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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
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Guide for agricultural advisors

Farming with Alternative Pollinators (FAP)

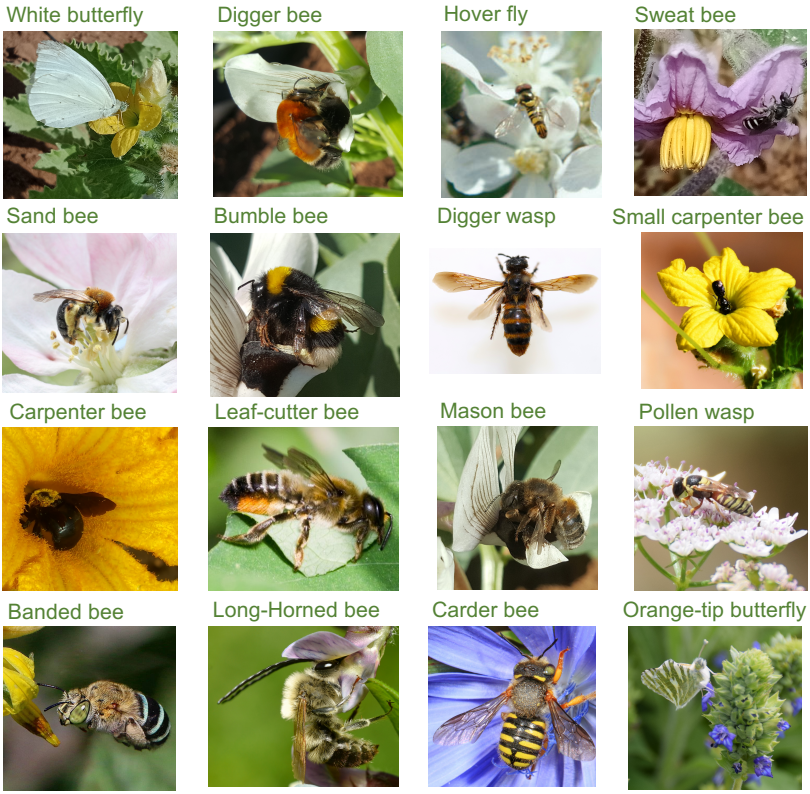






How to train farmers to protect pollinators and benefit more from their services

Inform farmers about the diversity of pollinators



Educate farmers about the importance and the great diversity of insect pollinators. Farmers don't recognize them as beneficial, they often consider them as pests, but pollinators contribute to crop productivity to a high extent.

Teach them to recognize diversity!

Insect pollinators include many different insect groups, the most important are bees, but butterflies and many groups of flies and wasps also play a major role in pollination. Except social wasps, bumble bees and honey bees, all of them are solitary.

Explain the value of crop pollination

IN JORDAN



x 26



Value of honey produced

Value of pollination

IN AFRICA



x 100



Value of honey produced

(FAO 2009)

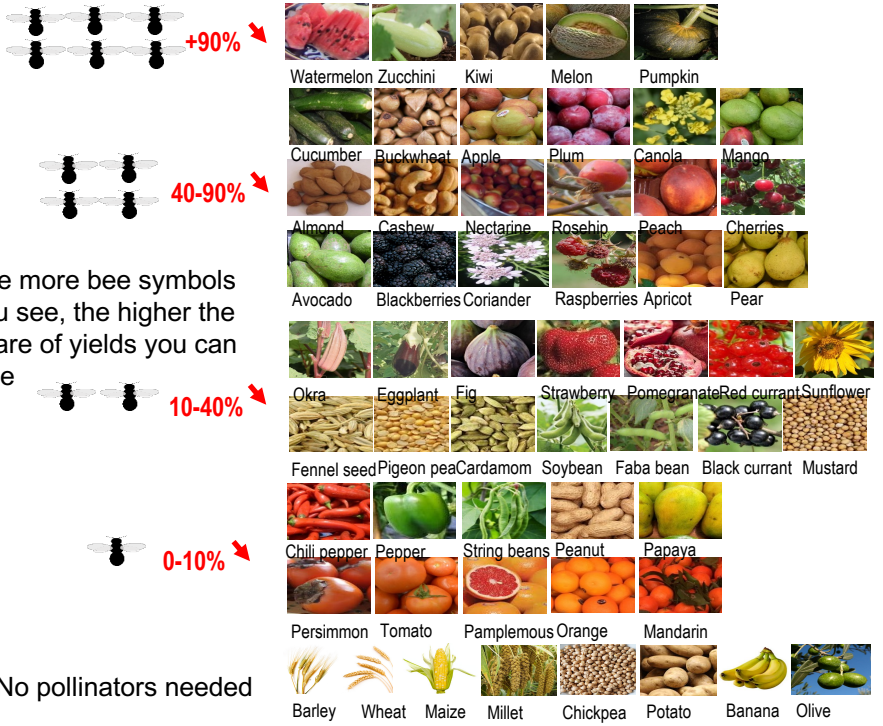
Value of pollination

Inform farmers about the economic value of pollinators.

Moroccan farmers think honey bees are more important than wild bees and other pollinators because they produce honey, but the value of pollination is much more important than the value of honey, and wild pollinators contribute to 85% of pollination.

The value of pollination in Jordan having similar crops as Morocco is estimated to be 26 times the value of honey.

Explain that lack of pollinators reduces the yield

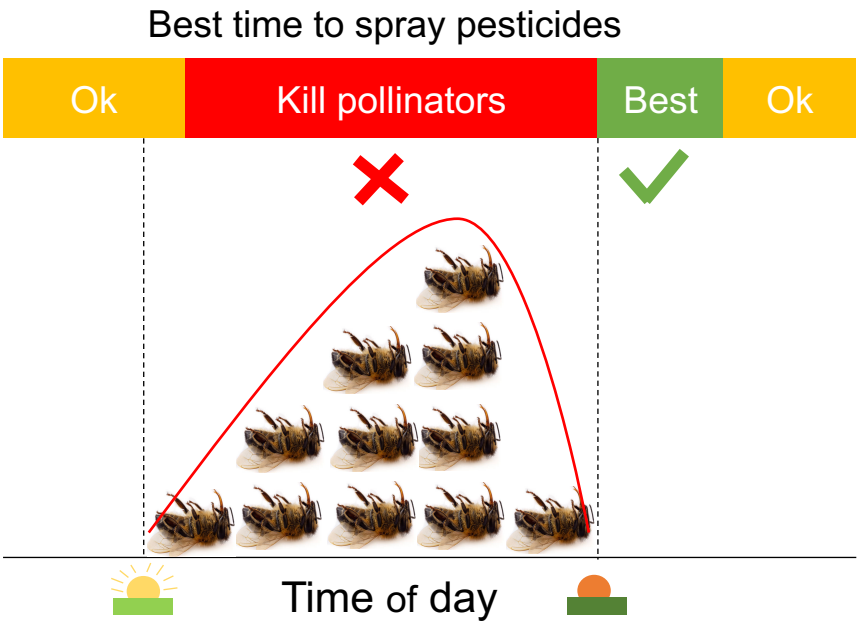


Crops don't all have the same dependency towards pollinators, some are highly dependent (ex: zucchini, 6 bee symbols, 90% loss of productivity without pollinators), some are less dependent (ex: okra, 2 bee symbols 10-40% production loss without pollinators) and some don't need pollinators at all (ex: wheat, no bee symbols, no loss of production without pollinators).

Inform farmers on levels of pollinator-dependency of crops and that pollinators can increase their yields. If farmers are not aware of it, they might take wrong decisions by, for example, increasing use of fertilizers.

Explain how to reduce pesticides

1. **Spray when pollinators are not flying**
   - *If possible*: before/after flowering period
   - *Otherwise*: after sunset (dusk to dawn)



Raise awareness about the decline of pollinators and the negative impacts of pesticides and many other chemicals. Train farmers on how to reduce pesticide use.

The timing of pesticide applications is very important. Farmers should avoid, if possible, to use pesticides during day time when pollinators are flying. Explain them that the best moment to spray is ideally after sunset but it can also be done before or during sunrise.

Explain how to reduce pesticides

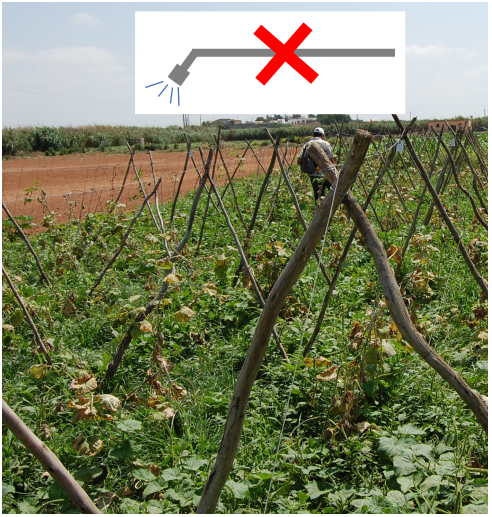
2. Remove weeds before spraying, it reduces your costs!

- Mow before applying pesticides

Best practice



Bad practice



Inform farmers, that for two reasons it is important to take off weeds from fields before using chemicals.

The more weeds are in the field, the higher is the quantity of chemicals farmers need to protect their plants. They save money, if they extract weeds first.

Also: Explain farmers that flowering weeds attract many pollinators contributing also to crop production so it is important to cut the weeds before applying pesticides to avoid killing pollinators.

Explain how to reduce pesticides

3. Reduce spray drift

- Spray on target only





- Use larger droplet sizes





- Avoid spraying under high wind speeds

Explain farmers that it is important to spray pesticides directly on the plant to avoid the waste of chemicals and money and reduce soil contamination.

Fine droplets tend to drift farther, so it's important to propose to farmers to reduce pressure or choose larger nozzles to reduce drift by producing larger droplets. It is important to tell farmers to regularly calibrate the spray equipment and to avoid spraying under high wind speed to avoid excessive drifting and contamination of surrounding environment. Otherwise they pay for crop protection in neighbour fields.

Explain how to reduce tillage

1. Practice shallow tillage (< 10 cm)

In Morocco, 70% of the wild bees nest in the ground

Sand bees



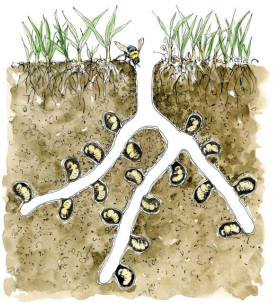


Illustration Elayne Sears

Sweat bees



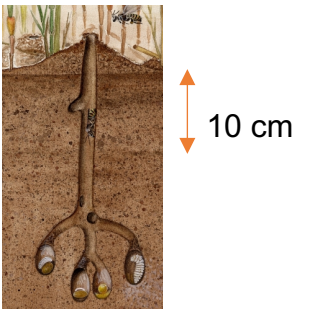


Illustration Art Cushman

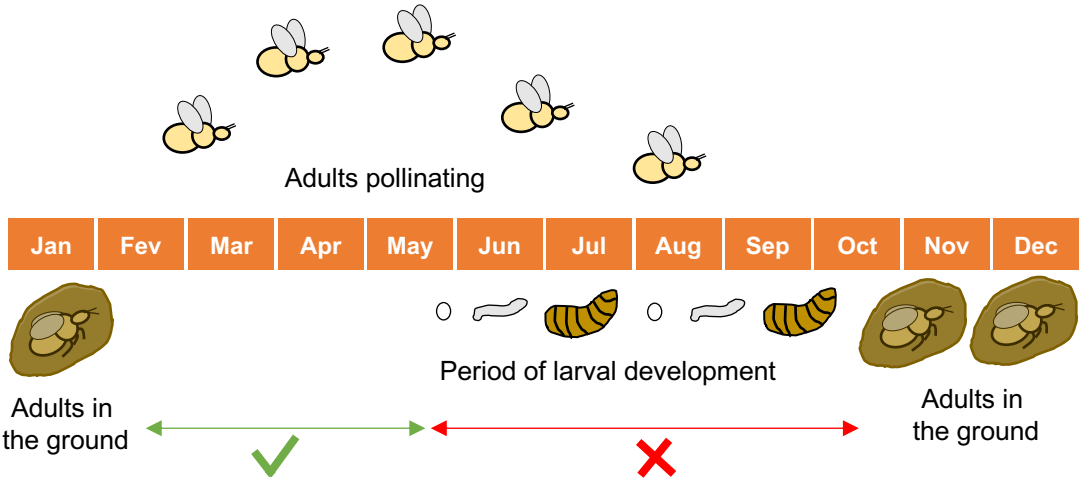
Shallow tillage (< 10 cm) reduce the risk of killing bee larvae

Propose to farmers to practice shallow tillage to reduce the risk of killing developing pollinator larvae.

Roughly 70% of Moroccan bee species are solitary and nest below ground. In farms, they are often found nesting in crop fields, orchards, close to irrigation canals. Bee nests can thus be affected by tillage. Different species nest at different depths below soil surface, but most cells are located between 10 and 40 cm deep, which is often within the tillage zone.

Explain how to reduce tillage

2. Reduce tillage frequency

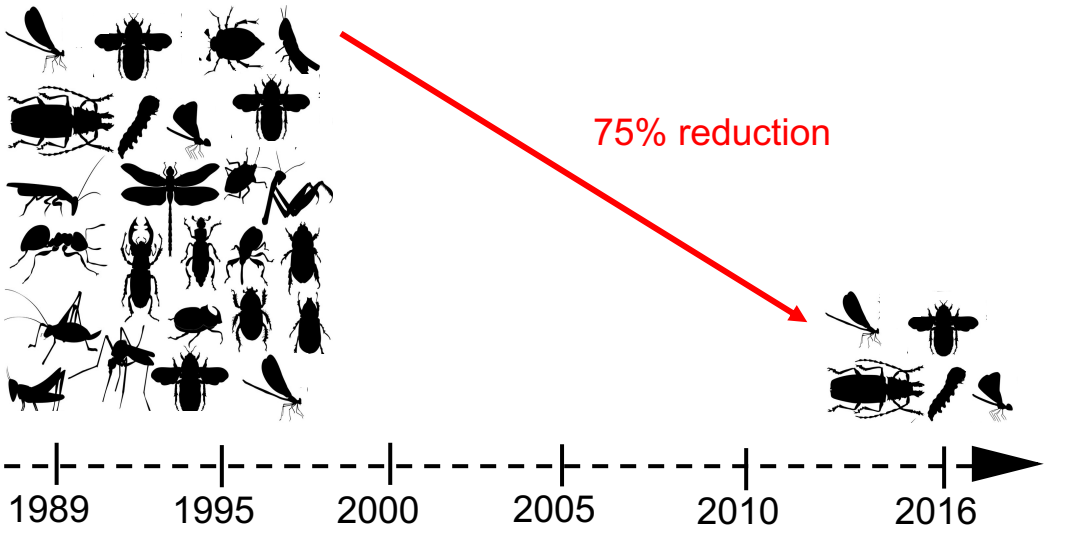


Tillage recommendation:

- Winter or early spring, when females are building nests and can still change nest location
- If possible, avoid tilling in the summer and early fall when the new generation is developing
- **If possible,** keep some areas unploughed

Suggest farmers to reduce the frequency of tillage to decrease the chances of killing bees.
Ground-nesting bees spend most of their lives developing in the ground in nest cells made by their mother. They are very vulnerable at this stage because they cannot escape. Tilling in spring when mothers are actively building nests can allow adult bees to change their nest location to less disturbed areas.

Raise awareness about the decline of pollinators



Loss in Germany within 27 years

Pollinator decline accelerates rapidly

(modified from Hallmann et al. 2017)

Encourage each farmer to contribute to pollinator protection to avoid such worst-case scenario for Morocco.

According to a recent study, insect abundance reduced by 75% in Germany in 27 years. Among them are many insect pollinators. Heavy decline is observed from many countries using monocultures, regularly pesticides and huge equipment for tillage, countries which cut trees and hedgerows and weeds for modern clean fields.

Explain farmers support pollinators in their fields and get much higher yields in return!

Farming with Alternative Pollinators (FAP)

FAP-eggplant field (Kenitra)



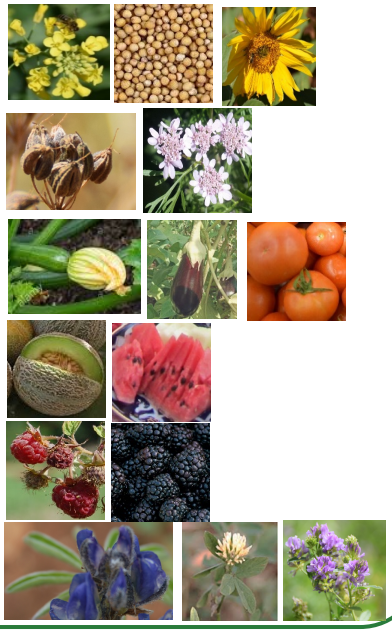
Explain which crops to plant to support pollinators

The habitat enhancement plants

Diversify the type of plants, with flowers of different types and colors, to attract a higher sity of pollinators.

Some pollinator-attracting marketable plants

- **Oil seeds** : canola, mustard, sunflower
- **Spices** : anise, coriander, basil
- **Vegetables** : zucchini, eggplant, tomato
- **Fruits** : melon, watermelon
- **Berries** : raspberry, blackberry
- **Forage plants** : lupinus, clover, sainfoin



Promote new habitat plants to farmers, advise them how to use and market them and generate a new source of income!

Inform farmers on the benefits and the use of spices and aromatic plants like for exemple anis, chia or basil that can be used as habitat enhancement plants. Anis for instance is used for its sweetening properties and has also many health benefits especially by stimulating the digestive sytem. Chia seeds are rich in Omega 3 and have also many health benefits.

Explain the importance of nesting and water support and how to build them



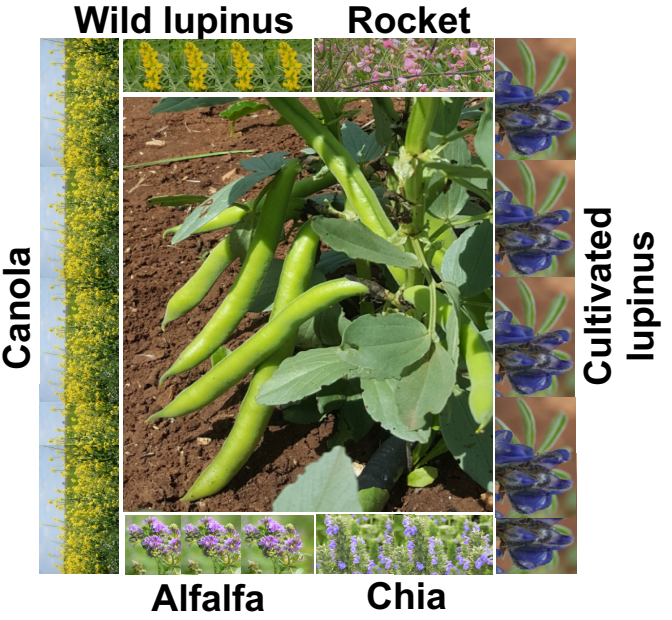


Bee hotel : Cut wooden blocks and bamboo sticks smaller than your box. Drill holes of different sizes into the wooden blocks. Cut off the top of 1,5L plastic bottles with a knife, then fill up the plastic bottle with bamboo sticks. Fill the bee hotel with the prepared material. No rules, just make sure that all the content is securely compacted.

Water point : Cut off a square 5L plastic bottle in half. Then pierce few holes in a 1,5L plastic bottle at the bottom and at the level of the height of the half cut 5L bottle. Dig a hole in the ground and put the half cut 5L bottle inside. Then add in the middle the pierced 1,5L bottle. Fill the rest of the space with small stones to prevent bees from drawing. Then fill up with water both the 1,5L bottle and half cut 5L bottle.

Explain how to get higher faba bean yields by protecting pollinators

FAP planting instructions



Main crop = 75% zone
Faba bean

Marketable habitat enhancement plants = 25% zone
Canola, wild and cultivated Lupinus, Chia, Alfalfa, Zucchini, Rocket

Explain farmers that most habitat enhancement plants need to flower at the same time as the main crop to ensure better pollination of the main crop, faba bean. Discuss the right timing for seeding of each plant with farmers and explain that some plants should also flower before and after the main crop to sustain pollinators.

As faba bean flowers early, it is difficult to find additional plants flowering so early, which also generate high income.

Explain how to increase your income through FAP

+ 75% on average (2017)







FAP



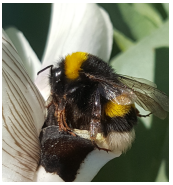
Without FAP

Explain farmers that FAP generates a higher income per surface and that the area for the main crop in the FAP-field usually produces more than the total control field. For most crops the habitat enhancement plants also generate valuable income.

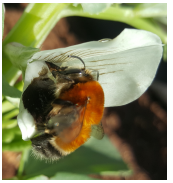
If the main crop is heavily attacked by pests or disease, the habitat enhancement plants can also buffer against income loss.

Describe the main pollinators of faba bean

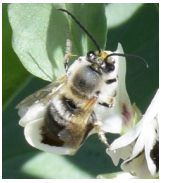
Bumble bee



Digger bee



Long-horn bee



Mason bee



Explain how to support these bees for nesting

Bumble bees live in colonies (1), the queen builds her nest inside abandoned holes of mice.
Digger bees are solitary and nest in the ground, often they dig horizontally into slopes (2).
Long-horn bees have the same nesting preferences as digger bees.
Mason bees are solitary and look for narrow cavities in dead trees.









Explain that faba bean flowers have their petals fused into a long tube that makes the nectar accessible only for pollinators that have a long tongue that can reach the end of the flower. Among them, bumble bees, digger bees, long-horned bees, mason bees are the most important pollinators of faba bean. They also pollinate other flowers with a deep corolla such as basil, mint, rosemary, sage, oregano, thyme or lavender. Propose farmers to seed also these plants in their farm to sustain important pollinators in the area.

Explain that keeping old wood will help support mason bees. You can also help them to make bee hotels out of bamboo canes and wood logs with drilled holes

Describe the main pollinators of eggplant

Carpenter bee



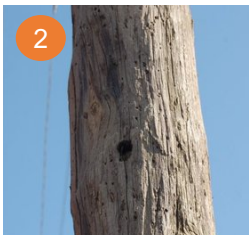
Banded bee



Explain how to support these bees for nesting

Carpenter bees are attracted by faba bean, tomato, eggplant and sunflower. They are solitary, the female chew large holes in old wood for their nests (1,2).
Banded bees are attracted by plants with narrow tube flowers like faba bean, sunflower, many aromatic plants (basil, mint, rosemary, sage, oregano, thyme) but also tomato, pepper and eggplant. They are solitary and nest on vertical slopes (3,4).





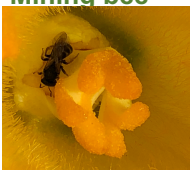




Explain that flowers of eggplant have their pollen firmly attached to the flowers making it very hard to collect for most bees. Mostly carpenter bees, banded bees and also bumble bees can do it by shaking flowers very fast by vibrating their wing muscles to detach the pollen. This way of collecting pollen is called buzz pollination.
Explain to farmers that keeping old wood in their farm will help attract and support carpenter bees. And protecting sites with vertical slopes available will support banded bees.

Describe the main pollinators of zucchini

Mining bee



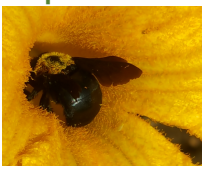
Sweat bee



Bumble bee



Carpenter bee



Explain how to support these bees for nesting

Mining bees are solitary and nest in the ground (1).
Sweat bees are mostly solitary and nest in the ground. You can notice the little mound of excavated soil left at the nest entrance (2).
Bumble bees live in colonies (3) in the ground.
Carpenter bees are solitary, the female chew large holes in old wood for their nests (4).









Explain to farmers that many pollinators of zucchini build their nests in soil. If they use a lot of pesticides, this soil can be toxic for females, so they die instead of laying eggs and there will be less pollinators in the next season. Zucchini flowers have a deep and wide open corolla so the access to the nectar and pollen is easy for many pollinators, including short tongue bees like mining bees and sweat bees and long tongue bees like bumble bees and carpenter bees. Propose farmers to seed sunflower, aromatic plants and other cucurbits to attract similar pollinators and increase crop productivity. Explain to farmers that clearing patches or bare ground and reducing tillage will support ground nesting bees. Keeping old wood in your farm will help attract and support carpenter bees.

Describe the main pollinators of cherry

Mining bee



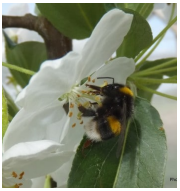
Hover fly



Mason bee



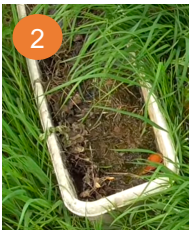
Bumble bee



Explain how to support these bees for nesting?

Mining bees are solitary and nest in the ground (1).
Hover flies, most species eat aphids as larvae, so they are beneficial also for pest control. Some species breed in stagnant little water puddles with organic rotting matter inside (2).
Mason bees are solitary. They look for narrow cavities in dead trees or bee hotels (3)
Bumble bees live in colonies (4), tin the ground.









Explain to farmers that cherry have flowers quite open and flat, so they attract very diverse groups of pollinators including short tongue insects such as mining bees, hover flies and also long tongue insects like mason bees and bumble bees. Cherry flowers bloom very early in the season so propose farmers to seed crops like canola, faba bean and coriander.
Explain them that clearing patches of bare ground and reducing tillage will support mining bees. Using a container with water and grass clippings will encourage hover flies breeding in their field. Keeping old wood or making bee hotels out of bamboo canes or wood logs with drilled holes will help support mason bees.

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