

## IMPACT OF PESTICIDE APPLICATION ON RICE CROP: STRATEGIES AND SUGGESTIONS

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### Abstract

Rice is the second largest foreign exchange earning commodity of Pakistan with \$2 billion exports, however, at present globally it ranks fifth as the rice trade. Pakistan's overall rice exports posted a 13.63% decline during the last two fiscal years 2020-21, due to the issues like aflatoxins, pesticide residue and also new regulations being made by various markets. It should be remembered that complaints of pesticide issue in rice consignments from Pakistan are at lower or negligible level but expected to rise in few years to detectable value. Maximum residue levels (MRLs) of pesticides beyond permissible levels on rice are causing threat to the export competitiveness of Pakistani rice in major global markets such as the United States, European Union (EU) and Middle East. During global Covid-19 crisis, countries are becoming more cognizant of health and safety concerns. There is notable indication that interaction with pesticides is linked with immune system disorder, hormone disparities (which can possibly rise the risk for diabetes, obesity, autoimmune ailments and reproductive system complications) and foodstuff allergies. Considerable efforts must be made to examine the current status of pesticides contamination and related health issues in Pakistan.

**Keywords:** Rice, Health, storage, Food and Agriculture Organization, Maximum Residue Limit, Integrated Pest Management

### Abbreviations

Maximum residue levels (MRLs), Food and Agriculture Organization, European Union (EU), Integrated Pest Management, Liquid chromatography/mass spectrometry (LC-MS/MS), , US Department of Agriculture's (USDA), Environmental Protection Agency (EPA), Agricultural Pesticide Technical Advisory Committee (APTAC), Good Agricultural Practices (GAP), Joint Meeting on Pesticide Residues (JMPR), Persistent Organic Pollutants (POPs), Prior Informed Consent (PIC), Strategic Approach to International Chemicals Management (SAICM)

### Introduction

Global Agriculture has been producing thousands tons of food for domestic and overseas markets. The main tool of the trade is insecticide (synthetic chemicals) that are used for integrated pest management. Pesticide not only increase the efficiency of growing crops but also improve quality of food produced. High level of pesticide residues remaining in/on food appeared as potential threat for human and animal life. Pre and

Post-harvest pesticide deposits in/or foodstuff produces a potential hazard. Pesticide application is generally less expensive than other alternatives like biological / mechanical pest / weed control. Conversely Merchants, vendors and local consumers assume visually inexpensive and flawless products after pesticide application. Pesticides choice should be contingent with strength of the farming system which need to be rehabilitated as improve agro-ecology (Gianani et al., 2011).

Globally, China and United States are among the largest manufacturers of pesticides. India levels at first as largest pesticide consumption country in the agriculture sector and Pakistan ranks second. Unfortunately, during the 1980s and 1990s, the agricultural areas of Punjab, Pakistan were heavily used with pesticides. pesticides trade and supply have shifted from civil sector to private zone, as a result five folds' increase in its application was observed with minimal upshot in production. Presently, in Pakistan 30 forms of fungicides, 05 acaricides, 39 weedicides, 06 rodenticides, and 108 types of general insecticides are applied on different crops (Mehmood et al., 2017; Maker et al., 2019).

More than 1300 compounds are used worldwide for plant protection at Agricultural products. Globally, crop protection agents used in rice mainly includes herbicides like oxadiargyl and quinchlorac, insecticides like deltamethrin and buprofezin (against the stem borer and leaf folder) and fungicides like tricyclazole, azoxystrobin and propiconazole (to prevent and control neck blast, dirty panicle, brown spot and sheath blight). Antibiotics i.e., kasugamycin (against bacterial blast) and storage areas are fumigated with organophosphorous insecticides such as pirimiphos-methyl or dichlorvos. Fumigation of containers and silos is usually done with methyl bromide or phosphine gas usually (Ahmad et al., 2008; Fothergill and Abdelghani, 2013). Tricyclazole is ordered as moderately hazardous pesticide. According to the EU, residue level of tricyclazole in rice has been revised at @ 0.01 mg/kg instead 1.0 ppm. Tricyclazole can persist in agricultural soils for 11 months under different climatic conditions (Shahid and

Riazuddin, 1999; Phong et al, 2009; Jeong et al., 2012).

It turns out that much of the use of pesticides, whether in technologically advanced or developing countries, is unnecessary, uneconomical or unstoppable. The presence of a pesticide in grain as sediment depends on when it was applied, on its degradation in the atmosphere and on its metabolism in the plant (Rao et al., 2007).

Pesticide use should be gradually reducing to a level that is effectively tolerable for crop production, and that threats should be negligible worldwide, pest and disease damage to agricultural products is expected to reduce the total yield of crops by 25% (Asiaiah et al., 2019). Insecticides can amass in the flora and fauna of ecosystem. After deposition, insecticides can be transported and extravagant in diet and even accumulate in soil and sediment to other areas of neighboring jurisdiction. This can pose threats to other environments, which are far from the point of contamination. Change in pesticide types and quantity might lead global organizations to analyze the residue and associated health risks. The pest infestation first emerged in the 1960s and 1970s with the production of improved varieties i.e., highly resilient and manure responsive crop around the globe. After 1970s, promotions were considered to spray in the diseased crops. Multiple pesticide residues are reported in food and aquatic life even in countries where strict registration procedures are available (Jaacks et al., 2022).

According to several studies, it is evident that surplus pesticide consumption is hazardous in several types of cancers, Parkinson's disease and Alzheimer's disease. There is substantial sign that pesticides exposure may disturb immune system and hormone imbalances. Several surveys have

reported their perceptible growth delay, communicative disorder and natal defects in children exposed to high intensities of pesticides.

Generally, surveillance of pesticides monitoring focus on right practice and amenability with Maximum Residues. These levels are established on the pesticides application in accordance to Good Agricultural Practices (GAP). Pesticides can be transferred inside grain

Other research show that pesticide exposure from food item can be linked with hyperactivity disorder (ADHD). (Fahad et al., 2015)

subjected to composition of applied chemistry. Some pesticides deposits in outer layer and can be removed during husking operation. Rice husk exclusion is not sufficient to eradicate pesticides consumption especially in rice (Karunarther et al., 2019).

**Table 1: Rapid alert for pesticide residue 2019 for Pakistani Rice (Rice Exporters Association Pakistan)**

Pesticide Name	India	Pakistan
Tricyclazole	24	-
Thiamethoxam	15	-
Carbendazim	5	1
Methamidophos	3	-
Chlorpyrifos	-	2
Profenovos	-	1
Buprofezin	1	-

Chlorpyrifos and Cypermethrin are used worldwide to control plant hoppers and borers in rice crop. In humans, chlorpyrifos blocks an enzyme called cholinesterase which the brain required to control nerve impulse. At early stage of life in children their Risks factors are high because of their developing nervous system. chlorpyrifos have Additional risks of includes headache, anxiety, nausea, diarrhea, fatigue and blurred vision, reduce birth weight during pregnancy, endocrine system disorder, prostate and lung cancer. Cypermethrin can causes muscle weakness, nausea, headache, salivation, shortness of breath, male infertility and cancer (Fazal et al., 2022).

**Pesticide residue/regulation law in Pakistan**

In most countries Pesticides are mainly regulated because of their potential influence on the environment and the health of the masses. Pakistan government and private bodies had developed certain laws listed below.

The Agricultural Pesticide Ordinance, 1971 was enacted after independence. It is a comprehensive regulation for formulation of new pesticide chemistries, regulating imports, sale, supply and quality control assurance, with penalties for non-compliances. In 1973, Pesticide Guidelines under the act were created and reviewed in 1979 for modification to private entities from public sector. Subsequently in 1992

pesticide imports under generic names was started to strengthen the penalties for contamination (Mahmood et al., 2014). Agricultural Pesticide Technical Advisory Committee (APTAC) was recognized to direct the Federal Government on all matters relating to use and registration. This committee is supervised by Ministry of Food, Agriculture and Livestock, and provincially headed by Plant Protection division, Karachi which is responsible for the registration, monitoring and assuring quality control (San et al., 2020, Khan et al., 2020).

### Registration of pesticides

It is carried out as three stages:

- (i) field trial for pesticide brand name (for which for consecutive 2 years were done for efficiency)
- (ii) Lab trial under generic name (for which government analyst's report is considered satisfaction)
- (iii) Import permit on the basis satisfactory documentary proof.  
In 1994, (23) twenty-three pesticides were deregistered and their use banned in the Pakistan. By 2000, 2,116 pesticides were registered out of which 498 products reached to trade names, 792 under generic names, and 826 traded locally. (Saud et al., 2021).
- (iv) Despite the boundaries, illicit pesticides are applied on a small scale in rural areas as these are trafficked from the adjoining countries. Law prosecution is generally poor. Although an adulterator is punishable by 7 (seven) year imprison with a fine of

Rs. 100000 (one million), unfortunately no proposed punishments devour seriously (Karim et al., 1999).

Contamination and application of counterfeit insecticides are because of importation of low standard products or formulation, fewer active ingredient, contamination by suppliers and dealers during labeling and packing locally (Mehmood et al., 2017).

### International pesticide residue regulation authorities

Checking residue level is the sole way to commendably govern the usage. Recently more programs/ agencies have been recognized with following on judicious application of pesticides and compliance as MRLs.

Regulation (EC) No 396/2005 directly deals public health, whereas the maximum pesticide residue levels (MRLs) in food based origin products are at the same tolerated level in all EU Member States. Regulations cover pesticides used in agriculture both inside and outside the EU. Production and use of persistent organic pollutants (POPs) is organized by The Stockholm Convention. Pesticide Management is an intended framework headed by FAO and reinforced by private associations and civil organizations (Florenceia et al., 2006).

A volunteer policy framework and strategy facilitated by UNEP is The Strategic Approach to International Chemicals Management (SAICM) to promote chemical safety around the world). An expert body run jointly by FAO and WHO is The Joint Meeting on Pesticide Residues (JMPR). The purpose was to survey the risk assessment on the pesticide residues regionally and provides guidance to other

countries. US Department of Agriculture’s (USDA) has been observing the U.S food supply for pesticide residues and testing of foods on a turning basis (Asiah et al., 2019).

For monitoring pesticides globally, The European Union (EU) has developed an inflexible to judges pesticide residues during and after crop production. US and EU are not a standard for developing countries (Cabasan et al., 2019; Khuhro al., 2020). Fewer states have cut pesticide consumption (particularly UK, France,

Denmark and Japan), but in most regions consumption considerably increased. In developing countries pesticide rules are not as strictly followed and farmers may take advantage in the prescribed pesticide due to high demand and unawareness for its toxicity in humans. Permissible residue confines between food stuff and the republic where they are recycled or distributed. Diverse countries have own standards and methods for monitoring to limit pesticide residues. (Fahad et al., 2015).

**Table-2. Maximum permissible level (ppm) of different Pesticide on Rice Crop by different Organization**

Compound	EU	USA	JAPAN	Codex Alimentarius
Chlorpyrifos	0.05	0.01	0.1	0.5
Chlopyrifos-methyl	3.0	6.0	0.1	0.1
Buprofezin	0.5	0.01	0.5	-
Carbendazim	0.01	0.01	1	2
Tricyclazole	1.0	0.01	3.0	–
Fipronil	0.005	0.04	0.01	0.01

\* Pakistan Govt. enforced the Pesticide limit of EU for international trade depending on the destination country’s law.

**Monitoring pesticide residue**

Globally the pesticides residues are determination by techniques like Liquid chromatography/mass spectrometry (LC–MS/MS), GC-MS and GC–MS/MS etc. LC–MS/MS and gas chromatography with electron capture detection (confirmed by GC–MS) are the leading techniques that are presently hired for pesticides quantification. A lot of attention has been concentrated on pesticide residues severity in food chain for public health and international food trade but this crucial area of study is still lacking behind in Pakistan in its import and export food stuff and other items (Mustafa et al., 2007).

**Alternative way to reduce pesticide residue in rice**

Individually hassle control strategy is not suitable to provide acceptable results in all situations.

- Research and hands-on field experience should be used for evidence-based rice production planning at the provincial level and policy recommendations at national level.
- Restructuring of Agriculture toward reconstruction can increase the competitive advantages and profitability in an environmental-friendly style.

- Application of the Participatory Technology Development (PTD) with the arrangements of the scientist, agricultural extension services, farmers
- Integrated Pest Management (IPM) is the best accessible alternative. It is commonly stated as a varied combination of methodologies to control pests; retain damaging levels by using control options that range from cultural practices to chemicals. Technologies involved, such as use of bio-pesticides, augmentation releases of predators/parasites, development of pest resistant species, crop rotation, cultural practices, and balanced usage of fertilizers.
- There should be explicit GAPs recognized in Punjab province of Pakistan for Rice crop that are internationally recognized standards or set of codes of practice that can be slowly introduced to farmers
- Review of policy and laws for pesticide regulation need amendments as per international demand.
- Organic fertilizers need to be encouraged to increase the soil fertility to control water scarcity issue.
- Breeding strategies are needed to create pest resistance varieties at huge scale.
- Biocontrol: application of botanical extracts and organic farming methods
- Sanitary phyto-sanitary regulation.
- Pesticide residue minimization is a shared responsibility of consumers, scientists, farmers, civil society and the private sector. Factual information needs to be disseminated to all stakeholder.
- Pesticide registration processes needs to be improved.
- Modern laboratory analysis is not only an important tool to control contaminants and residues, but it also helps to improve the quality of rice. Preservation of the authenticity and identity of high quality varieties by DNA-fingerprinting helps to promote rice as a premium food, because this cereal has the potential to be much more than a staple food and commodity.

#### **Conclusion**

Substantial energies are needed to observe the contemporary position of existing pesticides pollution and associated human health concerns in Pakistan. Advance research must be piloted to exactly fix their use and pollution level due to disclosure of pesticides in other crops too. Additionally, extensive research and development strategy must be planned for eco-friendly and profitable practices to remove these pollutants from the tainted surroundings. Clinical studies are too restricted to recognize the factual loss/threat occurred due to pesticide exposure. Hence, further exploration based on nutritional and clinical approach is commended to assess the exposure of organophosphates and pyrethroids in over-all population of Pakistan.

#### **Conflict of Interest**

The authors declare that there is no conflict of interest.

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