Life PollinAction

With the contribution of the LIFE Programme of the European Union LIFE19 NAT/IT/000848

# Guidelines

## CREATION AND MANAGEMENT OF HABITATS FOR POLLINATORS

AGRICULTURAL AREAS

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# Guidelines

## CREATION AND MANAGEMENT OF HABITATS FOR POLLINATORS

AGRICULTURAL AREAS

# THE LIFE POLLINACTION PROJECT
# ACTIONS FOR BOOSTING POLLINATION IN RURAL AND URBAN AREAS
# LIFE19 NAT/IT/000848

## THE PROJECT

The LIFE project PollinAction aims at the implementation of concrete actions to protect pollinating insects and to address the current 'pollination crisis'.
The causes of this phenomenon are numerous, but the most substantial impact can be attributed to human land use. The processes of urbanisation and the expansion of intensive agricultural areas have resulted in a profound simplification of the landscape and the disappearance of habitats that were once widespread. Meadows, small woods and hedges, as well as field and road edges, are becoming increasingly rare and reduced in size. Yet, it is precisely in these habitats that pollinators can find the resources they require to survive, including pollen and nectar, as well as areas in which they can nest and withstand the winter. In these simplified landscapes, ensuring the availability of habitats suitable for the needs of pollinating insects is the only effective strategy to promote their presence and activity. Small areas where these animals can find food resources as well as reproductive sites, and that allow them to move safely across the territory: meadows, small wooded patches, wetlands, hedgerows, extensive agricultural areas. These components interacting with each other give rise to a network, a Green Infrastructure, capable of providing multiple benefits to both wild species, plants and pollinators, and humans.

## WHO THEY ARE

The project, co-funded by the European Union, is coordinated by Ca' Foscari University of Venice and developed in collaboration with the Autonomous Region of Friuli-Venezia Giulia - Central Directorate for Agricultural, Forestry, and Fisheries Resources, Biodiversity Service; Veneto Region - Directorate for Agro-Environment, Programming, and Fisheries and Hunting Wildlife Management; Veneto Agricultural Innovation Agency - Veneto Agricoltura; Municipality of Caldogno; Concessioni Autostradali Venete - CAV S.p.A.; Aragon Agri-Food Research and Technology Center (CITA); ALBATROS S.r.l.; EcorNaturaSì SPA, SELC coop..

## THE AREAS

Italy (Veneto and Friuli-Venezia Giulia) and Spain (Aragon). Three settings: agricultural areas, urban areas, and road infrastructures.

## THE OBJECTIVES

LIFE PollinAction aims to mitigate the pollinator crisis through the creation or improvement of their habitats, primarily by increasing the richness of wild plant species. Specifically, LIFE PollinAction activities are dedicated to:

- creating approximately 28 hectares of new habitats rich in plant species, including 18 hectares of new meadows, 7 hectares of flowering strips, and 2 hectares of shrub patches;
- establishing 14 kilometers of new hedgerows;
- improving 230 hectares of meadows;
- assessing the ecosystem services provided by habitats and designing and implementing Payments for Ecosystem Services (PES) schemes to inform regional/national agricultural policy;
- designing milk, honey, and hay supply chains based on species-rich meadows to increase farmers' competitiveness.

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PREFACE

## WHY A GUIDE?

Agriculture represents the second most pervasive human activity on the planet, globally affecting over 1.5 billion hectares once occupied by natural ecosystems. The industrialization of agriculture and the introduction of intensive farming practices have resulted in increased yields. However, this has come at the expense of higher water consumption for irrigation, increased soil fertilization, and greater use of pesticides for pest and weed control. The impacts on water, soil, and air are significant, as is the loss of natural and semi-natural habitats and biodiversity. These factors negatively affects the functioning of agricultural systems and, consequently, production. The impact is particularly severe on services such as pollination or biological pest which are provided by animal organisms that find resources necessary for their life cycle completion within natural and semi-natural habitats. To address future climate, economic, and social challenges, it is urgent to identify and test new approaches that minimize environmental impacts while safeguarding production.

An effective solution involves the reintroduction of once-common habitats within farms and rural areas, such as meadows, flowering strips, or hedgerows. When properly managed, these habitats promote the presence of many different organisms that provide considerable benefits to the farm: pollinators, soil microorganisms that improve the absorption and utilisation of nutrients by plants, soil invertebrates that decompose organic matter and aerate soils, and insect species that contribute to crop pest control.

The indications provided in these Guidelines are a synthesis of the experiences gained during the LIFE PollinAction Project with the aim of providing technical and practical information for environmental restoration projects in agricultural areas. Specifically, the guide supports the European Union's pollinator initiative[1], adopted by the Commission in 2018, by outlining the steps needed to plan, create, and maintain natural and semi-natural habitats optimal for pollinators.

This guide, dedicated to the agricultural sector, forms part of a series that also includes a guide dedicated to the urban setting and another on road infrastructure.

[1] *https://environment.ec.europa.eu/topics/nature-and-biodiversity/pollinators_en*

## WHO IS THIS GUIDE FOR?

This guide is intended for farmers who wish to maintain or create pollinator habitats on their farm. Protecting pollinators on a farm may seem challenging due to a lack of suitable space or the use of pesticides that are harmful to insects. However, it can be much easier than you might think: all you need to do is maintain, and perhaps improve existing natural areas. And the benefits to the farm are manifold:

- natural and semi-natural habitats and the plants composing them support not only pollinators but also host a wide variety of organisms, including beneficial insects for pest control, soil microorganisms that improve the absorption and utilisation of nutrients by plants, and soil invertebrates that decompose organic matter and aerate soils;
- natural and semi-natural habitats help control erosion, contribute to mitigating nutrient loss from the soil, and improve water quality;
- increasing or improving habitats for pollinators on a farm can help enhance the activity and demonstrate to customers and the general public the value of environmentally conscious management;
- increasing or improving habitats for pollinators makes the farm more attractive and enhances the quality of life.

Whether the goal is to increase crop pollination or improve farm management, this guide provides practical indications for the creation and management of natural and semi-natural habitats.

## HOW TO USE THESE GUIDELINES

**Section 1** introduces the topic of pollinators on farms.
**Section 2** explains the key strategies to support pollinators on farms.
**Section 3** provides practical guidelines for creating or improving habitats for pollinators.

# SECTION 1

## WHO ARE THE POLLINATORS?

The honeybee is certainly the most famous. But there are at least 20,000 species of wild bees, in addition to bumblebees, butterflies, wasps, and even ants that play a fundamental role in safeguarding the environment, both natural and cultivated. The principal pollinators can be classified into four main groups.

## WHO ARE THE POLLINATORS

### HYMENOPTERA

*Bumblebees and bees, both social and solitary, wasps*

Bees are among the most efficient pollinating insects in handling flowers, and many plants, both wild and cultivated, have obligate relationships with them. Wasps also contribute to the pollination of many plant species and, like bees, require pollen and nectar for their survival. In some cases, ants can also make an important contribution to pollination.

*A specimen of Bombus pascuorum (Common Carder Bee)*

### LEPIDOPTERA

*Butterflies and moths*

They visit a wide variety of wild plants in search of nectar. They are less effective than bees in transporting pollen. Characterized by elongated and slender legs and a specialized tubular proboscis-shaped mouthpart, called spirotrumpet, they cannot intercept much pollen with their bodies, nor do they have special structures to collect it.

*A specimen of Macroglossum stellatarum (Hummingbird Hawkmoth) on Scabiosa sp.*

### DIPTERA

*Flies, including hoverflies*

They are an important yet often underestimated group of pollinators. Diptera are distinguished from other insects by their two membranous forewings and two reduced hindwings, which serve as balancing organs during flight. They are an ancient group and were probably among the first groups of pollinators. Diptera visit flowers to obtain nectar, which provides energy, and pollen, necessary for egg production.

*A specimen of Ectophasia crassipennis (Thick-legged Ectophasia) on Pimpinella saxifraga (Burnet-saxifrage)*

### COLEOPTERA

*Beetles and many others*

They are a very ancient and incredibly diverse group of pollinators. More than 300,000 species have been described worldwide, representing approximately 40% of known insects. Beetles have contributed to shaping the earliest pollination relationships between plants and insects.

*A specimen of Cetonia aurata (Rose chafer) on Prunus mahaleb (Mahaleb cherry)*

## WHY ARE POLLINATORS IMPORTANT?

Pollinators play a pivotal role in maintaining healthy ecosystems and ensuring food production by enabling flowering plants to reproduce. The work of pollinators is fundamental to the functioning of our agricultural system. It is estimated that approximately 90% of flowering plants and 75% of food crops worldwide depend entirely on pollinators. It is possible to consider the use of artificial pollination or the purchase of bees and bumblebees as potential solutions to the problem. But what about wild plants? Pollinators are crucial for the reproduction of wild plants as well. Without pollinators, plant populations would decline, even if other essential elements, such as soil, air, and nutrients, were available. Ensuring the survival and health of pollinator populations is thus essential for both natural ecosystems and agricultural sustainability.

## PLANTS AND POLLINATORS

Pollination by insects is one of the most striking examples of coevolution, whereby two different species, a plant and an insect, interact so closely that they mutually influence and evolve together. The relationships established between these two groups of organisms give rise to the high degree of complexity and diversity that is observed in nature.

Flowering plants have evolved a variety of structures and strategies suitable to attract specific pollinators. Flowers pollinated by insects typically exhibit bright colors and patterns, often invisible to the human eye, which guide insects towards pollen and nectar. In turn, insects have evolved body parts and behaviors conducive to pollinating specific plants. For instance, bees have developed a sucking mouthpart to absorb nectar and, in some species, small baskets on their hind legs to collect pollen.

About 90% of plants rely on other organisms such as insects, birds, or bats to transfer pollen from one plant to another.

Thanks to the pollination process, seed plants can produce seeds and fruits; similarly, plants provide insects with resources such as pollen and nectar, as well as reproductive and overwintering sites necessary for completing their life cycle.

## WHY ARE POLLINATORS DISAPPEARING?

The decline of pollinators is the result of a complex array of factors, including the spread of diseases and parasites, climate change, and the introduction of alien species. However, the most significant impact is associated with human land use practices. The expansion of urbanisation and intensive management of agricultural areas have led to the simplification of the landscape and the reduction, and in some instances, the complete loss, of natural and semi-natural habitats vital for pollinators.

*The implementation of intensive management strategies in agricultural landscapes results in the simplification of the landscape and the subsequent loss of natural and semi-natural habitats that are vital for pollinators*

# SECTION 2

## WHAT IS THE GOAL?

In agricultural settings, pollinators are adversely affected by a multitude of factors, including pesticide usage, the presence of parasites and diseases, the introduction of exotic species, and, most recently, climate change. However, the principal causes of their decline are the alteration and loss of natural and semi-natural habitats, including meadows, hedgerows, and woodlands. The expansion of intensive agriculture, which requires vast spaces, has resulted in the reduction of natural habitats, leading to the disappearance of plants that support pollinators by providing them with food (pollen and nectar) and shelter.

All interventions proposed in these Guidelines aim to **counteract biodiversity loss and enhance the ecological value of agricultural systems** by creating or improving habitats rich in entomophilous[2] flowering species, which are capable of providing nutritional resources (pollen and nectar) and ensuring reproductive sites for populations of pollinating insects. The presence of these elements on the farm will result in a significant increase in the richness and abundance of insects, including economically important species such as bees and bumblebees.

## NOT JUST POLLINATING INSECTS!

The creation of hedgerows, meadows, and wildflower strips at the edge of cultivated fields, greenhouses, or open-field horticultural or fruit crops, provides an effective refuge for various species of invertebrates and vertebrates, including beneficial insects that play a crucial role in biological pest control. These insects play a role in regulating pests of nearby crops, offering a viable alternative to the use of pesticides. Hedges, meadows, and wildflower strips also serve as buffer zones to separate fields from areas where chemical pest control methods are still used. It is important to acknowledge their role in reducing the risk of erosion and air pollution as well as their ability to enhance the aesthetic value of the agricultural landscape.

[2] *Entomophilous flowering plants rely on insects, especially bees, butterflies, moths, dipterans, and beetles, for pollination.*

## THE ECOSYSTEM SERVICES PROVIDED BY HABITATS IN AGRICULTURAL AREAS

**Biodiversity**
species, habitats

**Pollination**
habitats and resources for pollinating insects

**Buffer**
against soil erosion and pollution from pesticides and nutrient runoff

**Aesthetic value of the landscape**
well-being, recreation

**Biological control**
habitats, resources, and overwintering sites for natural enemies of pests

**Biomass production**
used as fodder fertilizer, and biogas

*The main ecosystem services provided by natural and semi-natural habitats in agricultural environments. The yellow boxes indicate services directly linked to production and overall functioning, while the green boxes indicate services related to society and the environment.*

## HOW MUCH SPACE DO I NEED?

There is no straightforward answer to this question, as the answer depends on the characteristics of the surrounding landscape. A general rule for agricultural areas is to create or preserve **at least five flower-rich patches of 0.5 hectares each (for a total of 2.5 hectares) for every 100 hectares of cultivated land**, combined with marginal habitats along the edges of cultivated land and **species-rich permanent meadows on another 2.5 hectares**.

All farms contain small marginal areas that are not utilized for production due to their lack of profitability. These areas may include small grassy patches, areas surrounding service buildings, small irregularly shaped areas where maneuvering machinery is difficult. But even the edges of drainage ditches, field edges, or property boundaries can be used for this purpose.

However, it is the type and the quality of the habitats created or improved that is crucial in conferring effectiveness to the areas designated for pollinators. Despite the vast diversity of pollinator species, they all require the presence of three types of habitats to survive and complete their life cycle:

- **foraging habitat:** areas characterised by the presence of floral resources (pollen and nectar), within a reasonable flying distance, spanning from spring to late autumn. The greatest number of pollinators and, consequently, the greatest demand for resources occurs in early summer, but the availability of floral resources must also be ensured in spring, when overwintering pollinators emerge from hibernation and need to feed, and in late summer, when pollinators need to feed in preparation for hibernation;
- **breeding habitat:** breeding habitats are species-specific. For example, some species of bees (both solitary and social) nest in bare ground, either by digging or utilising abandoned nests and burrows. Other bee species use leaves, while others utilise cavities in plant stems or walls. Butterflies require specific native plants, both herbaceous and shrubby species, which serve as food sources for their caterpillars;
- **overwintering habitat:** areas with vegetation that remain undisturbed from late summer until late spring, such as permanent grasslands, field edges or ditches, shrub patches, hedgerows, groves, isolated trees, but also woodpiles and litter.

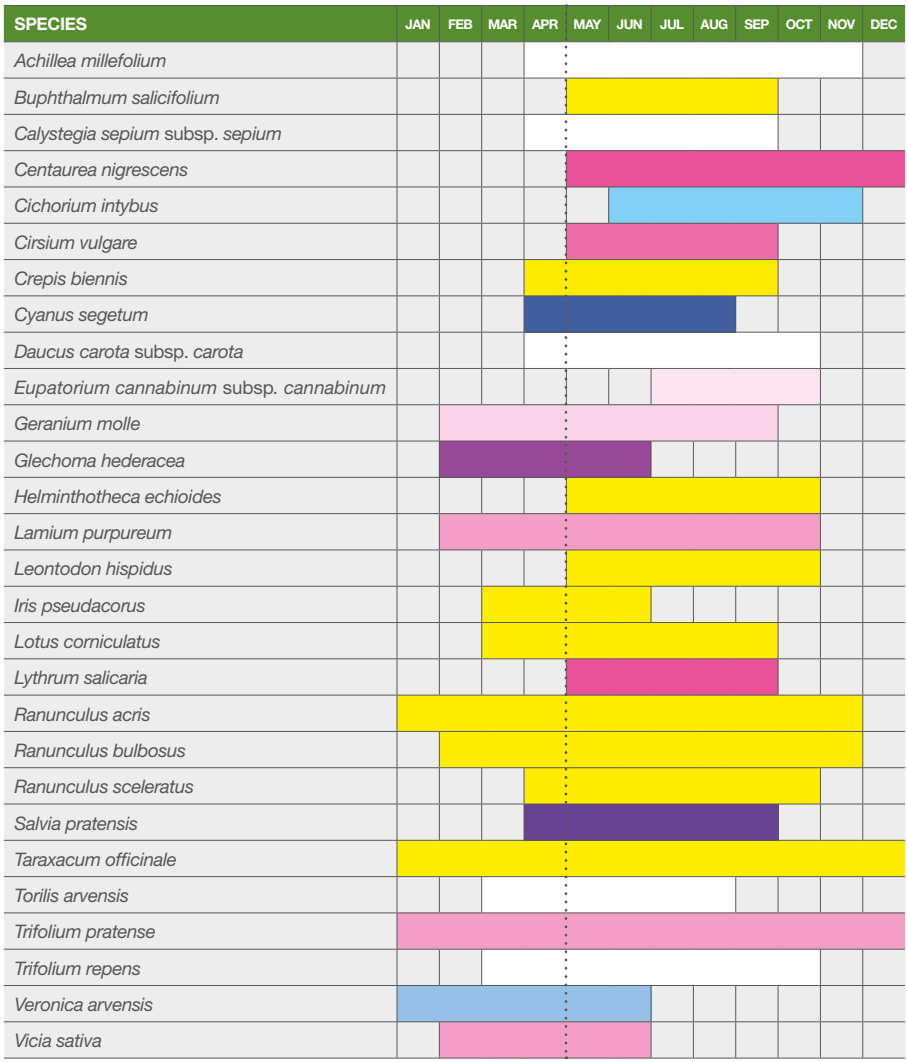
*Pontia edusa on Sanguisorba*

## WILD POLLINATORS: FOOD REQUIREMENTS AND HABITAT

| POLLINATORS | DIETARY REQUIREMENTS | BREEDING HABITAT | OVERWINTERING HABITAT |
|---|---|---|---|
| **Solitary bees (*Hymenoptera*)** | Pollen and nectar | The majority nest in bare or partially vegetated and well-drained soils. Others nest in narrow tunnels in the trunks of dead trees. Some build their nest by folding leaves over themselves. | Stems of dead plants, bark, reeds, foliage, and especially undisturbed soil are the winter homes of solitary bees. |
| **Bumblebees (*Hymenoptera*)** | Pollen and nectar | The majority nest in small cavities, often underground, in abandoned rodent nests, or in tree hollows, at the base of tufts of grass, or in wall crevices. | The queens overwinter underground in shaded areas, usually near trees, on embankments, and on north-facing slopes, to avoid emerging too early on a warm or sunny day in winter. |
| **Wasps (*Hymenoptera*)** | Pollen and nectar | Most wasp nests are made of paper. Wasps build their nests with saliva and chewed wood pulp. The appearance of the nests varies depending on the species that built them. They are usually built in sheltered areas with easy access to the outside, such as hollow trees, tall grass, or buildings. Other species build their nests out of mud in sheltered locations. | Some adult wasps overwinter in protected and undisturbed locations, such as under tree bark or in building cavities. |
| **Butterflies (*Lepidoptera*)** | Nectar | Butterflies construct their nests in proximity to plants that are utilized by caterpillars as a source of nourishment. | Most butterflies survive the winter as a chrysalis or larva (caterpillar) in vegetation or litter; others overwinter as adults in sheltered cavities or tree trunks; still others migrate over long distances. |
| **Hoverflies (*Diptera*)** | Pollen and nectar | Females lay eggs in suitable places where the larvae can find food. Species that feed on aphids lay eggs near aphid colonies, species with larvae that feed on plants lay eggs on host plants, while other species lay eggs in stagnant water. | Hoverflies have two strategies to survive the winter. They either burrow into the ground as larvae or go into hibernation as adults in sheltered places within the trunks of old trees or in building crevices. |
| **Beetles (*Coleoptera*)** | Pollen | Some species lay eggs among decomposing leaves, others in decaying wood, or in animal feces. | Adults survive the winter in tree cavities, among decomposing leaves, under logs, and in the soil. |

## BOX: FLOWERS FOR FREE

One of the most effective strategies for conserving pollinators is to preserve and enhance existing habitats. Some species that are vital for pollination are particularly prevalent in agricultural landscapes, field margins, and roadside habitats.




*LEGEND: The colored squares depict the flower color and the flowering period.*
*The plants to the left of the dotted vertical line provide important floral resources for insects early in the season*

## WHAT SHOULD I PAY ATTENTION TO?

### MATERIAL SELECTION

The selection of material, the plants, to be used is of paramount importance to ensure the success of the intervention, reduce the cost of cultivation treatments, and at the same time maintain the integrity and stability of natural ecosystems. It is imperative that the plants be of '**local provenance**', whereby the seed used for plant production must have been collected in the same 'region of provenance' (ROP) as that of the plants' destination.

In the event of unavailability, it may be accepted that the material has been sourced from other neighboring ROPs, and in any case from populations as close as possible in geographical proximity to the intervention site.

In cases where operations entail the utilisation of **seedlings in soil block**, at the time of delivery, these must be provided with the soil bed firmly attached to the roots and devoid of weeds. Additionally, they must be free of discernible pathologies and exhibit sufficient development of the aerial part to facilitate

### BOX: DEFINITION OF REGION OF PROVENANCE

For plant species, the region of provenance refers to the 'territory or set of territories subject to sufficiently uniform ecological conditions and on which there are top soils or sources of seeds sufficiently homogeneous from a phenotypic and, if evaluated, genotypic point of view, taking into account altitudinal limits where appropriate' (Directive 1999/105/EC on the marketing of forest reproductive material). Regions of provenance for forest species are defined nationally by Ministerial Decree No. 9403879 of 30/12/2020 'Establishment of the National Register of Basic Materials' and subsequent amendments and integrations, and possibly detailed by regional regulations. The recent Ministerial Decree No. 269708 of 11/06/2021 'Division of the Italian territory into Regions of Provenance' includes a cartographic representation of the aforementioned regions of provenance. This tool, available online[3], can also be adopted as a precautionary measure for herbaceous species, marketed in various forms (seedlings, seeds, brush-harvested seed, bulbs, etc.) and for which no analogous legislation exists. An additional classification[4] is also available online, comparable to previous one (although based on different criteria) and equally suitable when adopting a precautionary approach in the handling of plants and seeds. The guarantee of the origin of plant material is usually ensured by public nursery facilities that, for institutional purposes, produce only locally sourced plants. In any case, the costumer is required to verify the information regarding the origin of the plants, requesting documentation from the supplying nursery (which may or may not coincide with the producing nursery), as suggested below:

- if the plant nursery producing the plants is certified according to UNI EN ISO 22005 (traceability), it is sufficient for the nursery to declare, before delivery, the denomination (location and municipality) of the stand from which the batches supplied were collected;
- if the producing nursery is not certified according to traceability, the costumer is expected to request the following information: the source population (location, municipality) of the seed used, the year of collection of the same, the quantity used for the production of that batch of plants, and the corresponding number of plants obtained.

[3] *https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/17155*

[4] *Classification and mapping of the ecoregions of Italy. https://www.tandfonline.com/doi/full/10.1080/11263504.2014.985756*

effective handling by operators. Woody plants, trees and shrubs, must be well lignified, preferably of age less than/equal to 2 years (maximum 3 years), with a maximum height of 80-90 cm and a minimum of 20 cm. In cases where has become excessively twisted and compact due to prolonged nursery cultivation, it may be beneficial to sever the root ball at the end prior to planting. This can assist in the disentanglement of the roots and facilitate the establishment of a robust root system, thereby enhancing the speed of the seedling's establishment.

*If the top of the root system appears twisted, before planting, it may be useful to sever the end of the soil block to facilitate the disarticulation of the roots and accelerate the establishment of the young seedlings*

## BOX: WHY NATIVE PLANTS

Native plants, also referred to as indigenous plants, are species that have originated and evolved within the geographical area in which they are found; therefore, they have a long history of natural presence within the natural ecosystems of a given region. Non-native plants, also known as allochthonous, alien, or exotic species (*see BOX Exotic species on page 22*), are naturally widespread in other parts of the world, or even in other areas of our country (e.g., typical of Mediterranean climate areas), but they can thrive in other areas as ornamental or garden plants. Being adapted to the local climate and conditions, native plants better ensure the success of the intervention and its long-term duration. It is of the utmost importance to note that, although pollinators may find some nutritional value from exotic plants, native plants, due to their long history of coevolution, attract and support a greater diversity of native pollinators and are crucial for the survival of numerous species.

**LIFE PollinAction's Public Reference Nurseries**

The plants used for the creation and/or improvement of habitats in the LIFE PollinAction Project were produced and supplied by public nurseries, project partners.

- Centro Biodiversità Vegetale e fuori Foresta of Veneto Agricoltura in Montecchio Precalcino (VI): Via Bonin Longare, 6, 36030 - tel. 0445 864445;
- Regional nursery centers of Friuli-Venezia Giulia:
  - > Azienda Volpares in Palazzolo dello Stella (UD): Casali Volpares, near Palazzolo dello Stella (UD);
  - > Vivaio forestale Pascul di Tarcento (UD): Via Pradandons, 15 - tel. 0432 785029

*Cultivation of seedlings in soil blocks at Volpares Nursery (Palazzolo dello Stella)*

*Seeds of native species of hay meadows stored at Veneto Agricoltura Nurseries (Montecchio Precalcino)*

*Plots for intensive production of local seed for hay meadows at Veneto Agricoltura Nurseries (Crespano del Grappa)*

## BOX: EXOTIC SPECIES

Many of the plant species used in agriculture, horticulture, and forestry contexts are not native to our country. Rather, they have been introduced from other regions of the globe. Such species are designated as exotic or alien species. Most of these introductions have resulted in benefits, especially considering the agri-food sector, which largely depends on the cultivation of exotic species. However, some of these introduced species have naturalised in the regions of introduction and have spread uncontrollably, invading both natural ecosystems and agricultural and urban environments, causing various negative impacts. A typical example of an invasive species in agricultural environments is Johnson grass (*Sorghum halepense*). These particular exotic species are defined as invasive alien species because they have the ability to alter, and in some cases, irreversibly disrupt, the structure and functioning of ecosystems, with negative ecological and economic consequences. In some instances, these species have also been shown to have detrimental effects on human health.

Invasive species share some characteristics: the alarm bells!
- ability to colonize disturbed environments and bare ground
- very rapid growth
- short life cycle with early flowering and dissemination, often different from that of species
- production of large quantities of seeds and/or fruits
- effective propagation through vegetative means

Precisely the characteristics that make these species favored for ornamental greenery. Invasive exotic species represent a serious threat to biodiversity, and it is therefore essential to adopt responsible practices, first and foremost, by avoiding the use of invasive plant species.

The phenomenon of invasions is constantly increasing, with a considerable number of new species being introduced on a voluntary or accidental basis each year. For this reason, the European Commission has adopted a list of invasive alien species of EU relevance, which is updated on a periodic basis in accordance with EU Regulation 1143/2014[5]. The list identifies those invasive species whose negative effects are so significant that they require coordinated and uniform action at the EU level.

To learn more:
www.minambiente.it/pagina/specie-esotiche-invasive
www.specieinvasive.it
www.lifeasap.eu

[5] *https://eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:32014R1143&rid=1*

## SPECIES TO AVOID

| TREES |
|---|
| Box elder Maple (*Acer negundo*) |
| Tree of Heaven (*Ailanthus altissima*) |
| Cigartree (*Catalpa bignonioides*) |
| Chinese windmill palm (*Trachycarpus fortunei*) |
| Black Locust (*Robinia pseudoacacia*) |

| SHRUBS |
|---|
| Butterfly Bush (*Buddleja davidii*) |
| False Indigo bush (*Amorpha fruticosa*) |
| Cherry Laurel (*Prunus laurocerasus*) |
| Oval-leaved Privet (*Ligustrum ovalifolium*) |
| Chinese Privet (*Ligustrum sinense*) |
| Glossy Privet (*Ligustrum lucidum*) |
| Oregon Grape (*Mahonia aquifolium*) |
| Japanese Rose (*Rosa rugosa*) |
| Japanese Spirea (*Spiraea japonica*) |

| HERBACEOUS PLANTS |
|---|
| Panicled Aster (*Symphyotrichum lanceolatum*) |
| Balsam (*Impatiens* spp., various species) |
| Japanese Honeysuckle (*Lonicera japonica*) |
| Evening Primrose (*Oenothera* spp., various species) |
| Phacelia (*Phacelia tanacetifolia*) |
| Tawny Daylily (*Hemerocallis fulva*) |
| Buckwheat (*Fagopyrum esculentum*) |
| Canada Goldenrod (*Solidago canadensis*) |
| Giant Goldenrod (*Solidago gigantea*) |
| Japanese Knotweed (*Fallopia japonica*) |
| Kudzu (*Pueraria lobata*) |
| American Pokeweed (*Phytolacca americana*) |

## METHOD SELECTION

As described in Section 3, there are several techniques that can be employed for the creation or enhancement of habitats. The selection of the optimal method depends on various factors, such as the area to be treated, the practitioner's experience and technical preparation, or the availability of specific equipment. However, methods are not mutually exclusive, and often, the best result is achieved by integrating various techniques. These techniques include seed sowing, distribution of hay and/or brush-harvested seed, planting seedlings in soil blocks. In the latter case, one aspect to pay attention to is the **availability of materials**. Some species are not part of the ordinary production of nurseries, so it is necessary to organize the intervention well in advance.

## SITE CONDITIONS

The growth of plants is subject to several environmental factors, which exert a significant influence on their development. Each plant species has a defined tolerance range in relation to the various ecological factors such as light, temperature, humidity, and soil characteristics, within which it is able to perform its functions and complete its life cycle. To ensure the success of interventions, it is important to pay particular attention to the plant mix, which must be designed so as to use species appropriate to the intervention site.

## HOW MANY DIFFERENT SPECIES?

More is better! The richer and more diversified a habitat is, the more capable it is of withstanding a wide variety of environmental conditions. More importantly, the more diverse a habitat is in terms of plant species, the greater the number of pollinators it will attract. A diversified habitat ensures the presence of species with different floral traits, capable of satisfying pollinator insects with diverse feeding requirements and capabilities to manipulate flowers. Differences in floral traits such as flower shape, accessibility of resources, color, etc., make different plant species suitable for different pollinator insects. For example, open flowers, with exposed pollen and nectar, such as those of the buttercap (*Ranunculus* spp.), are easily accessible to numerous different groups of pollinators, while flowers with more complex corollas, such as those of the common sage (*Salvia pratensis*), with pollen and nectar difficult to access, can be pollinated only by a narrower group of insects. A high richness of species allows for staggered flowering, i.e., different flowering periods that ensure the supply of resources throughout the season. Finally, increasing the number of different species ensures the presence of plants with different vegetative characteristics (leaves and stems), able to provide resources, and breeding and overwintering habitats for different species of insects, including beneficial insects.

## MAIN FLOWER TRAITS OF THE SPECIES VISITED BY DIFFERENT GROUPS OF POLLINATORS

| POLLINATORS | COROLLA SHAPE | COLOR | FRAGRANCE | MAIN FLORAL RESOURCE | EASE OF ACCESS TO FLORAL RESOURCES | EXAMPLES | |
|---|---|---|---|---|---|---|---|
| **HYMENOPTERA** | Bilabiate | Blue and yellow | Sweet | Nectar | Limited | *Ajuga reptans, Salvia pratensis* |  1 |
| **LEPIDOPTERA** | Tubular | Red and purple | Sweet | Nectar | Limited | *Scabiosa triandra, Succisa pratensis* |  2 |
| **DIPTERA** | Disc | Yellow and white | Soft | Pollen | Good | *Achillea millefolium, Pastinaca sativa* |  3 |
| **COLEOPTERA** | Disc | White and cream | Unpleasant | Pollen | High | *Crataegus monogyna, Viburnum lantana* |  4 |

*1. Flowers with bilabiate morphology of Lamium orvala (Balm-leaved Red Deadnettle) - 2. Flowers with tubular morphology of Lythrum salicaria (Purple loosestrife) with pollinator (Pieris rapae - Small white butterfly) - 3. Head of Knautia arvensis (Common ambretta) with pollinator (Eristalis tenax - Drone fly) - 4. Inflorescence of disk flowers of Filipendula ulmaria (Common Meadowsweet)*

## BOX: EVEN THE EYE WANTS ITS PART!

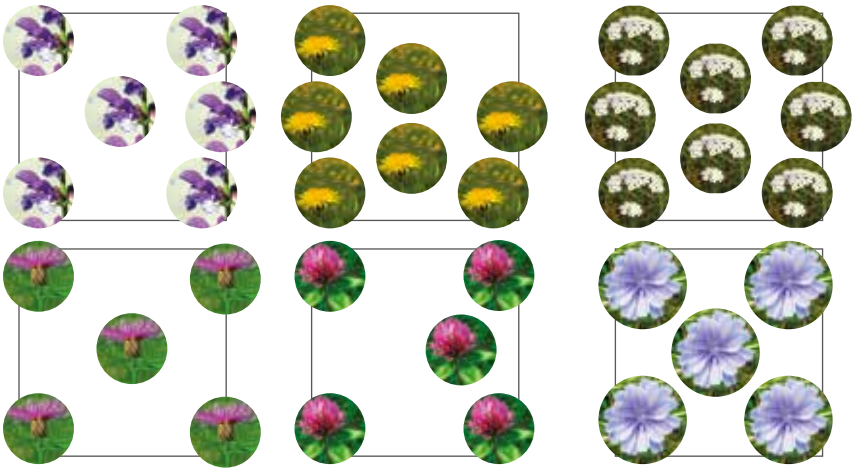
Pollinators do not just use size as a guide. They also use scents and colors. If interventions involve the use of seedlings in soil blocks, planting should be done in **small mono-specific groups**, meaning small groups of plants of the same species. This method ensures that the plants are more visible and therefore more attractive to insects during the flowering period. Furthermore, since pollinators tend to visit nearby flowers, mono-specific groups facilitate the transfer of pollen between individuals of the same species. A useful tip is to alternate mono-specific groups of species with different floral structures.

*Explanatory scheme of small mono-specific groups for the construction of wildflower strips*

The planting schemes can vary depending on the needs.
In **wildflower strips**, mono-specific groups can consist of a variable number of plants, ranging from 4 to 10. It is recommended that plants be spaced approximately 30-40 cm apart, but the distance should be evaluated taking into account the final size of the plants and their propensity for vegetative propagation. For example, for hygrophilous species like Water flag (*Iris pseudacorus*), which spread rapidly thanks to underground rhizomes, lower densities should be considered, such as 3 plants/m linear of the bank.
In the case of **meadows**, it is recommended to identify areas (plots) of about 2 square meters within which to carry out close planting of seedlings. The number of individuals per plot varies from 24 to 40, depending on the requirements and the size of the species at maturity. The density of planting plots should be at least 200 per hectare, also variable depending on the requirements.

*Geometric layout for the construction of a flower strip*

The plots can be arranged randomly within the site or following a straight line (transect), spaced about 3 meters apart. In cases where interventions involve rare or threatened species, lower densities than those indicated can be used, yet still ensuring the creation of small populations capable of flowering, ripening, and setting seeds.



*Explanatory scheme for the planting of species in plots to enrich species-poor meadows*

*Explanatory scheme for planting species in plots to enrich species-poor meadows*

*Detail of the plots. The actual number of individuals should be assessed taking into account the final size of the plants and their propensity for vegetative propagation*

## DESIGNING HABITATS TO COVER THE ENTIRE FLOWERING PERIOD

Ideally, a habitat should include a mix of species so as to ensure the provision of resources throughout the entire growing season, from April/May to September/October. Nevertheless, this is not always straightforward to accomplish.

The best strategy is to combine different habitats. For instance, many shrub species common in our countryside exhibit very early flowering, thereby providing resources when herbaceous plants are not yet in bloom. The combination of different habitats also enables the completion of the life cycle of different species; for example, many butterflies utilise meadows as a foraging habitat but require shrubs to lay eggs and for nutrition during larval development. A typical combination can therefore be a hedge or a patch of shrubs, which provide resources in early spring and nesting and overwintering sites, and meadows and wildflower strips, which provide resources at the peak of the season. The combination of different habitats also promotes landscape complexity and, consequently, that of plants and insects.

## MANAGEMENT

Proper habitat management is essential for their long-term maintenance. All habitats require some form of regular maintenance, both to ensure their initial establishment and to maintain them over time.

For **woody habitats** such as hedges and shrub patches, maintenance is required particularly during the **initial stages** and the first year, to control invasive herbaceous species, which can otherwise have a detrimental impact on the growth and survival of young woody seedlings.

Conversely, for **herbaceous habitats**, it is essential to implement, **regular annual maintenance** through mowing is necessary. In our climates, the absence of periodic mowing triggers spontaneous dynamics processes within the habitat. Initially the accumulation of dead plant matter results in a decrease, in the number of species, particularly entomophilous ones. Subsequently, the areas are colonized by brambles and shrubs and then by tree species. Mowing practice keeps weeds under control, ensures the maintenance of plant species diversity, and prevents the invasion of woody plants.

The frequency of mowing is also important: mowing more than 2(3) times a year results in a change in species composition, with an increase in some herbaceous species, usually, grasses, and a concomitant decline in species richness, particularly entomophilous ones.

The timing of mowing is also crucial in maintaining a good species composition. It is recommended that mowing be scheduled after entomophilous species have reached flowering and have disseminated, as this ensures their long-term presence.

## BOX: BEST PRACTICES FOR MOWING HABITATS FOR POLLINATORS

**When possible, mow no more than 50% of the habitat at once, or maintain uncut strips**
This approach allows for recolonisation of the mowed site by both plants and insects

**Schedule mowing over time**
Mowing should be scheduled after the entomophilous species have reached flowering and disseminated

**Mow no more than 2(3) times a year**
During the first year of establishment, more frequent mowing may be necessary for weed control; in this case, it should be completed before weeds go to seed

**Use a minimum cutting height of 20-25 cm**
Mowing at this height is an effective method for controlling invasive plants while simultaneously minimising the impact on native flora and fauna, including insects

# SECTION 3

# IMPLEMENTATION AND MANAGEMENT OF SPECIES-RICH HAY MEADOWS

The aim of this sheet is to illustrate the methods for the creation and management of perennial species-rich or polyphyte meadows (i.e., composed of many species). The target meadows of this sheet are not transient grasslands nor intensive permanent meadows, composed of few competitive species and aimed at producing high quantities of fodder for zootechnical purposes in the face of heavy nitrogen fertilization. Rather, the objective is to establish grassland ecosystems rich in species, particularly entomophilous species, capable of supporting high levels of biodiversity, with specific reference to pollinating insects. In lowland areas, three main types of meadows are distinguished based on soil conditions that influence their species composition: mesophilous or meso-hygrophilous grasslands, xeric or meso-xeric grasslands, and wet meadows. Despite the ecological differences, the techniques for establishing them are similar. The species, however, are obviously distinct.

The issues that arise in the establishment of species-rich meadows can be broadly classified into two categories:

- **the availability of seed** of the suitable species and of adequate geographic (and therefore genetic) origin. The most commonly available seeds on the market belong to varieties selected by humans, but even when it comes to native species, they are often produced in other areas of Europe (or sometimes the world). Instead, when reconstructing an ecosystem, it is important not only to use the right species but also to ensure the origin of the seed, which should preferably be locally sourced (*see BOX Definition of region of provenance on page 19*);
- **excessive soil fertility**, resulting from repeated fertilizations over the years, and **the high seed load of weed species** typical of many lowland agricultural soils. The first factor hinder the establishment of a species-rich meadow, as unnatural fertility favors the growth of few species, generally those less suitable for creating a diversified and flowering herbaceous cover. The second factor determines the proliferation, especially in summer, of unwanted species such as, for example, Johnson grass (*Sorghum halepense*), which, when very abundant, can compromise the structure and composition of the meadow.

## BOX: PERMANENT MEADOWS: WHAT ARE THEY

Species-rich permanent meadows are semi-natural herbaceous communities that are maintained solely through periodic mowing and occasional light fertilisation. They host a high number of spontaneous plant species, some of great interest, and represent the ideal habitat for many animal species. Once widespread elements of the landscape not only in hilly and mountainous areas but also in the plains, their presence has gradually decreased with the mechanisation of agriculture. In plain areas, albeit with geographical differences, permanent meadows can be classified into three main types, depending on soil conditions: mesophilous or meso-hygrophilous grasslands, xeric or meso-xeric grasslands, and wet meadows. According to EU legislation (Habitats Directive 92/4366)[6], these three types of meadows correspond to three types of habitats, identified by different codes.

**Mesophilous or meso-hygrophilous grasslands** refer to habitat 6510 'Lowland hay meadows'. These are mesophilous to sub-humid meadows, depending on micro-stationary conditions and the presence and the presence of backwater, dominated by tall oatgrass (*Arrhenatherum elatius*), floristically rich, and distributed from the plains to the mountain range (800-1000 m asl). This type of meadow, now rare and almost disappeared in the plains, is linked to a traditional type of farming that involves 2(3) cuts for haymaking per year and fertilization with well-rotted manure only. Mesophilous meadows also include pasture-meadows, which have a similar species composition but are used for grazing after the first cut. The abandonment or slowdown of traditional farming practices leads to the accumulation of dead plant biomass (litter) and the loss of species richness, followed often quite rapidly by phases of bush encroachment.

**Xeric or meso-xeric grasslands**, dominated by brome grass (*Bromus erectus* and *Bromus condensatus*), are typical of shallow soils on alluvial or fluvioglacial deposits but also develop on deeper soils. In Northern Italy, these grasslands refer to two types of habitats: 62A0 'Eastern sub-mediterranean dry grasslands (*Scorzoneretalia villosae*)', mainly present in the eastern plains, where they are enriched by the presence of various Illyrian and Eastern plant species, and 6210(*) 'Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)', mostly found towards the west. The maintenance of good habitat quality is ensured by extensive sheep grazing or regular mowing, once or twice a year, in more mature communities. Contrary to the meadows of habitat 6510, which tolerate light fertilization, these grasslands, when even lightly fertilized, undergo significant transformations, with a loss of species richness. In case of abandonment of traditional management practices, they undergo bush encroachment.

**Wet meadows** develop on soils characterized by a medium to high level of water availability and sometimes even a period of flooding. These meadows refer to habitat 6410 'Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)'. Dominated by purple moor grass (*Molinia caerulea*), these meadows are used for mowing or sometimes grazing. Given their low fodder value, in the past these meadows were mowed to obtain straw or bedding for livestock rather than for fodder.

They are usually not fertilized, and their low productivity level allows mowing only once or, at most, twice a year. Even in this case, changes in farming practices (e.g., fertilization) or their abandonment gradually led to an increase in abundance of few competitive species (typically grasses) and, subsequently, to the colonization of woody species. A traditional practice widely used to prevent bush encroachment and as rudimentary soil fertilization is burning or swaling, which involves burning crop residues or vegetation. In some regions, the practice of burning is prescribed for the extraordinary management of both wet meadows and peatlands.

[6] *https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:IT:PDF*

*Example of mesophilous hay meadow rich in species (high plain of Vicenza) referring to habitat 6510*

*Example of wet meadow rich in species (Friulan plain) referring to habitat 6410*

*Example of dry meadow rich in species (high Friulian plain) referring to habitat 62A0*

## THE IMPLEMENTATION OF THE MEADOW: HOW TO DO IT

### 1. Soil preparation

To convert an area previously used as arable land into a meadow, or a formerly cultivated land that is currently uncultivated, it is recommended to proceed as follows:

A. preliminary survey of the summer flora present in the plot: if common invasive plants are present (e.g., *Abutilon theophrasti, Amaranthus* sp., *Artemisia verlotiorum, Sorghum halepense,* etc.), proceed during the summer season with repeated mowing to prevent their spread (this situation is almost certain if the land was previously cultivated with corn or soybeans);
B. in September, soil cultivation (harrowing);
C. wait for the subsequent germination of unwanted weeds, which usually follows after rainfall ('false sowing');
D. mechanical removal of unwanted weeds (with further harrowing or chemical weeding).

#### BOX: WEEDING

If the preliminary survey of the summer flora present in the plot reveals high coverage of common invasive plants, it is possible to proceed with mechanical weeding, which allows the removal of the rhizomes and taproots of the most tenacious and aggressive species (e.g., Johnson grass and alfalfa).

**HOW TO PERFORM WEEDING**

Mechanical weeding should be carried out in the months of July and August, before preparing the seedbed in September, during periods characterized by maximum heat and drought - at least ten days of high temperatures and absence of rain.

To correctly carry out the operations, they must be scheduled in advance by monitoring the weather to perform weeding at the beginning of a very hot phase. Mechanical weeding will not be successful if performed at lower temperatures or during periods of abundant precipitation.

Mechanical weeding should be done by deep soil cultivation with a tool equipped with 'flaps' (or 'exploders') capable of bringing roots to the surface and exposing them to the effects of heat and drought, causing them to dry out completely.

For greater assurance of success, mechanical weeding should be performed twice in succession during hot and dry periods: preferably once in July and again by mid to late August.

Even if chemical weeding is carried out, it is advisable to apply the treatment under conditions of high temperatures and drought to ensure maximum effectiveness.

### 2. Creation of the meadow

Below are described three methods for the creation of species-rich meadows. Information on the species and seeding density is provided in the following paragraphs and in the following table.

## SPECIES FOR MEADOWS

| SPECIES - SCIENTIFIC NAME (CONTI ET AL. 2005; 2007) | FLOWERING PERIOD | TYPE | ENVIRONMENT | AVAILABILITY |
|---|---|---|---|---|
| *Achillea millefolium* | May-Oct | E | Ge | CP |
| *Ajuga reptans* | Dec-Jun | E | Ge | CP |
| *Allium carinatum* | May-Sep | E | X | N |
| *Allium lusitanicum* | Jun-Aug | E | X | N |
| *Alopecurus pratensis* subsp. *pratensis* | Mar-Jun | A | Ge | C |
| *Anthericum ramosum* | Apr-Jul | E | X | N |
| *Anthoxanthum odoratum* | Mar-Aug | A | Ge | CP |
| *Anthyllis vulneraria* | Mar-Aug | E | X | P |
| *Armeria helodes* | Apr-May | E | I | N |
| *Arrhenatherum elatius* | Apr-Jul | A | Ge | CP |
| *Bothriochloa ischaemum* | May-Nov | A | X | N |
| *Briza media* | Apr-Aug | A | Ge | CP |
| *Bromus erectus* | Apr-Jul | A | X | CP |
| *Bromus hordeaceus* | Apr-Jul | A | Ge | N |
| *Buphthalmum salicifolium* | May-Sep | E | X | P |
| *Campanula rapunculus* | Apr-Sep | E | X | CP |
| *Campanula sibirica* | Apr-Jun | E | X | N |
| *Centaurea dichroantha* | Jun-Sep | E | X | N |
| *Centaurea jacea* subsp. *forojulensis* | Jul-Oct | E | I | N |
| *Centaurea jacea* subsp. *gaudinii* | Jun-Oct | E | X | N |
| *Centaurea nigrescens* | May-Dec | E | Ge | CP |
| *Centaurea scabiosa* subsp. *scabiosa* | May-Aug | E | X | N |
| *Chrysopogon gryllus* | May-Jul | A | X | N |
| *Cirsium canum* | May-Sep | E | I | N |
| *Cirsium oleraceum* | May-Sep | E | I | P |
| *Cirsium palustre* | May-Sep | E | I | N |
| *Crepis biennis* | Apr-Sep | E | Ge | N |
| *Dactylis glomerata* | Feb-Jul | A | Ge | C |
| *Dianthus carthusianorum* | Apr-Aug | E | X | P |
| *Dorycnium herbaceum* | Apr-Jul | E | X | P |
| *Erucastrum palustre* | Mar-Jun | E | I | N |
| *Festuca pratensis* | Apr-Aug | A | Ge | C |

| SPECIES - SCIENTIFIC NAME (CONTI ET AL. 2005; 2007) | FLOWERING PERIOD | TYPE | ENVIRONMENT | AVAILABILITY |
|---|---|---|---|---|
| *Festuca rubra* | Apr-Oct | A | Ge | C |
| *Filipendula vulgaris* | Apr-Jul | E | X | P |
| *Galium mollugo* | May-Aug | E | Ge | N |
| *Galium verum* | May-Nov | E | Ge | CP |
| *Genista tinctoria* | Apr-Jul | E | X | P |
| *Gentiana pneumonanthe* subsp. *pneumonanthe* | Jun-Oct | E | I | N |
| *Gladiolus palustris* | Apr-Jun | E | I | N |
| *Helianthemum nummularium* subsp. *obscurum* | May-Aug | E | X | N |
| *Holcus lanatus* | Apr-Jul | A | Ge | N |
| *Homalotrichon pubescens* | May-Aug | A | X | N |
| *Iris sibirica* | Apr-Jun | E | I | N |
| *Knautia arvensis* | Apr-Sep | E | Ge | CP |
| *Lathyrus pratensis* | Apr-Aug | E | Ge | CP |
| *Leontodon hispidus* | May-Oct | E | Ge | CP |
| *Leucanthemum vulgare* subsp. *vulgare* | Feb-Oct | E | Ge | CP |
| *Leucojum aestivum* | Feb-May | E | I | N |
| *Linum flavum* | May-Jul | E | X | N |
| *Lolium multiflorum* | Apr-Jul | A | Ge | C |
| *Lolium perenne* | Feb-Oct | A | Ge | C |
| *Lotus corniculatus* | Mar-Sep | E | Ge | C |
| *Malva alcea* | May-Sep | E | Ge | CP |
| *Medicago lupulina* | Mar-Jul | E | Ge | C |
| *Molinia caerulea* | Jun-Sep | A | I | N |
| *Ononis spinosa* | Apr-Nov | E | X | N |
| *Parnassia palustris* subsp. *palustris* | May-Aug | E | I | N |
| *Peucedanum oreoselinum* | May-Aug | E | X | N |
| *Phleum pratense* | Mar-Oct | A | Ge | C |
| *Pimpinella major* | May-Aug | E | Ge | N |
| *Plantago altissima* | Apr-Oct | E | I | N |
| *Poa pratensis* | Apr-Sep | A | Ge | C |
| *Poa trivialis* | Apr-Sep | A | Ge | N |
| *Primula farinosa* | Apr-Jul | E | I | N |

| SPECIES - SCIENTIFIC NAME (CONTI ET AL. 2005; 2007) | FLOWERING PERIOD | TYPE | ENVIRONMENT | AVAILABILITY |
|---|---|---|---|---|
| *Prunella grandiflora* | May-Aug | E | X | N |
| *Ranunculus acris* | Jan-Nov | E | Ge | N |
| *Rhinanthus freynii* | May-Jul | E | X | N |
| *Salvia pratensis* | Apr-Aug | E | X | CP |
| *Scabiosa columbaria* | Apr-Oct | E | X | P |
| *Scabiosa triandra* | May-Sep | E | X | CP |
| *Scorzonera villosa* | Mar-Jun | E | X | N |
| *Senecio paludosus* subsp. *angustifolius* | May-Sep | E | I | N |
| *Serratula tinctoria* | Jul-Oct | E | I | P |
| *Silene flos-cuculi* | Apr-Aug | E | I | CP |
| *Stachys officinalis* | May-Oct | E | X | P |
| *Taraxacum officinale* (aggregate) | Jan-Dec | E | Ge | CP |
| *Taraxacum palustre* (aggregate) | Mar-Apr | E | I | N |
| *Tetragonolobus maritimus* | Apr-Jul | E | I | N |
| *Tofieldia calyculata* | May-Aug | E | I | N |
| *Tragopogon pratensis* subsp. *orientalis* | May-Aug | E | Ge | CP |
| *Trifolium campestre* | Mar-Aug | E | Ge | C |
| *Trifolium dubium* | Apr-Sep | E | Ge | N |
| *Trifolium pratense* | Jan-Dec | E | Ge | CP |
| *Trisetaria flavescens* | May-Aug | A | Ge | CP |
| *Vicia cracca* | Apr-Aug | E | Ge | N |

***E**: Insect-pollinated plant; **A**: Wind-pollinated plant (mainly grasses); **Ge** = Generalist; **I** = Hygrophilous; **X** = Tolerates aridity (dry soils, dry meadows); **C** = Commonly commercialized / easily available / widely used in artificial reseeding; **P** = Available, local provenance recommended; **N** = Rarely / difficult to find*

*Dosage: Grasses (in mixture) 7-10 g/sqm + Entomophilous species (in mixture) 1-4 g/sqm (for Leucanthemum vulgare and Trifolium pratense, do not exceed 0.1 g/sqm each)*

## 2a. By seeding seed mixtures

In this case, you can proceed by associating entomophilous plant seeds with a base of grasses intended to form the matrix of the meadow. Many of the most widespread species of grasses in lowland meadows (e.g., *Lolium multiflorum*, *Lolium perenne*, *Festuca arundinacea*, *Festuca pratensis*, *Festuca rubra*, *Poa pratensis*, etc.) have been widely used for decades for reseeding and forage meadows, using commercial seed. Since the genetic heritage of these species, which also spread their pollen over long distances through the wind, is likely different from the 'local' original one, it is possible to disregard the local origin and use easily available commercial mixtures as the 'base' of the meadow, to which other species are added. Conversely, for entomophilous species (e.g., *Centaurea nigrescens*, *Leucanthemum vulgare* subsp. *vulgare*, *Salvia pratensis*, etc.) and for other important species of grasses less commonly used in artificial reseeding (e.g., *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Briza media*, *Bromus erectus*, *Trisetaria flavescens*, etc.), it is recommended to use seed of guaranteed local origin.

Besides seed origin, to assure a successful intervention, it is crucial to use a **low seeding density for grasses** (max 10 g/sqm, but preferably 7-8); this base mixture should be then enriched by adding a mixture of entomophilous species with a density of 1-4 g/sqm; the quantity varies depending on the selected species and the actual availability of local origin seed. A scenic 'ready- to-go' flowering effect can be achieved by adding a small amount of cornflower seed (*Cyanus segetum*) to the mixture (0.15-0.20 g/sqm): cornflower is an annual species that blooms profusely in the first year while tending to disappear in subsequent years, as the grassland cover formed by perennial species closes, but still remaining, albeit sporadically, at the edges, along road edges, in the small areas of bare ground within the grassland (sometimes even in the soil disturbed by moles). In this way, the aesthetic (and apicultural) effect of the first year is combined with a contribution to the conservation of a species as iconic as it is rare.

Seeding is done **in autumn**, weather permitting (October 15-31 or according to the seasonal climate), by scattering seed by hand, or mechanically in case of a large area; on embankments, slopes, and overall on sloping surfaces, where it is necessary for the seed to adhere to the ground to prevent heavy rains from washing it away, by hydroseeding.

*Adding cornflower seeds to the meadow mixture ensures a ready-to-go aesthetic and apicultural effect in the first year*

*Hydroseeding of a mixture of native seeds on a small embankment. The green dye helps to better visualize the already seeded portion*

## 2b. Using seed-rich hay

This technique involves spreading hay obtained from high-quality meadows (i.e., characterized by a high species richness) on the prepared soil of the future meadow. This hay, harvested at the right time, will release any remaining seeds into the soil, and the stems will act as a covering. It is a very effective technique, which also avoids the purchase of seeds of uncertain origin on the market. The main limitations of this technique lie both in the limited availability of good '**donor**' **meadows** in the area (precisely because good meadows have almost disappeared, along with traditional small-scale livestock farming, which was their main supporter), and in logistics (transporting bales) as well as in the distribution of the hay on the ground, prepared as illustrated in the previous section 1) Soil Preparation. Therefore, the first thing to do is to identify the 'donor' meadow; the selection of the 'donor' meadow should be done by a specialist, preferably in May when the extent and variety of blooms can be fully appreciated, and there are optimal conditions for a floristic survey. The analysis of an expert also helps to avoid gathering hay from meadows that are clearly the result of reseeding (in this way, it would be exactly like buying seed of unknown origin). The owner should then be contacted to arrange for the purchase of the hay: a positive consequence of this technique is that it economically values the few well-managed meadows still present. A portion of local seed of native entomophilous species (*see paragraph 2a*) can be added to the hay to increase the flowering of the meadow: in this case, as in the following paragraph 2c., it is not necessary to establish a minimum quantity because it is in any case an improvement. To ensure the efficacy of the above-mentioned operations, proceed as follows:

A. mowing of the donor meadow, typically from mid to late June, depending on the weather conditions: it is necessary to monitor the maturity of the seeds. The right time is shortly before full maturity: mowing too early means having unripened seeds, while waiting for full maturity results in the falling to the ground, and therefore the loss, of many ripened seeds. Evaluation requires sensibility and experience, but a good method is to assess the spikes and inflorescences of the most abundant species, trying to shell them and compressing seeds between the fingers. If the seeds are green and when squeezed between the fingers they crush into a somewhat soft and moist paste, they are clearly unripened; sometimes, even if apparently dry and hardened, seeds do not easily detach if pulled by pinching them between the fingers (a hint that may indicate incomplete ripening is the presence and visibility of flower residues, e.g., anthers, stamens). When instead the seeds are rather tough and resist compression, the floral parts are mostly gone, and the grass spike is straw-colored, ripening is near. In this case, the seeds detach and remain in the hands rubbing the inflorescence actively but without excessive effort: at this point, mowing should be carried out within a few days. After mowing, take care to let the hay dry for 2/3 days with gentle turning, and then make the bales, if possible, not too large (3-4 quintals). In any case, mowing should take place on homogeneous meadows with a good species composition: fallow and abandoned areas (e.g., portions of

the meadow at the edge of the woods, partially invaded by brambles and bushes, or near areas disturbed with the presence of ruderal plants, such as those growing in cultivated fields, along roads, gravel, sidewalks, etc.) should be avoided;

B. preserve the bales in the shade, without plastic wrapping, until autumn;

C. spread the hay on the soil prepared as explained in section 1) Soil Preparation, during the month of October. The bales should be untied, and the hay distributed, with a pitchfork and rake in the case of small plots, or loaded onto a straw spreading machine/distributor (mulch spreader), pulled and operated by a tractor. The dose of hay is about 200 g/sqm and should be distributed as uniformly as possible to form a layer of hay about 2-3 cm thick over the entire area to be seeded. **The hay should be used within the year of harvest**.

*A species-rich hay meadow*

## BOX: HAYMAKING

The goal is to obtain hay rich in seeds, so it is important to avoid operations that may lead to excessive seed loss. Given the purpose, the methods rely on the experience of the operator. Below are some general guidelines used in other similar projects:

1. mowing can be carried out using common equipment (rotary disc mower, sickle bar mower, or conditioner mower with rollers - avoid flail mowers due to their tearing action on the stems);
2. the day after mowing, aerate or turn the hay using common equipment (tedders), but work at a reduced speed to minimize the 'beating' effect on the stems and limit seed loss;
3. based on weather and product moisture conditions (approximately on the 3rd-4th day after cutting), proceed with raking using a hay rake (wheel rake with tines or different). Move at a reduced speed and rotation compared to normal, creating 'open' windrows of medium size to avoid excessive 'beating' and allow the hay to continue drying;
4. when the hay is sufficiently dry, proceed with baling using a round baler, preferably in the morning. Prefer 'soft-core' bales, which allow for further moisture loss, and medium-sized bales: diameter = 120-130 cm, not exceeding;
5. store the bales on wooden pallets, preferably under a ventilated roof; alternatively, cover them with a suitable hay tarp (non-woven fabric, waterproof, and breathable). If the storage area is on packed earth (not concrete), it is advisable to place 2 layers of pallets at the base, on which to stack the bales, to allow better ventilation and prevent hay mold.

In summary, for planning:

- at least 200 g of hay is needed to cover 1 square meter;
- consequently, with 1 bale weighing 4 quintals, approximately 2,000 square meters of land can be covered; about 5 bales (each weighing 4 quintals) are needed to cover 1 hectare;
- as an indicative value, consider approximately 50 quintals of hay (60 in the case of more fertile meadows) obtainable from 1 hectare of mown meadow.

*Compiled by Valerio Bondesan - Veneto Agricoltura*

## 2c. Using brush-harvested seed

This technique envisages the use of brush-harvested seed collected from donor meadows. Like the previous method, it is a very effective technique that avoids the use of seeds of dubious and unsuitable origin, provided that, as with hay, the collection of brush-harvested seed is preceded by the identification of suitable donor meadows by qualified experts. But what is brush-harvested seed? According to the formal definition of European legislation (Directive 2010/60/EU), it is a 'mixture of seeds marketed as collected in the collection site, with or without cleaning'. In fact, it is a mixed seed of various species, 'dirty', that is, not cleaned of teguments or mixed with other dry parts of the plant (flowers, small portions of stems and leaves, etc.). According to an ancient custom, this material, which remained as residue from hay on the floor of barns or at the bottom of mangers under the crib, was collected and used for sowing.

Today, it results from a collection carried out specifically in donor meadows when the seed is ripe, using appropriate harvesting machinery (brush harvester) or even combine harvesters in the case of large flat surfaces. The precautions to be taken for the evaluation of ripeness, uniformity, and quality of the meadow are the same as those presented in paragraph 2b. for hay. Compared to the hay method, brush-harvested seed presents the undeniable advantage of greater practicality in storage and logistics (conservation, transport, distribution on the ground) but requires the availability of specific equipment for collection and adequate technical experience and preparation.

After harvesting, brush-harvested seed should be kept in an open and aerated place and turned over to favor dehydration and prevent mold. After a period of at least 15 days, if sufficiently dry, the material can be enclosed in suitable seed bags and stored until sowing, which can be carried out using the methods indicated above for seed mixtures (*paragraph 2a.*). The quantity to be used is approximately at least 1 quintal per hectare, preferably 2 or even 3-4 in the case of brush-harvested seed collected in previous years. According to experiences conducted in Lombardy[7], brush-harvested seed collected from 3 hectares of donor meadow is sufficient to sow 1 hectare.

Similarly to the two previous methods, it is advisable to add some seed of entomophilous species to the brush-harvested seed preferably before sowing, based on the availability of locally sourced seed (even a modest amount is still beneficial), in order to increase the flowering of the future meadow to some extent. Like pure seeds, brush-harvested seed sees a decrease in germination percentage over time but remains viable for about 3-4 years.

[7] *https://www.wearch.eu/inerbimenti-con-fiorume-autoctono-una-scommessa-possibile; http://centroflora.parcobarro.it/uploads/4/2/4/8/42483645/manuale_fiorume_parcoorobiebg.pdf*

*Gathering of brush-harvested seed on a mountain grassland using a special electric motor-powered harvester. The brush-harvested seed is then collected onto a cloth*

*Uploading phase of the brush-harvested seed from a combined harvester*

*Spreading of the brush-harvested seed on the floor of an aerated room for the drying phase*

*Distribution of brush-harvested seed on a permanent meadow during the improvement phase using a broadcast spreader. Seeding and reseeding operations should be carried out in autumn*

*Collection of brush-harvested seed at the Magredi del Dandolo di Maniago (PN) using a combine harvester*

*Unloading of the brush-harvested seed from the combine harvester before its trasportation to the drying facility*

*Drying of the brush-harvested seed in an outdoor shed. It should be moved twice a day for about a week*

## BOX: THE BRUSH-HARVESTED SEED SUPPLY CHAIN

In some regions of Italy (Lombardy and Friuli-Venezia Giulia), efforts have been made in recent years to develop a 'Brush-harvested seed Supply Chain' to create added value for species-rich permanent meadows.
For the owner or manager of such a biodiverse meadow, it is much more advantageous to use the land for brush-harvested seed production rather than just harvesting and selling hay. This is especially true considering the increasing demand from the market, which comes not only from enthusiasts of meadows but also from public entities involved in restoration projects or from other entities, both public and private, in relation to environmental compensation measures required following the implementation of large infrastructure projects such as pipelines, power lines, roads, railways, etc..
A brush-harvested seed supply chain project has been developed in the province of Brescia thanks to the initiative of the Centro Flora Autoctona of the Lombardy Region[8].
A similar project has been studied by the Friuli-Venezia Giulia Region as part of the specific action of the LIFE PollinAction Project dedicated to the implementation of supply chains for the valorization and management of protected permanent meadows under a specific Regional Law (LR9 of 2005) as ecological pillars supporting the pollination network.

[8] *https://centroflora.parcobarro.it/fiorume-345106.html*

*Dry meadow in the Friulan plain*

## MANAGEMENT AND MAINTENANCE OF THE MEADOW

**Mowing is crucial for meadow conservation**. Generally, in species-rich hay meadows, 2(3) cuts per year are carried out; in some cases, the second (or third) mowing is replaced by grazing. An excessively early first mowing tends to favor grasses over time and decrease the variety of flowering plants: a first mowing at the end of spring/early summer, around the end of the main grasses' maturation (June), allows the more interesting plant species and prolonged flowering to persist over time[9]. However, it should be noted that **this late hay has lower nutritional value compared to the fresher hay of May**: since only the possibility of obtaining hay of suitable quality for farmers' needs guarantees the long-term conservation of this habitat, according to previous experiences[10], if hay is used for livestock purposes, it is allowed to mow species-rich meadows in coincidence with the heading of the main grasses (around mid-May in our climate). Conversely, in the case of donor meadows used for hay or brush-harvested seed for the creation or improvement of meadows, mowing should be later and coincide with the maximum seed maturation period of the most interesting species.
In the anthropized plains, there is often a tendency for Johnson grass (*Sorghum halepense*) to spread within recently established meadows. This is a warm-season species that starts its life cycle from mid-summer onwards: to prevent its proliferation, which tends to depress the quality of the meadow from both a biodiversity and a livestock perspective, it is very important to intervene with a second summer mowing to prevent its dissemination, followed by another intervention in September. While the rule of 2, maximum 3 cuts per season remains valid for meadows in the mid-mountains or for 'ancient' and high-quality meadows, **for newly or recently established** meadows in our highly anthropized plain, rich in undesirable invasive species, even in the face of ongoing climate warming, **mowing frequency and methods may vary depending on the specific conditions encountered**, with an increase in the number of cuts where deemed necessary. Mowing, especially in summer, in the first year/first two years is particularly important in the presence of weeds[11], and in case of significant invasion, mowing should be repeated several times.
In the case of **mesophilous or meso-hygrophilous** meadows dominated by tall oatgrass (*Arrhenatherum elatius*), proper management involves mild fertilization with well-rotted manure[12]. In any case, **the spread of liquid manure or chemical fertilization should be excluded**, as they favor only a few competitive species at the expense of biodiversity.
In the case of newly sown meadows on agricultural land or, even more so, on soils reshaped with earth-moving machinery, shredding with release of shredded material onto the ground

[9] *It should be noted that for protected meadows (included in the Sites of the Natura 2000 Network), the recommended period for the first mowing starts from June 15th, a period that represents the best compromise between the dual need for biodiversity conservation in meadows and the management requirements of the productive world.*

[10] *Tomasi et al. (eds.), 2011. Guidelines for the management of community interest habitats in Trentino. LIFE11/NAT/IT000187 T.E.N. (in Italian)*

[11] *Scotton et al., 2012. Practical manual for seed collection and ecological restoration of species-rich grasslands. CLEUP, Padova. (in Italian)*

[12] *Manuring with well-rotted manure (not to be confused with liquid manure!) is part of the ordinary, traditional management of hay meadows. In the case of newly established meadows, it is not required for the first few years, but it can be adopted once the meadow is well-established and consolidated. It is useful to delve into the interesting topic of manure by consulting this article from the magazine "Vita in Campagna" (n. 12/2006) link to the article http://www.ediagroup.it/ita/Riviste/Vitincam/home_consigli/pdf/letame-corretto-impiego.pdf (in Italian)*

can be carried out in the first year after sowing to improve the organic matter content. Unlike mesophilous meadows, which tolerate light fertilization, **fertilization should be avoided in xeric or meso-xeric and wet meadows**. When fertilized, even lightly, these meadows undergo significant transformations, resulting in a loss of species richness.

| Summary Sheet | |
|---|---|
| **Characteristics** | perennial; prolonged and abundant flowering; high landscape value |
| **Location** | sunny areas; soils from light to heavy, from well-drained to wet |
| **Required skills** | creating a species-rich meadow requires adequate experience and technical preparation in sourcing and collecting plant material, as well as in preliminary soil preparation works |
| **Preliminary work** | harrowing, false sowing, harrowing (or weeding) |
| **Period of intervention** | mid-October |
| **Technique** | three creation techniques:<br>• by sowing a mixture of seeds of native species<br>• by the use of species-rich hay<br>• by brush-harvested seed |
| **Flowering period** | April-October |
| **Management** | • regular periodic mowing (2(3) cuts/year). Plan the first mowing in late spring/early summer, coinciding with the conclusion of the main grasses' maturation period (June)<br>• consider additional summer mowing if invasive species are present |
| **Remarks** | • identification of suitable donor meadows by qualified experts<br>• if you choose to use hay or brush-harvested seed<br>- carefully assess the quality of the donor meadow and the degree of seed maturity<br>- consider that the material should be harvested roughly from mid to late June, dried, and stored until use<br>• if you choose to sow seed mixtures<br>- use seeds of guaranteed local origin for entomophilous species<br>- use a low seeding density for grasses (max 10 g/sqm) and add 1-4 g/sqm of entomophilous species<br>• in the case of mesophilous or meso-hygrophilous meadows, provide a mild fertilization with well-rotted manure, excluding liquification or chemical fertilization<br>• avoid fertilization in the case of xeric, meso-xeric, and wet meadows |

# RESTORATION AND IMPROVEMENT OF EXISTING MEADOWS

This sheet aims to provide guidelines for the **improvement of existing meadows that have become impoverished in terms of species composition**.
Species impoverishment may result from the slowing down or intensification of traditional farming practices and can be restored through targeted interventions.
The abandonment of regular mowing leads to a progressive degradation of the meadow and to phenomena of matting (accumulation of dead plant mass, litter) and bush encroachment (invasion of woody species).

*The abandonment of regular mowing leads to a progressive degradation of the meadow, with the entry of ruderal species, often exotic ones (in this case, Erigeron annuus), and the invasion of woody species*

The use of synthetic fertilizers or increased fertilization and overseeding of forage species, on the other hand, result in a significant modification of the species composition of the meadows, which progressively simplifies. The increase in nutrients through fertilization tends to favor a few highly productive species in terms of hay yield, often facilitated by the sowing of commercial species such as clovers, ryegrass, alfalfa, and other forage plants.
In both cases, there is a loss of richness and variety of species, particularly those beneficial to pollinating insects. The need for improvement is often highlighted by the significant presence of synanthropic-ruderal[13] or exotic species, which are foreign to the local context.

[13] *Synanthropic-ruderal species are typically small-sized plants that spread in habitats altered and disturbed by humans, such as roadside edges, urban areas, or abandoned cultivated fields*

*The use of synthetic fertilizers or increased fertilization in mesophilous hay meadows causes a significant simplification of species composition in the meadows and loss of biodiversity*

## THE IMPROVEMENT OF THE MEADOW: HOW TO DO IT

### 1. Restoration of abandoned meadows

#### 1a. Restoration through mowing

If the impoverishment of the meadow results from a slowdown in management practices, the restoration of species richness can be achieved by implementing proper management, which involves 2(3) cuts during each growing season, with material removal. The first mowing should be carried out anticipating seed dispersal by ruderal and exotic species while allowing for the maturation and seed drop of spring-summer native species.

The second mowing, usually starting from mid-August, helps to limit the development of late-summer weed species (e.g., Johnson grass). The double mowing and hay removal are aimed to deplete the soil from excess biomass and plant residues, avoiding new inputs of organic matter and accelerating the settlement and balance over time, bringing the soil and meadow back to their original conditions, which are the most complex and rich in plant and animal biodiversity. In case the slowdown in management practices has led to shrub encroachment, it is necessary to proceed with clearing. The restoration of meadows subject to shrub encroachment and possible expansion of invasive exotic species (e.g., *Ailanthus altissima* or *Amorpha fruticosa*) is less problematic because the soil, once freed from the shrub layer, generally appears little altered and with a good seed bank (derived from the previous meadow). Only in the case of *Amorpha fruticosa*, due to its great sucker-producing capacity and its ability to fix atmospheric nitrogen, which causes a strong nutrient enrichment of the soil, the effort to contain regrowth from the roots may require up to 3-5 cuts per year.

## 1b. Enrichment through overseeding

The sowing for improvement purposes on a grass cover poor in species and flowers, is called overseeding. In this case, it is necessary to keep in mind that the seed must reach the soil, beneath the grass cover, so before sowing, it is necessary to mow the grass with a very low cut and then remove the mown grass.

Overall, methods depend on the size of the area to be overseeded and the available equipment: for **large surfaces**, there are specific seeders with a large seed hopper, combined with a harrow to prepare the soil, and a corrugated roller that facilitates seed penetration; alternatively, scarifiers/aerators can be used; for **smaller areas**, a variety of small equipment is available on the market (aerators, rollers, manual seeders); at a hobbyist level, even a simple preliminary work with a rake and broadcasting seeding can work; in any case, the principle is that the seed must reach the soil and not remain on the grass. In the case of overseeding, the quantity indicated in literature as sufficient is 0.5-1 g/sqm.

## 1c. Enrichment through planting of native seedlings in soil blocks

This type of intervention involves the use of native seedlings in soil blocks, which are pre-grown plant material.

The seedlings serve as 'seed carriers': once established, they can produce their own blooms and viable seeds for the spontaneous spread of species in the surrounding areas. This type of intervention is aimed at enhancing the habitat quality and its suitability for pollinators; it can also be used to accelerate meadow enrichment with species of conservation interest, as they may be rare or threatened.

*Native seedlings in soil blocks*

### BOX: WHY USE SEEDLINGS IN SOIL BLOCKS?

Compared to seeds, seedlings in soil blocks have the advantage of quicker development, enabling them to rapidly compete with existing species, thus avoiding strong competition during the initial growth phases, which are particularly difficult and delicate for plants, occurring in open field conditions.

The optimal **planting season** is in **autumn**, as with all other interventions involving the use of plant material. The seedlings in soil blocks should be placed into the ground after creating a hole suitable for the size of the underground part (root ball or soil block, etc.). The plant should be immersed in the soil up to the level of the collar; the roots should not be exposed, nor should the stem be excessively buried in the soil. Various types of tools can be used for planting, including:

- motorized augers with a small diameter tip;
- manual augers, if operating on existing vegetation, with the precaution of loosening the soil to a slightly larger extent than necessary to contain the soil block.

Planting schemes may vary depending on the requirements and characteristics of the soil. In all cases, **seedling planting should occur in small, mono-specific groups** (*see BOX Even the eye wants its part! on page 26*).

In the case of rare or threatened species, it is advisable to monitor the progress of transplants over time (viability, flowering, and fruiting); for this purpose, marking plots with a stake and a visible ribbon and recording the location with a GPS can facilitate quick identification of introduced individuals.

Planting seedlings in soil blocks is very resource and energy-intensive as it requires several preliminary phases ranging from careful seed collection to conservation, nursery sowing, possible potting-up, and subsequent planting in the wild. Furthermore, the establishment of young plants, especially under particularly challenging soil and climatic conditions (rocky and poor soils of the high plains), does not always yield the expected results, which depend on several factors that are not always predictable, including:

- the type of species and ecotype transplanted;
- the adaptability from the ‘protected’ conditions of the nursery to those encountered in the wild;
- unpredictable and sometimes particularly adverse climatic conditions after planting (prolonged drought, significant temperature fluctuations);
- trophic activity and uprooting by wild animals attracted to the young plants (especially crows, hares, and wild boars).

**For the reasons mentioned above, if the goal is simply to enrich the composition of a ‘hay-type’ meadow, overseeding is suggested** (*see paragraph 1b.*).

However, in a very different scenario, if the objective is to strengthen populations of rare species, usually associated with peculiar habitats such as dry meadows or wet meadows, or species not easily found through hay or brush-harvested seed, planting seedlings in soil blocks remains the most suitable method. As for the species, in both cases, reference can be made to the list in the table on page 35.

## 2. Restoration of intensive meadows

The restoration of intensive meadows can only be achieved through the cessation of fertilization practices, followed by species enrichment through overseeding or planting of seedlings in soil blocks. Furthermore, extensive management should be reinstated, involving 2(3) cuts during each growing season, with material removal. In the case of mesophilous meadows, a light fertilization should also be resumed (*see Management and Maintenance of the meadow in the chapter Implementation and Management of species-rich hay meadows*).

### Summary Sheet

| | |
|---|---|
| **Characteristics** | perennial; prolonged and abundant flowering; high landscape value |
| **Location** | sunny areas; soils ranging from light to heavy, from well-drained to moist |
| **Required skills** | average |
| **Preliminary work** | if work entails overseeding or planting seedlings in the soil blocks, it is necessary to provide a short cut with the removal of the mowed material |
| **Period of intervention** | mid-October |
| **Technique** | restoration of abandoned meadows:<br>a. restoration of regular mowing<br>b. overseeding<br>c. planting seedlings in soil blocks<br>restoration of intensive meadows:<br>a. cessation of fertilization and enrichment through overseeding or planting of seedlings in soil blocks |
| **Flowering period** | April-October |
| **Management** | • periodic mowing (2(3) cuts/year). Plan the first mowing at the end of spring/early summer, around the end of maturation of the main grasses (June)<br>• plan multiple summer cuts in the presence of invasive species |
| **Remarks** | • use seeds or seedlings in soil blocks of native species from certified nurseries and/or retailers<br>• for mesophilous or meso-hygrophylous meadows, consider light fertilization with well-rotted manure, excluding liquid manure or chemical fertilization<br>• avoid fertilization in the case of xeric, meso-xeric, and wet grasslands |

## ESTABLISHMENT AND MANAGEMENT OF WILDFLOWER STRIPS

This sheet explains how to create and manage wildflower strips. Flower strips are strips of entomophilous herbaceous plants, of varying width and linear shape, created at the edges of cultivated fields, greenhouses, vegetable or fruit crops in open fields, or at the base of a hedge. They can also be created along ditches, channels, and watercourses.

Despite variations, flower strips generally have a modest surface area, with variable length and a width ranging from 2-3 to 10 meters. They comprise a mix of native herbaceous plants and can be annual or perennial. Their species composition is very similar to that of species-rich meadows but may vary depending on the purpose and environmental conditions. The general rule is that **strips should be rich in plant species that differ in size, height, floral morphology, and flowering period**.

### THE ESTABLISHMENT OF ANNUAL WILDFLOWER STRIPS: HOW TO DO IT

Annual strips are **flowering strips composed of annual plant species**, meaning that they have a life cycle that begins at the time of sowing and ends after flowering, with the production of new seeds.
Annual strips do not need special care, but their creation requires preliminary soil preparation work that must be repeated. This type can be created in **dry and well-drained soil conditions**.

#### 1. Soil Preparation

Preliminary soil work is functional to prepare the seedbed and involves:
a. surface plowing of the soil without overturning the layers or alternatively milling;
b. harrowing of the soil to promote the germination of weed species seeds;
c. eradication of weed species, or repeated harrowing for the same purpose.
These operations must be **repeated every year before sowing**, skipping only deep operations in subsequent years after the first one.

#### 2. Creating Annual Flower Strips

The creation of annual strips involves the use of **mixtures of seeds from suitable native species**, preferably of local origin (see *BOX Definition of region of provenance page 19*). Sowing can be done manually for small areas or mechanically for larger areas. To facilitate sowing, the seeds can be mixed with a carrier such as sand to increase volume.
The suggested mixing ratio is 1 part seeds to 3 parts sand. Once applied, the seed can be lightly raked to ensure good contact with the soil. A seed quantity that ensures good coverage is about **5/10 g/sqm**; variations can be made depending on the composition of the seed mix.
**Sowing** should be carried out in **autumn**, typically in the second half of October, before the soil becomes excessively wet. To ensure a good diversity of species and

thus optimal habitat functionality, **the seed mixture** should contain a **number of different species** ranging from **10 to 15**.

*Annual wildflower strip of Matricaria chamomilla (Common Chamomile) along the edge of a cereal crop in a heterogeneous agricultural context (Cartigliano, VI)*

In general, it is advisable to **avoid sowing mixtures of annual and perennial species**; the necessary cutting of perennial species, in fact, results in the disappearance of annual species that do not reach flowering.
Some species have strong toxicity (*Agrostemma githago*, *Consolida regalis*, *Melampyrum arvense*), and this should be taken into account in contexts where seeds or plant parts may mix with fodder or cereals for human and animal consumption.

## BOX: MIXTURE OF NATIVE SPECIES SEEDS

| SPECIES | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Agrostemma githago* | | | | | | | | | | | | |
| *Anthemis arvensis* | | | | | | | | | | | | |
| *Borago officinalis* | | | | | | | | | | | | |
| *Calendula arvensis* | | | | | | | | | | | | |
| *Consolida regalis* | | | | | | | | | | | | |
| *Cyanus segetum* | | | | | | | | | | | | |
| *Legousia speculum-veneris* | | | | | | | | | | | | |
| *Melampyrum arvense* | | | | | | | | | | | | |
| *Mentha arvensis* | | | | | | | | | | | | |
| *Nigella damascena* | | | | | | | | | | | | |
| *Papaver rhoeas* | | | | | | | | | | | | |
| *Ranunculus arvensis* | | | | | | | | | | | | |
| *Trifolium incarnatum* | | | | | | | | | | | | |
| *Vicia sativa* | | | | | | | | | | | | |
| *Viola arvensis* | | | | | | | | | | | | |

LEGEND: The colored squares depict the flower color and the flowering period

### Summary Sheet

| | |
|---|---|
| **Characteristics** | annual; abundant flowering; high aesthetic value;<br>good for attracting pollinators and other beneficial insects |
| **Location** | warm, sunny, and sheltered areas; light and well-aerated soils |
| **Required skills** | average (preparation of the seedbed required) |
| **Preliminary work** | seedbed preparation, to be repeated every year |
| **Sowing period** | mid-October |
| **Technique** | manual or mechanical sowing depending on the surface area |
| **Flowering period** | May-September |
| **Management** | none |
| **Remarks** | • use seed mixtures of native species from certified nurseries and/or retailers<br>• the seed mix should ensure a high species richness |

## BOX: FLOWER STRIPS IN THE CAP

ECO-SCHEME 5 – SPECIFIC MEASURES FOR POLLINATOR

The Eco-schemes are tools for farmers, financed with 25% of the resources of the new CAP, aimed at making agriculture more sustainable and protecting the environment. Eco-schemes 5 'Specific measures for pollinators' aims to 'contribute to the conservation of biodiversity through the diffusion of crops of beekeeping interest and to a sustainable and reduced use of pesticides'. The spread of crops of beekeeping interest is promoted by maintaining or creating strips of flowering plants that provide nectar and pollen as food resources for pollinators. The choice of nectar and pollen species should be made with a view to promoting coherence with the characteristics of the intervention site. To facilitate their choice, specific guidelines have been produced concurrently with Eco-scheme 5: 'Guidelines for the selection of botanical species of beekeeping interest allowed for Eco-scheme 5 and other recommendations'. It should be emphasized that the choice of species to be used among those mentioned in the guidelines must always refer specifically to the local climatic and soil context. The construction of flowering strips must also comply with certain parameters, differentiated according to the type of crop, arboreal or herbaceous, in which the flowering strips are created.

Within **tree crops**, the flowering strips must have a minimum width of 20 m and a minimum surface area of at least 0.25 contiguous hectares. The coverage of plant species of beekeeping interest must be ensured on at least 70% of the committed area. Their construction must be done in the inter-row or outside the vertical projection of the canopy. From a management perspective, it is prohibited to:

- mow or shred the cover from germination to completion of flowering;
- use chemical herbicides. Only mechanical or manual control of non-beekeeping weed plants across the entire area is allowed;
- use other agrochemicals during flowering. For the rest of the year, the integrated pest management regulations must be followed;

Even within **herbaceous crops**, the flowering strips must have a minimum width of 20 m and a minimum surface area of at least 0.25 contiguous hectares. Furthermore, these must be constructed at a distance of 3 to 5 meters from neighboring crops (buffer zone) not subject to restrictions on the use of phytosanitary products. From a management perspective, it is prohibited to:

- remove, mow or shred the cover from germination to completion of flowering;
- use phytosanitary products until flowering is complete.

Additionally, only mechanical or manual control of non-beekeeping weed plants on the committed area is permitted.

[14] *https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/24482*

## CREATING PERENNIAL WILDFLOWER STRIPS: HOW TO DO IT

Perennial strips are **flower strips composed of plant species with a multi-year life cycle**. In many cases, the above-ground part of the plant dries up during the winter, but the root system continues to live, producing new shoots the following spring. Unlike annual strips, which consist of species that complete their cycle in one year and therefore need to be reseeded, perennial strips have the advantage of persisting for several years, blooming every year. However, their maintenance requires proper management. This type of strip can be created alongside fields, horticultural and fruit-growing crops, greenhouses, hedgerows, at the edges of drainage ditches, canals, and watercourses. Other suitable sites include the central sectors of inter-row spaces in perennial crops such as orchards. Depending on the soil characteristics, particularly moisture content, mesophilous and hygrophilous strips can be distinguished.

### 1. Soil preparation

Preliminary operations vary depending on the initial conditions of the site.

#### a. Mesophilous flower strips in areas previously used as arable land

In this case, the problems encountered are related to the excessive soil fertility due to repeated fertilization and the abundant load of weed seeds. The high nutrient content can cause failures as it promotes the growth of few species, generally grasses. The second factor determines, especially in summer, the proliferation of weed species that can compromise the structure and species composition of the strips. To convert land previously cultivated as arable land, it is recommended to proceed as follows:

A. preliminary survey of the summer flora present in the area: if common invasive plants are present (e.g., *Abutilon theophrasti*, *Amaranthus* sp., *Artemisia verlotiorum*, *Sorghum halepense*, etc.), proceed during the summer with repeated mowing to prevent dissemination (this situation is almost certain if the land was previously cultivated with maize or soybeans);
B. in September, work the soil (harrowing);
C. wait for the subsequent germination of unwanted weeds, which usually follows rain (so-called 'false sowing');
D. mechanically remove unwanted weeds (with further harrowing or chemical weeding).

In the design of the intervention, it is important to pay attention to the surface area to be allocated to the flower strip, especially regarding its width. It is good practice to provide from 1 to 3 (up to 5) meters between the edge of the strip and nearby crops, and at least 1 meter between the edge of the strip and boundary elements (hedges, drainage ditches, roads). This helps to limit the nutrient load coming from the crops and to prevent damage to the strip from agricultural operations and vehicle movements. Therefore, the total width to be allocated to a flower strip of, for example, 2 meters, should be at least 4-6 meters.

If the adjoining areas are colonized by brambles, it is necessary to proceed with their elimination through mechanical weeding, using a field shredder or brush cutter, bearing

in mind that, due to its high propagation capacity, complete elimination may require several passes. The best period to carry out the first mechanical mowing intervention is late autumn/winter when the plant is dormant and to avoid compromising any faunal presence. On the young shoots that follow, it is necessary to repeat the process at least 2/3 times throughout the season starting from resprouting.

### b. Flower strips in areas with dense sod

If there is already a dense sod layer in the area, the preliminary operations are reduced and aim to decrease the competition from existing species in favor of those to be planted to promote their establishment. In this case, the interventions consist of:

1. cutting the existing sod layer to a height between 3 and 5 cm;
2. disruption of the continuity of the existing sod layer through soil cultivation, which involves using a harrow, a scarifier, a rototiller, a flail mower, or a rotary seeder.

If the adjoining areas are colonized by brambles, it is necessary to proceed with their elimination (*see point a.*).

In case of flower strips created in the inter-row spaces in perennial crops such as orchards, attention must be paid to the root systems of the cultivated plants, reserving only the central strip of the rows for the flower strip.

### c. Perennial hygrophilous flower strip

Perennial hygrophilous strips are flower strips created in hygrophilous conditions, i.e., alongside drainage ditches, canals, watercourses, and water bodies. In this case, since soil cultivation operations could compromise the stability of the banks, preparatory interventions are limited to cutting the sod layer to a height between 3 and 5 cm to reduce competition from existing species in favor of those to be planted and facilitate their establishment. If the outer edge of the strip facing the ditch or canal is colonised by tall weed species, it would be useful to prepare a seedbed and establish a permanent cover by sowing a mix of commercial grasses suitable for wet soils. This approach would help to avoid the excessive proliferation, growth, and shading of the newly planted seedlings by the more vigorous weed species.

## 2. Creating perennial wildflower strips

This type of intervention involves the exclusive use of seedlings in soil blocks, i.e., plant material that is already developed. The seedlings should be planted after digging a hole in the soil suitable for the size of the root ball or soil block.

The plants should be immersed in the soil up to the level of the collar: the roots should never be exposed, nor should the stem be excessively buried in the soil. It is advisable to use adequately developed plants (around the second year of growth), with the soil block firmly attached to the root and free of weed plants. Various types of tools can be used for planting, but the use of motorized or manual augers with a small diameter tip is recommended.

If you are working on pre-existing sod, be sure to loosen the soil to a slightly larger extent than necessary to accommodate the soil block.

The planting scheme can vary depending on the requirements, but it is important that **the planting of seedlings occurs in small mono-specific groups** (*see Box Even the eye wants its part! on page 26*). In the case of hygrophilous strips, particular attention must also be paid to the water fluctuation zone, namely the surface between the minimum and maximum water levels. In the section of the bank in closest proximity to the water level, it is recommended that, species capable of tolerating periods of submersion should be situated.

To facilitate the management of the strip, it is recommended to locate late summer flowering species in designated sections, which should only be mowed at the end of summer (*see below Management and maintenance of wildflower strips*). In the case of mesophilous flower strips, the transplantation of seedlings can be combined with **the sowing of a seed mix** that helps increase species richness and accelerates the establishment of the strip. To increase ground cover, the seed mixture can also comprise seeds of less competitive grasses (*Anthoxanthum odoratum*, *Briza media*, *Trisetaria flavescens*). It is recommended that seeds be scattered between the seedlings, with a target density of 4 g/m² be scattered between the seedlings, with a target density of 4 g/sqm, with a maximum of 1/3 being grasses.

The ideal season for transplantation and potential sowing is **autumn**.

*Seedlings in soil blocks produced at the Volpares nursery (Palazzolo della Stella) from seeds of native species*

## MANAGEMENT AND MAINTENANCE OF WILDFLOWER STRIPS

As mentioned above, **annual flower strips** do not need special care, but their creation requires preliminary soil work that has to be repeated annually before sowing.
Conversely, like species-rich meadows, **the maintenance of perennial flower strips requires periodic mowing**.
In general, two cuts per year help maintain species composition and richness. To ensure that the planted or seeded species reach flowering and complete their vegetative cycle, the first mowing should not occur before mid-June. The second mowing should be done between late August and mid-September. In case of the spread of invasive species such as, for example, Johnson grass (*Sorghum halepense*), mowing frequency and methods may vary, with an increase in the number of cuts if necessary. Mowing, especially in summer is particularly important in the first year/two years and should be repeated several times if the invasion is massive. Another precaution concerns summer-flowering species. As mentioned earlier, it is advisable to limit them to specific areas of the strip, as they should only be mowed during the second mowing to allow them to complete their cycle.
In the case of hygrophilous strips, where intervention is carried out along the banks of watercourses managed by Reclamation Consortia, there must be a prior agreement to keep at least the first 50 cm of the bank uncut throughout the flowering season, intervening only for autumn mowing.

*Bumblebee in search of nectar*

## PERENNIAL WILDFLOWER STRIP SPECIES

| SPECIES - SCIENTIFIC NAME (CONTI ET AL. 2005; 2007) | FLOWERING PERIOD | TYPE | ENVIRONMENT |
|---|---|---|---|
| *Achillea millefolium* | May-Oct | E | Ge |
| *Ajuga reptans* | Dec-Jun | E | Ge |
| *Allium angulosum* | May-Aug | E | I |
| *Althaea officinalis* | Apr-Aug | E | I |
| *Anthoxanthum odoratum* | Mar-Aug | A | Ge |
| *Briza media* | Apr-Aug | A | Ge |
| *Caltha palustris* | Feb-Jun | E | I* |
| *Campanula glomerata* | May-Sep | E | Ge |
| *Centaurea nigrescens* | May-Dec | E | Ge |
| *Cichorium intybus* | Jun-Nov | E | Ge |
| *Cirsium arvense* | Apr-Nov | E | Ge |
| *Cirsium oleraceum* | May-Sep | E | I |
| *Cirsium palustre* | May-Sep | E | I |
| *Daucus carota* subsp. *carota* | Apr-Oct | E | X |
| *Echium vulgare* | Mar-Sep | E | X |
| *Eupatorium cannabinum* subsp. *cannabinum* | Jul-Oct | E | I |
| *Genista tinctoria* | Apr-Jul | E | I |
| *Gratiola officinalis* | May-Aug | E | I |
| *Hypericum perforatum* | Apr-Aug | E | Ge |
| *Inula britannica* | Jun-Sep | E | I |
| *Iris pseudacorus* | Mar-Jun | E | I* |
| *Knautia arvensis* | Apr-Sep | E | Ge |
| *Leontodon hispidus* | May-Oct | E | Ge |
| *Leucanthemum vulgare* subsp. *vulgare* | Feb-Oct | E | Ge |
| *Lysimachia vulgaris* | May-Aug | E | I |
| *Lythrum salicaria* | May-Sep | E | I* |
| *Malva alcea* | May-Sep | E | Ge |
| *Mentha longifolia* | May-Oct | E | I |
| *Onobrychis arenaria* | Apr-Aug | E | X |
| *Onobrychis viciifolia* | Apr-Aug | E | Ge |
| *Pastinaca sativa* | Jun-Aug | E | Ge |

| SPECIES - SCIENTIFIC NAME (CONTI ET AL. 2005; 2007) | FLOWERING PERIOD | TYPE | ENVIRONMENT |
|---|---|---|---|
| *Salvia pratensis* | Apr-Aug | E | X |
| *Scabiosa triandra* | May-Sep | E | X |
| *Scrophularia umbrosa* subsp. *umbrosa* | May-Sep | E | I |
| *Scutellaria galericulata* | May-Aug | E | I |
| *Senecio paludosus* subsp. *angustifolius* | May-Sep | E | I* |
| *Silene flos-cuculi* | Apr-Aug | E | I |
| *Stachys palustris* | May-Aug | E | I |
| *Symphytum officinale* | Apr-Nov | E | Ge |
| *Thalictrum lucidum* | May-Aug | E | I |
| *Tragopogon pratensis* subsp. *orientalis* | May-Aug | E | Ge |
| *Trifolium pratense* | Jan-Dec | E | Ge |
| *Trisetaria flavescens* | May-Aug | A | Ge |
| *Valeriana dioica* | Apr-Jul | E | I |
| *Veronica anagallis-aquatica* subsp. *anagallis-aquatica* | May-Oct | E | I* |

***E**: insect-pollinated plant; **A**: wind-pollinated plant (mainly grasses); **I**: hygrophilous; **Ge**: generalist; **X**: tolerates aridity (dry soils, dry meadows); *****: tolerates periods of submersion*

| Summary Sheet | |
|---|---|
| **Characteristics** | perennial; moderate to abundant flowering; high landscape value |
| **Location** | sunny and sheltered areas; soils ranging from light to heavy, from well-drained to moist |
| **Required Skills** | moderate (for mesophilous strips, soil and/or existing dense turf preparation is necessary) |
| **Preliminary Work** | mesophilous strips: In the presence of dense turf, cutting and breaking of the turf hygrophilous strips: cutting of the turf |
| **Period of intervention** | mid-October |
| **Technique** | manual transplantation in small mono-specific groups |
| **Flowering Period** | May-September |
| **Management** | • regular mowing. Plan for two cuts per year, with the first one after mid-June<br>• plan for multiple summer cuts in case of invasive species presence |
| **Remarks** | • use plants of native species from certified nurseries and/or retailers<br>• limit the first mowing to specific areas to allow summer-flowering species to complete their life cycle, subjecting them only to the second mowing<br>• since native plants used for wildflower strip creation may not always be available in nurseries' regular production, plan the intervention well in advance to source the material |

# ESTABLISHMENT AND MANAGEMENT OF SHRUB PATCHES AND HEDGES

This sheet illustrates the methods for creating and managing shrub patches and hedges, valorizing marginal areas within the farm. **Shrub patches** are formations that exhibit an areal (non linear) development, recreated on small marginal areas (typically not less than 100 sqm), and consist exclusively of shrub species. In contrast, **hedges**, are linear formations, typically created at the edge of crops or along the banks of channels and ditches. Unlike shrub patches, hedges can be more structurally diverse: they may include only the shrub component, or they may contain a tree component with different percentage of coverage. Once widespread in agricultural areas, these habitats are now almost disappeared, present only in small fragments. Their presence helps to increase the complexity of the rural landscape, often very simplified and poor in naturalistic terms; they also represent important habitats for many animal and plant species that find resources and shelter there, and that can also use them to move and spread within a hostile territory. Many native shrub species are highly attractive to numerous species of pollinating insects. Often, moreover, the flowering of different species follows one another between the end of winter and the end of spring, constituting a source of sustenance for pollinating insects when the floral resources provided by grassland species are not yet available.
In addition to providing suitable habitats for many wild species, these habitats provide numerous other services: they delimit and protect the boundaries of the farm, limit the spread of antiparasitic, fungicides, and chemical pesticides from cultivated areas to permanent meadows, limiting the consequent negative effects on biodiversity and beneficial insects. Hedges mitigate the wind, improve the local microclimate, regulate water runoff, and purify

## BOX: EARLY FLOWERING SHRUB SPECIES

| SPECIES | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cornus mas* | | | | | | | | | | | | |
| *Cornus sanguinea* | | | | | | | | | | | | |
| *Crataegus monogyna* | | | | | | | | | | | | |
| *Ligustrum vulgare* | | | | | | | | | | | | |
| *Prunus spinosa* | | | | | | | | | | | | |
| *Rosa canina* | | | | | | | | | | | | |
| *Salix cinerea* | | | | | | | | | | | | |
| *Viburnum lantana* | | | | | | | | | | | | |
| *Viburnum opulus* | | | | | | | | | | | | |

*LEGEND: The colored squares depict the flower color and the flowering period.*

it from nutrient loads, stabilize canal banks, provide poles for agricultural uses, and possibly wood for energy use, represent a trophic source for beekeeping (honey-bearing hedges), produce small fruits (e.g., *Corylus avellana*, *Prunus* spp., *Sambucus nigra*, etc.).

*The extensive early flowering ensures food resources for pollinator insects when floral resources provided by meadow species are not yet available*

*In addition to providing resources and refuge for many wild species, hedges increase the complexity of the agricultural landscape, which is often very simplified, limit the spread of pesticides and fungicides, mitigate the wind, improve the local microclimate, regulate and purify runoff water, stabilize canal banks, and provide poles for agricultural uses*

## ESTABLISHMENT OF HEDGES AND SHRUB PATCHES: HOW TO DO IT

The methods of intervention for the creation of hedges and shrub patches are similar; however, the species composition should be tailored to the local soil characteristics[15]. Possible issues may arise from previous tillage and fertilization practices to which agricultural land has been subjected.

### 1. Soil Preparation

Preliminary soil preparation varies depending on the characteristics of the planting site and aims to improve soil functionality and quality while reducing weed growth.

#### 1a. Areas previously used as arable land

To convert land recently used as arable land, it is essential to undertake deep soil tillage to break up any impermeable layer that often forms between the usual tillage depth and the underlying soil (30-50 cm). These layers can hinder the optimal development of plant root systems, thereby jeopardising the success of the intervention. This operation involves deep plowing to a depth of at least 60-80 cm, followed by superficial milling and harrowing. The process is as follows:

1. deep tillage using a subsoiler;
2. superficial milling of the soil;
3. preparation of the planting area by harrowing.

#### 1b. In the presence of sod

In this case, the soil should only be worked on the surface, with light milling or localized harrowing. Soil preparation should be done shortly before planting.

### 2. Establishment of the hedge and shrub patch

This intervention exclusively uses young **seedlings aged 1-3 years in soil blocks**. Planting operations are entirely manual or with the assistance of manual equipment, including transplanters. For planting, **a small planting hole** (average dimensions of 10 x 10 cm based on the size of the soil block) should be dug, into which the seedlings are placed, ensuring that the plant's collar is at ground level: the roots should not protrude, nor should the stem be excessively buried. The planting hole should then be filled with excavated soil, with slight pressure applied to the soil block to encourage root growth outside of the soil block itself.

For the establishment of a shrub patch, the plants should be planted according toa **checkerboard grid pattern**, with the shrubs staggered between rows. The planting density varies depending on the size and shape that the plant will assume when mature. For surfaces with regular shapes, typically square or circular, larger than 250-300 square meters, it is recommended to plant **one shrub every 2 meters** along each row, with **rows spaced 3-3.5 meters apart**; the **density** will therefore be **one plant per 7 square meters**. For surfaces with regular shapes smaller

[15] *Del Favero R., 1999. Biodiversity and indicators in the forest types of Veneto, Veneto Region - Regional Directorate of Forests and Mountain Economy and Italian Academy of Forest Sciences, pp 335 (in Italian).*

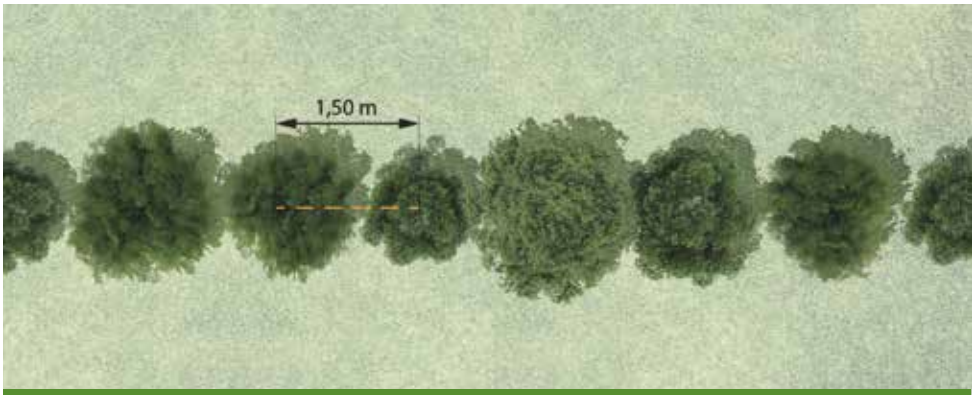
than 250-300 square meters, or for larger but narrow and elongated surfaces, it is possible to reduce the distance between rows to 2 meters, resulting in a planting **density of one plant per 4 square meters**.

For the creation of a **hedge**, once the soil has been prepared, it is necessary to apply **mulch** to limit competition from spontaneous vegetation on the young plants in the first few years after the intervention. This operation involves the utilisation of **biodegradable materials such as jute or coconut fiber** sheets to be laid down over the prepared soil prior to the planting of the seedlings. These materials must be firmly secured at the sides and heads of each continuous stretch of hedge. The seedlings are then planted at intervals corresponding to the incisions made in the sheets at the desired distances.

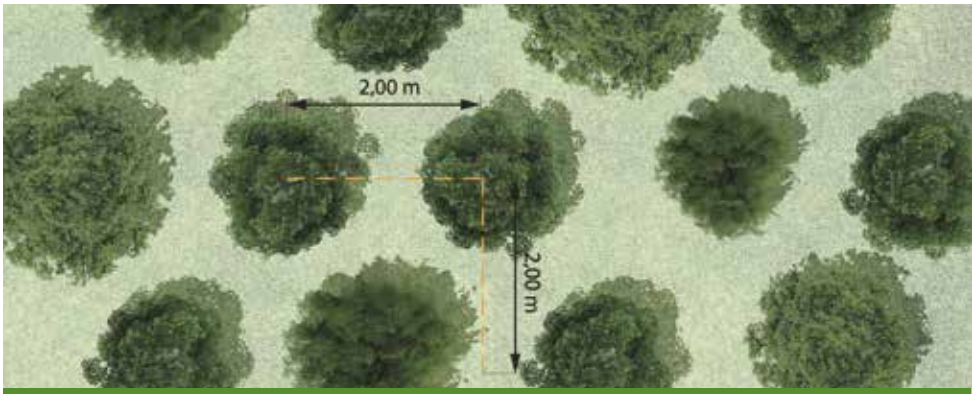
The distance typically used between seedlings is **1.5 meters**. In cases where the tree component is also included, it is advisable to provide a distance of **9 meters** between each tree.

The species used in the creation of hedges and shrub patches are typically part of the regular production of nurseries and therefore do not create problems in terms of availability.

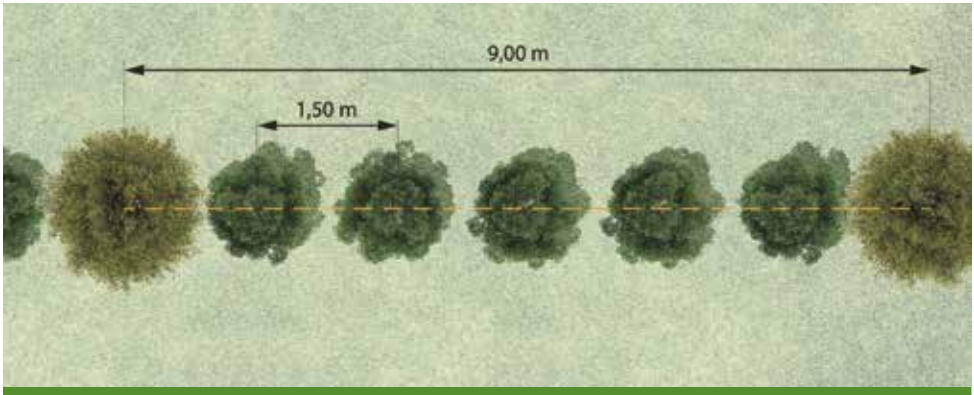
In the creation of a hedge that also includes a tree component, it is recommended that both the species selected and their position be considered with regard to the potential encumbrance and shading that they may exert once they have reached maturity.




*Planting schemes for hedges consisting exclusively of shrubs*




*Planting schemes for shrub patches*




*Planting schemes for mixed tree-shrub hedges*

## SPECIES - WOODY PLANTS

| SPECIES - SCIENTIFIC NAME (CONTI ET AL. 2005; 2007) | FLOWERING PERIOD | TYPE | ENVIRONMENT | DISTRIBUTION |
|---|---|---|---|---|
| *Acer campestre* | Mar-May | E | Ge | B/A |
| *Carpinus betulus* | Apr-Jun | A | Ge | B/A |
| *Cornus mas* | Jun-Apr | E | Ge | A |
| *Cornus sanguinea* | Apr-Jun | E | Ge | B/A |
| *Corylus avellana* | Feb-Apr | A | Ge | B/A |
| *Crataegus laevigata* | Mar-Jun | E | Ge | B/A |
| *Crataegus monogyna* | Mar-May | E | Ge | B/A |
| *Euonymus europeus* | Mar-Jun | E | Ge | B/A |
| *Frangula alnus* subsp. *alnus* | Apr-Jun | E | I | B/A |
| *Fraxinus ornus* subsp. *ornus* | Mar-May | E | Ge/X | B/A |
| *Ligustrum vulgare* | Mar-May | E | Ge | B/A |
| *Lonicera caprifolium* | Apr-Lug | E | Ge | B/A |
| *Lonicera xylosteum* | Apr-Lug | E | Ge | A |
| *Malus sylvestris* | Apr-May | E | Ge | B/A |
| *Prunus mahaleb* | Apr-May | E | Ge | B/A |
| *Prunus spinosa* | Jun-Apr | E | Ge | B/A |
| *Pyrus communis* subsp. *pyraster* | Mar-May | E | Ge | A |
| *Rhamnus cathartica* | Mar-Jun | E | X | B/A |
| *Rosa canina* | Mar-Lug | E | Ge | B/A |
| *Salix cinerea* | Feb-Apr | E | I | B |
| *Salix purpurea* | Feb-Apr | E | I | B/A |
| *Sorbus torminalis** | Mar-May | E | Ge | B |
| *Ulmus minor* | Feb-Mar | E/A | Ge | B/A |
| *Viburnum lantana* | Mar-May | E | I | B/A |
| *Viburnum opulus* | Apr-Jun | E | Ge | B/A |

***E**: insect-pollinated plant; **A**: wind-pollinated plant; **Ge**: generalist; **I**: hygrophilous*
***B**: Low Plain; **A**: High Plain; * prefers acidic soils, but adapts to limestone soils*

The plantings should be carried out during the dormancy, from **late autumn to late winter**, thus in the plains between the months of October and March, **anyway before the start of the spring vegetative awakening**, and avoiding periods with frozen ground. However, the optimal period remains autumn, especially the month of November.

### BOX: FIRE BLIGHT

In agricultural settings, the choice of species to use must consider the possible presence of orchards of the *Prunus* genus: in this case, the shrubby Rosaceae species typical of the Venetian plain cannot be used. Planting species of the genera *Crataegus*, *Sorbus*, *Pyrus*, *Malus* is not recommended in areas suited to fruit growing, especially in protected areas under the regional regulations in force, as they are highly susceptible to the Rosaceae fruit tree pathology called fire blight (*Erwinia amylovora*).

## MANAGEMENT AND MAINTENANCE OF HEDGES AND SHRUB PATCHES

Compared to herbaceous habitats, shrub patches and hedges pose **fewer management and maintenance issues**. In the first years after planting, and especially in the first one, it is essential to ensure the regular **mowing** to reduce competition from invasive herbaceous species. Once the seedlings have become established, mowing can decrease in intensity and frequency and will only serve to ensure better development for the shrubs or trees. After the third year from planting, mowing of the invasive species may no longer be necessary.

The images below illustrate the sequence of operations required to create a hedge or shrub patch. The creation of shrub patches or hedges necessitates a certain degree of expertise, predominantly in the context of preliminary soil preparation. It is also crucial to adhere to the procedures depicted in Figures 3 and 4. Following soil preparation, mulching is essential to prevent competition from spontaneous vegetation and ensure the survival of young plants during their initial years after the intervention.

*1. Surface preparation of the soil using a rotary tiller*


*2. Excavation of the hole using manual mechanical equipment or a motorized auger*


*3. Mulching of a circular area with a radius of at least 50 cm around the planting hole using biodegradable material such as coconut fiber or jute*


*4. Planting of seedlings inside the planting holes through an X-shaped slit in the mulch cover*

*5. Manual filling of the planting holes and soil compaction*

*6. Placement of the supporting pole*

*7. Localized fertilization using organic-mineral fertilizer*

## Summary Sheet

| | |
|---|---|
| **Characteristics** | perennial; abundant spring flowering; high landscape value |
| **Location** | sunny areas; soils ranging from light to heavy, from well-drained to moist |
| **Required Skills** | moderate (preparation of soil and/or existing sod is necessary) |
| **Preliminary Work** | soil preparation through deep plowing with a subsoiler, superficial milling, and area preparation through harrowing. In the presence of existing sod, light milling or localized harrowing |
| **Period of intervention** | mid-October to mid-December |
| **Technique** | manual staggered planting for shrub patches and linear planting for hedges |
| **Flowering Period** | January to July |
| **Management** | mowing of invasive herbaceous species during the first two years after planting |
| **Remarks** | • use plants of native species from certified nurseries and/or retailers<br>• for the creation of a hedge, apply mulch to limit competition from spontaneous vegetation using biodegradable jute or coconut fiber sheets |

# APPENDIX 1

# INTERVENTION TIMELINE

| | JAN | | FEB | | MAR | | APR | | MAY | | JUN | | JUL | | AUG | | SEP | | OCT | | NOV | | DEC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV |
| **Realization and Management of Species-Rich Hay Meadows from Former Arable land** | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Soil Preparation*** | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Mowing of the vegetation present in the former cultivation | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | |
| 2. Harrowing of the soil | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | |
| 3. Second harrowing following the germination of weed species | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | |
| ***Establishment of the Meadow*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Option A. Seeding of seed mixtures | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | |
| Option B. Use of hay rich in seeds | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Identification of the donor meadow | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | |
| 2. Mowing of the donor meadow | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | |
| 3. Drying of the hay | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | |
| 4. Preservation of the bales | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | |
| 5. Spreading of the hay | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | |
| Option C. Use of brush-harvested seed | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Identification of the donor meadow | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | |
| 2. Collection of the brush-harvested seed | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | |
| 3. Drying of the brush-harvested seed | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | |
| 4. Preservation of the brush-harvested seed in suitable bags | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | |
| 5. Spreading of the brush-harvested seed | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | |
| ***Management and Maintenance of the Meadow*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Option A: Mowing for livestock purposes | | | | | | | | | | ■ | | | | ■ | ■ | | | ■ | | | | | | |
| Option B: Mowing for conservation purposes (e.g., donor meadows) | | | | | | | | | | | ■ | | | | ■ | | | ■ | | | | | | |

| | JAN | | FEB | | MAR | | APR | | MAY | | JUN | | JUL | | AUG | | SEP | | OCT | | NOV | | DEC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV |
| **Restoration and Improvement of Abandoned Meadows** | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Restoration of the Meadow*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Option A. Recovery through mowing | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Brush clearing | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | |
| 2. Mowing with removal of clippings | | | | | | | | | | | ■ | | | ■ | | | ■ | | | | | | | |
| Option B. Enrichment through overseeding | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Low mowing of existing sod and removal of clippings | | | | | | | | | | | | | | | | | | ■ | | | | | | |
| 2. Overseeding with a mixture of seeds, seed-rich hay, or brush-harvested seed | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | |
| Option C. Enrichment through planting seedlings in soil blocks | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Low mowing of existing sod and removal of clippings | | | | | | | | | | | | | | | | | | ■ | | | | | | |
| 2. Planting seedlings in soil plugs | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | |
| ***Management and maintenance of the meadow*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mowing with removal of clippings | | | | | | | | | | | ■ | | | ■ | | | ■ | | | | | | | |
| **Restoration and Improvement of Intensive Meadows** | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Restoration of the meadow by ceasing liquid manure practices*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Option A. Enrichment through overseeding | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Low mowing of existing sod and removal of clippings | | | | | | | | | | | | | | | | | | | ■ | | | | | |
| 2. Overseeding | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | |
| Option B. Enrichment through planting seedlings in soil blocks | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Low mowing of existing sod and removal of clippings | | | | | | | | | | | | | | | | | | | ■ | | | | | |
| 2. Planting seedlings in soil blocks | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | |
| ***Management and maintenance of the meadow*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mowing with removal of clippings | | | | | | | | | | | ■ | | | ■ | | | ■ | | | | | | | |

| | JAN | | FEB | | MAR | | APR | | MAY | | JUN | | JUL | | AUG | | SEP | | OCT | | NOV | | DEC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV |
| **Creation and Management of Annual Wildflower Strips** | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Soil Preparation*** | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Surface plowing of the soil | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | |
| 2. Harrowing of the soil | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | |
| 3. Second harrowing after the germination of weed species | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | |
| ***Strip Creation*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Seeding of seed mixtures | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | |
| **Creation and Management of Perennial Wildflower Strips** | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Soil Preparation*** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Mesophilous flower strips in areas previously used as arable land* | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Harrowing of the soil | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | |
| 2. Second harrowing after the germination of weed species | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | |
| *Mesophilous flower strips in areas with dense sod layer* | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Low mowing of the existing sod and removal of clippings | | | | | | | | | | | | | | | | | | | ■ | | | | | |
| 2. Breaking the continuity of the sod layer | | | | | | | | | | | | | | | | | | | ■ | | | | | |
| *Hygrophilous flower strips* | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Low mowing of the existing sod and removal of clippings | | | | | | | | | | | | | | | | | | | ■ | | | | | |
| ***Strip Creation*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Planting of seedlings in soil blocks | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | |
| ONLY for mesophilous strips: seeding to support the planting | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | |
| ***Management and Maintenance of the Strip*** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Mesophilous flower strips* | | | | | | | | | | | | | | | | | | | | | | | | |
| Mowing with removal of clippings | | | | | | | | | | | | ■ | | | | ■ | ■ | | | | | | | |
| *Hygrophilous flower strips* | | | | | | | | | | | | | | | | | | | | | | | | |
| Mowing with removal of clippings | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | |

| | JAN | | FEB | | MAR | | APR | | MAY | | JUN | | JUL | | AUG | | SEP | | OCT | | NOV | | DEC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV | I-II | III-IV |
| **Realization and Management of Shrub Patches and Hedges** | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Soil Preparation*** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Areas previously used as arable land* | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Deep cultivation using a subsoiler | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Surface soil cultivation using superficial milling | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Preparation of the planting area through harrowing | | | | | | | | | | | | | | | | | | | | | | | | |
| *Areas with the presence of dense sod layer* | | | | | | | | | | | | | | | | | | | | | | | | |
| Light surface soil cultivation using superficial milling | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Establishment of the hedge and shrub patch*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Planting of seedlings and mulching | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Management and Maintenance of Hedges and Shrub patches*** | | | | | | | | | | | | | | | | | | | | | | | | |
| Mowing of weed species | | | | | | | | | | | | | | | | | | | | | | | | |

# APPENDIX 2

## LIST OF PLANTS MENTIONED IN THE TEXT WITH THEIR SCIENTIFIC BINOMIAL SPECIES NAMES AND COMMON NAMES

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| *Abutilon theophrasti* Medik. | Velvetleaf |
| *Acer campestre* L. | Hedge maple |
| *Acer negundo* L. | Box elder |
| *Achillea millefolium* L. | Common yarrow |
| *Agrostemma githago* L. | Common corn-cockle |
| *Ailanthus altissima* (Mill.) Swingle | Tree of Heaven |
| *Ajuga reptans* L. | Bugleweed |
| *Allium angulosum* L. | Mouse garlic |
| *Allium carinatum* L. | Keeled Garlic |
| *Allium lusitanicum* Lam. | Mountain garlic |
| *Alopecurus pratensis* L. subsp. *pratensis* | Meadow foxtail |
| *Althaea officinalis* L. | Common marshmallow |
| *Amaranthus* sp. | Amaranth |
| *Amorpha fruticosa* L. | False indigo-bush |
| *Anthemis arvensis* L. | Scentless chamomile |
| *Anthericum ramosum* L. | Branched St Bernard's lily |
| *Anthoxanthum odoratum* L. | Sweet vernal grass |
| *Anthyllis vulneraria* L. | Common kidneyvetch |
| *Armeria helodes* Martini & Poldini | Thrift |
| *Arrhenatherum elatius* (L.) P. Beauv. ex J. & C. Presl | Tall oat-grass |
| *Artemisia verlotiorum* Lamotte | Chinese mugwort |
| *Borago officinalis* L. | Common borage |
| *Bothriochloa ischaemum* (L.) Keng | Yellow bluestem |
| *Briza media* L. | Quaking-grass |
| *Bromus condensatus* Hack. | Brome grass |
| *Bromus erectus* Huds. | Meadow brome |
| *Bromus hordeaceus* L. | Soft brome |
| *Buddleja davidii* Franch. | Butterfly bush |
| *Buphthalmum salicifolium* L. | Ox-eye |
| *Calendula arvensis* L. | Field marigold |
| *Caltha palustris* L. | Marsh marigold |

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| *Calystegia sepium* (L.) R. Br. subsp. *sepium* | Hedge bindweed |
| *Campanula glomerata* L. | Clustered bellflower |
| *Campanula rapunculus* L. | Rampion bellflower |
| *Campanula sibirica* L. | Siberian bellflower |
| *Cardamine matthioli* Moretti | Mattioli's bellflower |
| *Carpinus betulus* L. | European hornbeam |
| *Catalpa bignonioides* Walter | Cigartree |
| *Centaurea dichroantha* A. Kern. | South Eastern Knapweed |
| *Centaurea jacea* L. subsp. *forojulensis* (Poldini) Greuter | Brown Knapweed |
| *Centaurea jacea* L. subsp. *gaudinii* (Boiss. & Reut.) Gremli | Gaudin's Knapweed |
| *Centaurea nigrescens* Willd. | Short fringed Knapweed |
| *Centaurea scabiosa* L. subsp. *scabiosa* | Greater knapweed |
| *Chrysopogon gryllus* (L.) Trin. | Scented grass |
| *Cichorium intybus* L. | Common chicory |
| *Cirsium arvense* (L.) Scop | Creeping thistle |
| *Cirsium canum* (L.) All. | Queen Anne's thistle |
| *Cirsium oleraceum* (L.) Scop. | Cabbage thistle |
| *Cirsium palustre* (L.) Scop. | Marsh thistle |
| *Cirsium vulgare* (Savi) Ten. | Spear thistle |
| *Consolida regalis* Gray | Forking larkspur |
| *Cornus mas* L. | Cornel cherry |
| *Cornus sanguinea* L. | European dogwood |
| *Corylus avellana* L. | Hazelnut |
| *Crataegus laevigata* (Poir.) DC. | Midland hawthorn |
| *Crataegus monogyna* Jacq. | Common hawthorn |
| *Crepis biennis* L. | Rough hawksbeard |
| *Cyanus segetum* Hill | Cornflower |
| *Dactylis glomerata* L. | Cat grass |
| *Daucus carota* L. subsp. *carota* | Wild carrot |
| *Dianthus carthusianorum* L. | Carthusian pink |
| *Dorycnium herbaceum* Vill. | Herbaceus Canary clover |
| *Echium vulgare* L. | Blue viper's-bugloss |
| *Erigeron annuus* (L.) Desf. | Annual fleabane |

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| *Erucastrum palustre* (Pirona) Vis. | Friulian Marsh rocket |
| *Euonymus europeus* L. | Common spindle |
| *Eupatorium cannabinum* L. subsp. *cannabinum* | Hemp-agrimony |
| *Fallopia japonica* (Houtt.) Ronse Decr. | Japanese knotweed |
| *Fagopyrum esculentum* Moench | Buckwheat |
| *Festuca arundinacea* Schreb. | Tall fescue |
| *Festuca pratensis* Huds. | Meadow fescue |
| *Festuca rubra* L. | Red fescue |
| *Filipendula ulmaria* (L.) Maxim. | Common meadowsweet |
| *Filipendula vulgaris* Moench | Dropwort meadowsweet |
| *Frangula alnus* Mill. subsp. *alnus* | Alder buckthorn |
| *Fraxinus ornus* L. subsp. *ornus* | Flowering ash |
| *Galium mollugo* L. | Hedge bedstraw |
| *Galium verum* L. | Yellow bedstraw |
| *Genista tinctoria* L. | Dyer's Greenweed |
| *Gentiana pneumonanthe* L. subsp. *pneumonanthe* | Marsh gentian |
| *Geranium molle* L. | Dovesfoot geranium |
| *Gladiolus palustris* Gaudin | Marsh gladiolus |
| *Glechoma hederacea* L. | Ground Ivy |
| *Gratiola officinalis* L. | Hedge hyssop |
| *Helianthemum nummularium* (L.) Mill. subsp. *obscurum* (Celak.) Holub | Common rock-rose |
| *Helminthotheca echioides* (L.) Holub | Bristly oxtongue |
| *Hemerocallis fulva* (L.) L. | Tawny daylily |
| *Holcus lanatus* L. | Common velvet grass |
| *Homalotrichon pubescens* (Huds.) Banfi, Galasso & Bracchi | Downy alpine oat grass |
| *Impatiens* spp. | Balsam |
| *Inula britannica* L. | British yellowhead |
| *Inula salicina* L. | Willowleaf yellowhead |
| *Iris pseudacorus* L. | Water flag |
| *Iris sibirica* L. | Siberian iris |
| *Knautia arvensis* (L.) Coult. | Common ambretta |
| *Lamium orvala* L. | Balm-leaved Red Deadnettle |

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| *Lamium purpureum* L. | Purple dead nettle |
| *Lathyrus pratensis* L. | Meadow vetchling |
| *Legousia speculum-veneris* (L.) Chaix | Venus's-looking-glass |
| *Leontodon hispidus* L. | Bristly hawkbit |
| *Leucanthemum vulgare* Lam. subsp. *vulgare* | Ox-eye daisy |
| *Leucojum aestivum* L. | The summer snowflake |
| *Ligustrum lucidum* Aiton | Glossy privet |
| *Ligustrum ovalifolium* Hassk. | Oval-leaved privet |
| *Ligustrum sinense* Lour. | Chinese privet |
| *Ligustrum vulgare* L. | Common privet |
| *Linum flavum* L. | Yellow flax |
| *Lolium multiflorum* Lam. | Italian rye-grass |
| *Lolium perenne* L. | Perennial ryegrass |
| *Lonicera caprifolium* L. | Perfoliate honeysuckle |
| *Lonicera japonica* Thunb. | Japanese honeysuckle |
| *Lonicera xylosteum* L. | European fly honeysuckle |
| *Lotus corniculatus* L. | Common bird's-foot trefoil |
| *Lysimachia vulgaris* L. | Yellow loosestrife |
| *Lythrum salicaria* L. | Purple loosestrife |
| *Mahonia aquifolium* (Pursh) Nutt. | Oregon grape |
| *Malus sylvestris* (L.) Mill. | Wild apple |
| *Malva alcea* L. | Greater musk-mallow |
| *Matricaria chamomilla* L. | Common Chamomile |
| *Medicago lupulina* L. | Black medic |
| *Medicago sativa* L. | Lucerne/Alfalfa |
| *Melampyrum arvense* L. | Field cow-wheat |
| *Mentha arvensis* L. | Corn mint |
| *Mentha longifolia* (L.) Huds. | Horsemint |
| *Molinia caerulea* (L.) Moench | Purple moor-grass |
| *Nigella damascena* L. | Love-in-a-mist |
| *Oenothera* spp. | Evening primrose |
| *Onobrychis arenaria* (Kit.) DC. | Sand esparcet |
| *Onobrychis viciifolia* Scop. | Sainfoin |

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| *Ononis spinosa* L. | Spiny restharrow |
| *Papaver rhoeas* L. | Common poppy |
| *Parnassia palustris* L. subsp. *palustris* | Grass of Parnassus |
| *Pastinaca sativa* L. | Wild parsnip |
| *Peucedanum oreoselinum* (L.) Moench | Mountain Parsley |
| *Phacelia tanacetifolia* Benth. | Phacelia |
| *Phytolacca americana* L. | American Pokeweed |
| *Phleum pratense* L. | Timothy |
| *Pimpinella major* (L.) Huds. | Greater burnet-saxifrage |
| *Pimpinella saxifraga* L. | Burnet-saxifrage |
| *Plantago altissima* L. | Narrowleaf plantain |
| *Poa pratensis* L. | Common meadow grass |
| *Poa trivialis* L. | Rough meadow grass |
| *Primula farinosa* L. | Bird's eye primrose |
| *Prunella grandiflora* (L.) Scholler | Self-heal |
| *Prunus laurocerasus* L. | Cherry laurel |
| *Prunus mahaleb* L. | Mahaleb cherry |
| *Prunus spinosa* L. | Blackthorn |
| *Pueraria lobata* (Willd.) Ohwi | Kudzu |
| *Pyrus communis* L. subsp. *pyraster* (L.) Ehrh. | Wild pear |
| *Ranunculus acris* L. | Tall buttercup |
| *Ranunculus arvensis* L. | Field buttercup |
| *Ranunculus bulbosus* L. | Bulbous buttercup |
| *Ranunculus sceleratus* L. | Celery-leaved buttercup |
| *Rhamnus cathartica* L. | Common buckthorn |
| *Rhinanthus freynii* (Sterneck) Fiori | Freyn's yellow-rattle |
| *Robinia pseudoacacia* L. | Black locust |
| *Rosa canina* L. | Dog rose |
| *Rosa rugosa* Thunb. | Japanese rose |
| *Salix cinerea* L. | Grey willow |
| *Salix purpurea* L. | Purple willow |
| *Salvia pratensis* L. | Meadow sage |
| *Scabiosa columbaria* L. | Small scabious |

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| | |
| *Scabiosa triandra* L. | Narrowleaf scabious |
| *Scorzonera villosa* Scop. | Scorzoner |
| *Scrophularia umbrosa* Dumort. subsp. *umbrosa* | Green figwort |
| *Scutellaria galericulata* L. | Marsh Skullcap |
| *Selinum carvifolia* (L.) L. | Little-leaf angelica |
| *Senecio paludosus* L. subsp. *angustifolius* Holub | Fen Ragwort |
| *Serratula tinctoria* L. | Saw-wort |
| *Silene flos-cuculi* (L.) Clairv. | Ragged-robin |
| *Solidago canadensis* L. | Canadian Goldenrod |
| *Solidago gigantea* Aiton | Giant Goldenrod |
| *Sorbus torminalis* (L.) Crantz | Wild Service-tree |
| *Sorghum halepense* (L.) Pers. | Johnson grass |
| *Spiraea japonica* L. | Japanese Spirea |
| *Stachys officinalis* (L.) Trevis. | Common hedgenettle |
| *Stachys palustris* L. | Marsh Woundwort |
| *Succisa pratensis* Moench | Devil's Bit Scabious |
| *Symphyotrichum lanceolatum* (Willd.) G.L.Nesom | Panicled Aster |
| *Symphytum officinale* L. | Comfrey |
| *Taraxacum officinale* (aggr.) | Common Dandelion |
| *Taraxacum palustre* (aggr.) | Marsh Dandelion |
| *Tetragonolobus maritimus* (L.) Roth | Dragon's teeth |
| *Thalictrum lucidum* L. | Shining meadow-rue |
| *Tofieldia calyculata* (L.) Wahlenb. | Tofield's Asphodel |
| *Torilis arvensis* (Huds.) Link | Spreading hedge parsley |
| *Trachycarpus fortunei* (Hook.) H. Wendl. | Chinese windmill palm |
| *Tragopogon pratensis* L. subsp. *orientalis* (L.) Celak. | Oriental goat's beard |
| *Trifolium campestre* Schreb. | Hop trefoil |
| *Trifolium dubium* Sibth. | The lesser trefoil |
| *Trifolium incarnatum* L. | Crimson Clover |
| *Trifolium pratense* L. | Red Clover |
| *Trifolium repens* L. | White Clover |
| *Trisetaria flavescens* (L.) Baumg. | Yellow oatgrass |

| Scientific name (Conti et al. 2005; 2007) | Common name |
|---|---|
| *Ulmus minor* Mill. | Field Elm |
| *Valeriana dioica* L. | Marsh Valerian |
| *Veronica anagallis-aquatica* L. subsp. *anagallis-aquatica* | Water Speedwell |
| *Veronica arvensis* L. | Wall Speedwell |
| *Viburnum lantana* L. | Wayfaring Tree |
| *Viburnum opulus* L. | Guelder-rose |
| *Vicia cracca* L. | Cow Vetch |
| *Vicia sativa* L. | Common Vetch |
| *Viola arvensis* Murray | Field Violet |

## NOTES: