



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



what does CABI do?

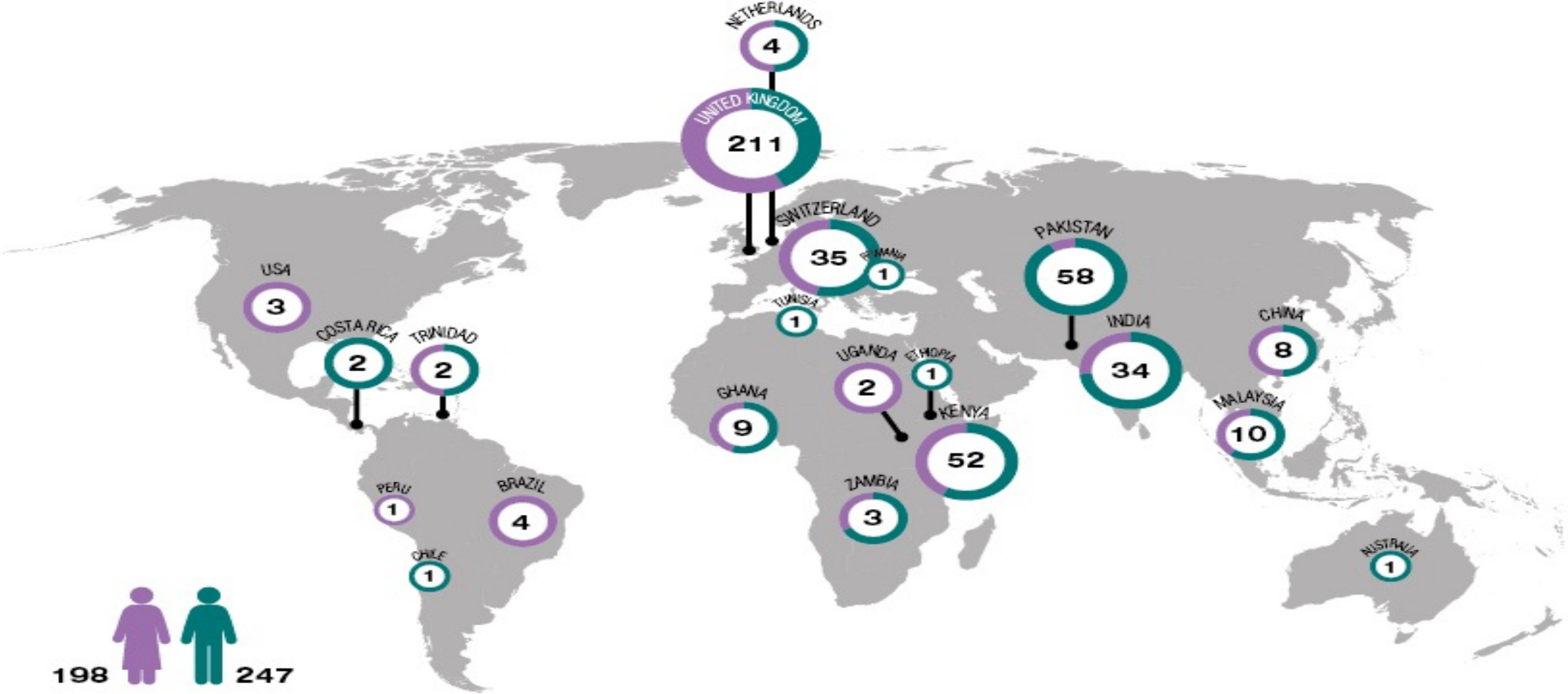
CABI addresses issues of global concern such as food security, through science, information and communication



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



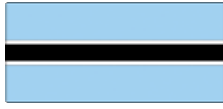
Bangladesh



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?

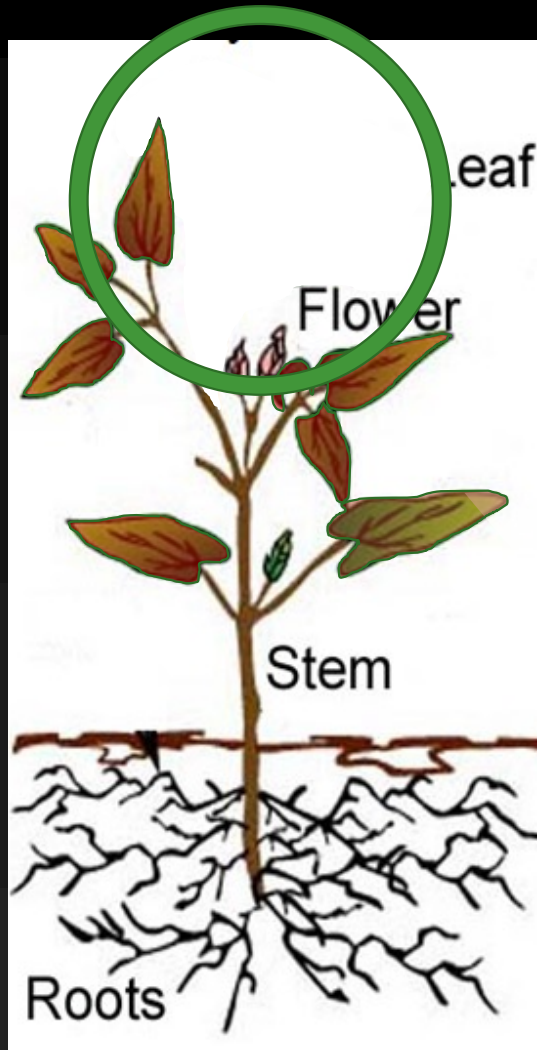
Most crop pathogens are fungal. Fungicide resistance has to be included as AMR

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.



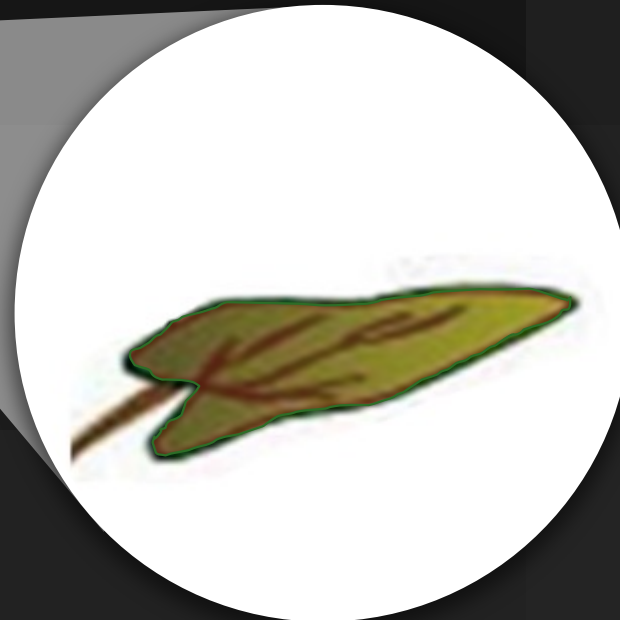
CHEMICAL CONTROL



Growth after spraying is unprotected

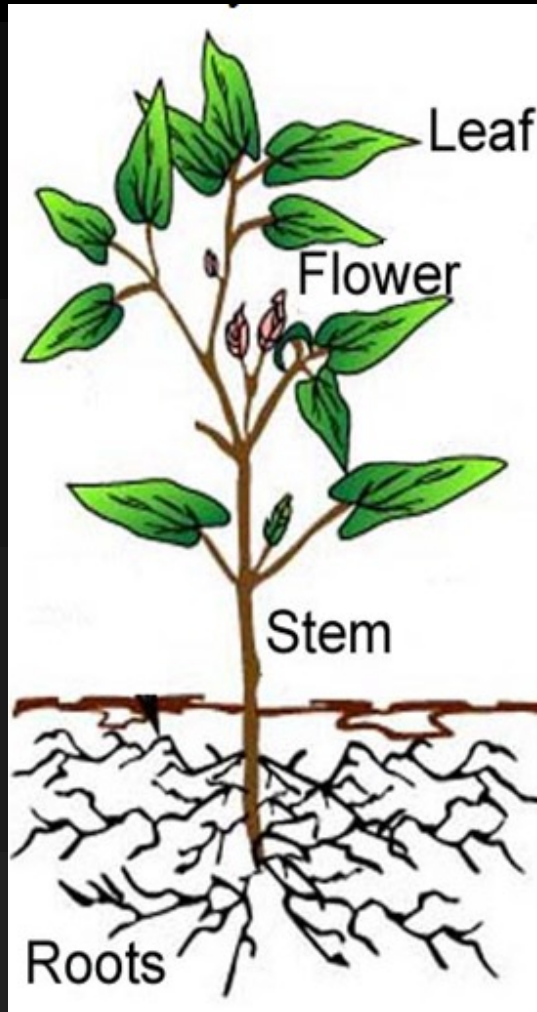
Protectants create a thin skin of fungicidal material over the plant

But you cannot spray what isn't there





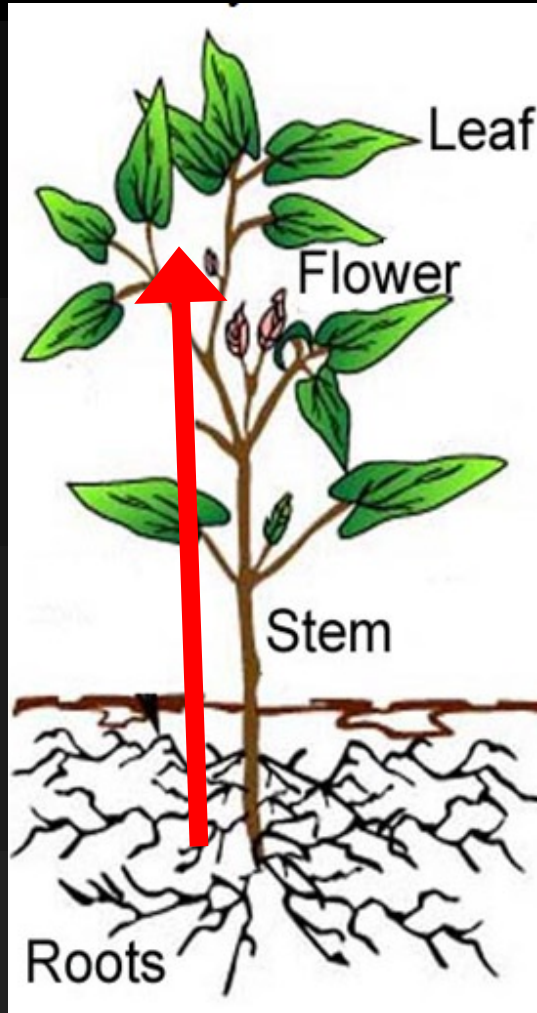
CONTACT FUNGICIDES



The fungicidal skin must remain for the plant to be protected



SYSTEMIC FUNGICIDES



Systemic chemicals enter the plant and cannot be washed off

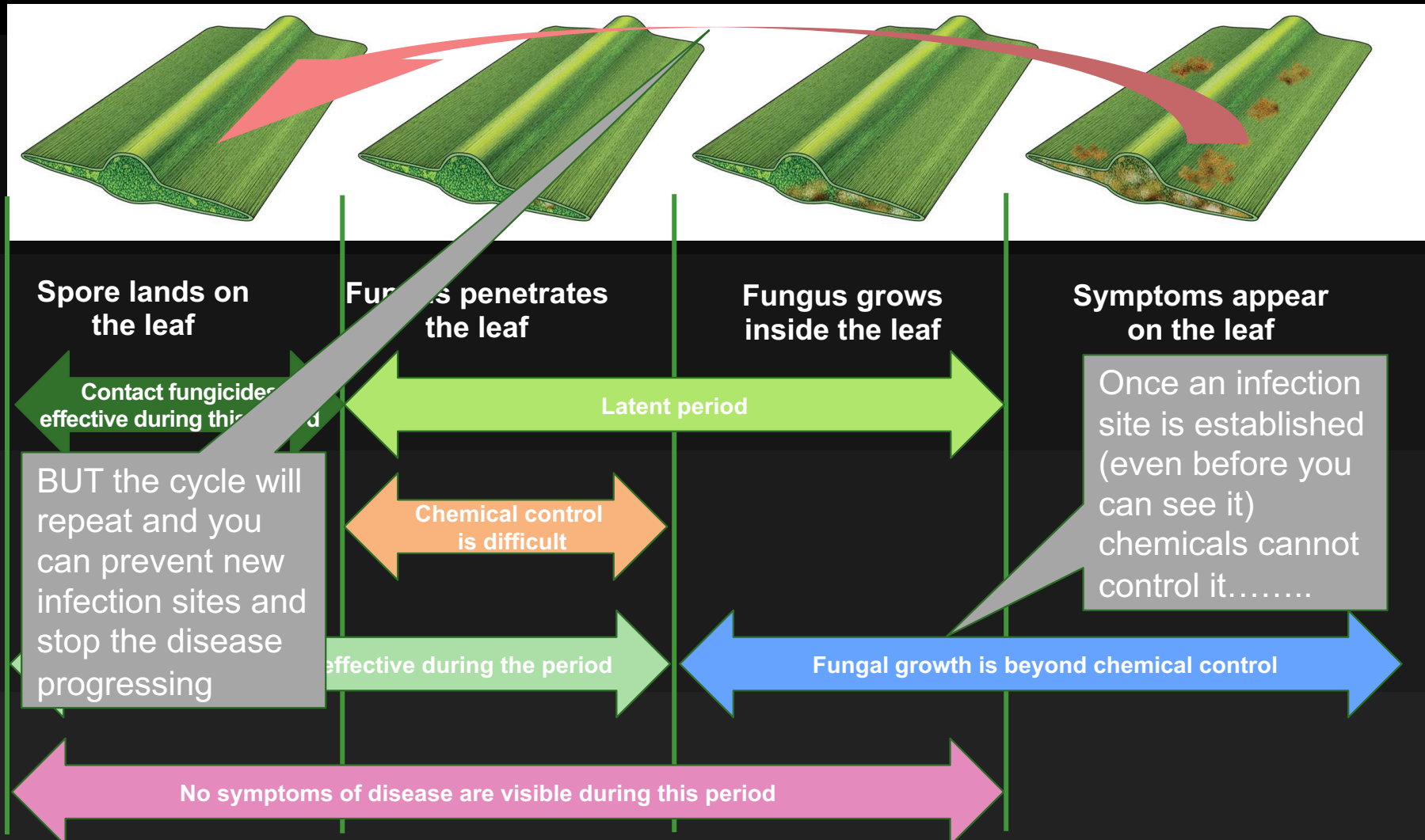
Movement is upwards and new growth is protected to some extent

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

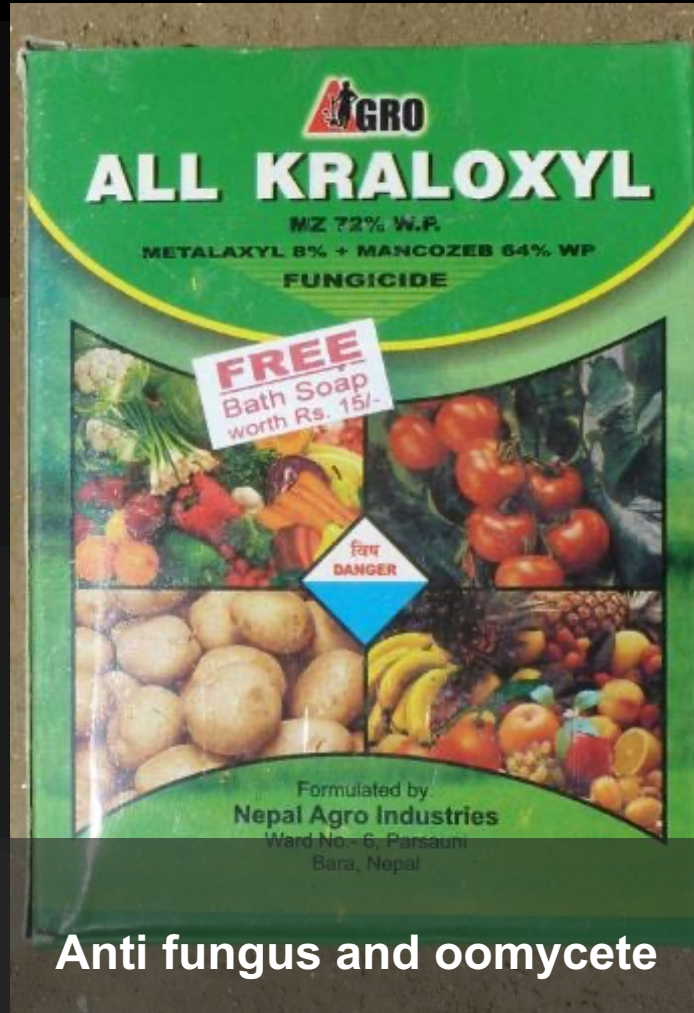




VARIOUS TYPES OF ANTI MICROBIAL PRODUCTS USED ON CROPS



Anti viral compounds

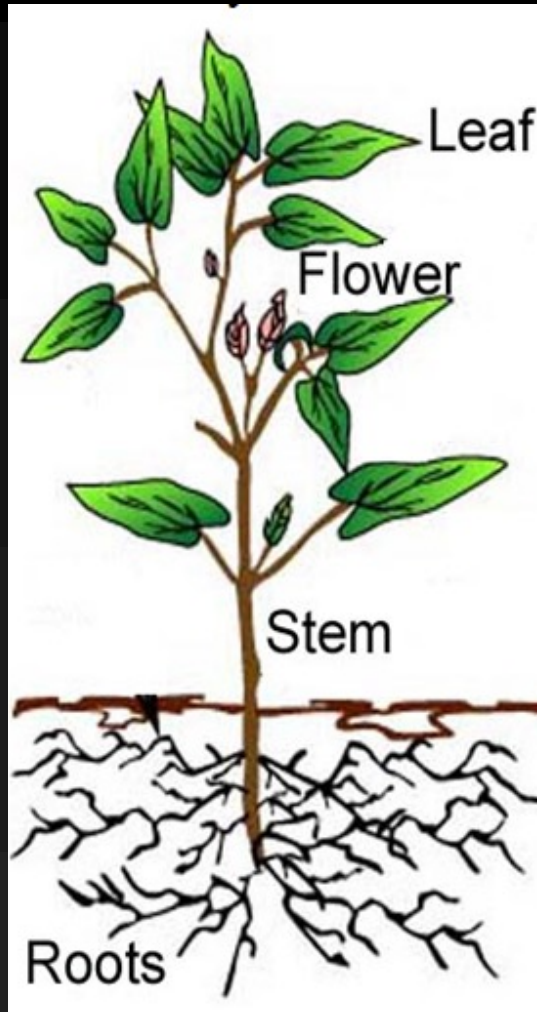


Anti fungus and oomycete





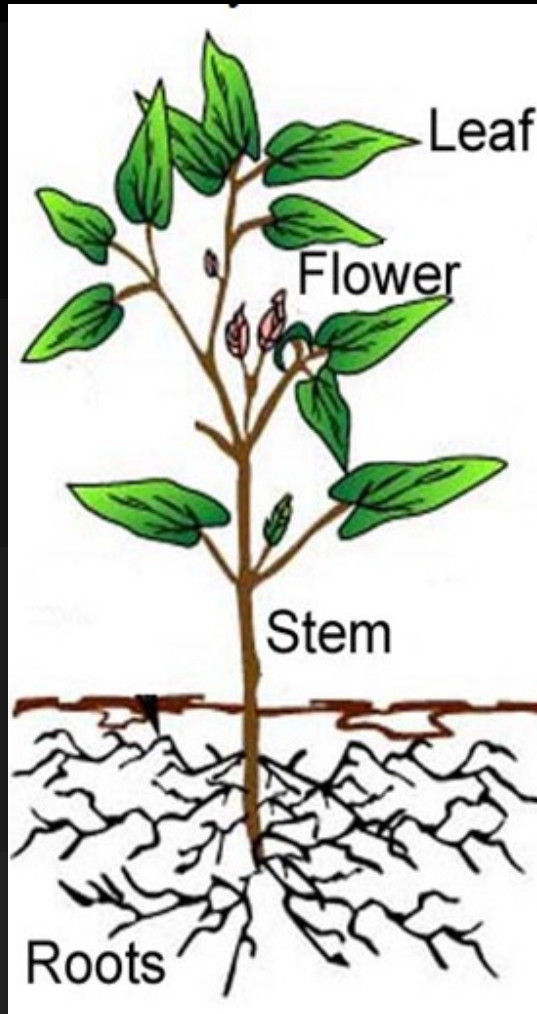
REASONS FOR FUNGICIDE FAILURE



- 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?



FRAC Classification of Fungicides

Fungal control agents by cross resistance pattern and mode of action 2022 (www.frac.info)

A: Nucleic Acids Metabolism

B: Cytoskeleton and Motor Proteins

C: Respiration

D: Amino Acid and Protein Synthesis

E: Signal Transduction

F: Lipid Synthesis or Transport / Membrane Integrity or Function

G: Sterol Biosynthesis in Membranes

H: Cell Wall Biosynthesis

I: Melanin Synthesis in Cell Wall

M: Chemicals with Multi-Site Activity

P: Host Plant Defence Induction

Unknown Mode of Action

BM: Biologicals with Multiple Modes of Action

NC: Not Specified

Legend

C: Respiration

C1: complex I NADH Oxidase-reductase

C2: complex II succinate dehydrogenase

C3: uncouplers of oxidative phosphorylation

C4: complex III cytochrome bc1 complex

C5: inhibitors of complex III

C6: inhibitors of complex IV

C7: inhibitors of oxidative phosphorylation ATP synthase

C8: ATP transport

C9: inhibitors of mitochondrial DNA replication

C10: inhibitors of mitochondrial DNA replication

C11: inhibitors of mitochondrial DNA replication

C12: inhibitors of mitochondrial DNA replication

C13: inhibitors of mitochondrial DNA replication

C14: inhibitors of mitochondrial DNA replication

C15: inhibitors of mitochondrial DNA replication

C16: inhibitors of mitochondrial DNA replication

C17: inhibitors of mitochondrial DNA replication

C18: inhibitors of mitochondrial DNA replication

C19: inhibitors of mitochondrial DNA replication

C20: inhibitors of mitochondrial DNA replication

C21: inhibitors of mitochondrial DNA replication

C22: inhibitors of mitochondrial DNA replication

C23: inhibitors of mitochondrial DNA replication

C24: inhibitors of mitochondrial DNA replication

C25: inhibitors of mitochondrial DNA replication

C26: inhibitors of mitochondrial DNA replication

C27: inhibitors of mitochondrial DNA replication

C28: inhibitors of mitochondrial DNA replication

C29: inhibitors of mitochondrial DNA replication

C30: inhibitors of mitochondrial DNA replication

C31: inhibitors of mitochondrial DNA replication

C32: inhibitors of mitochondrial DNA replication

C33: inhibitors of mitochondrial DNA replication

C34: inhibitors of mitochondrial DNA replication

C35: inhibitors of mitochondrial DNA replication

C36: inhibitors of mitochondrial DNA replication

C37: inhibitors of mitochondrial DNA replication

C38: inhibitors of mitochondrial DNA replication

C39: inhibitors of mitochondrial DNA replication

C40: inhibitors of mitochondrial DNA replication

C41: inhibitors of mitochondrial DNA replication

C42: inhibitors of mitochondrial DNA replication

C43: inhibitors of mitochondrial DNA replication

C44: inhibitors of mitochondrial DNA replication

C45: inhibitors of mitochondrial DNA replication

C46: inhibitors of mitochondrial DNA replication

C47: inhibitors of mitochondrial DNA replication

C48: inhibitors of mitochondrial DNA replication

C49: inhibitors of mitochondrial DNA replication

C50: inhibitors of mitochondrial DNA replication

C51: inhibitors of mitochondrial DNA replication

C52: inhibitors of mitochondrial DNA replication

C53: inhibitors of mitochondrial DNA replication

C54: inhibitors of mitochondrial DNA replication

C55: inhibitors of mitochondrial DNA replication

C56: inhibitors of mitochondrial DNA replication

C57: inhibitors of mitochondrial DNA replication

C58: inhibitors of mitochondrial DNA replication

C59: inhibitors of mitochondrial DNA replication

C60: inhibitors of mitochondrial DNA replication

C61: inhibitors of mitochondrial DNA replication

C62: inhibitors of mitochondrial DNA replication

C63: inhibitors of mitochondrial DNA replication

C64: inhibitors of mitochondrial DNA replication

C65: inhibitors of mitochondrial DNA replication

C66: inhibitors of mitochondrial DNA replication

C67: inhibitors of mitochondrial DNA replication

C68: inhibitors of mitochondrial DNA replication

C69: inhibitors of mitochondrial DNA replication

C70: inhibitors of mitochondrial DNA replication

C71: inhibitors of mitochondrial DNA replication

C72: inhibitors of mitochondrial DNA replication

C73: inhibitors of mitochondrial DNA replication

C74: inhibitors of mitochondrial DNA replication

C75: inhibitors of mitochondrial DNA replication

C76: inhibitors of mitochondrial DNA replication

C77: inhibitors of mitochondrial DNA replication

C78: inhibitors of mitochondrial DNA replication

C79: inhibitors of mitochondrial DNA replication

C80: inhibitors of mitochondrial DNA replication

C81: inhibitors of mitochondrial DNA replication

C82: inhibitors of mitochondrial DNA replication

C83: inhibitors of mitochondrial DNA replication

C84: inhibitors of mitochondrial DNA replication

C85: inhibitors of mitochondrial DNA replication

C86: inhibitors of mitochondrial DNA replication

C87: inhibitors of mitochondrial DNA replication

C88: inhibitors of mitochondrial DNA replication

C89: inhibitors of mitochondrial DNA replication

C90: inhibitors of mitochondrial DNA replication

C91: inhibitors of mitochondrial DNA replication

C92: inhibitors of mitochondrial DNA replication

C93: inhibitors of mitochondrial DNA replication

C94: inhibitors of mitochondrial DNA replication

C95: inhibitors of mitochondrial DNA replication

C96: inhibitors of mitochondrial DNA replication

C97: inhibitors of mitochondrial DNA replication

C98: inhibitors of mitochondrial DNA replication

C99: inhibitors of mitochondrial DNA replication

C100: inhibitors of mitochondrial DNA replication



Mode of Action of Fungicides

FRAC classification on mode of action 2011 (www.frac.info)

A: Nucleic Acid Synthesis

A1: RNA polymerase I
4 Phthalimides (Phthalimides)

A2: adenosine deaminase
8 Nucleoside Diphosphate

A3: DNA / RNA synthesis (prop.)
10 Imidazopyridines

A4: DNA topoisomerase type II (gyrase)
11 Carbonyl acids

B: Mitosis and Cell Division

B1: β -tubulin assembly in mitosis
1: MBC fungicides (= Methyl Benzimidazole Carbamates)

B2: β -tubulin assembly in mitosis*
10 N-phenyl carbamates

B3: β -tubulin assembly in mitosis
22 benzamides

B4: cell division (prop.)
20 phenylureas

B5: delocalisation of spectrin-like proteins
43 benzamides

C: Respiration

C1: inhibition of complex I
NADH Oxidoreductase
10 pyridinones

C2: inhibition of complex I: succinate dehydrogenase
17 SDH (succinate dehydrogenase complex)

C3: inhibition of complex III
cytochrome bcl (ubiquinol oxidase) at Qo site (cyt b gene)
11 Oxidopyridines (Quinone pyridinones)

C4: inhibition of complex III
cytochrome bc1 complex (cytochrome oxidase) at Cyt b site
10 Oxidopyridines (Quinone pyridinones)

C5: inhibition of complex III
cytochrome bc1 complex (cytochrome oxidase) at Cyt b site
10 Oxidopyridines (Quinone pyridinones)

C6: inhibitors of oxidative phosphorylation, ATP synthase
10 organo tin

C7: ATP production (prop.)
10 Oxidopyridines (Quinone pyridinones)

C8: uncouplers of oxidative phosphorylation
10

D: Amino Acid and Protein Synthesis

D1: methionine biosynthesis (oga gene) (prop.)
22 Oxidopyridines (OP fungicides)

D2: protein synthesis
22 Oxidopyridines (OP fungicides)

D3: protein synthesis
20 Phenylureas

D4: protein synthesis
22 Oxidopyridines (OP fungicides)

D5: protein synthesis
21 Oxidopyridines (OP fungicides)

E: Signal Transduction

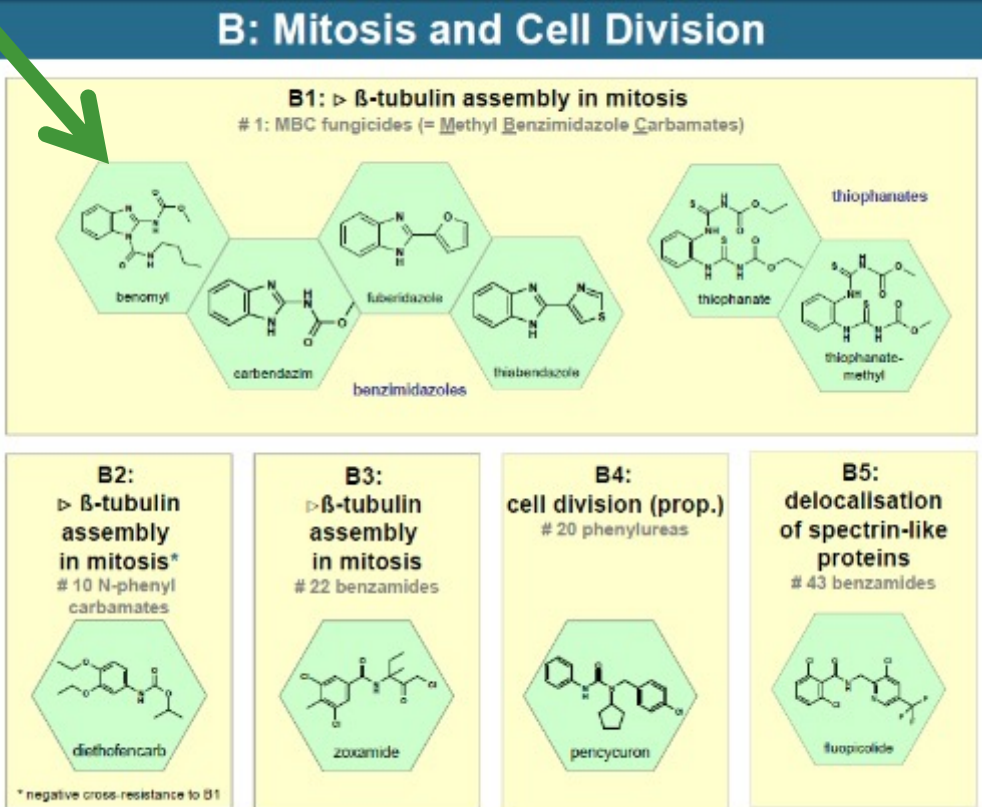
E1: Signal transduction (mechanism unknown)
10 Oxidopyridines (OP fungicides)

E2: Osmotic signal transduction
MAP / Histidine-kinase (os-2, HQH)

E3: Osmotic signal transduction
MAP / Histidine-kinase (os-2, HQH)

E4: Osmotic signal transduction
MAP / Histidine-kinase (os-2, HQH)

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





Mode of Action of Fungicides

FRAC classification

A: Nucleic Acid Synthesis

A1: RNA polymerase I
4: PA-fungicides (PhenylAmides)

A2: adenosine-deaminase
1: Nucleoside Phosphorylation

A3: Phospholipase C (ergosterol)
3: Phospholipase C (ergosterol)

A4: DNA / RNA synthesis (prop.)
11: Nucleoside Phosphorylation

A5: DNA topoisomerase type II (gyrase)
12: Nucleoside Phosphorylation

B: Mitosis and Cell Division

B1: 8-Subunit assembly in mitosis
7: Microtubule Inhibition

B2: 8-Subunit assembly in mitosis
13: Microtubule Inhibition

B3: 8-Subunit assembly in mitosis
14: Microtubule Inhibition

B4: cell division
15: Microtubule Inhibition

C: Respiration

C1: Inhibition of cytochrome b
16: Cytochrome b Inhibition

C2: Inhibition of cytochrome b
17: Cytochrome b Inhibition

C3: Inhibition of cytochrome b
18: Cytochrome b Inhibition

C4: Inhibitors of oxidative phosphorylation, ATP synthase
20: ATP synthase Inhibition

C5: Inhibitors of oxidative phosphorylation
21: ATP synthase Inhibition

C6: Inhibitors of oxidative phosphorylation
22: ATP synthase Inhibition

D: Amino Acid and Protein Synthesis

D1: methionine biosynthesis (oga gene) (prop.)
23: Methionine Biosynthesis

D2: protein synthesis
24: Protein Synthesis

D3: protein synthesis
25: Protein Synthesis

D4: protein synthesis
26: Protein Synthesis

D5: protein synthesis
27: Protein Synthesis

E: Signal Transduction

E1: Signal transduction (mechanism unknown)
28: Signal Transduction

E2: Osmotic signal transduction
29: MAP / Histidine-kinase (oa-2, HQH)

F: Cell Wall

F1: chitin biosynthesis
30: Chitin Biosynthesis

F2: chitin biosynthesis
31: Chitin Biosynthesis

F3: melanin biosynthesis
32: Melanin Biosynthesis

F4: melanin biosynthesis
33: Melanin Biosynthesis

G: Sterol Biosynthesis in membranes

G1: Sterol Biosynthesis inhibitor (SBI) class I: DMF fungicides
34: Sterol Biosynthesis Inhibition

G2: SBI class II: Amides
35: Sterol Biosynthesis Inhibition

G3: SBI class III: hydroxysteroids
36: Sterol Biosynthesis Inhibition

G4: SBI class IV: squalene epoxidase
37: Sterol Biosynthesis Inhibition

H: Other

H1: Other
38: Other

H2: Other
39: Other

H3: Other
40: Other

H4: Other
41: Other

H5: Other
42: Other

H6: Other
43: Other

H7: Other
44: Other

H8: Other
45: Other

H9: Other
46: Other

H10: Other
47: Other

H11: Other
48: Other

H12: Other
49: Other

H13: Other
50: Other

H14: Other
51: Other

H15: Other
52: Other

H16: Other
53: Other

H17: Other
54: Other

H18: Other
55: Other

H19: Other
56: Other

H20: Other
57: Other

H21: Other
58: Other

H22: Other
59: Other

H23: Other
60: Other

H24: Other
61: Other

H25: Other
62: Other

H26: Other
63: Other

H27: Other
64: Other

H28: Other
65: Other

H29: Other
66: Other

H30: Other
67: Other

H31: Other
68: Other

H32: Other
69: Other

H33: Other
70: Other

H34: Other
71: Other

H35: Other
72: Other

H36: Other
73: Other

H37: Other
74: Other

H38: Other
75: Other

H39: Other
76: Other

H40: Other
77: Other

H41: Other
78: Other

H42: Other
79: Other

H43: Other
80: Other

H44: Other
81: Other

H45: Other
82: Other

H46: Other
83: Other

H47: Other
84: Other

H48: Other
85: Other

H49: Other
86: Other

H50: Other
87: Other

H51: Other
88: Other

H52: Other
89: Other

H53: Other
90: Other

H54: Other
91: Other

H55: Other
92: Other

H56: Other
93: Other

H57: Other
94: Other

H58: Other
95: Other

H59: Other
96: Other

H60: Other
97: Other

H61: Other
98: Other

H62: Other
99: Other

H63: Other
100: Other

H64: Other
101: Other

H65: Other
102: Other

H66: Other
103: Other

H67: Other
104: Other

H68: Other
105: Other

H69: Other
106: Other

H70: Other
107: Other

H71: Other
108: Other

H72: Other
109: Other

H73: Other
110: Other

H74: Other
111: Other

H75: Other
112: Other

H76: Other
113: Other

H77: Other
114: Other

H78: Other
115: Other

H79: Other
116: Other

H80: Other
117: Other

H81: Other
118: Other

H82: Other
119: Other

H83: Other
120: Other

H84: Other
121: Other

H85: Other
122: Other

H86: Other
123: Other

H87: Other
124: Other

H88: Other
125: Other

H89: Other
126: Other

H90: Other
127: Other

H91: Other
128: Other

H92: Other
129: Other

H93: Other
130: Other

H94: Other
131: Other

H95: Other
132: Other

H96: Other
133: Other

H97: Other
134: Other

H98: Other
135: Other

H99: Other
136: Other

H100: Other
137: Other

H101: Other
138: Other

H102: Other
139: Other

H103: Other
140: Other

H104: Other
141: Other

H105: Other
142: Other

H106: Other
143: Other

H107: Other
144: Other

H108: Other
145: Other

H109: Other
146: Other

H110: Other
147: Other

H111: Other
148: Other

H112: Other
149: Other

H113: Other
150: Other

H114: Other
151: Other

H115: Other
152: Other

H116: Other
153: Other

H117: Other
154: Other

H118: Other
155: Other

H119: Other
156: Other

H120: Other
157: Other

H121: Other
158: Other

H122: Other
159: Other

H123: Other
160: Other

H124: Other
161: Other

H125: Other
162: Other

H126: Other
163: Other

H127: Other
164: Other

H128: Other
165: Other

H129: Other
166: Other

H130: Other
167: Other

H131: Other
168: Other

H132: Other
169: Other

H133: Other
170: Other

H134: Other
171: Other

H135: Other
172: Other

H136: Other
173: Other

H137: Other
174: Other

H138: Other
175: Other

H139: Other
176: Other

H140: Other
177: Other

H141: Other
178: Other

H142: Other
179: Other

H143: Other
180: Other

H144: Other
181: Other

H145: Other
182: Other

H146: Other
183: Other

H147: Other
184: Other

H148: Other
185: Other

H149: Other
186: Other

H150: Other
187: Other

H151: Other
188: Other

H152: Other
189: Other

H153: Other
190: Other

H154: Other
191: Other

H155: Other
192: Other

H156: Other
193: Other

H157: Other
194: Other

H158: Other
195: Other

H159: Other
196: Other

H160: Other
197: Other

H161: Other
198: Other

H162: Other
199: Other

H163: Other
200: Other

H164: Other
201: Other

H165: Other
202: Other

H166: Other
203: Other

H167: Other
204: Other

H168: Other
205: Other

H169: Other
206: Other

H170: Other
207: Other

H171: Other
208: Other

H172: Other
209: Other

H173: Other
210: Other

H174: Other
211: Other

H175: Other
212: Other

H176: Other
213: Other

H177: Other
214: Other

H178: Other
215: Other

H179: Other
216: Other

H180: Other
217: Other

H181: Other
218: Other

H182: Other
219: Other

H183: Other
220: Other

H184: Other
221: Other

H185: Other
222: Other

H186: Other
223: Other

H187: Other
224: Other

H188: Other
225: Other

H189: Other
226: Other

H190: Other
227: Other

H191: Other
228: Other

H192: Other
229: Other

H193: Other
230: Other

H194: Other
231: Other

H195: Other
232: Other

H196: Other
233: Other

H197: Other
234: Other

H198: Other
235: Other

H199: Other
236: Other

H200: Other
237: Other

H201: Other
238: Other

H202: Other
239: Other

H203: Other
240: Other

H204: Other
241: Other

H205: Other
242: Other

H206: Other
243: Other

H207: Other
244: Other

H208: Other
245: Other

H209: Other
246: Other

H210: Other
247: Other

H211: Other
248: Other

H212: Other
249: Other

H213: Other
250: Other

H214: Other
251: Other

H215: Other
252: Other

H216: Other
253: Other

H217: Other
254: Other

H218: Other
255: Other

H219: Other
256: Other

H220: Other
257: Other

H221: Other
258: Other

H222: Other
259: Other

H223: Other
260: Other

H224: Other
261: Other

H225: Other
262: Other

H226: Other
263: Other

H227: Other
264: Other

H228: Other
265: Other

H229: Other
266: Other

H230: Other
267: Other

H231: Other
268: Other

H232: Other
269: Other

H233: Other
270: Other

H234: Other
271: Other

H235: Other
272: Other

H236: Other
273: Other

H237: Other
274: Other

H238: Other
275: Other

H239: Other
276: Other

H240: Other
277: Other

H241: Other
278: Other

H242: Other
279: Other

H243: Other
280: Other

H244: Other
281: Other

H245: Other
282: Other

H246: Other
283: Other

H247: Other
284: Other

H248: Other
285: Other

H249: Other
286: Other

H250: Other
287: Other

H251: Other
288: Other

H252: Other
289: Other

H253: Other
290: Other

H254: Other
291: Other

H255: Other
292: Other

H256: Other
293: Other

H257: Other
294: Other

H258: Other
295: Other

H259: Other
296: Other

H260: Other
297: Other

H261: Other
298: Other

H262: Other
299: Other

H263: Other
300: Other

H264: Other
301: Other

H265: Other
302: Other

H266: Other
303: Other

H267: Other
304: Other

H268: Other
305: Other

H269: Other
306: Other

H270: Other
307: Other

H271: Other
308: Other

H272: Other
309: Other

H273: Other
310: Other

H274: Other
311: Other

H275: Other
312: Other

H276: Other
313: Other

H277: Other
314: Other

H278: Other
315: Other

H279: Other
316: Other

H280: Other
317: Other

H281: Other
318: Other

H282: Other
319: Other

H283: Other
320: Other

H284: Other
321: Other

H285: Other
322: Other

H286: Other
323: Other

H287: Other
324: Other

H288: Other
325: Other

H289: Other
326: Other

H290: Other
327: Other

H291: Other
328: Other

H292: Other
329: Other

H293: Other
330: Other

H294: Other
331: Other

H295: Other
332: Other

H296: Other
333: Other

H297: Other
334: Other

H298: Other
335: Other

H299: Other
336: Other

H300: Other
337: Other

H301: Other
338: Other

H302: Other
339: Other

H303: Other
340: Other

H304: Other
341: Other

H305: Other
342: Other

H306: Other
343: Other

H307: Other
344: Other

H308: Other
345: Other

H309: Other
346: Other

H310: Other
347: Other

H311: Other
348: Other

H312: Other
349: Other

H313: Other
350: Other

H314: Other
351: Other

H315: Other
352: Other

H316: Other
353: Other

H317: Other
354: Other

H318: Other
355: Other

H319: Other
356: Other

H320: Other
357: Other

H321: Other
358: Other

H322: Other
359: Other

H323: Other
360: Other

H324: Other
361: Other

H325: Other
362: Other

H326: Other
363: Other

H327: Other
364: Other

H328: Other
365: Other

H329: Other
366: Other

H330: Other
367: Other

H331: Other
368: Other

H332: Other
369: Other

H333: Other
370: Other

H334: Other
371: Other

H335: Other
372: Other

H336: Other
373: Other

H337: Other
374: Other

H338: Other
375: Other

H339: Other
376: Other

H340: Other
377: Other

H341: Other
378: Other

H342: Other
379: Other

H343: Other
380: Other

H344: Other
381: Other

H345: Other
382: Other

H346: Other
383: Other

H347: Other
384: Other

H348: Other
385: Other

H349: Other
386: Other

H350: Other
387: Other

H351: Other
388: Other

H352: Other
389: Other

H353: Other
390: Other

H354: Other
391: Other

H355: Other
392: Other

H356: Other
393: Other

H357: Other
394: Other

H358: Other
395: Other

H359: Other
396: Other

H360: Other
397: Other

H361: Other
398: Other

H362: Other
399: Other

H363: Other
400: Other

H364: Other
401: Other

H365: Other
402: Other

H366: Other
403: Other

H367: Other
404: Other

H368: Other
405: Other

H369: Other
406: Other

H370: Other
407: Other

H371: Other
408: Other

H372: Other
409: Other

H373: Other
410: Other

H374: Other
411: Other

H375: Other
412: Other

H376: Other
413: Other

H377: Other
414: Other

H378: Other
415: Other

H379: Other
416: Other

H380: Other
417: Other

H381: Other
418: Other

H382: Other
419: Other

H383: Other
420: Other

H384: Other
421: Other

H385: Other
422: Other

H386: Other
423: Other

H387: Other
424: Other

H388: Other
425: Other

H389: Other
426: Other

H390: Other
427: Other

H391: Other
428: Other

H392: Other
429: Other

H393: Other
430: Other

H394: Other
431: Other

H395: Other
432: Other

H396: Other
433: Other

H397: Other
434: Other

H398: Other
435: Other

H399: Other
436: Other

H400: Other
437: Other

H401: Other
438: Other

H402: Other
439: Other

H403: Other
440: Other

H404: Other
441: Other

H405: Other
442: Other

H406: Other
443: Other

H407: Other
444: Other

H408: Other
445: Other

H409: Other
446: Other

H410: Other
447: Other

H411: Other
448: Other

H412: Other
449: Other

H413: Other
450: Other

H414: Other
451: Other

H415: Other
452: Other

H416: Other
453: Other

H417: Other
454: Other

H418: Other
455: Other

H419: Other
456: Other

H420: Other
457: Other

H421: Other
458: Other

H422: Other
459: Other

H423: Other
460: Other

H424: Other
461: Other

H425: Other
462: Other

H426: Other
463: Other

H427: Other
464: Other

H428: Other
465: Other

H429: Other
466: Other

H430: Other
467: Other

H431: Other
468: Other

H432: Other
469: Other

H433: Other
470: Other

H434: Other
471: Other

H435: Other
472: Other

H436: Other
473: Other

H437: Other
474: Other

H438: Other
475: Other

H439: Other
476: Other

H440: Other
477: Other

H441: Other
478: Other

H442: Other
479: Other

H443: Other
480: Other

H444: Other
481: Other

H445: Other
482: Other

H446: Other
483: Other

H447: Other
484: Other

H448: Other
485: Other

H449: Other
486: Other

H450: Other
487: Other

H451: Other
488: Other

H452: Other
489: Other

H453: Other
490: Other

H454: Other
491: Other

H455: Other
492: Other

H456: Other
493: Other

H457: Other
494: Other

H458: Other
495: Other

H459: Other
496: Other

H460: Other
497: Other

H461: Other
498: Other

H462: Other
499: Other

H463: Other
500: Other

H464: Other
501: Other

H465: Other
502: Other

H466: Other
503: Other

H467: Other
504: Other

H468: Other
505: Other

H469: Other
506: Other

H470: Other
507: Other

H471: Other
508: Other

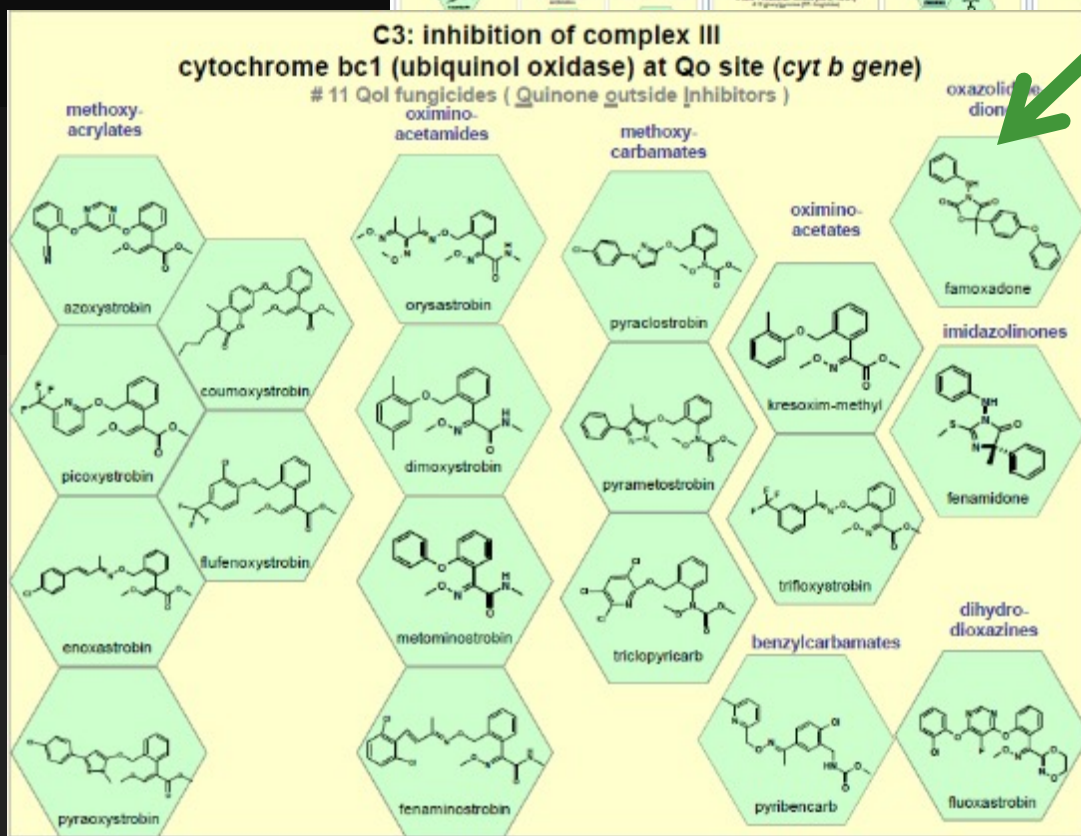
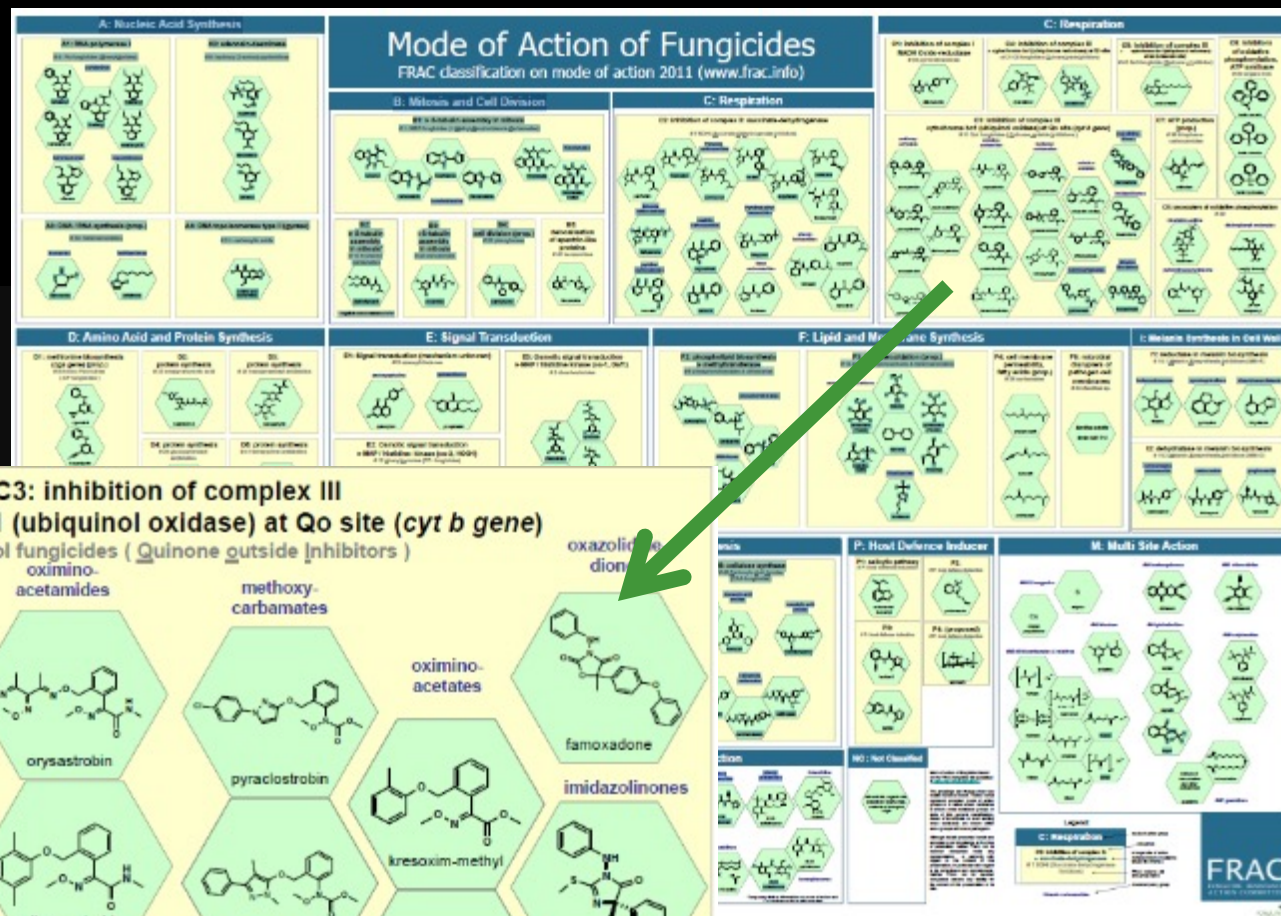
H472: Other
509: Other

H473: Other
510: Other

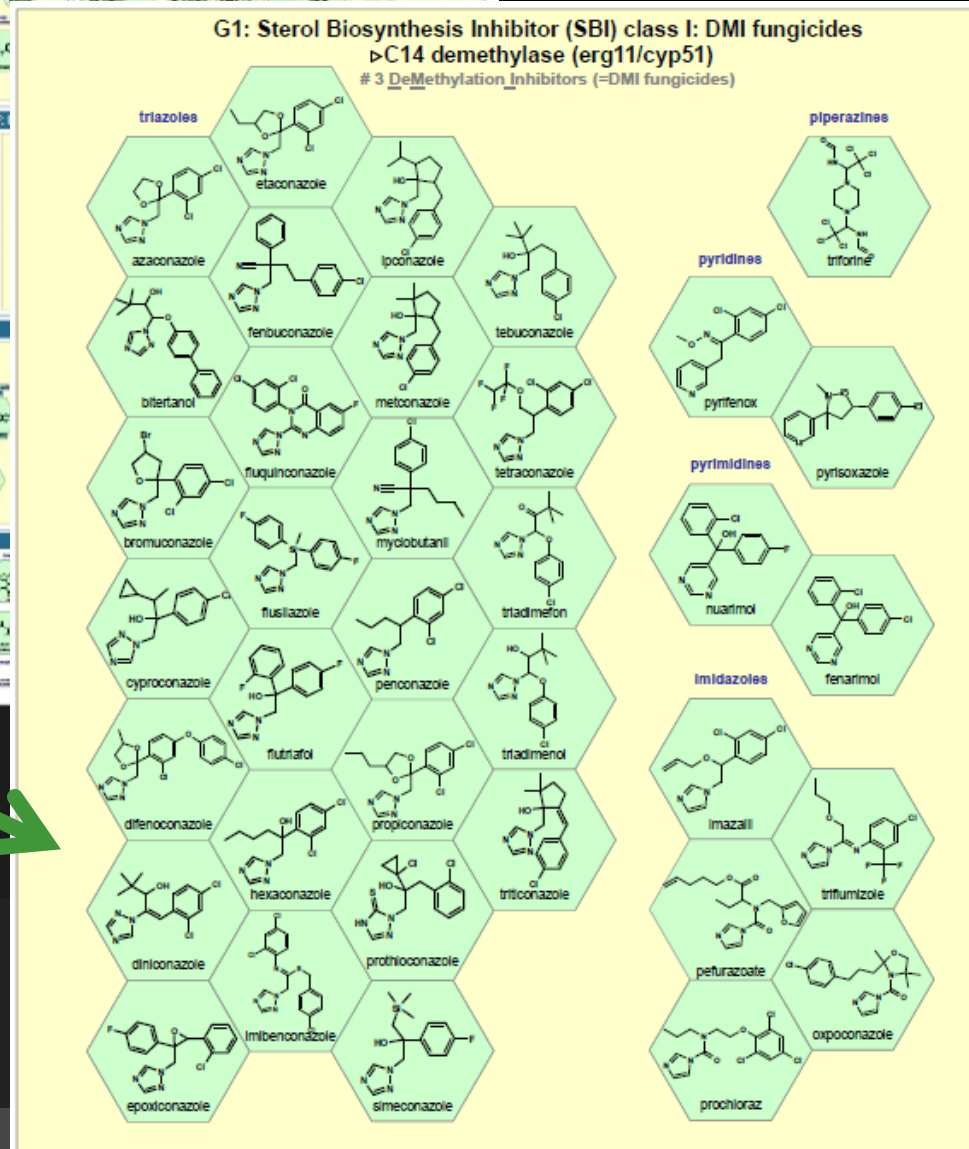
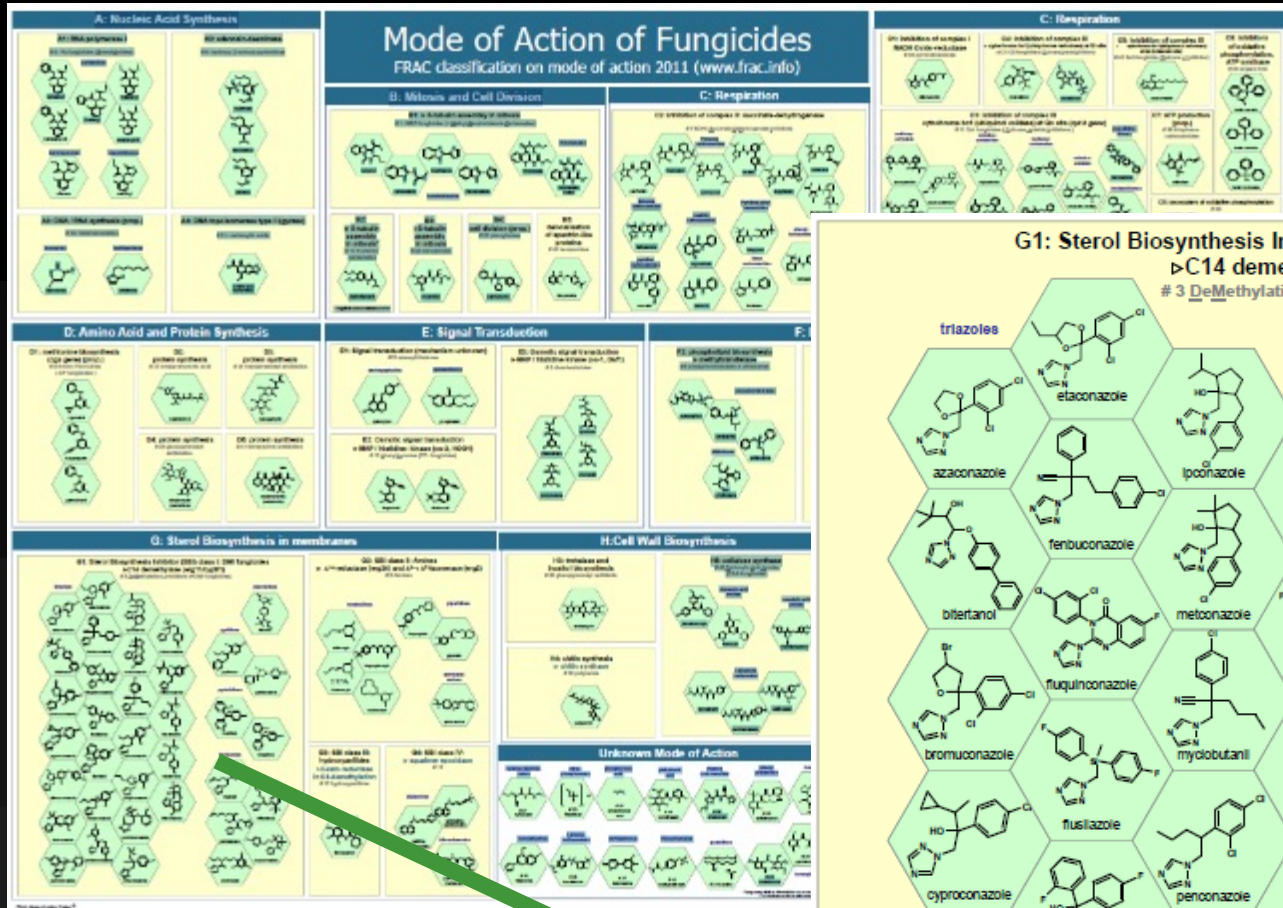
H474: Other
511: Other

H475: Other
512: Other

H476: Other
513



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 C14- demethylase in sterol biosynthesis (erg11/cyp51)	DMI-fungicides (DeMethylation Inhibitors) (SBI: Class I)	piperazines	triforine	<p>There are big differences in the activity spectra of DMI fungicides.</p> <p>Resistance is known in various fungal species. Several resistance mechanisms are known ind. target site mutations in cyp51 (erg 11) gene, e.g. V136A, Y137F, A379G, I381V; cyp51 promoter; ABC transporters and others.</p> <p>Generally wise to accept that cross resistance is present between DMI fungicides active against the same fungus.</p> <p>DMI fungicides are Sterol Biosynthesis Inhibitors (SBIs) but show no cross resistance to other SBI classes.</p> <p>Medium risk.</p> <p>See FRAC SBI Guidelines for resistance management</p>	3						
			pyridines	pyrifenoxy pyrooxazole								
			pyrimidines	fenarimol nuarimol								
			imidazoles	imazail oxpoconazole pefurazoate prochloraz triflumizole								
			triazoles	azaconazole bifertanol bromuconazole cyproconazole difenoconazole diniconazole epoxiconazole etaconazole fenbuconazole fluquinconazole flusilazole flutriafol hexaconazole imibenconazole ipconazole mefentrifluconazole metoconazole myclobutanil penconazole propiconazole simeconazole tebuconazole tetraconazole triadimefon triadimenol triticoconazole prothioconazole								
				triazolinthiones								
				G2			Δ^14 -reductase and $\Delta^2 \rightarrow \Delta^7$ -isomerase in sterol biosynthesis (erg24, erg2)	amines ("morpholines") (SBI: Class II)	<p>aldimorph dodemorph fenpropimorph tridemorph</p> <p>Decreased sensitivity for powdery mildews. Cross resistance within the group generally found but no to other SBI classes.</p> <p>Low to medium risk.</p> <p>See FRAC SBI Guidelines for resistance management</p>	5		
				G3			3-keto reductase, C4- de-methylation (erg27)	KRI fungicides (KetoReductase Inhibitors) (SBI: Class III)	hydroxyanilides	fenhexamid	Low to medium risk. Resistance management required.	17
									amino-pyrazolinone	fenpyrazamine		
				G4			squalene-epoxidase in sterol biosynthesis (erg1)	(SBI class IV)	thiocarbamates	pyributicarb	Resistance not known, fungicidal and herbicidal activity.	18
									allylamines	naftifine 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 tubulin polymerization	MBC - fungicides (Methyl Benzimidazole Carbamates)	benzimidazoles	benomyl carbendazim fuberidazole thiabendazole	Resistance common in many fungal species. Several target site mutations, mostly E198A/G/K, F200Y in β -tubulin gene.	1
			thiophanates	thiophanate thiophanate-meth	Positive cross resistance between the group members. Negative cross resistance to N-phenyl carbamates.	
	B2 tubulin polymerization	N-phenyl carbamates	N-phenyl carbamates	diethofencarb	Resistance known. Target site mutation E198K. Negative cross resistance to benzimidazoles.	10
					High risk.	
	B3 tubulin polymerization	benzamides	toluamides	zoxamide	Low to medium risk. Resistance management required.	22
			thiazole carboxamide	ethylamino-thiazole-carboxamide		
	B4 cell division (unknown site)	phenylureas	phenylureas	pencycuron	Resistance not known.	20
	B5 delocalisation of spectrin-like proteins	benzamides	pyridinylmethyl-benzamides	fluopicolide fluopimomide	Resistant isolates detected in grapevine downy mildew. Medium risk. Resistance management required.	43
	B6 actin/myosin/fimbrin function	cyanoacrylates	aminocyanoacrylates	phenamacril	Resistance known in <i>Fusarium graminearum</i> . Target site mutations in the gene coding for myosin-5 found in lab studies. Medium to high risk. Resistance management required.	47
					Less sensitive isolates detected in powdery mildews (<i>Blumeria</i> and <i>Sphaerotheca</i>). Medium risk. Resistance management required.	
B7 tubulin dynamics modulator	pyridazine	pyridazine	benzophenone	metrafenone	Reclassified from U8 in 2018	50
			benzoylpyridine	pyriofenone		
B7 tubulin dynamics modulator	pyridazine	pyridazine	pyridachlometyl	High risk.	53	



TABLE TO AVOID FUNGAL RESISTANCE

FUNGICIDES Mode of Action	Oomycetes; Water moulds Phytophthora/ Pythium, Damping off, Downy Mildew, White rusts	Ascomycetes; Fungi Many leaf diseases (e.g. Anthracnose, Alternaria blights, Fusarium, Cercospora, Powdery mildew, Scabs,...)	Basidiomycetes; Fungi Rusts, Smuts, Bunts, Rhizoctonia
Seed/ planting material	Metalaxyl-M¹ <u>Thiram</u> Cymoxanil ¹	Carboxin ¹ Fludioxonil¹ <u>Thiram</u> Silthiofam Fluopyram Prochloraz Ipconazole <i>Bacillus amyloliquefaciens</i>	Fludioxonil¹ Carboxin ¹ Flutriafol ¹ Prothioconazole¹ Prochloraz Triadimenol
Fruit crop leaf diseases	Metalaxyl-M¹ Dimethomorph Cymoxanil ¹ Ametoctradin Famoxadone Fenamidone Propamocarb Fluopicolide Cyazofamid	<u>Sulphur</u> Tebuconazole¹ Tetraconazole <u>Dithianon</u> Fenbuconazole¹ Fenarimol¹ Kresoxim-methyl ¹ Boscalid¹ <u>Chlorothalonil</u> Penconazole ¹ Thiophanate-Methyl Folpet Cyprodinil ¹ Fludioxonil¹ <u>Myclobutanil¹</u> <u>Mancozeb</u> Trifloxystrobin <i>Bacillus subtilis</i> These materials are active against Powdery mildews only <u>Pyrimethanil</u> Fenhexamid Fenpyrazamine <u>Potassium bicarbonate</u> <i>Aquisqualis</i>	There are very few basidiomycete fungi that cause disease on fruit crops and these are mostly controlled by cultural methods.
Vegetable leaf diseases	<i>Cerevisane</i> Metalaxyl-M¹ Cymoxanil ¹ Dimethomorph Fosetyl-AI Fluzinam Benthiavalicarb-isopropyl Mandipropamid Zoxamide Oxathiapiprolin , Propamocarb Fenamidone¹	Copper <u>Chlorothalonil</u> Thiophanate-Methyl Fenarimol¹ Isopyrazam Azoxystrobin¹ Cyproconazole ¹ Fludioxonil¹ Iprodione* Metconazole ¹ Difenoconazole ¹ Boscalid¹ Fenpropimorph¹ Pyraclostrobin ¹ Fluopyram Folpet Trifloxystrobin Tetraconazole Tridemorph Tebuconazole¹ Carbendazim* <i>Bacillus subtilis</i> Cyprodinil ¹	Difenoconazole ¹ Azoxystrobin¹ Boscalid¹ Cyproconazole ¹ Pyraclostrobin¹ <u>Chlorothalonil</u> Metconazole ¹ Tetraconazole Prothioconazole¹ Tebuconazole¹ Fenpropimorph¹
Cereal leaf diseases	As there are very few water moulds that attack cereal crops (Maize Sorghum Sugarcane are exceptions) There are very little data on which chemicals should be used but where legal many of the above would control the disease	Azoxystrobin¹ Thiophanate-Methyl Prothioconazole Folpet Epoxiconazole¹ Trifloxystrobin <u>Chlorothalonil</u> Difenoconazole ¹ Isoprothiolane Bixafen Quinoxifen¹ Boscalid¹ Pyraclostrobin ¹ Fenpropimorph¹ Bromuconazole¹ Tebuconazole Tridemorph Cyproconazole ¹	Azoxystrobin¹ Epoxiconazole¹ <u>Chlorothalonil</u> , Prothioconazole¹ Boscalid¹ Flusilazole¹ Tetraconazole Fenpropimorph¹ Fluopyram Trifloxystrobin Pyraclostrobin ¹ Difenoconazole ¹
Fruit /Ear diseases	The chemicals in this column are specialists used against watermoulds. They are frequently blended with the more general fungicides <u>Mancozeb</u> <u>Propineb</u> <u>Copper</u> <u>Metram</u> <u>Chlorothalonil</u> <u>Zineb</u> These have limited activity against watermoulds but are active against fungal diseases	<u>Propiconazole¹</u> <u>Fluoxastrobin¹</u> Cyproconazole ¹ Metconazole¹ Azoxystrobin¹ Carbendazim* Tebuconazole¹ <u>Chlorothalonil</u> Thiophanate-Methyl Fluxapyroxad Fludioxonil¹ <i>Bacillus subtilis</i>	<u>Chlorothalonil</u> Epoxiconazole¹ Cyproconazole ¹ Pydiflumetofen Azoxystrobin¹ Tebuconazole¹ Trifloxystrobin Prothioconazole¹ 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* (development of resistance to biocontrol agents is unlikely).

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

Bold indicates systemic activity. **First letter bold** indicates limited systemic activity
Underlining indicates multisite activity, * Indicates possibility of resistance unlikely ¹ Indicates resistance has been recorded *Italic* are fungicidal 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?

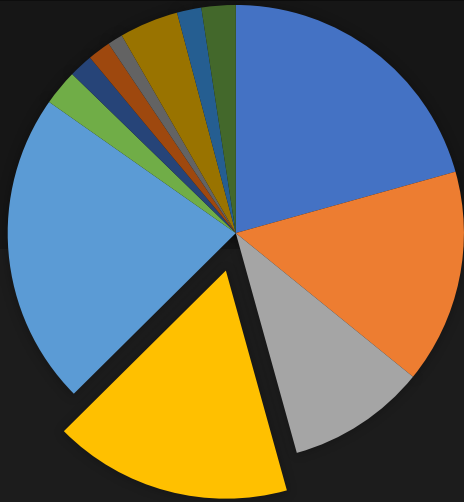
Extensive use of triazole fungicide use in the Dutch bulb industry.....



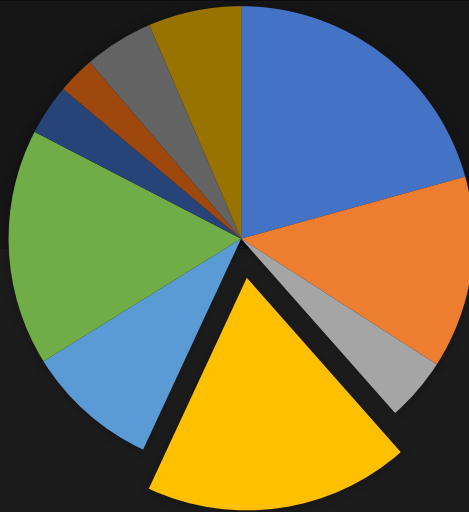


WHERE ARE THE AZOLES BEING USED?

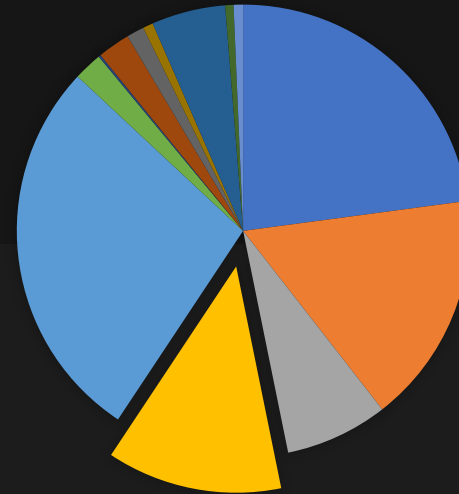
SEA



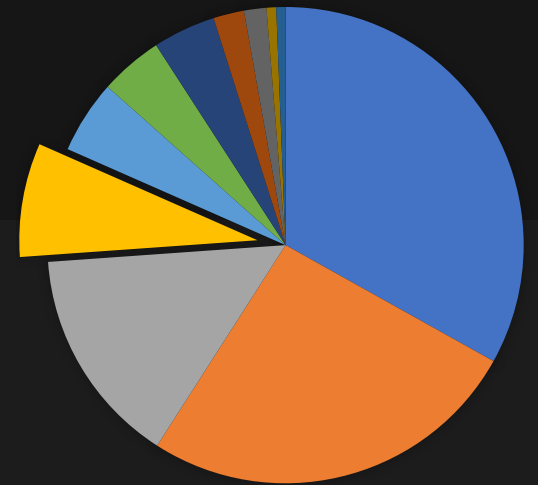
LAC



SA



SSA



FRAC M 03 FRAC M 01 FRAC 4 FRAC 3 FRAC 1 FRAC 11 FRAC 27



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 carotovorum & *atrosepticum*

Clavibacter michagensis

Agrobacterium (Radiobacter) tumefaciens

Xylella fastidiosa



NAMES OF BACTERIAL PLANT PATHOGENS?

Pseudomonas syringae

Ralstonia solanacearum

Xanthomonas campestris

Erwinia amylovora

Dickeya solani

Pectobacterium carotovorum

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

- Bismethiazol

- Bronopol

Antibiotics:

 - Medical antibiotics

 - Agricultural antibiotics



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

PLANT HEALTH CLINIC (ZAHANATI YA MIMEA) NAKURU NORTH DISTRICT BAHATI





CABI AND PLANTWISE: CLINICS







CABI AND PLANTWISE





CABI AND PLANTWISE



Send SMS to farmer

plantwise

To send an SMS of the recommendation to the farmer, select the language you want the SMS to be sent in and check this in the preview

If a phone number was recorded earlier in the form, this will appear here. This number can be edited.

Touch Send SMS

TYPE OF ORGANISM: BIOTIC

Fungi Bacteria Insect/Mite

DIAGNOSIS (start a new sheet for)

Pest/disease/weed

RECOMMENDATIONS FOR MANAGEMENT

Monitor problem Cultural Biological Host resistance Fungicides Insecticides Acaricides Nematicides Herbicides

FOLLOW UP ACTIVITIES:

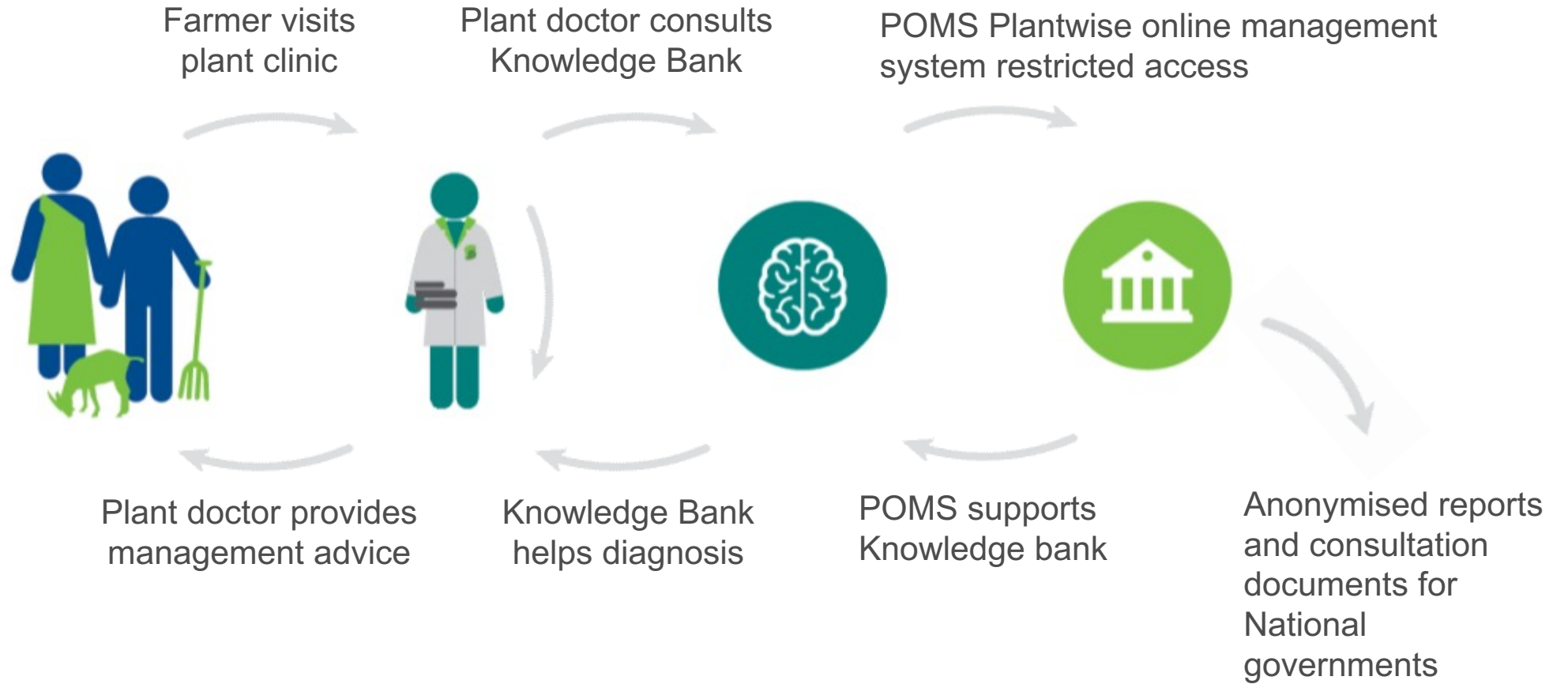
Sample sent to lab: Yes No

Factsheet given: Yes No

Field visit arranged: Yes No

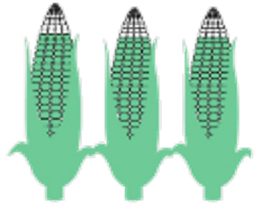


CABI AND PLANTWISE





CABI AND PLANTWISE



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

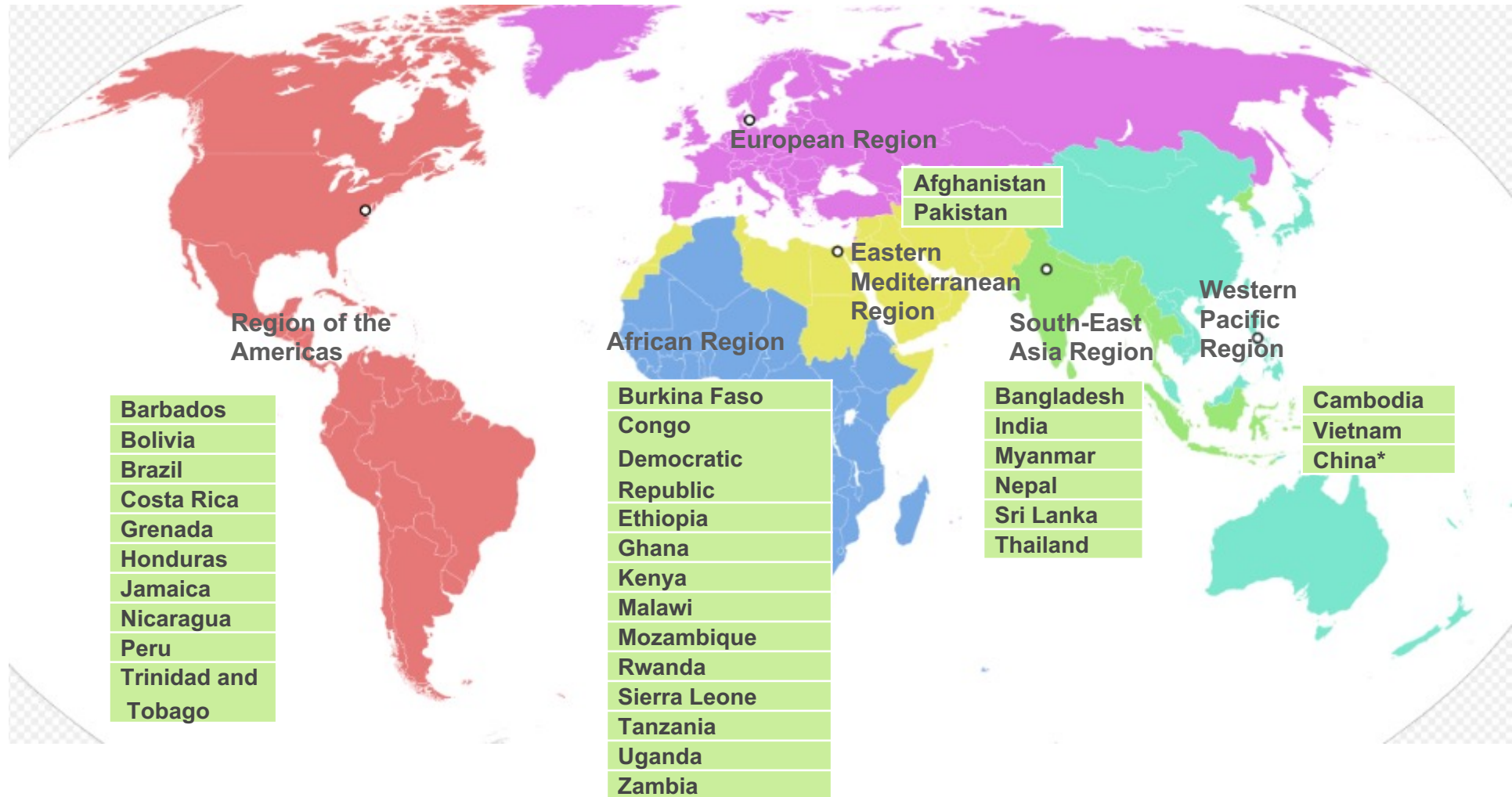


All Plantwise countries contribute funds and/or staff time towards activities



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

Countries in which Plantwise is operational





PLANTWISE DATA

O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
Crop	Crop	Variety	Sample	Development	Part Affected	Year First Noticed	Area Planted	Planted Unit	Percent Of Crop Affected	Symptoms	Distribution	Description Of Problem	Problem Type	Diagnosis
						2016	2100	m2	75%	Streak	Localised	Trên ngọn lá và mép lá bị biến vàng đến nâu cháy đốm qu	Bacterium	BENH BAC LA
						2015	0.25	Acres	25%	Drjng;Insect seen;Yell	Scattered	Manchas en las hojas	Bacterium;Fung	MANCHAS CAUSADAS P
						0	2	Acres	<25%	Drjng;Stunted	Scattered	HOJAS CON EL BORDE TEÑIDO O QUEMADO Y CC	Bacterium	BACTERIOSIS
						2017	1	Acres	25%	Drjng;Yellow	Even	Defoliation of the leaf along with scraping of chlorophyl	Insect	LEAF ROLLER
											Even	Marjinal scorchingPoor growth	Bacterium	BACTERIAL LEAF BLIGH
											Scattered	Leaf tip drjng with yellowing of the margins noticed.	Bacterium	BACTERIAL LEAF BLIGH
DUA CHUOT	CUCUMBER	Dua lai	Yes	Seedling	Stem/sho									
LUA	Rice	Bac thom so	Yes	Fruiting	Leaves									BENH HEO XANH DO VI K
Hot Pepper	Hot Pepper		Yes		Fruit/grair									BENH BAC LA DOM SOC
RICE	RICE		No		Leaves									BACTERIAL SOFT ROT
TOMATOES	TOMATO		Yes	Flowering	Leaves									BACTERIAL LEAF STREA
COTTON	COTTON	Cotton Bt	Unknown											BACTERIAL WILT
REPOLLO	cabbage	COFRANZOC	No	Seedling	Leaves									PHYSIOLOGICAL DISORD
PADDY	Rice	ADT 43	Yes	Intermediate	Leaves									PULGUILLA
RICE	RICE		No		Leaves					Yellow	Scattered			SKIPPER
RICE	RICE		No		Leaves					Drjng	Localised;Scattere	The rice leaf occuring wavq line at the marjin of rice lea	Bacterium	BACTRIAL LEAF BLIGHT
RICE	RICE		Yes		Leaves					Drjng	Localised	The leaf dries up with white lesions and the leaf blade ha	Bacterium	BACTERIAL LEAF BLIGH
BANANA	BANANA	MONTHAN	Yes	Fruiting	Leaves;W				25%	Surface growth	Localised	leaf yellowing from top to bottom	Bacterium	BACTERIAL BLIGHT
PADDY	Rice	BPT 5204	Yes	Intermediate	Leaves									FUSARIUM WILT
CITRUS	CITRUS	LOCAL	Yes	Fruiting	Fruit/grair									BACTERIAL LEAF BLIGH
PADDY	Rice	ADT 43	Yes	Intermediate	Leaves									CITRUS CANCKER
PADDY	Rice	ADT46	Yes	Intermediate	Leaves									BACTERIAL LEAF BLIGH
RICE	RICE		No		Leaves									LEAF SPOT
LUA	Rice		Yes		Seed									BACTERIAL LEAF BLIGH
CHICKPEAS	CHICKPEAS		Unknown											B?NH HOA CUC
DUA LE	Melon		Yes		Leaves					Drjng;Yellow	Scattered	Trên là có vết bệnh màu vàng nhạt, là có đốm khô, bị rạc	Funqus	SUONG MAI
PADDY	Rice	BPT 5204	Yes	Intermediate	Leaves	2015	5	Acres	25%	Bore holes;Drjng;Yell	Scattered	Leaf tip drjng and yellowing of margin with white patche	Insect	THRIPS
CAULIFLOWER	CAULIFLOWER	Non	Yes	Intermediate	Leaves;Stem/shoot	2015	100	m2	Unknown	Rots		rotting base on stemwhite drjng on leaf edge	Bacterium;Fung	BACTERIAL STALK ROT
TOMATE	TOMATO		Unknown		Leaves					Drjng	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%	Drjng;Insect seen;Yell	Localised	Leaf tip drjng, white patches with elongate brown colour	Funqus	PADDY BLAST
PADDY	Rice	ADT 43	Yes	Intermediate	Leaves	2018	3	Acres	25%	Bore holes;Chewed;Pr	Scattered	Central shoot drjng with Yellowing of leaf	Insect	INTERNODE BORER
RICE	RICE		Yes		Leaves									RICE BACTERIAL LEAF E
PADDY	Rice	CR 1009	Yes	Intermediate	Leaves									LEAF ROLLER
PADDY	Rice	BPT 5204	Yes	Intermediate	Leaves									BACTERIAL LEAF BLIGH
CITRUS	CITRUS		Unknown											BACTERIA
RICE	RICE	KD 18	No	Fruiting		2014	400.00	m2	<25%	Drjng	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%	Drjng;Insect seen;Stur	Scattered	Yellowing and drjng with appearance of onion leaf noti	Insect	GALL MIDGE
PADDY	Rice	CR 1009	Yes	Intermediate	Leaves	2017	3	Acres	25%	Chewed;Drjng;Leaf sp	Scattered	Leaf tip drjng, 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	Drjng;Yellow	Scattered	Yellowing with elongated brown colour spots on the lea	Funqus	PADDY BLAST
PADDY	Rice	ADT37	Yes	Intermediate	Leaves;Whole plant	0	2	Acres	25%	Drjng;Yellow	Even	Marjinal drjng of leavesPoor growth	Bacterium	BACTERIAL LEAF BLIGH
PADDY	Rice	BPT 5204	Yes	Intermediate	Leaves	2016	2	Acres	<25%	Drjng;Yellow	Scattered	Leaf tip drjng with yellowing of marjin 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	CRIOLO	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;Drjng;Insect s	Scattered	Central shoot drjng with yellowing along with white pati	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

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

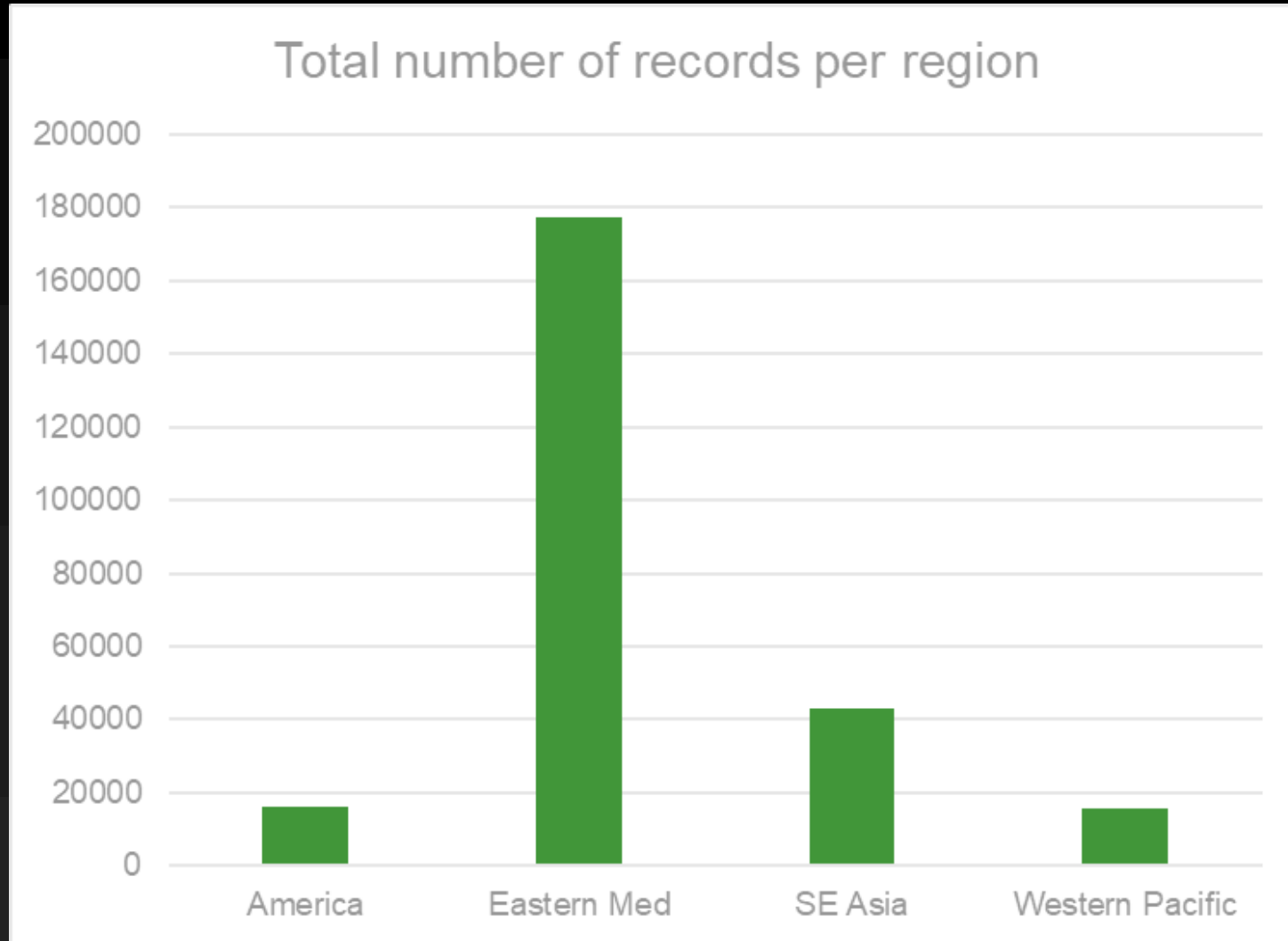
The data was analysed for those records naming antibiotics or the tradenames thereof

“Antibiotics” does not include all antimicrobials

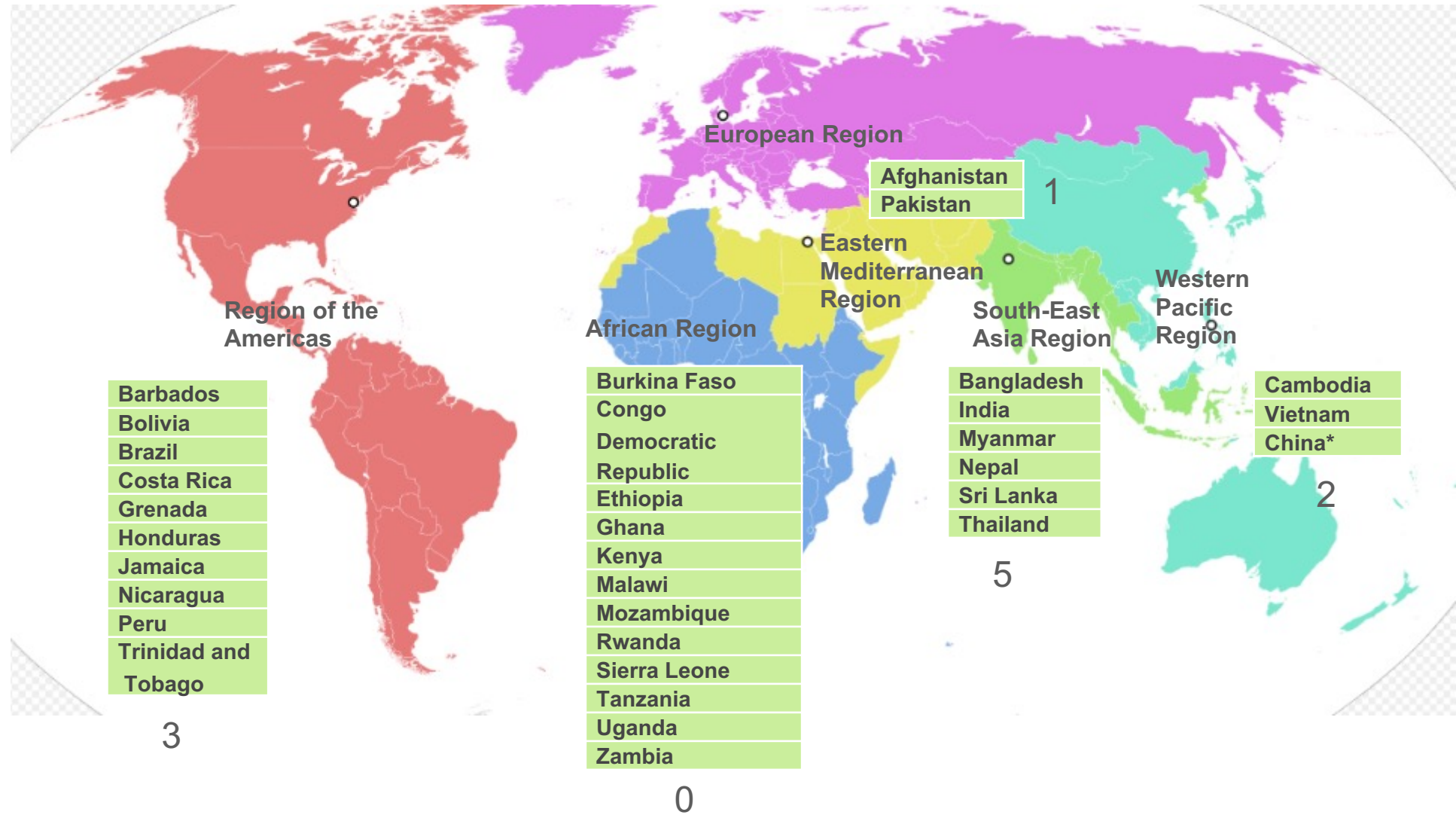
Use on animals and countries with less than 10 records were omitted as was the use of disinfectants claiming to be antibiotics



CABI AND PLANTWISE

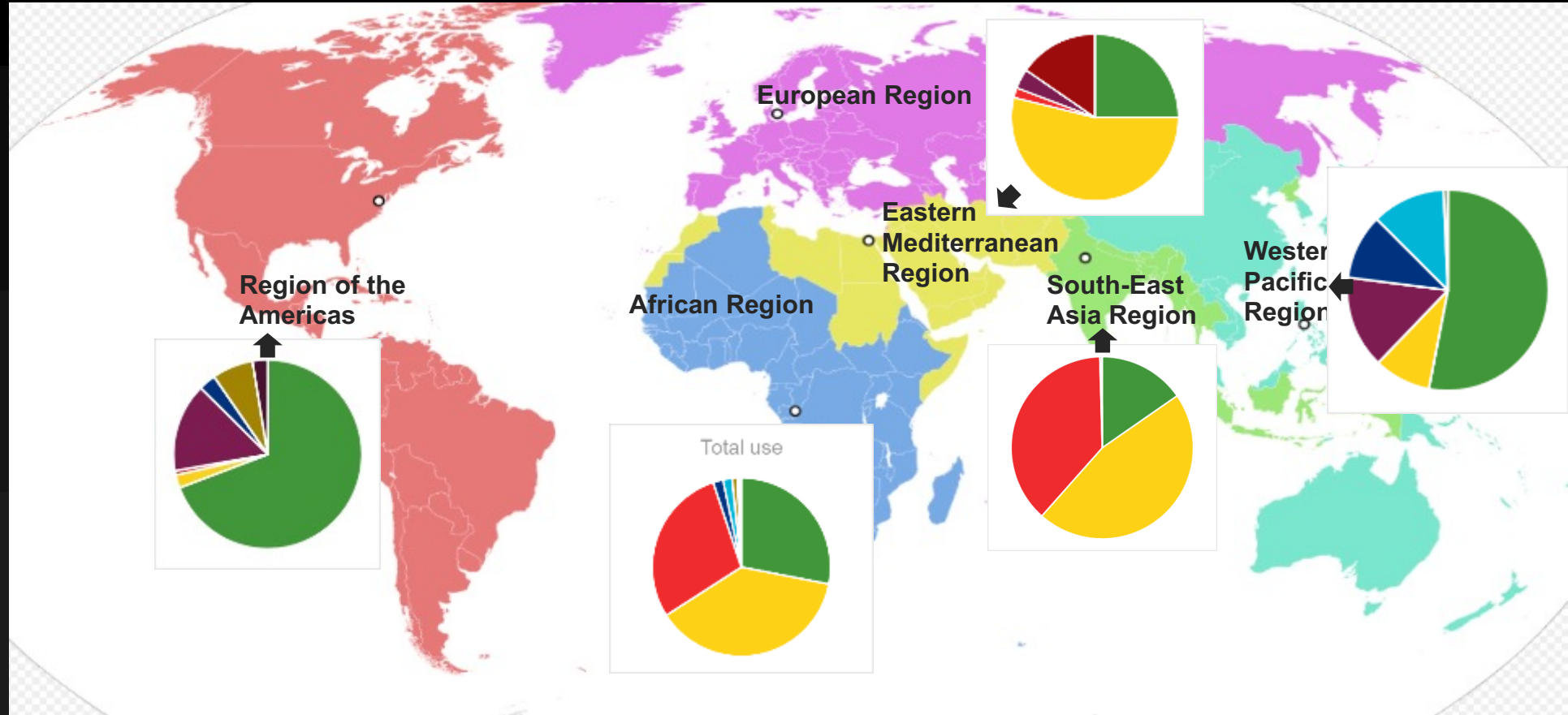


Countries in which Plantwise is operational





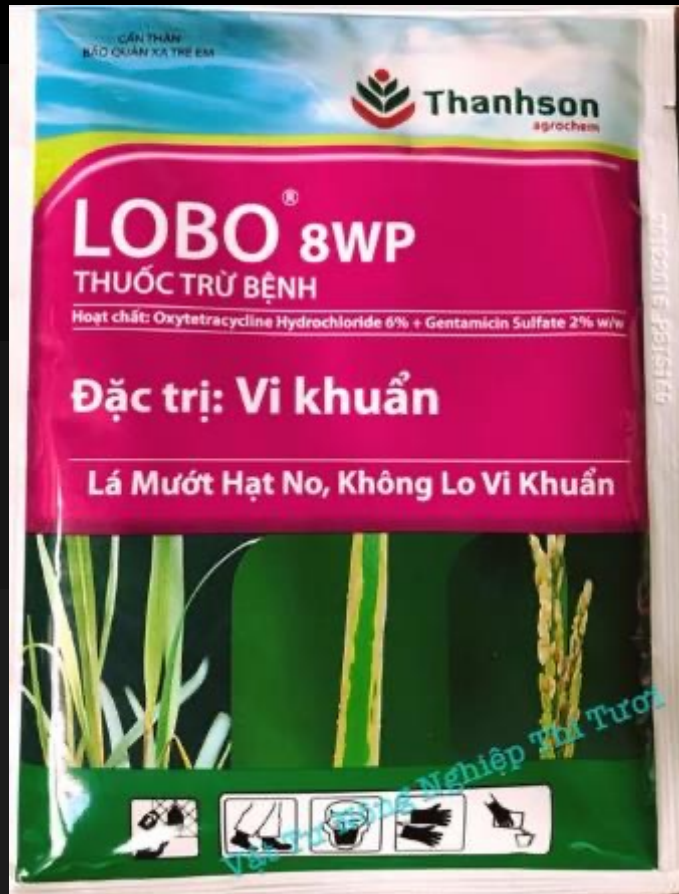
CABI AND PLANTWISE



- | | | | | |
|----------------|----------------|----------------|-------------------|---------------|
| ■ Kasugamycin | ■ Streptomycin | ■ Tetracycline | ■ Oxytetracycline | ■ Gentamicin |
| ■ Ningnanmycin | ■ Validomycin | ■ Cefadroxil | ■ Amoxicillin | ■ Antibiotics |



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...



Contact Supplier



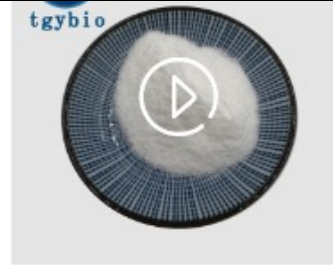
Agriculture **Streptomycin** 72%
SP/90% TC(CAS:57-92-1)

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...



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...



Contact Supplier



Agrochemical fungicide
Streptomycin sulfate 72% SP

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



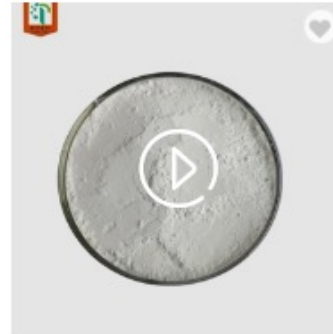
pesticide **Streptomycin sulfate**
3810-74-0 veterinary drugs

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



Tetracycline hcl

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



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 92.9%

"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%



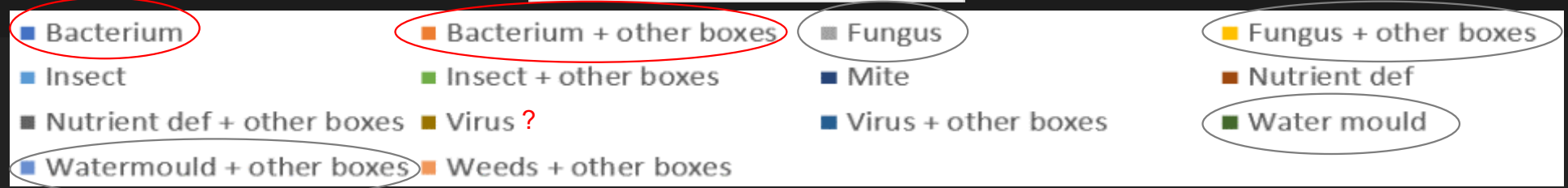
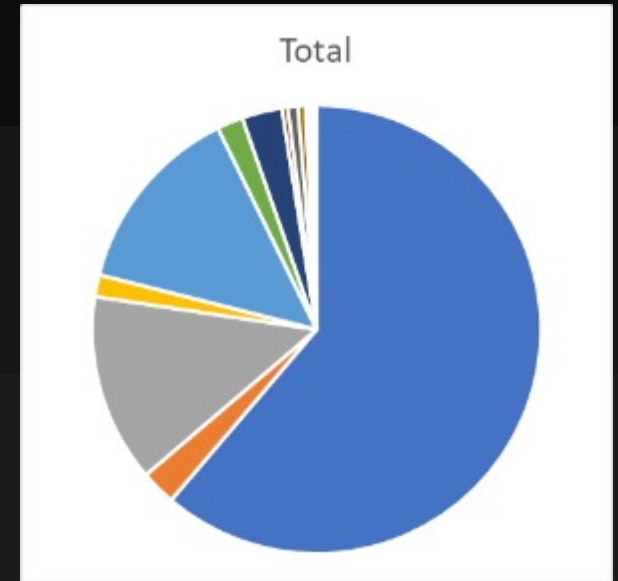
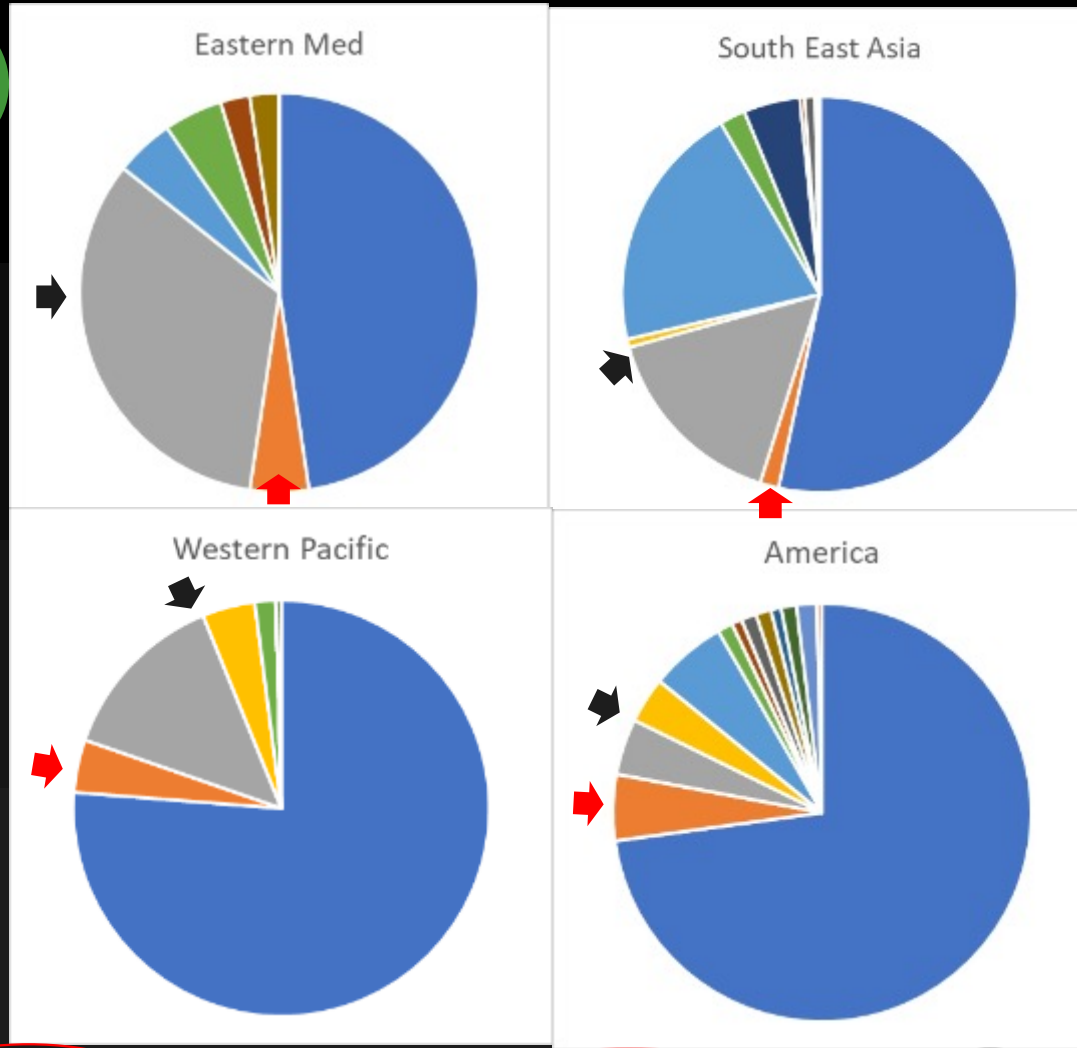
tetracycline antibiotic//Doxycycline hyclate//cas no.24390-14-5

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

6 YRS Wuhan Hengheda Phar...

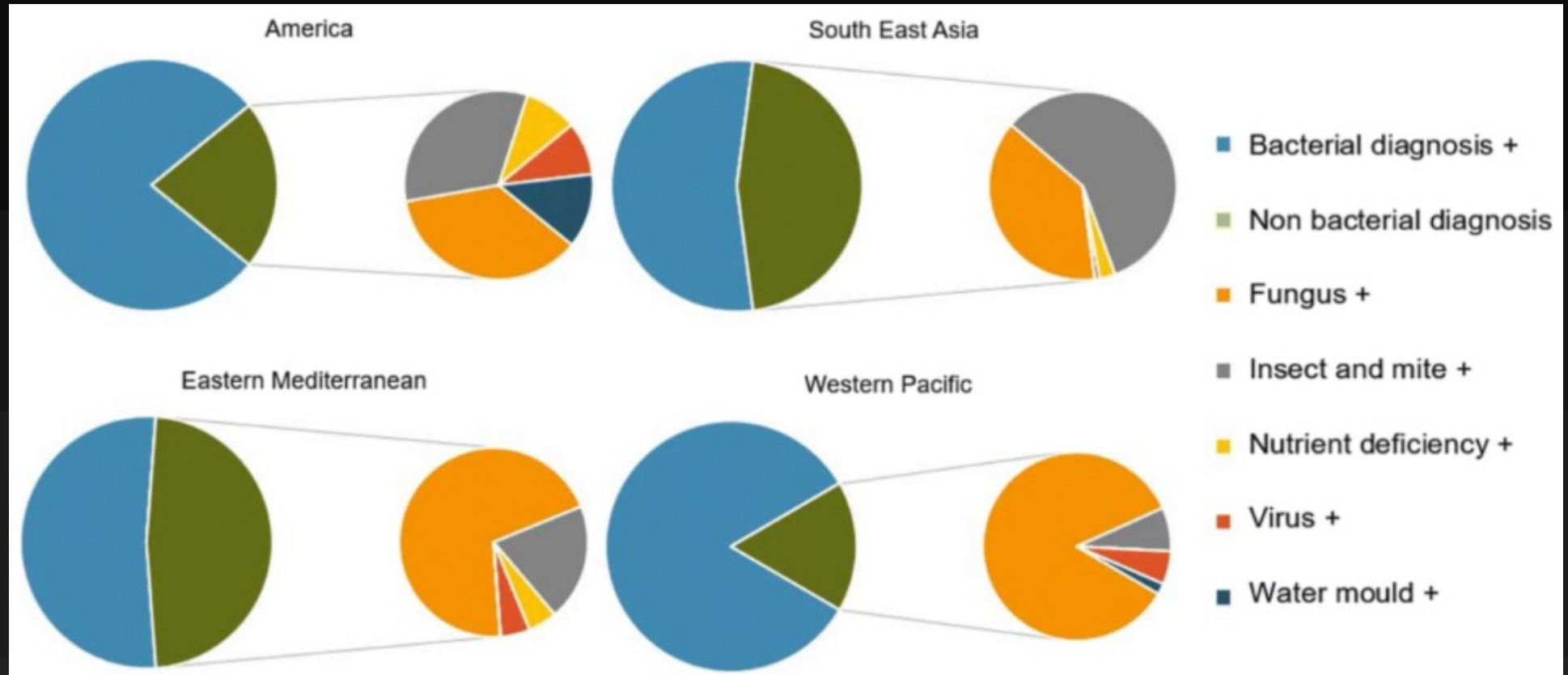


DIAGNOSIS





WHAT IS THE DIAGNOSIS?





AMOUNTS

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 to 11.25g 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



Available Online at ESci Journals
International Journal of Agricultural Extension
ISSN: 2311-6110 (Online), 2311-8547 (Print)
<http://www.escijournals.net/IJAE>

IS BUSINESS LINKAGE AFFECTING AGRICULTURAL ADVISORY SERVICES?
^aTao Zhang, ^bStefan Toepfer, ^aBuyun Wang, ^cHaomin Peng, ^cHuifeng Luo, ^dXuanwu Wan, ^bMin Wan*
^a Beijing Plant Protection Station, Xisanhuan Zhonglu 9, CN 100026 Beijing, People's Republic of China,
^b Chinese Ministry of Agriculture-CABI Joint Laboratory for Biosafety, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Yuanmingyuan Western Road 2, CN-100193 Beijing; People Republic China.
^c Xing'an Plant Protection Station, Jiaoyu Road 10, CN 541300 Xing'an county, Guilin Prefecture, Guangxi Zhuang Autonomous Region, People's Republic of China.
^d Sichuan Provincial Plant Protection Station, Wu Hou Ci Street 4, CN 610041 Chengdu, Sichuan province, People's Republic of China.



CHANGES IN LEGISLATION



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

Indian **CHEMICAL** News

ChemConnect
Creating a Robust Ecosystem | 2021


Home News **Chemical** Petrochemical Hydrogen Energy InFocus Exclusive Digitization Policy Events

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



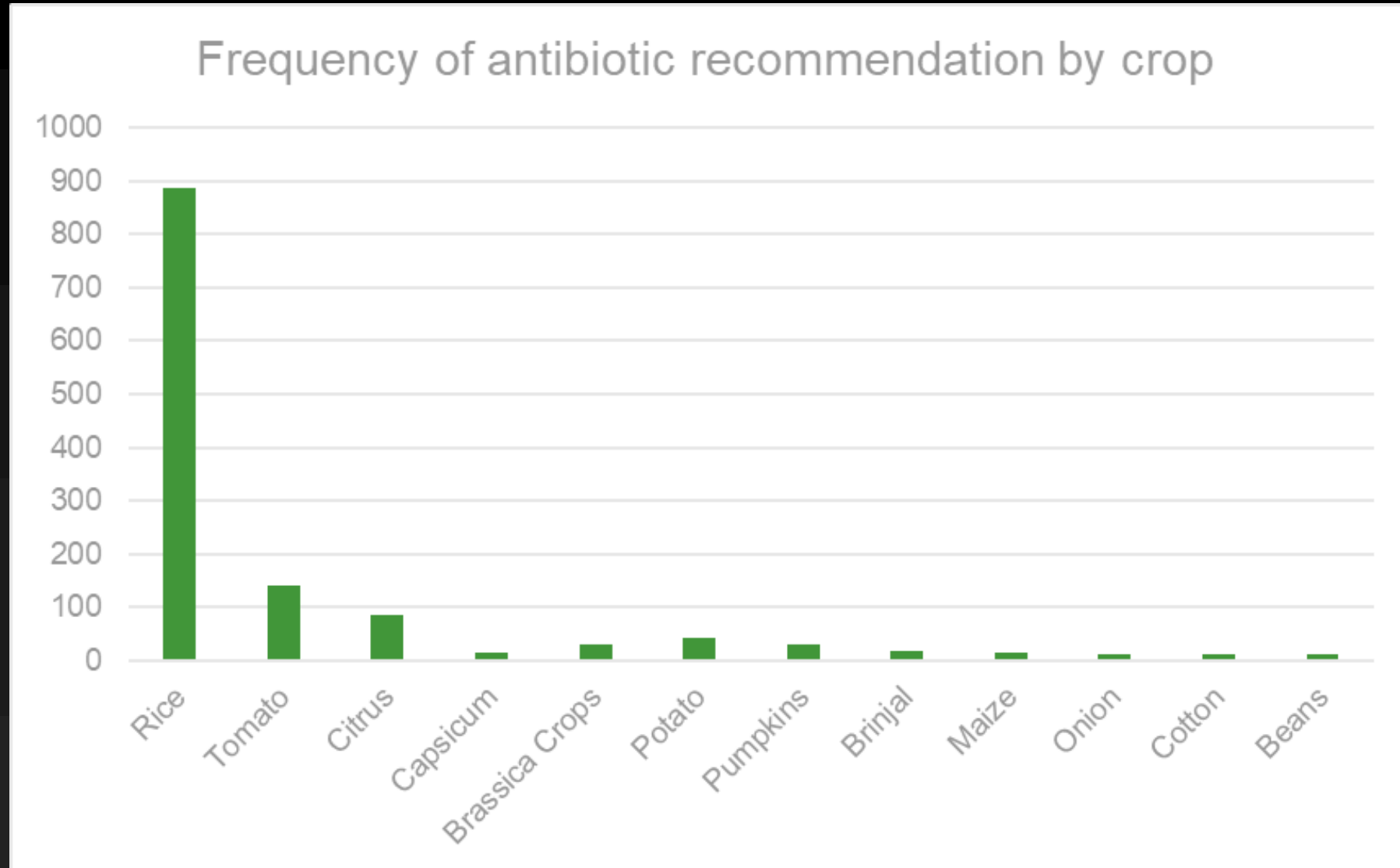
The Ministry of Agriculture has issued a draft order prohibiting the use of tuberculosis antibiotics - Streptomycin and Tetracycline on crops.

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 available.

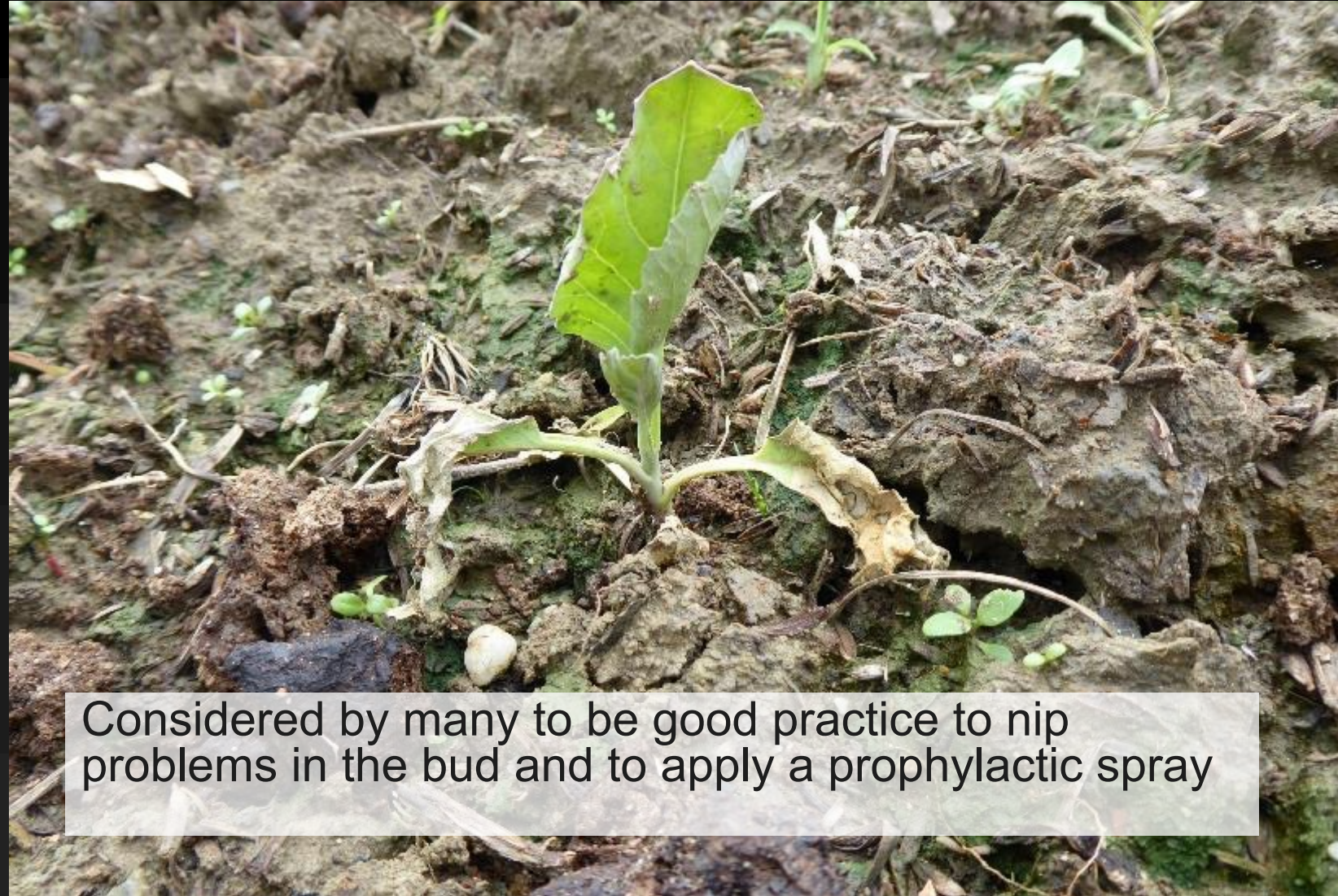


WHICH CROP RECEIVES THE MOST ANTIBIOTICS?

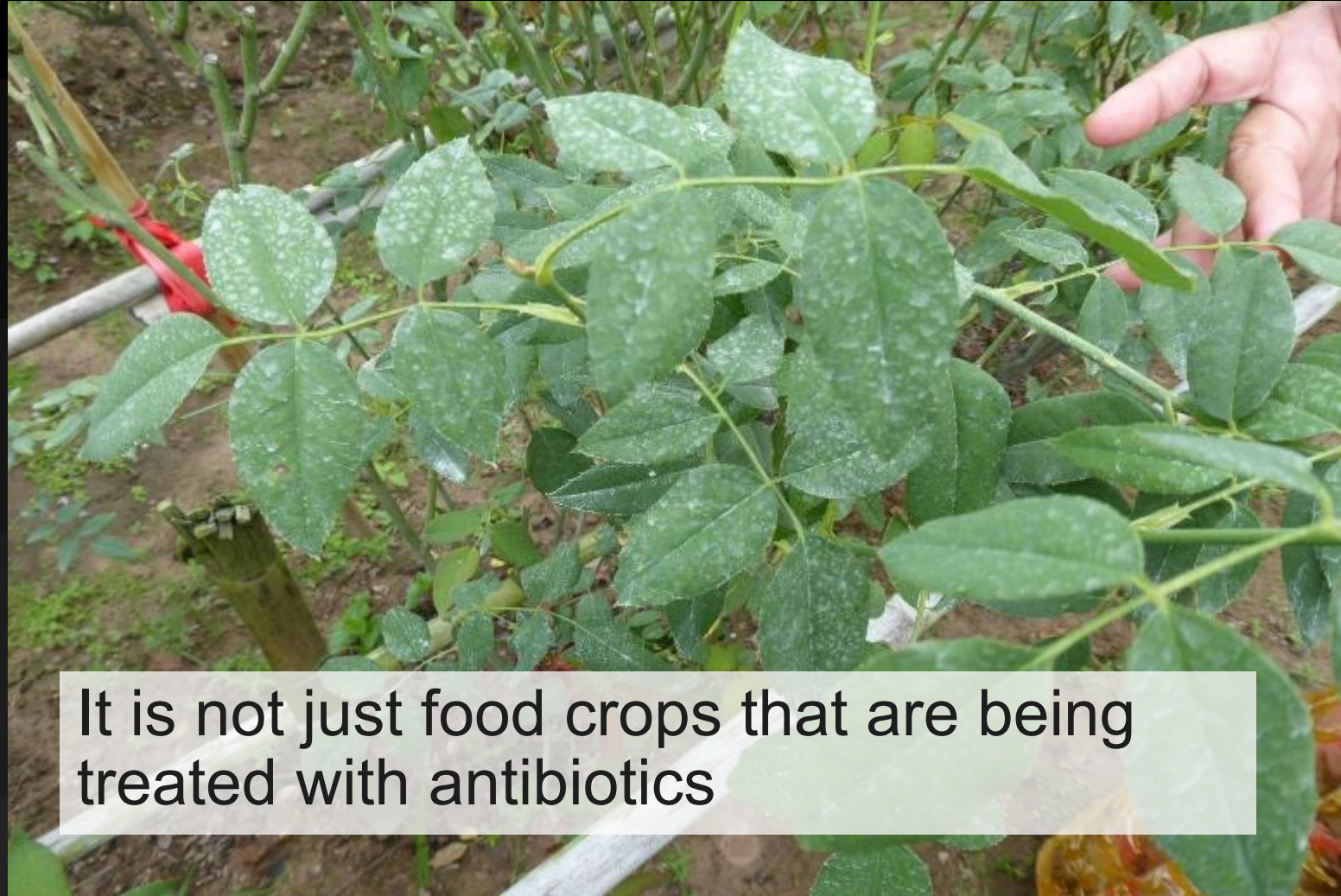




Antibiotics are not seen as being controversial
they are just another crop protection product



Considered by many to be good practice to nip problems in the bud and to apply a prophylactic spray



It is not just food crops that are being treated with antibiotics



This isn't accidental release of antibiotics into the environment

A group of people, including a man in a blue cap and a woman in a white headscarf, looking at a smartphone together. The image is semi-transparent, serving as a background for the text.

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**

شكرا جزيلًا
mercì
शुक्रिया
zikomo
xie-xie
obrigado
efharistó
merci
zikomo
gracias
urakoze
tak
ke itumetse
asante
danke
terima kasih
dhanyawaad

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



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



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