POLICY PAPER 136

Crop Grouping and Harmonization of Maximum Residue Limits: Solution to Off-Label use of Pesticides

NATIONAL ACADEMY OF AGRICULTURAL SCIENCES, NEW DELHI
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Preface

India ranks first in the world with highest net cropped area, but supported with one of the lowest number of pesticides registered for use in agriculture. It is however intriguing that nearly one fourth of diverse group of crops, mostly high value and low volume ones, remain secured under the labelled use of pesticides. Most of the crops constituting horticultural, plantation, oilseeds, pulses etc., quite often experience off-label use of pesticides.

The absence of label claims of pesticides for use on spices, fruits, leafy vegetables, etc., leave farmers with limited pest management options. The off-label use of pesticides has become a necessary evil and it is often the cause of residues of unregistered pesticides. The international trade risk on account of off-label use of the pesticides and the absence of country specific Maximum Residue Limits (MRLs) affect the export of several agricultural commodities. The practice of imposing Sanitary and Phytosanitary (SPS) based MRL standards by some importing countries has further reduced the market access of our agri-produce.

In Amrit Kaal, India aspires to increase its trade of horticultural commodities from <1% to at least 10%. This would be a wishful proposition unless SPS compliance Good Agricultural Practices (GAP) are kept in place. The development of Standard Operating Procedures (SOP) for crop group based harmonisation of MRLs can only provide a science based solution to reverse the existing scenario of lop-sided registration with less than 25% existing labels of crops. It is highly enigmatic that the principles of crop group based generation of MRLs of pesticides have approval of the Codex Committee on Pesticides Residues (CCPR) and is under practice by the developed world.

I congratulate the plant protection group to introduce a challenging issue, which if left unattended, can cripple the agricultural growth and pose serious human and environmental bio-safety and trade concerns. The recommendations that stemmed out of the brainstorming would be highly useful for the relevant authorities. I thank the Convener (Dr. Pranjib Kumar Chakrabarty); Co-Convener (Dr. Vandana Tripathy) and participants for their valuable inputs. I also place on record my appreciation and thanks to the Reviewers (Dr. C.D. Mayee & Dr. S.N. Puri) and Editors (Dr. V.K. Baranwal & Dr. R.K. Jain) for their efforts in bringing out this Policy Paper in the present form.

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(Himanshu Pathak)
President, NAAS

Crop Grouping and Harmonization of Maximum Residue Limits: Solution to Off-Label use of Pesticides

1. INTRODUCTION

It has been estimated by the Food and Agricultural Organization (FAO) that each year up to 40% of global crop production is lost due to pests and diseases (FAO, 2025). To prevent such losses, chemical pesticides are employed to protect crops and food commodities from insect pests, weeds and diseases. Pesticides have played a key role in improving agricultural productivity by preventing large crop losses, enhanced agricultural output and ultimately the farm income. Their non-judicious use on the other hand has led to pesticide residues in food, feed and the environment, pest resistance, pest resurgence, outbreaks of secondary pests, adverse effect on non-target organisms including natural enemies, pollinators, etc. The detection of pesticide residues above the permissible maximum residue limits (MRLs) in agricultural commodities remains a challenge for food safety as well as trade. Unlike the developed countries, India has a smaller number of pesticides registered for use in agriculture with significantly less usage of pesticide per hectare when compared globally. Due to exorbitantly high and unaffordable cost involved in the discovery of each new molecule (approx. INR 2700 crore) (CLI, 2024), there is limited access to newer effective molecules. In the absence of new and novel pest solutions, the farmers in India mostly rely on the age old and generic molecules and their formulations.

When a pesticide is approved by the regulator for use on a crop, it gets a 'label claim' for that crop, implying the legal sanction for its approved use in the country. Despite their approved usage on a specific crop/ commodity, there are cases when a pesticide is detected on the crop/ commodity for which it has not been registered/ approved for use. Such usage of pesticide is considered an off-label use and is not legally permitted. Of all the crops grown in India, 15-20% of the high-volume low value crops only enjoy label claim for use of pesticides. While the remaining 80-85% crops, mostly constituting minor crops of high value (spices, minor/ specialty crops, vegetable etc.), are still not covered under the registered use of pesticides. The industry finds it uneconomical to register pesticides on every crop individually due to high cost involved in their registration.

Pesticides serve as an indispensable arsenal in the hands of the farmers who use them readily to protect their crops from the losses irrespective of their approval for use. Thus, the off-label use of pesticides for crop protection is a necessary evil, not only in India but world over. As a result of this practice, it is the consumers and the nation at large who suffer huge losses in terms of compromised biosafety and trade restrictions by the importing countries. In view of these uncontrollable challenges

of the industries and farmers, it becomes an absolute joint responsibility of policy makers, researchers, and industries to work together to mitigate the issues amicably and work out a science-based biosafety ensured approach for harmonized use of pesticides.

This policy paper discusses the status of pesticide use for crop protection, food safety challenges, trade implications etc., arising due to off-label use of pesticides. It also outlines the strategies that could help mitigate the challenges arising out of the off-label use of pesticides through Group MRLs (Maximum Residue Limits), and minor use pesticides program.

2. PESTICIDE USE AND REGULATION

India consumed 40,094 tonnes of pesticides in 2023 (FAOSTAT, 2023). The per hectare consumption of pesticide in India is 0.45 kg, which is much lower as compared to the global average of 2.37 kg. Low consumption in India can be attributed to fragmented land holdings, low level of irrigation, dependence on monsoons, less awareness among farmers about the benefits of usage of pesticides etc. Cereals consume the highest amount of pesticides (~40%), followed by vegetables & fruits (14%), pulses (12%), cash crops (12%) and oilseeds (11%) (Rana *et. al.* 2022).

Before a pesticide is introduced in the country, it is mandatory to register it with the Central Insecticides Board and Registration Committee (CIB&RC) under the Insecticides Act (1968) and Rules (1971). The Act regulates the import, manufacture, sale, transport, distribution and use of insecticides to prevent risk to humans, animals and the environment and authorizes the regulatory agency to implement control over product quality, packaging, labelling, and safety of the users. For securing regulatory approval for a pesticide-crop combination, multi-location supervised field trials are conducted by the State Agricultural Universities/ ICAR Institutes for generating data on the efficacy of the pesticides against the target pests and analysis of the residues in/ on the desired crop. When a pesticide is approved by the CIB&RC for use on a crop, it gets a 'label claim' for that crop, implying the legal sanction for its approved use in the country. The registration process involves scientific evaluation of the bio-efficacy, chemistry, and toxicology data generated under different agro-climatic locations to ensure that the pesticide does not adversely affect the human and environment health (CIB&RC, 2024a).

The implementation of the Food Safety and Standards Act (2006) phased out the Prevention of Food Adulteration Act, PFA (1954) and Rules (1955) and led to the establishment of Food Safety and Standards Authority of India (FSSAI) in 2008, a statutory body under the Ministry of Health and Family Welfare. FSSAI lays down regulatory standards for food articles based on scientific assessment and regulates the manufacture, processing, distribution, sale, and import of food to ensure safe food for human consumption. Further, issues concerning food safety due to pesticide residues are handled under the Food Safety and Standards Act (2006) and Food Safety and

Standards (Contaminants, Toxins and Residues) Regulation (2011). On receiving the requisite data from the Registration Committee, the FSSAI fixes MRLs for pesticide-crop combinations. At present, 339 pesticides and 946 pesticide formulations of different types are registered for use in agriculture (CIB&RC, 2024b).

At the international level, the Codex Alimentarius Commission (CAC) establishes a code of food standards to contribute to the safety, quality and fairness of the international food trade. The Codex Committee on Pesticide Residues (CCPR) is responsible for establishing Codex Maximum Residue Limits (CXLs) for pesticide residues in food items or in groups of food or feed that move in the international trade. The CXLs are fixed by the JMPR (Joint Meeting of Pesticide Residues), an expert adhoc body administered jointly by FAO and WHO and is responsible for the scientific assessment of the pesticide toxicological and residue data.

3. CHALLENGES TO CROP PROTECTION IN INDIA

3.1. Lack of access to adequate crop protection solutions

As compared to other countries, number of registered pesticides in India are far less. As on date, 339 active ingredients of herbicides, insecticides, fungicides, growth regulators etc. are registered with their regulatory agencies for use in India (CIB&RC, 2024b), as compared to China (727) and Japan (590). It is obvious from the major use of pesticides that the agrochemicals in India are approved for use on about 100 crops only against major pests and diseases (CIB&RC, 2025). Minor crops such as spices, condiments, curry leaves etc., which are grown on a smaller area and have low dietary intake, do not attract commercial interest of the manufacturers to seek registration of pesticides as the cost of registration does not commensurate with their sale. As a result, limited crop protection solutions are available with the farmers leading to the practice of off-label use of pesticides.

3.2. Off-label pesticide use

The off-label use is encountered when a registered pesticide is used in a manner or in the crop where it doesn't have the MRL of the pesticide for its crop-specific use based on risk assessment. Worldwide countries have different guidelines to harmonize the off-label use of pesticides. For example, in Australia, a permit is required from Australian Pesticides and Veterinary Medicines Authority (APVMA) to use an unregistered chemical or a 'restricted use' chemical in an off-label manner (Agriculture Victoria, 2025). USA, Canada, Japan and China generally discourage or prohibit the off-label use of pesticides. However, in specific cases and certain circumstances, Japan gives some allowances with a clear justification for the use. Environment Protection Agency (EPA) in USA has a "Section 3C'' program that allows for certain off-label use of pesticide. Some major crops have approved label claim for many pesticides, while others have label claim for very few pesticides only.

Farmers in India are mostly unaware about the technicalities of pesticides like registered/ un-registered use of pesticides. They prefer pesticides which are economical, and highly effective, irrespective of their status of registration. Due to limited crop protection options available with farmers, they often use any pesticides available based upon their efficacy even if they are not registered for a particular crop leading to off-label pesticide detection. Another aspect of off-label use of pesticides is the non-existence of MRL or tolerance limit on non-recommended crops. Frequent detection of residues of pesticides in non-recommended food crops is a cause of growing concern. Apart from their potential health implications, their detection in the exportable commodities adversely affects the economy due to the rejection of export consignments by the importing country.

4. FOOD SAFETY CHALLENGES

4.1 Limited MRLs for pesticides

Maximum Residue Limit (MRL) or tolerance limit is the highest level of a pesticide residue that is legally tolerated in or on food when pesticides are applied correctly in accordance with Good Agricultural Practice (GAP). In India, a pesticide cannot be registered for use on a crop without first establishing its MRL. These are fixed after carrying out risk assessment of the pesticide residues detected on crops at harvest. MRL of a given pesticide varies from crop to crop depending upon the crop part used for consumption (eaten raw/ cooked, peeled/ unpeeled etc.), and residue accumulation and retention pattern in the organs. Since a pesticide could provide management of pests and diseases on more than one crop, it is desirable to bring maximum crops under the umbrella of registration (label expansion). The recent notification of the FSSAI including 2129 MRLs for 259 pesticides predominantly covers only the major crops and this has been a long drawn and expensive exercise (FSSAI, 2024). Instead, if the principles of crop grouping were applied, about 104 MRLs (29 groups and 75 subgroups) would have sufficed to bring almost all the crops grown in the country under the cover of registered use of pesticides. The minimum number of MRLs (104) that are needed to expand the label claims of pesticides on every crop cultivated in the country, is derived theoretically based upon the highest residue definition on the crop that represent members of each group (29) and the subgroup (75), respectively. Internationally, Codex defines MRLs for different pesticide crop-combinations based on the risk assessment conducted by FAO/ WHO/ JMPR for the global consumers. In the absence of national MRLs, Codex MRLs can be adopted for food safety.

4.2. Trade barriers: Rejection of export consignments

India is the leading producer and exporter of agricultural and horticultural crops, including spices, rice, tea, coffee, cashew, grapes, fresh vegetables, chilli powder etc. to various countries of the world. Though spices worth USD 400 million have been exported by India during 2023-24 in the global market and no pesticide is registered on spices (Anonymous, 2022), yet the farmers practice off-label use of pesticides for

protection of their crops. Presence of the residues above the default level (0.01 ppm) has become a major bottleneck in the trade of food commodities by exporting countries under the World Trade Organization (WTO) agreement on the application of Sanitary and Phytosanitary measures.

Variations in the MRLs of the same pesticide-crop combinations in the country of import and export may lead to non-tariff trade barriers (Table 1). About 40% of the

Table 1: MRLs of some pesticide-crop combinations in different countries*

Crop	Pesticide	MRL (mg/kg) (ppm)					
		India	USA	Japan	UK	EU	Codex
Rice	Tricyclazole	3.0	3.0	3.0	0.3	0.01	5.0
	Acephate	1.0	NA	0.01	0.01	0.01	1.0
	Buprofezin	0.05	1.5	0.5	0.01	0.01	NA
	Carbendazim	2.0	NA	1.0	0.01	0.01	2.0
	Carbofuran	0.1	0.2	0.01	0.01	0.01	0.01
	Chlorpyrifos	0.5	NA	0.01	0.01	0.01	NA
	Imidacloprid	0.05	0.05	1.0	1.5	0.01	0.05
	Propiconazole	0.05	7.0	0.1	0.01	0.01	4.0
	Tebuconazole	1.5	NA	0.05	1.5	1.5	1.5
	Thiamethoxam	0.02	6.0	0.3	5.0	0.01	3.0
Tea	Thiamethoxam	20.0	20.0	20.0	20.0	20.0 0.05 (w.e.f. March 2026)	20.0
Pomegranate	Bifenthrin	NA	0.5	NA	0.5	0.01	0.5
	Imidacloprid	NA	0.9	NA	1.0	0.01	1.0
Grape	Dithianon	NA	3.0	2.0	3.0	3.0	2.0 (Table grape) 5.0 (Wine grape)
Onion	Abamectin	NA	0.01	0.005	0.01	0.01	0.005
	Amectotradin	NA	1.5	2.0	1.5	1.5	1.5
	Difenoconazole	0.1	0.2	0.2	0.5	0.5	0.1
	Iprodione	NA	0.5	0.3	0.01	0.01	0.15

Source: Online MRL databases of individual countries.
*The list is not inclusive and is indicative; NA: Not Available

crops are prevented from being included in the trade chain due to the non-tariff trade barriers which arise because of the limited regulatory approval of safe and effective plant protection chemicals. Since MRLs for pesticides are not available on majority of the crops, the importing countries may set either default MRLs or fix stringent SPS based MRLs, often ignoring the existing Codex MRLs on the commodity and raising a non-tariff barrier. The non-compliance can also be enforced due to other reasons including the presence of residues of banned pesticides (CIB&RC, 2024c) that are not allowed for use by the national food law of the importing country or the presence of residues that are higher than the existing MRLs of pesticides. Such trade barriers result in out right rejection of the export consignments from the port of entry causing huge economic losses to the farmers and the nation at large.

The key strategies to address these rejections/ bans include implementing domestic reforms, bilateral discussions with trading partners, mutual collaborations and knowledge sharing, and raising the issue in multilateral organizations such as WTO. To overcome barriers related to off-label pesticide detection, importing countries may consider the MRLs of the exporting country or Codex MRLs.

5. MITIGATING CROP PROTECTION AND FOOD SAFETY CHALLENGES

5.1. Crop grouping for expansion of label claim

Crop grouping helps the countries to bring more pesticides and more crops under the umbrella of crop protection. Crops are grouped based on their similarities in botanical classification, morphology, cultural practices, growing seasons, locations or growth habit, edible portion of the commodity, as well as potential for retention of pesticide residues. It unites similar types of crops into a group or subgroup to facilitate the use of pesticides in as many crops as scientifically possible. Crop grouping enables extrapolation of the data generated for a major/ target crop to other related crops of the same crop group eliminating the need for fresh data for each individual crop in the group. The concept of crop grouping was adopted by Codex in 2012 and subsequently amended in 2017 in CXG 84-2012. According to the Codex crop grouping, the residue levels on a representative commodity can be used to estimate the residue levels on related commodities present in the same group/ subgroup for which trials have not been conducted through the method of residue extrapolation. Thus, the MRL fixed for the representative crop in a group can be extended to all the members of the same group/ subgroup as Group MRL.

Implementation of the crop grouping concept on a global scale has been rigorously pursued so that the growers have access to new and effective crop protection tools and technologies. Internationally there is no binding norms for naming any specific crop or minimum number of crops as representative. Each crop group is indicated by a representative crop which is generally the most economically important commodity in

production/ consumption/ residue accumulation in the group/ subgroup. The commodity is chosen such that it indicates the upper range of residues that can be encountered for the group/ subgroup based on same or comparable GAP and other available information. Group MRL, i.e. an MRL for the group may be estimated from the highest residue level for any of the individual representative commodities or from the larger combined data set (Codex, 2017).

In India, attempts were made to create core groups of crops falling within the same family, crop morphology, phenology, fruiting habit, pest and disease spectrum etc. in context to the pesticide application. The Department of Agriculture and Farmers Welfare constituted a Sub-Committee chaired by Dr. T.P. Rajendran (Former ADG, Plant Protection, ICAR) in 2013 to study the aspects of crop grouping within the draft principles of CCPR. The committee was entrusted with the responsibility to develop a national document on crop groups with the selection of suitable crops that would represent the members of respective crop group/ subgroup. The Committee submitted its report in 2015, in presence of then ADG PP&B and identified five representative crop types (fruits, vegetables, grasses, nuts and seeds, and herbs & spices) based upon the perception of risks of residues of pesticide used in the country. Subsequently, another Sub-Committee chaired by Dr. P.K. Chakrabarty (Former ADG, Plant Protection, ICAR) was constituted during 2016-18, which finalised the modalities for implementation of crop grouping. It recommended modifications in the existing crop grouping scheme, redefining the representative crops, added new crops native to India in the existing crop group, reduced data requirement and incentivization of additional data to extrapolate the MRLs of representative crops across the members in a group/ subgroup. Recently another Sub-Committee chaired by Dr. S.C. Dubey (Former ADG, Plant Protection, ICAR) was constituted in 2024, which suggested further modifications in the existing crop grouping scheme/ list of crops including representative crops, as per the latest Codex crop grouping classification. These committees worked in tandem to develop robust crop groups and sub-groups in Indian context adhering to the principles of CAC. This is done to ensure that once the residue of pesticides on the representative crop suitably defines the risk, the MRL can be extrapolated across the crops within the same crop group/ subgroup. Based on the principles of Codex crop classification, India accommodated nearly 554 crops into 29 groups and further 75 subgroups under these major groups with at least one crop representing each of these groups and subgroups (Anonymous, 2019).

At the international level, Crop Grouping Consulting Committee (ICGCC) is also working to harmonize crop groupings to update the Codex classification of foods and feeds. Thus, the adoption of crop grouping framework proposed by the national/ international committees would facilitate fair trade practices and help India move towards safe and sustainable crop protection and economic prosperity.

5.2. Data Requirement for Label expansion/ registration of pesticides

Globally, it is a standard practice to use OECD MRL (Organisation for Economic Development Maximum Residue Limit) calculator for deducing the MRL of pesticides based on residue data. The FSSAI (Food and Safety Standards Authority of India) is also using the OECD calculator for working out the MRL value based on the local residue data. The requirement of data generation for bio-efficacy and pesticide residue and registration for a single pesticide on each crop costs the manufacturers a huge sum of approximately Rs. 1 crore (CLI, 2021). On this analogy the registration of a single pesticide (if found effective) on all the 554 crops would cost a whopping amount of money (554*1 crore = ₹ 554 crore) to the industry. Unless this exorbitant cost of registration is incentivized through data bridging, extrapolation, reduction in the cost etc., the situation of registered use of pesticides will remain a predicament. The 369th meeting of the CIB&RC (Anonymous, 2016) constituted a Sub-Committee under the chairmanship of the then ADG (Plant Protection & Bio-safety), ICAR to decide upon the modalities for extrapolation of the MRL of the representative crop across the members of the group/ subgroup. A Workshop on "Crop Grouping & Minor Use Concept for Crop Protection Products in India" was organized during October 24-25, 2017 in collaboration with Crop Life India (CLI) and other pesticide associations to establish the guidelines for the implementation of principles of crop grouping as per the provisions of Codex MRL setting. It also advised the adoption of bio-efficacy and residue data requirements for minor crops based on the scientific rationale, data mining, extrapolation of national monitoring data, etc.

The CIB&RC in its 458th meeting (Anonymous, 2024) accepted the above crop group and the modalities for further incentivization of data and extrapolation across the member crops of the group/subgroup (Box 1). The proceedings of the meeting was submitted to the FSSAI for further suggestions and approval. One of the concerns of FSSAI was about the requirement of CCPR to generate residue data at eight locations. However, in India, presently residue studies are carried out in different agro-climatic regions (L) and seasons (S) in replicated (R) field trials (4L*1S*3R = 12 Locations) for major crops, except herbicides (3L*2S*3R = 18 Locations). Thus, in India residue data are generated at 12 and 18 locations respectively, instead of eight locations, which is the minimum requirement in case of CXLs. In view of this, the industry association requested FSSAI to maintain the existing residue data requirement for working out the MRL values using OECD calculator. Moreover, the National MRLs fixed so far with the same data set did not invite any issue in national residue monitoring programs for export of commodities to other countries. Additionally, in India, 1.25x dose is used for fixation of MRL, while the pesticides are recommended at 1x dose. Besides, the commodities where MRLs are not specified, the SPPR (Scientific Panel on Pesticide Residue) in the FSSAI considers CXLs to harmonize with Codex to avoid trade barriers. With multiple layers of protection and risk assessment in arriving at

Box 1: Proposed data generation scheme for extrapolation of MRLs

Proposal	Group	Bio-efficacy	Residue		MRL fixation/value (Subgroup)
			I/F/ST/ PGRs	Herbicide	
Existing	All crops	3L 2S	4L 1S	3L 2S	For every individual crop
Revised	Representative crop(s)	3L 2S	4L 1S	3L 2S	Sub-group or group MRL to be set based on representative crop
	Member crop (Major commodity in same subgroup as the representative crop)	2L 1S	NR	NR	Based on subgroup/ group MRL
	Member crop (other than major commodity in same subgroup)	1L 1S	NR	NR	Based on subgroup/ group MRL

I – Insecticides; F – Fungicides; ST – Seed treatment; PGRs – Plant growth regulators;
L – Number of locations; S – Number of seasons; NR – Not required

the final MRL based on the crop group, India is bound to achieve global supremacy in agriculture ensuring biosafety and food security.

In addition to the harmonization of MRLs on minor (spices/ specialty/ underutilized) based on crop grouping strategy, the Minor Use Foundation (MUF) further helps to incentivize the residue data for generation of CXLs. These MRLs can be adopted by any countries to comply with the SPS measures without facing any trade concerns. Global MUF's (GMUF) intent to sign MoU with India is under consideration in ICAR to further regularize off-label use of pesticides on these crops. Under the minor use program, GMUF is actively coordinating with countries in Asia, Africa, Latin America etc., for the ease of doing international trade by these countries. It will be in the interest of India to join hands with the MUF to derive the benefits of such international trade endeavours.

6. RECOMMENDATIONS

1. Harmonization of national MRLs through strategic adoption of suitable CXLs needs to be carried out (in case they are less stringent) to minimize its non-tariff trade concerns and facilitate smooth export of agricultural commodities to other countries. The adoption of MRL generated by Codex, of which India is also a signatory, would facilitate fair trade practices, thereby making India acceptable as a global food hub in Amrit Kaal.

2. Label expansion for regulated use of pesticides and setting of MRLs through data bridging/ incentivization should be adopted by India in priority to tide over the limited availability of crop protection solutions on various crops. Adoption of crop grouping approach needs to be pursued aggressively as it provides science based and economically rational solution for label claim expansion of the existing pesticides on other crops. The crop group based MRLs will provide effective solution to harmonize off-label use of pesticides on high value-low volume crops like spices/ specialty/ potential crops which can provide a huge economic edge to the country.
3. The crops like spices and other minor/ specialty crops require specific agroclimatic/ ecological niches and habitats for their growth (viz. saffron and shah jeera in Kashmir, black pepper in Kerala, large cardamom in NE, seed spices in Rajasthan, etc.). Their evaluation in different agroclimatic regions, as mandated for widely cultivated crops, is not possible. In such cases, the monitoring data for fixation of MRL can provide a globally accepted risk-based assessment for safe use of pesticides.
4. For easy international trade, active engagement is required with the Minor Use Programme promoted and coordinated by the Global Minor Use Foundation (GMUF).

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