

Challenges and Opportunities in Resistance Management: Affected Crops, Modes of Action and Selected Hotspots

CropLife MENA Regional Hub Meeting
Amman, Jordan

July 12, 2023

I. Billy Annan, Ph.D., M.B.A.
Chair of IRAC International & Ag Chair, IRAC Africa

Presentation Outline

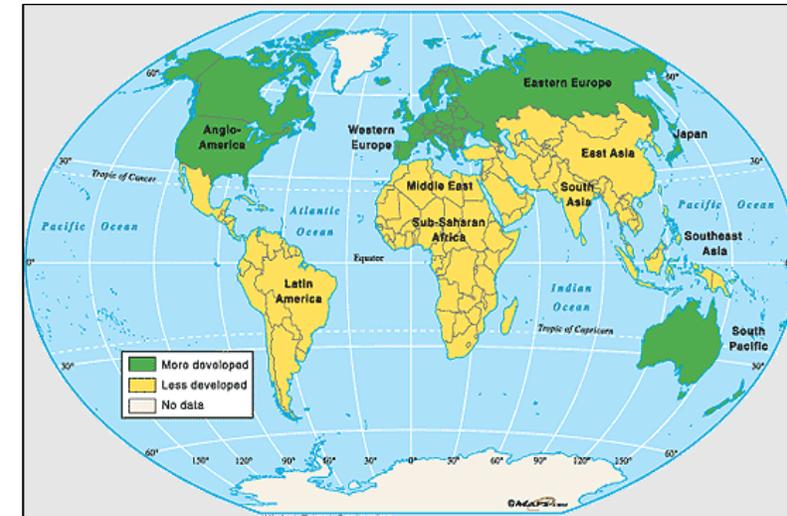
- Introduction of Paper: Abstract & Problem Statement
- Agriculture in Developing World
 - Uncomfortable Conversations: Opportunities, Challenges
 - Roles of Public vs. Private Entities in Promoting RM Best Practices
- *IRAC (RACs) Step into the 'Breach'*:
 - IRAC Organization: Summary of Goals, Tools and Resources
 - Examples of prog
 - MoA and Labeling Guidance
 - Communication and Education
 - Outreach Activities
- Technical Guidance for Resistance Monitoring and Resistance Management
- Newly-established IRAC Africa-Middle East Network and its Relevance
- Summary and Conclusions

Abstract & Problem Statement

- The developing world has significant advantages in arable land, biodiversity and other natural resources and in human resource and technical competency, and thus can play an important role in agricultural growth and productivity.
- Growth in global trade in agricultural commodities has led to the fast spread of pest problems in new regions. The developing world tends to be worse off in such developments. Examples include the recent spread of the fall armyworm from the Americas to Africa and southern Asia, and diamondback moth from Asia to RoW.
- However, the developing world is often not included as equal partners in global agricultural issues and appropriate mitigations.
- IRAC is a global agrochemical technical organization. It promotes the stewardship of insect control products, to preserve important production inputs for agriculture and health, including in the developing world.

Agriculture in the Developing World - *The Opportunities*

1. Historically many countries developed on platform of agriculture, e.g., Brazil, China, India, USA.
2. Developing world, a.k.a. 'Global South' or 'Third World' is next frontier for agricultural growth.
**This presentation highlights trends in Africa and Middle East, Latin America, and southern Asia.*
3. According to the World Bank (2021), agriculture is a significant avenue for addressing food security and poverty alleviation:
 - 65% of poor adults work in agriculture
 - accounts for >25% of GDP in the developing world
 - 2 to 4 times more effective in raising incomes vs. other sectors
4. Africa has ~60% of global arable land, thus with appropriate technologies can lead the next global agricultural revolution.
5. Recent data indicate that the developing world has significant role to play in agricultural productivity:
 - developing world has got richer faster
 - greatest gains in yield and profit
6. Solutions depend on raising production through technology.



Agricultural Systems in The Developing World - *The Challenges*

1. Increased incidence and severity of pest, disease and weed problems
 - knowledge of pests: spectrum, differences between pests & beneficial arthropods
 - availability of pest management products/facilities
 2. Liberalization of global trade in agriculture has introduced of new pests and resistant populations into new regions of the world, e.g., fall armyworm and diamondback moth
 3. Prevalence of pest resurgences and secondary outbreaks
 4. Lack of promotion of agricultural production beyond subsistence farming.
 5. Limited access to precision application methods
 - effective use of appropriate technologies, tools, and resources for greater impact
 6. Limited product use support and other technical systems/services
 - access to information and proper use of pesticides, product stewardship education
 7. Limited presence of agrochemical companies, such as R&D centers, manufacturing facilities, human resource development and local staffing
 8. Relatively poor regulatory structures and enforcement mandates
- ❖ **Above- scenario poses perfect scenario for pests to develop resistance.**

Establishing Resistance Management Best Practices in the Developing World

Role of Government (Countries & Development Partners)

1. Strengthening of regulatory environment and oversight
 - product registrations
 - prevention of illegal products
2. Capacity building in agriculture and agrochemicals
 - curriculum development: resources, skills and processes
 - establishment and broadening of extension services

Role of Agrochemical Companies & Industry Groups

1. Promote proper use of insecticides
2. Provide training and information materials for:
 - Farmer associations and other value chain players (e.g., distributors, retailers, etc.)
 - Governmental organizations: extension services, policy makers
 - NGOs and other influencers in the agriculture sector
 - Educational institutions: schools, universities, etc.
3. Increased presence in developing countries, in terms of facilities and local staffing
4. Collaborations among industry groups: private, public, trade associations

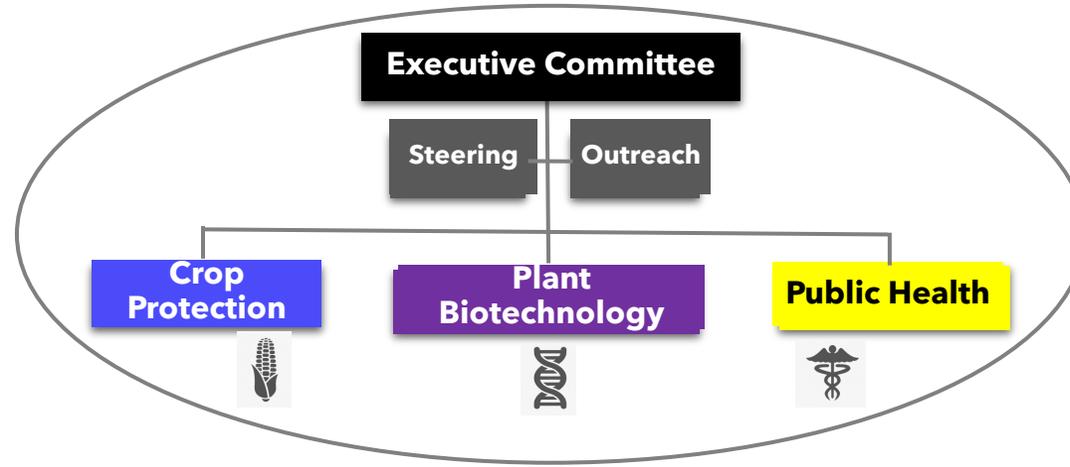
.....and IRAC (and the RACs) Step Into The 'Breach'!

1. Global Response to a Global Problem: Insecticide resistance is a global challenge and IRAC is delivering strategic responses with local and worldwide initiatives.
2. Objective: To prolong effectiveness of insecticides, acaricides and traits by providing information and guidance that supports the implementation of resistance management strategies, countering development of resistance
3. Core Sectors: Crop Protection, Plant Biotechnology, Public Health.
4. Specialized working groups
5. Tools: (i) **MoA classification**, (ii) **Resistance monitoring**, (iii) **Technical guidance documents for resistance management**, (iv) **Communication and education on insecticide resistance**, (v) **Outreach to country groups and other stakeholders**
6. Activities & Programs: Communications, Education, Meetings, Partnerships
7. Diversity: Worldwide coverage: different cultural backgrounds and technical and experiences of members
8. Collaborations: Together with counterpart RACs HRAC, FRAC and RRAC, IRAC is sponsored by the CropLife International (CLI) stewardship program.

IRAC International Operating Structure



IRAC INTERNATIONAL



- Methods
- Mode of Action
- Public Health
- Biotechnology
- Sucking Pests
- Chewing Pests
- Nematodes
- IRAC TASK TEAMS

IRAC Country & Regional Groups

IRAC Argentina	CropLife Australia	IRAC Brasil	IRAC China	IRAC India
IRAC Indonesia	IRAC Israel	IRAC Italy	IRAC Japan	IRAC Korea
IRAC Malaysia	IRAC Mexico	IRAC Morocco	IRAC Paraguay	IRAC Philippines
IRAC S. Africa	IRAC Spain	IRAC Taiwan	IRAC Thailand	IRAC Turkey
IRAC USA	IRAC Vietnam	IRAC Africa-ME	IRAC Asia	IRAC Europe



IRAC International Update: Goals, Tools & Resources

IRAC International:

- IRAC is dedicated to prolonging the effectiveness of insecticides, nematicides and acaricides by countering resistance.
- Our tools:
 - MoA classification
 - Resistance monitoring
 - Technical guidance documents for resistance management
 - Communication and education on insecticide resistance
 - Outreach to country groups and other shareholders
- Specialized working groups

IRAC:
MoA CLASSIFICATION

IRAC Mode of Action Classification

➤ MoA working group

22 Voltage-dependent sodium channel blockers <i>See footnotes for further information on sub-grouping</i>	22A Oxadiazines 22B Semicarbazones	Indoxacarb Metaflumizone
23 Inhibitors of acetyl CoA carboxylase	Tetronic and Tetramic acid derivatives	Spirodiclofen, Spiromesifen, Spiropidion, Spirotetramat
24 Mitochondrial complex IV electron transport inhibitors	24A Phosphides 24B Cyanides	Aluminium phosphide, Calcium phosphide, Phosphine, Zinc phosphide Calcium cyanide, Potassium cyanide, Sodium cyanide
25 Mitochondrial complex II electron transport inhibitors <i>See footnotes for further information on sub-grouping</i>	25A beta-ketonitrile derivatives 25B Carboxanilides	Cyenoxyprafen, Cyflumetofen Pyflubumide
28 Ryanodine receptor modulators	Diamides	Chlorantranilprole, Cyantranilprole, Cyclanilprole, Flubendiamide, Tetranilprole
29 Chordotonal organ modulators - undefined target site	Fonicamid	Fonicamid



Insecticide Resistance Action Committee
Mode of Action Classification

Key to Targeted Physiology

- Nerve & Muscle
- Growth & Development
- Respiration
- Midgut
- Unknown or Non-specific

Group 1: Acetylcholinesterase (AChE) inhibitors
(Only representative actives of the groups are shown)

1A Carbamates
1B Organophosphates

Group 2: GABA-gated chloride channel antagonists

2A Cyclopyrimidines
2B Phenylpyrazoles (Fipronil)

Group 3: Sodium channel modulators
(Only representative actives of group 3A are shown)

3A Pyrethroids
3B DDT, Malathion

Group 4: Nicotinic acetylcholine receptor (nAChR) competitive modulators

4B Nicotine
4C Sulfoximides
4D Salutaridols
4F Pyridylidene
4A Neonicotinoids
4E Mesothiazols

Group 5: Nicotinic acetylcholine receptor (nAChR) allosteric modulators site I

5 Spinosyns

Group 6: Glutamate-gated chloride channel (GluCl) allosteric modulators

6 Auroxime & Milbemectin

Group 7: Juvenile hormone mimics

7A Juvenile hormone analogues
7B Fenoxycarb
7C Pyriproxyfen

Group 8: Miscellaneous non-specific (multi-site) inhibitors

8A Alkyl halides
8B Chlorophacin
8C Fluorides
8D Sorbic acid
8E Tartar emetic
8F Methyl isothiocyanate generators

Group 9: Chordotonal organ TRPV channel modulators

9D Pyrazoles
9E Pyrazoles

Group 10: Mitochondrial complex I electron transport inhibitors

10A Chlorantranilprole
10B Spirochlorfen
10C Spirochlorfen
10D Spirochlorfen

Group 11: Microbial disruptors of insect midgut membranes

11A Bacillus thuringiensis
11B Bacillus thuringiensis
11C Bacillus thuringiensis

Group 12: Inhibitors of mitochondrial ATP synthase

12A Diafenathion
12B Organotin miticides
12C Propargyl
12D Teraflon

Group 13: Uncouplers of oxidative phosphorylation via disruption of proton gradient

13 Pyrimethanil, Sulfoximide, Dithianon

Group 14: Nicotinic acetylcholine receptor (nAChR) channel blockers

14 Nitenpyrin, Imidacloprid, Thiamethoxam, Acetamiprid, Clothianidin

Group 15: Inhibitors of chitin biosynthesis affecting ChS1
(Only representative actives of group are shown)

15 Benzoylureas

Group 16: Inhibitors of chitin biosynthesis, type 1

16 Buprofezin

Group 17: Molting disruptors

17 Cyromazine

Group 18: Ecdysone receptor agonists

18 Dicyclohexyldiureas

Group 19: Octopamine receptor agonists

19 Atrazin

Group 20: Mitochondrial complex III electron transport inhibitors - Qo site

20A Hydroxymethylnon
20B Acetamiprid
20C Flucypridin
20D Bifenoxate

Group 21: Mitochondrial complex I electron transport inhibitors

21B Rotenone
21A MET acaricides and insecticides

Group 22: Voltage-dependent sodium channel blockers

22A Oxadiazines
22B Semicarbazones

Group 23: Inhibitors of acetyl CoA carboxylase

23 Tetronic & Tetramic acid derivatives

Group 24: Mitochondrial complex IV electron transport inhibitors

24A Phosphides
24B Cyanides

Group 25: Mitochondrial complex II electron transport inhibitors

25A beta-ketonitrile derivatives
25B Carboxanilides

Group 26: Ryanodine receptor modulators

26 Chlorantranilprole, Cyantranilprole, Cyclanilprole, Flubendiamide, Tetranilprole

Group 27: Chordotonal organ nicotinamide inhibitors

27 Fonicamid

Group 28: GABA-gated chloride channel allosteric modulators

28 Meta-diamides & Isoxazolines

Group 29: Baculoviruses

29 Granuloviruses & Nucleopolyhedroviruses

Group 30: Nicotinic acetylcholine receptor (nAChR) allosteric modulators site II

30 Omega-ketone HOTA-Hv1a peptide

Group 31: Calcium-activated potassium channel (KCa2) modulators

31 Acetamiprid

Group 32: Mitochondrial complex II electron transport inhibitors - Qi site

32 Flurothiazuron

Group 33: Chordotonal organ modulators - undefined target site

33 Dicyclohexyldiureas

UN: Unknown or uncertain mode of action

UN1 Botanical essences
UN2 Botanical essences
UN3 Botanical essences
UN4 Botanical essences
UN5 Botanical essences
UN6 Botanical essences
UN7 Botanical essences
UN8 Botanical essences
UN9 Botanical essences
UN10 Botanical essences
UN11 Botanical essences
UN12 Botanical essences
UN13 Botanical essences
UN14 Botanical essences
UN15 Botanical essences
UN16 Botanical essences
UN17 Botanical essences
UN18 Botanical essences
UN19 Botanical essences
UN20 Botanical essences
UN21 Botanical essences
UN22 Botanical essences
UN23 Botanical essences
UN24 Botanical essences
UN25 Botanical essences
UN26 Botanical essences
UN27 Botanical essences
UN28 Botanical essences
UN29 Botanical essences
UN30 Botanical essences
UN31 Botanical essences
UN32 Botanical essences
UN33 Botanical essences
UN34 Botanical essences
UN35 Botanical essences
UN36 Botanical essences
UN37 Botanical essences
UN38 Botanical essences
UN39 Botanical essences
UN40 Botanical essences
UN41 Botanical essences
UN42 Botanical essences
UN43 Botanical essences
UN44 Botanical essences
UN45 Botanical essences
UN46 Botanical essences
UN47 Botanical essences
UN48 Botanical essences
UN49 Botanical essences
UN50 Botanical essences
UN51 Botanical essences
UN52 Botanical essences
UN53 Botanical essences
UN54 Botanical essences
UN55 Botanical essences
UN56 Botanical essences
UN57 Botanical essences
UN58 Botanical essences
UN59 Botanical essences
UN60 Botanical essences
UN61 Botanical essences
UN62 Botanical essences
UN63 Botanical essences
UN64 Botanical essences
UN65 Botanical essences
UN66 Botanical essences
UN67 Botanical essences
UN68 Botanical essences
UN69 Botanical essences
UN70 Botanical essences
UN71 Botanical essences
UN72 Botanical essences
UN73 Botanical essences
UN74 Botanical essences
UN75 Botanical essences
UN76 Botanical essences
UN77 Botanical essences
UN78 Botanical essences
UN79 Botanical essences
UN80 Botanical essences
UN81 Botanical essences
UN82 Botanical essences
UN83 Botanical essences
UN84 Botanical essences
UN85 Botanical essences
UN86 Botanical essences
UN87 Botanical essences
UN88 Botanical essences
UN89 Botanical essences
UN90 Botanical essences
UN91 Botanical essences
UN92 Botanical essences
UN93 Botanical essences
UN94 Botanical essences
UN95 Botanical essences
UN96 Botanical essences
UN97 Botanical essences
UN98 Botanical essences
UN99 Botanical essences
UN100 Botanical essences

Use of Sub-Groups:

- Sub-groups represent distinct structural classes which are believed to have the same mode of action.
- Sub-groups provide differentiation between compounds that may bind at the same target site but are structurally different enough that risk of **resistance cross-resistance** is lower than for those chemical analogues.
- Cross-resistance potential between sub-groups is higher than between groups, so relation between sub-groups should be considered only when there are no alternatives, and only if cross-resistance does not exist, following consultation with local expert advice. These exceptions are not sustainable, and alternative options should be sought.

Disclaimer: While CropLife International and IRAC make every effort to present accurate and reliable information, they do not guarantee the accuracy, completeness, efficacy, timeliness, or correct sequencing of such information. Inclusion of active ingredients on the IRAC Code List is based on scientific evaluation of their mode of action. It does not provide any kind of endorsement for the use of a product or a judgment on efficacy. CropLife International and IRAC are not responsible for, and expressly disclaim all liability for, damages of any kind arising out of use, reliance on, or reliance on information provided. Listing of chemical classes or mode of action must not be interpreted as approval for use of a compound in a given country. Prior to implementation, each user must determine the current registration status in the country of use and strictly adhere to the uses and instructions approved in that country.



CropLife

IRAC Mode of Action Classification

MoA Working Group updates:

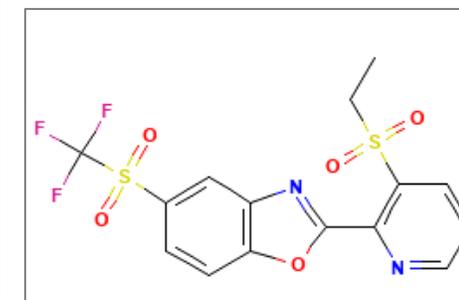
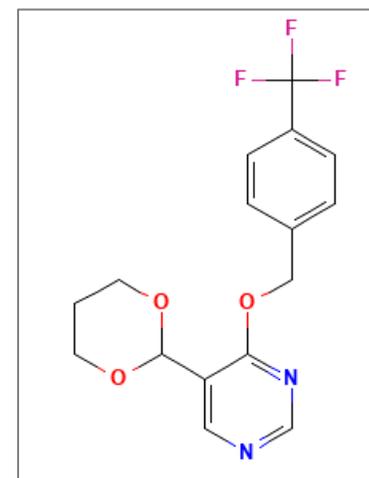
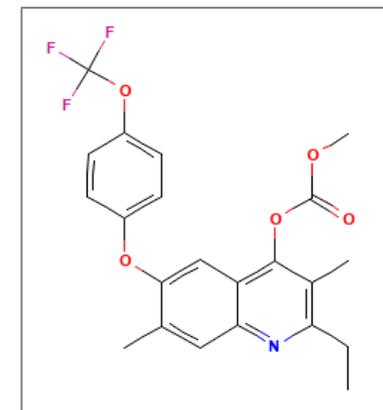
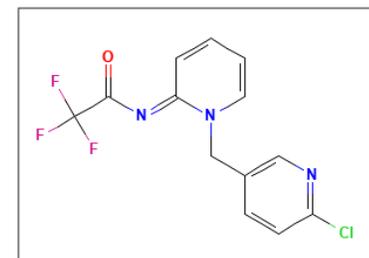
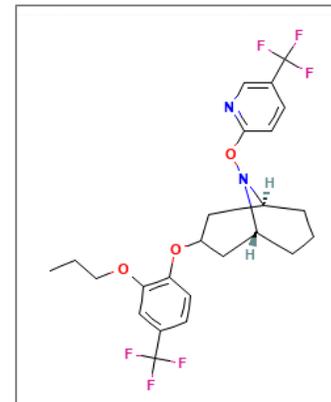
➤ MoA Classification Scheme (v.10.4) & MoA Poster released on website (Dec 2022)

- New MoA Groups:

- **Group 33:** calcium-activated potassium channel (KCa2) modulators: '**Acynonapyr**'
- **Group 34:** METI complex III electron transport inhibitors - Qi site: '**Flometoquin**'
- **Group new:** Chordotonal organ modulators, undefined site: '**Dimpropyridaz**'
- **Sub-group 4F** 'Pyridylidenes: '**Flupyrimin**'
- **Group 30:** Isocycloseram was added
- **Group UN (unknown MoA):** 'Oxazosulfyl' and 'Benzpyrimoxan' were added
- **New 'targeted physiology group':** RNAi-based technologies, titled 'RNA interference mediated target suppressors' (new MoA group, added to Appendix 6 for a.i.'s pending registration): '**Ledprona**' -> Colorado Potato Beetle

➤ v.10.5 - (March 2023) - New MoA Group listings:

- **Group 29:** renamed to "chordotonal organ nicotinamidase inhibitors"
- **Group 36:** A new MoA Group which contains the active '**Dimpropyridaz**' (group is named "Chordotonal organ modulators - undefined target site")
- **Dicloromezotiaz**, previously, in Appendix 6 (active ingredient pending registration), has been moved to Group 4E, Mesoinics, within Group 4, "Nicotinic acetylcholine receptor (nAChR) competitive modulators".
- **New peptide, U1-AGTX-Ta1b-QA**, classified as "Unknown or uncertain MoA - subgroup UNP (peptides of unknown or uncertain MoA)" and has been added to the Classification Scheme, Appendix 6, pending registration





IRAC MoA Classification

MoA Classification Goal & Context

The IRAC Mode of Action (MoA) classification provides growers, advisors, extension staff, consultants and crop protection professionals with a guide to the selection of acaricides or insecticides for use in an effective and sustainable acaricide or insecticide resistance management (IRM) strategy.

It is the definitive, global classification scheme on the target sites of acaricides and insecticides.



IRAC App

The IRAC app interface consists of three main sections:

- Home Screen:** Features the IRAC logo, a 'RESET' button, and a search bar. Below is a list of 8 MoA categories, each with a dropdown arrow:
 - 1 Acetylcholinesterase (AChE) inhibitors
 - 2 GABA-gated chloride channel blockers
 - 3 Sodium channel modulators
 - 4 Nicotinic acetylcholine receptor (nAChR) competitive modulators
 - 5 Nicotinic acetylcholine receptor (nAChR) allosteric modulators - Site 1
 - 6 Glutamate-gated chloride channel (GluCl) allosteric modulators
 - 7 Juvenile hormone mimics
 - 8 Miscellaneous non-specific (multi-site) inhibitors
- Search Results:** A search for 'flum' displays a list of insecticides:
 - cyflumetofen
 - flumethrin
 - hexaflumuron
 - metaflumizone
 - noviflumuron
 - triflumezopyrim
 - triflumuron
- Classification Diagrams:** A grid of diagrams illustrating the MoA classification scheme, with the IRAC logo and 'MoA of Pesticide Classification' text.

IRAC:
COMMUNICATION & EDUCATION

Communication and Education

Mode of Action Labeling

- Initiative lead by CropLife International and its country organizations with support of the RACs
- Mode of Action (MoA) information, standardized icons & RM instructions
- Member companies of CropLife International and IRAC international promised implementation.
- The initiative is progressing well with 87% of countries on track.



Communication and Education

Mode of Action labeling

GROUP 1A INSECTICIDE

GROUP N-3 NEMATOCIDE

Accompanying label Language

RESISTANCE MANAGEMENT

Include:

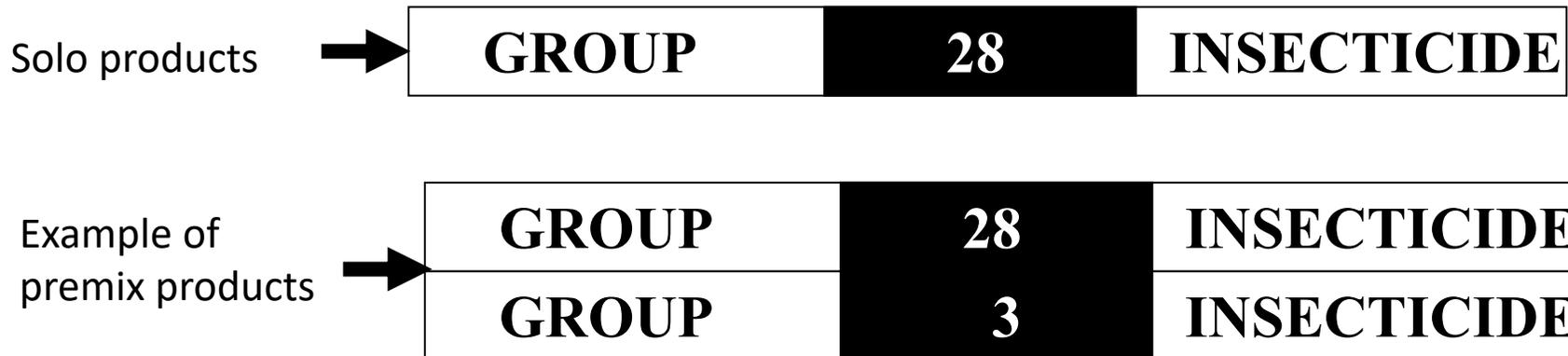
- The name of the active ingredient(s) and MoA identifier
- A statement that the product should be rotated with different modes of action using mode of action treatment windows
- Guidance to avoid treating consecutive insect generations with the same mode of action



IRAC Mode of Action Classification & Label Language on RM

1. Include an IRM section on the label, even if some country regulatory policies allow for little content.

- a. Example with Group 28: Where necessary, change conventional thinking of regulators and work as an industry to add Group 28 MOA icon and IRM language to country labels.
- b. If country does not yet allow MoA icon, then include the term 'IRAC Group 28, Diamide' in the label text; (under: general information, IRM, IPM, etc.)



- **Acceptable Diamide WG Criteria:** One of statements (a) or (b) must appear on the label.

IRAC:
***OUTREACH TO COUNTRY GROUPS AND OTHER
STAKEHOLDERS***

IRAC Outreach Activities to Address IRM Gaps in The World (1)

- 1. Established country/regional support groups in the developing world**
 - Asia rice pest campaigns
 - Africa Team (new!)
- 2. Partnerships with other industry groups and influencers**
 - International agricultural organizations (e.g., CLI, FAO, PR-PICA, GFRAS, country groups)
 - *GFRAS example: Provide advocacy and leadership on pluralistic and demand-driven rural advisory services for sustainable development*
 - other possible linkages with academia, professional societies (e.g., ESA), etc.
- 3. IRAC communication materials**
 - E-connection newsletter, leaflets/booklets
- 4. Audio-visual Aids**
 - pictograms & cartoons
 - videos, audio tapes
- 5. Translation of brochures and promotional materials, e.g., MoA and IRM Videos**
 - multilingual translations into several local/regional languages
 - ✓ *existing: Arabic, Bahasa (Indonesian), English, French, Hindi, Italian, Japanese, Korean, Mandarin Chinese, Portuguese, Russian, Spanish, Tagalog (Philippines)*
 - ✓ *newest: Serbian, Swahili, Turkish*

IRAC Outreach Activities to Address IRM Gaps in The World (2)

6. Publications/Print materials

- MoA classification booklets; posters of chemical structures of different MoA subclasses
- white papers & peer-reviewed journal articles

7. Farmer outreach (CLI communication)

- relaunch and disseminate IRM leaflets.
- develop master document that can be used for translation into multiple languages
- support for CLI and ICM consultants in the creation of a digital information platform

8. Training modules (CP WG)

- pest pages, posters, booklets, guideline documents, etc.
- upgrade and disseminate training modules
- enhance promotional programs/accessibility to online modules and other training materials

9. Developing a Massive Open Online Course (MOOC) for RM in Vectors - by PH WG

- target influencers of insecticides use and stewardship
- collaborate with and adopt best practices from other RACs and WGs
- collaborate with CropLife International (CLI), and CL country/regional teams
- support consortium for vector IRM course
- possible support for future crop/IRM MOOC



Resistance management strategies

1. Integrated Pest Management (IPM)
2. Good application practices
3. Use the correct pesticide dose
4. Use good quality, genuine pesticides
5. Calibrate and maintain the application equipment
6. Mode/Site of Action (MoA) rotation
7. Double-hit strategy
8. Preservation of susceptible insects



Development of pesticide resistance

Practices that may prevent or avoid the development of pesticide resistance

- Using non-pesticide crop and pest management practices for all types of pests – insects, mites, weeds, diseases, and so on.
- Avoiding repeated use of the same pesticide, or pesticides with the same mode of action.
- Rotating pesticides with different mode/site of action.
- Using pesticides that target the most susceptible stages.
- Using selective pesticides, avoiding continual use of broad spectrum pesticides. This is not necessarily true for weeds.
- Applying pesticides according to the dose rates on the label.
- Ensuring even and adequate coverage of the target area.
- Using genuine products.



Cooperation Among Stakeholders

- Consistent messaging from different respected sources
- Grower groups can forge collective action
- Country and regional RACs can ensure alignment on local strategies
- IPM Centers
- Translations and local adaptation of global guidance
- Training of growers, applicators, consultants, and crop advisors
- Massive Online Open Course
 - ***leverage IRAC resistance management expertise to benefit global agriculture***

Recent Examples of IRAC Success Stories

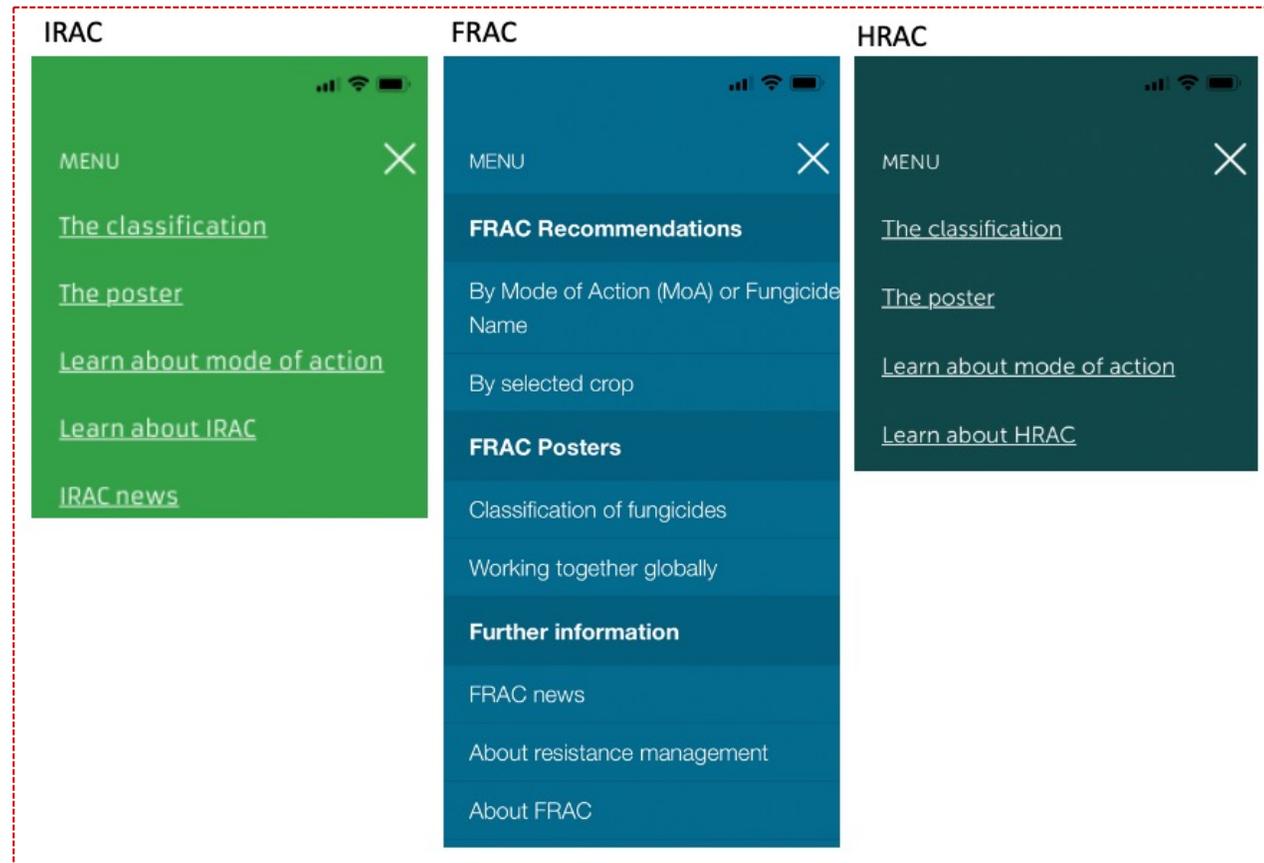
1. Promotion of IRAC MoA number and icon campaign on country labels
2. Mode of action mechanisms and rotations for effective resistance management
3. MoA classification for effective IRM programs (online & printed)
 - Lepidoptera: FAW training module and response
 - Sucking pests IRM guidelines
 - Nematicides MoA Classification
4. New pest pages (to provide training on pest biology and resistance status worldwide)
5. Industry & professional association meetings, e.g., [ESA](#)
6. Establishment of more than ~30 functional country/regional groups, including the most recent - IRAC Africa-Middle East

GROUP	1A	INSECTICIDE
GROUP	N-3	NEMATICIDE



Cross-RAC Collaborations: Databases & GRM App

MoA App - combined RAC GRM App. Note: IRAC, FRAC & HRAC have different levels of additional information available from the Apps, directly and via links to related websites but this could be expanded - **screenshots from the MoA Apps below**:





GESTION DE LA RESISTANCE AUX INSECTICIDES

Pourquoi m'intéresser?

Avantages de la Gestion de la Résistance aux Insecticides

ECONOMIE D'ARGENT:

- Maintient pour longtemps les produits les plus efficaces et minimise le besoin de changement pour des produits plus chers ou moins efficaces.

ECONOMIE DE TEMPS:

- Moins de temps à passer au champ car le besoin des applications multiples est réduit.

AMELIORATION DE LA QUALITÉ DE LA PRODUCTION:

- Suivre strictement les instructions sur l'étiquette aidant ainsi à réduire les dommages et résidus causés par des pesticides.

PROTECTION DE VOTRE PARCELLE & HABITATION:

- Maintenir les insecticides les meilleurs et les plus sains réduit le besoin d'utiliser les options de contrôle des ravageurs les moins favorables sur le plan environnemental.



Pour plus d'amples informations sur la gestion effective de la résistance aux insecticides veuillez contacter le conseiller agricole de votre société cotonnière le plus proche pour les meilleures pratiques de gestion de la résistance.

Réalisé avec le concours de




www.irac-online.org www.croplifeafrica.org

PR-PICA

- A cotton producer initiative across 7 West African countries.
- Having seen the IRAC MoA animation were convinced of the need to introduce MoA labelling throughout the region.
- Introduced IRM training in 2021
- * Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Mali, Senegal, Togo



CONNAÎTRE LE MODE D'ACTION DE VOTRE PRODUIT INSECTICIDE EST LA CLÉ DE LA GESTION DE LA RÉSISTANCE

Le mode d'action de l'insecticide peut être facilement identifié selon l'étiquette de classification de l'IRAC.

GROUP	3A	CYPERMETHRINE
GROUP	1B	CHLORPYRIFOS

Tous les insecticides ayant le même code ont le même mode d'action.

Les produits insecticides peuvent contenir différents ingrédients, mais ils peuvent agir suivant le même mode d'action

Il est important d'éviter d'utiliser de façon répétée des insecticides ayant le même mode d'action

Pour éviter la résistance aux insecticides faire une rotation d'insecticides avec différents modes d'action.

Insecte Ravageur

Conseil additionnel clé pour éviter le développement de la résistance

- Suivre les recommandations de l'étiquette pour les doses d'application et de volume d'eau.
- Utiliser des équipements d'application bien entretenus et bien calibrés.
- Cibler le stade le plus sensible du cycle de vie de l'insecte ravageur.
- Recourir aux insecticides ayant un impact minimum sur les ennemis naturels du ravageur.
- Éviter les insecticides ayant des problèmes de résistance connus.

Disponible pour le téléchargement: www.croplifeafrica.org ou www.prpica.org

Réalisé avec le concours de Croplife Africa Middle East pour le compte des membres de














MANAGE FALL ARMYWORM IN 3 STEPS



1. Incorporate agronomic actions



2. Identify pest and decide when to treat



3. Control FAW using IRM principles

Implement Integrated Pest Management (IPM) Through The Season



Fall Armyworm – FAW – *Spodoptera frugiperda*

This poster is for educational purposes only. Details are accurate to the best of our knowledge but IRAC and its member companies cannot accept responsibility for how this information is used or interpreted. Advice should always be sought from local experts or advisors and health and safety recommendations followed

IRM – Insecticide Resistance Management

*Courtesy Ken Gray Photograph Collection (P 256), Special Collections and Archives Research Center, Oregon State University Libraries.

IRAC document protected by © Copyright – 2021 For further information visit the IRAC website: www.irac-online.org

IRAC:

EXAMPLES OF TECHNICAL GUIDANCE FOR RESISTANCE MONITORING AND RESISTANCE MANAGEMENT

Examples of IRAC Guidance for Resistance Management

1. Biotech working group

- FAW IRM in Bt corn

2. Chewing Pest working group

- poster for cabbage stem flea beetle published; poster for tobacco budworm & RSB ongoing

3. Crop Protection WG

- Role of Insecticide Mixtures and IRM; Impact of novel or unconventional use patterns for insecticides on resistance management

4. Methods working group

- new methods for RSB, jassids, bedbugs; new videos for shipping insect samples; diet incorporation

5. Nematodes working group

- poster for cabbage stem flea beetle published; poster for tobacco budworm & RSB ongoing

6. Public Health working group

- The Resistant Mosquito: staying ahead of the game in the fight against malaria

7. Sucking Pest working group

- presentations: stink bug & maize LH RM data; poster: silverleaf whitefly; IRM guidelines: cereals in Europe

8. Resistance Management

- RM monitoring data sharing (guidelines and NDA template from IRAC Executive Committee)

IRAC:

NEW AFRICA-MIDDLE EAST TECHNICAL NETWORK

IRAC AFRICA-MIDDLE EAST TEAM

- Goal: **leverage IRAC RM expertise to contribute to agriculture and sustainable food security in A-ME region**

ORGANIZATION

- Newest IRAC Group, formed in March 2021
- originally as IRAC Africa but renamed in August 2022 as IRAC Africa-Middle East
- ~25 members from different companies operating in A-ME region and global experts with interest in the region
- support from IRAC International, and CLI Stewardship (especially with Andy Ward, Director)
- recognized as IRAC Regional Team; page on IRAC website: <https://irac-online.org/countries/africa-middle-east/>
- Steering Team formed in February 2022 to serve as coordinating leadership, comprises: **Amr Moussa** (BASF), **Franck Parfait-Krah** (Bayer), **Isaac Oyediran** (Syngenta), **Noredine Elaasri** (FMC), **Roleen LaGrange** (CL-SA), **Zaid Nabas** (Syngenta), **Vincent Gall** (Certs Belchim), **Billy Annan** (FMC/IRAC International)
- Quarterly general meetings, interspersed with Steering Team meetings, as needed
- Interest from with CL-AME since October 2022 in participation of IRAC Africa meetings, and on-going strengthened collaborations with CL-AME since February 2023 with **Evelyn Lusenaka** (Stewardship), and team: **Bakr Abdelmoneim** (ME-NA), **Robert Nofemela** (Southern Africa), **Sylvain Ouedraogo** (West Africa)



IRAC AFRICA-MIDDLE EAST TEAM

- Goal: leverage IRAC RM expertise to contribute to agriculture and sustainable food security in A-ME region

TECHNICAL/OPERATIONAL GOALS (SUPPORT FROM CLAME/CLI)

- Challenge with full membership attendance in meetings, CLI/CLAME can help by emphasizing to companies
- suggested hotspots/concerns for resistance management in CLAME region: ***Amrasca biguttula*** (cotton jassid) – West Africa; ***Bemisia tabaci*** (SLWF) – multiple crops/MoAs/countries; ***Myzus persicae*** (GPA) – multiple crops/MoAs/countries; ***Plutella xylostella*** (DBM) resistance on brassicas (diamides/countries?); ***Spodoptera frugiperda*** (FAW) on corn – multiple MoAs/countries; ***Tetranychus urticae*** (TSSM) – multiple crops/MoAs/countries; ***Tuta absoluta*** (TLM) on fruiting vegetables – MoAs/countries; Vectors: e.g., **mosquitoes**
- Collaborations with local and global organizations in A-ME: e.g., PR-PICA in W/Africa for cotton jassid RM
- Long term collaborations with technical subject experts in CL-ME for baseline (pest) susceptibility monitoring in and field (resistance) monitoring in key countries
- Support with funding from CLAME, CLI, PR-PICA, and other organizations, governments and public sources in A-ME region, for resistance management work of interest in target areas
- Continued support and collaborations from CLAME in other areas, e.g., training and outreach
- other support as appropriate, e.g., expertise leveraging, tech transfer, capacity building, databases, etc.

SUMMARY & CONCLUSIONS

General Summary

1. Expanding global trade and limited knowledge about pest resistance have contributed to the rapid spread of insect pest problems and even introduction of resistant pest species/ populations into new geographies, e.g., FAW from Americas into Africa & Asia.
2. Developing countries have technical capabilities to make significant contributions to global agriculture but may have limited resources, thus need partnerships.
3. It is imperative to engage pest management experts and institutions in developing world in monitoring, evaluation and mitigation of insecticide resistance issues.
4. IRAC is a global network of different companies with members having broad experiences and multidisciplinary backgrounds and collaborations with international partners.
5. IRAC/RACs are in unique position to support the implementation of sustainable resistance management practices to benefit agriculture, esp. in the developing world.
6. Agricultural institutions and policy makers must utilize the expertise of IRAC/RACs in resistance management to benefit of agriculture, especially in developing world.

IRAC Resources and Programs

1. IRAC International

- Governance: Executive, Steering & Outreach Committees
- Geographic Reach: ~30 Country WGs, expansion into new regions/countries
- ~10 multinational companies, members with diverse/rich experience

2. Technical Working Groups & Task Teams

- Pest-based (by crop groups): Chewing Pests, Sucking Pests, Nematodes
- Functional: Mode of Action, Test Methods
- Segments: Biotechnology, Crop Protection, Public Health

3. Social media: YouTube channel (~900 subscribers), Twitter, Facebook

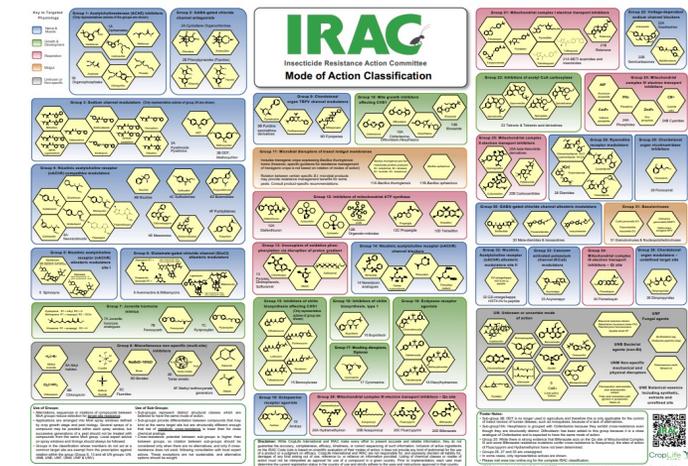
4. Meetings

- IRAC International: Annual Face-to-Face or Virtual teleconferences
- Country WGs meet regularly, run local workshops & training sessions

5. Internet App: Mode of Action (MoA) classification

6. Webpage and web-based resources:

- Selected country WGs websites
- IRAC International: <https://irac-online.org/>



IRAC

Insecticide Resistance Action Committee

THANK YOU!

