Yellow color code indicate highly toxic, as per pesticide labeling requirement in India

[14]Blue colour code indicate moderately toxic, as per pesticide labeling requirement in India.

Chart 19 Label information on protective clothing



Crop recommendation for use as per pesticide labels

The labels were also analysed for advice or recommendations of crops for which the pesticides can be used. The observations are given below for each of the pesticides.

1. Chlorpyrifos: The crops recommended on the prvoduct label of all the 22 brands of five different formulations of chlorpyrifos recorded in Jharkhand are summarized below.

Crops recommended for Chlorpyrifos 20%EC: as per the label claims of five brands of chlorpyrifos 20% EC formulation, they were recommended for 18 uses as shown in the table given below. Not all the five brands recommended these 18 uses, but different brands made recommendations on different crops. The point to be noted here is that this recommendation includes both specific crops as well as crop categories such as cereals, fruits, pulses and vegetables. Thus both approved and non-approved uses were on the labels of many products.

Table 27 Recommended crops as per their label claims for chlorpyrifos 20%EC

Sl. no	Crops recommended as per label	Approved /not approved by CIB&RC
1	Apple	Approved
2	Beans	Approved
3	Cereals	Not approved
4	Cotton	Approved
5	Fruits	Not approved
6	Gram	Approved
7	Ground nut	Approved
8	Mustard	Approved
9	Oil seeds	Not approved
10	Paddy	Approved
11	Plantation crops	Not approved
12	Pulses	Not approved
13	Sugarcane	Approved
14	Tobacco	Approved
15	Vegetables	Not approved
16	Soil grubs	Not approved
17	Miscellaneous crops	Not approved
18	For termite control: barley, gram, sugarcane, wheat; buildings and forests.	Approved

Crops recommended for Chlorpyrifos 50% + Cypermethrin 5% EC: there were 12 brands recorded for this combination formulation in Jharkhand and the labels recommended them for five crops – including vegetables, paddy, cotton, mango and sugarcane. This includes three non-approved uses: mango, sugarcane and vegetables.

Table 28 Crop recommendation for Chlorpyrifos 50% + Cypermethrin 5% EC and approval status

Sl. no	Crops recommended	Approved /not approved by CIB&RC
1	Cotton	Approved
2	Mango	Not approved
3	Paddy	Approved
4	Sugarcane	Not approved
5	Vegetables	Not approved

Crops recommended for Chlorpyrifos 50% EC: three brands were recorded for chlorpyrifos 50% , with three uses: cotton, paddy and termite control on buildings. All these uses are approved by CIB&RC.

Crops recommended for Chlorpyrifos 16% + Alphacypermethrin 1% EC: two brands of this combination formulation of chlorpyrifos was recommended for only one crop - cotton, and this is the only crop approved by CIB&RC for the formulation.

2. Fipronil: Four brands of fipronil in three formulations were recorded in Jharkhand, recommended for cabbage, chilli, cotton, grapes, paddy and sugarcane. All of these were approved uses in India.

Table 29 industry recommended crops as per their label claims for fipronil

Fipronil 0.3%GR	Fipronil 5% SC	Fipronil 80% WG
Paddy Sugar cane	Cabbage Chilli Cotton Paddy Sugarcane	Grapes Paddy

3. Atrazine: of the four brands of atrazine noted from Jharkhand, two of them recommended it for two crops - maize and sugarcane; one recommended it for three crops - maize, bajra and potato; and the remaining one recommended it for four crops – maize, bajra, sugarcane and potato. Yet atrazine is approved for weed control only in maize.

4. Paraquat dichloride: the seven brands of paraquat dichloride noted from Jharkhand were recommended for 12 crops and aquatic weed control, but three of them were not approved.

Table 30 Industry recommendation for paraquat and approval status

Sl. no	Crops recommended	Approved /not approved by CIB&RC
1	Apple	Approved
2	Cotton	Approved
3	Grapes	Approved
4	Maize	Approved
5	Mint	Non approved
6	Paddy	Approved
7	Potato	Approved
8	Rubber	Approved
9	Sugarcane	Not approved
10	Tapioca	Not approved
11	Tea	Approved
12	Wheat	Approved
13	Aquatic weed control	Approved

Information on Container disposal

None of the brands contained instructions on the label for proper disposal of pesticide containers and leftovers. 38.63% of brands simply stated 'destroy' the containers after use, however they did not give any sense of how to dispose of containers and left over pesticides properly and safely. The remaining 61.36% brands did not contain any information on disposal of containers and leftover pesticides. In addition, proper information on how to decontaminate the containers was not on the labels of these pesticides.

Amount of information varies with different languages in same label

Field data from Jharkhand reveals that the amount of information provided on the labels of pesticide products in various languages differs greatly. The data shows that the amount of information provided in Hindi is less than that given in English. For example, information provided in English gives name of crops the pesticide can be used on, whereas the same in Hindi on the label omitted this important information. This was recorded for the label of 'Yorker' brand of Chlorpyrifos 50% + Cypermethrin 5% manufactured by Saga pesticides. This poses serious risks as those farmers or workers who can read and understand only Hindi would never get to know crops for which respective pesticides can be applied, and it can lead to illegal uses (non-approved uses or misuses) by the farming community.

Provision of instruction leaflets: though labels of 72.72% of brands recorded from Jharkhand stated 'read the leaflet' before use, 88.64% of brands did not provide an instruction leaflet along with the pesticide package or container.

Analysis of pesticide packaging: An analysis of the pesticide packaging was also done with all the brands recorded from Jharkhand. It shows that the packaging contained label information on brand name, name of active ingredient and concentrations, name of the manufacturer, registration number, manufacturing licence number, among other details such as batch number, date of manufacturing and expiry, etc. The pesticide packaging was bottles, packets, sachets and cans. They were in finely sealed condition. Decanting was not observed from the shops visited. When the containers were examined to check if they are attractive for re-use or for storing, it was noted that about 70% of the containers/packaging are attractive for re-use. It was also noted that none of the brands were ready-to-use, except for the granular formulations.

OBSERVATIONS ON LABELS OF PESTICIDES MARKETED BY AGROCHEMICAL TNCS: DOW, BAYER, AND SYNGENTA

Product labels of five brands of three of the four pesticides focussed on in this study were analysed to assess the information provided. This analysis was mainly done to have an understanding of the labelling practices of big agrochemical transnational corporations, whose products are reported on in this study. They are Dow Agrosciences, Bayer Crop Science, and Syngenta. The products analysed include Dursban (chlorpyrifos 20%EC) of Dow Agrosciences, Regent SC (fipronil 5% SC), Regent GR (fipronil 0.3%GR) and Jump (fipronil 80% WG) of Bayer Crop Science, and Gramoxone (paraquat dichloride 24% SL) of Syngenta. This analysis focussed only on product labels and lacks a review of information provided in leaflets, as leaflets of the above mentioned five brands were not obtained from those who reported their use from the study area.

Application recommendation: Dow, Syngenta and Bayer provided crop-pest combinations for which the products can be used, but Syngenta's label for Gramoxone contained one crop –sugarcane – which was a non-approved crop. However, Dow Agrosciences, on the label of Dursban, gave a general recommendation "for the control of pests of pulses, cereals, oil seeds, vegetables, fruits and plantation crops and tobacco, and for termite control in agriculture crops and forestry". Such a recommendation would mislead the users unless the specific crop-pest combination approved by CIB&RC are given and would lead to non-approved as well as illegal uses. This can be considered as a 'misbranded' pesticide according to the definition of 'misbranded' provided in the Insecticide Act 1986; which states as per 3 (k) (i) "if its label contains any statement, design or graphic representation relating thereto which is false or misleading in any material particular, or if its package is otherwise deceptive in respect of its contents".

Symptoms of poisoning and first aid: Dow gives symptoms of poisoning and first aid measures on the label, but such information was not found for the products of other companies. Details on first aid measures were noted only on the label of Dow's Dursban. It also provided information on drug therapy but others have not given the same on product labels.

Antidote statement: According to the Insecticide Rules, 1971, an antidote statement has to be provided on the product label. An antidote statement was noted on the labels of five products. An exact antidote was stated on Dow's product Dursban: "inject atropine suphate 2 to 4 mg and repeat every 5-10 minutes till fully atropinised. Administer 1-2g of 2-PAM dissolved in 10cc distilled water and inject intravenously, very slowly for 10-15 minutes. If necessary give artificial respiration. Diagnosis can be confirmed by estimating cholinesterase activity of blood". However, the labels of the three Bayer products stated "No specific antidote is known, treat symptomatically". The

antidote statement for Syngenta's Gramoxone has only vague information: "Administer a 15% aqueous suspension of fuller's earth plus a suitable purgative eg. Maanitol 20% solution, sodium sulphate, haemodialysis or haemoperfusion may be necessary".

Precautionary statement: A precautionary statement was on the labels of four out of five products. Bayer's Jump did not have one. The statement "avoid contact with skin, eyes, and mouth, and do not inhale spray mist; wash the affected areas before eating, drinking and smoking; avoid contamination of environment and water" was on the label of Dow's Dursban. Two of the Bayer products - Regent 5% SC and Regent 0.3% GR - had the following precautionary statement: "keep away from foodstuffs, empty foodstuff containers and animal food, avoid contact with mouth, eyes, and skin, avoid inhalation the spray mist, spray in the direction of wind and wash thoroughly the contaminated clothes and parts of the body after spraying or broadcasting". However, another product of Bayer, Jump, did not have the precautionary statement. Syngenta's Gramoxone had the following statement: "handle with care. Can be fatal if swallowed; read instructions carefully before use; and do not apply through a mist blower".

Personal protective equipment: Information regarding protective clothing such as "wear protective clothing like apron, gloves, face shield and boots" was noted on the label of Dow's Dursban, while a general statement like "wear full protective clothing while spraying or broadcasting" was noted on the label of two Bayer products – Regent SC and Regent GR. However, they did not give details on what is/ are the required protective clothing to be used while working with the pesticide. One Bayer product (Jump), and Syngenta (Gramoxone) did not have such details on their labels.

Storage information: There was guideline information on storage on the labels of three products, but it was lacking on a Bayer product, Regent GR and Syngenta's product Gramoxone. Dow's Dursban states "store in well-built, properly ventilated, well lit and dry rooms of sufficient dimensions or shall be kept in separate almirahs under lock and key". Regent SC of Bayer had the following storage information: "keep in cool dry place away from heat and open fire"; however that of regent GR shows "store in a cool dry well-built, well-ventilated place having sufficient dimensions".

Disposal of containers: Guidelines on disposal of containers was noted on the Dow's Dursban, which states "the empty containers should never be re-used and should be destroyed and buried in a safe place; dispose of packages or surplus material and washings in a safe manner so as to prevent environmental and water pollution". Three Bayer products and the Syngenta product did not have information on container disposal methods.

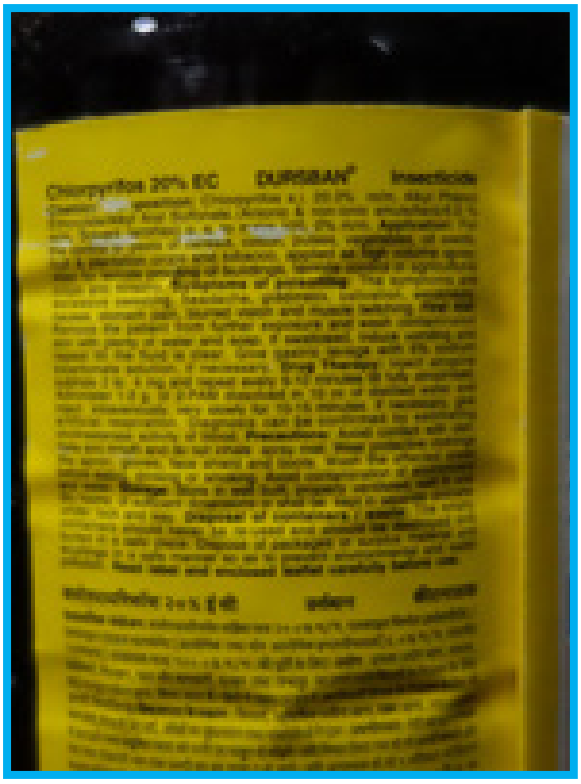
Caution statement on use: A caution statement "not to be used on crops other than specified on this label / leaflet" was noted Bayer's Regent SC and Regent GR. A statement "do not use

the product near the areas of bee keeping; not to be used on crops other than specified on this label / leaflet" was noted on the other Bayer product Jump; whereas, Dow's Dursban and Syngenta's Gramoxone lacked such a caution statement.

Instruction leaflet: Labels of all the brands had a statement to "read the instruction leaflet before application or medical treatment or for directions and dosage". However, field data revealed that leaflets were not always provided along with the pesticides. More than half of the farmers interviewed responded that they did not get instruction leaflets when they bought most of the pesticides. This is an important fact to be noted: that though it is mandatory that instruction leaflets be provided along with each pesticide packets/bottles, in many cases it is not happening.

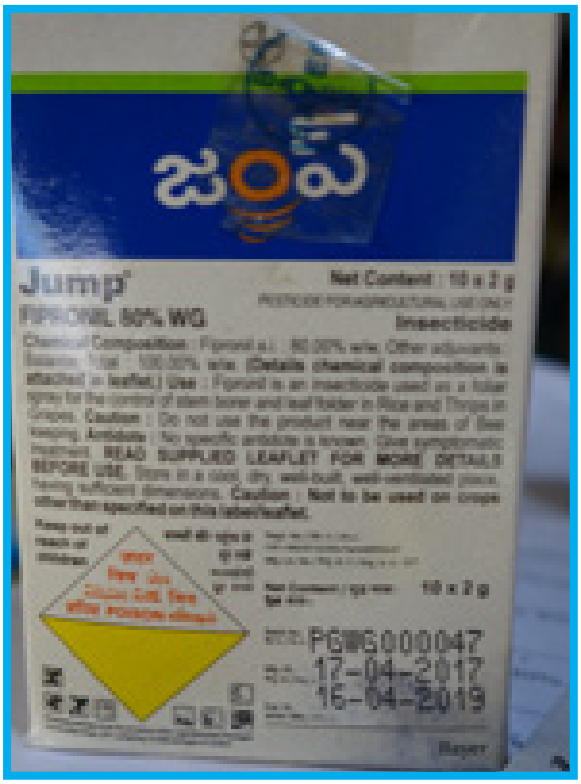
Information on how to uses the product: None of the product labels contained information on how to uses the product; they stated "read the enclosed leaflet before use". Since the label does not contained important information such as required dosage, mixing and application requirements, it is important that instruction leaflets are provided to the end users. However, field data shows that instruction leaflets were not provided along with many of the products. It needs to be ensured that such instruction leaflets are really reaching the hands of farmers; and that the instruction leaflets containing all the relevant information mandatorily to be provided are actually given to farmers in local language as well as in legible font size.

Label language: The Rule 19 (7) of the Insecticide Rules, 1971 mandates "the label and leaflets to be affixed or attached to the package containing insecticides shall be printed in Hindi, English and in one or two regional languages in the areas where the said packages are likely to be stocked, sold or distributed". English and Hindi are the languages in which the label was provided in all the five products analyzed in this study. Instructions in local language were also noted in some products - Dursban, Jump and Gramoxone in Jharkhand.



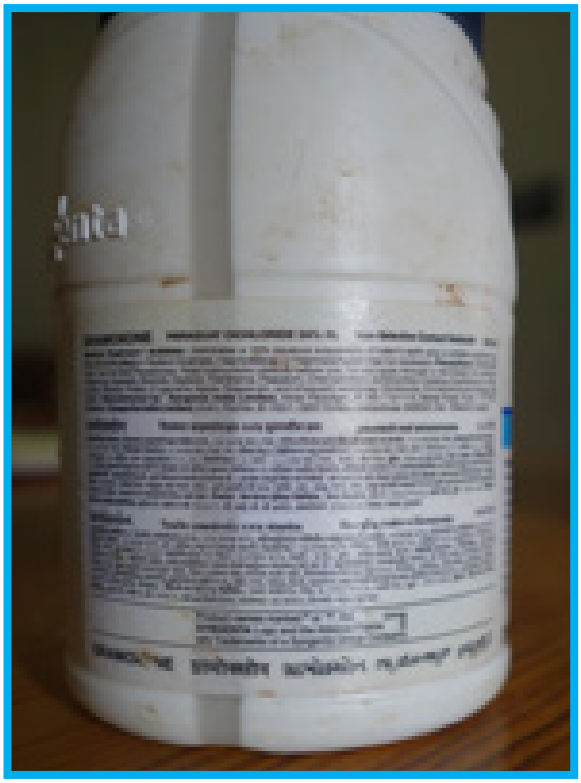
Chlorpyrifos_20__EC_Dursban_DowAgroSciences_Eng_closeup

Fipronil_0.3__GR_Regent_Bayer_back



Fipronil_80__WG_Jump_Bayer_box_Eng

Fipronil_80__WG_Jump_Bayer_sachet



Paraquat_Gramoxone_Syngenta_back_Eng_Hindi

Regent SC fipronil 5_sc BAYER

A farmer spraying pesticide without wearing PPE. Credit: Dileep Kumar

OBSERVATIONS ON PESTICIDE ADVERTISEMENT

A couple of advertisements on pesticides were recorded during the field study, from the states of Jharkhand and West Bengal. These advertisements showcased Bayer pesticide products, on wall paintings and posters pasted on wall.

Advertisement from West Bengal

On these advertisements Bayer showed its product Regent SC, containing the insecticide fipronil. Such wall paintings or posters pasted on walls were reported from several places in the study area, mostly on buildings near farm fields. The language of the advertisement was Bengali, the state language in West Bengal.

Advertisement1 From West Bengal

The advertisement reported from West Bengal lacked appropriate hazard phrases and warning symbols, as well as instructions to the users. It did not contained representation of potential dangerous practices. The Adv.1 shown above, from West Bengal contained the following text (translated): 'a bit more Regent a lot more profit, I am using you may do, extra protection from stem borer, do spray do believe, more tillers more grain more profit, 8kg per acre'.

Advertisement 2 From West Bengal

Advertisement 2 is a wall poster noted from West Bengal. It contained two parts that state five benefits of Regent. The left side of the poster shows the following text corresponding to the title and five figures in translation: spray regent, more root, stem borer suppression, more tillers, sucking through roots, strong plants, more growth, more profit. The right side of the poster contained the following text in translation: 'regent SC spray, 1=5, spray as, believe in it'

Advertisment from Jharkhand

Advertisement from Jharkhand

The Bayer's advertisements reported from Jharkhand included a small poster pasted on a wall, as well as a big wall poster. The smaller poster shows a faulty message of mixing the insecticide Regent with a fungicide Antracol and shows a text message in Hindi, which means 'we are together means, good harvest'. In the poster, the numbers (1+1=11) gives a notion that it will give a multiplied effect by mixing the two pesticides. The bigger poster listed many Bayer pesticides including Regent (fipronil) that are recommended to be used on paddy. They lacked any hazard phrase, warming symbols and instructions.

Advertisment from Jharkhand – Wall poster

The colorful advertisements reported in this study have been providing misleading messages and promoting unscientific practices. Bayer advertisements show a misleading message and unscientific statement on them. One of the advertisements suggests using eight kilograms of fipronil per acre of paddy field, while the others list multiple results of using the pesticide. One of the advertisements from Jharkhand was promoting illegal use or misuse, as it recommends mixing an insecticide and a fungicide. All these advertisements are colourful, attractive and could be tempting farmers to follow them.

4 ANALYSIS AND DISCUSSION

Non-approved uses of Pesticides

Use of pesticides on non-approved crops has become a major problem in India. Such usage is confirmed by the presence of residues of non-approved pesticides in several food commodities. A comparative analysis between the use of pesticides recorded in the current study and the approved uses[15] of herbicides and insecticides revealed a number of non-approved uses of the insecticides chlorpyrifos and fipronil and the herbicides atrazine and paraquat dichloride. Consolidated pesticide-wise analysis of the approved and non-approved uses recorded in this study, based on farmers data, is given below. A 2015 report titled 'Conditions of paraquat use in India' also reported several non-approved use of paraquat happening in India (Kumar, D. 2015). It also recorded that pesticide manufacturers, retailers and agriculture officers were giving inappropriate recommendations to farmers. Retailers, agriculture offices and agents of manufactures and/or distributors are the major sources of information for farmers; often retailers and agents are more easily accessible to them than agriculture officers. Similar observations were noted in the 2015 report as well.

The practices followed by farmworkers also showed that these pesticides were applied on non-approved crops as well. Large numbers of non-approved uses were observed from the response recorded from workers. Thus illegal use and misuse of pesticides were noted from practices of farm workers as well, which, anyway would have been done as per the direction of farmers who hired these workers

[15]Use approved by Central Insecticides Board and Registration committee, Directorate of Plant protection, Quarantine and Storage, Department of Agriculture and Cooperation, Government of India.

Table 31 Consolidated data on approved use, recommended use and field use

Pesticides	Number of approved crops/ uses	Total number of crops/ uses recommended by manufacturers	Number of non-approved crops/ uses recommended by manufacturers	Total Number of crops/ uses recommended by SAD/U	Number of non-approved crops/ uses recommended by SAD/U	Total number of crops/ uses reported from the study	Number of Non-approved crops/ uses reported from the study
Chlorpyrifos (five formulations)	18	19	9	11	5	23	15
Fipronil (five formulations)	9	6	0	10	2	27	20
Atrazine (1 formulation)	1	4	3	5	4	19	18
Paraquat (1 formulation)	11	13	3	8	4	23	18

Non-Approved use - concern over Food Safety

Normally pesticides are approved for specific crop-pest combinations with a pre-harvest waiting period (although many approved uses in India do not have waiting periods set). A waiting period denotes the interval to be followed between the last pesticide spray and harvest. Use of pesticides for the crops not approved poses significant threat to food safety. Numerous non-approved uses were reported for all the four pesticides in this study. There exists significant risk when food crops and vegetables fall under non-approved uses.

The dangers of a pesticide being applied for non-approved crops are many, including that waiting periods are not known. Generally, for many of the vegetable crops, farmers are not able to follow the recommended waiting period between last application and harvest (even in the case of approved uses) because the yields are harvested either once or twice in a week. As per the approved uses of paraquat, chlorpyrifos and fipronil, the minimum waiting period is seven days and a maximum waiting period given was 296 days. For fipronil, seven, 15 and 32 days of waiting period were noted for cabbage, onion and paddy respectively. Thus wide variations were noted in the case of many pesticide-crop combinations that, in reality, farmers might not be able to follow.

In addition to waiting periods, the maximum residue limits (MRLs) are not set for such

non-approved crops. A 2013 report showed that there are a number of pesticides in India for which MRLs are not fixed (Bhushan, C., et al., 2013). This report also revealed that MRLs were not fixed for all the approved uses. Therefore, technically, such crops and pesticides may not come under the purview of residue tests and monitoring as the reference values are not set and thus it may leave many of the non-approved uses not monitored for food safety standards and thereby putting consumers at risk of exposure to such pesticides unknowingly. For example, monitoring has detected residues of chlorpyrifos in 19 non-approved crop products (FSSAI, 2019) in India, indicating wide spread unproved uses.

Lack of proper training and access to right information

Observations from this study, especially on training, awareness, and sources of information for pesticide use, are a serious concern. For more than half of the sampled farmers, major sources of information on pesticide use were retailers, agents of companies or distributers and peer farmers. Similar observations were noted in the 2015 report, Conditions of Paraquat use in India (Kumar, D., 2015). That report also revealed that retailers and agents have greater influence among the farming community than the agriculture extension services as the latter are located far away. The reality of nearly 80% of farmer respondents applying pesticides without getting proper training or awareness programs shows the worrying situation that is actually happening in the field. Farm workers were also not provided with adequate information or proper training on pesticide use, safety measures to be employed and use of personal protective measures; similar observations were also noted by Kumar, D. (2015).

It is also an important fact that pesticides are sold even without proper labels and information leaflets; such practices often leave farmers unaware of the inherent risks and precautions to be followed. Moreover, certain brands provide less information in Hindi than in English. The reality is that the majority of the farmers and workers are unable to read and comprehend the information provided in the label and instruction leaflet, even if they are provided. This needs to be addressed seriously and proper urgent action is required to resolve this issue. Further, selling pesticides without the mandatory information leaflet is a violation of the Insecticides Act and Rules. This situation of multiple issues of not providing the necessary information to the end users is further aggravated by inappropriate recommendations from pesticide manufacturers and advice from retailers as well as agents of distributors, as the majority of the farmers depend on these sources for information on pesticide use. Other studies show that, even when labels and information leaflets are provided, they often are not/cannot be read by the users and/or understood (Waichman et al. 2002; Damalas et al. 2006). Additionally, in areas where the literacy rate is low, written instructions may be useless, even though it is important to provide information meant for users in labels and instruction leaflets. A study conducted by Amar, D. et al. (2010) found a common complaint from

the field that the material written on labels was not readable because of small font size.

Lack of proper training and awareness often leads to unintended uses of pesticides. 'Unintended use' comprises numerous actions, which violate laid down norms and safe practices, including the decision making for the selection of suitable pesticides, application methods and employing safety measures. Further, this leads to non-approved uses as well. Often farmers end up using a mixture of several different pesticides.

Kavitha and Sureshkumar (2016) observed in their study conducted in Tamilnadu that the knowledge, of not only farmers but also for the community in general, was limited regarding pesticide purchase, use and safety. A study done by Singh and Gupta (2009) showed the majority of pesticides users were unaware of pesticide types, their mode of action, potential hazards and safety measures. The current study reveals similar results on purchase, use and safety. All the above facts, coupled with the lack of proper monitoring and regulation by the relevant authorities, results in unintended uses of toxic agrochemicals, thereby putting community, public health and the environment at high risk.

These observations would be true for other pesticides as well. Kavitha and Sureshkumar (2016) noted pesticide users such as farmers and workers in developing nations like India are at a much higher risk of pesticide exposure due to lack of adequate safety measures and awareness. Amar, D. et al. (2010) found that a significant proportion of farmers have not received proper training and awareness on pesticide use. Similarly, this study also noted that farmworkers have less awareness about the handling of agrochemicals and their toxicity.

Various practices noted in the study that lead to exposure to the pesticides can be seen as an indicator of poor awareness among the farming community, which in turn is an indication of failure of pesticide governance and industry practices regarding training and awareness creation.

Recommended PPE is not used

None of the respondents were using the recommended PPE while working with pesticides. The safety measures used, as reported in the study, were only makeshift measures such as using clothes to cover the face. The majority of the respondents were not using even minimum protective measures. Further, the retail points did not have PPE for distribution. These results are more or less in line with observations of some studies that noted only 20% of pesticide users wear three protective items during spraying in India (Kumar, D. 2015). Another study noted that a very high proportion of farmers interviewed in Asia, especially in Bangladesh, India, Philippines and Sri Lanka, do not wear the minimum protective clothing consisting of long-sleeved shirts and long trousers and shoes or boots while spraying (Matthews, 2008).

The Indian Insecticide Rules, 1971 clearly state the protective clothing, equipment and respiratory devices required to be used while

working with pesticides. Rule 39 says 'the protective clothing shall be made of materials which prevent or resist the penetration of any form of insecticides formulations. The materials shall also be washable so that the toxic elements may be removed after each use'. However, the various articles used by respondents to protect theselves do not seem to be providing the required protection. And none of the respondents have reported the use of a respiratory device. A complete suit of protective clothing shall consist of the following: protective outer garment/overalls/hood/hat, rubber gloves or such other protective gloves extending half-way up the fore-arm, made of materials impermeable to liquids; dust-proof goggles and boots. The correct, complete set of PPE of good quality needs to be available to farmers and farmwrokers who want to use pesticides. If the authorities or traders are unable to provide it, and/or the farmers and farmworkers cannot wear it, then the government needs to step in to ban such pesticides that require the use of PPE, as recommended by Article 3.6 of the International Code of Conduct on Pesticides Management.

Article 3.6 the International Code of Conduct on Pesticides Management states "pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small scale users and farm workers in hot climates"

Pesticide contaniers, mostly of paraquat dumped near to farming area, Credit: Dileep Kumar

Provisions regarding protective measures as put forth by the Indian Insecticide Rules 1971*

Rule 39. Protective clothing

(1) Persons handling insecticides during its manufacture, formulation, transport, distribution or application, shall be adequately protected with appropriate clothing.

(2) The protective clothing shall be used wherever necessary, in conjunction with respiratory devices as laid down in rule 40.

(3) The protective clothing shall be made of materials, which prevent or resist the penetration of any form of insecticides formulations. The materials shall also be washable so that the toxic elements may be removed after each use.

(4) A complete suit of protective clothing shall consist of the following dresses, namely:

(a) Protective outer garment / overalls / hood / hat;

(b) Rubber gloves or such other protective gloves extending half way up to the fore-arms, made of materials impermeable to liquids;

(c) Dust-proof goggles

(d) Boots

Rule 40. Respiratory devices:

For preventing inhalation of toxic dusts, vapours or gases the workers shall use any of the following types of respirators or gas-masks suitable for the purpose, namely:

a. Chemical cartridge respirator
b. Supplied air respirator
c. Demand flow, type respirator
d. Full face or half face gas masks with canister

In no case shall the concentrates of insecticides in the air where the insecticides are mixed exceed the maximum permissible values.

Rule 42. Training of Workers:

The manufacturers and distributors of insecticides and operators shall arrange for suitable training in observing safety precautions and handling safety equipment provided to them.

*Source: http://cibrc.nic.in/insecticides_rules.htm; http://www.mahaagri.gov.in/ActsandRules/Insecticide_Rules_1971.html#39

*Source: http://cibrc.nic.in/insecticides_rules.htm; http://www.mahaagri.gov.in/ActsandRules/Insecticide_Rules_1971.html#39

Pesticide use Results in Exposure and Poisoning

Several practices have been reported, in the study, that increase risk of exposure to pesticides. Storing pesticide containers within house premises, use of leaking faulty spraying equipment, washing equipment near to water sources used by villages, lack of proper PPE, continuously working for three-four days spraying with pesticides, spraying practices in fields, etc, all increase the risk of exposure. Further, entering the pesticide sprayed fields can be dangerous: there is a considerable chance of exposure if farmers or workers enter too soon after the application, as they often do. They do not use PPE for working in sprayed fields. However, farming communities are not properly trained or rightly informed about such precautionary measures to be followed while working in a sprayed field to minimize the risk of exposure. Similar observations have been noted in literature, that storage of pesticides within house premises and in reach of children are a major cause of poisoning incidents involving children (Balme et al. 2010; UNEP 2004). Amar, D. et al. (2010) noted an overwhelming majority of farmers did not keep the pesticides in safe locations. This current study has documented several poisoning cases as well. Matthews (2008) reported that farmers and workers in developing countries use backpack/knapsack sprayers that are frequently leaking, and were not using required PPE. Further, the practices of not taking a bath or wash after pesticide application may lead to continuous exposure. Ntow (2006) reported lack of proper disposal of containers could lead to exposures. Use of containers for food and beverages is a major cause of exposures. Empty pesticide containers, if not properly disposed of, not only pose a threat to the environment, but also to people – for example children who may use them for play. A 2010 study conducted in Kolhapur district in Maharashtra found unsafe disposal of containers. It also observed that 33% of the respondents washed the used pesticide containers and re-used them for various purposes (Amar, D. et al. 2010).

Shah, et al (1987) reported that there are different pathways through which children and people can be exposed to atrazine and other herbicides. Those who live downstream from the fields where atrazine was applied to crops may be exposed through contaminated water, as well as farm workers and applicators being exposed. Children may be exposed by playing in dirt that contains pesticide drift and also through contaminated water.

The current study has reported exposures and poisoning related health effects among both farmers (about 18% respondents) and farm workers (about 40% respondents). Boedeker et al. (2020) provides a global estimate of 44 % of farmer and farmworkers suffering unintentional acute pesticide poisoning every year, with that figure rising to 66% in India. This report further estimated that about 60 % of global unintentional deaths from pesticides occurs in India. These higher figures of poisoning and death could be atributed to the high toxicity of the pesticides used, together with the poor practices of pesticide usage, as observed in the current study.

Inadequate Retail Practices

The fact that 6.67% of retailers sell pesticides without having the requisite licence, as noted in this study, is a matter of concern and such instances reveal a gross failure of the pesticide licencing and regulatory system. Additionally, a significant percentage of retailers have been selling pesticides without obtaining proper training. The illegal practice of decanting and selling pesticides in plastic carry bags and other bottles observed from the study is another issue. These practices further aggravate problems of pesticide use. Similar observations were also previously reported for paraquat use in India, with paraquat being decanted and sold in plastic carrying bags and empty bottles (Kumar, D. 2015 and 2017). Leverton, et al. (2007) observed that decanting pesticides into empty drinking bottles or food containers and/or using empty pesticide containers for food and drinks is still common malpractice in many countries and can cause severe poisoning. The International Code of Conduct on Pesticide Management says this about the practice of decanting:

"10.4 Governments should take the necessary regulatory measures to prohibit the repackaging or decanting of any pesticide into food, beverage, animal feed or other inappropriate containers and rigidly enforce punitive measures that effectively deter such practices."

Additionally, pesticide sales points are located very close to schools, medical facilities, food item stores and eateries, which pose risks to users of such facilities. Another important factor noted in this study is the non-availability of PPE at pesticide sales points. A similar observation was recorded by Kumar, D. (2015 and 2017) – that retail points do not sell the required PPE in India.

Environmental Burden of Pesticides

Over the past decades, a number of studies and reports have raised concerns over the environmental impacts of pesticides. Studies reveal that not all applied pesticides may actually reach targeted pests and the remaining pesticide has the potential to get into the soil, water and the atmosphere (UNEP, 2021; Gill, H. K. , & Garg, H. 2014). A 2016 bulletin of the Indian Society of Soil Science reported that only one percent of the applied pesticide strikes the target (Katyal, et al. 2016). The rest, 99 percent, is wasted and contributes to pollute and damage the ecosystem. Pimentel and Levitan (1986), stated in their paper that, there has been an estimate indicating that less than 0.1% of the pesticides applied to crops actually reach the target pest with the rest finding its way to soil, air and water. Most of the synthetic pesticides (insecticides, fungicides, herbicides and plant growth regulators) are toxic and capable of harming all forms of life besides the target pest. The property of persistence has resulted in accumulating toxic pesticides in the environment and ecosystem, and thereby turns it into a reservoir of toxic chemicals harmful to human health and other organisms. They induce hazardous effects for all forms of life, apart from polluting food, soil, water and air. Several studies have pointed out that application of toxic chemicals over the past decades

on soils, plants, seeds and crop harvests has damaged the agro ecosystems, putting both aquatic and terrestrial life forms at risk of exposure and consequent undesirable effects such as fewer species, lower populations, and more fragile and non-resilient ecosystems. Many studies show that the toxic chemical pollution of the environment has long-term effects on human life too (Shah, R., 2020; Sabarwal, A., et al., 2018; Aktar, M. V., et al., 2009).

VIOLATION OF NATIONAL REGULATION

The actual use of atrazine, paraquat dichloride, chlorpyrifos and fipronil in India is found to have violated national laws and rules. First of all, violation is noted in the use of these pesticides for non-approved crops. The use approved by CIB&RC is violated by a number of uses on non-approved crops as reported in the study. It is also noted that the State Agriculture Department has been recommending crops that are not approved by CIB&RC for these pesticides.

Secondly, the Rules 16, 17, 18 and 19 of the Insecticides Rules 1971 are found to have been violated, as sale of pesticides without labels and instruction leaflets was recorded from the field; as was the decanting of pesticides and selling in other bottles and plastic bags.

Thirdly, Insecticide Rules 39 sub rules 1, 2, 3 and 4 are found to have been violated, as the protective equipment as laid down by these Rules is not available either in the villages, retail points or agriculture offices, and none of the farmers surveyed reported use of such protective equipment. Further, such details were not provided on the product labels.

Fourth, the Insecticide Rules 42 is found to have been violated, as the majority of the farmers have been using pesticides without getting proper training. The Rule 42 states that "training of Workers: manufacturers and distributors of insecticides and operators shall arrange for suitable training in observing safety precautions and handling safety equipment provided to them".

Fifth, the Rule 44 sub rule 1 is found to have been violated. This rule states that "it shall be the duty of manufacturers, formulators of insecticides and operators to Dispose packages or surplus materials and washing in a safe manner so as to prevent Environmental or water pollution". However, such a disposal process is not reported in the field.

VIOLATION OF INTERNATIONAL CODE OF CONDUCT ON PESTICIDES MANAGEMENT

The International Code of Conduct on Pesticides Management (the Code) is a set of guidelines established by the Food and Agriculture Organization of the United Nations and the World Health Organziation, to ensure sound management of pesticides. The Code provides a framework for regulation and management of pesticides throughout their lifecycle and applies to govnerments, the pesticides industry and distributors, and all sectors of society

involved in pesticide management and use.

Uses of atrazine, paraquat dichloride, chlorpyrifos and fipronil is happening in India contrary to a number of articles of the Code, which was ratified by the Indian government and pesticide industry. Non-adherence to a number of article provisions was found in this study, and this includes:

Article 3.6 states that "pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users and farm workers in hot climates".

Comment: As India generally enjoys a tropical climate with humidity and maximum temperature above 30 degree Celsius, the use of pesticides for which PPE is recommended violates this Article of the Code. Use of the recommended PPE in such climate conditions is unsuitable, uncomfortable, and results in heat stress. Therefore, pesticides that require this PPE should have their approval withdrawn and be withdrawn from sale.

Article 5.2.5: "Halt sale and recall products as soon as possible when handling or use pose an unacceptable risk under any use directions or restrictions and notify the government".

Comment: As a number of non-approved uses have been reported, and adverse health effects from exposure to these products, unacceptable residual risk for such products occurs. Recognizing this, as well as the conditions of use that do not favor the use of recommended PPE, it can be seen that Article 5.2.5 is violated regarding the sale and use of atrazine, paraquat dichloride, chlorpyrifos and fipronil in India.

Article 5.3 states "Government and industry should cooperate in further reducing risks by: 5.3.1 promoting the use of personal protective equipment which is suitable for the tasks to be carried out, appropriate to the prevailing climatic conditions and affordable". 5.3.3 "Establishing services to collect and safely dispose of used containers and small quantities of leftover pesticides".

Comment: This study has found that recommended PPE is not available or accessible to farmers, and there are no mechanisms established for the collection and disposal of used containers.

Article 7.4: "Governments and industry should ensure that all pesticides made available to the general public are packaged and labelled in a manner which is consistent with FAO/WHO or other relevant guidelines on packaging and labelling and with appropriate national or regional regulations."

Comment: This study has found that labels of pesticide containers have inadequate information on PPE, application dosage, proper container disposal, pesticides are sold wthout providing leaflets, and decanting of pesticides.

Article 8.2 Pesticide industry should: 8.2.1: "Take all necessary steps to ensure that pesticides traded internationally conform at least to":

8.2.1.1: "Relevant international conventions and regional, sub-regional or national regulations"

8.2.4: "encourage importing agencies, national or regional formulators and their respective trade organizations to cooperate in order to achieve fair practices as well as marketing and distribution practices that reduce the risks posed by pesticides, and to collaborate with authorities in stamping out any unethical practice within the industry"

Comment: This study has found unfair practices such as providing misleading information and promoting unscientific practices in advertisements.

Article 10.3.2: "packaging or repackaging is carried out only on licensed premises that comply with safety standards where the responsible authority is satisfied that staff are adequately protected against toxic hazards, that adequate measures are in place to avoid environmental contamination, that the resulting product will be properly packaged and labelled, and that the content will conform to the relevant quality standards".

Comment: This study has found that decanting is practiced in some retail points, with out observing safety precautions. Further, label or leaflet is not provided to buyers.

Article 10.4: "Governments should take the necessary regulatory measures to prohibit the repackaging or decanting of any pesticide into food, beverage, animal feed or other inappropriate containers and rigidly enforce punitive measures that effectively deter such practices".
Comment: This study has found that decanting is practiced in some retail points - often into plastic carry bags and soft drink bottles, with out following safety precautions.

INTERNATIONAL COVENANT ON ECONOMIC, SOCIAL, AND CULTURAL RIGHTS (ICESCR)

The International Labour Organisation's Convention 184 on occupational health and safety in agriculture requires governments to ensure that there are preventive and protective measures for the use of chemicals and handling of chemical waste at the level of the undertaking covering:

- the preparation, handling, application, storage and transportation of chemicals;
- agricultural activities leading to the dispersion of chemicals;
  the maintenance, repair and cleaning of equipment and containers for chemicals;
  the disposal of empty containers and
- the treatment and disposal of chemical waste and obsolete chemicals.

Comment: This study has found unsafe practices of storage, prepration, handling, and application of pesticides, washing of equipments and sprayer, and disposal of empty containers of pesticides.

5 CONCLUSION

This study on two insecticides (chlorpyrifos and fipronil), and two weedicides (atrazine and paraquat dichloride) reveals a dangerous situation with pesticide use and regulation in India. While the Central Insecticides Board and Registration Committee (CIB&RC), which is the pesticide registration authority in the country, has approved certain uses of pesticides in India, it was found that the State Agriculture Departments and industry have recommended these four chemicals for more crops/uses than their approved use, indicating non-compliance with national regulation, as well as promoting illegal uses. Because of this, the actual use happening in the field is far beyond the approved uses, pointing to unintended and illegal uses. Additionally, the pesticide industry is promoting non-approved uses on its labels, clearly in contravention of the national regulation and the International Code of Conduct on Pesticide Management.

Awareness on pesticide use and safety measures among the farming community was meagre, pointing to the fact necessary information has not been given to the users and thus they do not have access to the critical information on pesticide toxicity and safety. The means of providing information on pesticide use and precautions, particularly labels and instruction leaflets, have been ineffective due to the fact that generally farmers or workers did not/could not read labels or information leaflets, because either the details given in them was in very small font size that are unable to be read, users do not know the language, are unable to comprehend it, or are illiterate, or the labels and/orleaflets were missing. Inadequate retail practices were observed: there were no caution, advice or information about approved uses of pesticide, use of PPE and safety measures. The recommended PPE given on the pesticide label and leaflet was not even available in the retail points. Further, colourful and attractive pesticide advertisements contained misleading information and unscientific statements, and were promoting unintended or illegal uses.

Many practices that could lead to exposure to the pesticides and poisoning, including storing pesticides within house premises, applying pesticides with faulty spraying equipment, not using recommended protective measures, washing equipment near to water sources used

for household purpose including for drinking, working in sprayed fields, and poor management of empty containers with household reuse, were reported in the study. Exposure to pesticides due to spillage, inhalation of spray mist and direct contact with pesticide spray mist has been reported as well, with the development of illnesses and farming communities becoming victims of pesticide poisoning.

Thus, use of chlorpyrifos, fipronil, atrazine, and paraquat dichloride were found to have been violating national regulations as well as the International Code of Conduct on Pesticides Management. Given the dangerous ground reality of pesticide use in the country and the fact that these pesticides are known to cause severe health and environmental damages, including but not limited to endocrine disruption, neurodevelopmental effects, cancer and reproductive problems, it is high time that government of India takes decisions to protect people in the country by banning use of these four dangerous plant protection chemicals and promoting non chemical alternatives based on the principle of agroecology. The government also needs to improve monitoring of the compliance of the pesticides industry with its regulations.

REFERENCES

Aktar, M. W., Sengupta, D., & Chowdhury, A. 2009. Impact of pesticides use in agriculture: their benefits and hazards. Interdisciplinary toxicology, 2(1), 1–12. https://doi.org/10.2478/v10102-009-0001-7

Amar, D., Javadekar P., and Jagtap M., 2010. Modern Agricultural Practices: a Dilemma of Farmers and Farm Workers' Health in the Cash Crop Zone in the Maharashtra State. Bhatter College Journal of Multidisciplinary Studies, Vol. 1, No. 1. pp80-88

Anupama S., J. P. S. Gill, J. S. Bedi, and P. A. Pooni. 2014. Monitoring of Pesticide Residues in Human Breast Milk from Punjab, India and Its Correlation with Health Associated Parameters. Bull Environ Contam Toxicol DOI 10.1007/s00128-014-1326-2

Balme, K. H., Roberts, J. C., Glasstone, M., Curling, L., Rother, H. A., London, L., Zar, H. and Mann, M. D., 2010: Pesticide poisonings at a tertiary children's hospital in South Africa: an increasing problem. Clinicical Toxicology 48(9):928-34.

Barbara, D., 2004. Why Paraquat Should Be Banned Outlooks on Pest Management. http://www.pan-germany.org/download/paraquat_0412.pdf

Bhushan, C., Bhardwaj, A., and Misra, S. S., 2013. State of Pesticide Regulations in India, Centre for Science and Environment, New Delhi.

Blodgett, D. J., 2006. Organophosphate and Carbamate Insecticides. Small Animal Toxicology, 2nd ed.; Peterson, M. E.; Talcott, P. A., Eds.; Elsevier Saunders: St. Louis, pp 941-947

Boedeker W, Watts M, Clausing P, Marquez E. 2020. The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. BMC Public Health 20 (1875). https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-09939-0

Burke, R. D., Todd, S. W., Lumsden, E., Mullins, R. J., Mamczarz, J., Fawcett, W. P., Gullapalli, R. P., Randall, W. R., Pereira, E., & Albuquerque, E. X. (2017). Developmental neurotoxicity of the organophosphorus insecticide chlorpyrifos: from clinical findings to preclinical models and potential mechanisms. Journal of neurochemistry, 142 Suppl 2(Suppl 2), 162–177. https://doi.org/10.1111/jnc.14077

CARE Ratings, 2017. Outlook of Indian Pesticide Industry, Ratings Department, Care Ratings, May 31, 2017.

CARE Ratings, 2018. Rating Methodology for Pesticide Companies. CARE Ratings Limited. http://www.careratings.com/upload/NewsFiles/GetRated/Rating%20Methodology%20for%20Pesticide%20Companies_Oct19.pdf Accessed on 9th December 2019.

Chodorowski, Z., Anand, J. S. 2004. Accidental Dermal and Inhalation Exposure with Fipronil-A Case Report. J. Toxicol. Clin. Toxicol. 42 (2), 189-190.

Choudhury, P. P., Singh, R., Ghosh, D., and Sharma, A. R., 2016. Herbicide Use in Indian Agriculture. ICAR - Directorate of Weed Research, Jabalpur, Madhya Pradesh, 110 p.

Christensen, K., Harper, B., Luukinen, B., Buhl, K., and Stone, D. 2009. Chlorpyrifos Technical Fact Sheet; National Pesticide Information Center, Oregon State University Extension Services.

CIB&RC, 2015. Minutes of 361st special meeting of Registration Committee (RC) held on 22.12.2015 (Downloaded from http://www.cibrc.nic.in/361rc2015.pdf , on 13th January 2016)

CIB&RC, 2016. Major uses of herbicides (approved under the insecticides act, 1968) as on 30th June 2016. Central Insecticide board and Registration Committee. Directorate of Plant Protection Quarantine & Storage; Department of Agriculture & Cooperation, Ministry of Agriculture government of India. (Downloaded from http://cibrc.nic.in/mupi2012.doc 3rd October 2017)

CIB&RC, 2016. Major uses of Insecticides (approved under the insecticides act, 1968) as on 30th June 2016. Central Insecticide board and Registration Committee. Directorate of Plant Protection Quarantine & Storage; Department of Agriculture & Cooperation, Ministry of Agriculture government of India. Pages 15-16. (Downloaded from http://cibrc.nic.in/mupi2012.doc on 3rd October 2017)

CIB&RC, 2017. Insecticides / Pesticides Registered under section 9(3) of the Insecticides Act 1968 for use in the India. Central Insecticide Board and Registration Committee, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. As on 30th June 2017 (downloaded from http://www.cibrc.nic.in/reg_products.doc on 18th September 2017)

CIB&RC, 2019. Insecticides / Pesticides Registered under section 9(3) of the Insecticides Act 1968 for use in the India. Central Insecticide Board and Registration Committee, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. As on 31st October 2019. (Downloaded form http://ppqs.gov.in/sites/default/files/list_of_pesticides_registered_upto_31.10.2019.pdf on 12th December 2019)

CIB&RC, 2019. Major uses of herbicides (approved under the insecticides act, 1968) as on 31th October 2019. Central Insecticide board and Registration Committee. Directorate of Plant Protection Quarantine & Storage; Department of Agriculture & Cooperation, Ministry of Agriculture government of India. (Downloaded from http://ppqs.gov.in/sites/default/files/mup_herbicide_.pdf on 12th December 2019)

Cole, L. M., Nicholson, R. A., and Casida, J. E. 1993. Action of Phenylpyrazole Insecticides at the GABA-Gated Chloride Channel. Pestic. Biochem. Physiol. 46, 47-54.

Damalas, C. A., Georgiou, E. B., and Theodorou, M. G., 2006. Pesticide use and safety practices among Greek tobacco farmers: A survey. International Journal of Environmental Health Research. 16 (5):339 - 348.

Dinham, B., 2003. Growing vegetables in developing countries for local urban populations and export markets: problems confronting small-scale producer. Pest Management Science 59:575–582. DOI: 10.1002/ps.654.

Dinham, B., 2007. Pesticide users at risk. Survey of availability of personal protective clothing when purchasing paraquat in China, Indonesia and Pakistan and failures to meet the standards of the Code of Conduct. Berne Declaration (BD), Pesticide Action Network Asia and the Pacific (PAN-AP), Pesticide Eco-Alternatives Center (PEAC), Gita Pertiwi, Lok Sanjh. http://www.evb.ch/cm_data/Paraquat-Code_Survey_FINAL_rev1.pdf

Dinis-Oliveira R. J., Remião, F., Carmo, H., Duarte, J. A., Navarro, A. S., Bastos, M. L., and Carvalho F. 2006. Paraquat exposure as an etiological factor of Parkinson's disease. Neurotoxicology 27(6):1110-22

EXTOXNET, 1996. Atrazine. Pesticide Information profile. Extension Toxicology Network. http://extoxnet.orst.edu/pips/atrazine.htm Accessed on 16th October 2018.

FAO and WHO, 2014. The International Code of Conduct on Pesticide Management. World Health Organization and Food and Agriculture Organization of the United Nations. www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/Code/CODE_2014Sep_ENG.pdf

FICCI, 2016. Next Generation Indian Agriculture - Role of Crop Protection Solutions, A report on Indian Agrochemical Industry July 2016, Federation of Indian Chambers of Commerce and Industry (FICCI).

FSSAI, 2017. Notification on Draft Regulations, Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India.

FSSAI, 2019. Letter dated 16th October, 2019. Moniroting of Pesticide Residues in food products-Reg. File No7(5)2019/Pesticide Residues/RCD/FSSAI. Food Safety and Standards Authority of India. https://www.fssai.gov.in/upload/advisories/2019/10/5da705b31ca78Letter_Report_Pesticides_MRL_16_10_2019.pdf

Gawarammana, I. B., & Buckley, N. A., 2011. Medical management of paraquat ingestion. British journal of clinical pharmacology, 72(5), 745–757. https://doi.org/10.1111/j.1365-2125.2011.04026.x

Gill, H. K., & Garg, H. 2014. Pesticides: Environmental Impacts and Management Strategies. In M. L. Larramendy, & S. Soloneski (Eds.), Pesticides - Toxic Aspects. IntechOpen. https://doi.org/10.5772/57399

Hainzl, D., and Casida, J. E., 1996. Fipronil insecticide: Novel photochemical desulfinylation with retention of neurotoxicity. Proc. Natl. Acad. Sci. 93, 12764-12767.

Hainzl, D., Cole, L. M., and Casida, J. E. 1998. Mechanisms for Selective Toxicity of Fipronil Insecticide and Its Sulfone Metabolite and Desulfinyl Photoproduct. Chem. Res. Toxicol. 11, 1529-1535.

Hazarika, J., Ganguly, M., Borgohain, G. et al. 2020.Endocrine disruption: molecular interactions of chlorpyrifos and its degradation products with estrogen receptor. Struct Chem 31, 2011–2021. https://doi.org/10.1007/s11224-020-01562-4 .

IGSSS, 2017. Why farmers quit? A study on farmers' suicides in Odisha, conducted by Baitarani Initiative, IGSSS, New Delhi.

ILO and WHO, International Safety Card on Glyphosate (ICSC: 0160). International Labor Organisation and World Health Organisation. https://www.ilo.org/dyn/icsc/showcard.display?p_version=2&p_card_id=0160

Isenring, R. 2017. Adverse Health Effects Caused by Paraquat: A bibliography of documented evidence. Public Eye, PAN UK, PAN Asia Pacific. https://www.publiceye.ch/fileadmin/files/documents/Syngenta/Paraquat/PE_Paraquat_2-17_def.pdf (accessed Sept. 30, 2017)

Jackson, D., Cornell, C. B., Luukinen, B., Buhl, K., and Stone, D. 2009. Fipronil Technical Fact Sheet; National Pesticide Information Center, Oregon State University Extension Services. http://npic.orst.edu/factsheets/archive/Fptech.html.

Jennings, K. A., Keller, R. J., and Doss, R. B., 2002. Human Exposure to Fipronil from Dogs Treated with Frontline. Controv. Toxicol. 44 (5), 301-303

Karanth, S., and Pope, C., 2000. Carbosylesterase and A-Esterase Activities during Maturation and Aging: Relationship to the Toxicity of Chlorpyrifos and Parathion in Rats. Toxicol. Sci. 58, 282-289.

Katyal, J. C., Chaudhari, S. K., Dwivedi, B. S., Biswas,

D. R., Rattan, R. K., and Majumdar, K., (Editors). 2016: Soil Health: Concept, Status and Monitoring. Bulletin of the Indian Society of Soil Science 30, 1-98.

Kavitha, D., and Sureshkumar, M., 2016. Use Of Pesticides In North Tamil Nadu (Namakkal)-Impacts On Human Health And Persistence In Environment. IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS). Volume 11, Issue 5 Ver. I (Sep. - Oct.2016), PP 131-137

Kranthi , K. R., 2014. Cotton Production Systems - Need for a Change in India Cotton Statistics and News. Cotton Association of India. http://www.cicr.org.in/pdf/Kranthi_art/cotton_prod_system_dec_2014.pdf

Kumar, D., 2015. Conditions of Paraquat use in India. Pesticide Action Network (PAN) India http://www.pan-india.org/wp-content/uploads/2017/03/BD_paraquat_4-15_def-WEB.pdf

Kumar, D., 2017. Paraquat dichloride retailing in India : a case study from west Bengal. A sequel to 'Conditions of paraquat use in India' 2015. Pesticide Action Network (PAN) India. http://www.pan-india.org/wp-content/uploads/2017/04/Paraquat-retainiling-in-India_PAN-India-04.2017.pdf

Leverton, K., Cox, V., Battershill, J., Coggon, D., 2007. Hospital admission for accidental pesticide poisoning among adults of working age in England, 1998–2003. Clinical Toxicology (45) 5: 594-597

Manish, M., and Saurabh, R., 2017. India Agrochemicals on Fertile ground. Religare Institutional Research. https://www.dsij.in/productAttachment/premarketreports/Market_Agrochemicals_Religare_10.01.17.pdf

Marquez, E., 2014. Atrazine. PAN AP Factsheet Series on Highly Hazardous Pesticides. PAN AP.

Matthews, G. A., 2008. Attitudes and behaviours regarding use of crop protection products – A survey of more than 8500 smallholders in 26 countries. Crop Protection (27):834 – 846.

NCBI, 2018a. PubChem Compound Summary for CID 2730, Chlorpyrifos. https://pubchem.ncbi.nlm.nih.gov/compound/Chlorpyrifos

NCBI, 2018b. PubChem Compound Summary for CID 3352, Fipronil. https://pubchem.ncbi.nlm.nih.gov/compound/Fipronil

NCBI, 2018c. PubChem Compound Summary for CID 2256, Atrazine. https://pubchem.ncbi.nlm.nih.gov/compound/Atrazine

NCBI, 2018d. PubChem Compound Summary for CID 15938, Paraquat dichloride. https://pubchem.ncbi.nlm.nih.gov/compound/Paraquat-dichloride.

Ntow, W. J., Gijzen, H.J., Kelderman, P., and Drechsel, P., 2006. Farmer perceptions and pesticide use practices in vegetable production in Ghana. Pest Management Science 62 (4): 356–365.

Moebus, S., & Boedeker, W., 2021. Case Fatality as an Indicator for the Human Toxicity of Pesticides-A Systematic Scoping Review on the Availability and Variability of Severity Indicators of Pesticide Poisoning. International journal of environmental research and public health, 18(16), 8307. https://doi.org/10.3390/ijerph18168307

PAN, 2021a. PAN International List of Highly Hazardous Pesticides. Pesticide Action Network International. https://pan-international.org/wp-content/uploads/PAN_HHP_List.pdf

PAN, 2021b. PAN consolidated list of Bans. Pesticide Action Network International. https://files.panap.

net/resources/PAN-Consolidated-List-of-Bans.xlsx

PIB, 2015. Label on Pesticide Products. Press Information Bureau, Government of India. https://pib.gov.in/newsite/PrintRelease.aspx?relid=124297 Pimentel D, Levitan L. 1986. Pesticides: amounts applied and amounts and amounts reaching pest. Bioscience 27:178-185.

PPQ&S, 2019a. Consumption of chemical pesticides in various States/UTs during 2014-15 to 2018-19. Pesticide Monitoring and Documentation Unit. Directorate of Plant Protection and Quarantine and Storage, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Government of India.

PPQ&S, 2019b. Area under cultivation and under use of chemical & bio- pesticides during 2014-15 to 2018-19. Pesticide Monitoring and Documentation Unit. Directorate of Plant Protection and Quarantine and Storage, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, Government of India.

Qaim, M. 2003. Bt cotton in India: Field trial results and economic projections. World Development 31:2115–2127

Raina, S., Sood, V., Shah, B., Thakur, M., and Sharma, R., 2019. Acute herbicide poisoning: an emerging phenomenon in Himachal Pradesh, India. Recent Adv Biol Med. Vol. 5, Article ID 881092, 5 pages. https://doi.org/10.18639/RABM.2019.881092

Radhakrishnan S. and Kuruganti K., 2012. 10 Years of Bt Cotton: False Hype and Failed Promises Cotton farmers' crisis continues with crop failure and suicide. Coalition for GM Free India. http://indiagminfo.org/wp-content/uploads/2012/03/Bt-Cotton-False-Hype-and-Failed-Promises-Final.pdf

Ratra, G. S., and Casida, J. E., 2001. GABA receptor subunit composition relative to insecticide potency and selectivity. Toxicol. Lett. 122, 215-222.

Reddy, N., and Kumar, D., 2017. Pesticide Poisonings in Yavatmal District in Maharashtra: Untold Realities. PAN India. http://www.pan-india.org/wp-content/uploads/2017/10/Yavatmal-Report_PAN-India_Oct-2017_web.pdf (accessed Sept. 30, 2017)

Reigart, J. R., and Roberts, J. R., 1999. Organophosphate Insecticides. Recognition and Management of Pesticide Poisonings, 5th ed.; U.S Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, U.S. Government Printing Office: Washington, DC.

Richard H. S., and Harley R. S., 1969. Atrazine metabolism, selectivity, and mode of action. J. Agric. Food Chem., 17 (2), pp 199–205 DOI: 10.1021/jf60162a044 Publication Date: March 1969.

Sabarwal, A., Kumar, K., & Singh, R. P. 2018. Hazardous effects of chemical pesticides on human health-Cancer and other associated disorders. Environmental toxicology and pharmacology, 63, 103–114. https://doi.org/10.1016/j.etap.

Schreck, E., Geret, F., Gontier, L., and Treilhou, M., 2008. Neurotoxic effect and metabolic responses induced by a mixture of six pesticides on the earthworm Aporrectodea caliginosa nocturna. Chemosphere 71(10) 1832-1839.

Sebiomo, A., Ogundero V. W., and Bankole, 2011. Effect of four herbicides on microbial population, soil organic matter and dehydrogenase activity. Afr J Biotechnol. 10 SA 770–778

Shah, R., 2020, 'Pesticides and Human Health', in A. Nuro (ed.), Emerging Contaminants, In-

techOpen, London. 10.5772/intechopen.93806.

Shah, P. V., Fisher, H. L., Sumler, M. R., Monroe, R. J., Chernoff, N., and Hall, L. L., 1987. Comparison of the pe-netration of 14 pesticides through the skin of young and adult rats, J. Toxicol. Environ. Health, (21), 35

Singh, B., and Gupta, M. K., 2009. Pattern of use of personal protective equipments and measures during application of pesticides by agricultural workers in a rural area of Ahmednagar district, India. Indian journal of occupational and environmental medicine, 13(3), 127.

Smegal, D. C., 2000. Human Health Risk Assessment Chlorpyrifos; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, Health Effects Division, U.S. Government Printing Office: Washington, DC. pp 1-131

Thompson, C. M., and Richardson, R. J., 2004. Anticholinesterase Insecticides. Pesticide Toxicology and International Regulation; Marrs, T. C.; Ballantyne, B., Eds.; John Wiley and Sons, Ltd.: West Sussex, England. pp 89-127.

Tomlin, C. D. S., 2006. The Pesticide Manual, A World Compendium, 14th ed.; British Crop Protection Council: Alton, Hampshire, UK. p 186-187

UMES, 1999. Herbicide Mode of Action and Injury Symptoms. 1999. North Central Regional Extension Publication No. 377. University of Minnesota Extension Service http://www.cof.orst.edu/cof/fs/kpuettmann/FS%20533/Vegetation%20Management/Herbicide%20Mode%20of%20Action%20and%20Injury%20Symptoms.htm, Accessed on 16th October 2018.

UNEP, 2021. Environmental and health impacts of pesticides and fertilizers and ways of minimizing them. https://www.unep.org/resources/report/environmental-and-health-impacts-pesticides-and-fertilizers-and-ways-minimizing

UNEP, 2004. Childhood pesticide poisoning: information for advocacy and action. Geneva, Chemicals Programme of the United Nations Environment Programme (UNEP), Food and Agriculture Organisation, World Health Organisation. http://www.who.int/entity/ceh/publications/pestpoisoning.pdf. (accessed Oct. 2, 2017).

USDHHS,1997. Toxicological Profile for Chlorpyrifos; U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Public Health Service: Atlanta.

USEPA, 1999. Reregistration Eligibility Science Chapter for Chlorpyrifos Fate and Environmental Risk Assessment Chapter; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, Environmental Fate and Effects Division, U.S. Government Printing Office: Washington, DC.

USEPA, 2003. Interim Reregistration Eligibility Decision for Atrazine Case No. 0062. USEPA. https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/ired_PC-080803_1-Jan-03.pdf, Accessed on 16th October 2018.

USEPA, 2013. Atrazine Updates, 2013 and IRDS for Atrazine. US EPA https://archive.epa.gov/pesticides/reregistration/web/html/atrazine_update.html, Accessed on 16th October 2018.

USEPA, 2021. Paraquat Dichloride - Interim Registration Review Decision Case Number 0262. Docket Number EPA-HQ-OPP-2011-0855. United States Environmental Protection

Agency. https://downloads.regulations.gov/EPA-HQ-OPP-2011-0855-0307/content.pdf

Wagner, S. L, 1997. Diagnosis and Treatment of Organophosphate and Carbamate Intoxication. Human Health Effects of Pesticides; Keifer, M. C., Ed.; Hanley and Belfus: Philadelphia. Vol. 12, pp 239-249

Waichman, A. V., Römbke, J., Ribeiro, M. O. A., and Nailson, C.S. N., 2002. Review Articles Use and fate of pesticides in the Amazon State, Brazil Risk to human health and the environment. Environmental Science and Pollution Research 9 (6): 423-428, DOI: 10.1007/BF02987596

Watts, M., Peter C., Angeliki L., Gesine S., Rina G., Emily M. 2014. Factsheet on Chlorpyrifos. PANAP factsheet on Highly Hazardous Pesticides, PANAP. http://files.panap.net/resources/pesticides-factsheet-hhps-chlorpyrifos.pdf (accessed Sept. 30, 2017)

Watts, M., 2010. Paraquat Monograph. PAN AP. http://archive.panap.net/sites/default/files/monograph_paraquat.pdf (accessed Sept. 30, 2017)

Watts, M., 2012. Factsheet on Fipronil. PANAP factsheet on Highly Hazardous Pesticides, PANAP. http://archive.panap.net/sites/default/files/pesticides-factsheet-hhps-fipronil.pdf (accessed Sept. 30, 2017)

Watts, M., 2012. Paraquat. Factsheet. PAN AP factsheet series on Highly Hazardous Pesticides. http://dev.panap.net/sites/default/files/pesticides-factsheet-hhps-paraquat.pdf (accessed Sept. 30, 2017)

WHO, 1997. Pesticide Residues in Food: Fipronil; International Programme on Chemical Safety, World Health Organization.

WHO, 2009. Atrazine and its metabolites. http://www.who.int/water_sanitation_health/dwq/chemicals/dwq_summary_20100701_en.pdf , Accessed on 16th October 2018.

WHO. 2020. WHO recommended classification of pesticides by hazard and guidelines to classification, 2019 edition. Geneva: World Health Organization; Licence: CC BY-NC-SA 3.0 IGO. https://apps.who.int/iris/rest/bitstreams/1278712/retrieve

State Of Chlorpyrifos, Fipronil, Atrazine, And Paraquat Dichloride In India
An overview of regulation, recommended use, field use and residues detected in Kerala.

A. Regulation in Kerala

Unlike in other Indian states, Kerala government had made concerted efforts to ban hazardous pesticides. In 2011 Kerala government had decided to ban usage of atrazine and paraquat dichloride among others in the state due to public health concerns[1]. The two insecticides, chlorpyrifos and fipronil have been recommended for several crop-pest combinations in the state[2], though the former has been a restricted pesticide since 2015, means it can be sold only with the recommendation/prescription by agriculture officers[3]. Atrazine is not recommended, but paraquat is recommended for weed control in one crop.

B. Recommended use in Kerala and compliance with national approved use

Chlorpyrifos is recommended for fifteen crops[4] (black pepper, tapioca, coconut, banana, mulberry, cowpea, cardamom, cashew, paddy, pineapple, tea, cotton, arecanut, eucalyptus, and mangium) however only two of them- paddy and cotton- are in compliance with the national approved use of pesticides in India[5], with the remaining 13 uses are in violation of national regulation. While Fipronil is recommended for use on four crops such as banana, coconut, paddy and pineapple, only paddy is in compliance with the national approved use, with the remaining three are in violation of approved use. Paraquat dichloride is recommended for weed control in rubber plantations, which complies with its approved use.

C. Field use reported

PAN India's field monitoring in Thrissur, Thiruvananthapuram and Wayanad districts since 2015 reveals use of chlorpyrifos and paraquat dichloride in Kerala. Widespread use of chlorpyrifos has been detected in banana, paddy, vegetables such as bitter gourd, cowpea, French beans and ginger fields, whereas paraquat use has been noted in arecanut, banana, coconut, coffee, black pepper, ginger, rubber, vegetable fields as well as in courtyards, and road sides. Use of fipronil is reported in pineapple fields.

D. Residues of the four pesticides reported in food commodities

Among the four pesticides, residues of chlorpyrifos were reported in the analysis conducted by the 'Safe to Eat program' of Government of Kerala. Recent reports of pesticide residue analysis conducted between April 2021 and March 2022 have revealed the presence of chlorpyrifos residues above the maximum residue limit (MRL) in 19 commodities. A significant percentage (more than 50% of sample of some commodities) of market and farm gate samples of vegetables, fruits, spices, other food items reported presence of chlorpyrifos residues, among others. In all these samples, chlorpyrifos has been reported as non-recommended/non approved pesticide and the residue level was above the MRL prescribed by Food Safety and Standards Authority of India. Commodities where pesticide residues were found include bitter gourd, cucumber, red spinach, capsicum, cabbage, okra, carrot, beans, French beans/cowpea, green chilli, coriander & pudina leaves, grapes, cardamom, cumin & cumin powder, coriander powder, Kashmiri chilli and snake gourd.

---

[1] Kerala Government order number(MS) 116/2011/agri dated 07.05.2011.
[2] Packag of Pratices Recommendation(2016), Kerala Agriculture University.
[3] Directorate of Agriculture Development and farners Welfare, Kerala Government Circular number TQ(01)35006/16, dated 22.08.2016
[4] Note 2
[5] Major Uses of Insecticides. CIBRC. 2021.

Highly Hazardous Pesticide Series

STATE OF CHLORPYRIFOS FIPRONIL, ATRAZINE & PARAQUAT DICHLORIDE IN INDIA

Highly Hazardous Pesticides have been widely used in India since a long time. Regulation has not been effective and scientific expertise on pesticides is often subsumed in the policy trade-offs. This report presents pathetic state of four pesticides - chlorpyrifos and fipronil atrazine and paraquat dichloride - in India based on survey conducted in seven states. It exposes gaps in national approved uses of the pesticides and recommendation given by state agriculture authorities as well as industry, lack of proper training and access to right information for pesticide users, inadequate retail practices and various factors that contributes to exposure and poisoning. The overall pesticide use scenario recorded in the study violates national regulatory requirements as well as the International Code of Conduct on Pesticide Management, and indicates significant lacunae in regulation and accountability, which points to an anarchic situation with regard to management of toxic agrochemicals that are inherently harmful to people and environment.

About the author

A. D. Dileep Kumar is a postgraduate in Zoology, and he has completed Post Graduate Diploma in Pesticide Risk Management from the University of Cape Town, South Africa in 2019. Since 2013 he has been exclusively working on pesticides and related problems; has travelled across India and conducted field studies to understand ground reality of pesticide use, and its public health and environmental impacts. He has published studies and popular science articles on pesticide use, pesticide regulation, pesticide poisoning, agro ecology and sustainable development goals. Since 2019, he has been attending the Basal, Rotterdam and Stockholm (BRS) Conventions as an NGO observer.

PAN INDIA

PAN ASIA PACIFIC