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System Approach of IPM in Sustainable Agriculture and to Mitigate the Challenges in India's Agricultural Export Ambitions

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ABSTRACT

The global food basket has been greatly enriched by India's agriculture and diverse climate types which have evolved a great potential for export of large quantum of agricultural horticultural produce and processed foods. Unfortunately, post-harvest losses of these produce in India are higher which may be attributed to poor post-harvest management, absence of cold chain and processing facilities. In addition to these losses during export, India's ambitions as a global agri-export hub faced serious damage due to stringency on maximum residue limit (MRL) norms of the developed country. Increased use of pesticides may be attributed to the resistance to pesticides as a result of excessive and injudicious use by the farmers which eventually lead to higher residue levels in food commodities. To cope up with this situation knowledge dissemination among farmers proper about the severe consequences of using excessive pesticides and insist them to adopt IPM strategy, regular surveillance of field as well as market by appropriate authorities needed to be monitored.

Key words : MRL, Pesticide residues, International trade, Agri-trade in West Bengal, IPM strategy, Awareness.

Introduction

India's agrarian culture and diverse climate types have made significant contributions to the global food basket. Mangoes, curries, snacks, and spices from India are famous all over the world. For a quick look at some data points, India leads the production of bananas, papayas, and mangoes in the world. It is also the largest milk producer and the largest producer of spices in the world. With regard to vegetable production, India stands second worldwide. Apart from fulfilling domestic demand, Indian agricultural and horticultural produce, as well as processed foods, is exported to more than 100 countries in the world, particularly to countries in the Middle East, SAARC countries, the EU and the U.S. In the FY 2019, exports of agricultural and processed food products totalled USD 3.59 billion. Agri-processing and Agri exports attain importance as a key area especially because post-harvest losses in India are high, and range from 8-18%. The reasons include poor post-harvest management, absence of cold chain and processing

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facilities. Rather than allowing produce to go waste, having a well-planned export system will help cut down losses and at the same time, earn revenue for the country. Also, a farmer-centric approach is required for improved income through value addition at source itself so that losses across the value chain can be minimized.

MRL limits are defined as safe limits that are supposed to define the maximum expected level of a pesticide (*or any other agricultural chemical*) on a food commodity after its safe and authorized use. It may be noted that these limits are food product specific and serve as monitoring tools to prevent illegal and/or excessive use of a pesticide and ensure compliance with the registered label. While developed countries have traditionally been stringently on maximum residue limit or MRL norms, the same are now being adopted in bits and pieces by some developing countries. This is leading to stoppage in shipments and general panic among the exporting community. In the long term, it can cause serious damage to India's ambitions as a global agri-export hub. Indian Food & Bevarage players have faced numerous issues based on MRL levels over the past few years in markets such as the US, Vietnam, EU, Saudi Arabia, Japan and Oman. Recently, Egypt has introduced checks on agriculture produce against 450 pesticides at port which resulted in non-clearance of containers of rice and spices from India at Egyptian ports. India needs to aggressively counter MRL changes where they lack scientific basis, either bilaterally or through the WTO. On the other hand, it is necessary to comprehensively audit, the gaps with internationally accepted norms and address them through urgent countermeasures. The number of SPS measures notified to the WTO has increased exponentially and standards have consistently evolved in national, international and individual supply chains. This is even more prominent in major markets like the US, the EU and Japan, where SPS requirements such as maximum residue limits of various Plant Protection Products (*PPPs*) and levels of contamination have grown more and more stringent. Exports of products including fresh fruits, spices, rice, tea and marine products have faced rejections or bans in markets such as the US, Vietnam, EU, Saudi Arabia, Japan and Bhutan, due to issues related to health and food safety standards.

Why pesticide residues occur in agricultural commodities???

- Contamination of the crops or animals exposed to chemicals in the environment
- Intentional use of pesticides for crop protection or stored products
- Unintentional exposure to pesticides would occur in crops, grown in soil treated.
- Previously contaminated by foliar treatment of other crops grown earlier in the rotation.

Impact of pesticide residues in international trade is due to following reasons

1. Presence of higher than approved level of pesticide residue

In the past, a number of Indian consignments to US and EU (European Union) markets have faced notifications, rejections and alerts due to the presence of

higher than approved levels of pesticide residue.

2. Frequent Lowering of MRLs

In case of certain chemicals, developed countries lower their MRLs frequently, sometimes more than twice or thrice in a year, which creates barriers for exporters. For example, a number of exporters in the survey pointed out that the EU lowers the MRLs of chemicals very frequently. Though the EU issue the MRL change notifications and a 6-month notice to implement the new limits is given, this period may not be sufficient for Indian farmers to change the cropping pattern in their fields. The exporters also pointed out that every time the MRLs changes, they may have to change their lands from which they source and conduct laboratory tests to ensure that their products are conform to the new MRL standards. This would add up the cost and leads to reduction in their profits.

3. Lowering of MRLs without any Scientific Justification

According to Article 5.7 of WTO SPS Agreement, sometimes, as a precautionary principle MRLs may be lowered without scientific justification and this may go unchallenged in the WTO

4. Lack of Harmonisation of Standards across Countries

Different countries permit different MRLs, and exporters have to meet individual country requirements to be able to export to the respective markets.

5. Rigid Import Requirements Imposed by Importing Countries

The rigid import requirements imposed by importing countries could be often, that the exporting countries should have specific requirements regarding technology used, laboratory testing procedures, etc., which exporters have tocomply with.

6. Strict pesticide residue standards have severe negative effects on trade in developing countries, resulting in a significant decrease in the export of food and agricultural products from developing countries.

7. Even if such standards are adopted, most producers and exporters fail to incorporate such standards in their production process due to limited financial capacity and expertise.

8. International harmonisation of MRL does not exist at a global level.

9. Even though the Codex Alimentarius contains defined levels, they are not statutory.

10. National authorities have the authority to set these limits. As a result, these legal limits can differ significantly from one country to the next.

There are some incidents listed below where many export consignments had been cancelled by foreign countries due to the MRL value higher than their recommendation

1. Rejection of chilli consignments from India

Aflatoxin, a food contaminant, has a zero tolerance threshold in the United States. As a result, a few consignments of chilli and chilli products from India were rejected. In Europe, the MRL for aflatoxin is 0.01 ppm. The European Commission (EC) announced on April 4, 2005 that the presence of Sudan dyes in food products

is prohibited due to their carcinogenic nature. Italy rejected an Indian shipment of crushed hot chilli containing the illegal colours Sudan 1 and Sudan 4 in June 2005. The EU rejected 12 Indian food shipments in June, while the US rejected 216 Indian shipments.

2. Rejection of okra from India

The EU rejected an okra shipment from India because pesticide traces exceeded the MRL. Monocrotophos and Acephate were 0.13 ppm in the exported shipment, whereas triazophos was 0.11 ppm. Monocrotophos has an MRL of 0.2 ppm in India, and the other two pesticides are not recommended for use on okra. Monocrotophos, acephate, and triazophos each have EU MRLs of 0.05, 0.02, and 0.01 ppm respectively.

3. Rejection of Indian grapes

Different MRLs in exporting countries are hampering the Indian Ministry of Commerce and Industry's drive to raise grape exports from 37,000 to 44,000 tonnes. Indian grapes have a limited export season, lasting approximately six to seven weeks. An impasse induced by chlormequat, one of 98 pesticides tested on grape consignments to the EU, posed a threat to exports to the EU. In mid-April 2010, the European Union banned table grape shipments containing chlormequat chloride, a Plant Growth Regulator. Chlormequat chloride (lihocin) has an MRL of 0.05 mg/kg in the EU.

4. Pesticide residue problem in rice

Basmati rice is mostly imported by European countries. The EU rejected a shipment of Basmati rice due to isoprothiolane pesticide levels. Finland turned down an organic rice shipment from India. Pesticide residues of inorganic bromide 23 mg/kg were found in a shipment of organic long grain aromatic rice. Wooden pallets used in the shipment of organic products were treated with methyl bromide, which is banned under organic standards all over the world. Due to an increase in the level of tricyclazole (0.1 mg kg 1) in the edible portion of Indian Basmati rice, the European Union reduced imports by up to 1.62 lakh tonnes from April to December 2018. During April-December 2018, India's basmati exports to the EU fell by nearly 60% compared to the previous year, reaching 1.62 lakh tonnes. As a result, basmati rice exports decreased by 60% in comparison to the previous year.

5. Pesticide residue in tea

Teekanne, the Indian market leader, had a delivery of Darjeeling gold tea denied in Germany in 1995 because of the tea leaves containing excessive amounts of illegal pesticides. The insecticides tetradifon and ethion were found in substantially higher concentrations in the tea leaves than Germany's MRLs. Interestingly, different countries' MRLs for the same herbicide vary dramatically. The rejected tea consignment, for example, included 0.24 mg of tetradifon per kilogramme of tea. This was 24 times Germany's fixed MRL. On June 30, 2000, officials from the EU Health and Consumer Protection Bureau announced the new EU Act 2000 42EC. The Maximum Residue Levels (MRLs) for several pesticides were changed as a result of this act. The EU implemented new 134 MRLs for pesticides in tea products on July 1, 2001. The new

EU Food Safety Act has had a substantial impact on the world's main tea exporters, as seen by the drop in export volume. According to quantitative study, tea exports have decreased by 61.6 percent after the MRL was dropped to a 5% significance threshold.

6. Rejection of toxic wheat from Australia (Import scenario)

Australia shipped 1250 tonnes of poisonous wheat to India. The shipment contained 0.07 ppm of chlorpyrifos, which was higher than the Indian tolerance. The MRL in India is set at 0.05 ppm, while the MRL in Australia is set at 0.5 ppm.

In the EU, on the other hand, Indian export products that have faced issues on MRL levels in 2020 include:

- Sesame Seeds – Ethylene Oxide (insecticide)
- Chillies – Chlorothalonil (fungicide)
- Frozen curry leaves – Chlorpyrifos (pesticide)
- Frozen diced red chilli puree: Methamidophos, monocrotophos, acephate, propargite and triazophos
- Frozen blanched vannamei shrimp – Nitrofuran (metabolite) furazolidone
- Basmati Rice – Thiamethoxam, tricyclazole and buprofezin

Current Agri Trade Scenario of West Bengal

- West Bengal's agricultural (Edible vegetable, edible fruit, cereals, milling products, oil seeds, fodder, resins etc.) export in 2019-20 valued at $413.18 million. Top 5 Importing countries are Nepal, Bangladesh, China, Italy, UAE and Thailand. Export of Rice (HS 1006) valued $194.59 million in 2019-20. Top 5 Importing countries are Benin, Egypt, Malaysia, Togo and Sudan**.** (*Source: DGCIS*).
- In the agro and food processing sector, West Bengal is one of the top 3 states with the state specializing in the production and export of vegetables and cereals. The state accounts for 30% of potatoes, 27% pineapples, 12% of bananas and 16% of India's rice production. West Bengal is the largest producer of rice, pineapple, fruits and vegetables in the country and second largest producer of potato and lychees (https://intueriglobal.com/agro-food-processing-in-west-bengal-sector-analysis/).
- In West Bengal, productivity growth in agriculture, particularly in food grain production, contributed significantly to the overall economic growth of the State since the early 1980s. It contributed 21.77% to the State's GSDP in 2018-19.
- The state accounts for 80% of the country's jute production with Hooghly having the maximum concentration of jute mills as the jute belt of West Bengal (https://www.firstpost.com/india/jute-industry-in-west-bengal-faces-crisis-low-wages-exploitation). In fact, The state became the top exporter of vegetables in 2018- 2019. West Bengal produced 29.55 million tonnes (mt) of vegetables in 2018-19 as against 27.70 mt in 2018.
- In spite of leading producer of vegetables, fruits and other products export to high value markets is very

less compared to other states. West Bengal's produces are mainly exported to Bangladesh, Nepal and Bhutan and to some extend to Middle Eastern countries. Among other exportable products such as Onion, Grapes, Pomegranate, Mangos, Litchi all are the produce of other states.

Existing Agri export zone of West Bengal

Crop	Export Zone
Pineapple	Jalpaiguri, Siliguri, Coochbehar, North Dinajpore
Mango	Malda, Murshidabad
Litchi	Malda, Murshidabad, Nadia, North 24 Parganas
Vegetables	Nadia, North 24 Parganas, South 24 Pargana, Howrah
Potato	Hooghly, Bardhaman, Howrah, East Medinipur

Source – Intueri Global

Steps of IPM for sustainable Agriculture and reduction of MRL values in Food crops

Integrated Pest Management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimises economic, health and environmental risks. Control techniques have developed significantly since 2500 BC when the Ancient Sumerians used sulphur compounds to control insects. It was made necessary by changes in farming practices such as block cropping, rely on a smaller selection of varieties, travel, the growing movement of food and trade around the world and more recently, the impact of climate change. All these factors have encouraged the wider spread and more rapid colonisation of pests. Concurrently, these advancements in pest control have enabled farmers to increase yields and simplify cropping systems, contributing to the production of safe, high quality, affordable food. Though Plant Protection Products (PPPs) have benefitted global food production, but in some countries and with certain crops, inappropriate use of pesticides has contributed to concerns around human health and negative environmental impacts, such as water contamination and loss of biodiversity. Increased pest resistance, deauthorization of pesticide products and public concern around the use of PPPs, all means of maintaining plant health for productive cropping is a significant and ongoing challenge to the agricultural and horticultural industries. The consumption of pesticides in India increased several hundred folds from 154 MT in 1953-54 to 80,000 MT in 1994-95 with the Green Revolution being a major contributor. However, since then, the consumption

steadily dropped to 54,135 MT in 1999-2000 because of the ban and restriction on the use of organochlorine pesticides and the introduction of the Integrated Pest Management programme. In the last decade from 2012-13 to 2021-22, India's consumption of chemical pesticides has been an average of 58,429.7 MT. Among states, Maharashtra is the largest consumer of chemical pesticides followed by Uttar Pradesh. With more than 10,000 MT consumed by each of these states annually, the two states alone contributed to 38% to 42.4% of the total chemical pesticides consumed in the country every year since 2015-16. Punjab is the third highest consumer with an average of more than 5525 MT consumed from 2015-16 to 2020-21. Punjab's data for 2021-22 is not yet available. The three states together contributed 48% to 51% of the total consumption during the six years from 2015-16 to 2020-21. IPM aims to address this challenge through the integration of positive and diverse solutions. The following measures are being suggested to reduce the toxicity level in crops for increasing the export potentiality.

1. Proper identification of damage and responsible "pest" : Cases of mistaken identity may result in ineffective actions. If plant damage due to over-watering are mistaken for a fungal infection, a spray may be used needlessly and the plant still dies. If a beneficial insect is eating aphids on a sickly plant, the insect might be killed because of "circumstantial evidence", and make the problem

2. Learn pest and host life cycle and biology : At the time you see a pest, it may be too late to do much about it except maybe spray with a pesticide. Oftentimes, there is another stage of the life cycle that is susceptible to preventative actions. For example, weeds reproducing from last year's seed can be prevented with mulches.

3. Monitor or sample environment for pest population : Preventative actions must be taken at the correct time if they are to be effective. For this reason, once you have correctly identified the pest, you begin monitoring **before** becoming a bigger problem. For example, in school cafeterias where roaches may be expected to appear, sticky traps are set before school starts. Traps are checked at regular intervals so you can see them right away and do something before they get out of hand. Some of the things you might want to monitor about pest populations include :

- pest present/absent?
- distribution - all over or only in certain spots?
- increasing or decreasing in numbers?

4. Establish action threshold (economic, health or aesthetic) : In some cases, a certain number of pests can be tolerated. Soybeans are quite tolerant of defoliation, so if you have only a few caterpillars in the field and their population is not increasing dramatically, there is no need to do anything. Conversely, there is a point at which you MUST do something. For the farmer, that point is the one at which the cost of damage by the pest is MORE than the cost of control. This is an economic threshold. Tolerance of pests varies also by whether or not they are a health hazard (low tolerance) or merely a cosmetic damage (high tolerance in a non-

commercial situation). Personal tolerances also vary - many people dislike any insect; some people cannot tolerate dandelions in their yards.

5. Choose appropriate combination of management tactics : For any pest situation, there will be several options (Cultural, Mechanical, Biological and Chemical) to consider. Four primary components of IPM include:

- Host plant resistance,
- Manipulation of the farming system,
- Enhanced bio-control, and
- Selective use of bio rational and/or synthetic pesticides

6. Evaluate results : We need to evaluate the following options for considerable pest management

- whether our actions have the desired effect or not.
- Whether the adopted management practices gave satisfaction or not.
- Whether there were any side effects due to the adopted preventive measures.
- The future endeavours for the prevailing pests situations.

Major crop pests & their IPM strategy to negate Pest problem as well as MRL and also economical to farmers :

Sl.no.	**Export potential Crops**	**Pests & IPM strategy**
1	Taro (*Colocasia esculenta*)	https://ppqs.gov.in/sites/default/files/taro-ipm-for-export.pdf
2	Snake gourd (*Trichosanthes anguiana*)	https://ppqs.gov.in/sites/default/files/snake-gourd-ipm-for-export.pdf
3	Smooth gourd (*Luffa acutangula*)	https://ppqs.gov.in/sites/default/files/smooth-gourd-ipm-for-export.pdf
4	Sapota (*Manilkara zapota*)	https://ppqs.gov.in/sites/default/files/sapota-ipm-for-export.pdf
5	Ridge gourd (*Lufa acutangula*)	https://ppqs.gov.in/sites/default/files/ridge-gourd-ipm-for-export.pdf
6	Pumpkin (*Cucurbita pepo*)	https://ppqs.gov.in/sites/default/files/pumpkin-ipm-for-export.pdf
7	Okra (*Abelmoschus esculentus*)	https://ppqs.gov.in/sites/default/files/okra-ipm-for-export.pdf
8	Mango (*Mangifera indica*)	https://ppqs.gov.in/sites/default/files/mango-ipm-for-export.pdf

Sl.no.	Export potential Crops	Pests & IPM strategy
9	Little Gourd (*Coccinia grandis*)	https://ppqs.gov.in/sites/default/files/little-gourd-ipm-for-export.pdf
10	Lablab Beans (*Lablab purpureus*)	https://ppqs.gov.in/sites/default/files/lablab-bean-ipm-for-export.pdf
11	Guava (*Psidium guajava*)	https://ppqs.gov.in/sites/default/files/guava-ipm-for-export.pdf
12	French bean (*Phaseolus vulgaris*)	https://ppqs.gov.in/sites/default/files/french-bean-ipm-for-export.pdf
13	Fenugreek (*Trigonella foenum-graecum*)	https://ppqs.gov.in/sites/default/files/fenugreek-ipm-for-export.pdf
14	Drumstick (*Moringa oleifera*)	https://ppqs.gov.in/sites/default/files/drumstick-ipm-for-export.pdf
15	Custard Apple (*Annona reticulata*)	https://ppqs.gov.in/sites/default/files/custard-apple-ipm-for-export.pdf
16	Cowpea (*Vigna unguiculata*)	ipm-for-export.pdf
17	Brinjal (*Solanum melongena*)	https://ppqs.gov.in/sites/default/files/cowpea-https://ppqs.gov.in/sites/default/files/brinjal-HYPERLINK "https://ppqs.gov.in/sites/default/files/brinjal-ipm-for-export.pdf"ipm-for-export.pdf
18	Bottle Gourd (*Lagenaria siceraria)*	https://ppqs.gov.in/sites/default/files/bottle-gourd-ipm-for-export.pdf
19	Bitter Gourd (*Momordica charantia*)	https://ppqs.gov.in/sites/default/files/bitter-gourd-ipm-for-export.pdf
20	Betelvine (*Piper betel*)	https://ppqs.gov.in/sites/default/files/betel-vine-ipm-for-export.pdf
21	Basil *(Cyamopsis tetragonoloba*)	https://ppqs.gov.in/sites/default/files/basil-ipm-for-export.pdf
22	Apple (*Malus domestica*)	https://ppqs.gov.in/sites/default/files/pop-apple_final-_08.12.2022.pdf

Sl.no.	Export potential Crops	Pests & IPM strategy
23	Turmeric (*Curcuma longa*)	https://ppqs.gov.in/sites/default/files/ipm_pop-turmeric.pdf
24	Grapes (*Vitis vinifera*)	https://ppqs.gov.in/sites/default/ files/ ipm_pop_grapes.pdf
25	Pineapple (*Ananas comosus*)	https://ppqs.gov.in/sites/default/files/ HYPERLINK "https://ppqs.gov.in/sites/default/files/%20ipm_pop_for_pineaaple_for_producing_%20quality_fruits_for_export.pdf"ipm_pop_for_pineaaple_for_producing HYPERLINK "https://ppqs.gov.in/sites/default/files/%20ipm_pop_for_pineaaple_for_producing_%20quality_fruits_for_export.pdf"_quality_fruits_for_export.pdf
26	Banana (*Musa* sp.)	https://ppqs.gov.in/sites/default/files/ HYPERLINK "https://ppqs.gov.in/sites/default/files/%20ipm_pop_for_banana_for_producing_%20quality_fruits_for_export.pdf"ipm_pop_for_banana_for_producingHYPERLINK "https://ppqs.gov.in/sites/default/files/%20ipm_pop_for_banana_for_producing_%20quality_fruits_for_export.pdf"_quality_fruits_for_export.pdf
27	For management of specific pests	https://ppqs.gov.in/advisories-section

Related websites may be followed for safe & judicious use of pesticides:

Sl.no.	Organization	Website/link
1	CIB& RC	https://ppqs.gov.in/divisions/central-insecticides-board-registration-committee
2	Registered products (pesticides)	https://ppqs.gov.in/divisions/cib-rc/registered-products
3	Major uses of pesticides	https://ppqs.gov.in/divisions/cib-rc/major-uses-of-pesticides
4	IPM package of practices	https://ppqs.gov.in/ipm-packages

Conclusion

Pesticides are used to protect crops when used in the recommended dose for a particular pest or broader range, however they started developing resistance in pesticides as a result of excessive and injudicious use, which has led to the use of higher doses of pesticides in food commodities in order to protect the crop, and this excessive use has resulted in higher residue levels in food commodities, leading to hamper in international trade, which is why it has become necessary -

1. To raise awareness of a forbidden pesticide's use in a food product.
2. Growers in importer or exporter countries should know which pesticides (registered) to use.
3. Harmonization of MRL values across nations is required.
4. Surveillance of the domestic market to ensure food safety. Availability of high detection instrumentation facility and adoption of universal method for testing and analysis.
5. For important export food commodities, web based software such as Grapenet (created by APEDA, the Agricultural and Processed Food Export Development Authority) should be established.
6. Retailers' licences will be revoked if they seek to sell pesticides that are prohibited.
7. West Bengal has a comparative advantage in terms of production of fresh and processed food products, there is an immediate need to upgrade quality in order to sustain high exports through good agricultural practices.
8. With growing consciousness about food safety and health standards globally, the way forward requires West Bengal to undertake several domestic reforms to improve the quality of its fresh and processed products and upgrade pesticide residue standards to reduce rejections in international markets.

- In case of any rejections and unreasonably high standards without scientific justification set by importing countries, Indian exporters can raise concerns at both bilateral and multilateral forums. For this, there is need for scientific research and adequate data to establish its case.

In a nutshell, proper knowledge among farmers about the severe consequences of using banned or excessive pesticides should be disseminated, and regular surveillance of field as well as market food commodities should be monitored, and to export the commodities, all necessary data related to quarantine should be generated and made available on web-based software (such as grapenet in the case of grapes) so that only that country should be able to export the commodities.

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