# *An overview of crop protection and AMR*

There is more to AMR than antibiotics and human diseases

*FAO knowledge dissemination dialogues on AMR*

Data compiled by Phil Taylor and Rob Reeder

Phil Taylor 8th Sept 2022

# what is CABI?

## CABI is a not-for-profit science-based development and information organization

KNOWLEDGE FOR LIFE

CABI

# what does CABI do?

## CABI addresses issues of global concern such as food security, through science, information and communication

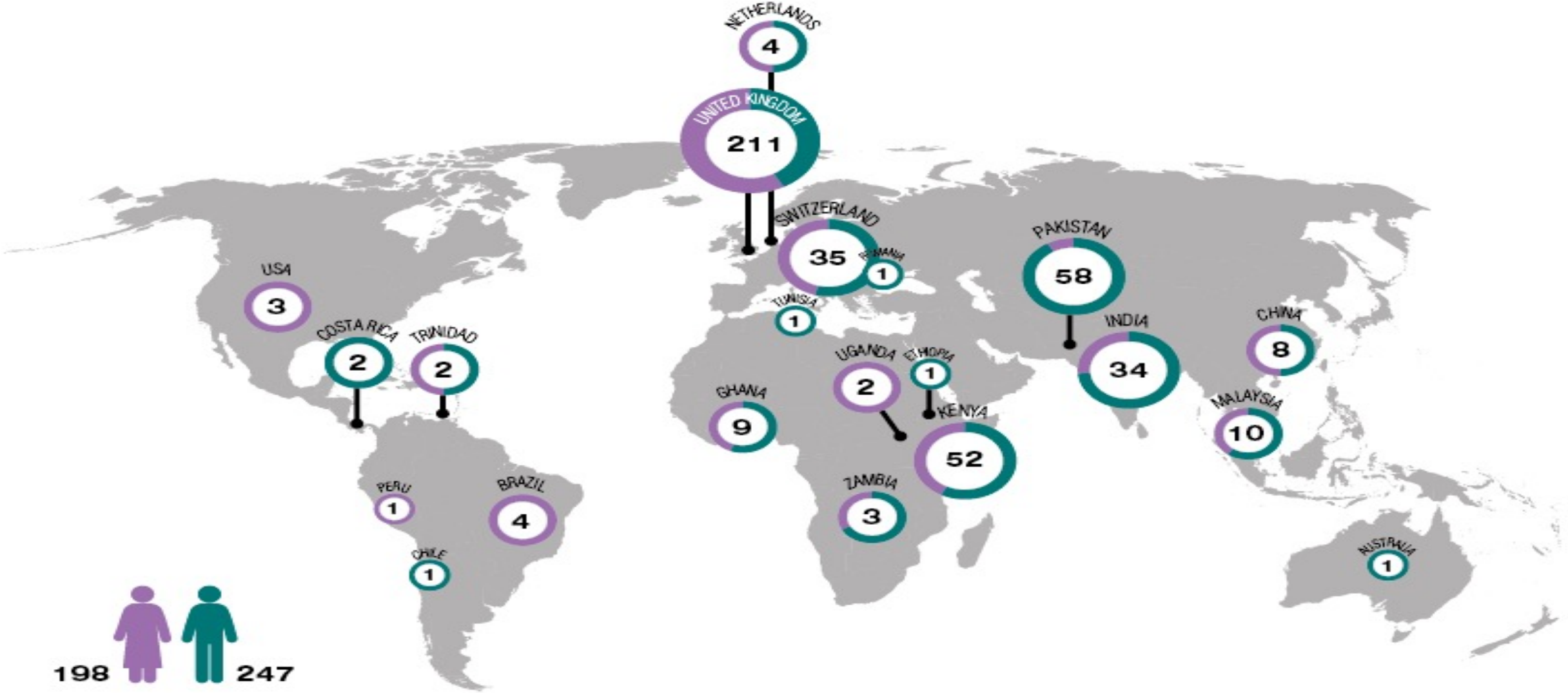


CABI

# what are CABI's activities?

- international development and research
- publishing
- microbial services

# **Global reach** We have 480+ staff across 21 locations worldwide




Afghanistan


Anguilla


Australia


Bahamas


Bangladesh


Barbados


Bermuda


Botswana


British Virgin Islands


Brunei Darussalam


Burundi


Canada


Chile


China


Colombia


Cote d'Ivoire


Cyprus


DPR Korea


Gambia


Ghana


Grenada


Guyana


India


Jamaica


Kenya


Malawi


Malaysia


Mauritius


Montserrat


Myanmar


Nigeria


Pakistan


Papua New Guinea


Philippines


Rwanda


Sierra Leone


Solomon Islands


South Africa


Sri Lanka


St Helena*


Switzerland


Tanzania


The Netherlands


Trinidad & Tobago


Uganda


United Kingdom


Vietnam


Zambia

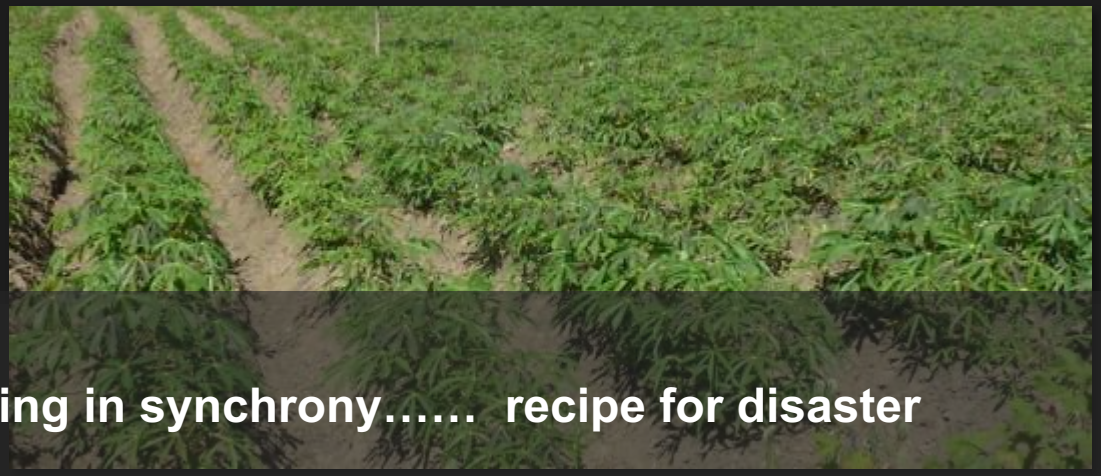

Zimbabwe

# our member countries

# WE TEND TO THINK OF AGRICULTURE AS A NATURAL PROCESS

Agricultural monoculture plays into the hands of diseases

# WE TEND TO THINK OF AGRICULTURE AS A NATURAL PROCESS



Identical plants planted at the same time growing in synchrony…… recipe for disaster

# HOW CAN WE STOP CROP DISEASES?


Crop rotation

Keep things clean


Resistant varieties

# Once the epiphytotic* has taken off, what is going to stop it?

*Epiphytotic = epidemic but for plants

Growing on a small scale and on a large scale are entirely different

# FUNGAL DISEASE SYMPTOMS

# BACTERIAL DISEASE SYMPTOMS

# CONTRASTING BACTERIAL AND FUNGAL DISEASE SYMPTOMS

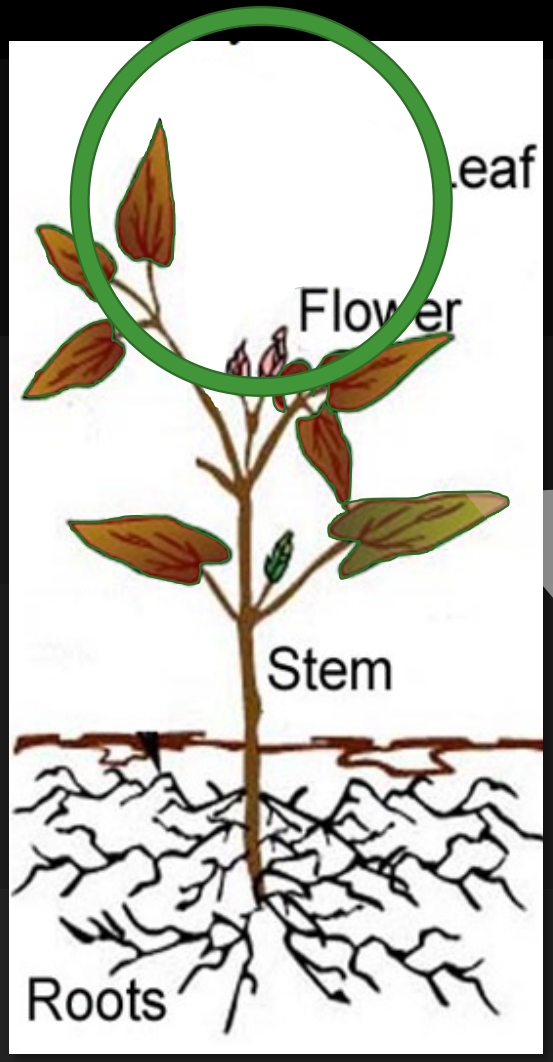
# WHEN CONSIDERING CROPS WHAT DOES AMR MEAN?

Most crop pathogens are fungal.  Fungicide resistance has to be included as AMR

For many years resistance of plant pathogens to crop based fungicides was considered unrelated to medicine or veterinarian science

Time are changing and these various disciplines cannot be considered separate any longer.

# CHEMICAL CONTROL

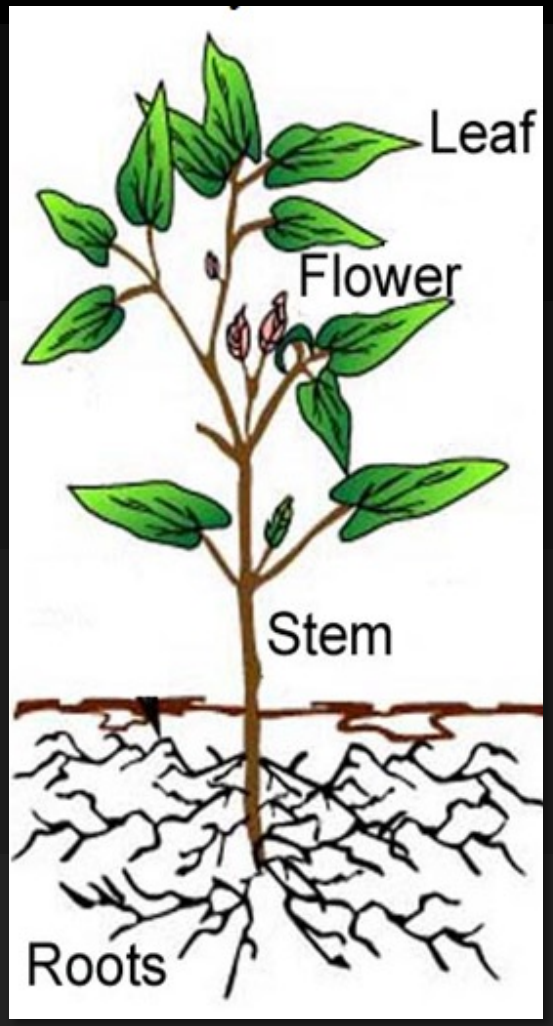



Growth after spraying is unprotected

Protectants create a thin skin of fungicidal material over the plant

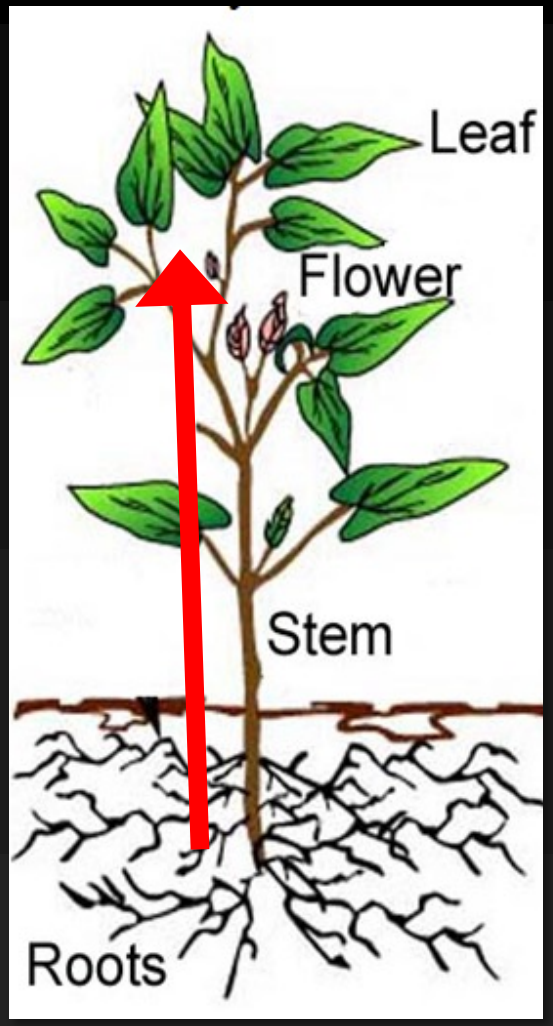
But you cannot spray what isn't there

# CONTACT FUNGICIDES




The fungicidal skin must remain for the plant to be protected

# SYSTEMIC FUNGICIDES



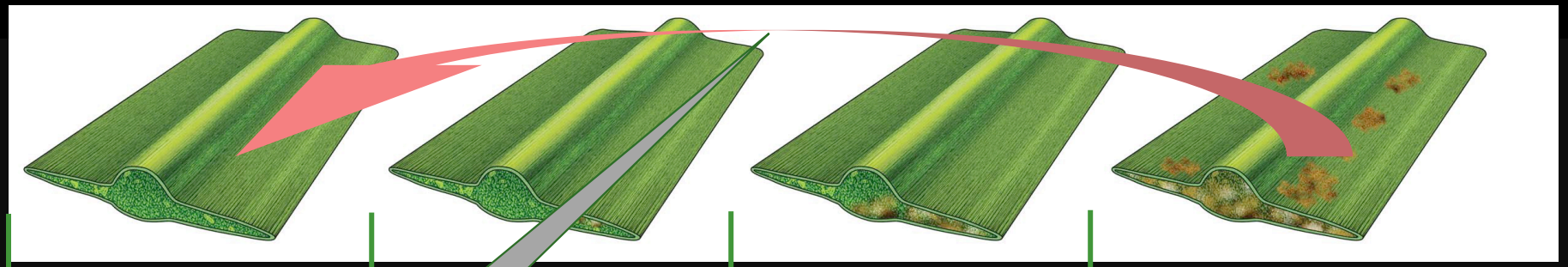

Systemic chemicals enter the plant and cannot be washed off

Movement is upwards and new growth is protected to some extent

Foliar sprays are not effective on diseases affecting roots

A good spray programme will combine a contact with a systemic fungicide

# SPRAY TIMING AND LATENT PERIOD



Spore lands on the leaf

Fungus penetrates the leaf

Fungus grows inside the leaf

Symptoms appear on the leaf

Contact fungicides effective during this period

Latent period

BUT the cycle will repeat and you can prevent new infection sites and stop the disease progressing

Chemical control is difficult

Once an infection site is established (even before you can see it) chemicals cannot control it……..

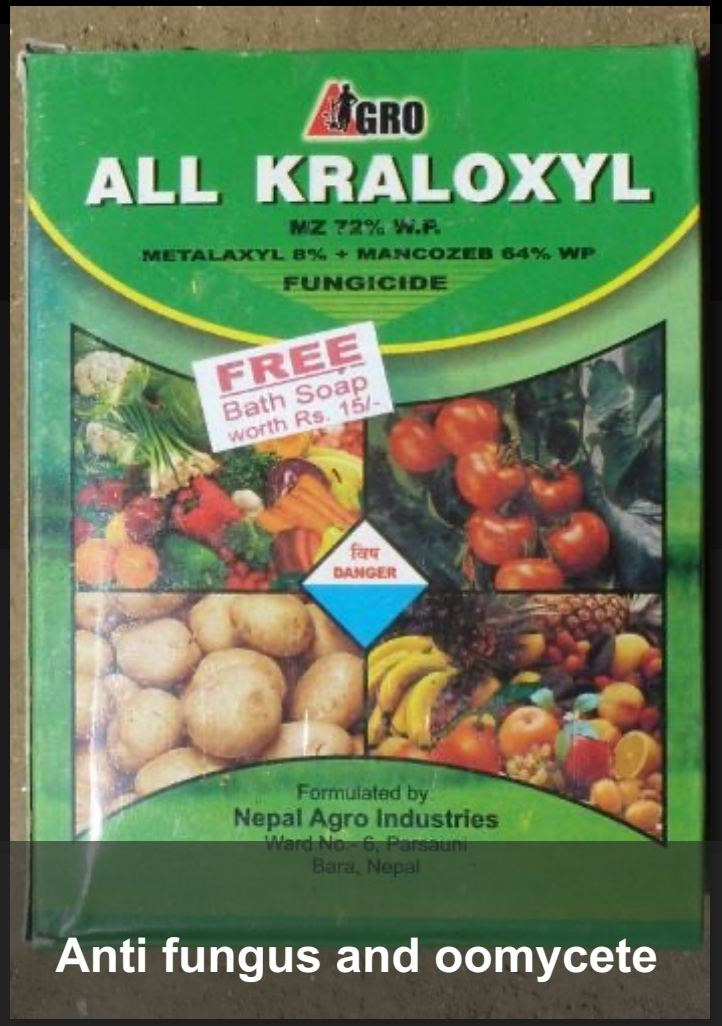
effective during the period

Fungal growth is beyond chemical control

No symptoms of disease are visible during this period

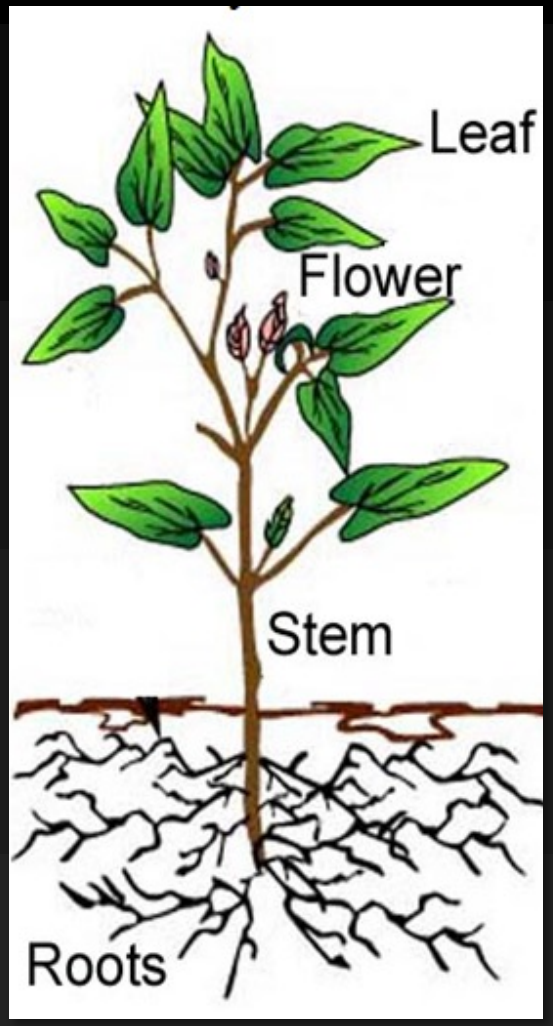
# VARIOUS TYPES OF ANTI MICROBIAL PRODUCTS USED ON CROPS


Anti viral compounds



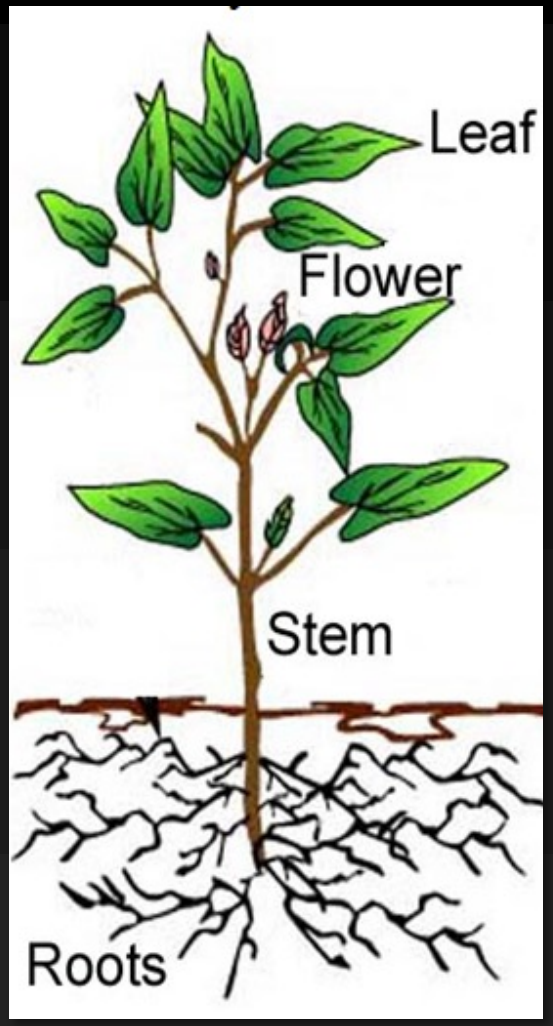

Anti fungus and oomycete

# REASONS FOR FUNGICIDE FAILURE




- Washed off
- Degraded by sunlight
- Wrong chemical applied
- Pest or disease is resistant
- Did not adhere when applied
- Did not get complete coverage
- Counterfeit product
- Wrong dilution*

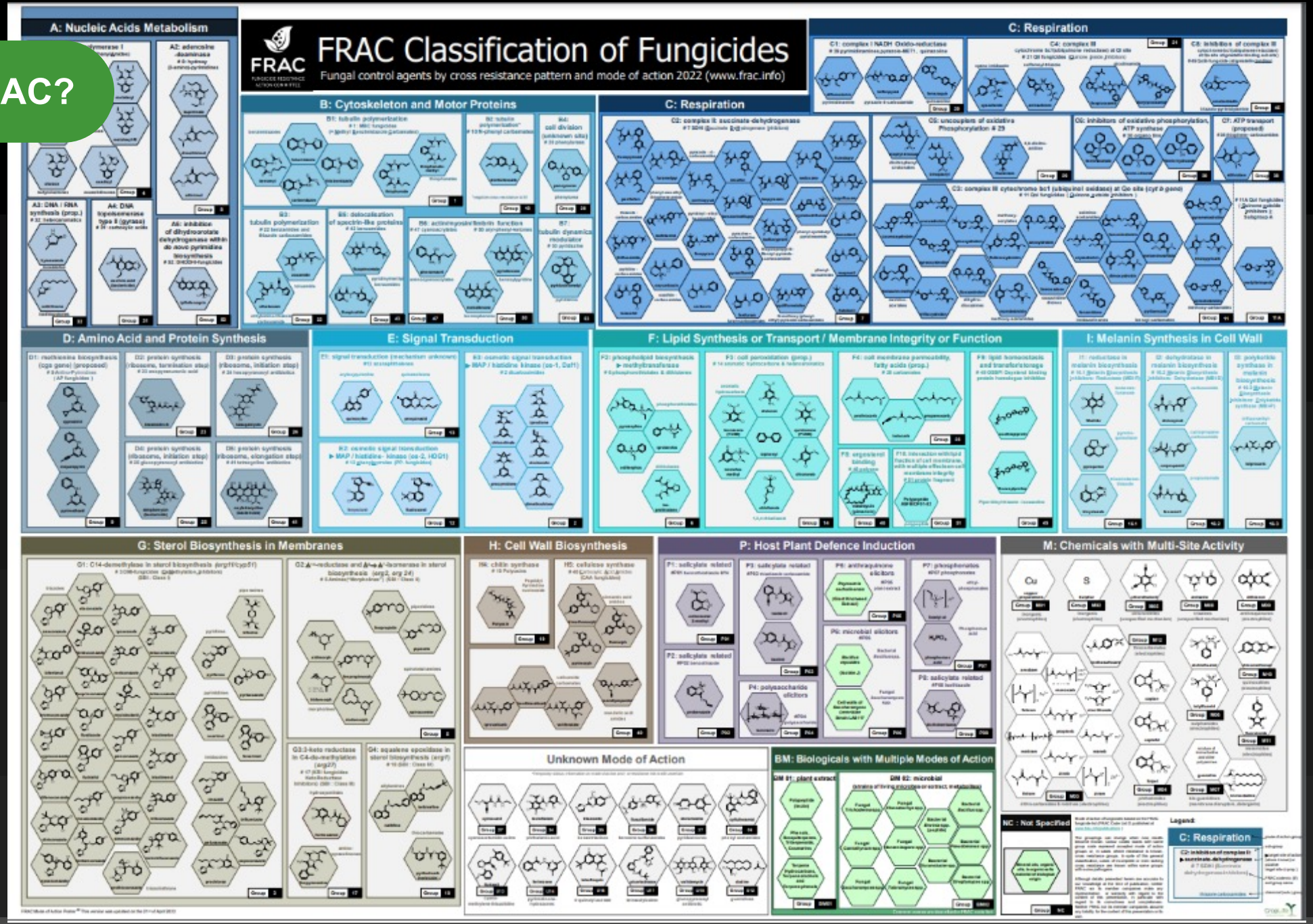
# REASONS FOR FUNGICIDE FAILURE

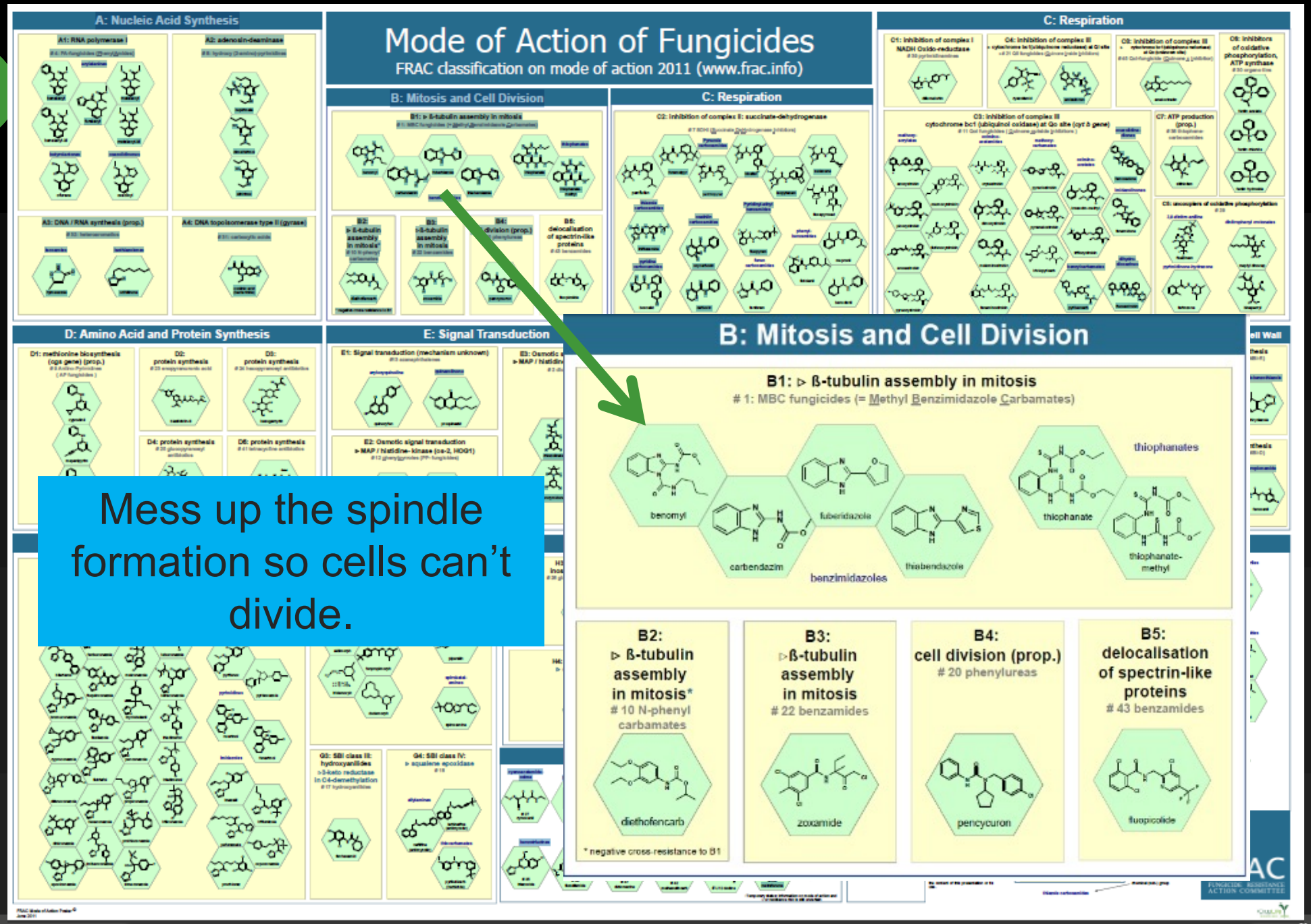



- Unlike medicines plant disease control is mostly done by unskilled people

- Chemicals are put on by untrained people
- Repeated use of same chemical group
- Reduced dose
- Increasing the dose to overcome resistance

# FRAC?

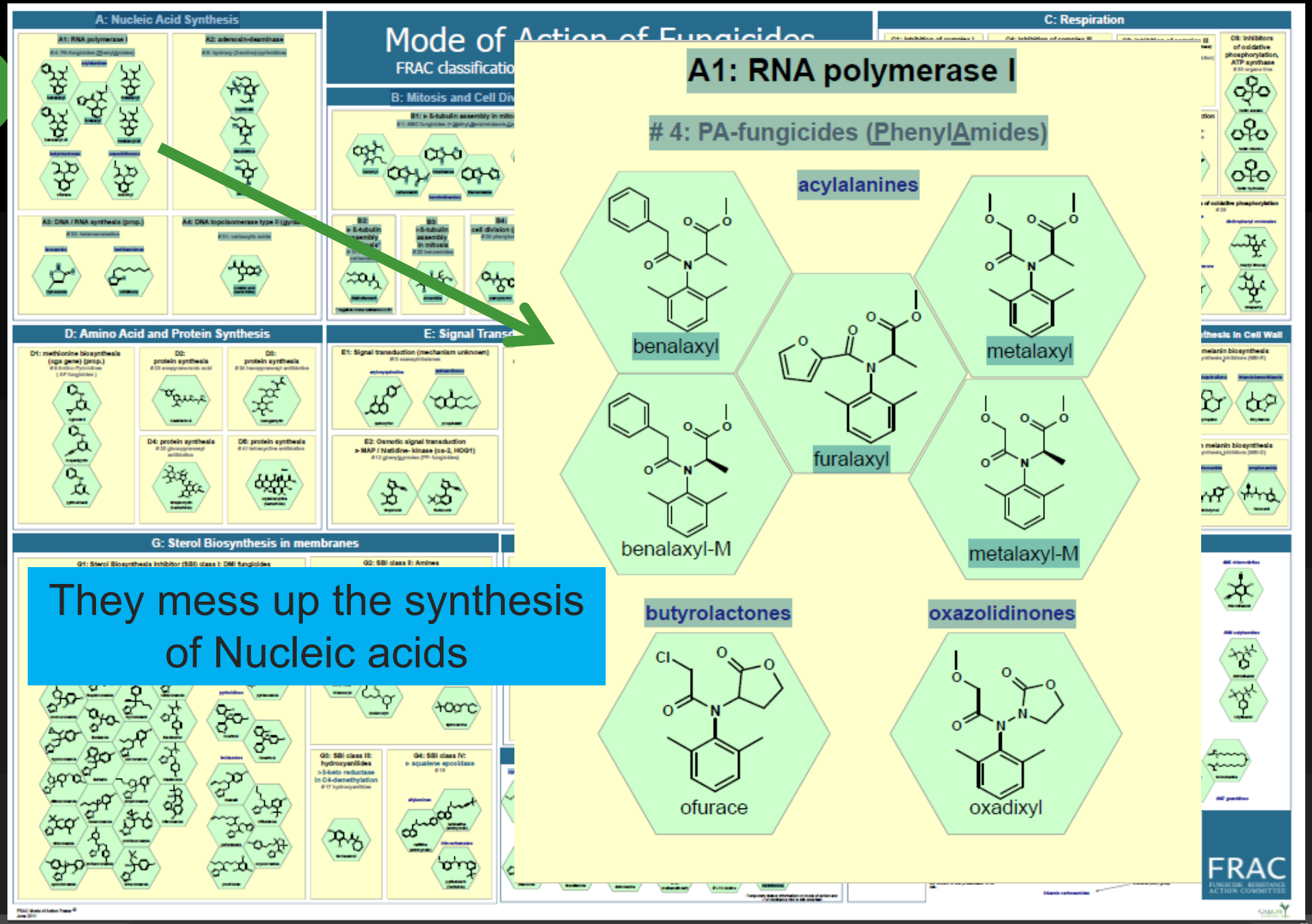





Mess up the spindle formation so cells can't divide.



Green may be used to emphasise words



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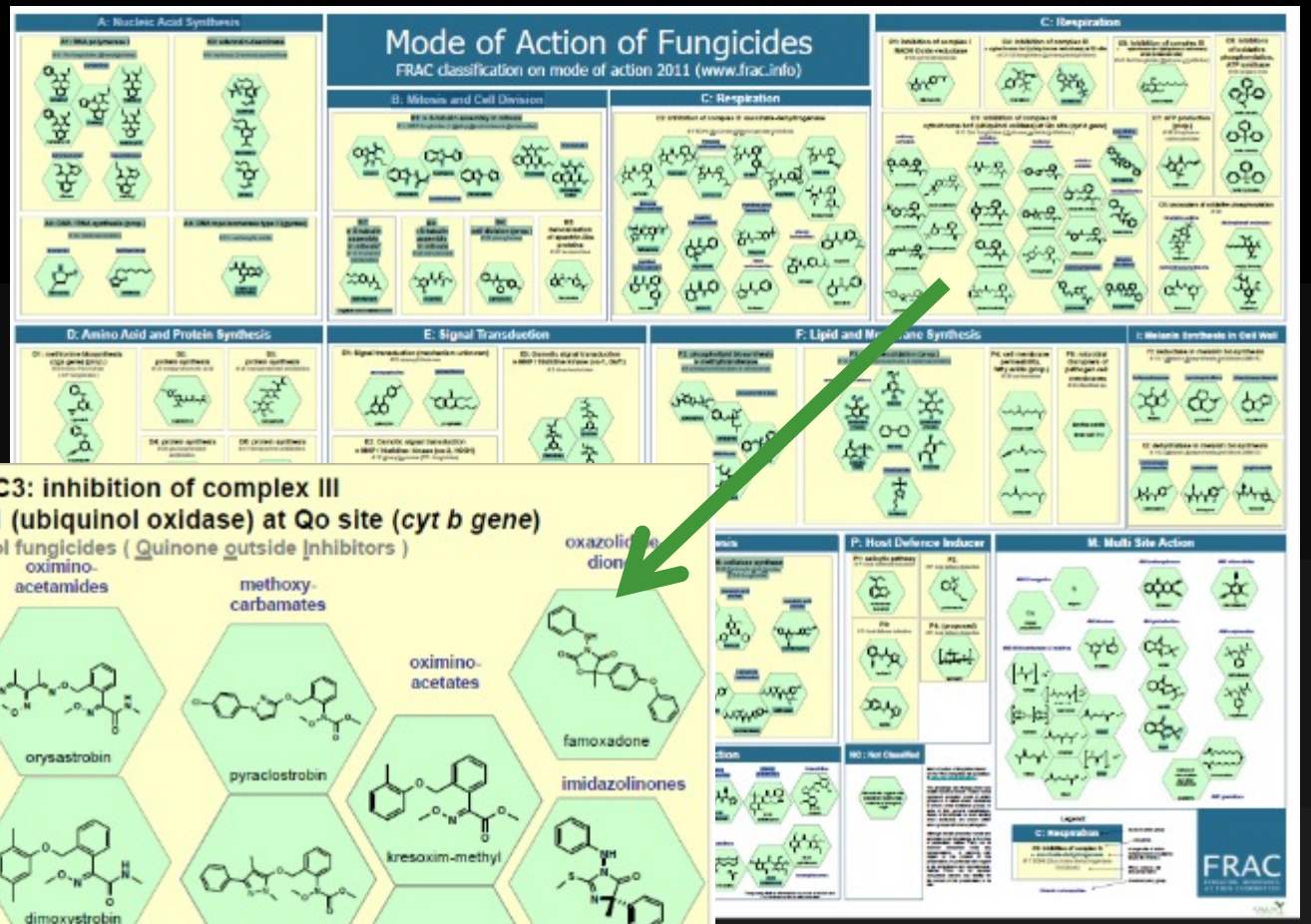
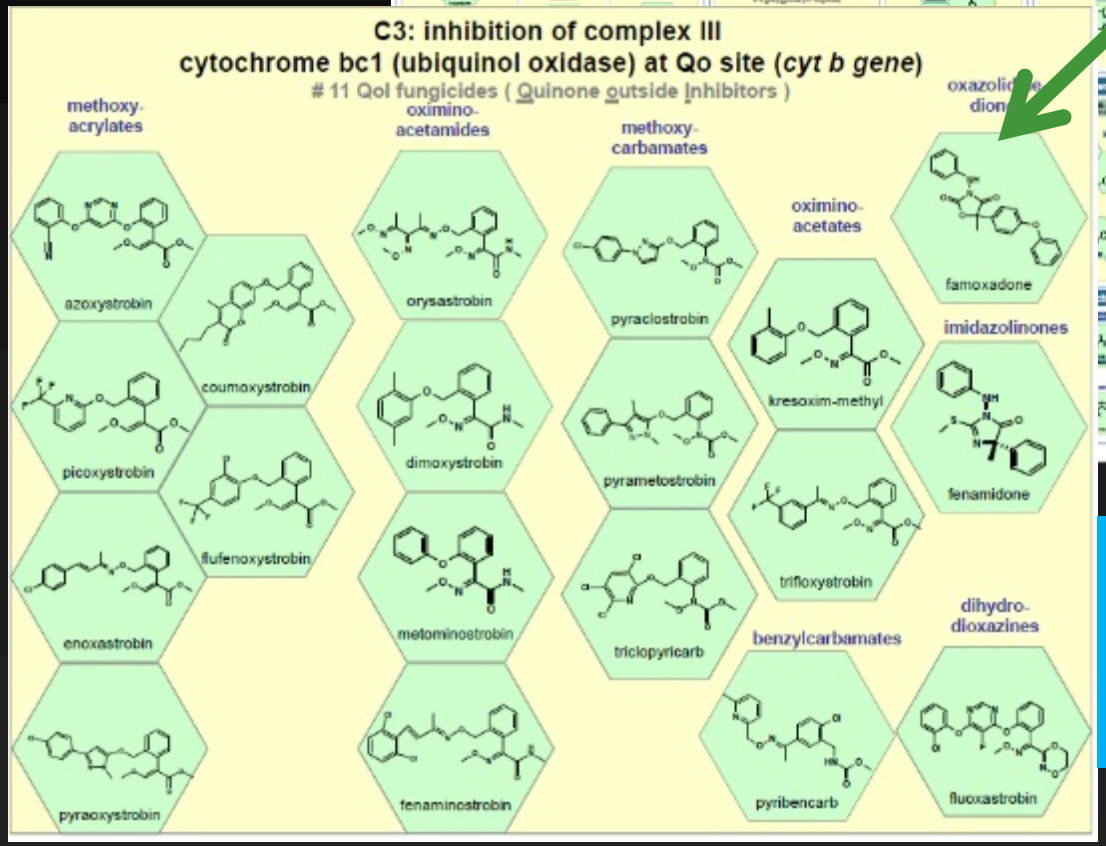
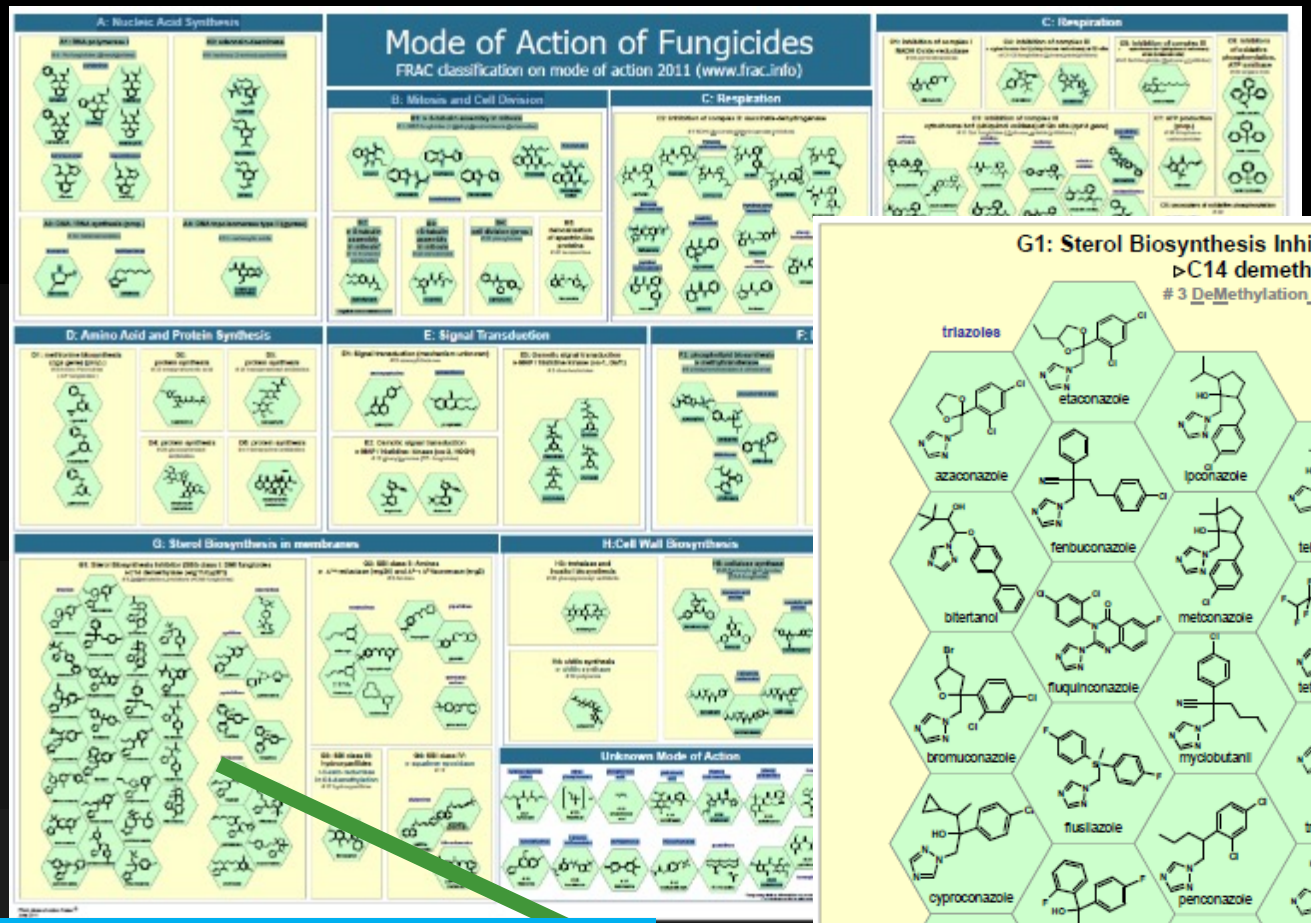
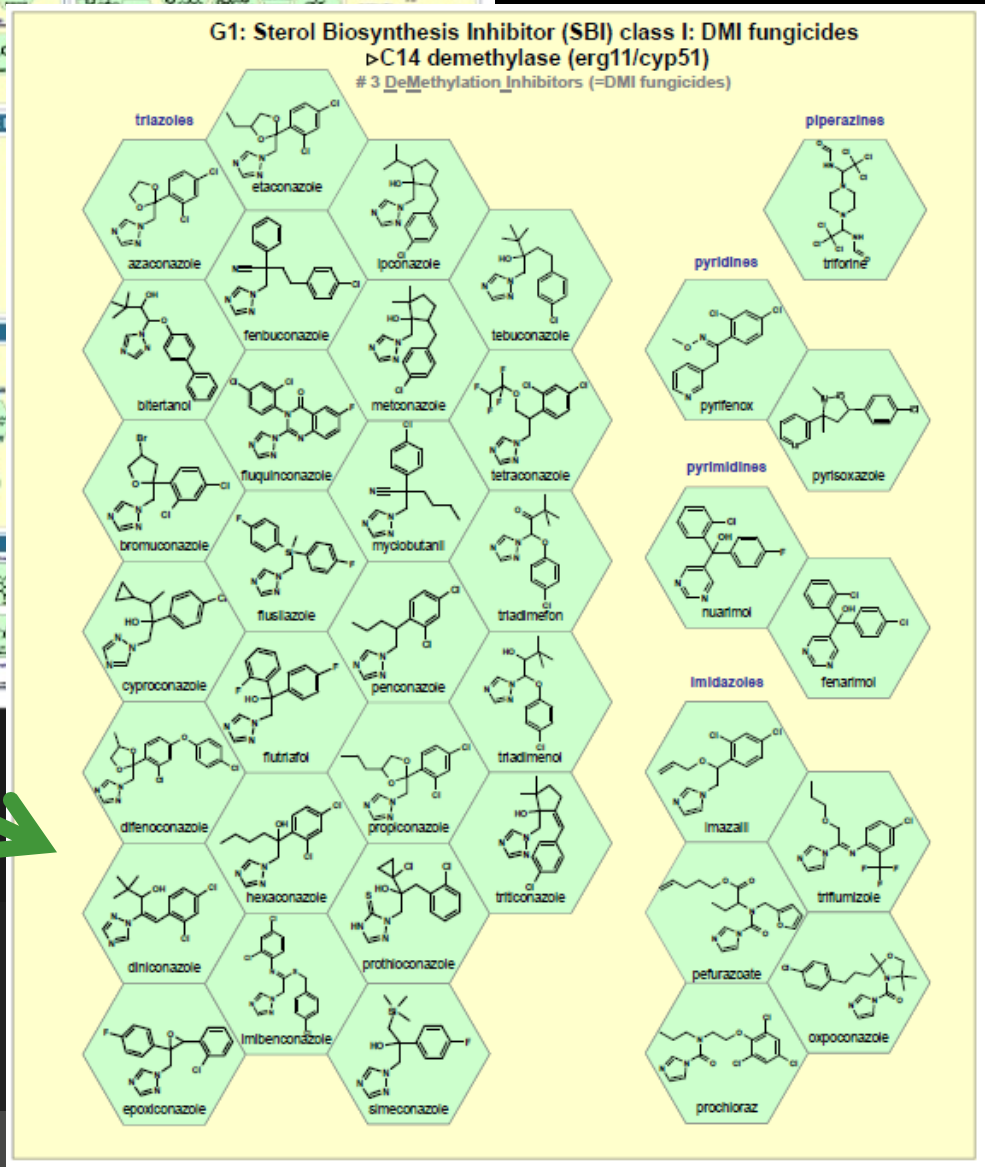



They interfere with the biochemistry of respiration




These mess up sterol production so the fungus can't make membranes

Itraconazole
Voriconazole
Posaconazole

# FUNGICIDE RESISTANCE IN PLANT PATHOGENS

| Resistance risk classification | Number of fungicide groups (FRAC code list) | Number of fungicides | Worldwide sales (US$×1000)[b] |
|---|---|---|---|
| High | 4 | 30 | 4 041 |
| High to medium | 4 | 24 | 836 |
| Medium | 8 | 51 | 3 868 |
| Medium to low | 11 | 36 | 1 269 |
| Low | 11 | 23 | 2 348 |
| Not known | 19 | 32 | 718 |
| Others (bactericides, etc.) | | | 225 |
| Total | 57 | 196 | 13 305 |

## *FRAG guidance*

- Fungicide resistance management (soft fruit 2022)
- Fungicide resistance management (cereals 2021)
- Fungicide resistance management (cereals and the use of multisites 2020)
- Fungicide resistance management (potato late blight 2018)
- Fungicide resistance management (oilseed rape 2017)
- Fungicide resistance management (apple and pear pathogens 2015)

| MOA | TARGET SITE AND CODE | GROUP NAME | CHEMICAL OR BIOLOGICAL GROUP | COMMON NAME | COMMENTS | FRAC CODE |
|---|---|---|---|---|---|---|
| G: sterol biosynthesis in membranes | G1<br>C14- demethylase in sterol biosynthesis *(erg11/cyp51)* | DMI-fungicides (DeMethylation Inhibitors)<br>(SBI: Class I) | piperazines | triforine | There are big differences in the activity spectra of DMI fungicides.<br>Resistance is known in variou fungal species. Several resistance mechanisms are known ind. target site mutations in cyp51 (erg 11) gene, e.g. V136A, Y137F, A379G, I381V; cyp51 promotor; ABC transporters and others.<br>Generally wise to accept that cross resistance is present between DMI fungicides activ against the same fungus.<br>DMI fungicides are Sterol Biosynthesis Inhibitors (SBIs) but show no cross resistance to other SBI classes.<br>**Medium risk.**<br>**See FRAC SBI Guidelines for resistance management** | 3 |
| | | | pyridines | pyrifenox<br>pyrisoxazole | | |
| | | | pyrimidines | fenarimol<br>nuarimol | | |
| | | | imidazoles | imazalil<br>oxpoconazole<br>pefurazoate<br>prochloraz<br>triflumizole | | |
| | | | triazoles | azaconazole<br>bitertanol<br>bromuconazole<br>cyproconazole<br>difenoconazole<br>diniconazole<br>epoxiconazole<br>etaconazole<br>fenbuconazole<br>fluquinconazole<br>flusilazole<br>flutriafol<br>hexaconazole<br>imibenconazole<br>ipconazole<br>mefentrifluconazole<br>metconazole<br>myclobutanil<br>penconazole<br>propiconazole<br>simeconazole<br>tebuconazole<br>tetraconazole<br>triadimefon<br>triadimenol<br>triticonazole | | |
| | | | triazolinthiones | prothioconazole | | |
| | G2<br>$\Delta^{14}$-reductase and $\Delta^{8}\rightarrow\Delta^{7}$-isomerase in sterol biosynthesis *(erg24, erg2)* | amines ("morpholines")<br>(SBI: Class II) | morpholines | aldimorph<br>dodemorph<br>fenpropimorph<br>tridemorph | Decreased sensitivity for powdery mildews. Cross resistance within the group generally found but no to other SBI classes.<br>**Low to medium risk.**<br>**See FRAC SBI Guidelines for resistance management** | 5 |
| | | | piperidines | fenpropidin<br>piperalin | | |
| | | | spiroketal-amines | spiroxamine | | |
| | G3<br>3-keto reductase, C4- de-methylation *(erg27)* | KRI fungicides (KetoReductase Inhibitors)<br>(SBI: Class III) | hydroxyanilides | fenhexamid | Low to medium risk. Resistance management required. | 17 |
| | | | amino-pyrazolinone | fenpyrazamine | | |
| | G4<br>squalene-epoxidase in sterol biosynthesis *(erg1)* | (SBI class IV) | thiocarbamates | pyributicarb | Resistance not known, fungicidal and herbicidal activity. | 18 |
| | | | allylamines | naftifine<br>terbinafine | Medical fungicides only. | |



| MOA | TARGET SITE AND CODE | GROUP NAME | CHEMICAL OR BIOLOGICAL GROUP | COMMON NAME | COMMENTS | FRAC CODE |
|---|---|---|---|---|---|---|
| B: Cytoskeleton and motor protein | B1<br>tubulin polymerization | MBC - fungicides (Methyl Benzimidazole Carbamates) | benzimidazoles | benomyl<br>carbendazim<br>fuberidazole<br>thiabendazole | Resistance common in many fungal species. Several target site mutations, mostly E198A/G/K, F200Y in β-tubulin gene.<br>Positive cross resistance between the group members. Negative cross resistance to N-phenyl carbamates.<br>**High risk.**<br>**See FRAC Benzimidazole Guidelines for resistance management** | 1 |
| | | | thiophanates | thiophanate<br>thiophanate-methy | | |
| | B2<br>tubulin polymerization | N-phenyl carbamates | N-phenyl carbamates | diethofencarb | Resistance known. Target site mutation E198K. Negative cross resistance to benzimidazoles. High risk. Resistance management required. | 10 |
| | B3<br>tubulin polymerization | benzamides | toluamides | zoxamide | Low to medium risk. Resistance management required. | 22 |
| | | thiazole carboxamide | ethylamino-thiazole-carboxamide | ethaboxam | | |
| | B4<br>cell division (unknown site) | phenylureas | phenylureas | pencycuron | Resistance not known. | 20 |
| | B5<br>delocalisation of spectrin-like proteins | benzamides | pyridinylmethyl-benzamides | fluopicolide<br>fluopimomide | Resistant isolates detected in grapevine downy mildew. Medium risk. Resistance management required | 43 |
| | B6<br>actin/myosin/fimbrin function | cyanoacrylates | aminocyanoacrylates | phenamacril | Resistance known in *Fusarium graminearum*. Target site mutations in the gene coding for myosin-5 found in lab studies. Medium to high risk. Resistance management required. | 47 |
| | | aryl-phenyl-ketones | benzophenone | metrafenone | Less sensitive isolates detected in powdery mildews (*Blumeria* and *Sphaerotheca*) Medium risk. Resistance management required.<br>Reclassified from U8 in 2018 | 50 |
| | | | benzoylpyridine | pyriofenone | | |
| | B7<br>tubulin dynamics modulator | pyridazine | pyridazine | pyridachlometyl | **High risk.** | 53 |

# TABLE TO AVOID FUNGAL RESISTANCE

| FUNGICIDES Mode of Action | Oomycetes; Water moulds<br>Phytopthora/ Pythium, Damping off, Downy Mildew, White rusts | Ascomycetes;Fungi<br>**Many leaf diseases** (e.g. Anthracnose, Alternaria blights, Fusarium, Cercospora, Powdery mildew, Scabs,...) | Basidiomycetes; Fungi<br>Rusts, Smuts, Bunts, Rhizoctonia |
|---|---|---|---|
| **Seed/ planting material** | **Metalaxyl-M**[1]<br>Thiram Cymoxanil[1] | Carboxin[1] Fludioxonil[1] Thiram Silthiofam **Fluopyram**<br>Prochloraz **Ipconazole** *Bacillus amyloliquefaciens* | Fludioxonil[1] Carboxin[1]<br>Flutriafol[1] **Prothioconazole**[1]<br>Prochloraz **Triadimenol** |
| **Fruit crop leaf diseases** | **Metalaxyl-M**[1] **Dimethomorph**<br>Cymoxanil[1] Ametoctradin Famoxadone<br>**Fenamidone** **Propamocarb**<br>**Fluopicolide** Cyazofamid | Sulphur **Tebuconazole**[1] **Tetraconazole** Dithianon, **Fenbuconazole**[1]<br>**Fenarimol**[1] Kresoxim-methyl[1] **Boscalid**[1] Chlorothalonil Penconazole[1]<br>Thiophanate-Methyl Folpet Cyprodinil[1] Fludioxonil[1] Myclobutanil[1] Mancozeb<br>Trifloxystrobin *Bacillus subtilis*<br>These materials are active against Powdery mildews only<br>Pyrimethanil **Fenhexamid** Fenpyrazamine Potassium bicarbonate *A quisqualis* | There are very few basidiomycete fungi that cause disease on fruit crops and these are mostly controlled by cultural methods. |
| **Vegetable leaf diseases** | *Cerevisane* **Metalaxyl-M**[1] **Cymoxanil**[1]<br>**Dimethomorph** Fosetyl-Al Fluazinam<br>**Bentiavalicarb-isopropyl** **Mandipropamid**<br>Zoxamide **Oxathiapiprolin**,<br>**Propamocarb** **Fenamidone**[1] | Copper Chlorothalonil Thiophanate-Methyl **Fenarimol**[1] **Isopyrazam**<br>**Azoxystrobin**[1] Cyproconazole[1] Fludioxonil[1] Iprodione* Metconazole[1]<br>Difenoconazole[1] **Boscalid**[1] **Fenpropimorph*** Pyraclostrobin[1]<br>**Fluopyram** Folpet Trifloxystrobin **Tetraconazole**<br>**Tridemorph** **Tebuconazole**[1] Carbendazim* *Bacillus subtilis*<br>Cyprodinil[1] | Difenoconazole[1] **Azoxystrobin**[1]<br>**Boscalid**[1] Cyproconazole[1]<br>**Pyraclostrobin**[1] Chlorothalonil<br>Metconazole[1] **Tetraconazole**<br>**Prothioconazole**[1]<br>**Tebuconazole**[1] **Fenpropimorph*** |
| **Cereal leaf diseases** | As there are very few water moulds that attack cereal crops (Maize Sorghum Sugarcane are excpetions) There are very little data on which chemicals should be used but where legal many of the above would control the disease | **Azoxystrobin**[1] Thiophanate-Methyl **Prothioconazole** Folpet<br>**Epoxiconazole**[1] Trifloxystrobin<br>Chlorothalonil Difenoconazole[1] **Isoprothiolane** **Bixafen**<br>**Quinoxyfen*** **Boscalid**[1] Pyraclostrobin[1] **Fenpropimorph***<br>**Bromuconazole**[1] **Tebuconazole** **Tridemorph** Cyproconazole[1] | **Azoxystrobin**[1] **Epoxiconazole**[1]<br>Chlorothalonil, **Prothioconazole**[1]<br>**Boscalid**[1] **Flusilazole**[1] **Tetraconazole**<br>**Fenpropimorph*** **Fluopyram**<br>Trifloxystrobin Pyraclostrobin[1]<br>Difenoconazole[1] |
| **Fruit /Ear diseases** | The chemicals in this column are specialists used against watermoulds. They are frequently blended with the more general fungicides<br>Mancozeb Propineb Copper Metiram Chlorothalonil Zineb<br>These have limited activity against watermoulds but are active against fungal diseases | Propiconazole[1] Fluoxastrobin[1] Cyproconazole[1] **Metconazole**[1]<br>**Azoxystrobin**[1] Carbendazim* **Tebuconazole**[1] Chlorothalonil<br>Thiophanate-Methyl **Fluxapyroxad** Fludioxonil[1] *Bacillus subtilis* | Chlorothalonil **Epoxiconazole**[1]<br>Cyproconazole[1] Pydiflumetofen<br>**Azoxystrobin**[1] **Tebuconazole**[1]<br>Trifloxystrobin **Prothioconazole**[1] Flutriafol[1] |

Chemicals are coloured according to their mode of action. Repeated use of the same chemical or same mode of action will lead to resistance. Use of mixtures of fungicides groups (colours) and regularly changing between modes of action (colours) will prevent this.
For the fungi imperfecti follow guidelines for Ascomycetes. **Copper** containing products are the only chemical ones approved by Plantwise as treatment for bacterial diseases. Biocontrol agents in *italics* (developement of resistance to biocontrol agents is unlikely).

- Sterol biosynthesis membranes morpholines
- Sterol biosynthesis De Methylation Inhibitors
- Mitosis and cell division
- Respiration Quinone inside inhibitors
- Respiration Quinone outside inhibitors
- Respiration Succinate dehydrogenase inhibitors
- Unknown
- Multisite activity
- Lipids and membrane synthesis
- Disruption of DNA synthesis
- Signal transduction

| | | | | |
|---|---|---|---|---|
| **Bold** indicates systemic activity. **F**irst letter bold indicates limited systemic activity | Underlining indicates multisite activity, resistance unlikely | * Indicates possibility of resistance | [1] Indicates resistance has been recorded | *Italic* are fungicidial microorganisms and not chemicals |

# HOW DOES FUNGICIDE USE IN CROPS AFFECT MEDICINE?

C.auris was not known as a pathogen prior to 2009

Burst onto the scene in multiple locations in the last 10 years or so.

There has been no selection for fungicide resistance yet it has arisen multiple times across the globe fully fungicide resistant

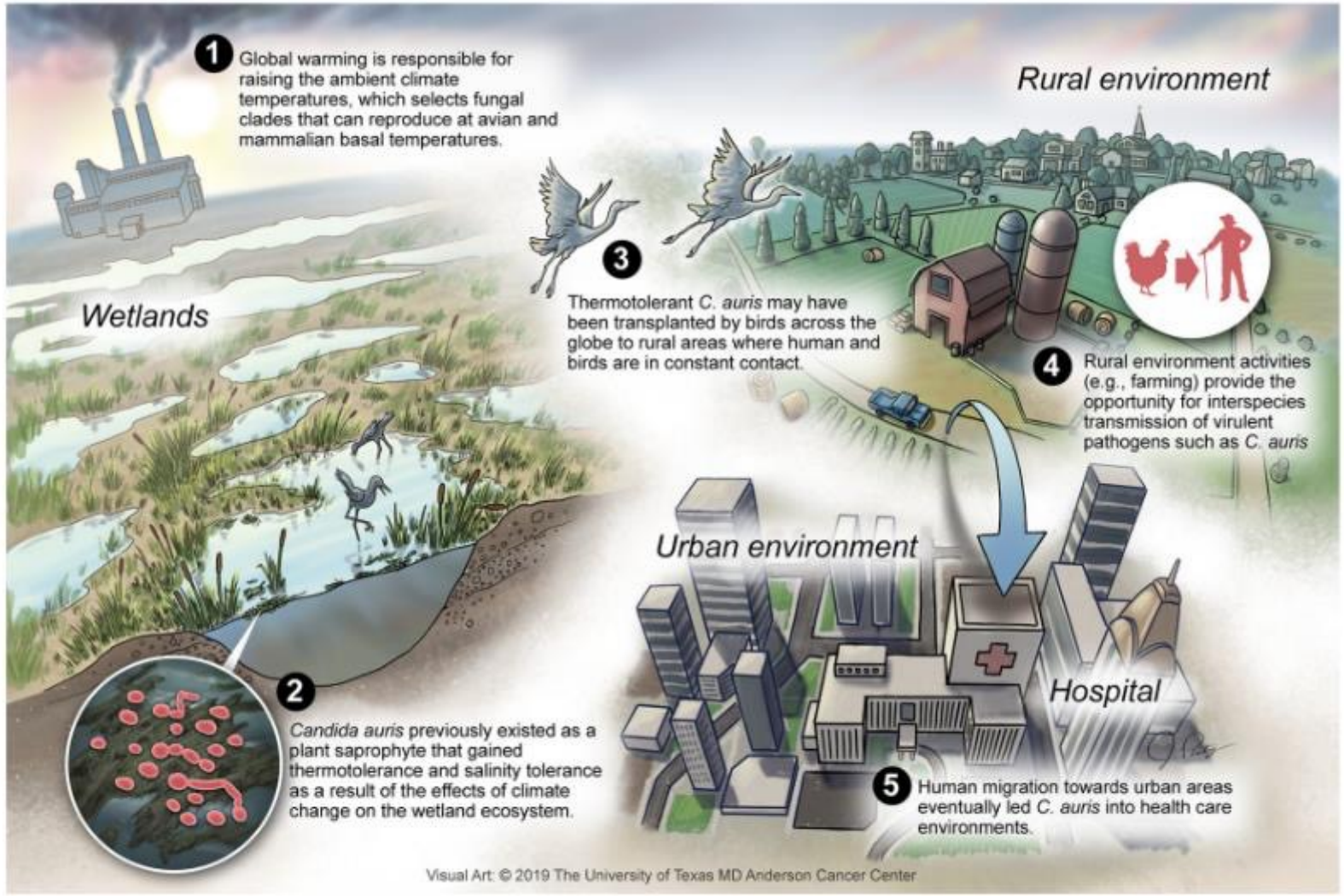
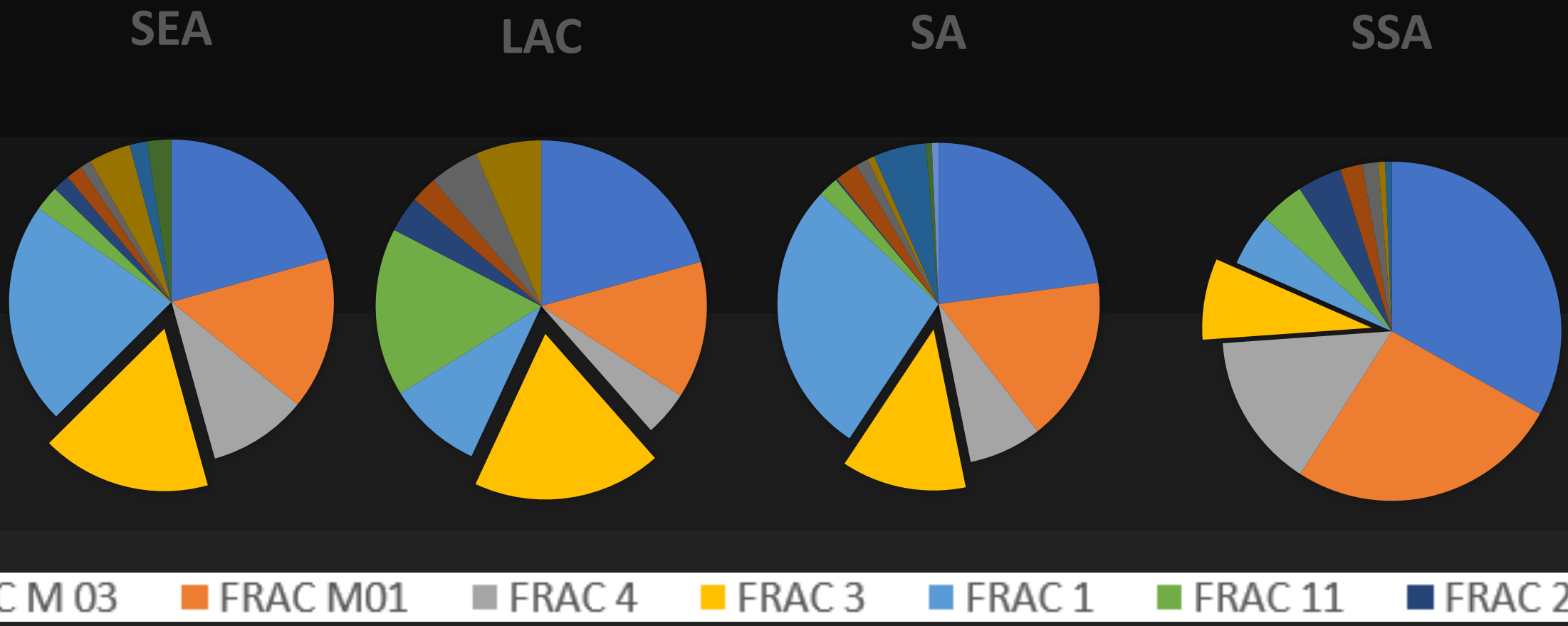



**FIG 2** Proposed scheme for the emergence of *C. auris*.

# HOW DOES FUNGICIDE USE IN CROPS AFFECT MEDICINE?

Extensive use of triazole fungicide use in the Dutch bulb industry……

# WHERE ARE THE AZOLES BEING USED?



# AMR IN BACTERIAL PLANT PATHOGENS

Is there is also a link between the control of bacterial plant pathogens and medicine?

# NAMES OF BACTERIAL PLANT PATHOGENS?

*Pseudomonas syringae*

*Ralstonia solanacearum*

*Xanthomonas campestris*

*Erwinia amylovora*

*Dickeya solani*

*Pectobacterium cartovorum & atrosepticum*

*Clavibacter michagensis*

*Agrobacterium (Radiobacter) tumefaciens*

*Xylella fastidiosa*

# NAMES OF BACTERIAL PLANT PATHOGENS?

***Pseudomonas syringae***
***Ralstonia solanacearum***
***Xanthomonas campestris***
***Erwinia amylovora***
***Dickeya solani***
***Pectobacterium cartovorum***
***Clavibacter michagensis***
***Agrobacterium (Radiobacter)***
***Xylella fastidiosa***

*Pseudomonas syringae* pv. *aceris* maple.
*Pseudomonas syringae* pv. *actinidiae* kiwifruit
*Pseudomonas syringae* pv. *aesculi* horse chestnut.
*Pseudomonas syringae* pv. *aptata* beets.
*Pseudomonas syringae* pv. *atrofaciens* wheat.
*Pseudomonas syringae* pv. *dysoxylis* kohekohe tree.
*Pseudomonas syringae* pv. *japonica* barley
*Pseudomonas syringae* pv. *lapsa* wheat.
*Pseudomonas syringae* pv. *panici Panicum* species.
*Pseudomonas syringae* pv. *papulans* crabapple
*Pseudomonas syringae* pv. *phaseolicola* bean
*Pseudomonas syringae* pv. *pisi* peas.
*Pseudomonas syringae* pv. *syringae*, *plums and bean*

# CONTROL OF BACTERIAL PLANT PATHOGENS?

Prevention;
- Clean seed
- Clean equipment
- Crop rotation
- Resistant varieties
- Trickle irrigation
- Control of vectors

Treatment;
- Copper salts
  - Copper sulphate
  - Copper oxychloride
  - Copper hydroxide
- Bismerthiazol
- Bronopol

- Antibiotics:
  - Medical antibiotics
  - Agricultural antibiotics

# CABI AND PLANTWISE

Why are small holder farmers not more productive?

What is lacking ?  What is needed?

More research?

More equipment?

How much more equipment and what kind of research?

# CABI AND PLANTWISE: CLINICS



# CABI AND PLANTWISE: CLINICS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# CABI AND PLANTWISE

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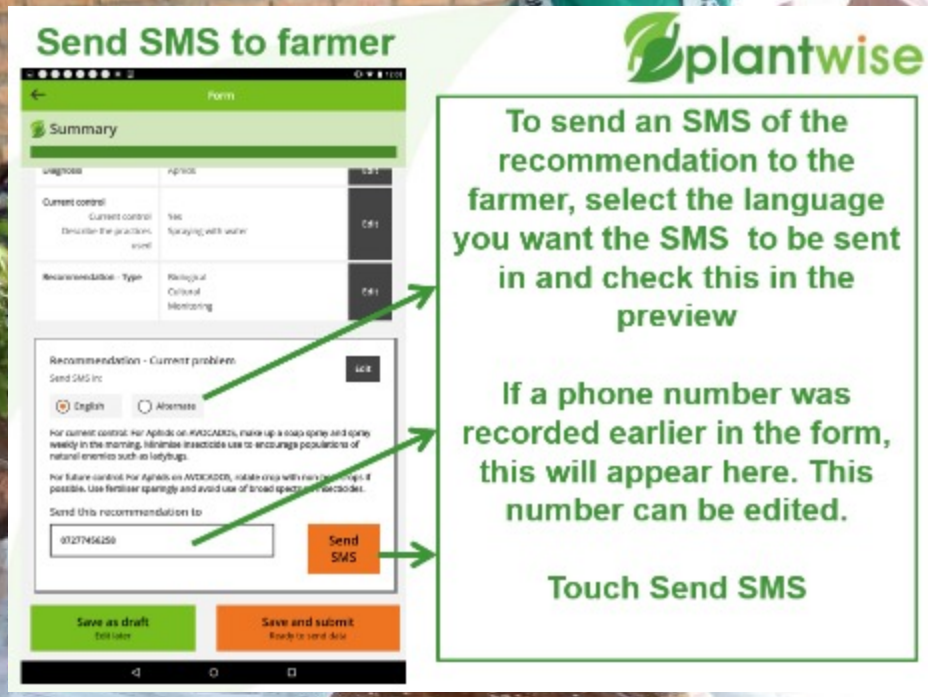



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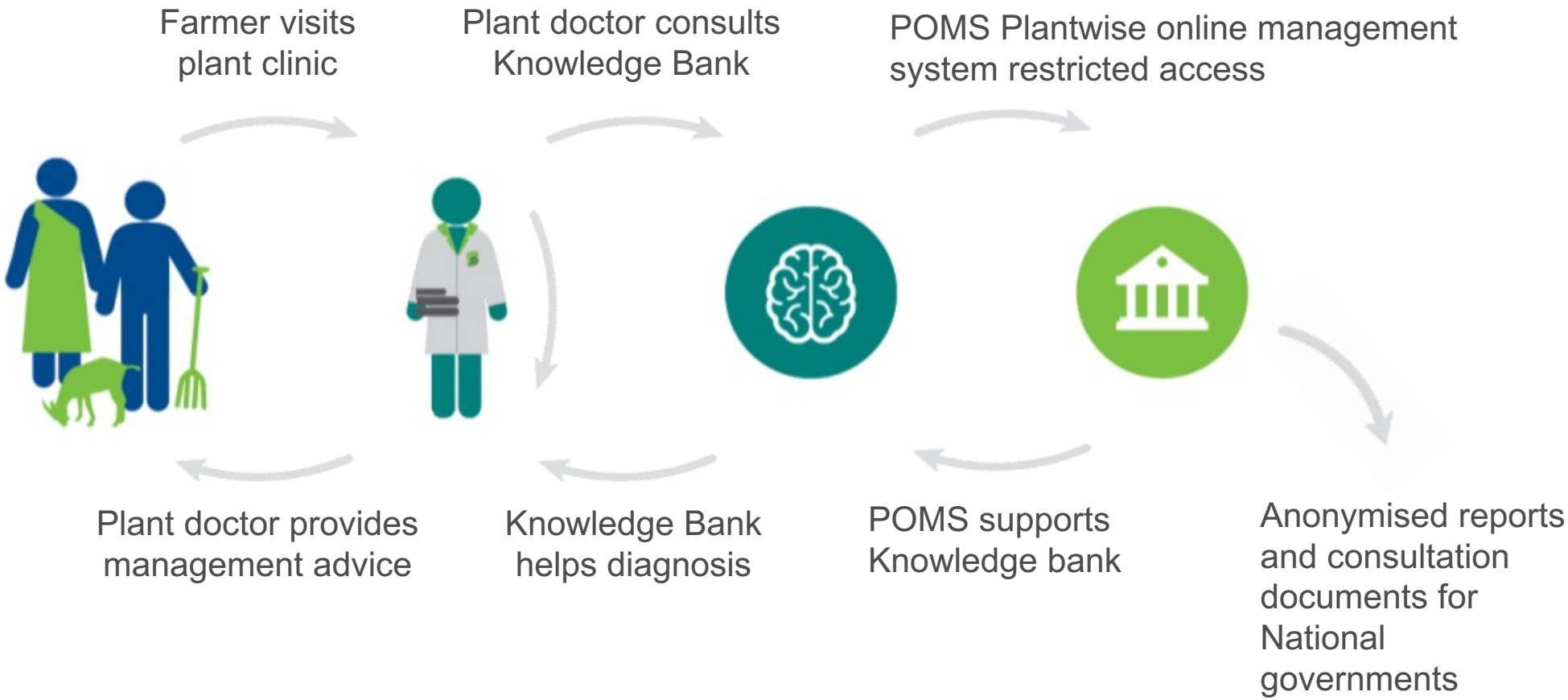

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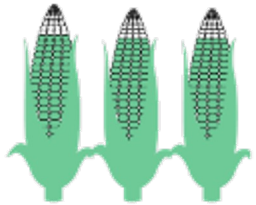

**79% of farmers reported yield** increases after visiting a plant clinic

**70% of farmers reported their income increased** after visiting a plant clinic

**Over half** of plant clinic prescriptions recommend non-chemical inputs

**25% of Plantwise plant doctors** worldwide are female

**All Plantwise countries** contribute funds and/or staff time towards activities

Plantwise has linked with **70 private sector organisations**

# Countries in which Plantwise is operational

# PLANTWISE DATA

Data is held securely by CABI but is owned by the countries

The data was analysed for those records naming antibiotics or the tradenames thereof

“Antibiotics” does not include all antimicrobials

Use on animals and countries with less than 10 records were omitted as was the use of disinfectants claiming to be antibiotics

| O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crop | | Sample | Development | | Year First | Area | Planted | Percent Of | | | | Problem | |
| | | | | | | Noticed | Planted | Unit | Crop Affected | Symptoms | Distribution | Description Of Problem | Type | Diagnosis |
| | | | | | | 2016 | 2100 | m2 | 75% | Streak | Localised | Trên ngọn lá và mép lá bị biến vàng đến nâu chạy dọc gâ | Bacterium | BỆNH BẠC LÁ |
| | | | | | | | | | | Mosaic | Scattered | Manchas en las hojas | Bacterium;Fung | MANCHAS CAUSADAS P |
| | | | | | | | | | | | Scattered | HOJAS CON EL BORDE TEÑIDO O QUEMADO Y CC | Bacterium | BACTERIOSIS |
| | | | | | | 2015 | 0.25 | Acres | 25% | Drying;Insect seen;Yell | Scattered | Defoliation of the leaf along with scraping of chlorophy | Insect | LEAF ROLLER |
| | | | | | | 0 | 2 | Acres | <25% | Drying;Stunted | Even | Marginal scorchingPoor growth | Bacterium | BACTERIAL LEAF BLIGH |
| | | | | | | 2017 | 1 | Acres | 25% | Drying;Yellow | Scattered | Leaf tip drying with yellowing of the margins noticed. | Bacterium | BACTERIAL LEAF BLIGH |
| DUA CHUOT | CUCUMBER | Dua lai | Yes | Seedling | Stem/sho | | | | | | | | | BENH HEO XANH DO VI K |
| LUA | Rice | Bac thom so | Yes | Fruiting | Leaves | | | | | | | | | BENH BAC LA ĐOM SOC |
| Hot Pepper | Hot Pepper | | Yes | | Fruit/grair | | | | | | | | | BACTERIAL SOFT ROT |
| RICE | RICE | | No | | Leaves | | | | | | | | | BACTERIAL LEAF STREA |
| TOMATOES | TOMATO | | Yes | Flowering | Leaves | | | | | | | | | BACTERIAL WILT |
| COTTON | COTTON | Cotton Bt | Unknown | | | | | | | | | | | PHYSIOLOGICAL DISORD |
| REPOLLO | cabbage | CORANZOC | No | Seedling | Leaves | | | | | | | | | PULGUILLA |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | | | | | | | | | SKIPPER |
| RICE | RICE | | No | | Leaves | | | | | Yellow | Scattered | The rice leaf occuring wavy line at the margin of rice lea | Bacterium | BACTRIAL LEAF BLIGHT |
| RICE | RICE | | No | | Leaves | | | | | Drying | Localised;Scattere | The leaf dries up with white lesions and the leaf blade ha | Bacterium | BACTERIAL LEAF BLIGH |
| RICE | RICE | | Yes | | Leaves | | | | | Surface growth | Localised | leaf yellowing from top to bottom | Bacterium | BACTERIAL BLIGHT |
| BANANA | BANANA | MONTHAN | Yes | Fruiting | Leaves;W | | | | | | | | | FUSARIUM WILT |
| PADDY | Rice | BPT 5204 | Yes | Intermediate | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| CITRUS | CITRUS | LOCAL | Yes | Fruiting | Fruit/grair | | | | | | | | | CITRUS CANKER |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| PADDY | Rice | ADT46 | Yes | Intermediate | Leaves | | | | | | | | | LEAF SPOT |
| RICE | RICE | | No | | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| LUA | Rice | | Yes | | Seed | | | | | | | | | B?NH HOA CUC |
| CHICKPEAS | CHICKPEAS | | Unknown | | | | | | | | | | | BORER |
| DUA LE | Melon | | Yes | | Leaves | | | | | Drying;Yellow | Scattered | Trên lá có vết bệnh màu vàng nhạt, lá có đốm khô, bị rác | Fungus | SUONG MAI |
| PADDY | Rice | BPT 5204 | Yes | Intermediate | Leaves | 2015 | 5 | Acres | 25% | Bore holes;Drying;Yellc | Scattered | Leaf tip drying and yellowing of margin with white patche | Insect | THRIPS |
| CAULIFLOWER | CAULIFLOWER | Non | Yes | Intermediate | Leaves;Stem/shoot | 2015 | 100 | m2 | Unknown | Rots | | roting base on stemwhite drying on leaf edge | Bacterium;Fung | BACTERIAL STALK ROT |
| TOMATE | TOMATO | | Unknown | | Leaves | | | | | Drying | Scattered | PUNTUACIONES NECROTICAS Y AMARILLENTAS | Bacterium | BACTERIOSIS |
| CHICKPEAS | CHICKPEAS | | No | | | 2015 | 6.00 | Acres | Unknown | | | INSECTS | | INSECTS |
| PADDY | Rice | PONNI | Yes | Intermediate | Leaves | 2016 | 1 | Acres | <25% | Drying;Insect seen;Yell | Localised | Leaf tip drying, white patches with elongate brown colou | Fungus | PADDY BLAST |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | 2018 | 3 | Acres | 25% | Bore holes;Chewed;Dr | Scattered | Central shoot drying with Yellowing of leaf | Insect | INTERNODE BORER |
| RICE | RICE | | Yes | | Leaves | | | | | | | | | RICE BACTERIAL LEAF B |
| PADDY | Rice | CR 1009 | Yes | Intermediate | Leaves | | | | | | | | | LEAF ROLLER |
| PADDY | Rice | BPT 5204 | Yes | Intermediate | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| CITRUS | CITRUS | | Unknown | | | | | | | | | | ec | BACTERIA |
| RICE | RICE | KD 18 | No | Fruiting | | 2014 | 400.00 | m2 | <25% | Drying | Scattered | symptoms spread from leaf edges to leaf blades, and s | Bacterium | BACTERIAL BLIGHT |
| PADDY | Rice | BPT 5204 | Yes | Intermediate | Leaves | 2015 | 2 | Acres | 25% | Drying;Insect seen;Stur | Scattered | Yellowing and drying with appearance of onion leaf noti | Insect | GALL MIDGE |
| PADDY | Rice | CR 1009 | Yes | Intermediate | Leaves | 2017 | 3 | Acres | 25% | Chewed;Drying;Leaf sp | Scattered | Leaf tip drying ,yellowing of margin is noticed. | Bacterium | BACTERIAL LEAF BLIGH |
| CHILLIES | PIMENTON | local | Yes | Intermediate | Stem/shoot | 2016 | 500 | m2 | 25% | Wilted | Even | leaves wilting | Bacterium | BACTERIAL WILTING |
| PADDY | Rice | CO 50 | Yes | Intermediate | Leaves | 2016 | 2 | Acres | Unknown | Drying;Yellow | Scattered | Yellowing with elongated brown colour spots on the lea | Fungus | PADDY BLAST |
| PADDY | Rice | ADT37 | Yes | Intermediate | Leaves;Whole plant | 0 | 2 | Acres | 25% | Drying;Yellow | Even | Marginal drying of leavesPoor growth | Bacterium | BACTERIAL LEAF BLIGH |
| PADDY | Rice | BPT 5204 | Yes | Intermediate | Leaves | 2016 | 2 | Acres | <25% | Drying;Yellow | Scattered | Leaf tip drying with yellowing of margin is noticed | Bacterium | BACTERIAL LEAF BLIGH |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | | | | | | | | | MITES |
| PADDY | Rice | ADT 45 | Yes | Intermediate | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | | | | | | | | | MITES |
| CAM | CITRUS | | No | | Fruit/grair | | | | | | | | | BENH LOET |
| PADDY | Rice | BPT 5204 | Yes | Intermediate | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| TOMATE | TOMATO | | No | | Twig/bran | | | | | | | | | RALSTONIA |
| PADDY | Rice | ADT 36 | Yes | Intermediate | Leaves | | | | | | | | | STEMBORER |
| PADDY | Rice | BPT 5204 | Yes | Seedling | Leaves | | | | | | | | | LEAF FOLDER |
| PUMPKINS | PUMPKIN | | No | | Whole pla | | | | | | | | | BACTERIAL WILT |
| PADDY | Rice | ADT 39 | Yes | Intermediate | Leaves | | | | | | | | | PADDY BLAST |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | | | | | | | | | BACTERIAL LEAF BLIGH |
| DURAZNO | Peach | CRIOLLO | Yes | Fruiting | Leaves;Stem/shoot | 2014 | 20.00 | Plants | <25% | | Even | HOJAS CRESPAS TALLO ENRRULADOR, HOJAS C | Insect;Nutrient d | PULGON |
| PADDY | Rice | ADT 43 | Yes | Intermediate | Leaves | 2018 | 3 | Acres | 25% | Chewed;Drying;Insect s | Scattered | Central shoot drying with yellowing along with white pat | Insect | STEM BORER |
| RICE | RICE | KD 18 | No | Mature | Leaves | 2014 | 360.00 | m2 | <25% | Yellow | Scattered | symptoms spread from leaf edges to leaf blades, and s | Bacterium | BACTERIAL BLIGHT |

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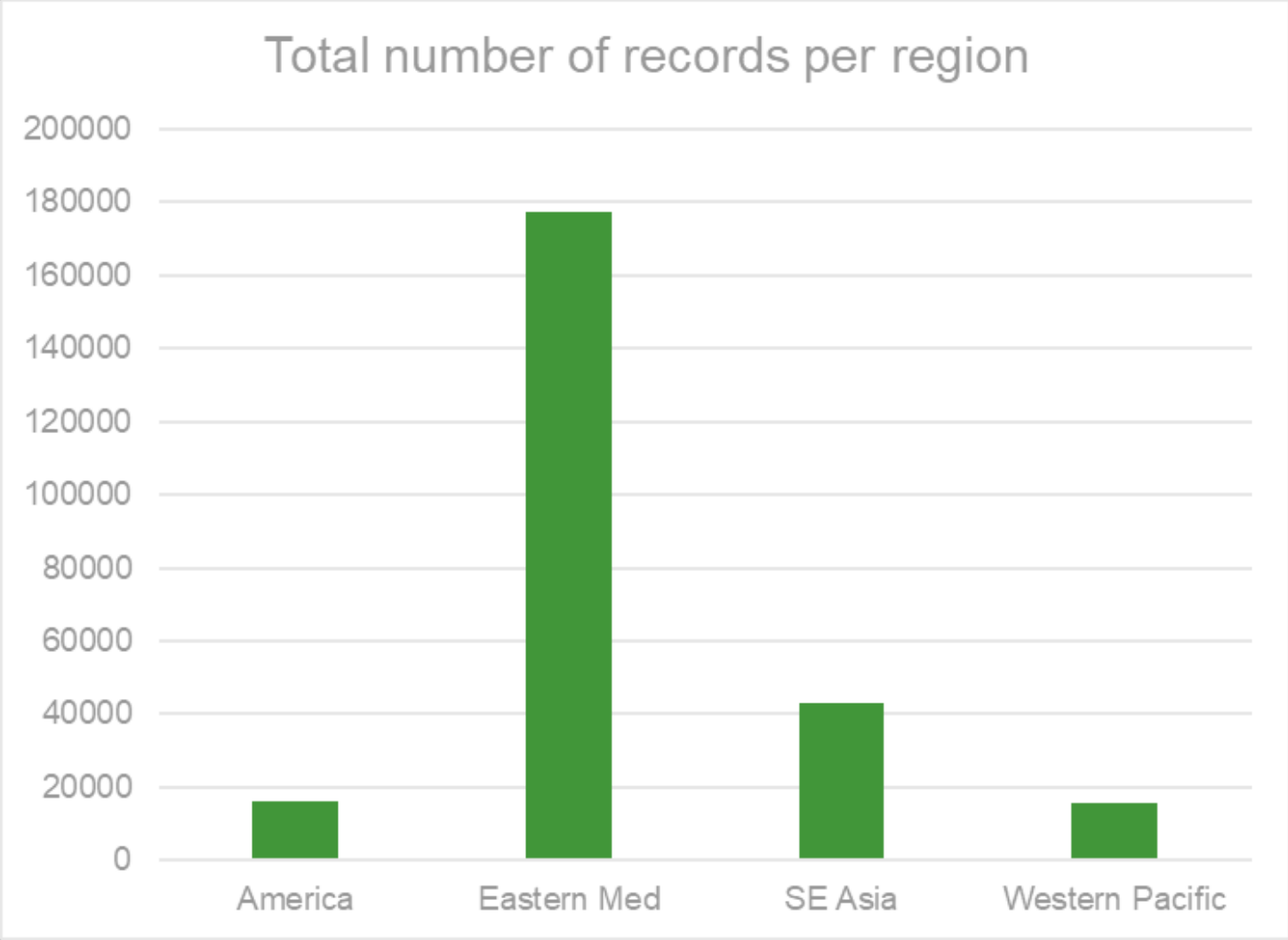
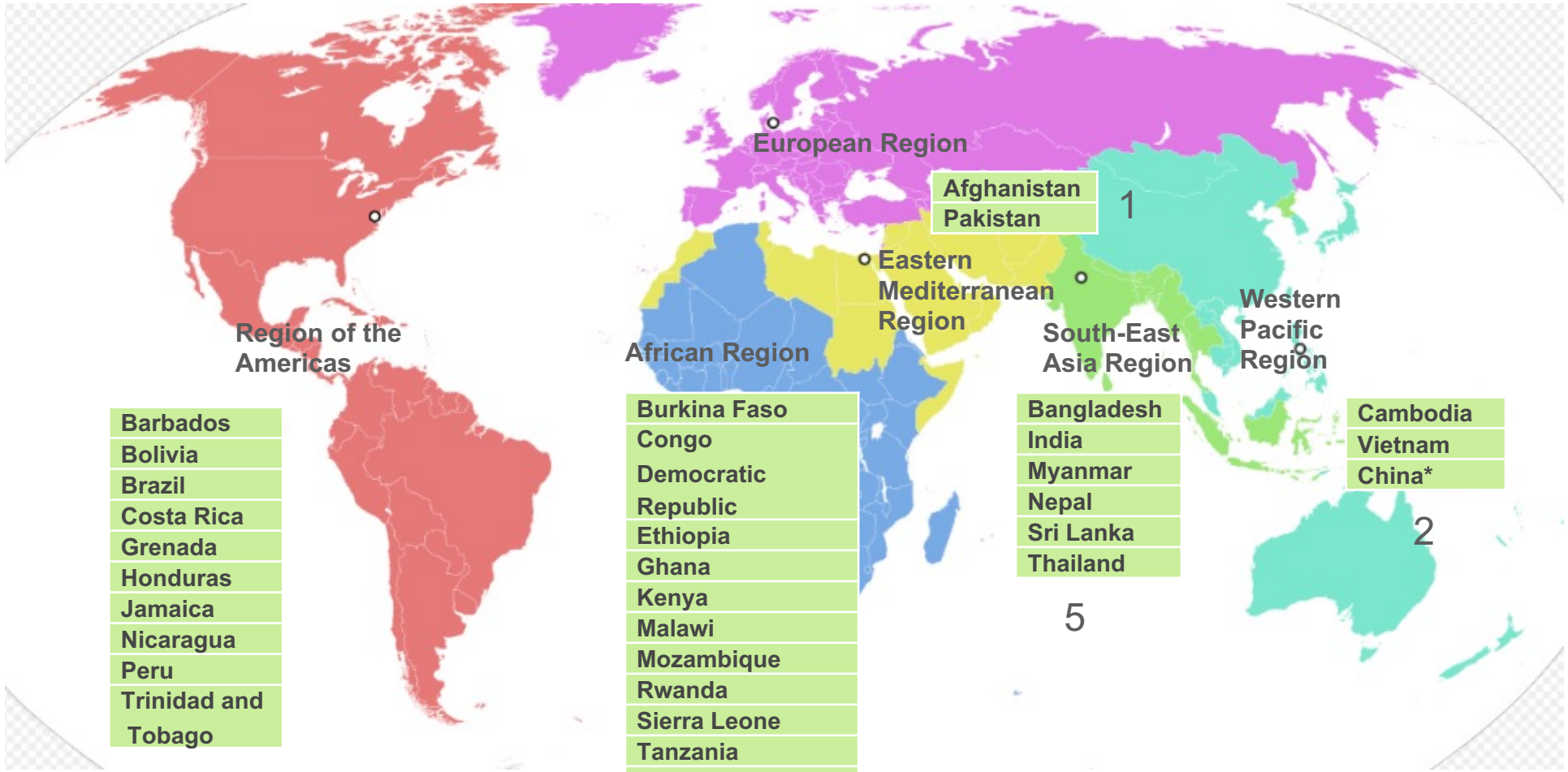


# Countries in which Plantwise is operational




Afghanistan
Pakistan

1

Barbados
Bolivia
Brazil
Costa Rica
Grenada
Honduras
Jamaica
Nicaragua
Peru
Trinidad and Tobago

3

Burkina Faso
Congo Democratic Republic
Ethiopia
Ghana
Kenya
Malawi
Mozambique
Rwanda
Sierra Leone
Tanzania
Uganda
Zambia

0

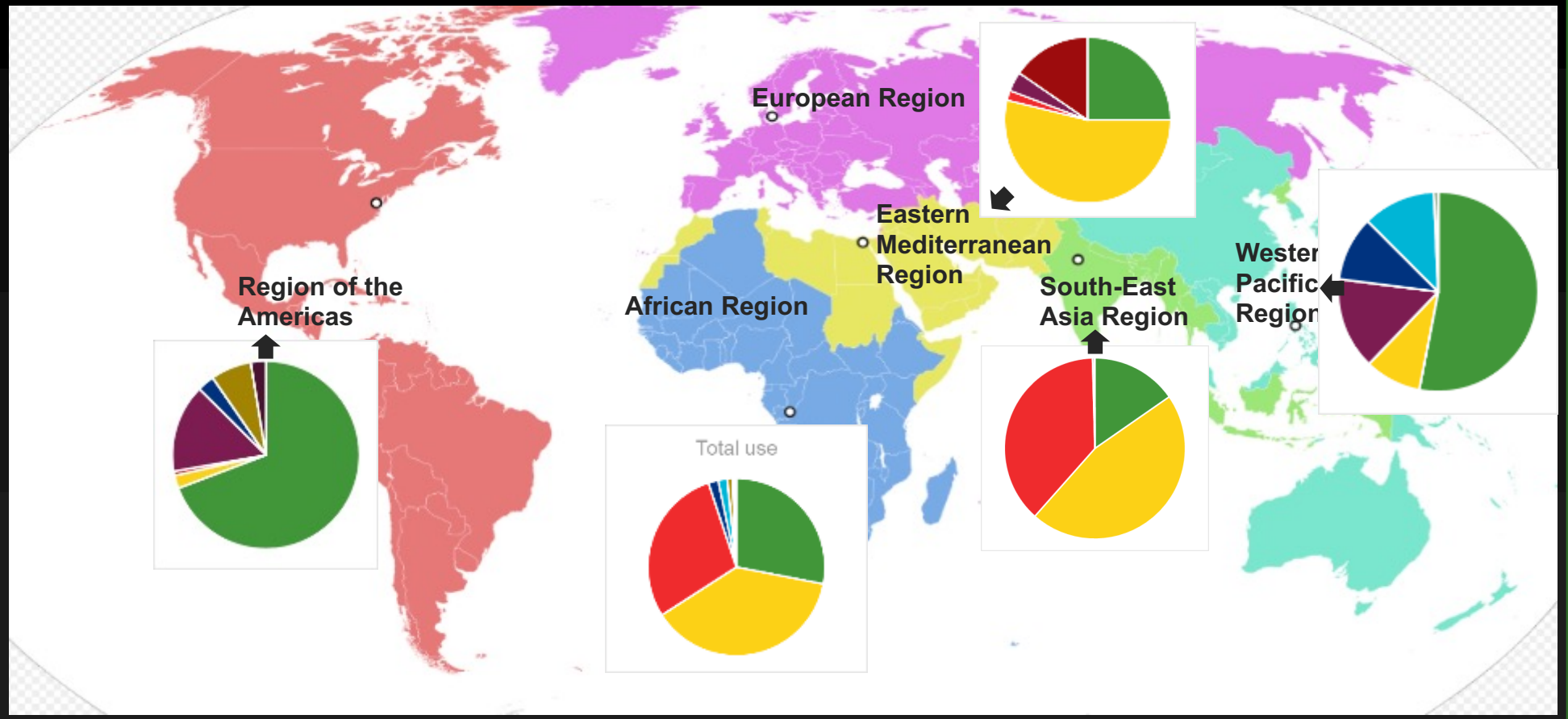
Bangladesh
India
Myanmar
Nepal
Sri Lanka
Thailand

5

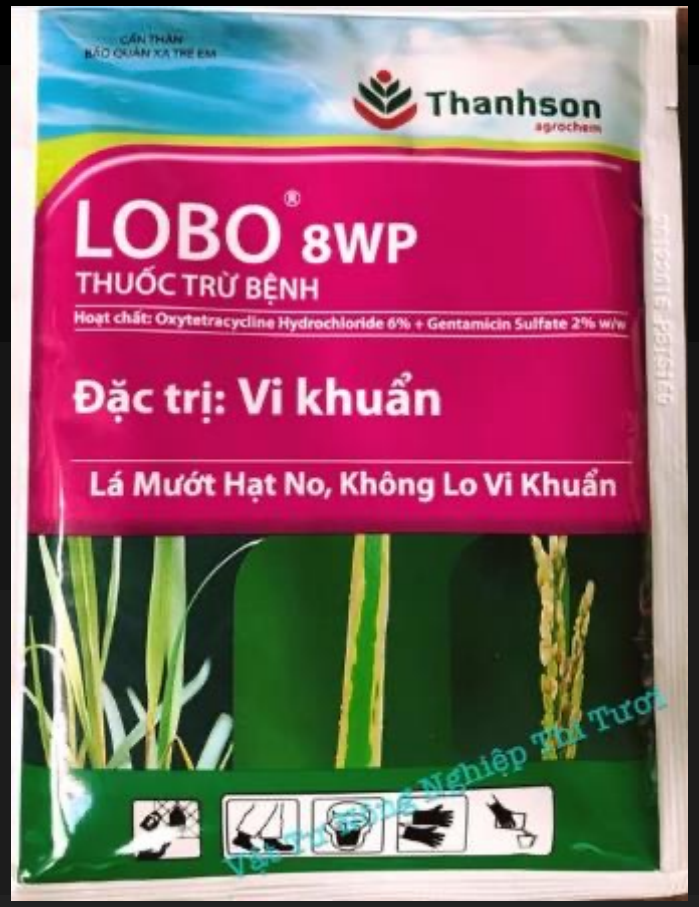
Cambodia
Vietnam
China*

2

# CABI AND PLANTWISE



# ANTIBIOTICS ON CROPS




- 16 brand names are included in the data but this is a small fraction of those that are available
- Antibiotics are often blended together
- Oxonilic acid and/or copper is sometimes included in the formulation
- It is often stated that antibiotics are only used on high value crops (such as top fruit) due to the prohibitive cost; that could be an explanation as to why there is zero use in Africa

# COST

Streptomycin Sulphate 3810-74-0

**US $1-30** / Kilogram
**1 Kilogram** (Min. Order)

11 YRS Henan Kingway Che...

Contact Supplier

15-20% SP 72%SP streptomycin

**US $1-100** / Kilogram
**25 Kilograms** (Min. Order)

8 YRS Lianyungang Rely Intl...

55.0%

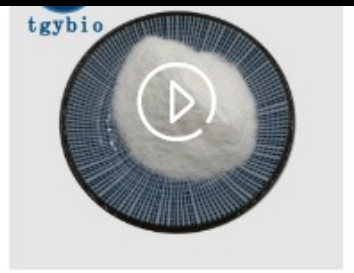
Contact Supplier

Agriculture Streptomycin 72% SP/90% TC(CAS:57-92-1)

**US $1-50** / Kilogram
**5 Kilograms** (Min. Order)

16 YRS Jiangsu Guotai Inter...

Contact Supplier




Supply High Quality Streptomycin Sulfate CAS 3810-74-0

**US $10-36** / Kilogram
**1 Kilogram** (Min. Order)

1 YR Xi'an Tian Guangyuan...

96.0%

Contact Supplier

Fungicide CAS No 3810-74-0 streptomycin sulphate 72%SP

**US $1-34.31** / Kilogram
**25 Kilograms** (Min. Order)

6 YRS Shijiazhuang Awiner...

Verified

86.0%

Contact Supplier


Agrochemical fungicide Streptomycin sulfate 72% SP

**US $10-50** / Kilogram
**1 Kilogram** (Min. Order)

pesticide Streptomycin sulfate 3810-74-0 veterinary drugs

**US $1-500** / Kilogram
**1 Kilogram** (Min. Order)

Streptomycin sulfate 3810-74-0

**US $4-5** / Liter
**1000 Liters** (Min. Order)

Low price streptomycin sulfate, fungicide streptomycin sulphate

**US $10-55** / Kilogram
**1 Kilogram** (Min. Order)


HOT Agrochemical Fungicide Streptomycin sulfate 95%TC

**US $35-45** / Kilogram
**10 Kilograms** (Min. Order)

# COST


Pharmaceutical raw material 99% purity bulk powder Tetracycline hcl

**US $1-50** / Kilogram
**1 Kilogram** (Min. Order)

7 YRS Shangqiu Kangmeida Bi...
82.4%
"Good seller" (1)

Contact Supplier

Add to Compare

< Sponsored Listing
Tags: Tetracycline Hcl | Tetracycline Hcl

Pharmaceutical 99% Tetracycline Hcl/ tetracycline antibiotics

**US $12.5-31.3** / Kilogram
**1 Kilogram** (Min. Order)

2 YRS Xi'an Henrikang Biotech...
92.7%

Contact Supplier


ZNSN Veterinary medicine oxytetracycline injection

**US $0.1-0.1** / Boxes
**10 Boxes** (Min. Order)

2 YRS Henan Zhongsheng Ani...
75.8%

Contact Supplier

Tetracycline Antibiotic Oxytetracycline Hcl GMP Factory

**US $1-100** / Kilogram
**1 Kilogram** (Min. Order)

9 YRS Vega Pharma Limited
Verified
"Carefully packed" (1)

Contact Supplier

Wholesale bulk tetracycline powder Tetracycline HCL/Tetracycline

**US $1-50** / Kilogram
**1 Kilogram** (Min. Order)

6 YRS Xi'an Huisun Bio-Tech C...
92.9%

Contact Supplier


99% Purity Best Price TETRACYCLINE HCL

**US $49-65** / Kilogram
**1 Kilogram** (Min. Order)

4 YRS Xi'an Sonwu Biotech Co....
95.1%


China 99% Tetracycline , cas 60-54-8

**US $1-10** / Kilogram
**1000 Kilograms** (Min. Order)

6 YRS Labeyond Chemicals (D...
85.7%

Factory supply top quality Tetracycline with reasonable price

**US $1-50** / Kilogram
**1 Kilogram** (Min. Order)

4 YRS Xi'an Geekee Biotech Co...
90.3%


Tetracyclines ,CAS 60-54-8,/bacteriostatic agent, Assay:

**US $33-46** / Kilogram
**1 Kilogram** (Min. Order)

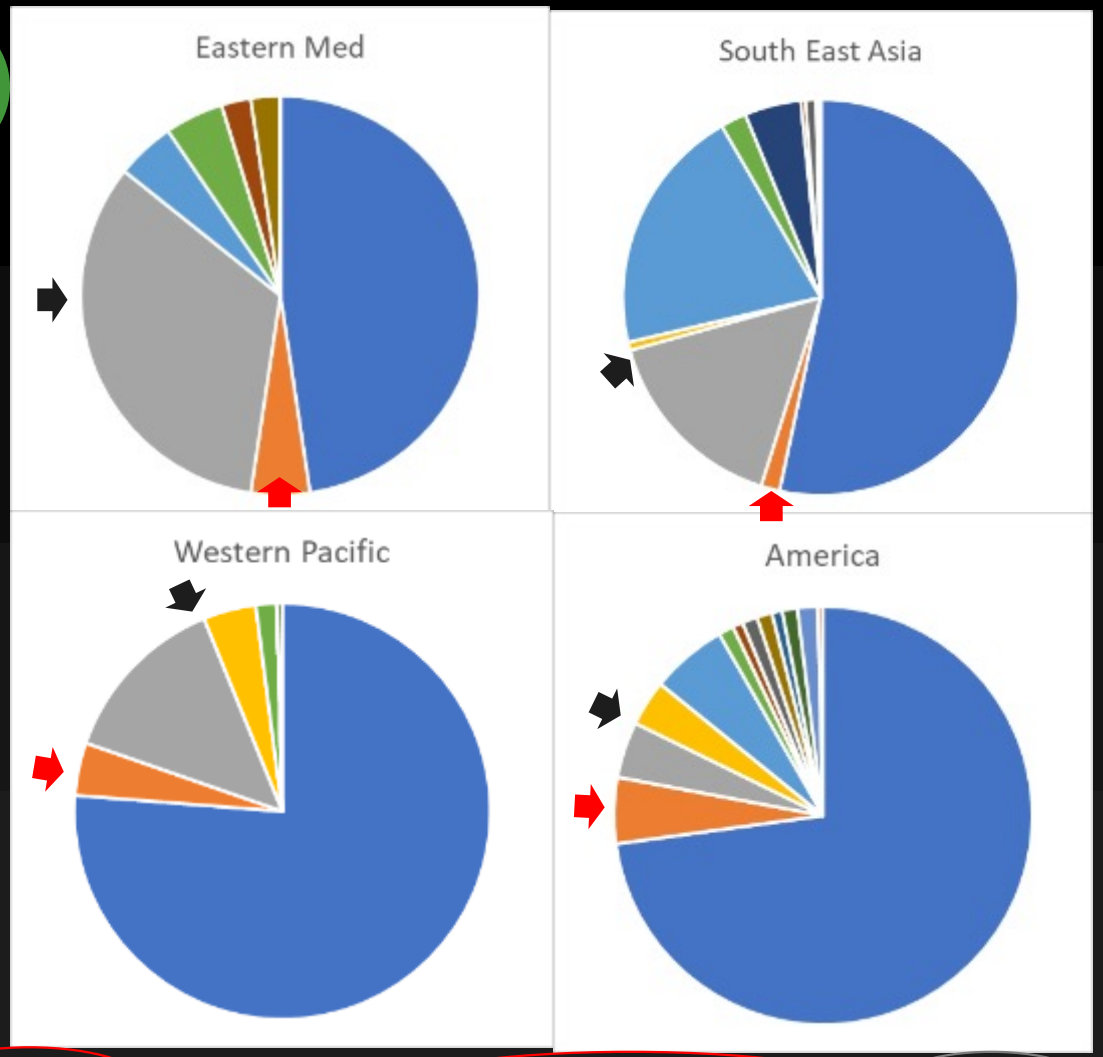
7 YRS Shanghai Ruizheng Che...
Verified
92.4%

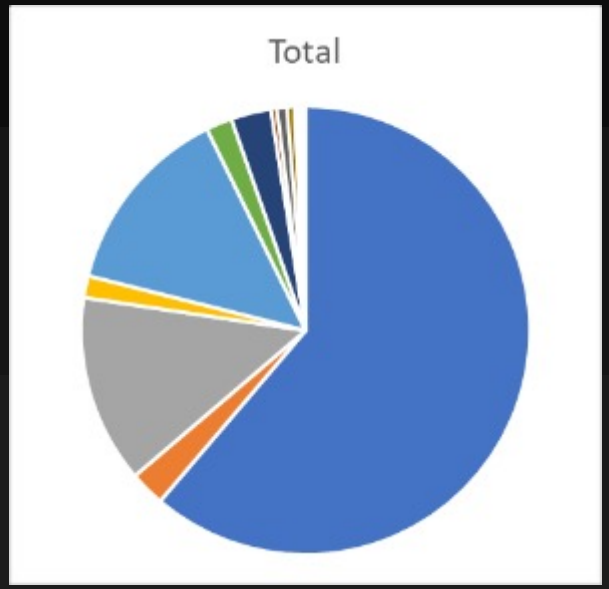
tetracycline antibiotic//Doxycycline hyclate//cas no.24390-14-5

**US $1-10** / Gram
**100 Grams** (Min. Order)

6 YRS Wuhan Hengheda Phar...

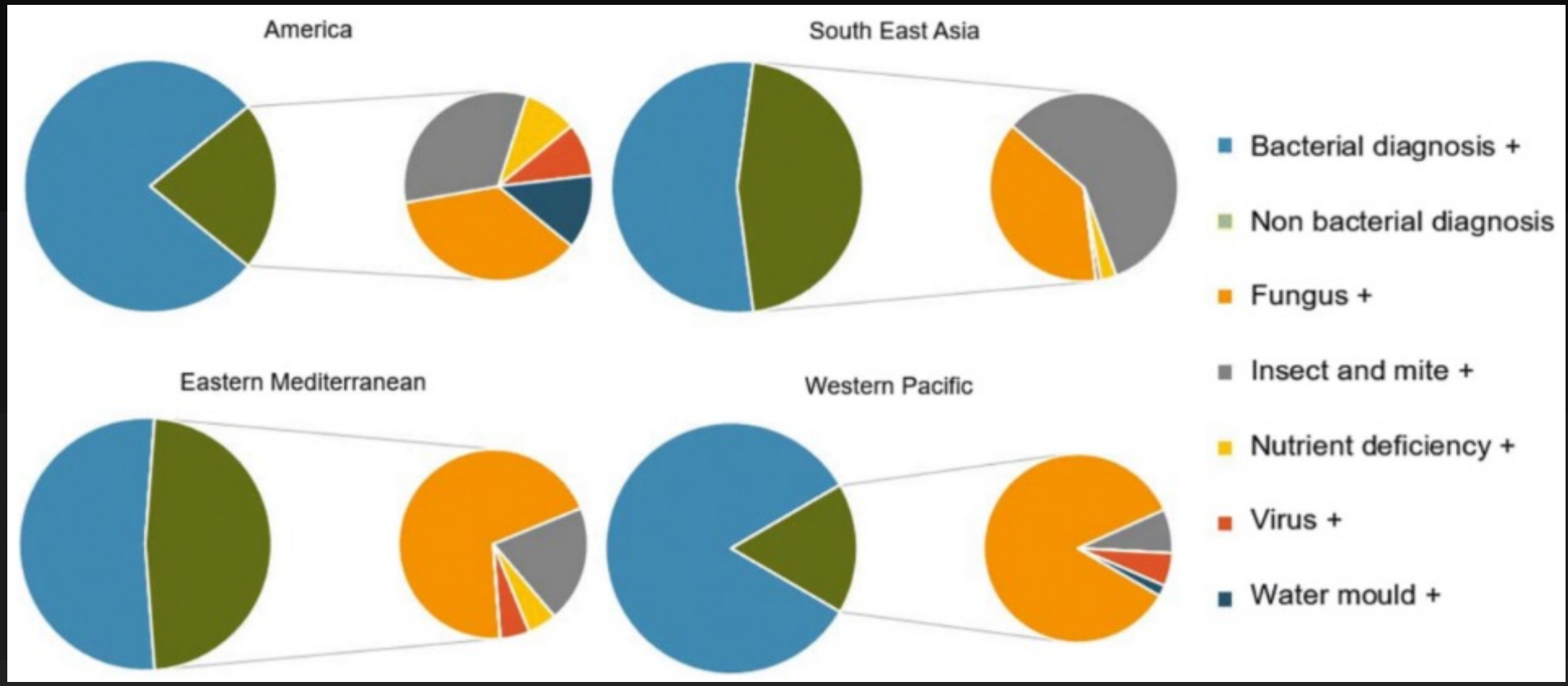
# DIAGNOSIS




- Bacterium
- Bacterium + other boxes
- Fungus
- Fungus + other boxes
- Insect
- Insect + other boxes
- Mite
- Nutrient def
- Nutrient def + other boxes
- Virus ?
- Virus + other boxes
- Water mould
- Watermould + other boxes
- Weeds + other boxes

# WHAT IS THE DIAGNOSIS?

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IS BUSINESS LINKAGE AFFECTING AGRICULTURAL ADVISORY SERVICES?

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# Antibiotics and crops

- In some years in SE Asia nearly 10% of the recommendations on rice contained an antibiotic
- Typical dose of a typical product 125g per Ha
- Equates to11.25g of streptomycin and 1.25g tetracycline per Ha
- Over 75 million Ha of rice are grown in SE Asia and the data would suggest that over 63 tonnes of streptomycin and 7 tonnes of tetracycline are used on it each year

# CHANGES IN LEGISLATION


indianchemicalnews.com/chemical/govt-prohibits-use-of-tb-antibiotics-on-crop-11743

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Home » Chemical » Govt. prohibits use of TB antibiotics on crop

## Govt. prohibits use of TB antibiotics on crop

***No person shall import, manufacture or formulate Streptomycin and Tetracycline for use in agriculture in India with effect from February 1, 2022***

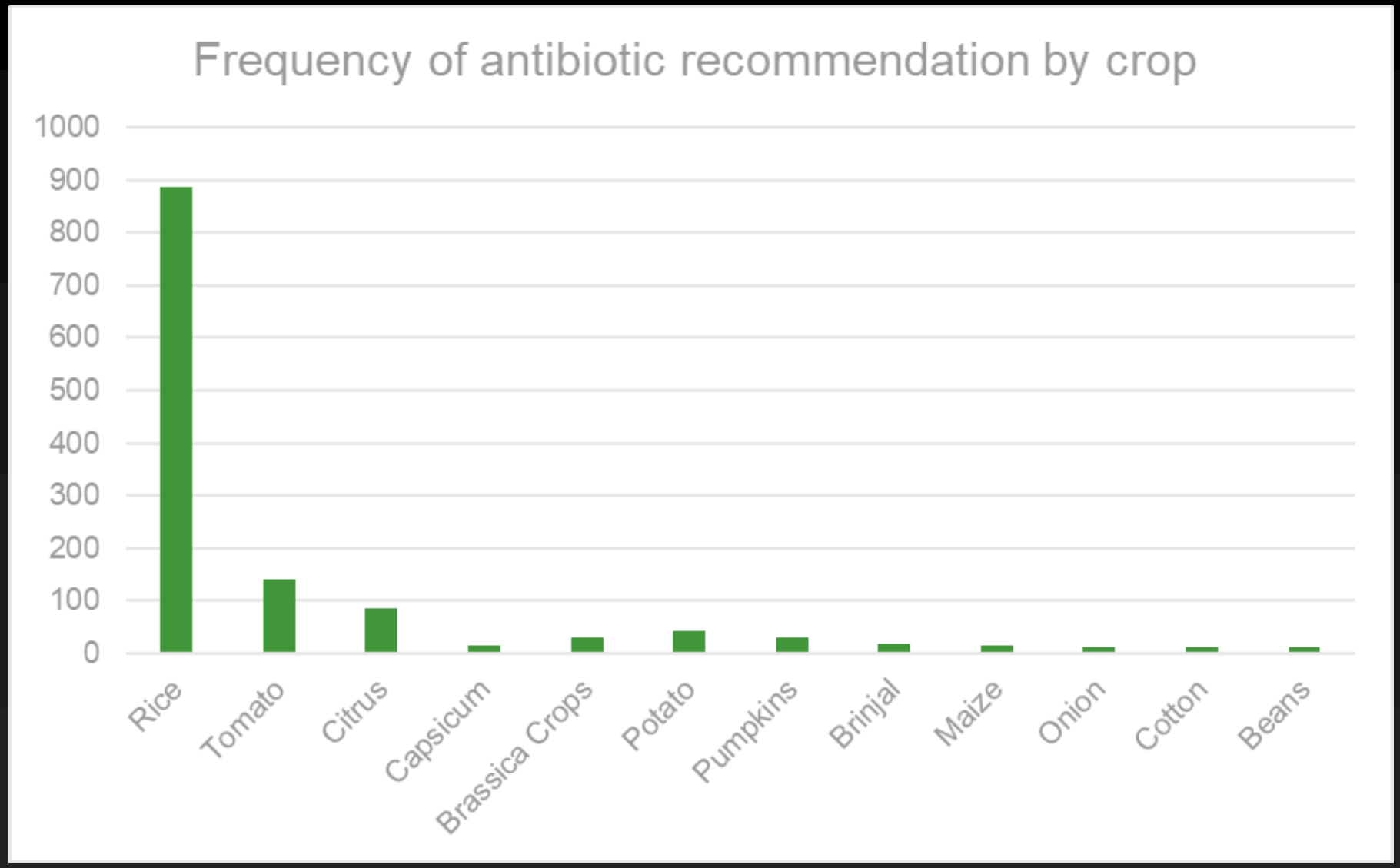
By ICN Bureau | December 23, 2021

The Ministry of Agriculture has issued a draft order prohibiting the use of tuberculosis antibiotics - Streptomycin and Tetracycline on crops.

Continued use of these substances in agriculture may pose the risk of developing resistance to these antibiotics in both human beings and animals.

The Registration Committee on Agrochemicals had constituted a Sub-Committee to explore the possibility of phasing out antibiotics or antibacterial substances for use in agriculture if alternatives are

# WHICH CROP RECEIVES THE MOST ANTIBIOTICS?



# CABI AND PLANTWISE

Antibiotics are not seen as being controversial they are just another crop protection product

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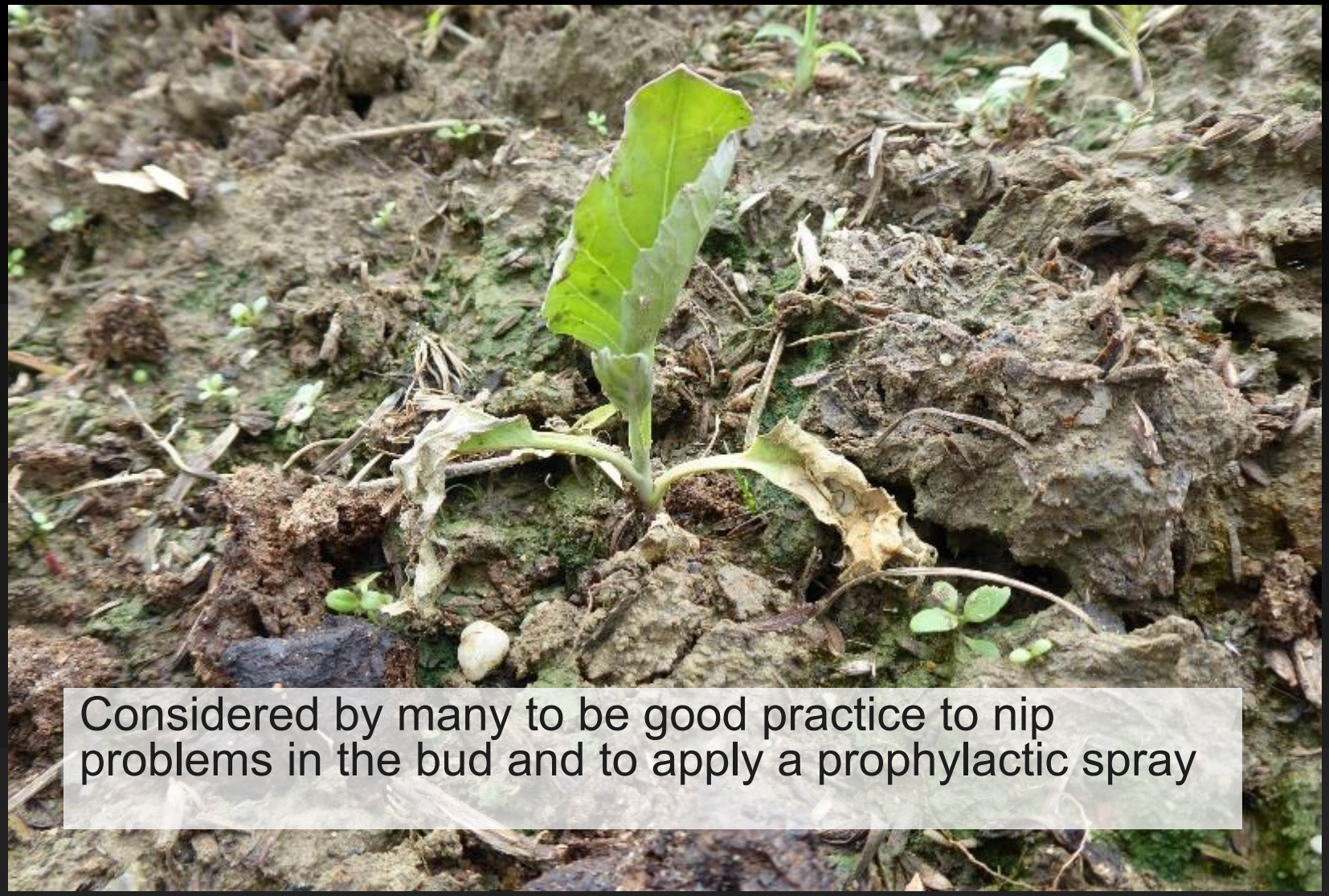
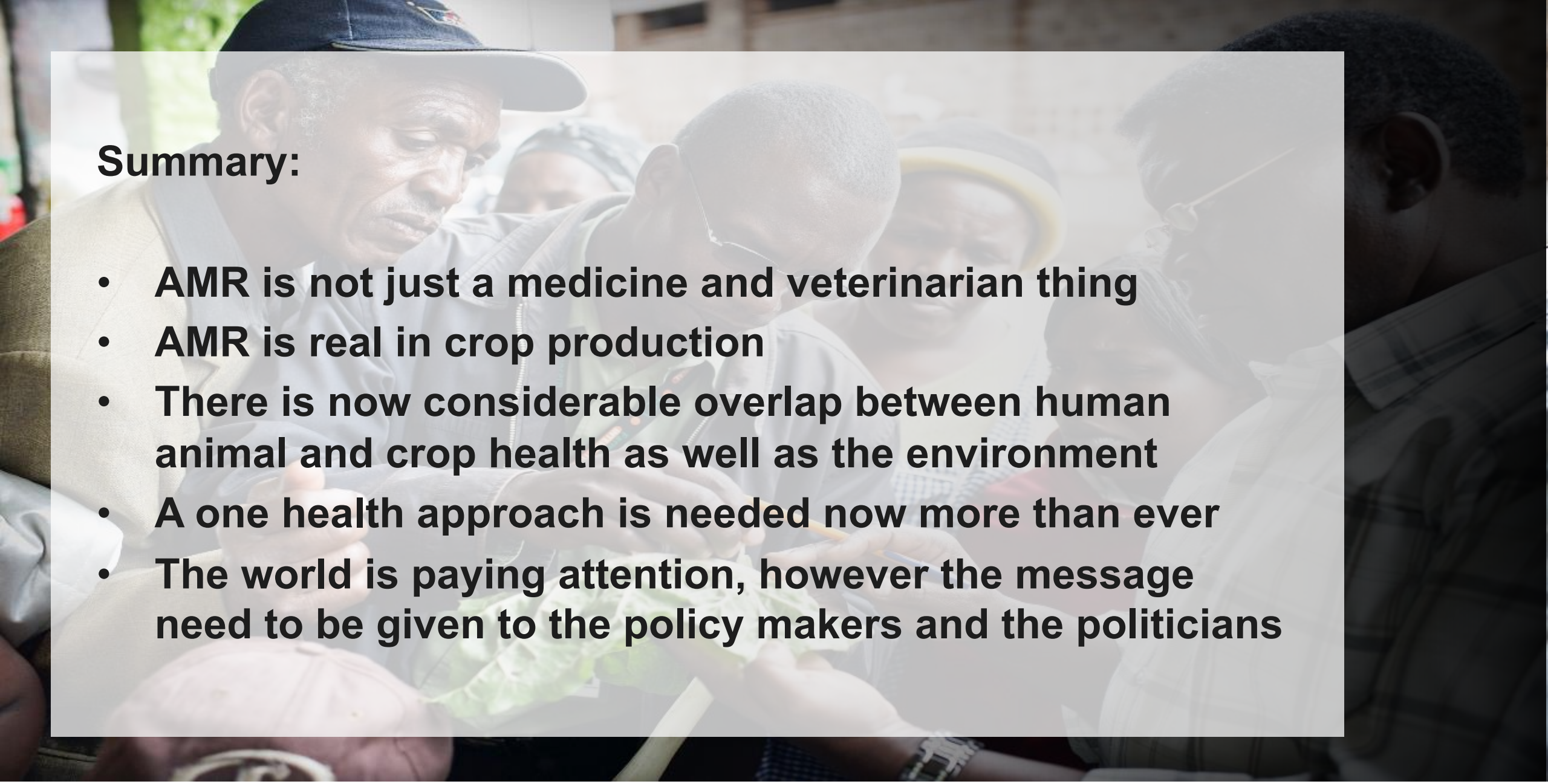


# CABI AND PLANTWISE

This isn’t accidental release of antibiotics into the environment



## Summary:

- AMR is not just a medicine and veterinarian thing
- AMR is real in crop production
- There is now considerable overlap between human animal and crop health as well as the environment
- A one health approach is needed now more than ever
- The world is paying attention, however the message need to be given to the policy makers and the politicians


CABI is an international intergovernmental organisation, and we gratefully acknowledge the core financial support from our member countries (and lead agencies) including:

UKaid from the British people

Ministry of Agriculture and Rural Affairs, People's Republic of China

Australian Government Australian Centre for International Agricultural Research

Agriculture and Agri-Food Canada

Ministry of Foreign Affairs of the Netherlands

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC