



## Organic Farming and biodiversity



According to the IFOAM<sup>1</sup> definition, organic farming is "a production system that sustains the health of soil, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promotes fair relationships and a good quality of life for all involved". Organic agriculture is based on principles of health, ecology, fairness and care, and its application respects the farm's ecological cycles or promotes the farm's biodiversity.

Biodiversity - cultivated or not - including agro-ecosystems, has decreased over the last decades due to the simplification and specialization of farming systems. Some of the major roles biodiversity plays in the functioning of agro-ecosystems, particularly in the balance between pests and biological control agents or the recycling of nutrients, have been replaced by the increasing use of inputs (fertilizers and phytosanitary products).

The techniques and principles of organic farming are based on respect, preservation and development of biodiversity in order to maintain these essential functions and ensure the agrosystem's productivity

### What is biodiversity ?

Biological diversity or biodiversity encompasses all forms of life and ecosystems. Jean-Pierre Sarthou (INRA) defines several components of agricultural biodiversity :

- Resources components (pollinators, predators, parasitoids, decomposers),
- Destructive components (diseases, pests, pathogens),
- Wild relatives of domesticated plants and animals,
- Productive components (animal and plant species selected by human hands).

All these components interact in agricultural systems to ensure productivity. However, in agricultural systems which are always unstable because of perpetual disturbances related to agricultural activity (cultivation, plant protection applications for example), biological balances are very difficult to set up between these different components.

Organic farms, which are generally diversified, with preserved and maintained hedgerows, provide an area more favorable to biodiversity and to the development of balances necessary for the health of crops than conventional systems dedicated to monoculture and open spaces (Bourdais, 2001).

### An observation from 2001 at Suscinio

Since 2001, on the Agrobiologic Platform of Inter Bio Bretagne in Suscinio (P.A.I.S.)<sup>2</sup>, the presence of a wide variety of pests has been observed, but in small quantities which rarely reach a harmful level. This is especially true for pests of artichoke and cabbage (aphids and caterpillars).

A first inventory was taken in 2001 and 2002 on a reduced scale (5 000 m<sup>2</sup>), and for only one production (artichoke). It identified no fewer than 12 aphid species, none of which had caused enough damage to the culture to require phytosanitary treatment.

On this same plot and its field margins (hedgerows, embankments), some species of beneficial insects (including several ladybirds *Coccinella septempunctata*, and lacewings *Chrysoperla lucasina*) naturally present in the environment have been identified. Traces of the presence of other natural pest enemies (aphid mummies, consequences of the presence of parasitic wasps) as well as aphids infected with entomopathogenic fungi were also observed.

A natural balance has limited infestations and harmful effects of pests.



## Organic Farming and Biodiversity Programme at the P.A.I.S.

A balance occurred on one plot, but could this happen on a larger scale production system ?

From 2006, the P.A.I.S. has been making an inventory of flora and fauna throughout Suscinio site with the aim of identifying the mechanisms and actors (pests and their natural enemies, host plants, prey and alternative hosts...) involved in the natural balances in this agroecosystem, which has been farmed organically since 1999.

### • Inventory of flora and fauna

The first step in the program (2006-2007) was to describe and map Suscinio site (see box page 4) and carry out an inventory of the flora present in the area. During this period, the vegetation on the embankments and in the hedges on the site was identified as grass stratum, bushes and trees (3.8 km for the 17 hectares of the farm or 223 meters per hectare<sup>3</sup>).

### • Ordinary biodiversity and high value biodiversity

The vast majority of recorded species belongs to the ordinary biodiversity which can be commonly found in the Brittany territory, or even within the national territory. However, some rarer species belong to the high value biodiversity and are only found in a few places. This is the case for bats (*Pipistrelle*) which are present in Suscinio, as well as a syrphid species recorded for the first time in the North West of France, *Eupeodes goeldini*.

The parcels of land and the network of hedges and embankments are home for around **160 plant species**, including fifteen tree species (including three species of oak, ash or aspen), twelve shrubs (ivy, elderberry, hawthorn...) and over one hundred herbaceous species as well as twenty vegetables, legumes and cereals species grown on the farm.

This great plant diversity, which can flower from March to November, allows the presence of numerous animals, including arthropods, on the site, as well as birds and small mammals which play an important role in the regulation of pests. Indeed, the diversity and the staggered periods of flowering provide shelter, especially during the winter. They also ensure the presence of food (pollen, nectar, foliage) pre-and post-hibernation in early spring and late autumn for phytophagous which are present throughout most of the year, ensuring the presence of early populations of prey, and hosts for biological control agents.

More than **260 species of arthropods** (especially insects living in soil or on plants) were identified, **51 species of birds** (including four species of raptors, but also four species of tits), **8 mammals** (bat, otter, deer...) and some **amphibians** (frogs, salamanders) were observed<sup>4</sup>.

These species do not all have a direct effect on agricultural production. However, among the more than 300 animal and 160 plant species, there are many species of crop pests (aphids, butterflies, whiteflies...), and their natural enemies (predators, parasites and more or less specific parasitoids), but also many species which are "indifferent", but which play an important role of hosts or alternative preys for biological control agents.

The site's diversity of plants and habitats has also resulted in the presence of many species of pests, auxiliaries, or "indifferent" species. The greater the

diversity of animals, the greater the likelihood of species which present a risk for agriculture. However, the amount of pests (e.g. aphids) has never led to the destruction of a culture. Diversity has also led to a variety of natural enemies, and their presence allows a quick and natural regulation of pest populations. There is, therefore, no infestation of crops by pests at Suscinio site.

### • Mechanisms of regulation of pest populations

Take the example of aphids. The presence of this pest on the crops is a recurring problem at Suscinio, and it can be helpful to understand the complex relationships between these pests and their predators and parasites (parasitic wasps), found in large quantities in the environment of the PAIS.

#### ► Aphids

#### From crop pests...

During the inventory period, **18 species of aphids** had been identified in the cultures and field boundaries. Of these, we can mention some which are harmful to crops :

- ***Aphis fabae***, highly polyphagous species that are found on crops such as faba beans, or vegetables such as artichokes, carrots, potato or cucumber in greenhouses,
- ***Hyadaphis foeniculi*** which parasitizes wild and cultivated Umbelliferae such as carrots and fennel,
- ***Brevicoryne brassicae***, cabbage aphid, very common in Brittany.

#### ... to indifferent species

Several species called indifferent - ***Phyllaphis fagi* or *Tuberculatus annulatus*** - are also present around crops. Species which are restricted respectively to oak and beech never attack crops; they can serve as prey or alternative hosts for many biological control agent species (arthropods, but also mammals, amphibians, birds). They aid the permanent presence of biological control agents in the environment, allowing their rapid development when a pest aphid population appears.

#### ► Aphidophagous auxiliaries

Among the auxiliaries, there are species that attack only aphids (predators or parasitoids of several species of aphids), polyphagous species (predators of aphids, mites, whiteflies...).

See graph opposite ►

#### Polyphagous species

Several species of **stink bugs** (Heteroptera, or Anthochorid Myridea) were identified. Some of them are crop pests, but others are predators which may feed on aphids and other pest insects (whiteflies, mealy bugs, for example). This may be the case of the stink bug *Campyloneura virgula*.

Some **web spiders** (Argiopidae) are also present in the environment of the PAIS. They indiscriminately attack all species that are trapped in their webs, including pests. Winged aphids (which found colonies) can be their prey too.

Spiders and stink bugs have a predatory activity which is difficult to quantify. However, their diversified feeding habitudes mean they do play an important auxiliary role. It is the same for **bird** species present on the site which feed on insects (garden warbler or tit for example), as well as **bats** (pipistrelle) and **frogs** recorded on the site.



**The specific auxiliaries**

Among the predatory species most specified, and probably also the best known we can mention hoverflies, Neuroptera, and ladybirds, represented by a wide variety of species at Suscinio. Hoverflies (Diptera can be mistaken for wasps because of their appearance), are flies which play a major role as a biological control agent in cultures.

Their diet (voracious larvae eating aphids, and adult eating pollen) makes them useful allies of farmers in terms of biological control and field pollination.

**19 species of hoverflies** were identified at Suscinio, the most numerous among them are *Episyrphus balteatus*, *Melanostoma scalare* or *Syrphus ribesii*.

An individual of this species can consume more than 200 aphids during its larval stage, which is more than a ladybird will consume throughout his entire life.

**Six different species of ladybirds**, the best known beneficial aphidophagous, have been identified in Suscinio. Along with the famous red 7 points ladybird *Coccinella septempunctata*, the 11 or 14 points ladybirds (*Coccinella undecimpunctata quatuordecimpunctata* and *Propylea quatuordecimpunctata*) have been observed too. This family can be raised and used as a biological control agent in closed environments (greenhouses).

This is also true for lacewings and another family of **Neuroptera**, of which three native species have been identified (*Dichocrysa prasina* and *Chrysoperla lucasina* for example).

As for hoverflies, these species are advantageous as they are good pollinators at the adult stage (they feed on nectar and pollen) and good regulators of aphid populations in the larval stage.

Finally, there are also native species of **midges** (diptera of which larvae predators aphids) and **parasitic wasps of aphids**, of which some species are raised to be used as agent of biological control in greenhouses.

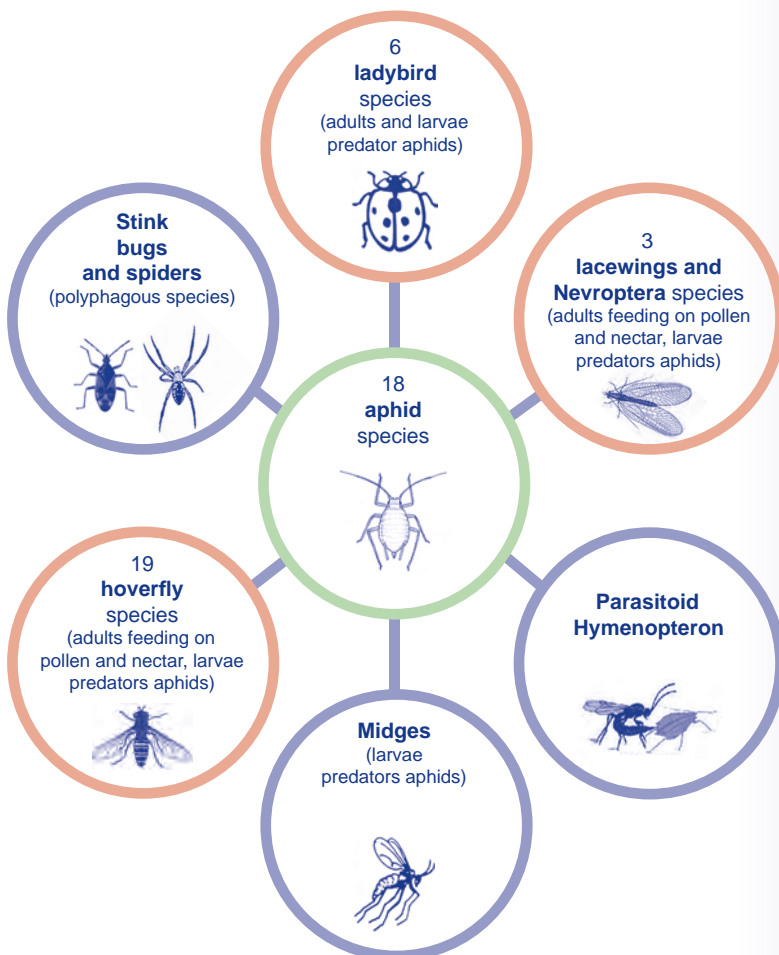
Thus, a natural biodiversity exists in Suscinio environment, supporting the existence of a stream of species with diversified (ou "varied") biology and feeding (parasitoids, general or specialized predators).

This allows the development of a balance and ensures the aphid populations stay below harmful levels.

It is the same for other pests. The Pieridae (*Pieris brassicae* and *Pieris rapae*) are often parasitized by the hymenopteron *Apanteles glomeratus*. Sciarid flies in seeds, and on onions and cabbages are also the target of some species of Staphilinidae (3 species of *Aleochara*).



**Biological control agents involved in aphids population regulation at Suscinio**



**Agrobiologic Platform Inter Bio Bretagne Suscinio**

The Platform Agrobiologic Inter Bio Bretagne Suscinio (P.A.I.S.) is located at the Agriculture School of Suscinio, Morlaix (29), at the heart of the vegetable growing area of Brittany. Six of the 17 ha of the organic farm are used by the P.A.I.S.

Located on the watershed of the Dourduff and along the Bay of Morlaix, the site is characterized by different soil types, mainly of silt of varying depth (a few centimeters to 1,2 m). It has specialized in organic crop production since its conversion in 1999.

The P.A.I.S. is the inter-professional station dedicated to organic plant production. Its fields of activity mainly concern vegetable production, and also, since 2009, field crops.

The missions of the P.A.I.S. include :

- The evaluation of existing genetic resources in organic farming and the development of varieties adapted to organic farming for the most popular cultivated vegetables,
- The development of an organic seed sector,
- The answer to technical questions concerning, among other things, commercial organic varieties, materials and crop protection,
- The study of interactions between agricultural practices and biodiversity.



### Impact of organic farming on biodiversity, including functional biodiversity

A study conducted by Cemagref (Bourdais, 2001) showed that, compared with conventional agriculture, organic farming has a very positive impact on all aspects of the environment: water quality (because synthetic herbicides and pesticides are not used), soil fertility (crop rotation, organic fertilization, use of green manure), and preservation of other aspects of the environment such as biodiversity and natural resources (establishment and maintenance of hedges and embankments).

Organic farming practices can encourage the presence of an efficient functional biodiversity, necessary for the proper operation of the natural balance between pests and biological control agents.

The restoration and preservation of biodiversity allows the development of biological control by conservation, that is to say control of pests by auxiliaries naturally present in the environment.

Their presence is favored by human activity and the management of the borders of plots.

The biological control by conservation is complementary to the biological control in a closed environment where the raised biological control agents are introduced.

### Conclusions and perspectives

The inventory carried out at the site of Suscinio confirms the results of former studies conducted on biodiversity in agrosystems in agrobiology : the practices of organic farming support biodiversity.

It encourages crop biodiversity (diversified production, not monoculture), biodiversity in the soil (rotations, green manure), biodiversity around the fields (development and maintenance of slopes and hedges)...

In hedged farmland areas, biodiversity has to be maintained. For this reason, hedgerows and embankments should be preserved and managed in ways to suit the local conditions, with non-cultivated areas with diverse flora maintained on farms in order to create areas undisturbed by agricultural activities, and as continuously as possible to allow migration of animals along these "ecological corridors". These zones of ecological compensation are essential to the preservation of biodiversity and provide the necessary balance to the productivity of agricultural systems conducted in organic farming.

In greenhouses or in areas without hedged farmland, it can be useful to take action to recreate the biodiversity, including crop diversification, or to create grass strips or flower bands to attract and host assistants and pollinators and limit the use of inputs.

The biological control used in the greenhouses only mimics some part of what happens naturally in the environment. It may be necessary to use biological control agent livestock in very specific conditions, particularly in greenhouses. However, inoculating a non native biological control agent in the environment (with the ecological risks that entails) is never a preferable solution to the natural presence of native biological control agents, in and around the cultivated parcels of land. It is therefore necessary to put together all methods that preserve or encourage the presence of a variety of wildlife on farms, necessary for healthy crops.

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<sup>1</sup> IFOAM : International Federation of Organic Agriculture Movements.

<sup>2</sup> The PAIS is the experimental station of the Inter Bio Bretagne dedicated to organic plant production. It is located in Morlaix (29), at the farm of the agriculture school of Suscinio which is organic since 2001.

<sup>3</sup> We talk about hedged farmland when the network of hedges and embankments are relatively continuous and represent more than 100 linear meters per hectare.

<sup>4</sup> The study focused on arthropods, the other groups (mammals, amphibians, birds) were not specifically inventoried. However, species that were found were identified.



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◀ Bocage landscape of the site of Suscinio, in border of the bay of Morlaix

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