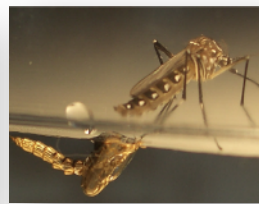
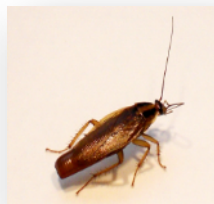




Insecticide Resistance Action Committee

INSECTICIDE RESISTANCE MANAGEMENT IN URBAN PESTS



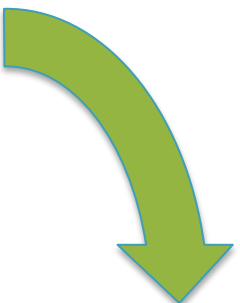
IRAC?

- Insecticide Resistance Action Committee (IRAC)
 - Formed in 1984
 - Specialist technical group of the agrochemical industry association CropLife International.
 - Provides a coordinated industry response to the development of resistance in insect and mite pests.

“Resistance Management for Sustainable Agriculture and Improved Public Health”

IRAC

1992-London



Insecticide Resistance

- “A heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species” (IRAC 2011)



Insecticide Resistance

- Basically: You used to be able to control a pest population with a given insecticide, but now you can't

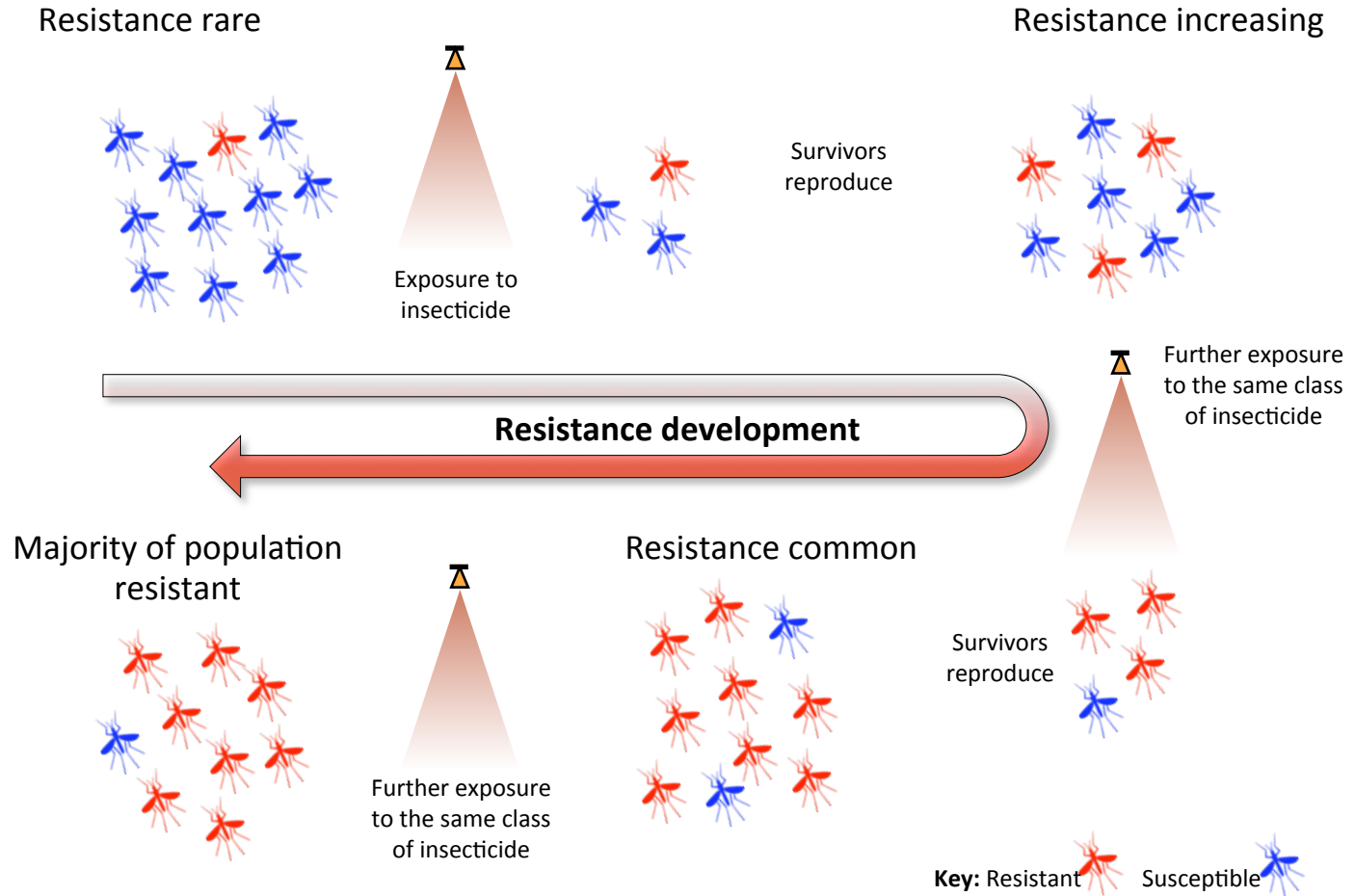


Insecticide Resistance

- Resistance develops due to selection pressure on an insect population, where a subset of the population is able to survive and reproduce after exposure to an insecticide application.

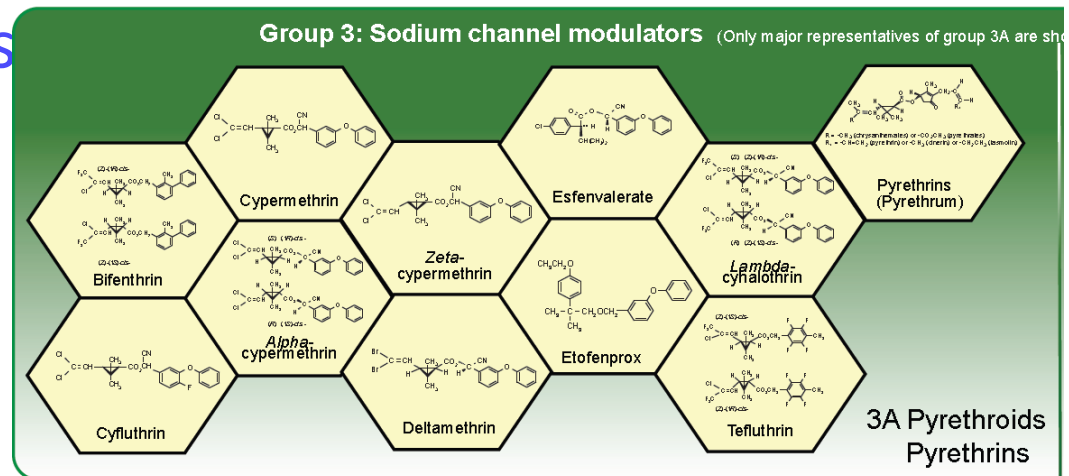


Insecticide Resistance



Insecticide classification

- Insecticides can be classified by their Mode of Action (MoA) based on their site of action
- Insecticides from the same chemical class, e.g. pyrethroids, will have the same MoA
 - There may be many different commercial products based on insecticides from the same chemical class



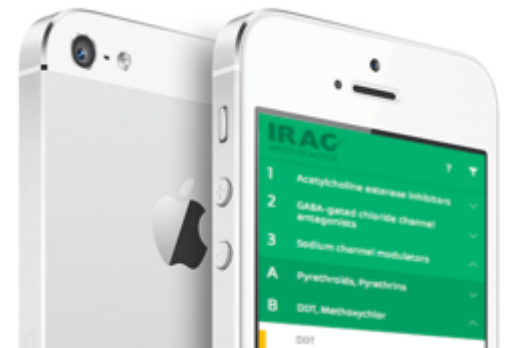
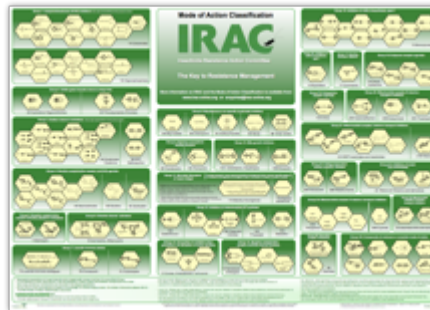
Insecticide classification

- If an insect pest population develops resistance to one insecticide from a MoA class, there will be a high probability that they will have reduced susceptibility to all members of that MoA class – this is called “cross resistance”
 - E.g. if an insect pest population shows reduced susceptibility to one pyrethroid insecticide, there is a high probability they will have reduced susceptibility to other pyrethroids

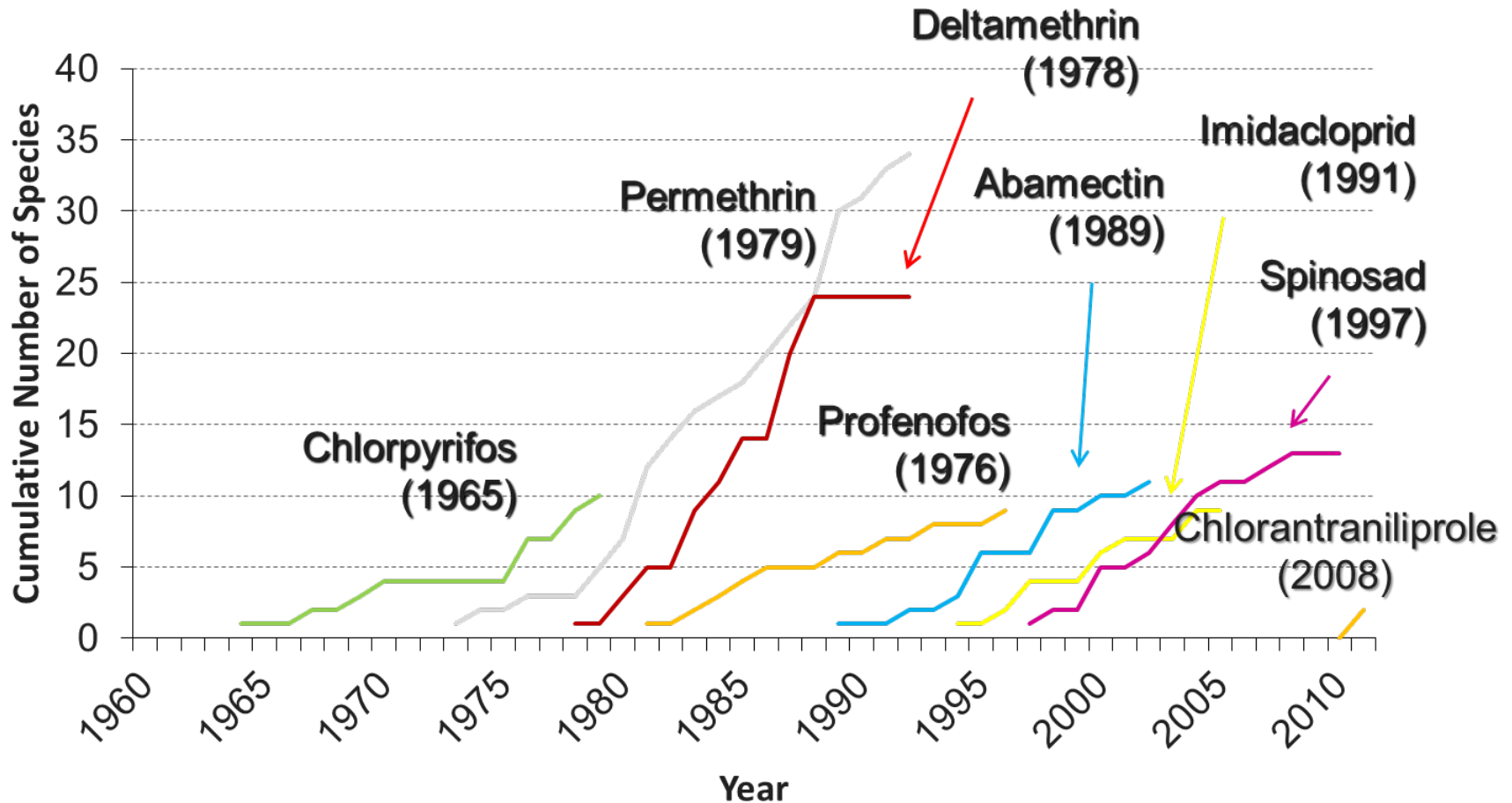


Insecticide classification

- IRAC has produced a comprehensive classification of all commercially available insecticides, allowing products with the same MoA to be readily identified.
 - The MoA classification is freely available online, (www.irc-online.org) as a poster or as an “App” for smart phones (Apple and Android)



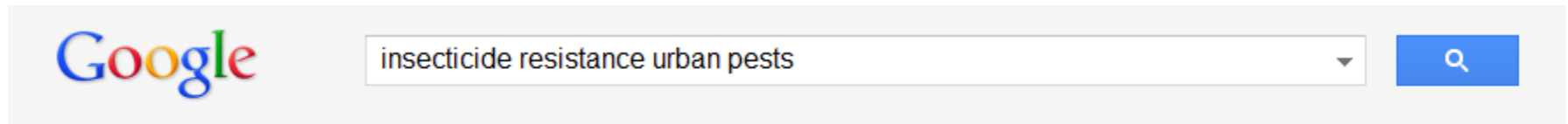
Cases of resistance during the first 14 years following launch (number of species - lab and field)



Resistance can and will develop to any insecticide!

Insecticide Resistance

- There are many reports and papers published describing reduced insecticide susceptibility in urban insect pests
- However, few offer practical advice on how to minimise and manage the development of insecticide resistance



Scholar

About 26,600 results (0.08 sec)

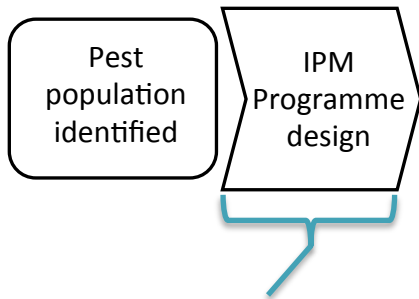
Insecticide Resistance Management

- The aim of an Insecticide Resistance Management (IRM) programme is:
 - “To take actions that reduce an insect population to an acceptable level, in such a way as to maintain the long term effectiveness of the control interventions employed.”



Insecticide Resistance Management

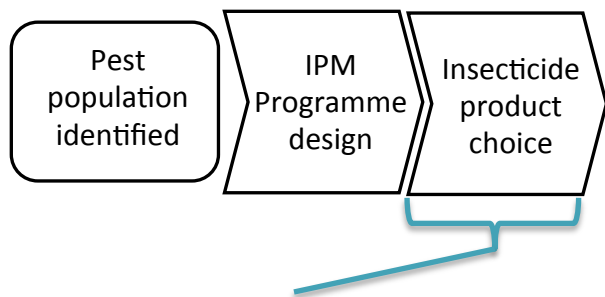
- When an insect pest problem has been identified, the first step in any control programme, is to decide whether and how it will be controlled



What action will be taken?
Physical, chemical or biological control? Exclusion, hygiene, education? No action?

Insecticide Resistance Management

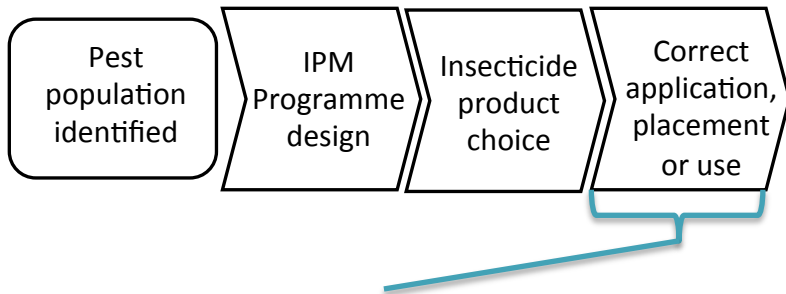
- If an insecticide intervention is warranted, then a choice must be made as to which product to use



Which insecticide class will be used? Which presentation (bait, residual spray, aerosol, etc.) and which product will be fit for purpose?

Insecticide Resistance Management

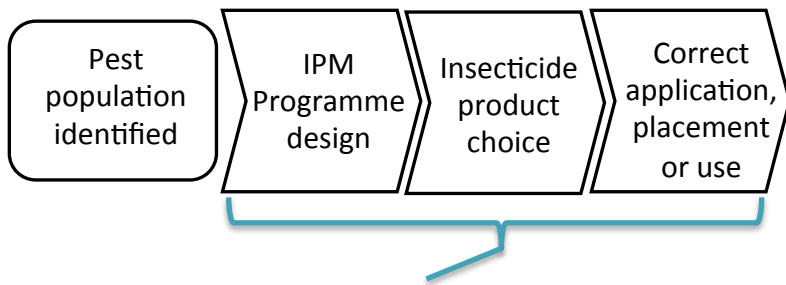
- The insecticide application must be applied at the correct location and time, with suitable application equipment and trained operators



Correctly maintained and used application equipment, trained operator, follow product label directions

Insecticide Resistance Management

- These three steps will define how effective the pest control will be, and the size and composition of any surviving pest population, which impacts insecticide resistance development

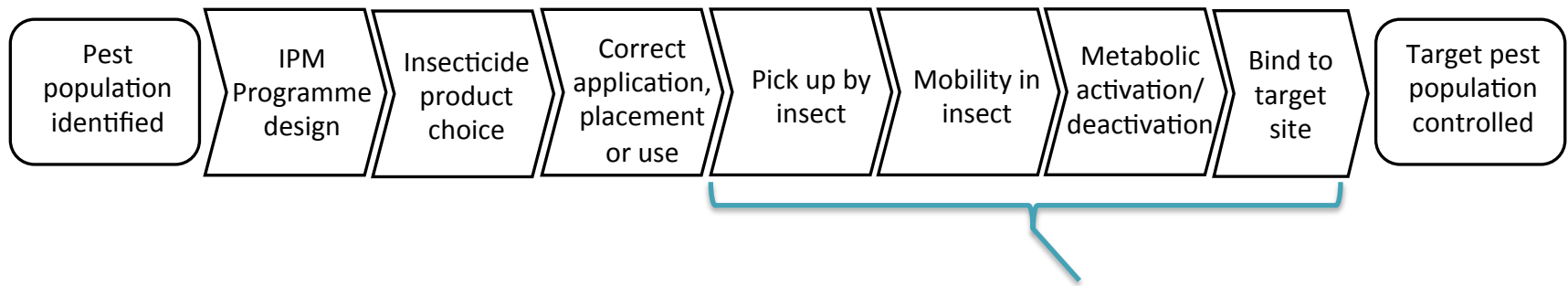


If none of the pest population survive these interventions, they can't pass on any genes for reduced susceptibility

PMPs impact on pest population. Which if IPM/IRM are incorporated will increase customer satisfaction and reduce the potential for resistance development

Insecticide Resistance Management

- A number of steps occur after an insecticide application, which ultimately lead to the successful control of the pest population

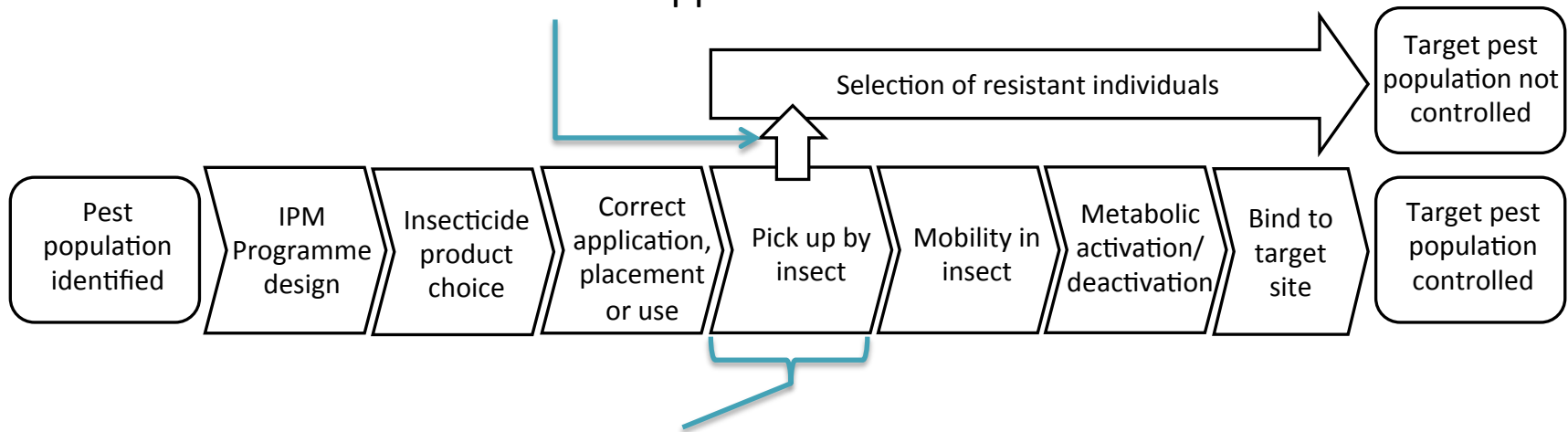


The insecticide's journey from application to target binding site, leading to control of the target insect. This can be impacted by the development of insecticide resistance and requires that you design the correct IPM/IRM programme to minimise its impact.

Insecticide Resistance Management

- Impact of insecticide resistance

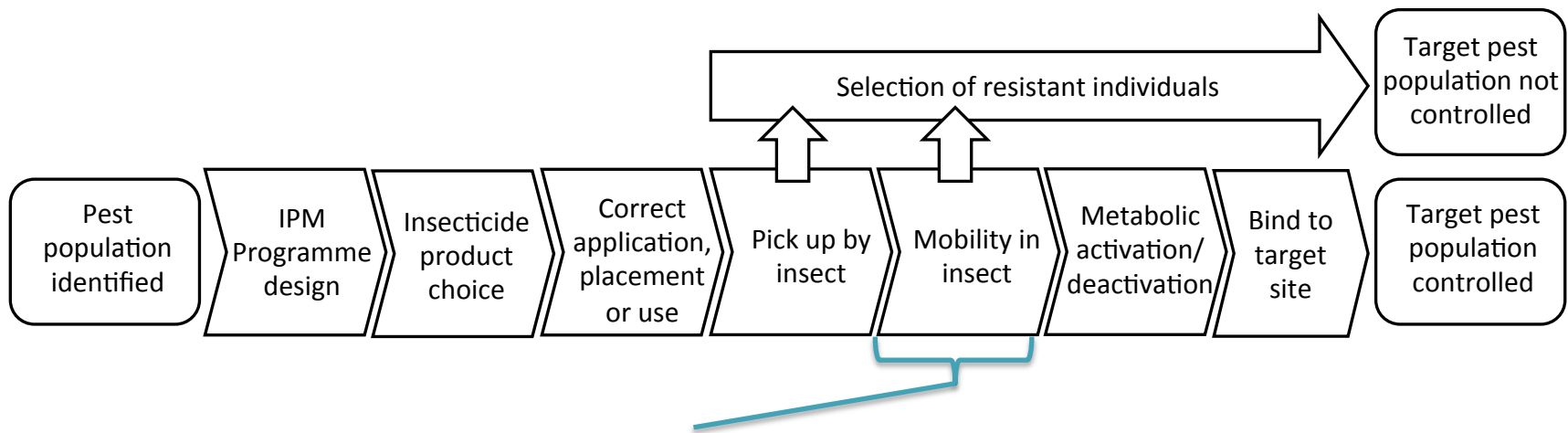
Some of the pest population survives the insecticide application



Insect pest's behaviour changes to minimise contact with and pickup of insecticide. E.g. bait aversion, changes in diurnal activity, etc.

Insecticide Resistance Management

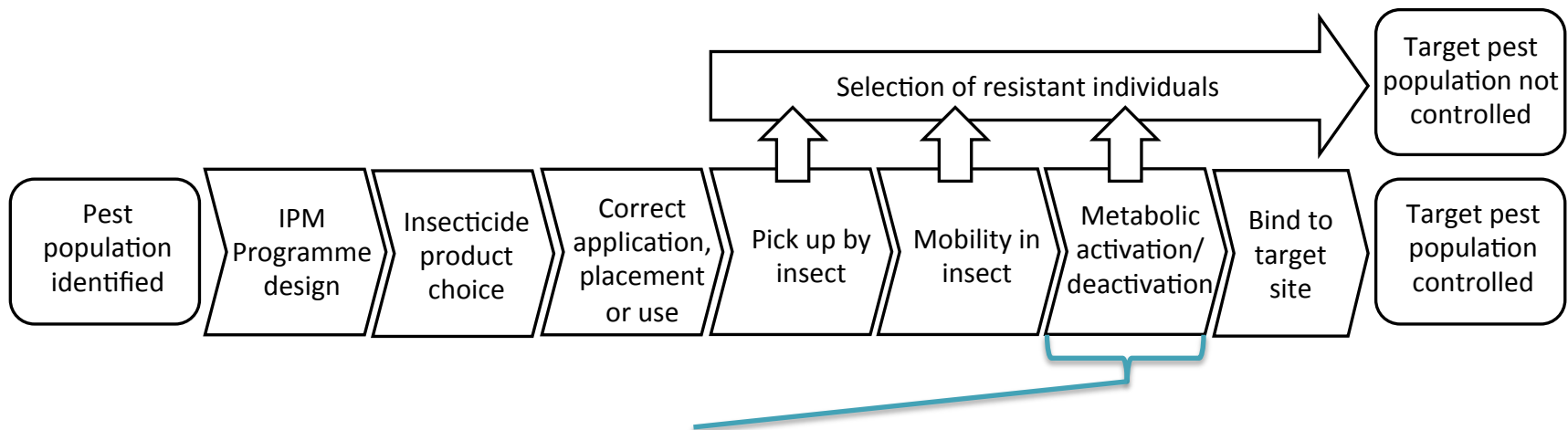
- Impact of insecticide resistance



Changes to insect pest's cuticle, reducing insecticide penetration; increased rates of insecticide excretion, modified active transport, etc.

Insecticide Resistance Management

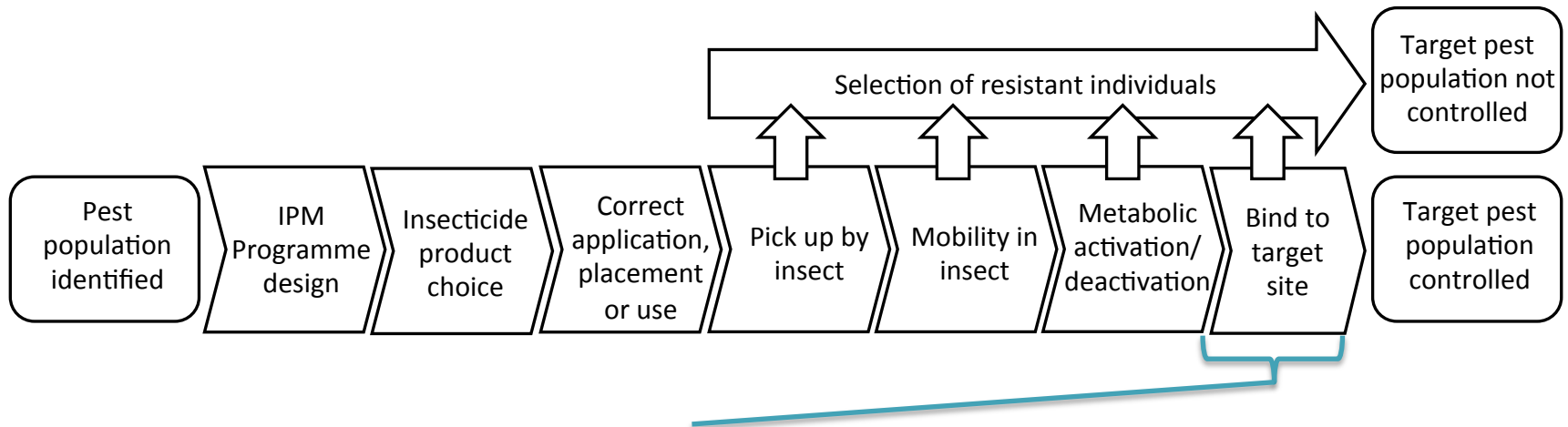
- Impact of insecticide resistance



Over expression of existing enzymes, or expression of novel enzymes, that degrade insecticide or sequester it. Under expression of, or altered specificity of, enzymes that “activate” some insecticides.

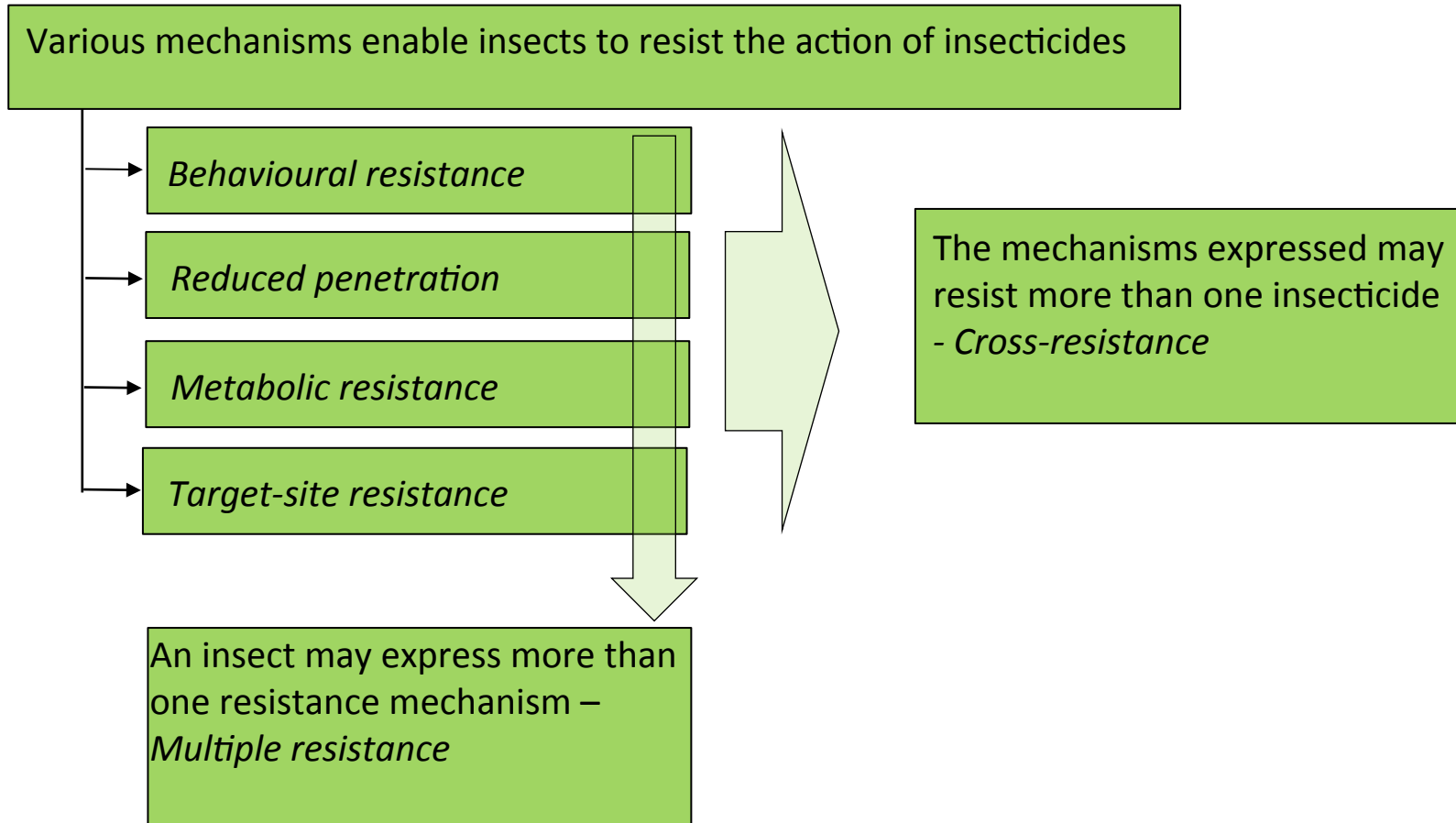
Insecticide Resistance Management

- Impact of insecticide resistance



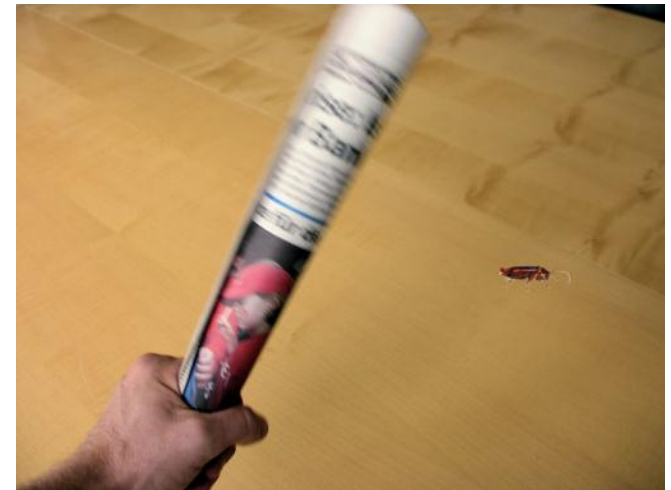
Modification of insecticide's target binding site such that it no longer binds sufficiently to cause desired toxicological impact, e.g. KDR, RDL, MACE.

Insecticide Resistance Management



Insecticide Resistance Management

- Insecticide Resistance Management should be undertaken as part of an Integrated Pest Management (IPM) programme that includes use of both insecticidal and non-insecticidal interventions.



Insecticide Resistance Management

- When insecticide resistance is developing, the pest population may only be able to survive a sub-optimal application of the insecticide
- The PMP should therefore ensure that they employ best practice IPM to deliver optimal control of the pest population using:

Insecticide Resistance Management

- A fully trained operator who follows the product label
- Insecticide to which the target pest population is susceptible – from a different IRAC MoA group
- Appropriate quality insecticide product
- Maintained and calibrated application equipment
- Where appropriate, physical control measures
- Remove food and water sources and suitable harbourages so that any survivors of the insecticide intervention have limited opportunity to reproduce and pass on the genes that confer reduced insecticide susceptibility

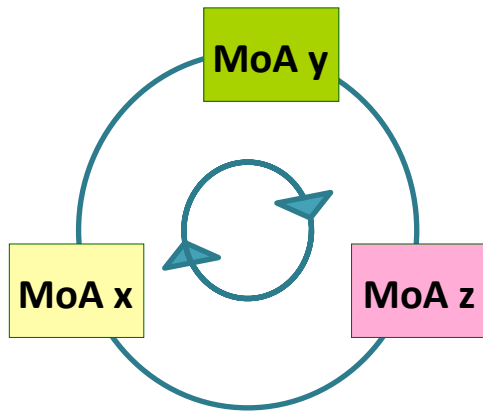
Insecticide Resistance Management

- There are several tools that can be used in an IRM programme, but all rely on minimising the selection pressure for resistance development by limiting the exposure of consecutive generations of a pest population to insecticides that have the same mode of action

Insecticide Resistance Management

- **Rotation**

- The rotation over time of two or more insecticide classes with different modes of action (MoA). This approach assumes that if resistance development to one insecticide is rare then multiple resistance will be extremely rare

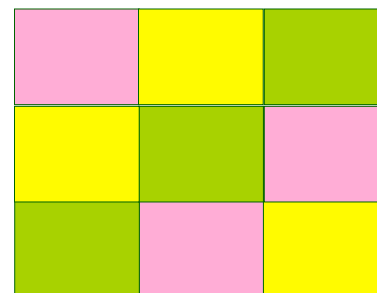


x, y, z, insecticides from different MoA classes

Insecticide Resistance Management

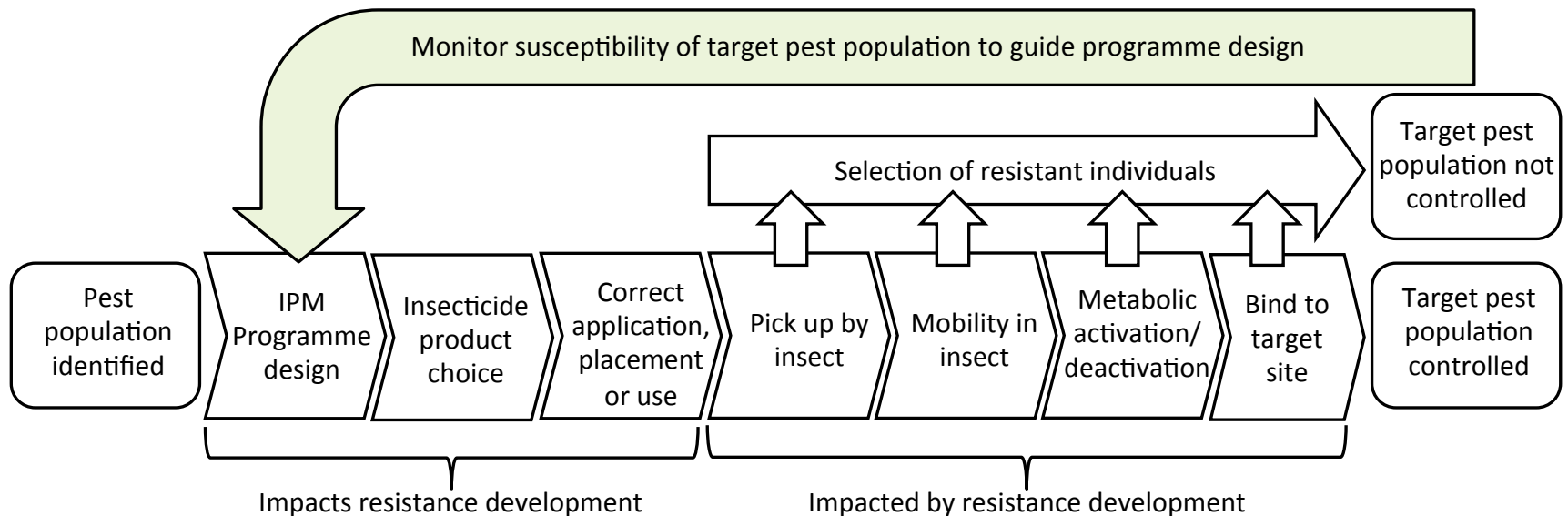
- Mosaic

- Where the pest population has free movement across a geographically spread area, e.g. in a large apartment block, or industrial building complex, insecticides from different MoA classes can be used in different locations. This approach assumes that if the population loses susceptibility to one insecticide class, they will be controlled by the second class as they move through their range



Insecticide Resistance Management

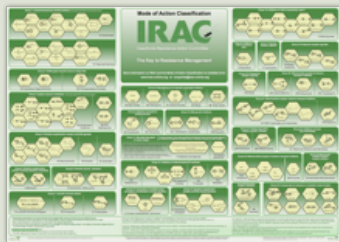
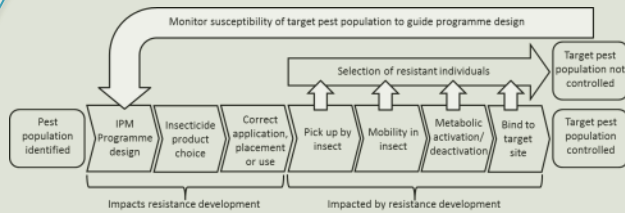
- Monitoring the insecticide sensitivity of a pest population enables an informed choice of which insecticide to use in an IPM programme



Summary

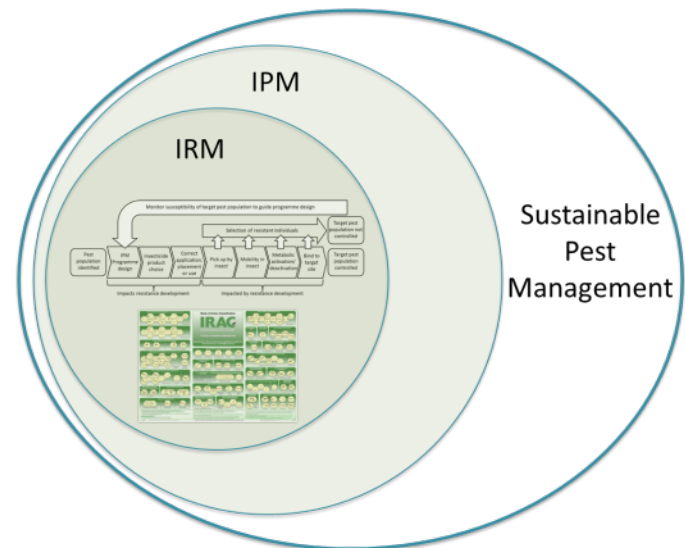
Healthy and
pest-free
urban
environment

Sustainable
Pest
Management



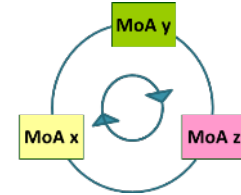
Conclusion

- Insecticide susceptibility in a pest population is a valuable asset
- Actions which minimise the selection pressure for resistance development, before an insecticide resistance problem is identified in the target pest, should be encouraged
- IRM should always be considered in the context of a wider IPM programme



Conclusion

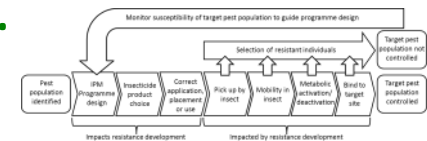
- Rotations and mosaics of insecticides from different mode of action classes form the basis of an IRM strategy.



- The IRAC mode of action classification scheme is a valuable tool to support the informed selection of insecticides for such rotations and mosaics.



- An appreciation of the chain of events that occurs when an insecticidal intervention is used to control a pest population, helps to identify those activities that can be optimised in the development of an effective IRM programme.



For further information and educational material about IRM in Public Health and Urban Pest settings, please visit the IRAC website

www.illac-online.org

With thanks to the IRAC Public Health Team

