AGRICULTURE AND NATURAL RESOURCES DIVISION

Plant Protection Guide

Farmers' Friends

July 2016

Introduction

This guide is written to assist farmers growing crops both under covered production and in open field production.

Farmers' friends are insects or other invertebrates which kill pests on crops. There are two main groups of farmers' friends:

- Species which occur on the island and happen to eat pests, these are called natural enemies;
- Species which have been deliberately introduced to target specific pests, these are called biological control agents, or biocontrol agents for short.

Farmer's friends tend not to eliminate the pest completely, but can make a big contribution towards keeping pest numbers at an acceptably low level, particularly in the closed environment of a polytunnel. The effect is not immediate like that of a pesticide as the farmer's friends have to hunt out and find their prey, the pest. Once present, however, farmers' friends cost nothing and can find pests long before they are evident to the farmer. They are therefore valuable allies in the fight against pests. The down side is that farmer's friends tend to be very vulnerable to pesticides which therefore have to be used strategically to avoid compromising the presence of farmers' friends.

The ANRD approach is that of prevention and the early detection of pests and diseases to avoid a build up to a damaging level. The aim is to minimise the use of chemical pesticides. This is in the interests of the end consumer of the produce, to reduce the development of pesticide resistance, protect farmers' friends, protect the environment and last but by no means least, cut down on costs. This approach is called integrated pest management.

The guide has five parts:

Section 1 gives some general guidelines on scouting, hygiene, plant protection and record keeping.
Section 2 gives information on how to encourage natural enemies
Section 3 gives information on biological control agents in St Helena
Section 4 gives information on specific farmers' friends
Section 5 gives details of where to find further information and technical support.

We hope that it is useful and welcome all comments and suggestions for improvements.

1. Some general guidelines

Scouting:

- Check the crop daily if possible. Walk along each row looking at the entire plant, particularly examining any which stand out in the row as looking obviously sick, slower growing or discoloured.
- There seem to be more pests and diseases on the plants in the outer rows of fields or polytunnels and less on plants in the middle.
- For signs of pests, look for holes in the rows, discoloured leaves, insect droppings, or leaves browned and drooping.
- For signs of farmers' friends, look for ladybird adults and larvae, hoverflies flying around, and tiny black mosquito-like creatures flying around - these are adult parasitic wasps.

Plant protection:

- Clean away weeds, they can harbour pests.
- Pick off any caterpillars and other obvious pests and take them away for burning, to stop infestations arising.
- Use as little pesticide as possible. This saves you money, protects the useful farmers' friends, protects the pesticide sprayer, the consumer of the crop and the environment, and also reduces the chances of pesticide resistance developing so that sprays will continue to work when you really need them.
- Always read the pesticide label carefully.

Records:

- Keep records of all the sprays you use.
- Keep records of what you harvest (weights and/or prices) so you know if you're breaking even.

2. Integrated pest management

It is a sad fact that relying on pesticides and heavy spraying only results in the pest developing resistance and all the farmers' friends being killed. It is exactly the same in medicine; if you use a lot of antibiotics, each time they work less and less well, and in the end not at all. In St Helena two major pests reached this stage in the past and are now very difficult to control with pesticides, these are the diamondback moth and the whitefly.

The solution is to use integrated pest management, or IPM as it is known. IPM is the careful blend of traditional methods of pest control with modern ones. IPM suggests that pests can be managed much more efficiently if you let nature do as much as possible, and if you also help nature as much as possible. A good farmer follows a few simple steps:

- Produce a healthy plant in the first place. This means choosing the right crop and variety for your soil type and the time of year, using good seed, applying the right amount of water and feeding the crop correctly as it grows. Information on these aspects is given in the ANRD Plant Protection Guides.

- Encourage farmers' friends to the plot by planting flowers and herbs. Many farmers' friends have different diets as adults and young, the adult often eats nectar while the young are the predators of aphids and mealybugs. The adult stage is therefore attracted to flowers and if there are none around the crop there will be few farmers' friends around.

- Help farmers' friends by intercropping crops which don't share many common pests, such as tomatoes and cabbages or onions and carrots, this slows down the spread of pests.

- Watch the crop to spot any pest or diseases as soon as they occur. This is called "scouting" and should be done daily if possible. Don't waste money spraying pesticides until you actually need to, this protects the environment, water and the health of the sprayer, as well as protecting farmers' friends.

- Use only specific pesticides when it is possible to do so, to target the pest and avoid killing farmers' friends.

IPM is not the same as organic farming. Organic farmers use no artificial pesticides and rely entirely on natural enemies, biological control and natural plant products, whereas IPM farmers use pesticides when they need to.

The UK has a national objective to adopt IPM as part of the National Action Plan for Sustainable Use of Pesticides, published in 2013. St Helena is way ahead, as IPM was introduced to the island as early as 1997.

The natural enemies present on St Helena are listed below, and information on each group is given in Section 4:

- Ladybirds
- Parasitic wasps
- Lacewings
- Hoverflies
- Ground beetles
- Mantids
- Dung flies
- Spiders

3. Biological control agents

Classical biological control, or biocontrol in short, is the use of a host-specific natural organism to manage the population of another, the target species. The target species being managed is a pest or weed which is causing economic damage to crops, negatively affecting animal or human health, causing nuisance to people, or negatively affecting native or endemic species.

Natural enemies typically don't result in the eradication of the pest, although this can happen in special situations. Typically, pest numbers become so low that damage is minimal or at an acceptably low level, or for example in the case of an aggressive and widespread invasive weed species, natural enemies can slow down their growth so that other management methods become more effective. Modern biocontrol focuses on highly host-specific natural enemies which lack the ability to switch host or prey and so offer no risk of becoming pests in their own right. The commonest biocontrol agents for crop pests are parasitic wasps, very small wasps where the free-flying adults feed on nectar, while the females lay their eggs on a host which the wasp larvae kill as they develop, using the hosts body for food. Parasitic wasps have proven highly host-specific and successful for a number of target pests around the world.

St Helena has a long history of biological control and a number of species have been introduced. Not all have survived as the earlier introductions tended to consist of small numbers which were released directly into the field with no follow-up. Between 1999 and 2000 the IPM Project introduced a total of 6 species to control 4 pest species, the diamondback moth, cabbage leaf miner, citrus woolly whitefly and citrus psyllid, all of which have proved successful. Building on the skills developed during the project, a further three species of parasitic wasp were introduced in 2002 to target the Mediterranean Fruit fly and Pumpkin fly, on a trial basis. These three species have dispersed around the island but are not showing any signs of controlling the target pests.

The table below shows the various introductions which have been made to the island over time, and how they have succeeded.

Target pest	Introduction history	Date of introduction	Success?
To control insect pests			
Australia bug, *Icerya purchasi*	Ladybird: *Rodolia cardinalis*	1896 and 1898	Successful
Eucalyptus snout beetle, *Goniopterus scutellatus*	Parasitic wasp: *Anaphoidea nitens*	1958	Successful
Potato tuber moth, *Phthorimea operculella*	Parasitic wasps: *Diadegma sp.* *D. surendrai* *D. mollipla* *Temelucha sp.* *Campoplex haywardii* *Orgilus Lepidus* *O. parcus* *Agathis unicolorata* *Apanteles scutellaris* *A. Subandinus* *Microchelomus curvimaculatus* *Bracon gelechidae* *Copidosoma uruguayensis* *C. Koehleri* *Eriborus trochanteratus*	Between 1970 and 1972	Some success, but most did not survive
Mealybugs	Ladybird: *Cryptolaemus montrouzieri*	1971	Some success
Armyworm, S*podoptera littoralis*	Parasitic wasps: *Telenomus nemus* *Euplectrus plathypenae*	Between 1975 and 1980	Not successful
Diamondback moth, *Plutella xylostella*	Parasitic wasp: *Oomyzus sokolowski*	1975	Did not survive
	Parasitic wasps: *Diadromus collaris* *Cotesia plutella*	1999	Successful
Jacaranda bug, *Insignorthezia insignis*	Ladybird: *Hyperaspis pantherina*	1993	Successful
Cabbage leaf miner, *Liriomyza brassicae*	Parasitic wasp: *Diglyphus begini*	2000	Successful
Citrus psyllid, *Trioza erytreae*	Parasitic wasp: *Tamarixia dryi*	2000	Successful
Citrus woolly whitefly, *Aleurothrixus floccosus*	Parasitic wasp: *Cales noaki*	2000	Some success
Medfly, *Ceratitus capitata*	Parasitic wasps: *Fopius ceratitivorous* *Psytallia concolour*	2002	Not successful
Pumpkin fly, *Dacus ciliatus*	Parasitic wasp: *Psytallia phaeostigma*	2002	Not successful

Target pest	Introduction history	Date of introduction	Success?
To control weeds			
Prickly pear cactus, *Opuntia* spp.	Moth: *Cactoblastis cactorum*	1971	Some success
Lantana, *Lantana camera*	True bugs: *Uropleta girardi* *Teleonemia scrupulosa*	1971 – 1972	Some success
	True bug: *Diastema tigris*	1971 - 1972	Did not survive
Gorse, *Ulex europaeus*	Thrip: *Sericothrips stapylinus*	1995	Did not survive
	Mite: *Tetranychus lintearius*	1995	Not successful

A large number of the early introductions consisted of a single release of a few individuals which didn't survive to establish themselves on the island. Experience around the world has indicated that success of biocontrol agents is directly related to the number introduced, with higher numbers leading to a higher likelihood of establishment and success. The biocontrol unit addressed this from 1995 onwards by breeding up new biocontrol agents in a programme of repeated releases of as high numbers as possible. Those achieved in the early phases of mass breeding and releases are shown in the table below:

Target pest	Biocontrol agent	Numbers released at a range of sites around the island
Diamondback moth	*Diadromus collaris*	16,031
Diamondback moth	*Cotesia plutella*	13,401
Leafminer	*Diglyphus begini*	3,022
Citrus woolly whitefly	*Cales noaki*	2,047
Citrus psyllid	*Tamarixia dryi*	137
Medfly	*Fopius ceratitivorous*	11,572
Medfly	*Psytallia concolour*	31,326
Pumpkin fly	*Psytallia phaeostigma*	9,806

Breeding biocontrol agents is a highly specialized skill which it takes years to develop. Key factors which contributed to the success of the introductions from 1995 onwards are therefore:

- The presence of dedicated and experienced staff;

- Mass-production and multiple release of the biocontrol agent on-island in a dedicated facility to ensure establishment through large scale and repeated introductions;
- Collaboration with farmers to avoid killing biocontrol agents through extensive use of broad-spectrum pesticides.

Introducing new biological control agents.

All new potential biocontrol agents are comprehensively screened to check that they won't become a pest once they are introduced to the island, and the screening process is defined in the Import Health Standards for the Importation of Biological Control Agents to St Helena. This is based on International Standards for Phytosanitary Measures No. 3 "Guidelines for the Export, Shipment, Import and Release of Biological Control Agents and Other Beneficial Organisms" (2005).

For first introductions of a new species to the island the importer needs to submit a proposal on a standard form. Proposals must include the following: the objective of the introduction, justification for the selection of the proposed biological control agent, and an assessment of the risk associated with its introduction. They must also include information on the importers technical capacity and source of funding to carry out the introduction, and an appropriate source of organisms. A brief outline is also required of how it is proposed to breed up and / or release the new species. The proposal is reviewed by a panel comprising representatives of key sectors such as agriculture and environment, and there may also be at least one independent external adviser.

If the proposal is accepted there is then a public consultation period of 1 month. If the final decision is positive, the importer can then apply to ANRD for an import licence. At this stage they are required to provide full technical details of the following: how the specimens will be brought to the island, the mass-rearing (if appropriate) programme, and plans for release and post-release monitoring.

On arrival the consignment of individuals of the new biocontrol agent is inspected by the biosecurity officers. If they fail to meet the import health standards they may be refused entry, or confiscated and destroyed at the expense of the importer.

Biopesticides

As well as the conventional chemical pesticides such as Garden Ripcord (a typical insecticide) there are also sprays which use insect diseases to kill the pest. These are called biopesticides. This is actually a form of biocontrol as it's using natural enemies, but in this case applied as a pesticide.

Insects have a whole range of disease which affect them and nothing else. For example, caterpillars are susceptible to the bacteria *Bacillus thuringiensis*, known as "Bt" for short, and if lots of bacteria are sprayed over an infested crop the caterpillars will eat them, get sick and die. Bt is so good it is commercially available in various forms consisting of different strains of the bacteria. The *kurstaki* strain is particularly toxic to diamondback moth caterpillars while the *aizawai* strain is more toxic to armyworm and looper caterpillars. The Bt product Dipel (Bt variety *kurstaki*) is currently the best spray for diamondback moth caterpillars on St Helena as they are resistant to most chemical sprays through previous overuse of pesticides.

The adult moths are not affected by Bt as the bacteria only work once they've been eaten by the caterpillar. The spray should be applied at dusk to the underside of leaves and anywhere else the caterpillars are feeding. The bacteria are killed by sunlight so care must be taken to avoid spraying in bright light. Within 30 minutes of eating bacteria the caterpillar stops feeding and rests immobile on the leaves. Within 24 hours it is dead and turns black, sometimes dropping off the leaf, sometimes the blackened bodies remain on the leaf and can be seen hanging down.

Two other biopesticides used by ANRD are Mycotal and Naturalis-L. Both consists of the spores of a fungus toxic to whitefly, one called *Lecanicillium muscarium* in Mycotal, and one called *Beauveria bassiana* in Naturalis-L. Mycotal requires very high humidity of 95% in order to be effective which is hard to achieve. Naturalis-L claims to be toxic to whitefly adults and grubs, red spider mites, rust mite and thrip, and is potentially a useful preventative spray for tomatoes grown under covered production during the high-risk summer months, when pests are most active. Unfortunately, neither product has so far proved good at keeping whitefly grubs down compared to the use of *Encarsia* parasitic wasps (see below under "Parasitic wasps" for more information on *Encarsia*).

Bacterial sprays tend to be very expensive, and also have a short shelf life. As they are only toxic to the target pests, however, there is no harvest interval.

4. Specific information on farmer's friends

Ladybirds

There are at least 10 known species of ladybird present on St Helena and they are all good predators of aphids and mealybugs. Different species concentrate on different prey. Below are details of the adults and larvae of the six species you are most likely to see, and what each one attacks.

Common ladybird
Scientific name: *Cheilomenes lunata*

This is the commonest ladybird species on the island. It comes in two colour forms, red and yellow. Both the adult and young eat aphids, but the young is particularly voracious and can eat up to 40 aphids in an hour.

Adult	Larva
	

Harlequin ladybird
Scientific name: *Harmonia axyridis*

This is the newest arrival to St Helen and was discovered as recently as December 2015. It is the largest of the island's ladybirds and known to be a voracious predator to aphids. Worldwide this species has a variety of colours and spots, but on the island it is only known as yellow/orange/red with scattered black spots.

Adult	Larva
	

Yellow or orange-cheeked ladybird
Scientific name: *Exochomus flavipes*

This is smaller than the lunate ladybird and has a very shiny black appearance. It eats mealybugs.

Adult	Larva
	

Yellow ladybird
Scientific name: *Psyllobora variegata*

The yellow ladybird is about the same size as the yellow-cheeked ladybird, and can be variable in the number and size of the spots. It eats aphids, and also fungus.

Adult	Larva
	

Red-headed ladybird
Scientific name: *Cryptolaemus montrouzieri*

This species was deliberately introduced as a biocontrol agent. It is about the same size as the yellow-cheeked ladybird, and it eats mealybugs.

Adult	Larva
	

Cardinal ladybird
Scientific name: *Rodolia cardinalis*

This species was deliberately introduced as a biocontrol agent. The cardinal ladybird is about the same size as the yellow-cheeked ladybird. It attacks the Australia bug.

Adult	Larva
	

White-spotted ladybird
Scientific name: *Hyperaspis pantherina*

This species was deliberately introduced as a biocontrol agent. It is small, and attacks the Jacaranda bug.

Adult	Larva
	

Parasitic wasps

There are many species of parasitic wasp on St Helena, but most of them you will be unaware of. One conspicuous species is the big, metallic green wasp which can often be seen walking on house walls in the sunshine around the island – this species is hunting cockroaches. However, unlike their cousins the common wasp and the honey bee, parasitic wasps tend to be dull black or brown in colour, and most are very small. They also have a strange lifestyle which makes them very useful for pest managers. The adults are completely harmless and feed on flower nectar and sugars. When the female is ready to lay eggs she seeks out a host insect – often a caterpillar – and stings it by laying an egg in it. The young wasp grows up eating the host alive and so kills it. Each species of wasp can usually only lay

its eggs in a single host species, so they are totally specific. If the host species dies out, the parasitic wasp does too.

Parasitic wasps have been introduced to St Helena to control a range of pests, and this has been noticeably effective for four pests: diamondback moth, whitefly, citrus psyllid and citrus woolly whitefly. Details are given in the separate sections below.

Diamondback moth

Diamondback moth was one of the major pests to cabbages in the 1990s and by that time had also become resistant to chemical pesticides. It was brought under control through an extensive biocontrol programme using three different species of parasitic wasp.

Cotesia plutellae is the smallest of the three, and stings very young diamondback moth caterpillars. *Diadegma* is a little larger and stings middle sized caterpillars, and *Diadromus collaris* is the largest and stings caterpillars as they turn into a cocoon. So any caterpillars which escape one species of wasp are vulnerable to attack by the next, and the only life stages which are safe are the adult and the egg.

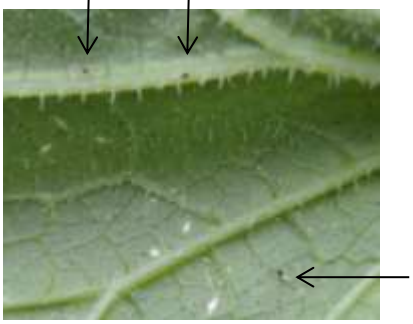
Between them, these three species have now brought the diamondback moth under control. In addition, sudden outbreaks which threaten the crop and seem to have escaped biocontrol can be knocked back with the biopesticide "Bt" (see above under "Biopesticides"), which is not toxic to the parasitic wasps, leaving them to do their job in safety.

Cotesia plutella cocoon on cabbage, having emerged from parasitized diamondback moth caterpillars.	*Diadegma* searching for diamondback moth caterpillars on broccoli
	

Whitefly

Whitefly are very common pests to many crops, and especially tomatoes, beans and cucurbit crops (pumpkin, squash, marrow and cucumber), especially in the protected environment of a polytunnel. Like the diamondback moth they are resistant to most chemical pesticides and so are very hard to control.

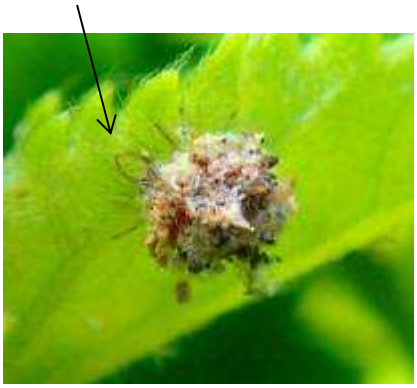
There is a natural enemy present on St Helena, the tiny parasitic wasp called *Encarsia formosa*. It is not known how it arrived on the island, but most probably it came along with the whitefly pest itself many decades ago. The adult wasp eats nectar and also feeds directly on whitefly nymphs, it lays its eggs in the nymphs where the wasp grub feeds on and kills the young whitefly. Whitefly pupae which have been parasitised by *E. formosa* appear black in colour whereas healthy whitefly pupae are white or pale yellow.

Encarsia parasitized (black dots) and unparasitised (green dots) whitefly nymphs	Adult *Encarsia* are tiny, 3 are arrowed in this photo
	

Encarsia occurs all over the island. As whitefly breed faster than the wasp, under normal conditions it often fails to give any control. In the confined area of a polytunnel repeated intensive introductions of *E. formosa* adults, introducing between 100 and 150 adults each week for up to 12 weeks in a standard 60 x 26 ft polytunnel containing 400 tomato plants, can result in a reduction of the whitefly population to non-damaging levels.

Lacewings

The adult green lacewing is a delicate bright green fly with gauzy green wings. It can often be seen at night coming to lights around houses. Both adults and young are voracious predators which feed on aphids, psyllids, whitefly and mites. The young are hard to spot as they cover their backs with bits of bark and leaf as camouflage against birds, just the big jaws sticking out at the head end (shown by the arrow in the photo below).



Hoverflies

Hover flies are very common on St Helena, and there are several species which you are likely to see. These are the black and yellow or black and white striped flies which hover over flowers on sunny days. They are quite harmless themselves, but their young, like those of lacewings, are voracious predators of aphids, and each one can eat up to 1000 in its life.

The thick-kneed hoverfly	The large hoverfly
	

Ground beetles

Sometimes you will see large black/brown beetles energetically running along the ground, both at night and during the day. Look closely at the head and you will see a pair of powerful jaws sticking out in front. These are ground beetles and they are hunting any small, soft insect or other creature to eat. Caterpillars, cutworm, slugs and worms will all be taken by this fierce little predator.

Ground beetles don't climb up plants and can only catch things they meet on the ground. However, they are a useful addition to the zoo of natural enemies and should be allowed to go their way and do their work.

Mantids, dung flies and spiders

The praying mantis (scientific name *Miomantis caffra*) is a relatively new arrival to St Helena and it is not known how it arrived. The first one was seen in February 1992 at Cow Path, and it is now common in the hotter areas of the island such as Half Tree Hollow and Jamestown. They are good general predators and take many house flies as well as other pests.

Dung flies (scientific name *Scathophaga stercoraria soror*) can often be seen perched on crops during the day. These are large brown flies which breed in animal dung. They have a characteristic yellow stripe down the back. The adult is a predator and will take many small pest species.

Dung fly	Praying mantis
	

All spiders are predators and will eat soft bodied insects such as aphids, small caterpillars, flies and other pests. They are therefore to be encouraged. Some spin webs to catch flying prey, while others hunt on foot and use their silk to tie up anything they catch.

5. Support and advice

ANRD can provide technical advice and support to assist you in identifying pests and farmers' friends, and also offers a complete professional spraying service. Call Pest Control on 24724.

There is a wealth of information available on the internet. Some useful websites are:

- ANRD IPM webpage: http://www.sainthelena.gov.sh/integrated-pest-management/
- IPM Online (University of California): http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html
- Pesticide Action Network UK: http://www.pan-uk.org/about
- Plantwise Knowledge Bank: http://www.plantwise.org/KnowledgeBank/Home.aspx
- Pests of Field Crops in Southern Africa: http://www.pestsandcrops.com/index.htm