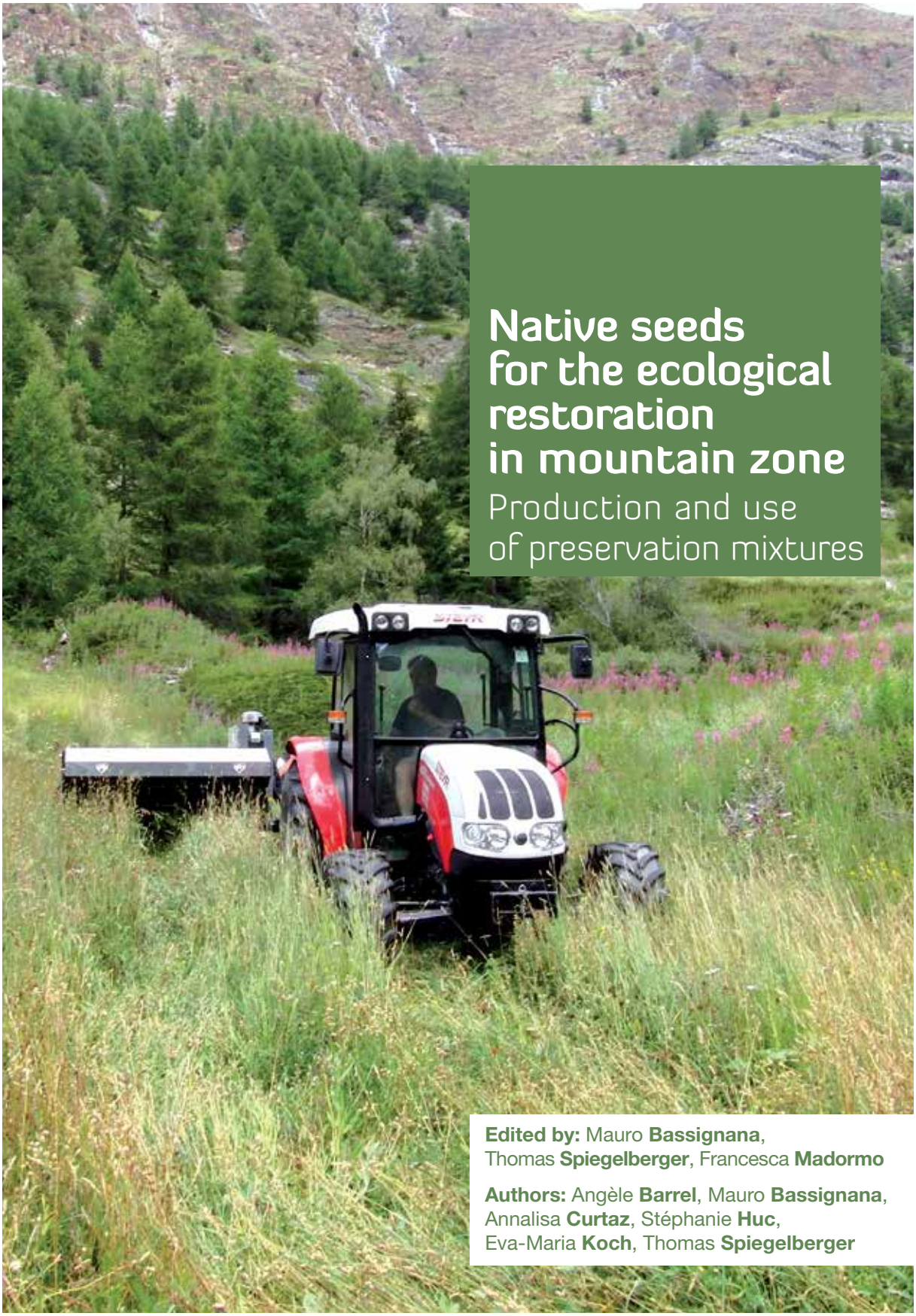

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Production and use of preservation mixtures

Edited by: Mauro **Bassignana**, Thomas **Spiegelberger**, Francesca **Madormo**

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The project
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Chapter 1
Introduction

Chapter 1
Introduction

The large grassland areas in the Alps are a valuable asset for agricultural activities and for mountain tourism. The earthworks necessary for a better agricultural management of land or for tourism activities sometimes require heavy modelling of the slopes, in a fragile environment.

Restoration of the vegetation at the end of the earth moving works is now a common practice. Current methods are very different from those used a few decades ago. All over the Alps, soil management is treated with more attention and revegetation methods are used that improve the distribution of seeds and their persistence in the soil. These innovations allow to obtain, quickly, a vegetal cover.

The environment protection is now at the centre of the issues related with regional development. The local authorities, as well as private facilities (for example, ski resorts, contractors, etc.), are more sensitive to the environmental sustainability of these operations.

Mountain agriculture as a whole and, in particular, livestock farming is recognized today as a source of biodiversity, related to management of grasslands that host rare species or remarkable plants, typical of the alpine environments. Enhancing the role of agriculture in providing goods and services that promote biodiversity in these areas appears, within this context, an interesting possibility to diversify farm incomes.

Despite the considerable efforts made for revegetation research in the mountains, the origin of seeds remains an issue to examine in depth. It is widely recognized that site-specific seeds can better withstand the conditions, sometimes extreme, of mountain areas, especially at higher elevations. The tests conducted in the Pyrenees and in the Eastern Alps showed the superiority of local seeds compared to those obtained from plants not adapted to the hard climatic conditions of high-altitude environments.

The use of local seeds should also be promoted for a second reason: seed collection or multiplication can provide an income support for farms wishing to invest in this field.

Restoration of semi-natural grasslands with high biodiversity could offer the farmers a real chance for diversification, by allocating a portion of their grassland to the production of seeds of native species that can be used on surfaces to be reseeded.

The context, therefore, seems favourable for the emergence and development of a new economic and sustainable mountain agriculture supply chain, based on a dynamic perspective: sustainable land management.

The authors of this publication wish to contribute to increase the knowledge on the feasibility of direct harvest of local seeds, analysing the legal framework, the technical and economic point of view and the environmental outcomes.

Chapter 2
The legal framework

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The legal framework

2.1 1 The legislation governing the production and placing on the market of plant species

The European Union has been legislating the production and placing on the market of plant species including seeds since the 1960s.

Rules to be abided by

Considering that "placing on the market" is the transfer of plant products to third parties, even at no cost, for commercial purposes, the EU has established that:

1 The seeds can only be placed on the market once they have officially been examined and certified as **basic** seeds, **certified** seeds, **commercial** seeds and **standard** seeds;
2 The varieties allowed to be marketed have to be listed in **catalogues**;
3 A variety listed in catalogues has undergone tests for **distinctness**, **stability** and **homogeneity**; in addition it needs to be of **value for cropping and use**;
4 The plant varieties which can be placed on the market are listed in an **industrial property** system;
5 The **producers** have to be listed in official **registers** specifically provided.

The placing on the market of vegetable species

The marketing of seeds and fodder plants (species discussed during the Alp'Grain project) needs to be in accordance with the 14 June 1966 Council **directive 66/401/EEC**, which provides a list of all plants considered fit for fodder, divided into genera and species. Before being allowed on the market, these need to be marketed in homogeneous lots, placed in sealed containers, marked and stamped with an official label[1].

The intellectual property of plant species

Plant species and their seeds are subject to the norms set by the **Community protection regime** for **new plant varieties** (Community plant variety rights; Council Regulation (EC) No. 2100/94 of 27 July 1994) which grants Community rights to the person who creates or discovers and develops the variety, named the "breeder"[2].

This regime includes limitations to the Community rights for acts carried out for non-commercial purposes, for experimental purposes as well as for presenting, discovering or developing new varieties.

Furthermore, the system allows derogation for 21 plant species in order to safeguard agricultural production (the "farmer's privilege"). These species include eight *fodder plants*, all grain legumes (field bean, yellow lupin, chickpea milkvetch and field pea) or plants for cutting (lucerne, Egyptian clover, Persian clover and common vetch). Thanks to these derogations[3], the farmer is allowed to sow again the product of the harvest obtained on his own holding as long as it is not a hybrid or a synthetic variety covered by the Community plant variety right. Furthermore there are no quantity restrictions placed on the agricultural holding as long as the latter does not exceed its needs.

The operators involved

According to European legislation the subjects operating in the business of plant species are:

- **breeders**;
- **producers** or anyone producing plants and

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1 Articles 8, 9 and 10 of the directive 66/401/EEC.
2 Art. 11, paragraph 1. **3** Art. 14, paragraph 1.

plant products and who need to be listed in official registers[4];
- **small producers** or **processors** whose entire yield and sale of plants are "intended for final usage by persons on the local market and who are not professionally involved in plant production" and who do not need to be registered[5].

Implementation of the directives regarding the seeds of fodder plants in the member countries

Italy has numerous official acts for the implementation of European directives, which regulate the seed industry:
- 25 November 1971 law number 1096;
- 8 October 1973 decree number 1065 of the President of the Republic;
- 20 April 1976 law number 195;
- 24 April 2001 legislative decree number 212;
- 9 May 2001 decree number 322 of the President of the Republic;
- 19 August 2005 legislative decree number 214;
- 12 November 2009 ministerial decree.

This legal framework that implements the structure and contents of the European standards is based on two pillars: the **certification** and **registering** of varieties placed on the market.
In some cases, Italian standards specify some concepts that are not clearly defined by European directives. The former specify **seed producers** as "companies who hold the seeding license needed and who undertake themselves, or under clearly stated contract, the production, processing and sale of seeds"[6], whereas **farmers producing plant propagating material** are "farms or registered agricultural companies registered with the chambers of commerce, of industry of craft and agriculture and who carry out, although not necessarily exclusively, agricultural work aimed at the multiplying of seeds on behalf of seed producers"[7]. In compliance with Italian legislation, any batch of seeds that includes two or more species, and where the percentage of the seed in larger quantity is less than 95% of the total weight, is necessarily defined as a **blend**[8].

France has transposed the European directives regarding the marketing and certification of seeds into its own jurisdiction with the **18 May 1981 decree number 81-605** which specifies that only seeds of officially registered varieties can be placed on the market; this underlies the principles of the official catalogue and certification and defines the rules concerning the labelling of packages containing seeds, if these are to be placed on the market; the **15 September 1982 by-law** regarding the marketing of fodder seeds defines the standards which certified seeds as well as standard seeds have to comply to before being marketed.
The production, control and certification of seeds come under the supervision of the **General technical regulation**, which is ratified by a Ministry of Agriculture by-law. Amongst the **Annex technical regulations** which complete it and define the rules and standards governing different species, groups of species and blends, there is also the regulation for the fodder plant certified seeds, grasses and legumes approved by the 2 December 2013 by-law as well as the Annex technical regulation for monitoring and official labelling for **blends of meadow seeds**, approved by the 17 March 2004 by-law, which specifies that species included in a blend have to belong to those with the compulsory certification given to plants used as fodder. The varieties are those included in the French Catalogue or the European Catalogue and have to have successfully completed the official agronomic and technological tests for the production of fodder. The minimum percentage of any variety that can be included in a blend is set at 5%.

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4 Art. 6, paragraph 6 of the directive 2000/29/EC.
5 Art. 7 of the directive 2000/29/EC. **6** Art. 1 of the 8 October 1973 decree number 1065 of the President of the Republic. **7** *Ibidem* **8** Art. 10 of the 25 November 1971 law number 1096.

Recent developments

The production and distribution of reproductive material of plants are at the heart of a social and political debate, in view of their numerous implications linked to issues such as the protection of biodiversity, the spreading of GMOs, the univocal definition of professional operators.
On 6 May 2013, the European Commission adopted a proposal that was rejected by the European Parliament in March 2014; a request for another The proposal aimed to reinforce and clarify existing laws by repealing and replacing the 12 existing reference directives: whereas the preliminary declarations were clearly in support of the preservation of agro-biodiversity in agriculture and plant genetic resources, the operational tools and action plan put forward were deemed insufficient.

The structure and contents of the proposed regulation were criticised and viewed unfavourably by the technical Commissions of Agriculture and the Environment as well as by agricultural organisations and environmentalists throughout Europe.
Stakeholders for agro-biodiversity in particular reacted unfavourably to the reduction in the rights of farmers to reuse their own seeds and to the restrictions in the exchange of material for the reproduction of plants between non-professional operators.
Reviewing is underway and the efforts of stakeholders are now aimed at supporting the amendments to the regulation that encourage the preservation of biodiversity as well as the protection of old and local varieties.

■ 2.2 The regulation regarding biodiversity and conservation of plant genetic resources

Only since the '90s, the EU has allowed the marketing of seeds also to be directed to the in-situ conservation and sustainable use of plant genetic resources threatened by genetic erosion or associated with specific natural or semi-natural habitats.

In 1998, the fodder plant seed regulation[9] opens the marketing of seed mixtures of plants, either for fodder and not[10], intended for use in the preservation of the natural environment. New developments, however, are limited by specific and restrictive conditions[11], requiring that the seeds origin is known and approved by the competent authority of each Member State, and the seeds are subject to quantitative restrictions.
The EU began to legislate on issues of biodiversity and conservation of plant genetic resources in greater depth during the early 2000s, with the Council Regulation (EC) 870/2004 dated April 24 2004, establishing a Community programme regarding conservation, characterization, collection and utilization of genetic resources in agriculture.
The in-situ conservation and sustainable use of plant genetic resources become a rule by virtue of Directive 2008 /62 / EC dated June 20 2008.
For the first time the EU allows derogations for inclusion in the national catalogues and for marketing of landraces and varieties that have adapted naturally to local and regional conditions, and which are threatened by genetic erosion (**conservation varieties**).
The Directive specifies that the conservation varieties may be grown and marketed even where they do not comply with the general requirements as regards the inclusion in the catalogue and the marketing.

Directive 2010/60/EU

Fodder plants considered as seed mixtures used to preserve the natural environment, become the subject of a specific directive: the Commission's directive 2010/60/EU dated August 23 2010, providing for certain derogations

9 Directive 98/95/EC dated December 14 1998
10 Article 13 paragraph 1, Directive 66/401/EEC and subsequent amendments and supplements
11 Article 22 bis, Directive 66/401/EEC and subsequent amendments and supplements

for marketing of fodder plants seed mixtures intended for use to preserve the natural environment.

Approved derogations

The Directive allows marketing fodder plant seed mixtures, even where they are not composed by varieties included in the national catalogue or in the European register, if they are intended to preserve the natural environment.
Therefore, the European legislation authorizes the marketing of conservation mixtures, thanks to their function of preserving agro-biodiversity and conserving plant genetic resources.

Type of vegetal materials treated

Vegetal materials are marketed as "preservation mixtures" and are grouped in two categories:

- **directly harvested mixture**, i.e. a mixture marketed as collected, with or without cleaning;
- **crop-grown mixture**, obtained by mixing seeds produced in breeding fields, from plants born from seed taken at the collection site and grown separately as single species.

Where to collect

The area where the seed has been collected, defined as **collection site** (Figure 1), which has not been sown in the previous 40 years and is characterized by a specific habitat.
The collection site must be located within a **source area**, nationally designated as a special area of conservation (SAC)[12] or as an area that contributes to the conservation of plant genetic resources[13]. The source area must be inserted within the **region of origin**, to which the mixture is naturally associated, and which may include an area that crosses the border of other Member States.
The region of origin corresponds also to the area within which the marketing of the seed mixture for the preservation is possible.

What to collect

The **directly harvested mixture** must respect specific technical conditions essential to recreate the habitat of the collection site, such as a percentage of components and an adequate germination percentage, a restricted level of species or subspecies not characteristics of the habitats, a modest content of *Rumex* spp. and the absence of certain invasive species (*Avena fatua*, *A. sterilis* and *Cuscuta* spp.).

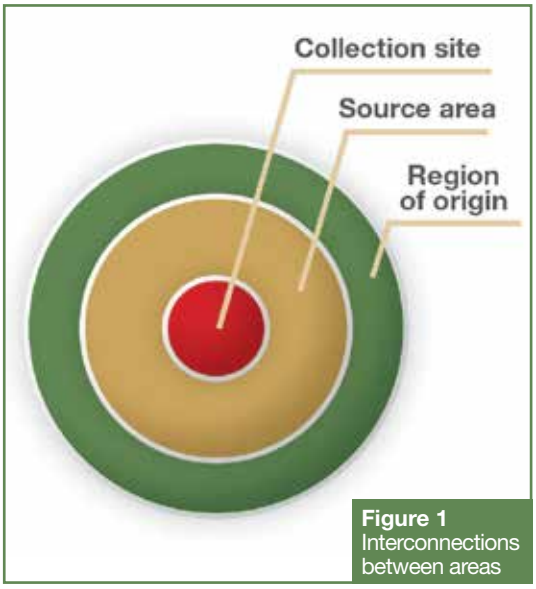

Figure 1
Interconnections between areas

Crop-grown mixtures, composed by seeds in purity that are later mixed, shall conform to the commercial requirements imposed by the Directive in question, as for the specific purity for fodder plants and maximum contents of seeds of other plant species.
The Alp'Grain project has experienced the production and use of **directly harvested mixtures**. All references to the legislation depicted in forthcoming chapters, therefore, will focus on this mixture.

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12 Pursuant to Article 4 (4), Directive 92/43/EEC (Habitats Directive). **13** Designated by the State in accordance with the national procedure based on criteria comparable to those provided for in Article 4(4) of Directive 92/43/EEC in conjunction with Article 1(k) and (l) of that Directive, and which is managed, protected and under surveillance in a manner equivalent to Articles 6 and 11 of that Directive.

Marketing

Marketing of seed mixtures for conservation shall be subjected to a number of obligations and restrictions.

1) **Applications for authorisation**
   Marketing of preservation mixtures must be authorized by the Member State following a specific application for the producer. This application must be submitted before beginning each production season and shall contain all the information necessary to verify compliance, including quantity of the mixture for which the application is requested, size and location of the intended collection sites. At the end of the season, furthermore, producers shall have to notify the marketed quantities.

2) **Verifications**
   To verify compliance of the mixtures and grant the authorization, the Member State shall carry out visual inspections in the collection site during the period of growth at appropriate intervals thereafter and shall document the results.

3) **Quantitative restrictions**
   Every year the Member State shall verify that the quantities marketed of preservation mixtures do not exceed 5% of that of fodder plant seed mixtures. If the Member State evaluates that there is likelihood of exceeding that percentage, it shall give each producer an amount of saleable mixtures during the production season.

4) **Guarantee of traceability of mixtures**
   In order to be marketed, the preservation mixtures may be packed in closed packages and containers bearing a sealing device, applied by the producer, including specific information such as the legend «preservation fodder plant seed mixture, intended for use in an area of the same habitat type as the collection site, not considering the biotic conditions».

Transposition of Directive 2010/60/EU in Italy

In Italy Directive 2010/60/EU was implemented by means of the Legislative Decree dated August 14 2012, n. 148 and subsequent amendments and supplements, authorizing the marketing of seed mixtures intended for use in the preservation by way of derogation of Article 12, paragraph 1, of Law 1096/1971.
The decree recognizes the contents of the Directive completely, differentiating only for purely national aspects:

- references to the Italian legislation;
- identification of the Council for research and experimentation in agriculture - Centre for experimentation and certification of seed (*Consiglio per la Ricerca e la sperimentazione in Agricoltura - Centro di sperimentazione e certificazione delle sementi: CRA-SCS*) as being responsible for granting the authorizations and to verify the implementation of the Decree's provisions;
- the possibility for regions and provinces with autonomous status to assume the powers to authorize the marketing of seed mixtures upon a the request of a producer;
- the authority of the CRA-SCS or regions and provinces with autonomous status as regards the visual inspections of the collection site of directly harvested preservation mixtures;
- notifications from producers to the regions and provinces with autonomous status, the CRA-SCS and the Ministry of Agricultural, Food and Forestry Policies (MiPAAF);
- the supersession clause[14], under which the rules of the Decree related with issues being covered by the legislative

14 Pursuant to Article 117 paragraph 5 of the Constitution.

competence of the regions and provinces with autonomous status of Trento and Bolzano, which have not already carried out the transposition of Directive 2010/60/EU, shall apply until the date when the rules enter into force for each autonomous region and province, within the constraints set forth by European laws and fundamental principles of the same Decree.

The Aosta Valley, as an autonomous Status region, has the power to transpose the European directives with regional implementation. To this date, however, as the regional regulatory framework does not contain specific implementation rules for of Directive 2010/60/EU, this matter is governed by the Legislative Decree 148/2010.

Transposition of Directive 2010/60/EU in France

France transposed Directive 2010/60/EU to its national legal system by means of **the Decree**

The international context

At an international level and since the '70s different legal instruments, which include treaties and protocols, have been adopted for the protection of species and natural habitats.

The treaties are legally binding for the subscriber States, whose own domestic laws, regulations and procedures need to comply with the obligations imposed.

Main international acts for the safeguarding of biodiversity are:

- **Berne Convention on the Conservation of European Wildlife and Natural Habitats**, signed in Berne on 19 September 1979; its aims are the conservation of wild flora and fauna and their natural habitats as well as the promotion of European cooperation in this field.
- **Convention on Biological Biodiversity**, approved at the Earth Summit held in 1992 in Rio de Janeiro; its aims are the conservation and sustainable use of biodiversity as well as a fair and equitable sharing of benefits resulting from the use of genetic resources.
- **International Treaty on Plant Genetic Resources for Food and Agriculture** signed at the FAO Conference in Rome on 3 November 2001. With this treaty the subscriber States are expected to adopt adequate measures for the sustainable use of resources such as defining an agricultural policy that supports the preservation of diversity in agricultural systems, the use of locally grown plants as well as the reviewing and adapting of legislation ruling over the trading of varieties and the distribution of seeds.
- **The Cartagena Protocol** (2003) integrates the Rio Convention with legislation on biosafety and GMOs.
- **The Nagoya Protocol** (2010) completes the Rio Convention with rules for access to genetic resources and the equitable sharing of benefits arising from their utilization.
- **The Strategy for Biodiversity** for the period 2011-2020 was adopted in Nagoya in 2010 and aims to urge those nations that adhered to the Rio Convention to promote concrete actions in support of biodiversity. Out of the 20 objectives set for 2020, the adhering countries will need to demonstrate the preservation of at least 17% of land areas and inland waters as well as 15% in environmental recovery of degraded areas.

dated January 24 2012 and the **technical regulations issued on 15 and 16 March 2012**, by which it adopted the legislative provisions necessary to comply with the points contained in the Directive.
The Decree covers the technical contents of the Directive and inserts some specific aspects such as:

- reference to the French legislation;
- the possibility for the Minister of Agriculture to authorize the use of preservation mixtures with different characteristics from those established in the Directive, in case of tests and scientific purposes.

The first technical regulation attached (15 March 2012) concerns the varieties of fodder plants and lawn grasses, and sets out the conditions and the authorizing methods to market seed mixtures for the preservation of the natural environment.
In particular, the Regulation:

- recognises technical definitions contained in the Directive;
- designates the section **fodder plants and lawn grasses** of the Technical Committee for Plant Breeding (*Comité Technique Permanent de la Sélection des plantes cultivées* - CTPS) as the responsible authority for plant genetic resources;
- establishes an ad hoc committee of the CTPS section **fodder plants and lawn grasses** to manage all authorizations and sets the skills;
- sets that the committee shall verify the consistency between mixture and habitat;
- identifies the **producer** as the subject conditioning directly harvested seed mixtures or mixing and conditioning crop-grown mixtures;
- specifies all the information that shall be indicated in the application for authorization, addressed to the secretary of the CTPS.

The second technical regulation (16 March 2012) focuses on production and control of seed mixtures intended to preserve the natural environment, and establishes conditions and production methods for the preservation mixtures authorized by the Minister of Agriculture.
In particular, the Regulation:

- refers to the technical contents of the Directive and regulation issued on 15 March 2012;
- establishes the criteria for registration of producers and defines the reporting obligations and accounting of harvested mixtures;
- defines the Official Service for Control and Certification (*Service officiel de contrôle et certification* - SOC) as the responsible authority for all on-field and in laboratory controls.

2.3 The regulatory framework in Switzerland

In Switzerland, the preservation of biodiversity is regulated by federal laws by means of the Federal Act regarding the Protection of Nature and the Cultural Heritage (NCHA) dated July 1 1966, and then further modified taking into account the international treaties.
To curb the loss of biodiversity, in 1988 Switzerland introduced the obligation for ecological compensation[15]: specific areas are identified (defined as ecological compensation areas, ECAs) whose management will promote biological biodiversity and contribute to the variety of the landscape. For this reason, the ECAs have been identified in both the landscaping and agricultural spheres.
On a landscape level, the Cantons impose ecological compensations, both internally and externally of urban settlements, providing in exchange financial contributions to the manager of the ECAs. In urbanised areas, such compensations may be done thanks to an appropriate planning and revaluation of free surfaces, with sustainable management of watercourses and forests.
In agriculture, these ecological compensations are mandatory for direct payments[16]. Farmers perceive contributions for the biodiversity if at least 7% of the utilised agricultural land[17] is addressed to ecological compensation, cultivating

15 Article 18 1bis NCHA. **16** Article 76 of the federal act on agriculture. **17** Article 14 Ordonnance fédérale du 7 décembre 1998 sur les paiements directs versés dans l'agriculture (OPD).

extensive grasslands, flowering fallows, hedges and riparian woods[18].

Concerning the seeding or re-seeding of the ECAs, the Swiss federal centre of excellence for agricultural research (Agroscope) indicates the seed mixtures to be used for sowing meadows and pastures; the law itself recommends the use of hay flower resulting from long-time existing grasslands, compared to standardized seed mixtures.

The opportunity to sow the ECAs with spontaneous local seeds has encouraged some seed producers to develop the cultivation of these species and place them on the market. These mixtures, initially intended for ECAs, are now used in other areas (grass areas in urban environments, roads, ski slopes, environmental rehabilitation).

The diffusion of seed of spontaneous species encouraged the Swiss Commission for Wild Plant Conservation (CPS) to propose specific recommendations for the production and use of these materials[19], including a list of recommended species and specific technical guidance regarding re-vegetation requirements, respecting biodiversity and habitat conservation.

Concerning grass areas, the CPS advises specific operating methods, which become mandatory when working inside ecological compensation areas:

– the seed used must originate from the same bio-geographical region of the site that needs to be reseeded or in a similar area from a geographical and ecological point of view;
– the ecological requirements for the species used, such as their altitudinal origin and soil conditions, must be those of the site to be re-vegetated;
– non-indigenous species and subspecies must not be present in the seed mixtures;
– no commercial varieties and cultivars of local species must be sown in natural environments;
– introduction and propagation in the environment of non-indigenous invasive species and GMOs are forbidden;
– all restored surfaces must be managed according to the agricultural practices that are mandatory for ECAs;
– the restored sites must be supervised in order to control the balanced development of all species and avoid the diffusion of unwanted plants.

Concerning actions to promote environmental regeneration and landscape requalification, specified in Article 18 of the NCHA or inserted in the planning of the National Ecological Network (REN), the Federal Office for the Environment (FOEN) recommends the use of local species mixtures, the use of hay flower from meadows and pastures, especially if intended for mountain areas and to comply with CPS recommendations.

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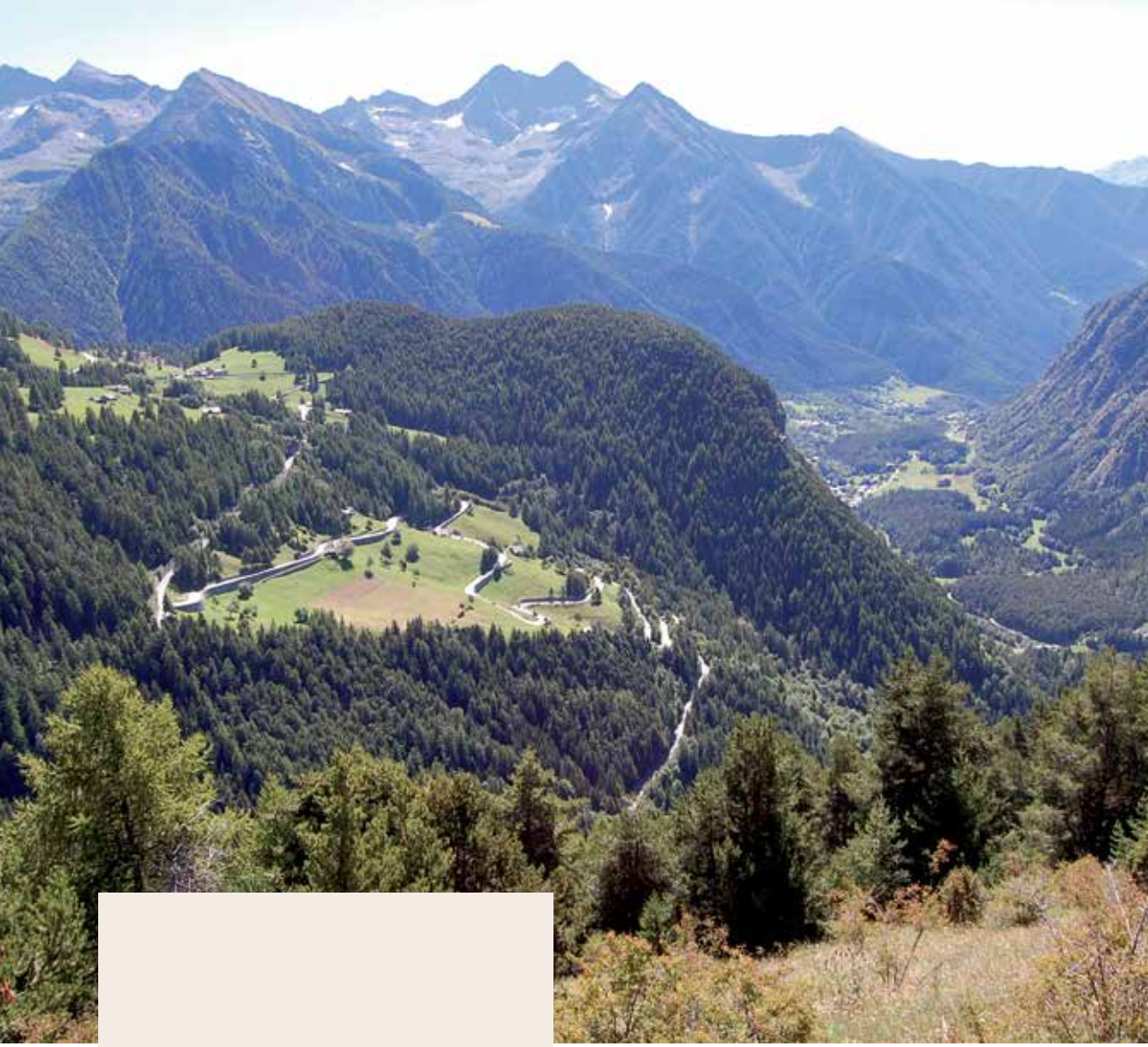
18 Article 55 OPD. **19** CPS, 2009.



Chapter 3
The regions of origin and the source areas

Chapter 3
The regions of origin and the source areas

As seen in the previous chapter, preservation mixtures may be collected and used only within the "regions of origin", geographically delimited on the basis of the habitats and wild plant species present.
Identification of the regions of origin, within the competence of the Member States, was currently completed only in Austria and Germany, countries where the marketing of local seeds was launched.

3.1 Europe biogeographical regions

In concordance with homogeneous ecological characteristics, Europe is divided into 11 biogeographic regions (Figure 2). The territorial division, which exceeds national borders by introducing the concept of "environmental units", takes into account the geographical, historical, evolutionary, climatic, topographic and soil conditions influencing the geographical distribution of living beings.
The EU Member States are included in the 9 following biogeographical regions: Alpine, Atlantic, Boreal, Continental, Macaronesian, Black Sea, Mediterranean, Pannonian and Steppic.

Italy is divided into the Alpine, Continental and Mediterranean regions, and the Aosta Valley is totally inserted in the Alpine region.
The French territory is part of the Alpine, Atlantic, Continental and Mediterranean regions, while Savoy, Haute Savoy and Isère are predominantly within the Alpine region and for a smaller portion within the Continental one.

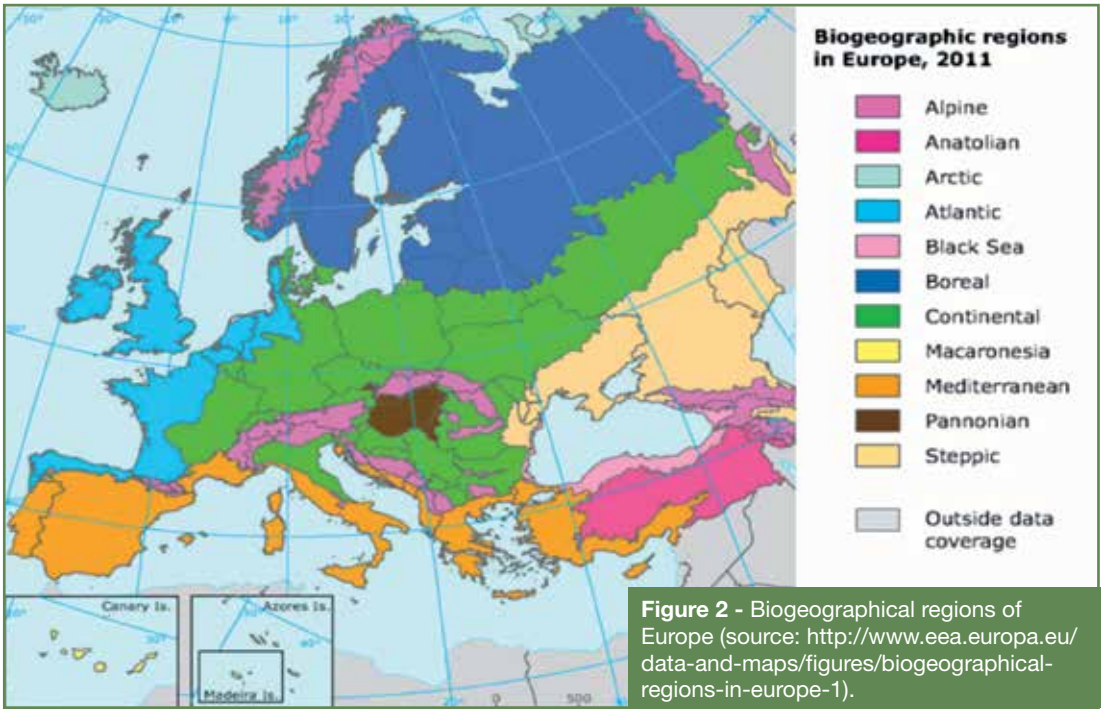


Figure 2 - Biogeographical regions of Europe (source: http://www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-1).

This biogeographic division, however, seems to be far too vast in order to achieve the goals of preserving biodiversity and preserving plant genetic resources, as it does not take into account the specific ecological requirements of the plant species, such as origin, altitude, aspect and physicochemical conditions of the soil.

3.2 The regions of origin

Identification of the regions of origin

The **region of origin**, area to which the preservation mixtures are naturally associated and where they can be used, may also be extended over to several Member States.

The definition of the regions of origin is delegated by law to the Member States, based on the information provided by the authorities in charge of plant genetic resources, or by recognized organisations working in the field, or in Italy, by the Autonomous Regions and Provinces.

As pointed out by Wieden *et al.* (2012), the delimitation of regions of origin should not be too small, in order not to endanger the economic development of the local seed market, due to inadequate supplies (reduced surfaces for their collection and low number of farms) and insufficient demand for seeds (limited environmental restoration projects).

Some examples of regions of origin

Several European countries have identified, within their national borders, regions of origin specified for the production and use of wild plant species.

This geographical division is used to define the origin of the seed, regulate the fields of propagation and delimit the local seed marketing areas.

Switzerland, divided by a biogeographical point of view into 6 main divisions and 11 subdivisions, identified 4 major regions of origin aimed at seed production (Figure 3): the Northern Alps (including the 3 main divisions on the northern side of the Alps), Western Alps, Eastern Alps and Southern Alps.

The biogeographical regions of Switzerland
(Gonseth et al., 2001)
6 main divisions
11 subdivisions

Figure 3 - The biogeographical regions of Switzerland (Source: OFEV, http://www.bafu.admin.ch/gis/02911/07403/index.html?lang=fr)

Regarding environmental restoration, the Swiss Commission for the preservation of wild plant recommended to respect geographical origins: for common and poorly geographically differentiated species, it is sufficient to take into account the 4 major regions, while for species with infrequent and discontinuous distribution, it is essential to respect the geographical origin of the 11 subdivisions.

Within the European Union, Germany's example deserves to be mentioned, which identified 22 regions in its territory of origin, and Austria's,

which is divided into 10 major regions[20]. Autochthonous plant material is collected within these areas and used to produce seeds for their reutilisation in restorations within the region of origin.

In France

A map of French regions of origin was drawn during the project *Flore locale & Messicoles*[21] and two collective brands of quality were developed ("*Végétal local*" and "*Vraies messicoles*") to ensure the geographical origin of the plant material, from its production up to its marketing (Figure 4). Regulations and maps were approved in 2014 by the Ministries of Agriculture and of Ecology, Sustainable Development and Energy. The geographical division reached detailed municipal scales, and was prepared, based on existing maps (hydrography, climate, vegetation, soils and geology), by a group of technicians of the National Botanical Conservatories and independent experts.
The map identifies 11 regions of origin and 28 associated natural units; the Alpine region is divided into Northern and Southern Alps.
The quality management system ensures that all plant materials placed on the market come from the region of origin of reference, and constrains their use to that area.

Figure 4 - The regions of origin for quality brands Végétal local and Vraies messicoles (Source: http://www.fcbn.fr/ressource/cartes-des-regions-dorigine-pour-les-signes-de-qualite).

In Italy

In Italy, there are still no examples of subdivisions into regions of origin.

In the Alp'Grain area

The Departments of Isère, Savoy, Haute Savoy and the neighbouring Aosta Valley are part of the North Western Alps and are located within the Alpine biogeographical region.
In this cross-border area, which shows homogenous biogeographical characteristics, as demonstrated by studies and data collected over the years regarding the flora of the North Western Alps[22], it would be appropriate to define the regions of origin in order to reduce losses of biodiversity significantly and encourage the use of native plant species.
Following the example of the most virtuous countries as well as the experience acquired with the Alp'Grain project, it is possible to identify a region of a cross-border area (intra-Alpine area of the Western Alps) for preservation mixtures of most common habitats, and a more localized subdivision for mixtures suitable for priority habitats.

3.3 The source areas

The **source area** is the geographic area within which the donor site must be located, and must belong to an area designated by the State as a Special Area of Conservation or an assimilated area, as it contributes to the preservation of plant genetic resources, and designated by the Member State in accordance with a national procedure based on comparable criteria.
The source area must be located within a region of origin.

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20 Feucht *et al.*, 2012. **21** Implemented by the National Federation of Botanical Conservatories (*Fédération des Conservatoires botaniques nationaux* - FCBN) during 2012-2014. **22** See, for example, Bassignana & Bornard, 2001.

In the Aosta Valley

The Aosta Valley ensures the preservation of natural and semi-natural habitats, wild flora and fauna, by means of the Regional Law No. 8, dated 21 May 2007, which transposed the "Habitat" Directive.

There are currently 30 sites in this region, which belong to the European ecological Natura 2000 network (Figure 5):

- 25 Special Areas of Conservation (SACs);
- 2 Special Protection Areas (SPAs);
- 2 Special Areas of Conservation and Special Protection Areas (SACs/SPAs);
- 1 Site of Community Importance and Special Protection Area (SCI/SPA).

The area covers about 30% of the region, including almost all of the protected areas, and concerns, in their larger part, territories located at high altitudes, on an average higher than 1600 m above sea level.

All 30 sites located in the Aosta Valley are potentially "source areas" for preservation mixtures; however, their geographical characteristics are not ideal for their commercial production, due to their high average altitude, difficulty of access and prevalence of high altitude natural environments.

The best habitats suited for the production of seeds are natural dry and mesophilic grasslands, typical of "Species-rich *Nardus* grassland, on siliceous substrates in mountain areas", "Lowland hay meadows" and "Mountain hay meadows", which are underrepresented in the Natura 2000 areas of the Aosta Valley. These habitats are widespread throughout the region, outside the European ecological network. To expand these "source areas", in the Aosta Valley the instruments made available by the regional law 8/2007 could be implemented, which provides, in addition to SACs, SPAs and SCIs, the constitution of other protected areas for biodiversity preservation, such as the **Sites of Regional Natural Interest** (*Siti di Interesse naturalistico Regionale* - SIR), geographically defined and delimited, contributing significantly to the maintenance or restoration of natural or semi-natural habitats or a species of regional interest, and the **regional ecological network**, that connects all the local areas with greater natural interest (protected areas, Natura 2000 areas, SIRs and ecological corridors).

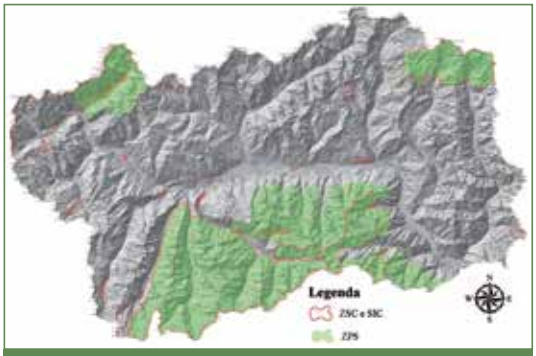

Figure 5 - Natura 2000 areas in the Aosta Valley (Source: http://www.regione.vda.it/risorsenaturali/conservazione/natura2000/siti/default_i.aspx)

In Savoy, Haute Savoy and Isère

France transposed the Habitats Directive into its national legal system by means of Law No. 95-101 dated 2 February 1995 and Decree No. 95-631 dated 5 May 1995.

In Savoy (Figure 6), Haute Savoy and Isère, 81 sites of the European ecological Natura 2000 network were identified, 3 of which are located in two departments[23]:

- 61 Sites of Community Importance (SCIs) and Special Protection Area (SCIs/SPAs);
- 20 Special Protection Areas (SPAs).

Some agricultural areas (grassland) in Natura 2000 sites are suitable for the collection of wild seeds. In these areas, Territorialized Agri-Environmental Measures (TAEM) are being carried out to preserve the habitats and species of Community interest (Figure7).

The sites of the three French Departments that are located within the Continental biogeographical region are not suitable source areas for alpi-

23 Source: www.rhone-alpes.developpement-durable.gouv.fr/les-acteurs-natura-2000-de-rhone-alpes-a2653.html

ne zones, while those of the Alpine region include semi-natural dry and mesophilic grasslands, which are common to the protected areas in the Aosta Valley.

Other potential source areas

Among the priorities of the European Union concerning rural development for the period 2014-2020, are preserving, enhancing and restoring the ecosystems and biodiversity related to agriculture and forestry within Natura 2000 sites and in high nature value farmland[24].

In this context, "High Nature Value Farmlands" (HNVFs), were recognized as those areas where agriculture is the predominant land use, and maintain a high number of species and habitats, many of which are of Community interest.

These areas could be included as "source areas", as they contribute to the preservation of plant genetic resources and can be considered as protected areas, as they are managed through specific conservation plans.

In France[25] and Italy[26] these "high nature value farmlands" were already mapped on a national scale. In Italy, also, the National Rural Network[27] made some in-depth research at regional levels (including the Aosta Valley), which could be used as a basis to identify HNVFs and develop the marketing of preservation mixtures.

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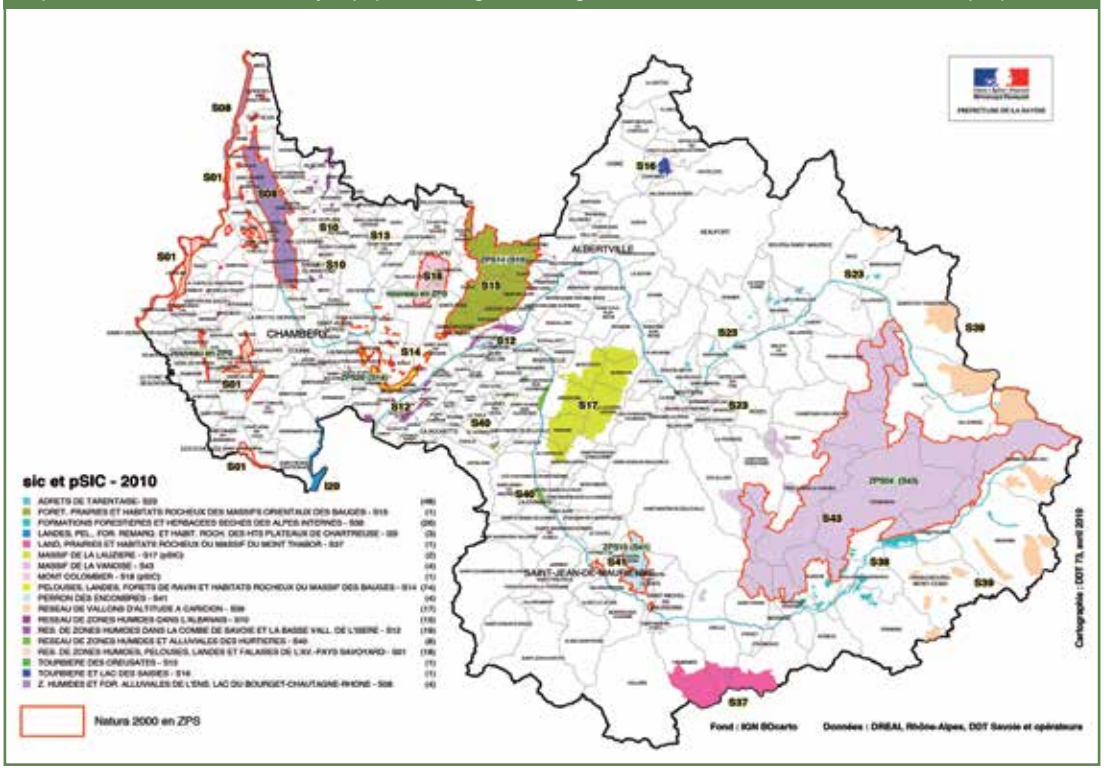
24 Priority 4, article 5 of Regulation (EU) N. 1305/2013 of the European parliament and of the Council dated 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005. **25** European Forum on Nature Conservation and Pastoralism (EFNCP) http://www.efncp.org/projects/hnv-farming-france/ **26** Trisorio *et al.*, 2013. **27** De Natale *et al.*, 2014.

Figure 6 - Natura 2000 sites in Savoy (Source: http://www.observatoire.Savoy.equipement-agriculture.gouv.fr/PDF/Cartes/4.10a_Natura2000.pdf)



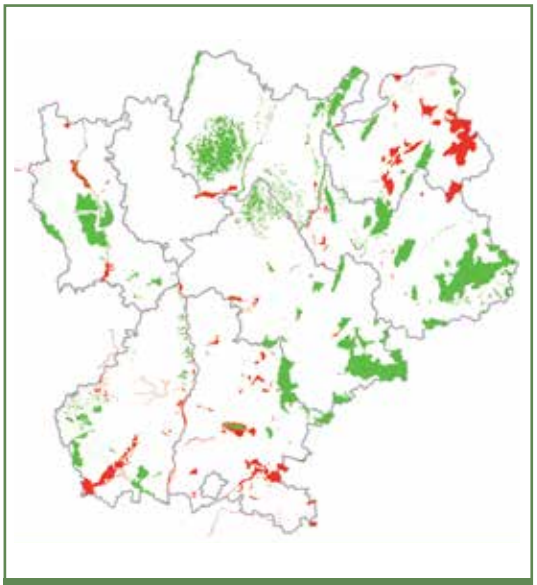


Figure 7 - Farmland sites subject to TAEM in Rhône-Alpes Region. (Source: http://www.rhone-alpes.developpement-durable.gouv.fr/IMG/pdf/N2000_MAET_201406_cle289226.pdf, June 2014)

3.4 Mapping of potential source areas

To identify potential eligible areas for the production of local seeds, cartographic analysis were conducted aimed at mapping source areas and collection sites throughout the territory of the Aosta Valley and Northern French Alps.

In the Aosta Valley

The aim of the study was to identify eligible areas for the collection of plant material to be used to revegetate certain demonstration sites.
The method adopted was based on the use of territorial information systems[28] that allowed the overlapping of map databases useful to identify eligible areas for the purposes of the Alp'Grain project.
The analysed area is the whole region of Aosta Valley, divided into 74 municipalities.
The mapping work has consisted in:

1) identifying the types of land use classifiable as permanent grasslands;
2) mapping certain excluded areas (object of earth moving or colonized by non-indigenous or nitrophilous species);
3) mapping areas with adequate vegetation characteristics, within which it is possible to identify collection sites;
4) verify the eco-pedological affinities of the collection sites and receptor sites identified in the project;
5) represent the source areas currently present in the Aosta Valley.

The cartography was drawn up from databases available using the following information:

- perimeters SACs-SCIs and SPAs[29] updated at 2014;
- land use and land cover (CORINE land cover - year 2006);
- eco-pedological map[30] drawn up by the Ministry of the Environment - Nature Conservation Service - scale 1:250.000.

The overlapping data identified areas potentially useful for the collection of local seeds, both within the Natura 2000 areas as well as the remaining part of the Aosta Valley (Figure 8).
Then, on this basis, the distribution map of invasive alien species[31] was overlapped, as well as the map of grasslands sown with commercial mixtures or intensively managed.
The final overlapping of the layers allowed to exclude areas not suitable to be donor sites and to define the set of those that are potentially useful as collection sites, to be included within a network of source areas (Figure 9).
For the identification of potential collection sites, the mapping of source areas should be completed with a characterization of the habitats, the exact identification of the species-rich grasslands and the analysis of affinities between donor sites and receptor sites, in order to obtain an operating instrument to promote the

28 GIS open source Qgis. **29** www.minambiente.it/pagina/schede-e-cartografie#sthash.RBpDwaye.dpuf **30** www.pcn.minambiente.it/catalogo/metadatoFull.html?_cache=yes&doc=/db/metadati/pcn/rndt_m_amte_META302.xml **31** Curtaz *et al.,* 2011.

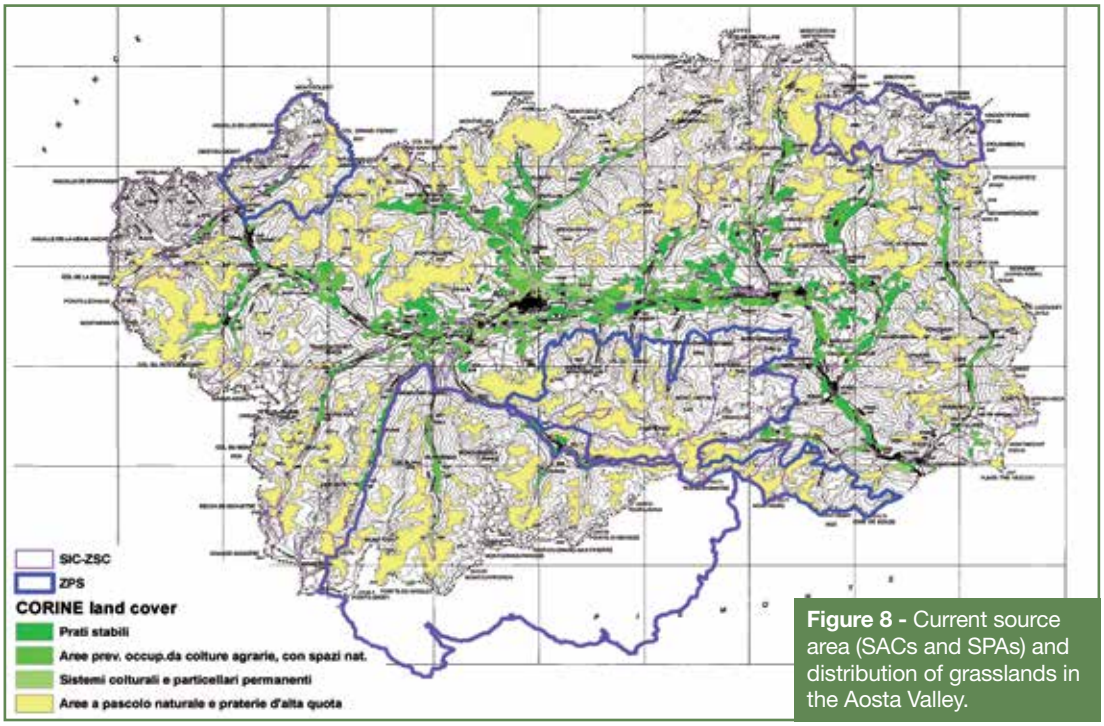


Figure 8 - Current source area (SACs and SPAs) and distribution of grasslands in the Aosta Valley.

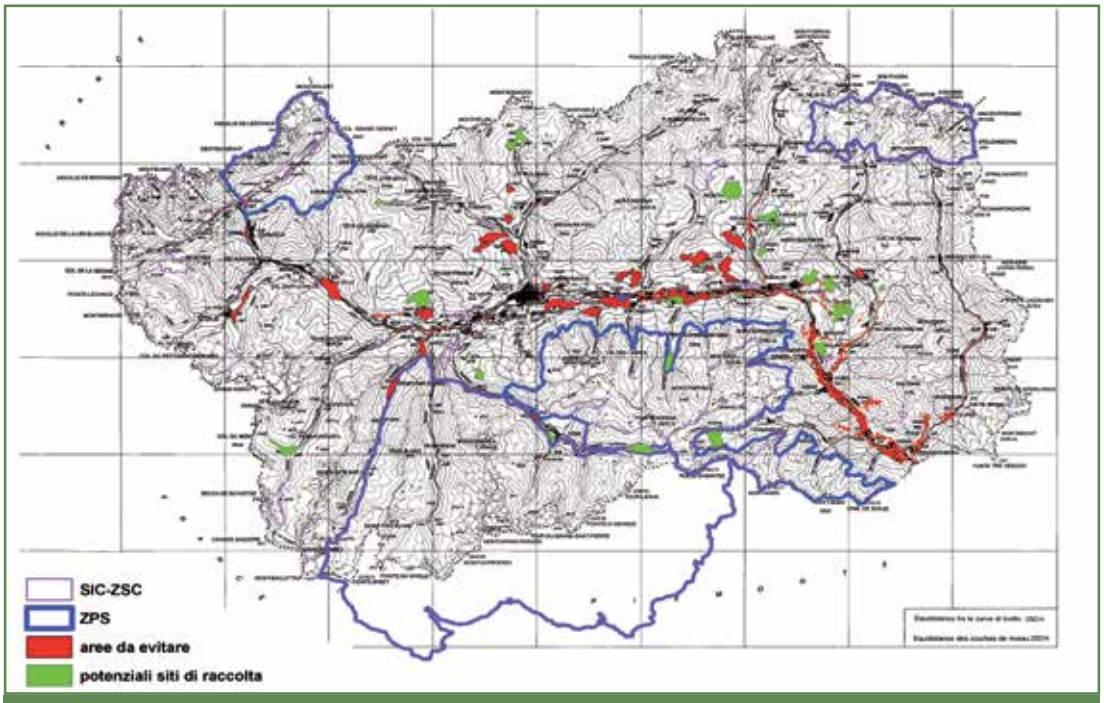


Figure 9 - Areas to be avoided and potential collection sites in the grasslands of the Aosta Valley.

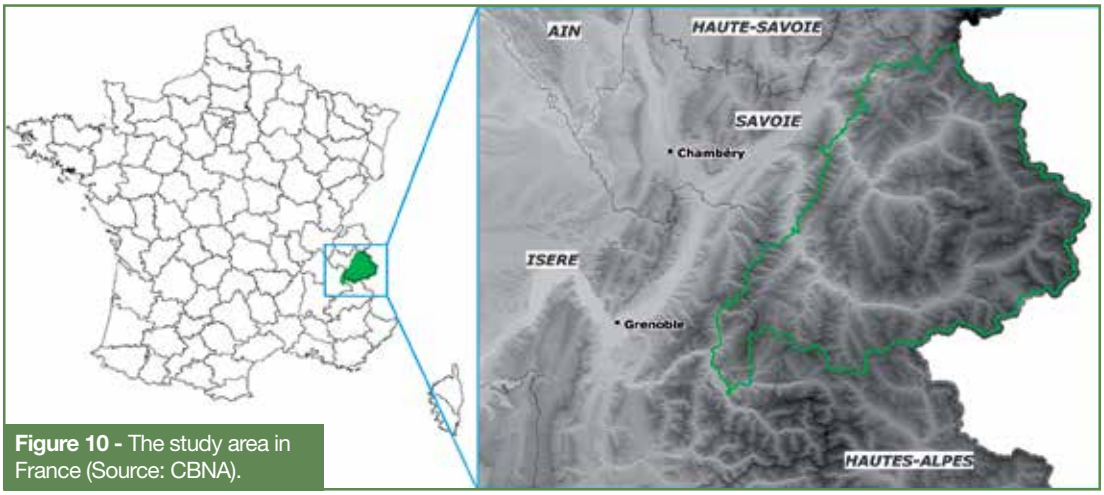


Figure 10 - The study area in France (Source: CBNA).

use of preservation mixtures and to help foster the interaction between demand and supply[32].

In France: practical tools to support the choice of collection sites

Within the Alp'Grain project and in collaboration with the Alpine National Botanical Conservatory (*Conservatoire Botanique National Alpin* - CBNA), a typological subdivision and mapping of the collection areas of local seeds in mountain meadows and pastures were carried out in the French Northern Alps.

The aim of the study was to verify that the potential seed producing areas and receptor sites have similar specific compositions and/or genotypes. For this purpose, the following were carried out:

- mapping of potential donor and receptor sites;
- verification between the map's results and on-field realities.

The analysis area is located in the Vanoise massif and is composed mainly by the following geographical sectors: Tarentaise, Maurienne, Grandes-Rousses and Beaufortain. The municipalities involved are 100, of which 93 are in Savoy and 7 in Isère.

The mapping was based on many available data (for example, BD ALTI® 25m of the IGN *Graphic Land Register - Registre parcellaire graphique* etc.) to map homogeneous areas as regards:

- geology;
- exposure;
- altitude;
- vegetation, habitat.

This mapping allowed the spatial definition of donor and receptor sites that are consistent in terms of **ecological factors** (vegetation, habitat) as well as **geographical** ones (geology, exposure, altitude).

Data regarding flora and habitat

Starting from the principle that the more adequate to local ecological conditions (substrate, humidity etc.) are sown species, the more successful will be the revegetation intervention, and to complete the map of donor-receptor sites, an approach based on the habitats of the different species was followed.

In fact, every habitat (for example, "Alpine and subalpine calcareous grasslands") hosts a particular floristic group. Cartographic information on habitats allows then to optimize the choice of the collection site (or sites) to identify ecologically compatible species with the receptor site. In the absence of precise ecological information regarding the receptor area, this data allows to increase the diversi-

32 Hefter *et al.*, 2012.

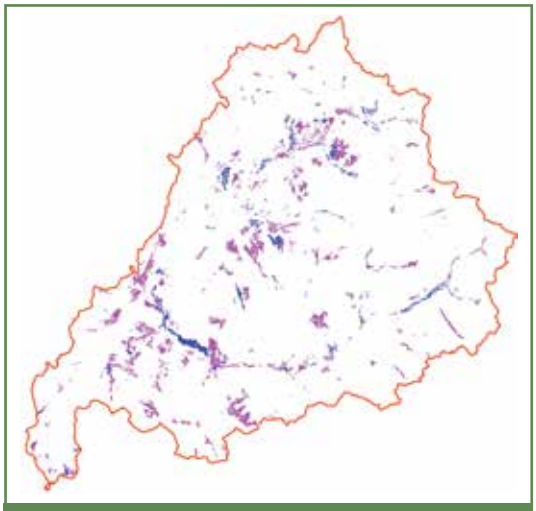


Figure 11 - Example of position of habitat presence polygons (Source: CBNA).

ty of sown species, orienting the collection in different habitats.

Furthermore, data on accessibility and slope (which should not exceed 25 degrees) were added in order to specify the operating conditions of each site. Natura 2000 areas were also included to know which one could clearly be chosen as collection site, taking into account the regulatory aspects related to preservation mixtures. Finally, the results from the pastoral survey 2012-2014 conducted by SUACI[33] were used to identify abandoned areas, which could be put into value for the seed collection, if ecological, geographical and technical factors allow doing so.

Concrete examples of using cartography:

- Data extraction of the presence of grasslands at low altitude in polygons for stratum collection-use (Figure 11). Other than the absence of data, there are three possible values:
  1 - Habitat: certain presence of the habitat;
  2 - Species data: likely presence of the habitat, based on a number of found species exceeding the minimum threshold beyond which the presence of the habitat is likely;
  3 - Potential species data: potential presence of the habitat (calculation on the floristic survey below the threshold).
- Overlapping of collection-use areas maps and of habitats location based on floristic surveys (Figure 12).

In the medium-term, the cartography –available on Internet– could serve as a working tool to ease the choice of a collection site and the search of all necessary information.

33 http://enquete-pastorale.irstea.fr.

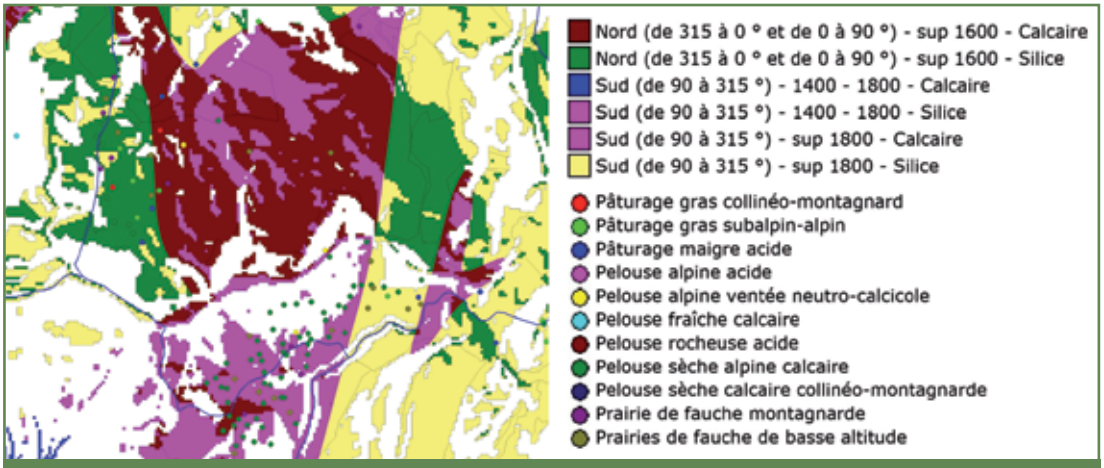


Figure 12 - Habitats in the La Plagne area (Source: CBNA).

Chapter 4
Harvesting of preservation mixtures

Chapter 4
Harvesting of preservation mixtures

Selection of the collection site (donor site) represents an essential point in order to obtain quality materials for using in areas to be revegetated.

4.1 The legal framework

Seed collected in grasslands can be used for reseeding and, being a vegetable material, its production and marketing as a "preservation mixture" follow the rules imposed by European and national regulations[34].

Legally, the collection site of the vegetable material must respect specific characteristics:
1) it must be located within a source area in a defined region of origin;
2) its characterising habitat type must be known;
3) it has not been sown in the previous 40 years.

In Italy and France, source areas are:
- special areas of conservation (SACs);
- special protection areas (SPAs), as zones that contribute to the preservation of plant genetic resources and are managed, protected and followed-up as SACs.

Furthermore, legally, the location, size and productivity of these collection sites must be known before beginning each production season, and notified in the application for authorisation by the producer.

Analysing the current legislation, it is to be considered that the harvested seeds, if reused within the farm, could come from species-rich grasslands of the same farm, without any geographical limitations, quantitative restrictions and obligations regarding authorisations and/or procedures.

4.2 Selection of the collection site

Criteria for identifying the site

Once the conditions imposed by the current legislation have been met, the collection site must respect certain technical and agronomic conditions:
- location in a similar area, from the geographical and ecological point of view, to the area to be reseeded;
- floristic composition similar to that of the area to be re-established;
- high species richness and suitable fodder and ecological value;
- low presence of invasive species, especially if they are indicators of poor management (umbelliferae, *Rumex* spp. etc.)
- absence of invasive exotic species;
- when harvesting with machines (brush harvesting, green hay harvesting, threshing etc.), the site should be easily accessible, have regular surfaces and smooth slopes.

Identification of an appropriate collection site can be difficult because of:
- limited availability of farm surfaces to be allocated to seed production;
- intensive use of the most accessible plots;
- high presence of invasive species in grasslands with unsuitable agronomic management (*Heracleum sphondylium, Pastinaca sativa, Rhinanthus alectorolophus, Rumex* spp. etc.);
- reduced availability of grasslands that have not been reseeded during the last few decades;
- distance from the place where the harve-

34 Directive 2010/60/EU and transposition in Member States.

sted material shall be packed, or, in case of green or dry hay, distances from the site to revegetate;
- absence of a thematic cartography showing and differentiating potential collection areas.

Good farming practices for a «good collection site»

A donor site rich in species (more than 30) is the result of a reasoned management of the parcel[35].

If the collection site is a meadow or pasture, it is recommended to:
- keep a traditional management of the surfaces: **2 cuts + 1 grazing** (generally in autumn) at the bottom of the valley, **1 cut + 1 grazing** at higher altitudes;
- carry out every second year early cuts (to decrease species such as umbelliferae) and late cuts (to encourage dissemination of a greater number of grasses, legumes and other dicotyledons);
- perform the second cut after the flowering of late species (e.g. *Centaurea jacea*);
- carry out springtime grazing every second year, in order to allow an alternation between early and late mowing;
- dry the hay for 2 to 3 days in the field, in order that seeds may fall to the ground;
- ensure adequate water supply, and where possible, compensate the lack of water during the dry years with irrigation;
- keep a medium level of fertilization, spreading cured manure in autumn and reducing slurry spreading after mowing;
- carry out a cleaning cut after grazing in autumn;
- perform early grazing or a mechanical *déprimage* (chopping when the turf is 20 cm tall), in case of an excessive presence of umbelliferae or *Rhinanthus alectorolophus*.

If the collection site is a pasture, it is advisable to:
- graze it at least once every year;
- carry out the springtime grazing not too late, when the turf is 20 to 30 cm tall (best time: flowering of dandelion);
- plan short periods of presence on the parcels, allowing the turf to store sufficient reserves for the regrowth, and not favouring grazing resistant species only;
- avoid grazing on wet soils or with very short vegetation, in order not to damage the turf;
- carry out a cleaning cut in autumn to eliminate grazing refusals.

Analysis of the floristic composition

Knowledge of the floristic composition of the donor site is fundamental in different steps of the harvesting and use of conservation mixtures:
- before collection, the type of habitat of the donor site shall be known, as requested by the current legislation;
- during the harvesting period, to follow-up the phenological trend of the dominant species and identify the best time for harvesting.
- after the collection, to choose the adequate mixture for the area to be revegetated.

The floristic composition of the donor site is to be determined detecting all present species and their relatively abundance.

According to the complexity of the habitat, it is possible to choose between different methods to survey the flora, which lead to more or less detailed results and need different competences: for priority habitats it is appropriate to require specialised professionals (agronomists, botanists…), for semi-natural habitats (meadows and pastures) the analysis can be carried out by the same farmers, if they have been trained adequately.

In many cases, it may be sufficient to provide a description of the donor site using the informative sheets of the typologies of pastures and meadows, available for the Aosta Valley, for Savoy and Haute Savoy[36]. Thanks to these technical sheets, in fact, it is possible to determine the type of the meadow or pasture by way of descriptions that do not require any specialized botanical knowledge.

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35 For details: Koch *et al*, 2010; Caillet-Bois *et al*, 2014. **36** Hauwuy *et al.*, 1991; Jeannin *et al.*, 1991; Roumet et al., 1999; Bassignana and Bornard, 2001.

Within the Alp'Grain project, a quick method was used in the Aosta Valley, based on the exhaustive list of species and their subdivision into three groups:
- dominant species;
- abundant species;
- other (species with few individuals or detected only on the edge of the parcel).

Based on a visual estimate, a percentage cover was assigned to every group and, for the "dominant" and "abundant" categories, to each species; for the third category, the percentage cover was subdivided equally between all species.

Choice of the site size

The choice of the size for collection site (or sites) is linked to the farmer's availability and to the quantity of seed needed to reseed the receptor site.

The production depends on altitude, culture type, floristic composition, harvesting time and techniques.

The relationship between the surface of the donor site and that of the receptor site can vary from 1:2 (meadow on the valley floor, with high seed production) to 8:1 (alpine pasture, with limited soil cover and seed production)[37]. In case of use of green or dry hay rich in seeds, the quantity of dry matter should not exceed 700 g/m^2. In effect, exceeding quantities may reduce the light penetration to the soil and therefore limit or prevent the settlement of young seedlings[38].

■ 4.3 The collection sites of the Alp'Grain project

Within the Alp'Grain project, the seed was harvested from five meadows in the Aosta Valley and from two pastures in France. The following pages outline concisely the main characteristics, the management and seed harvesting technique, as well as the list of species of each site.

Sites in the Aosta Valley

Fénis - Miseregne

Altitude: 500 m a.s.l.
Harvest date: 28/06/2013
Harvested surface: 1100 m^2
Management:
- Furrow irrigation
- Fertilisation: slurry distribution in spring
- 2 cuts + grazing in autumn

Harvesting equipment: pull type seed harvester
Number of species detected: 44[39]
Composition[40]**:** *Arrhenatherum elatius* (25%), *Dactylis glomerata* (15%), *Trisetaria flavescens* (10%), *Anthriscus sylvestris* (4%), *Artemisia vulgaris* (4%), *Lotus corniculatus subsp. corniculatus* (4%), *Phleum pratense* (4%), *Poa pratensis* (4%), *Salvia pratensis* (4%), *Tragopogon pratensis* (4%), *Trifolium pratense* (4%), *Trifolium repens* (4%), *Vicia cracca* (4%).
Other species (10%): *Achillea millefolium, Anchusa officinalis, Centaurea nigra, Colchicum autumnale, Convolvulus arvensis, Crepis biennis, Daucus carota, Echium vulgare, Elytrigia repens, Erigeron annuus, Euphorbia cyparissias, Galium mollugo, Galium verum, Heracleum sphondylium, Hypericum perforatum, Knautia arvensis, Leucanthemum vulgare, Medicago*

37 For more information: Kirmer *et al*., 2012. **38** M. Scotton, personal communication. **39** Two of which have not been determined. **40** In this publication, the nomenclature shall follow, as much as possible, the one reported by Bovio (2014), which is based on the Checklist of Italian Flora and on the website of Euro+Med PlantBase (www.emplantbase.org/home.html).

lupulina, Medicago sativa, Onobrychis viciifolia, Picris hieracioides, Plantago lanceolata, Potentilla argentea, Ranunculus acris, Ranunculus bulbosus, Rumex obtusifolius, Schedonorus arundinaceus, Taraxacum sect. Ruderalia, Trifolium hybridum.

Verrayes - Marquiron

Altitude: 1300 m a.s.l.
Harvest date: 17/07/2013 and 14/07/2014
Harvested surface:
2400 m^2 (2013) and 3000 m^2 (2014)
Management:

- Sprinkler irrigation
- Fertilization: manure distribution every second year
- 2 cuts + grazing in autumn

Harvesting equipment: pull type seed harvester
Number of species detected: 49
Composition: *Poa pratensis* (12%), *Trisetaria flavescens* (10%), *Dactylis glomerata* (8%), *Ononis spinosa* (5%), *Trifolium pratense* (5%), *Trifolium repens* (5%), *Vicia cracca* (5%), *Arrhenatherum elatius* (4%), *Avenula pubescens* (4%), *Briza media* (4%), *Poa bulbosa* (4%), *Schedonorus pratensis* (4%), *Anthriscus sylvestris* (3%), *Heracleum sphondylium* (3%), *Lotus corniculatus subsp. corniculatus* (3%), *Medicago lupulina* (3%), *Medicago sativa* (3%), *Trifolium montanum* (3%).
Other species (10%): *Achillea millefolium, Bromopsis erecta, Carum carvi, Centaurea nigra, Colchicum autumnale, Crepis biennis, Daucus carota, Equisetum arvense, Festuca rubra, Galium mollugo, Galium verum, Helianthemum nummularium, Knautia arvensis, Leontodon hispidus, Leucanthemum vulgare, Onobrychis viciifolia, Pastinaca sativa, Phleum pratense, Plantago lanceolata, Potentilla argentea, Poterium sanguisorba, Ranunculus acris, Ranunculus bulbosus, Rumex acetosa, Salvia pratensis, Scabiosa columbaria, Silene latifolia, Silene vulgaris, Taraxacum sect. Ruderalia, Tragopogon pratensis, Veronica arvensis.*

Champdepraz – La Veulla

Altitude: 1300 m a.s.l.
Harvest date: 30/07/2013
Harvested surface: 1000 m^2
Management:

- Sprinkler irrigation
- Fertilization: manure distribution in autumn
- 2 cuts + grazing in autumn

Harvesting equipment: pull type seed harvester and hand-held vacuum shredder for *Agrostis capillaris*
Number of species detected: 57
Composition*: Agrostis capillaris* **(8%),** *Galium boreale* (8%), *Festuca rubra* (7%), *Ranunculus acris* (7%), *Bistorta officinalis* (6%), *Leontodon hispidus* (6%), *Schedonorus arundinaceus (6%), Anthoxathum odoratum* (5%), *Dactylis glomerata* (5%), *Rhinanthus alectorolophus* (5%), *Trifolium repens* (5%), *Avenula pubescens* (4%), *Bromopsis erecta* (4%), *Poa trivialis* (4%), *Salvia pratensis* (4%), *Leucanthemum vulgare* (3%).
Other species (13%): *Achillea millefolium, Anthyllis vulneraria, Astrantia major, Briza media, Campanula glomerata, Campanula rotundifolia, Centaurea nigra, Cerastium fontanum, Colchicum autumnale, Convolvulus arvensis, Dry-*

mocallis rupestris, Erigeron annuus, Euphrasia officinalis, Galium rubrum, Heracleum sphondylium, Knautia arvensis, Lathyrus pratensis, Lolium perenne, Loncomelos pyrenaicus, Lotus corniculatus subsp. corniculatus, Medicago sativa, Melilotus albus, Melilotus officinalis, Phleum pratense, Plantago lanceolata, Plantago major, Poa pratensis, Polygala comosa, Potentilla erecta, Ranunculus bulbosus, Ranunculus montanus, Rhinanthus minor, Rumex acetosa, Silene nutans, Silene vulgaris, Stellaria graminea, Trifolium montanum, Trifolium pratense, Trisetaria flavescens, Trollius europaeus, Vicia cracca.

Cogne – Prati di S. Orso

Altitude: 1500 m a.s.l.
Harvest date: 12/08/2013
Harvested surface: 1100 m^2
Management:
- Sprinkler irrigation
- Fertilization: manure distribution in autumn
- 1 cut + 1 grazing or 2 cuts

Harvesting equipment: pull type seed harvester
Number of species detected: 35
Composition: *Bistorta officinalis* (9%), *Dactylis glomerata* (9%), *Trisetaria flavescens (8%), Geranium sylvaticum* (7%), *Festuca rubra* (6%), *Schedonorus pratensis* (6%), *Trifolium repens* (5%), *Poa trivialis* (4%), *Ranunculus acris* (4%), *Taraxacum sect. Ruderalia* (4%), *Vicia cracca* (4%), *Agrostis capillaris* (3%), *Anthriscus sylvestris* (3%), *Campanula rhomboidalis* (3%), *Carum carvi* (3%), *Heracleum sphondylium* (3%), *Trifolium pratense* (3%), *Achillea millefolium* (2%), *Alchemilla vulgaris* (2%), *Lathyrus pratensis* (2%).
Other species (10%): *Anthoxanthum odoratum, Arrhenatherum elatius, Cerastium fontanum, Chenopodium album, Elytrigia repens, Galium mollugo, Phleum pratense, Phyteuma ovatum, Rhinanthus alectorolophus, Rumex alpestris, Rumex alpinus, Scorzoneroides autumnalis, Silene dioica, Tragopogon pratensis, Vicia sepium.*

Cogne – Goilles dessus

Altitude: 1800 m a.s.l.
Harvest date: 20/08/2014
Harvested surface: 7000 m^2
Management:
- Sprinkler irrigation
- Fertilization: slurry distribution in spring and manure distribution in autumn
- 1 cut (early or late, every second year) + 1 grazing (in autumn or spring, every second year)

Harvesting equipment: pull type seed harvester
Number of species detected: 74
Composition: *Dactylis glomerata* (15%), *Onobrychis viciifolia* (15%), *Trisetaria flavescens* (10%), *Salvia pratensis* (7%), *Silene vulgaris* (7%), *Trifolium repens* (6%), *Knautia arvensis* (5%), *Trifolium pratense* (5%), *Tragopogon pratensis* (4%), *Festuca rubra* (3%), *Carum carvi* (2%), *Lathyrus pratensis* (1%), *Picris hieracioides* (1%), *Ranunculus acris* (1%), *Vicia cracca* (1%).
Other species (17%): *Achillea millefolium, Agrostis capillaris, Allium sphaerocephalon, Anchusa officinalis, Anthoxanthum odoratum, Anthriscus sylvestris, Arrhenatherum elatius, Artemisia absinthium, Artemisia campestris, Astragalus alopecurus, Biscutella laevigata, Bistorta officinalis, Brachypodium pinnatum, Briza media, Bromopsis erecta, Bupleurum ranunculoides, Campanula glomerata, Campanula rhomboidalis, Campanula rotundifolia, Carduus*

defloratus, Carex caryophyllea, Carlina acaulis, Centaurea scabiosa, Centaurea triumfettii, Chamaenerion angustifolium, Cirsium acaulon, Clinopodium acinos, Clinopodium alpinum, Colchicum autumnale, Crepis conyzifolia, Echium vulgare, Elytrigia repens, Euphrasia officinalis, Festuca ovina, Festuca valesiaca, Galium lucidum, Galium rubrum, Geranium sylvaticum, Helianthemum nummularium, Laserpitium siler, Leontodon hispidus, Leucanthemum vulgare, Lotus corniculatus subsp. alpinus, Lotus corniculatus subsp. corniculatus, Medicago lupulina, Melilotus albus, Phleum pratense, Plantago media, Poa pratensis, Rumex acetosa, Schedonorus pratensis, Silene nutans, Stachys recta, Taraxacum sect. Ruderalia, Thalictrum foetidum, Thalictrum minus, Trifolium aureum, Trifolium montanum, Veronica chamaedrys.

Sites in France

La Plagne - Dou du Praz

Altitude: 2140 m a.s.l.
Harvest date: 30/08/2013
Harvested surface: sampling of some hundreds of square metres within a parcel of about 1 ha
Management: Grazing
Harvesting equipment: pull type seed harvester, self-propelled outdoor vacuum
Number of species detected 90
Composition: Species present in percentages between 5 and 25%: *Alchemilla monticola, Anthyllis vulneraria, Carex sempervirens, Festuca rubra, Juniperus sabina, Sesleria caerulea, Trifolium montanum, Trifolium pratense.*
Other species: *Achillea millefolium, Ajuga reptans, Alchemilla alpigena, Antennaria dioica, Arabis ciliata, Arnica montana, Aster alpinus, Avenula pubescens, Bartsia alpina, Bellidiastrum michelii, Biscutella laevigata, Bistorta vivipara, Briza media, Campanula barbata, Campanula rhomboidalis, Campanula scheuchzeri, Campanula thyrsoides, Carduus defloratus, Carex atrata, Carlina acaulis, Carum carvi, Cerastium arvense, Chamaenerion angustifolium, Crepis aurea, Crepis conyzifolia, Crocus vernus, Dactylorhiza majalis, Deschampsia cespitosa, Erigeron alpinus, Festuca laevigata, Galium pumilum, Galium verum, Gentiana alpina, Gentiana verna, Geum montanum, Globularia cordifolia, Gymnadenia conopsea, Gymnadenia nigra, Helianthemum nummularium, Hieracium caesioides, Homogyne alpina, Kobresia myosuroides, Lathyrus pratensis, Leontodon hispidus, Leucanthemum vulgare, Lotus corniculatus subsp. corniculatus, Luzula multiflora, Nardus stricta, Oxytropis campestris, Pedicularis gyroflexa, Pedicularis verticillata, Phleum alpinum, Phyteuma orbiculare, Pilosella lactucella, Pinus sylvestris, Plantago alpina, Plantago atrata, Plantago media, Poa alpina, Poa pratensis, Polygala alpestris, Potentilla aurea, Potentilla erecta, Pulmonaria montana, Pulsatilla vernalis, Ranunculus acris, Rumex alpestris, Salix reticulata, Scabiosa lucida, Silene nutans, Soldanella alpina, Stachys officinalis, Taraxacum sect. Ruderalia, Thesium pyrenaicum, Thymus serpyllum, Trifolium alpinum, Trifolium badium, Trifolium repens, Trisetaria flavescens, Trollius europaeus, Vaccinium uliginosum, Veratrum lobelianum.*

Termignon - Refuge de l'Arpont

Altitude: 2300 m a.s.l.
Harvest date: 09/09/2013

Harvested surface: sampling of some hundred square metres within one parcel of about 0.5 ha
Management: grazing
Harvesting equipment: hand-held seed harvester, hand-held vacuum shredder
Number of species detected: 84
Composition:
Species present in percentages between 5 and 25%: *Alchemilla xanthochlora, Avenella flexuosa, Calamagrostis varia, Campanula scheuchzeri, Carum carvi, Festuca rubra, Festuca violacea, Helictochloa versicolor, Lotus corniculatus subsp. corniculatus, Myosotis alpestris, Nardus stricta, Poa alpina, Silene nutans, Thymus serpyllum aggr., Trifolium pratense.*
Other species: *Agrostis capillaris, Ajuga pyramidalis, Allium schoenoprasum, Anthoxanthum odoratum, Arrhenatherum elatius, Bartsia alpina, Bistorta officinalis, Bistorta vivipara, Botrychium lunaria, Campanula barbata, Campanula rhomboidalis, Carex echinata, Carex nigra, Carex pallescens, Carex sempervirens, Centaurea uniflora, Cerastium fontanum, Chaerophyllum hirsutum, Crepis aurea, Deschampsia cespitosa, Empetrum nigrum, Eriophorum latifolium, Euphrasia minima, Festuca acuminata, Geum montanum, Geum rivale, Homogyne alpina, Huperzia selago, Hylotelephium anacampseros, Hypericum maculatum, Imperatoria ostruthium, Leontodon hispidus, Luzula campestris, Minuartia rostrata, Parnassia palustris, Paronychia polygonifolia, Pedicularis verticillata, Phleum alpinum, Phyteuma betonicifolium, Polygala vulgaris, Polystichum lonchitis, Potentilla aurea, Potentilla grandiflora, Primula farinosa, Ranunculus acris, Ranunculus montanus, Rhinanthus alectorolophus, Rhododendron ferrugineum, Rumex alpinus, Sagina saginoides, Scorzoneroides helvetica, Sedum villosum, Selaginella selaginoides, Sempervivum montanum, Senecio doronicum, Taraxacum sect. Ruderalia, Thymus pulegioides, Tofieldia calyculata, Trichophorum cespitosum, Trifolium badium, Trifolium repens, Trifolium thalii, Trisetaria flavescens, Trollius europaeus, Vaccinium myrtillus, Vaccinium uliginosum, Vaccinium vitis-idaea, Veratrum lobelianum, Veronica fruticans.*

4.4 Harvesting time

Because of staggered ripening of the different species, the decision to harvest depends on the species that are most appropriate to achieve the objectives of revegetation (restoration of habitats, prevention of soil erosion etc.), knowing that in the first cycle seeds of grasses will be more abundant, while in further regrowth the proportion of legumes and other dicotyledons will increase.
Moreover, seed remain on the plant for variable periods after the physiological maturation: shorter periods for *Arrhenatherum elatius, Trisetaria flavescens, Avenula pubescens* and *Briza media*, longer ones for *Dactylis glomerata, Bromopsis erecta* or *Lolium perenne*[41].

When to harvest?

The harvest can be performed in **one single step**, trying to harvest as many mature seeds as possible, or **in different moments**, to promote the presence of the most representative species of the donor site[42]. In relation with the organizational aspects and with the extension of donor sites, in the Alp'Grain project harvests were always carried out in one single step, at the end of the spring growth cycle, when the amount of mature seeds was maximum.
Direct monitoring of the **phenology** of the species of interest may be integrated by the calculation of **growing degree-days**[43].
The frequency of the phenology observations, which is also linked to weather conditions (rainfall, temperature, winds), must increase upon approaching the harvest (end of June to end of July, in mountain meadows, or even later in subalpine pastures), as a sudden temperature increase can induce an accelerated phenological evolution of the species. Furthermore, the wind can also cause the loss of significant amounts of mature seed, especially for species that loose it easily, such as *Arrhenatherum elatius*.
There are grass species with early, intermediate

41 Scotton and Piccinin, 2003; Scotton *et al.*, 2012c.
42 Scotton *et al*., 2010. **43** Niqueux and Arnaud, 1981; Jouglet *et al,* 1982.

and late maturity[44]. The following describes the maturation period of main grasses, based on the available literature and our on-field observations.

Early species:
- *Anthoxanthum odoratum;*
- *Deschampsia cespitosa;*
- *Nardus stricta;*
- *Poa alpina;*
- *Poa pratensis.*

Species with intermediate phenology evolution:
- *Arrhenatherum elatius;*
- *Avenula pubescens;*
- *Briza media;*
- *Bromopsis erecta;*
- *Dactylis glomerata;*
- *Festuca ovina;*
- *Festuca rubra;*
- *Festuca violacea;*
- *Lolium perenne;*
- *Trisetaria flavescens.*

Late species:
- *Agrostis capillaris;*
- *Brachypodium pinnatum;*
- *Phleum pratense.*

Due to the staggered ripening of the spontaneous species, furthermore, the choice of the harvest date for grasses is not always easy, and must be supplemented by observing the phenology of legumes and other dicotyledons.

The dandelion is a species that blooms early and during the seed harvest (end of June to the end of July on meadows at 1200 to 1300 m a.s.l.) has already disseminated or has only few achenes. Examples of species with an intermediate maturation are *Anthriscus sylvestris* and *Ranunculus acris*, while a late species is *Leucanthemum vulgare*.

On meadows below 1300 m a.s.l., the following has been noted:
- corresponding to the fully ripening of *Arrhenatherum elatius* and late milk-early dough stage of *Dactylis glomerata* and T*risetaria flavescens*, flowering plants of *Tragopogon pratensis, Silene latifolia, Ononis spinosa* and *Centaurea* spp. can still be found, while seeds of *Taraxacum sect. Ruderalia* have already been loosened and those of Salvia pratensis are still green and unripe;
- observing plants of *Trifolium pratense, Knautia arvensis* and *Vicia* spp. wither and *Leucanthemum vulgare* in advanced flowering, it will be probable that *Arrhenatherum elatius* is already disseminating;
- when *Dactylis glomerata* is in full fruiting, *Galium mollugo, Plantago lanceolata* and *Bistorta officinalis* have already disseminated, while legumes such as *Lotus corniculatus* and *Trifolium pratense* (which we found to be the latest between the present species of clover) have already ripe seeds;
- when the grass seeds are ready for harvest, there are plants of *Achillea millefolium* still flowering;
- in case of grasses that scarcely hold their seed back, such as *Arrhenatherum elatius, Anthoxanthum odoratum, Briza media* and *Agrostis capillaris*, it is important to start the harvest as soon as the seeds have passed the hard dough stage, to prevent them from falling to the ground or being scattered on very windy days.

In subalpine pastures, it was observed that:
- when the seeds of *Festuca violacea* or *Festuca rubra* have surpassed their dough maturity, species such as *Alchemilla xanthochlora, Geranium montanum, Myosotis alpestris, Potentilla aurea* and *Trifolium pratense* are also ready to disseminate. On the other hand, *Bistorta officinalis, Centaurea uniflora, Cerastium fontanum, Plantago alpina, Polygala vulgaris, Potentilla grandiflora, Silene nutans, Thymus serpyllum* and *Trifolium montanum* are still in full flowering or in their early fruiting stages.

Calculating the growing degree days

The phenological evolution can change considerably from one year to another, even in the same site, in relation to local weather conditions. The adequate moment to harvest can also be determined thanks to phenological models based on **growing degree-days**.

They consist in the calculation of the sum of growing degrees during a given period and allow to estimate the development of a specific

44 Jeangros and Amaudruz, 2005; Scotton *et al.*, 2010.

plant. The growing degrees are calculated as the difference between the mean daily temperature and the minimum cardinal temperature (also called the "minimum growth temperature"), which is the value below which a species stops its vegetative activities.
During the Alp'Grain project, from the beginning of the growing season, regular inspections were carried out (initially every 2 weeks, then weekly close to the harvest period) of the phenological stage of some species whose phenology is well known. For each of them, the growing degree-days were associated with the corresponding phenological stage. The sum of the values obtained, divided by the number of species considered, gave the mean growing degree-days of the vegetal population. The figure recorded was also used to estimate how many days were missing from the optimal harvest time, knowing the growing degree days corresponding to the stage of full fruiting of the different species, and considering the daily gains ranging from 10 degrees (in case of unfavourable meteorological conditions) to 12 (in case of favourable meteorological conditions).

4.5 Harvesting techniques

Once the seeds are ready to be harvested, the weather forecast[45] needs to be checked before proceeding, to avoid bad weather conditions that may have a negative influence on the quantity and quality of the collected material.
In case of harvesting by haymaking, at least 2 to 3 days of good weather are needed, while for harvesting as green hay, by threshing or simply brushing, one day with a favourable forecast is sufficient. Furthermore, when brushing, it is not advisable to collect the material the day after a rain, as the seeds tend to remain attached to the plant.
If the date of collection falls in a very windy period, it is advisable to collect as soon as possible, to avoid that the majority of the seeds (in particular those of grasses) may fall to the ground.
There are several techniques and equipment for harvesting revegetation materials. As each one has both advantages and disadvantages, before harvesting it is important to keep in mind several aspects.

- Objects to be collected: individual species, groups of species or most of the species present on the site at a given moment.
- Characteristics of the donor site: accessibility, slope and regularity of the ground, distance from the site to be revegetated.
- Efficiency of the different harvesting techniques: in terms of quantity of seed collected in relation to that present on the standing plants or in terms of number of species collected in relation to those present at the donor site.
- Availability of equipment in the farm.
- Harvesting costs, including working time and transport of the implements and of the harvested product.
- The possibility to store the collected material, according to its humidity and volume.
- Post-harvest treatments: time, costs and equipment for possible drying and cleaning of the collected materials.

Within the Alp'Grain project, we compared manual harvest, mechanical harvest with handheld (a vacuum shredder and a brush seed harvester) or with self-propelled or pull-type devices (a self-propelled outdoor vacuum and a pull-type brush seed harvester).
These techniques will be described briefly in the following pages. For other systems and further information, please refer to the "*Practical handbook for seed harvest and ecological restoration of species-rich grasslands*" Scotton *et al*., 2012b.

Manual harvest

Manual harvesting, either by cutting or by rubbing the infrutescences manually is used to harvest individual species. It is used when we would like to obtain material for the multiplication of certain species or, associated with mechanical techniques, to collect the seeds of species that reach maturation in a different time compared with that chosen for the harvest.
The advantage of this technique is the possibility

45 Scotton *et al.,* 2012c.

Figure 13 - Seed harvest with the hand-held vacuum shredder

to collect seed at their optimal maturity, overcoming the problem of staggered ripening between different species or within the same species.
The material obtained is nearly free of vegetal fragments different from the seed, so it is very fast to clean, but manual harvesting requires long working times, which can further increase for species whose seeds are difficult to remove (e.g. *Leontodon hispidus*).
During the Alp'Grain project, this technique was used to harvest early species (*Bistorta officinalis*) or to harvest the seeds of a single species (e.g. *Poa alpina, Festuca laevigata* and *Avenula pubescens*) in different times.

Equipment for mechanical harvesting

In Italy, a pull-type seed harvester was used in meadows, while in Savoy, to harvest seed in subalpine pastures, four machines were compared:

- hand-held vacuum shredder;
- hand-held seed harvester;
- self-propelled outdoor vacuum;
- pull type seed harvester.

Hand-held vacuum shredder

A hand-held vacuum shredder Stihl mod. SH86 (Figure 13) was used, which sucks the seeds exploiting the flow of air produced by the motor and conveys them to a bag behind. The bag allows transfer of air and must be emptied frequently to ensure an efficient suction.
The hand-held vacuum shredder is particularly interesting to harvest seed of shorter plants, such as *Anthyllis vulneraria* or *Helianthemum nummularium*, in hard-to-reach areas for heavier equipment.

Hand-held seed harvester

A brush seed harvester produced in Canada by *Prairie habitats* was used, driven by the motor of a grass trimmer and equipped with a rotating brush whose nylon filaments break the seed off and conveys it to a bag behind the reel (Figure 14). The brush is 50 cm wide and the filaments are of different types, depending on the seed to be harvested.

Self-propelled outdoor vacuum

The self-propelled outdoor vacuum Billy Goat model KV600P is a machine designed to clean dry leaves, cut grass or other organic materials from green areas (Figure 15).
Due to its characteristics, it can be employed usefully in seed harvesting on regular grounds and gentle slopes, in short turf and for small sized species (e.g. clovers, *Leontodon hispidus* etc.). In these cases, harvest efficiency is comparable or higher than that of the pull-type seed harvester.
The lightness of the instrument and the act of aspiration cause minor damages to the vegetation and minimize biomass losses; after the seed harvest the sward can be grazed properly.
This machine can be used on small surfaces with short vegetation (<30 cm). This last cha-

Figure 14 - Seed harvest with the Hand-Held Seed Harvester

Figure 15 - Seed harvest with the self-propelled outdoor vacuum

racteristic excludes the use of the self-propelled outdoor vacuum on hay meadows (vegetation higher than 40 cm). Furthermore, the aspiration is effective to harvest light seeds that are spread mainly by the wind, while in the case of seeds that are harder to tear off, a more vigorous mechanical action is needed (for example, brushing).

Pull-type seed harvester

This machine (Figure 16) is produced by *Prairie habitats*, too. It is equipped with a brush that rotates on a horizontal axis, detaches the seeds situated at height above 30 to 60 cm from the ground and conveys them to a reservoir behind. The width of the instrument tested in this project was 1.8 m, but there are models up to 2.3 m. From what has been observed directly, the impact of the pull-type seed harvester on the sward is limited, and a few days after the seed harvest mowing or grazing can be carried out without too many problems.

Thanks to its reduced weight (from 250 to 450 kg, depending on the model) and because the pull-type seed harvester is powered by an independent motor, this machine can be pulled not only by a tractor, but also by an off-road vehicle or a quad. The main limit of the pull-type seed harvester is its width, which does not allow circulating on roads being towed by a vehicle, and forces to transport it on a truck or on a trailer.

Mechanical harvesting with hand-held devices

Figure 16 - Seed harvest with the Pull-type Seed Harvester

Both the hand-held vacuum shredder and the hand-held brush harvester show low productivity and, requiring long working times, are heavy for the operator (Table 1).

In terms of harvested species, they are complementary, in particular regarding legumes and other dicotyledons. In tests on subalpine pastures, there was a percentage of clean seed

Table 1 - Results obtained during the harvest with hand-held devices on subalpine pastures.

	Working times (h/ha)	Dry material harvested (kg/ha)	Quantity of clean seeds (kg/ha)	% seeds	Working productivity (kg seeds/h)
Hand-held vacuum shredder	72.2	30.3	6.8	22.4	0.2
Hand-held seed harvester	33.3	12.3	2.4	19.3	0.1

Table 2 - Results obtained during the harvesting with self-propelled or pulled on subalpine pastures.

	Working times (h/ha)	Dry material harvested (kg/ha)	Quantity of clean seeds (kg/ha)	% seeds	Working productivity (kg seeds/h)
Self-propelled outdoor vacuum	8.2	40.5	11.8	29.2	1.4
Pull-type seed harvester	3.6	14.0	4.6	32.6	1.3

equal to about 20% of the total, rather low if compared to data reported by other Authors[46].
The use of hand-held harvesting devices is interesting where the use of self-propelled or pulled equipment is not possible, or in areas with low and sparse vegetation or for harvesting species with an important ecological value, such as the site of the Refuge de l'Arpont in the Vanoise National Park. In hay meadows, they can be used in a complementary manner to pulled or self-propelled implements.

Mechanical harvest with pulled or self-propelled implements

In all donor sites characterized by gentle slopes, regular and easily accessible to the machines, it is possible to perform mechanical harvesting, which requires shorter execution times and in general has a good collection efficiency (Table 2).
Harvesting efficiency is influenced by local climatic factors, as anticipated, but also by correct technical choices in the calibration and use of machines (forward speed, height and direction of rotation of the brush, etc.). In general, it was found that all different harvesting techniques provide materials that need several cleaning steps before being sowed.

Self-propelled outdoor vacuum

In tests conducted on short swards, the self-propelled outdoor vacuum showed a superior harvesting efficacy, both in productivity and total yields, than the pull-type seed harvester (Table 2). Therefore this device can also be considered as complementary to the pull-type seed harvester, in habitats with short vegetation. It is known that the combination of multiple harvesting machines allows better adaption to the topographical conditions of the collection site as well as the characteristics of the vegetation, ensuring optimum yields[47].

Pull-type seed harvester

The pull-type seed harvester is the most appropriate machine for seed harvesting in hay meadows, but the data obtained also demonstrated its effectiveness for subalpine pastures (Table 2).
The productive results of this machine were influenced by the regularity of the ground, turf height and uniformity, phenology of the species present, as well as the height, speed and direction of rotation of the brush.
Table 3 presents the results obtained during the harvests in the Aosta Valley in 2013 and 2014. In the best operating conditions, on permanent meadows and pastures, about **100 kg/ha** of brush harvested seeds were collected with the pull-type seed harvester. Except for the case of Prati di S. Orso in Cogne, where large staggered ripening of species reduced the yield, the pull-type seed harvester collected an abundant biomass, containing a significant proportion of parts of leaves, stalks and infructescences. Even after a rough cleaning, the brush-harvested seeds still included a significant proportion of other plant fragments, which explains why they represented, in weight, between 70 and 80% of the harvested materials.
For better removal of impurities, a fixed thresher was used in 2014, which allowed to clean the propagating material very well, removing all coarse vegetal parts and making it suitable to be distributed with a hydroseeder. After this

46 Scotton *et al.,* 2012b. **47** Krautzer and Wittmann, 2006.

Table 3 - Results obtained with the pull-type seed harvester on hay meadows of the Aosta Valley

Site	Fénis	Verrayes	Champdepraz	Cogne Prati di S.Orso	Verrayes	Cogne Goilles dessus
Harvesting date	**28/06/2013**	**17/07/2013**	**30/07/2013**	**12/08/2013**	**14/07/2014**	**20/08/2014**
Harvested material (kg/ha)	*	140	130	49	126	185
Brush harvested seeds in the harvested material (%)	*	71	73	79	54	55
Brush harvested seeds (kg/ha)	88	100	94	38	68	102
Pure seeds in the brush harvested seeds (%)	57.7	36.0	52.1	21.8	46.4	58.9
Harvested seeds (kg/ha)	50.7	36.0	48.9	8.3	31.6	60.1
Weight of 1000 seeds (g)	1.45	1.37	0.34	2.06	*	*
Harvested seeds (n/m²)	3,494	2,627	14,522	402	*	*

*Not measured.

step, the separated brush harvested seeds were about half of the harvested material.
With increasingly finer sifting (sieves from 5 to 0.63 mm), the content of pure seed and weight of 1000 seeds in the materials harvested in 2013 were also determined (Table 3).
The percentage content of seeds was quite variable, ranging from a minimum of 22% to a maximum of 59%. A mean of about **39 kg/ha** of seed was collected, with the best results obtained in Cogne - Goilles dessus (about **60 kg/ha**).
The weight of 1000 seeds is strongly influenced by the floristic composition, which explains the variability recorded in the different sites, with a minimum in Champdepraz, where *Agrostis capillaris* and other species with small seeds were abundant, and a maximum in Cogne - Prati di S. Orso, with species such as heavy seeded *Bistorta officinalis* and *Heracleum sphondylium*.
As a result of these differences and of the yields obtained, in the five experimental sites, we collected from 400 seeds/m² in Cogne - Prati di S. Orso, to 14,500 seeds/m² in Champdepraz.

4.6 Characteristics of the harvested materials

Regulatory framework

In the European Directive 2010/60/EU and in the technical regulations for production and control of seed mixtures that are intended to preserve the natural environment in France, for **directly harvested mixtures**, it is stated that the percentage of the components of seeds mixtures, represented by species and subspecies that are characteristic of the habitat type of the donor site, must be such as to recreate the habitat type of the donor site properly.
In addition, to obtain the permission for a donor site, the following conditions must be met:

- the maximum level of seeds of species (or subspecies) that are not characteristic of the habitat type of the donor site must not exceed 1% by weight, while the presence of Rumex spp. (excluding *Rumex acetosella* and *Rumex maritimus*) is limited to 0.05% by weight;
- no directly harvested mixtures may contain seeds of *Avena fatua, Avena sterilis* or *Cuscuta* spp.;
- all directly harvested mixtures may contain seeds of fodder plants included in Directive 66/401/EEC, or seeds of non-fodder species under this Directive. In case that the preservation mixture contains a variety for conservation, Directive 2008/62/EC and the approved technical regulations for production and control of

Figure 17 - *Nardus* grassland, Dou du Praz, La Plagne, 2140 m a.s.l. (Picture: CBNA).

seed varieties for preservation, as set forth in the Decree dated 16 December 2008, shall be applied.

Characteristics of the harvested material in the Alp'Grain project

In order to evaluate the feasibility and yield of harvesting local seed in mountain grasslands and to ensure the success of any revegetation measures, it is essential to study the seed germinating process. This phase begins with the collection of mature seeds until the emergence of radicle[48] is detected. Plant growth at high altitudes is a complex process, and quickly at the same time, influenced by the competition between species, as well as by geophysical factors (climate, slope, soil etc.).

From this perspective, therefore, we studied the performance (**maximum** and **minimum germination**) of seed lots collected in 2013, focusing on the most interesting species for revegetation purposes. The results obtained will be useful to insert properly the seed collection into the schedule of traditional agricultural practices and they will allow to choose the species to be collected and the methods to be adopted, according to the different objectives (marketing, personal use, preservation of biodiversity, etc.), considering the maturing stages of the different species.

Within the Alp'Grain project, the seed harvested was analysed in:

- a *Nardus* grassland grazed by bovines, located in Dou du Praz (Figure 17), in the ski area of La Plagne in Savoy, at 2140 m a.s.l.;
- four grasslands in the Aosta Valley, between 500 and 1500 m a.s.l.

Effectiveness of the collection Quantity of pure seed

Pure seed content (seeds separated from impurities, with or without their envelope or *pericarp*) in the samples harvested (Figure 18) and their weight were determined with the purpose of:

- knowing the effectiveness of harvesting with the tested machines;
- providing an estimate of the density of the material to be sown later.

The mixture harvested in La Plagne contained an average of 32.5% of seeds. On average, with the pull type seed harvester 326 g of seeds were collected per kg of material harvested, 292 g with the self-propelled outdoor vacuum and 224 g with the hand-held vacuum shredder.

In the Aosta Valley, the harvest in the five meadows with the pull type seed harvester allowed to obtain mixtures with an average content of pure seed equal to 45.5 %, after a first rough cleaning of the harvested material. The content of seeds was quite variable, ranging from 21.8% to 58.9%.

Since 2009, the N'Py ski areas in the French Pyrenees have been collecting seeds with a pull type seed harvester, on pastures located between 1200 and 1800 m a.s.l.. Their report[49] shows an average percentage of pure seed between 38 and 71% of the harvested material.

Figure 18 - Seed mixtures harvested by a pull type seed harvester (30 August 2013, La Plagne).

48 Baskin & Baskin, 1998. **49** Ski areas N'Py, 2012.

In the surfaces grazed before harvesting, the content of pure seed was lower than in those that were not grazed.
To provide some general guidelines regarding harvesting in certain habitats, it would be necessary to repeat the collections for several years. After these first tests carried out in the Alp'Grain project, it seems clear that pure seed percentages are heavily influenced by technical, ecologic, climatic and geographical factors:

- implements used during the harvest;
- harvest period;
- management of the surfaces (grazing, cutting);
- type of habitat and height of the vegetation;
- weather (temperature, rainfall, etc.);
- altitude and aspect.

All these factors must be taken into account to optimize the results of the harvesting.

Figure 19 - Seed selection for classification (Picture: CBNA).

Figure 20 - Seed determination (Picture: CBNA).

Alpine bluegrass (*Poa alpina*, Figure 21) is an important species for reseeding ski areas because it has the following advantages[50]:

- large ecological amplitude (for example it is tolerant to cold weather and droughts) and altitudes (from 600 to 3600 m a.s.l.);
- high colonizing aptitude, quickly covering the soil and occupying open spaces due to any shortcomings during the reseeding;
- although its root system is superficial, it can cover the soil effectively when it is associated with deep rooted species, such as Alpine Birdsfoot-trefoil (*Lotus corniculatus* subsp. *alpinus*);
- finally, it develops preferably in high altitude grassland (subalpine and alpine) rather rich in organic matter, corresponding to our study area.

Figure 21 - Alpine bluegrass (*Poa alpina*), an important species for revegetation.

50 Géni'Alp, 2014.

Composition of seeds - List of species in the harvested mixtures

To determine the number of different species present in the harvested material, seeds were classified (Figures 19 and 20)
This allowed to:

- know the species harvested ;
- compare the harvesting mixture with the vegetation detected at the donor site;
- evaluate the adequacy of the machines used to harvest interesting species for re-vegetation in high mountains, such as *Poa alpina*.

Table 4 - Effectiveness of the harvest in the five test sites in 2013 (Source: CBNA).

	Number of species present	Number of harvested species	Rate of presence* (%)
La Plagne	90	31	34.4
Champdepraz	57	24	42.1
Cogne	35	17	48.6
Fénis	44	14	31.8
Verrayes	49	21	42.9

* Number of harvested species/number of species present.

To compare the material harvested with the vegetation of the donor sites, several samples were divided and the isolated seeds were determined and counted.
This work allowed to know the number of species present in the mixtures, their abundance and evaluate the effectiveness of the harvest (Table 4).

As mentioned earlier, more species were detected in the French subalpine pasture than in the Aosta Valley meadows. It is known, in fact, that the species richness of the subalpine pastures is greater than the one of meadows. In addition, the site of Dou du Praz in La Plagne includes two *facies* (*Nardus* grassland on acidic soil and *Sesleria* grassland on calcareous soil) that have two different floristic corteges.
Overall, it was observed that the number of harvested species was proportional to the species richness (Figure 22).

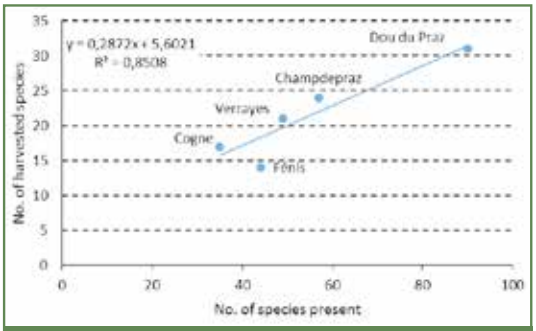

Figure 22 - Relationship between the number of species harvested and the one of the species detected in the experimental sites in Italy and France.

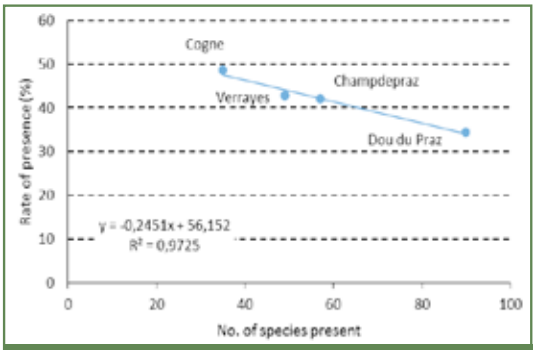

Figure 23 - Relationship between the rate of presence and the number of species found in the experimental sites in Italy and France.

Only the Fénis site, the first site to be harvested, perhaps on a too early date, deviated from the general trend, showing a rate of presence of 31.8%, the lowest value among all the sites.
For the other four sites, a close and inversely proportional correlation was found between their floristic richness and the rate of presence (Figure 23).

The more abundant are the species in the vegetation, then, the more difficult would it be to harvest them. Another element that may have affected the relatively low result of Dou du Praz is the lower height of the vegetation, which may have reduced the effectiveness of the machines used during the harvest.

Example 1: mixture harvested at Dou du Praz with the pull-type seed harvester, the self-propelled outdoor vacuum and manually

Number of harvested species: 31

Figure 24 shows that 48% of the mixture were grasses (A*venula pubescens, Phleum alpinum, Festuca rubra, Sesleria caerulea, Poa alpina* etc.); other species were one sedge (*Carex atrata*), one clover (legumes – *Trifolium* spp.) and other dicotyledons, the most abundant of which was *Leontodon hispidus*.

The results showed a difference of distribution in large groups. In particular, the composition

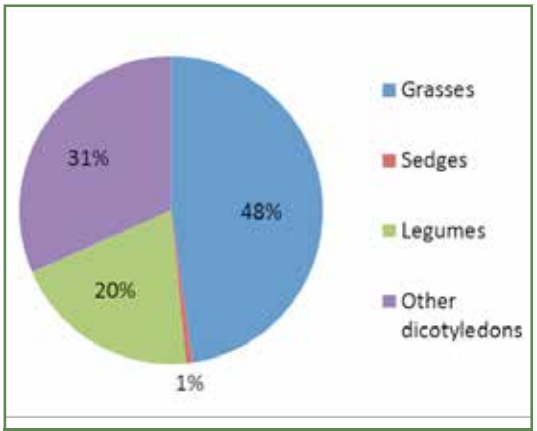

Figure 24 - Subdivision of the mixture collected at Dou du Praz in main vegetable groups, calculated according to the weight (Source: CBNA).

was simplified since the collection privileged grasses and disadvantaged legumes, although it ensured a good diversity of species. The mixture obtained seems effective for revegetation, composed of species suitable to colonize the soil (grasses and legumes).

The machines used (pull type seed harvester and self-propelled outdoor vacuum) are both suitable to harvest key species for revegetation of subalpine grasslands, such as *Poa alpina, Festuca rubra* or clovers. In general, in the tests the pull type seed harvester collected more grasses, while the self-propelled outdoor vacuum collected more seeds of dicotyledons, such as *Leontodon hispidus*, and legumes, such as different clovers.

Example 2: mixture harvested with the pull-type seed harvester in the meadow of Cogne-Prati di S. Orso

Number of species harvested: 17

This mixture (Figure 25) contained only grasses, more than proportionally to their presence in the vegetation, and various dicotyledons. The most abundant grasses were *Festuca rubra* (50%) and *Dactylis glomerata* (12%). Ten

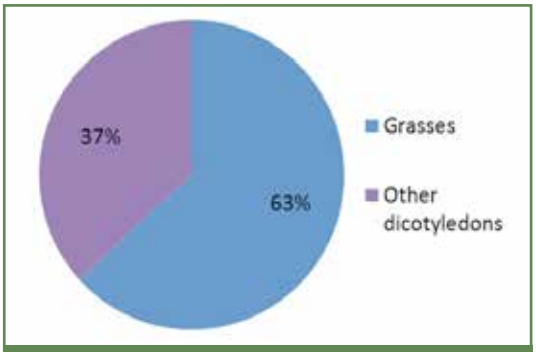

Figure 25 - Subdivision of the mixture collected in the meadow of Cogne-Prati di S. Orso, calculated according to the weight (Source: CBNA).

species of dicotyledons were present, the most abundant of which were *Bistorta officinalis* (18%) and *Heracleum sphondylium* (13%). The legumes, which constituted about 15% of the vegetation, were not mature enough at the moment of harvesting, which explains why their seeds were not found in the harvested mixture.

Seed viability - Germination tests

Germination tests allowed to determine the revegetation potential of the mixtures and of the most interesting species for revegetation in mountain zone.

The results in Table 5 show that only the mixture harvested in Champdepraz had a germination rate of more than 90%, provided by the good germinative power of Agrostis capillaris, its seeds representing 93% of those harvested in this meadow. On the other hand, the seeds that showed the lowest germination rates (just above 50%) were those collected in the subalpine pasture of La Plagne: it is known, in fact, that the germinative power decreases with altitude.

Table 5 - Germination and mortality rates (%) of mixtures harvested in the donor sites. *For each column, means with the same letter are not significantly different from each other (Tukey HSD test, p<0.05).*

Site	Germination rate (%)		Mortality rate (%)	
	Mean	Standard deviation	Mean	Standard deviation
La Plagne	51.0 ^{c}	±2.8	24.5 ^{a}	±1.8
Champdepraz	91.2 ^{a}	±6.2	6.5 ^{b}	±4.6
Cogne	60.6 ^{bc}	±2.3	24.3 ^{a}	±2.5
Fénis	73.1 ^{b}	±11.4	24.8 ^{a}	±9.9
Verrayes	61.3 ^{bc}	±6.1	24.6 ^{a}	±8.4

Despite a sometimes high internal variability in each mixture -as highlighted by the standard deviations- the differences between sites were statistically significant, clearly separating the mixtures of Champdepraz from those of other meadows of the Aosta Valley. The latter showed germination rates ranging from 60 to 73%, values which may however be considered to be satisfactory, taking into account that these seeds came from non-selected wild species and were collected in bulk. Except for the mixture of Champdepraz, the germination tests showed that almost 1/4 of the harvested seeds was not vital.

The differences may be the effect of harvest periods that are not fully appropriate for certain species, but are also due to the diverse composition of the vegetation at the experimental sites, to the gradual maturation of species and to the inherent variability of wild populations, as the results shown in Table 6 seem to suggest. The test evidenced, in fact, a higher germinative power of *Dactylis glomerata* seeds harvested in Verrayes and Fénis compared to those coming from Cogne, while populations of *Schedonorus arundinaceus* from Verrayes and Cogne germinated more than those from Fénis.

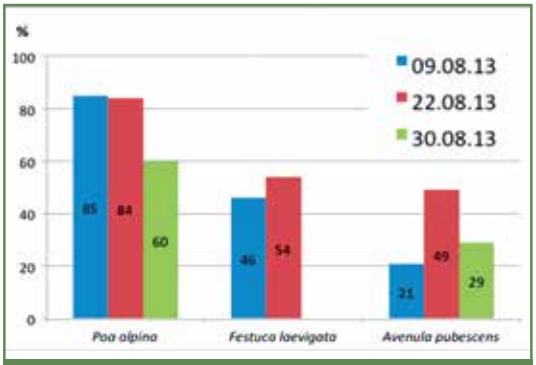

Figure 26 - Comparison of germination rates (%) for three species harvested on different dates.

Table 6 - Germination and mortality rates (%) of *Dactylis glomerata* and *Schedonorus arundinaceus* harvested at Cogne, Fénis and Verrayes. *For each column, means with the same letter are not significantly different from each other (Tukey HSD test, p<0.05).*

	Site	Germination rate (%)		Mortality rate (%)	
		Mean	Standard deviation	Mean	Standard deviation
Dactylis glomerata	**Cogne**	36.3 ^{b}	±8.5	58.8 ^{a}	±2.5
	Fénis	71.3 ^{a}	±14.9	27.5 ^{b}	±12.6
	Verrayes	80.0 ^{a}	±8.2	20.0 ^{b}	±8.2
Schedonorus arundinaceus	**Cogne**	98.8 ^{a}	±2.5	1.3 ^{b}	±2.5
	Fénis	87.5 ^{b}	±6.5	12.5 ^{a}	±6.5
	Verrayes	97.5 ^{a}	±2.9	2.5 ^{b}	±2.9

To deepen the analysis of the relationship between harvesting periods and germination rates, the seeds of 3 interesting species for re-vegetation in mountains were compared (*Poa alpina*, *Festuca laevigata* and *Avenula pubescens*), collected on three different dates (9, 22 and 30 August 2013) in La Plagne (Figure 26).

On average, germination rates were higher for seeds of *Poa alpina* than for the other two grasses (76% vs. 50% of *Festuca laevigata* and 33% of *Avenula pubescens*). As regards the influence of the date, no univocal trend was detected for the three species. The statistical analysis allows to outline the following trends for two of these species:

- in the case of *Poa alpina*, the highest rates (>80%) were obtained when the seeds were harvested within the first three weeks of August;
- in the case of *Avenula pubescens*, the germination rate reached its maximum for seed harvested during the third week of August, but not more than 50%.

The differences observed in the three species emphasize the need to know the viability of each species, and the importance of following-up their phenology, in order to determine the adequate period to harvest the largest number of desired species. The harvest date is often the result of a compromise in terms of maturity of the different valuable species, which do not necessarily have the same phenological cycle.

Figure 27 - Seed of *Avenula pubescens*.

Weight of 1000 seeds

The weight of the seeds is an important parameter, since it expresses their maturity indirectly, and can allow to estimate the success of their settlement and dispersion capacity[51]. The weight of 1000 seeds may change due to weather conditions during the seed growth, to harvest date and to storage conditions. It is determined from on an average of several samples of seeds, according to a proportionality calculation.

The weight of 1000 seeds of *Poa alpina, Festuca laevigata* and *Avenula pubescens* was calculated in relation with their harvest date (Figure 27). The data obtained is comparable to the one reported by other authors[52]: 0.5-0.7 g for *P. alpina*, 0.8-1.0 g for *F. laevigata* and 2.6 g for *A. pubescens*.

The weight of the seeds of the three grasses reached its maximum during the harvest carried out on 22 August, compared to that of seeds harvested on 30 August, with a significant difference for seeds of *Poa alpina* (reduction equalling 0.12 g, or about 1/5 of the average weight of 1000 seeds). In the case of *Avenula pubescens*, a difference was observed of 0.81 g (about 1/3 of the weight indicated by the FAO) between 22 and 30 August. The weight of 1000 seeds of *Festuca laevigata* between 9 and 22 August decreased by 0.26 g, which is about 1/4 of the average weight of this species.

The results emphasize the importance of the harvest date to ensure a satisfactory germination rate. In order to collect seeds with high

Table 7 - Weight of 1000 seeds of mixtures harvested with the pull type seed harvester in different donor sites.

Site	Weight of 1000 seeds (g)
La Plagne	0.72
Champdepraz	0.33
Cogne	2.14
Fénis	1.45
Verrayes	1.37

51 Pluess *et al.*, 2005. **52** FAO, 2014; Krautzer, 1997.

Table 8 - Usual and delayed cutting dates for each seed donor site.				
Site	Usual cutting		Delayed cutting	
	Date	Phenological stage of *Dactylis glomerata*	Date	Phenological stage of *Dactylis glomerata*
Champdepraz	04/07/2013	full bloom	30/07/2013	late fructification
Cogne Goilles dessus	28/07/2014	end of bloom	20/08/2014	late fructification
Cogne Prati di S. Orso	02/08/2013	fruiting	12/08/2013	late fructification
Fénis	17/06/2013	beginning of fructification	28/06/2013	late fructification
Verrayes	18/06/2013	full bloom	17/07/2013	late fructification

weight, therefore, the harvest date should be scheduled according to the most interesting species for the site revegetation.
Generally, the weight of 1000 seeds is measured for each individual species, but within the Alp'Grain project it was also measured for the whole of each different mixture.
The results presented in Table 7 show strong variations between sites, related to their floristic composition and, consequently, to the differences in size and weight of the seeds of the species. In Italy, the harvests were carried out in meadows, at lower altitudes and with a vegetation composed of species (except for *Agrostis capillaris*, that was very abundant in Champdepraz) with larger seeds than those of the subalpine pastures of La Plagne.

4.7 Consequences of seed harvesting on forage production

Due to the extensive management of grasslands in the Aosta Valley, haymaking is often performed during the full bloom of *Dactylis glomerata* or even later[53].
The use of permanent meadows and pastures to harvest seed imposes a delay in the cutting or grazing time, and involves collecting a part of the biomass. In order to evaluate how these factors influence forage production, the yield of these meadows was measured and the grass quality was analysed either in usual haymaking time or at seed harvesting, the latter being in a more advanced phenological stage.

On average, the seed collection forced to mow twenty day later than the usual cutting date, ranging from a minimum 10-11 days in Cogne-Prati di S. Orso and Fénis, to a maximum 29 days in Verrayes (Table 8).

With the exception of the Fénis site, delay in harvesting always resulted in a reduction of

53 Roumet *et al.*, 1999.

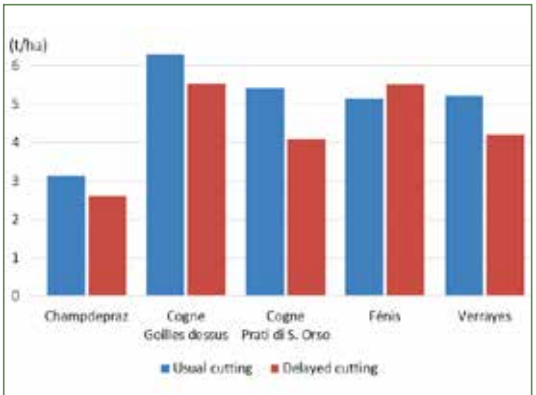

Figure 28 - Yield (t/ha DM) in the donor sites of the Aosta Valley

Table 9 - Forage value and forage production in the donor sites of the Aosta Valley (DM=Dry Matter; MFU=Milk Forage Units).

	Grass forage value (MFU/kg DM)		Forage production (MFU/ha)		
Site	**Usual cut**	**Delayed cut**	**Usual cut**	**Delayed cut**	**Balance (%)**
Champdepraz	0.73	0.76	2294	1975	-14%
Cogne-Goilles dessus	0.80	0.82	5026	4523	-10%
Cogne-Prati di S. Orso	0.75	0.78	4066	3169	-22%
Fénis	0.79	0.74	4070	4067	0%
Verrayes	0.76	0.71	3962	2974	-25%

the biomass present in the grassland (Figure 28). The average reduction was approximately 18%, with a minimum of 12% in Cogne-Goilles dessus and a maximum of 25% in Cogne-Prati di S. Orso.
The phenology progress determined a reduction of the grass forage value only in the sites of Fénis and Verrayes, where grasses represented at least 50% of the vegetation. In the other three sites, instead, where the meadows were richer in legumes and other dicotyledons, grass quality did not decrease (Table 9).

Globally, as a result of changes in the quantity and quality of the grasses in the Aosta Valley sites, there was an average reduction of fodder production of about 14%, with significant differences between the different locations.
On the subalpine pasture of Dou du Praz in La Plagne, an analysis of the grass samples collected on 30 August 2013 (date of the seed collection) did not evidence any significant differences compared to the samples collected on 22 July 2013 (grazing starting date), either for their Crude Protein content, or for their digestibility.

Chapter 5
Processing and packaging of preservation mixtures

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To ensure the conservation of the material collected it is necessary to dry and, if required, to clean the harvested seeds; these materials can be marketed as preservation mixtures only if the producer obtained from the responsible authorities, at the beginning of the production season, a proper authorisation to market them.

5.1 Regulatory framework

Who can produce with sale purposes

In Italy, any operators who wish to carry out production, processing and sale of preservation mixtures must submit a request for authorization to the CRA-SCS before the beginning of such activities, while in France all operators must contact the Official Service for Seed Control and Certification (*Service officiel de contrôle et certification* - SOC).

In Italy, all seed producers, in addition to be listed in the companies' register of the competent Chamber of Commerce and to have a VAT number, must possess the facilities and equipment suitable to process the specific seeds and must also satisfy certain professional requirements

The Ministerial Decree No. 26250 dated 12/11/2009 states that the minimum **equipment** necessary to produce and process the seed for selling purposes are to be "appropriate for the species processed". Given that the standard reference for preservation mixtures does not provide more precise indications, following the trial experience it is estimated that for the production and processing of these mixtures a pull type seed harvester and a fixed threshing machine may be sufficient.

The **professional requirements** are satisfied if the owner, or an employee of the company, is in possession of adequate knowledge regarding phytosanitary and quality regulations concerning the categories of vegetables produced. All seed producers, furthermore, must also demonstrate that they have specific professional knowledge about production and mechanical selection methods and about seed regulations. This knowledge is understood to have been acquired if the technical manager holds a degree or a diploma in agricultural or forestry education (seed producers are required to have worked in the seed business for at least 5 years) or attended successfully a specific training course or passed successfully an interview with the Plant Health Service destined to check their relevant knowledge.

Those who multiply seeds for companies authorized to perform seed activities and **small producers**[54] do not need any authorisation from the regional Plant Health Service, while farmers who collect the seeds at donor sites for third parties, don't have to request authorization from the CRA-SCS.

An analysis of the current legislation[55] leads to believe that those operators producing only preservation mixtures can be equivalent to the producers of conservation varieties and, therefore, be exempted from the professional requirements of seed companies.

In Italy, the producers of preservation mixtures must apply for the authorization to market them

54 "Small producers" are those who produce and sell plants and vegetal products which in their totality are destined for final use, in the context of the local market, to persons or buyers who are not professionally involved in the production of plants. **55** D.lgs. 214/2005 and D.M. 26250 of 12/11/2009.

to the CRA-SCS, while in France[56] they must apply to the SOC.
The application for authorization must be submitted before starting each production season (in France, on June 30) and should include:

- name and address of the producer;
- harvesting method: directly harvested mixtures;
- percentage by weight of the components as species and, where relevant, subspecies that are characteristic of the habitat of the donor site;
- quantity of the mixture to which the authorisation is to apply;
- region of origin;
- restriction to marketing in the region of origin;
- source area;
- collection site and its physical characteristics (location and surface);
- habitat type of the collection site;
- year of collection.

The producer, furthermore, must provide all useful technical information to check the preservation mixture conformity.

What kind of processing can be done

The reference legislation establishes that directly harvested mixtures may be marketed with or without being cleaned, without providing any further information regarding the processing and preservation procedures.

How can they be marketed

All preservation mixtures can be sold only in sealed packages, and sealed in such a way that they cannot be opened without damaging their seals.
The package must bear a mandatory label containing the following information:

- the legend “EU rules and standards”;
- name and address of the person responsible for affixing the labels or his identification mark;
- harvesting method: directly harvested mixtures;
- year of the sealing expressed as: «sealed ...» (year);
- region of origin;
- source area;
- collection site;
- habitat type of the collection site[57];
- the words «preservation fodder plant seed mixture, intended for use in an area of the same habitat type as the collection site, not considering the biotic conditions»;
- reference number of the lot given by the person responsible for affixing the labels;
- the percentage by weight of the components as species and, where relevant, subspecies ;
- declared net or gross weight;
- where granulated pesticides, pelleting substances or other solid additives are used, the nature of the additive and the approximate ratio between the weight of clusters or pure seeds and the total weight shall be indicated.

5.2 Processing in order to sell preservation mixtures

The collected seeds, just after being harvested, have a moisture content that is not suitable for their preservation and may contain, in addition to the seeds, a variable quantity of plant material. Therefore, it is necessary to dry the mixtures and it is advisable to clean them, in order to ease their sale and use.

Drying

If you have a drying kiln, you can save time by using forced ventilation. If you do not have one,

56 For the French law, “producers of preservation mixtures” are the operators registered before the Official Seed Control and Certification (*Service officiel de contrôle et certification* - SOC) that collect and/or market directly harvested mixtures, or produce preservation mixtures by mixing the cultivated seeds. **57** For habitats identified within the Italian territory, see: http://vnr.unipg.it/habitat/.

you should store the brush-harvested seeds in a ventilated room, protected from the rain and direct winds, spreading it over a large area, ventilated and raised from the ground.
To speed up drying times, avoid the development of mould and preserve the quality of seeds, the material must be placed in not too thick layers (around 25 to 30 cm) and must be turned daily until completely dry. Of course, the duration of this phase is related with the moisture levels of the materials to be dried.

Cleaning the collected material

The collected materials contain a portion more or less abundant of leaves, inflorescences and stems. The amount of this fraction depends on the harvesting method (minimum in the case of manual harvesting, greater in the case of mechanical harvesting) and operating choices (in the case of the pull type seed harvester, the height of the brush and the speed influence the quality of the brush-harvested seeds).
Completed the drying process, therefore, it is advisable to clean the material to make it suitable for seeding.
Depending on the quantity and quality of the collected materials and their mode of use, manual separation, sifting or threshing may be employed.
Only in the case of manual seeding on small surfaces, the collected material does not need any special cleaning operations.

Manual separation

This operation consists in releasing the seeds from their coarse materials, in particular from stems and grass leaves, using first a pitchfork and then shaking the hay manually to drop the finer fraction. The work is lengthy, the material obtained is rather coarse and can only be sown manually.

Mechanical separation

If the material to be treated is not too abundant (a few tens of kilograms), it can be further cleaned with a laboratory thresher after its manual separation. The screening thus realized allows to separate the larger plant bulk from the seed and smaller and lighter plant parts, which does not hinder its mechanical seeding.
If you need to separate greater quantities, however, you should use a properly calibrated thresher.

Seed preservation

While the site is being prepared to be reseeded, the clean and threshed seed should be stored in suitable containers and in ventilated areas. Following this preservation method, the harvested seeds should be used within 12 months of their collection, since their preservation at ambient temperature reduces their germination, particularly of grasses.

Packaging

In order to be sold, it is necessary to pack and label the preservation mixtures in accordance with the current laws and regulations in effect.

■ 5.3 Management of the material after harvesting: the Alp'Grain experience

The mixtures obtained were transported to a barn, arranged on a flat surface formed by pallets covered with cotton towels and turned daily for 5 to 7 days, as needed. To clean them, those collected in smaller quantities were screened with an experimental Wintersteiger LD 350 thresher, while to clean those seeds collected in abundant quantities a Vignoli model Mimosa fixed thresher was used with excellent results. The clean seed was stored inside the barn in big bags.
Table 10 presents the data concerning the amounts of brush-harvested seeds collected in donor meadows and the production of the mixtures obtained following different cleaning methods. It can be seen that their cleaning efficiency improves passing from manual to mechanical separation; in particular, the threshing eliminated almost all of the coarse part present in the collected material, and a seed rich mixture suitable for mechanical seeding was obtained.

Table 10 - Amount of materials collected by brushing, cleaning processes and production obtained in donor sites of the Alp'Grain project.

Site	Champdepraz	Cogne-Goilles dessus	Cogne-Prati di S. Orso	Verrayes 2013	Verrayes 2014
Collection surface (m^2)	1,000	7,000	1,100	2,400	3,000
Collected material (kg)	13.0	129.8	5.4	33.6	37.8
Cleaning process	Manual cleaning	Threshing	Manual cleaning	Manual cleaning + sifting	Threshing
Separated and cleaned materials (kg)	9.4	71.4	4.2	24.0	20.4
Waste materials (kg)	3.6	58.4	1.2	9.6	17.4
Brush harvested seeds in the collected material (%)	72%	55%	78%	71%	54%

Chapter 6
Revegetation with preservation mixtures

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Revegetation with preservation mixtures

The use of preservation mixtures is the last step in the chain experienced within the Alp'Grain project. According to the characteristics of the receptor site, the most suitable donor site was identified, and the most adequate seeding method was chosen.

6.1 Regulatory framework

Marketing of preservation mixtures is allowed only if aimed to preserving the natural environment and in the context of preservation of genetic resources, as indicated expressly in Article 2 of Directive 2010/60/EU and in the national laws that incorporate it.
In Italy and France there are no rules requiring the use of local seeds for revegetating purposes, although many customers, especially public institutions that operate in protected areas, require or recommend the use of mixtures of site-specific species and varieties.
The regulatory instruments that specify the current obligations of using site-specific seed are:

- **preservation measures** of sites in the Natura 2000 network, aimed to maintain or restore the natural habitats and species found there. For instance, the preservation measures for SACs of the Aosta Valley enforced, in case of grassland improvement projects, the use of correct grazing methods and management that do not alter their natural floristic composition; in case of seeding due to small damages to the sward, the use of site-specific species and varieties is mandatory.
- **park management plans**, which are the planning tools for protected territories. As an example, here there are some requirements of the plans for the Aosta Valley parks:
  - the surfaces of denuded land should be greened wherever possible, favouring the colonization of their surfaces by perennial local species[58];
  - sowing non-native fodder species is not allowed, while thickening of the sward with local species is fostered[59];
  - when grass is sown on denuded lands as a result of works or exceptional events, proper authorisation must be requested from the park to use the seeds[60].

Finally, it is important to note that among the priorities of the rural development policies for the period 2014-2020, restoring, preserving and enhancing the ecosystems related with agriculture and forestry are to be found, with particular regard to the protection, restoration and enhancement of biodiversity (especially in Natura 2000 sites and in areas with natural constraints or other specific constraints), high natural value farmland and landscape management[61].

6.2 Revegetation techniques

The choice of the revegetation method depends on different factors. First, it is important to consider the aims to be achieved (sward restoration in agricultural areas object of improvement operations, protection of embankment from erosion, preservation of habitats with high ecological value etc.). Other aspects to be considered are the type of receptor site (for example, meadows, pastures, Natura 2000 sites),

58 Management plan for the Gran Paradiso National Park – Implementing rules Art. 12, paragraph 3. **59** Territorial management plan of Mont Avic Natural Park (MANP), 3.7 Agropastoral activities. **60** Territorial management plan of MANP, Procedure of VAS, Document 1/5. **61** Regulation (UE) n. 808/2014 of the Commission dated 17 July 2014.

type of material used (brush harvested seeds, green or dry hay), distances from the donor site, available implements and machinery, next, its economic aspects and management plan for the site after being sown[62].

An area can be revegetated by:

- seeding commercial or preservation mixtures;
- distributing biomass rich in seeds (e.g. green or dry hay, hay flower);
- use of specific materials (e.g. turves);
- seeding mixtures with special techniques (e.g. mulch sowing).

During the Alp'Grain project, the following revegetation methods were used:

- manual seeding (sites at Fénis, Rhêmes-Notre-Dame, Verrayes, Dou du Praz and Refuge de l'Arpont);
- hydroseeding (sites at Courmayeur and Jovençan).

The choice depended on the characteristics of the material to be distributed: for roughly cleaned brush harvested seeds, rich in fragments of stems, leaves and inflorescences, manual seeding was preferred, while with more cleaned brush harvested seeds, resulting from threshing, hydroseeding was adopted.

Hereinafter, the revegetation techniques used during the experimental tests of the Alp'Grain project are described. For other methods and additional information it is suggested to consult the "*Practical handbook for seed harvest and ecological restoration of species-rich grasslands*" (Scotton *et al.*, 2012b) and "*Comment reconstituer la flore en montagne pyrénéenne? - Un guide de restauration écologique*" (Dupin *et al.*, 2014).

Manual seeding

Manual seeding allows to distribute both the seed and the coarse vegetal material evenly, which also has a mulching function. In order to ensure their even distribution it is advisable to add sand to dilute the seed, and run two crossed seeding passes.

The recommended dose for harvesting is 2 to 5 g/m^2 of pure seed. It may take up to 15 g/m^2 in case of reseedings at higher altitude, and up to 25 g/m^2 of brush-harvested seeds, in case its seed content is very poor[63].

As manual seeding times are high, it is recommended for small areas only (up to 2500 m2) or on embankments that are not too steep.

Hydroseeding

Hydroseeding is a particular technique suitable for reseeding natural environments and under difficult conditions connected with slope and altitude. The preservation mixtures cleaned with a thresher are suitable for hydroseeding, as they are rich in seed and contain minute sized plant materials, which does not obstruct nozzles and pumps, and can have, on the contrary, a positive mulching effect. Similarly to hydroseeding with commercial seeds, these mixtures are also mixed with water, glue, mulch and possibly with fertilisers.

Seeding time

The best time to seed is late autumn or winter, but in general, seeding is performed in spring or summer, either on farmland or on skiing slopes. Since sowing at the end of the preparatory work is essential, it is necessary that local seed mixtures are immediately available. It would be perfect, therefore, to program the operations at the site so that the end of the work falls a few weeks after the seed harvest. Otherwise, it is necessary to collect the seed during the previous year and store it in a suitable room waiting for the sowing time.

Good practices for preparing the site to be revegetated

In order to obtain a regular sward, it is very important to prepare the soil to be seeded carefully. Once the site is set up, it is important to proceed with its base fertilization, applying 30 to 40 t/ha of mature manure. This way, correct contents of organic matter and proper soil fertility levels are ensured[64].

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62 Kirmer *et al.,* 2012. **63** *Ibidem.* **64** Bassignana *et al.,* 2011.

Before seeding, it is advisable to perform some finishing operations:
- one final clearance of stones (mechanical or manual raking);
- rolling (with cultipacker or with an excavator bucket in case of embankments) to compact the soil surface and prevent the seed from being sown too deep;
- a good raking to create surface roughness.

It is important to seed as soon as the soil is ready, not leaving any room for wild species such as *Chenopodium album* or *Amaranthus retroflexus*. Otherwise, before seeding, remove any vegetation that was already settled, disking or cutting it.

6.3 Choice of sites

Considering the fact that the use of local seeds, other than in sites with high preservation value, can also be interesting in areas with different uses, the following were reseeded:
- Verrayes, Fénis and Jovençan (permanent meadows);
- Rhêmes-Notre-Dame and La Plagne (pastures and skiing slopes);
- Courmayeur and Termignon (natural high altitude areas).

Choice of the donor sites was based, in general, on criteria such as eco-pedological affinities, altitude and geographical proximity to the sites to be reseeded. The main characteristics of the receptor and donor sites in the Aosta Valley are presented in tables 11 and 12.

The Aosta Valley was subdivided into five altitudinal belts according to the Regional Plan for Water Protection and the technical document regarding measures for the preservation of the SCI of the Natura 2000 network:
- hill, from 300 to about 800-1000 m;
- mountain, from 800-1000 to about 1500-1800 m;
- subalpine, from 1500-1800 to about 2000-2200 m;
- alpine, from 2000-2200 to about 3000-3200 m;
- nival, from 3000-3200 to 4810 m.

The eco-pedological map that categorizes the soils according to their hydrological characteristics, erosion risks, soil-vegetation relationship

Table 11 - Main features of the receptor sites in Aosta Valley

Receptor site	Altitude (m a.s.l.)	Aspect	Localization
Fénis - Les Crêtes	500	Flat	Central valley floor
Jovençan - Chandiou	600	Flat	Central valley floor
Verrayes - Chéssilier	1300	South	Sunny slope of the central valley
Rhêmes-Notre-Dame Canavesan	1600	North-West	Shaded slope of a lateral valley
Courmayeur - Pavillon	2200	Est	Upper central valley

Table 12 - Main features of the donor sites in Aosta Valley

Donor site	Altitude (m a.s.l.)	Aspect	Localization
Fénis - Miseregne	500	Flat	Central valley floor
Verrayes - Marquiron	1300	South	Sunny slope of the central valley
Champdepraz - La Veulla	1300	South	Sunny slope of a lateral valley
Cogne - Prati di S. Orso	1500	Flat	Sunny slope of a lateral valley
Cogne - Goilles dessus	1800	South-West	Sunny slope of a lateral valley

Table 13 - Correspondences between receptor and donor sites in Aosta Valley.				
Receptor site	Donor site	Eco-pedological conditions	Altitudinal belt	Geographical proximity
Fénis Les Crêtes	**Fénis Miseregne**	+++	+++	+++
Jovençan Chandiou	**Verrayes Marquiron**	-	-	+
Verrayes Chéssilier	**Verrayes Marquiron**	+++	+++	+++
Rhêmes-Notre-Dame Canavesan	**Cogne Prati di S. Orso**	++	+++	++
Courmayeur Pavillon	**Cogne Goilles dessus**	+	+++	++

and preservation features was used to highlight the ecological and edaphic conditions.
The correspondences observed adopting the criteria described above are presented in Table 13.

In general, when the donor and the receptor sites were close, there was full correspondence of their characteristics (Fénis and Verrayes), or they shared many common features, such as altitudinal belt and aspect, as in the case of Rhêmes-Notre-Dame and Cogne-Prati di Sant'Orso, or their altitude and eco-pedological conditions, as in the case of Courmayeur and Cogne-Goilles dessus.

In only one case (Jovençan, Verrayes – Marquiron) the seed from a donor site was tested in a quite different area. In the future, it will be interesting to follow the evolution of the vegetal cover.

The following pages describe the main characteristics of the experimental sites, the restoration works performed and the revegetation tests realized.

For the sites of Verrayes, Fénis, Rhêmes-Notre-Dame and La Plagne, reseeded in 2013, the results were evaluated in the following year, estimating the land cover, determining the vegetation composition (using the Daget and Poissonet method), calculating their biodiversity indexes (Shannon's index and equitability) and measuring their forage production.

For the sites that were reseeded in 2014 (Jovençan, Courmayeur and Termignon), this evaluation shall be done in 2015, and their results will be published in the website www.iaraosta.it.

6.4 Revegetation of permanent meadows

Fénis – Les Crêtes

Altitude: 500 m a.s.l.
Soil characteristics: sub-alkaline sandy-loam, soil, rich in organic matter and in total nitrogen.
Works carried out on the site
- Tree felling (10% of their surface)
- Topsoil removal
- Earth movement
- Topsoil bringing back (10% of the surface)

- Fertilization with 15 t/ha of mature manure and 5 t/ha of compost
- Stone burying
- Final manual stone removal

Revegetation methods

Manual seeding of preservation mixture (PM)
Seed origin: Fénis
Sowing date: 18/09/2013
Sowing rate: 8 g/m^2 of brush harvested seeds (as 4.6 g/m^2 of pure seeds)
Surface: 1100 m^2

Mechanical sowing of commercial mixture (CM)
Implements used: seed drill, broadcast seeder
Mixture composition: *Dactylis glomerata* (35%), *Schedonorus pratensis* (20%), *Poa pratensis* (15%), *Lolium perenne* (10%), *Trifolium pratense* (10%), *T. repens* (10%).
Sowing rate: 15 to 20 g/m^2

Jovençan - Chandiou

Altitude: 600 m a.s.l.
Works carried out on the site
- Tree felling (5% of the surface)
- Earth movement (5% of the surface)
- Surface levelling
- Tillage
- Stone crushing

Revegetation methods

Hydroseeding of preservation mixture (PM)
Seed origin: Verrayes - Marquiron
Sowing date: 20/10/2014
Sowing rate: 10 g/m^2 of brush harvested seeds
Surface: 2000 m^2

Mechanical sowing of commercial mixture (CM)
Implement used: seed drill
Mixture composition: *Dactylis glomerata* (20%), *Lolium rigidum* (20%), *Poa pratensis* (15%), *Festuca rubra* (10%), *Onobrychis viciifolia* (10%), *Phleum pratense* (10%), *Trifolium pratense* (10%), *Vicia sativa* (5%).

Verrayes - Chéssilier

Altitude: 1300 m a.s.l.
Soil characteristics: sub-alkaline sandy-loam soil, rich in organic matter and in total nitrogen.
Works carried out on the site:
- Tree felling (20% of the surface)
- Topsoil removal
- Earth movement
- Fertilization with 20 t/ha of mature manure
- Stone burying (50% of the surface)
- Stone crushing (50% of the surface)

Revegetation methods

Manual seeding of preservation mixture (PM)
Seed origin: Verrayes - Marquiron
Sowing date: 05/08/2013
Sowing rate: 9 g/m^2 of brush harvested seeds (as 3.2 g/m^2 of pure seeds)
Surface: 1300 m^2

Mechanical sowing of commercial mixture (CM)
Implements used: seed drill
Mixture composition: *Dactylis glomerata* (35%), *Poa pratensis* (20%), *Lolium perenne* (15%), *Schedonorus pratensis* (15%), *Onobrychis viciifolia* (5%), *Trifolium pratense* (5%), *T. repens* (5%).
Sowing rate: 20 g/m^2

Evaluation of the reseeding effectiveness in the sites of Verrayes and Fénis

Soil cover

The percentage of land cover was evaluated during the spring and summer of the year following the seeding, in 10 sample areas (1 m2 each) distributed randomly on the reseeded surface. The results were excellent, reaching values higher than 80% in all the parcels. Generally, the commercial mixtures allowed to obtain a slightly higher soil cover, but the differences were never statistically significant.

Table 14 - Soil cover (%) in the site reseeded with preservation (PM) and with commercial (CM) mixtures.

Site	Date of the survey	Parcel	
		MP	MC
Verrayes	29/04/2014	84.0	95.0
	10/07/2014	83.0	81.0
Fénis	16/05/2014	91.0	96.5
	10/07/2014	89.5	95.5

Vegetation analysis and biodiversity indexes

Fénis

Fifty-six species were registered in the parcel sown with the preservation mixture (PM) and 41 in the one seeded with the commercial mixture (CM); besides the floristic richness, also the other biodiversity indexes were higher in the former (Table 15).

In the PM parcel, 78% of the coverage was given by 8 species, six of which were grasses (Figure 29), while the vegetation of the CM parcel was dominated by only 4 species, with percentages ranging between 23 and 12% (Figure 30). Three of these species (*Trifolium repens, Lolium perenne* and *Dactylis glomerata*), which made up 55% of the mixture seeded, represented 63% of the vegetation. The fourth species was *L. multiflorum*, relatively abundant even if it was not included in the mixture used.

Table 15 - Floristic richness, Shannon's index and equitability in the parcels reseeded with preservation (PM) and with commercial mixture (CM) in Fénis.

	Parcel	
	MP	MC
Floristic richness (No. of species)	56	41
Shannon's index	3.93	2.92
Equitability	0.68	0.54

Verrayes - Chéssilier

In Verrayes, too, the biodiversity of the PM parcel was significantly higher than that of the CM parcel: more species were found (55 vs. 32) and they made up the vegetation in a more balanced way, as evidenced by the indexes shown in Table 16.

Analysing the composition of the PM parcel in detail (Figure 31), it is worth noting that the preservation mixture allowed the establishment of a greater number of species: 77% of the vegetation was represented by 11 species, seven of which were grasses. In the parcel reseeded with commercial mixture, on the other hand, (Figure 32) 3 of the 4 dominant species (Dactylis glomerata, Trifolium repens and Lolium perenne), which represented 55% of the mixture seeded, accounted for 69% of the vegetation.

Forage production

To evaluate the influence of the type of mixture on the yield and quality of the forage obtained

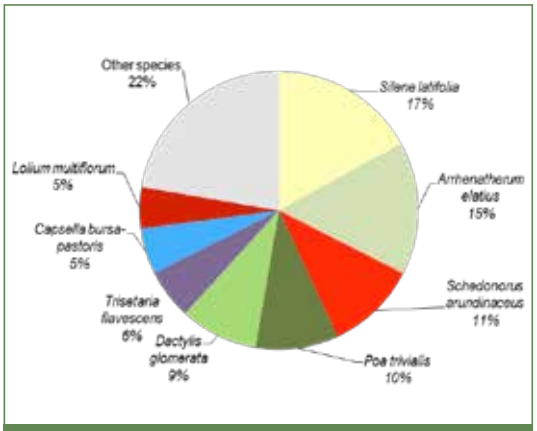

Figure 29 - Vegetation composition of the PM parcel in Fénis.

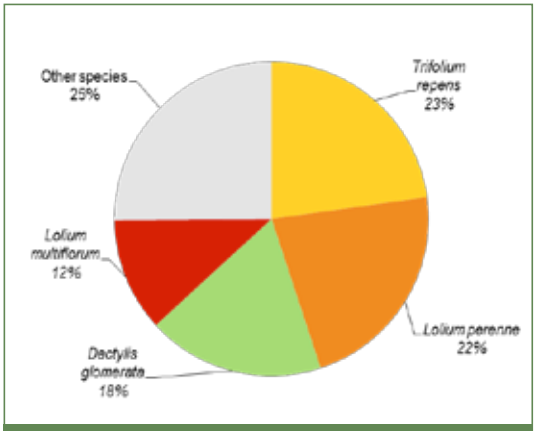

Figure 30 - Vegetation composition of the CM parcel in Fénis.

Table 16 - Floristic richness, Shannon's index and equitability in the parcels reseeded with preservation (PM) and with commercial mixture (CM) in Verrayes.

	Parcel	
	PM	CM
Floristic richness (n. of species)	55	32
Shannon's index	4.25	3.00
Equitability	0.73	0.60

after reseeding, some samples of grass were collected during the first and second cuts.
In both sites, during the first cut, biomass production in the PM parcel was lower than in the CM one, while in the second cut these results

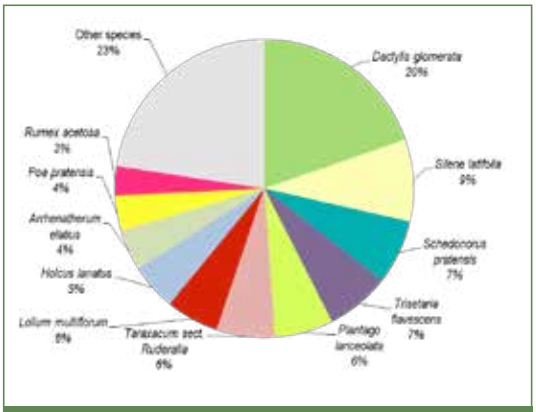

Figure 31 - Vegetation composition of the PM parcel in Verrayes.

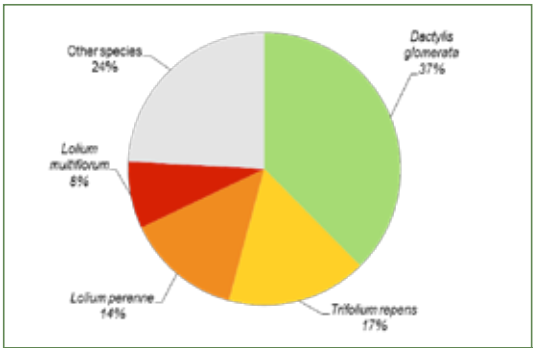

Figure 32 - Vegetation composition of the CM parcel in Verrayes.

were reversed. The differences were never statistically significant, due to the variability observed among the different samples gathered from each parcel (Tab. 17).
As for the forage quality of the grass and for total forage production, too, the differences between the parcels were never statistically significant (Tab. 18). It is worth emphasising that in both sites the forage production in PM parcels was distributed in a more regular manner in the first and second cut, while in the CM parcels it was concentrated, in an unbalanced way, in the first cycle.

Table 17 - Biomass at the 1st and 2nd cut.

Site	Cut	Parcel	Biomass (t/ha DM) *Mean (±Standard deviation)*
Fénis	1st	PM	4.40 (±1.28)
		CM	6.69 (±1.76)
	2nd	PM	3.37 (±0.84)
		CM	2.50 (±0.43)
Verrayes	1st	PM	5.52 (±1.85)
		CM	6.73 (±1.68)
	2nd	PM	3.88 (±0.84)
		CM	2.92 (±0.32)

General considerations

The commercial mixtures are composed of a limited number of species, compared to the preservation mixtures, but they generally establish faster.
In general, our observations confirmed that the selected species of commercial mixtures grow faster, and allow to cover earlier the soil, at the expense of spontaneous species. The preservation mixtures, instead, apart from being composed of a higher number of species, left more space to the species already present in the soil seed bank, producing a more varied turf.
Meadows reseeded with local seed compensated the slightly smaller production of the first cut with a better distribution of their forage resources during the year, ensuring, in the second cut, a more abundant production compared to the parcels that were sown with the commercial mixtures.
It will be interesting to follow-up the evolution of this sward in the future, in order to see if the observed differences, which were not statistically significant, will increase or will diminish.

Table 18 - Fodder value and fodder production for the 1st and 2nd cutting periods (DM=Dry Matter; MFU=Milk Forage Units).

Site	Cut	Parcel	Forage value of the grass (MFU/kg DM) *Mean (±Standard deviation)*	Forage production (MFU/ha) *Mean (±Standard deviation)*
Fénis	1st	PM	0.78 (±0.02)	3436 (±943)
		CM	0.84 (±0.07)	5567 (±1105)
	2nd	PM	0.74 (±0.03)	2487 (±543)
		CM	0.77 (±0.03)	1925 (±272)
Verrayes	1st	PM	0.81 (±0.02)	4444 (±1462)
		CM	0.82 (±0.04)	5496 (±1238)
	2nd	PM	0.77 (±0.01)	3001 (±638)
		CM	0.78 (±0.01)	2283 (±225)

6.5 Revegetation of pastures and skiing slopes

Rhêmes-Notre-Dame - Canavesan

Altitude: 1600 m a.s.l.

Soil characteristics: sub-alkaline sandy-loam soil, rich in organic matter and in total nitrogen.

Works carried out on the site

- Tree felling
- Topsoil removal
- Earth movement
- Topsoil bringing back
- Excavator trampling

Revegetation methods

Manual seeding of preservation mixture (PM)

Seed origin: Cogne-Prati di S. Orso

Sowing date: 18/10/2013

Sowing rate: 7 g/m^2 (as 1.5 g/m^2 of pure seed)

Surface: 500 m^2

Mechanical sowing of commercial mixture (CM)

Seeding techniques: manual seeding, hydroseeding

Mixture composition: Alpine mixture

Sowing rate: 52 g/m^2

Evaluation of the reseeding effectiveness of the sites at Rhêmes-Notre-Dame

Soil cover

A little less than a year after sowing the soil cover in the parcel sown with commercial mixture was 90%, while that of the parcel sown with local seeds was significantly lower (63%).

Vegetation analysis and biodiversity indexes

Also in this site, the PM parcel showed a greater diversity than the CM parcel (Table 19). The differences between the two treatments, however, were lower than the differences recorded in the above- presented meadows.

Table 19 - Floristic richness, Shannon's index and equitability in the parcels reseeded with preservation (PM) and with commercial mixture (CM) in Rhêmes-N.D.

	Parcel	
	PM	Cm
Floristic richness (No. of species)	40	32
Shannon's index	3.90	3.31
Equitability	0.73	0.66

In the PM parcel, 72% of the vegetation was composed of 8 species, three of which (*Anthriscus sylvestris, Heracleum sphondylium* and *Rumex acetosa*), which gave 18% of the vegetal cover, have poor forage value (Figure 33). The two umbelliferae constituted 6% of the vegetation of the donor grassland.

In the CM parcel, 3/4 of the vegetation was composed of only 5 species, all of them grasses except for *Trifolium repens* (Figure 34).

General considerations

Acknowledging that successful reseeding on skiing slopes depends on different factors,

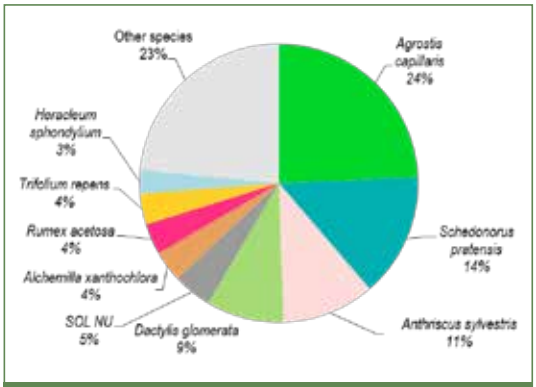

Figure 33 - Vegetation composition of the PM parcel in Rhêmes-N.D.

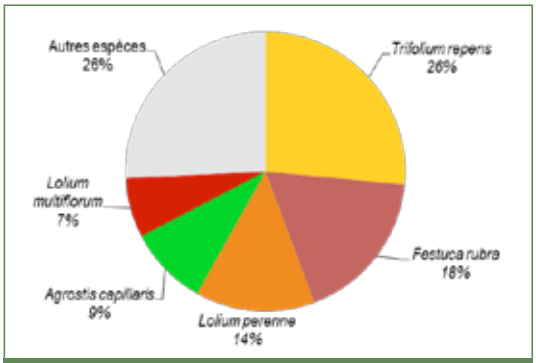

Figure 34 - Vegetation composition of the CM parcel in Rhêmes-N.D.

such as altitude, slope and type of mixtures used, and that it is essential, moreover, to manage these parcels after the seeding, however, the modest cover observed in the PM parcel one year after its seeding is probably due to a too low seeding rate, associated with a slower growth, which gave way to the growth of less interesting species such as umbelliferae.

It will be worth to follow the evolution of this sward in the future, as well as that of the CM parcel, where the presence of species that are not site-specific, such as the two *Lolium*, should decrease in the coming years.

La Plagne - Dou du Praz

Altitude: 2100-2200 m a.s.l.

Works carried out on the site: harrowing

Surface: 15 parcels of 18.75 m^2 each

Sowing date: 09/10/2013

Revegetation methods

An experimental test was set up at the site of La Plagne, to compare 5 revegetation techniques, with 3 repetitions each (Figure 35).

After seeding, the surface was trampled in order to compact the soil and facilitate seed penetration.

Manual seeding of preservation mixture

Seed origin: La Plagne-Dou du Praz

Seed rate: PM1: 6.5 g/m^2 - PM2: 13 g/m^2

Manual seeding of hay flower (HF)

Hay flower from meadows between 800 and 1800 m

Seed rate: 10 g/m^2

Hand sowing of commercial mixture (CM)

Trois vallées mixture composition: *Phleum pratense* (20%), *Festuca rubra* (20%), *F. nigrescens* (20%), *F. ovina* (15%), *Lolium perenne* (10%), *Trifolium repens* (10%), *Lotus corniculatus* subsp. *corniculatus* (5%).

Seed rate: 10 g/m^2

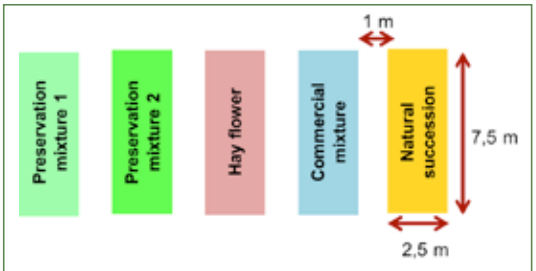

Figure 35 - Simplified schema of the experimental parcels in La Plagne.

Natural succession (NS)
The parcel was not reseeded and its revegetation was left to natural colonisation from the soil seed bank.

Evaluation of the effectiveness of the revegetation methods at La Plagne

Soil cover

Surveys carried out in July 2014 showed similar results for five techniques compared (Table 20). During the works, the ground was managed correctly, which allowed the soil seed bank to

express itself fully, reaching a land cover close to 60%. The effect of various revegetation methods is currently not evaluable, due to the great variability detected between parcels, and heterogeneous cover within the same parcel. For example, in one of the PM1 plots, cover percentages ranged from 25 to 90%. The same was found in the parcels left to the natural succession (from 25 to 100%). For the time being, then, the results obtained show no significant differences between the revegetation methods.

Table 20 - Soil cover achieved with the five methods compared at La Plagne (the explanation of acronyms is clarified in the text).

	PM1	PM2	HF	CM	NS
Cover (%)	43	39	52	54	59

Vegetation analysis and biodiversity indexes

As for the soil cover, the floristic richness was similar for the five compared techniques (27 to

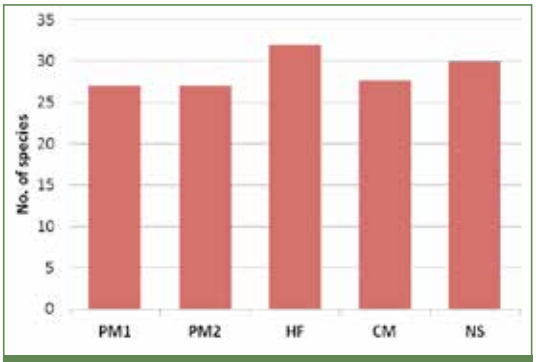

Figure 36 - Number of species in the five treatments compared at La Plagne.

32 species). Thanks to a proper soil management during the works, even in the plots that were not reseeded many species were identified (Figure 36).
In the first season after seeding, the grasses dominated the vegetation, with percentages from 44 to 57% (Figure 37). All the clovers (*Trifolium badium*, *T. montanum, T. repens* and *T. pratense*) were between 4 and 9% of the vegetation, while birdsfoot trefoil (*Lotus corniculatus* subsp. *corniculatus*) was absent. The parcels reseeded with hay flower (HF) or not reseeded

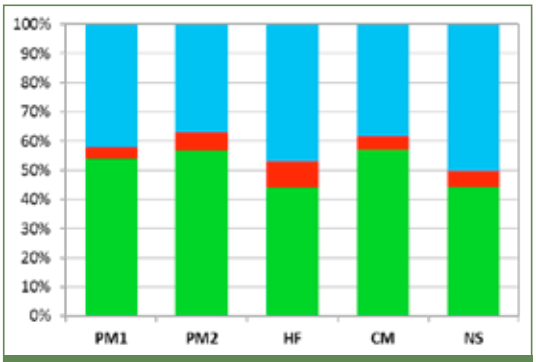

Figure 37 - Abundance (%) of groups of species for the five revegetation techniques compared at La Plagne (the grasses in green, the legumes in red and other dicotyledons in blue).

(NS) differed from the others due to a greater abundance of dicotyledons.
A strong presence of disturbance indicator species (such as *Tussilago farfara, Plantago major* and *Plantago atrata*) was observed (Table 21).

The two treatments with preservation mixtures (PM1 and PM2) stood out due to a greater abundance of *Poa alpina*, a species that is particularly sought for its agronomic qualities.

Table 21 - Abundance (%) of main species in the five treatments compared at La Plagne.

	PM1	PM2	HF	CM	NS
Agrostis capillaris	7.7	7.7	8.0	5.0	7.0
Alchemilla vulgaris	5.6	1.2	6.9	1.3	6.1
Elytrigia repens	3.5	6.1	8.8	7.6	4.9
Festuca rubra	13.9	9.8	2.1	11.5	-
Plantago atrata	7.6	0.9	5.2	3.6	10.7
Plantago major	5.3	7.2	2.5	4.1	7.9
Poa alpina	11.6	16.6	6.5	8.2	6.2
Poa annua	7.1	9.7	10.9	8.2	18.4
Poa pratensis	5.4	4.0	4.0	11.5	3.7
Scorzoneroides helvetica	8.8	6.6	-	-	0.4
Tussilago farfara	2.5	6.8	3.2	7.3	7.7
Other species	21.0	23.4	41.9	31.7	27.0

6.6 Revegetation of Natural Areas at high altitudes

Termignon - Refuge de l'Arpont

Altitude: 2309 m a.s.l.
Works carried out on the site: harrowing
Surface: 12 parcels of 10 m² each
Sowing period: May 2014

Revegetation methods

An experimental test was set up at the site of Termignon, to compare 4 revegetation methods (Figure 38) with 3 repetitions each. After sowing, the surface was trampled to compact the soil and facilitate seed penetration.

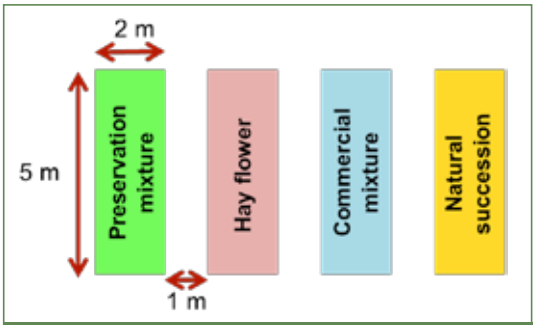

Figure 38 - Simplified scheme of the experimental parcels installed at Refuge de L'Arpont

Manual seeding of preservation mixture
Seed origin: Refuge de l'Arpont
Seed rate: 10 g/m²
Manual seeding of hay flower
Seed rate: 10 g/m²
Manual seeding of commercial mixture
Trois vallées mixture composition: *Phleum pratense* (20%), *Festuca rubra* (20%), *F. nigrescens* (20%), *F. ovina* (15%), *Lolium perenne* (10%), *Trifolium repens* (10%), *Lotus corniculatus* subsp. *corniculatus* (5%)
Seed rate: 10 g/m²
Natural revegetation

Courmayeur - Pavillon

Altitude: 2200 m a.s.l.
Works carried out on the site
- Topsoil stripping
- Laying of soil dug in the site
- Positioning of rocks

Revegetation methods

Hydroseeding of preservation mixture
Seed origin: Cogne-Goilles dessus
Sowing date: 24/10/2014
Seed rate: 19 g/m²
Surface: 1600 m²
Manual seeding of commercial mixture
Mixture composition: *Festuca rubra* (30%), *F. nigrescens* (20%), *F. ovina* (15%), *Agrostis capillaris* (10%), *Schedonorus pratensis* (10%), *Phleum pratense* (5%), *Medicago lupulina* (5%), *Trifolium repens* (5%).
Seed rate: 30 g/m²

6.7 Hydroseeding tests at Jovençan and Courmayeur

An AGROTEC hydroseeder with a 2500 litre tank was employed, with internal paddle agitation and feed screw pump driven by the vehicle own power, for the hydroseeding tests carried out in the autumn of 2014.
The hydroseeding was prepared mixing the preservation mixtures with water, and possibly

Figure 39 - Hydroseeding of the experimental plot at Courmayeur - Pavillon.

with other components (glue and mulch), immediately before sowing, in order to prevent stratification inside the tank.

In the experimental parcel of Jovençan, in a flat area, 20 kg of local seed mixture were blended with 2000 l of water. Since the Courmayeur parcel was located on the steep slopes of Mont Blanc, two bales of mulch and some glue were added to the mixture prepared with the same doses.

The mixtures of local seed, after being mechanically cleaned with a fixed thresher, were suitable for hydroseeding and did not obstruct any tubes or nozzles.

The execution times were quantified in 15 minutes/1000 m^2 under the easiest conditions at Jovençan (soft slopes, without any obstacles), while in the most difficult ones at Pavillon, these times doubled.

Chapter 7
Economic sustainability of preservation mixtures

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Economic sustainability of preservation mixtures

The production for marketing of preservation mixtures depends on several regulatory, ecological, agronomic and technological factors (presented above) and their **economic sustainability** within a local production chain.
The economic aspects are critical to activate an adequate supply for the working context. The offer depends directly on the farmers' interest in allocating a portion of their land to produce seeds, and the interest of an operator who may wish to market the produced mixtures. This interest is manifested only in those cases where there is a real prospect of **diversifying the farm income** and market local seed mixtures.
The creation of a supply-chain is subjected to the presence of a demand. It is therefore essential to identify potential markets for preservation mixtures, by analysing the current demand and the predictable ones as well. Finally, it is necessary to determine the relationships between all the sector players.

7.1 Economic aspects of local seed production

The economic sustainability of producing preservation mixtures was verified through the elaboration of an economic and technical balance of the production process[65].
We proceeded in phases, in order to collect all the technical and economic elements needed to plan production and marketing.
First, all **operating and rent costs** of the pull type seed harvester were defined, since it is an essential implement to produce directly harvested mixtures commercially.
Second, **cost of production** of preservation mixtures were estimated depending on the organisation structure of the producers. The **companies** potentially in the area were described and the costs of production of preservation mixtures obtained from **permanent meadows** and from **subalpine pastures** were examined.

Calculation of hourly cost of the pull type seed harvester

The collector must have this machine, either purchasing or rent it, and has to know its operating cost.
The operating cost of farm implements is composed of **fixed costs** (fixed items of expenditure and independent of their use) and **variable costs** (proportional to their use)[66].
During the calculation, thanks to the experience gained in the Alp'Grain project, the annual hours of use of the pull type seed harvester were evaluated to be at least 120, corresponding to 15 working days; its annual estimated employment allows to collect the material on a surface of a size adequate for the local context and justifies the purchase of the harvester.
The tables below show parameters used to calculate the operating costs of this equipment:

Machine with a 4 cycle engine, 205 cc. Fuel consumption (gas): 0.20 litres/h	
DATA	
Displacement	205 cc
Value as new (€)	15,000
Residual value (€)	1,500
Current value (€)	6,000
Useful life (years)	15
Future duration (years)	10
Annual use (h)	120
Recover value (%)	10%
Repair coefficient (on value as new)	40%
Maintenance (h/h worked)	0.05

65 Agostinetto *et al.,* 2007 **66** Assirelli & Pignedoli, 2005a and 2005b.

Footprint (m^2)	8.00
Interest rate (%)	5%
Liability insurance	not due
Fire insurance (% insured value)	0.25%
Shelter (% on value of building)	3%
Value as new shelter area (€/m^2)	450
Fuel consumption (l/h)	0.20
Lubricant consumption (% on fuel consumption)	0.03
Gas cost (€)	1.761
Lubricant cost (€)	13.86
Manpower cost for skilled agricultural workers (€/h)	11.24

The operating costs are divided as follow:	
FIXED COSTS (FC)	**€/year**
Amortisation	900.00
Interests	375.00
Fire insurance	25.00
Shelter	108.00
TOTAL FC	1,408.00
VARIABLE COSTS (VC)	**€/h**
Fuel	0.35
Lubricants	0.01
Maintenance	0.56
Repairs	7.50
TOTAL VC	8.42
COST PER HOUR (€/H)	**20.16**

It is known that the operating costs of an agricultural machine generally decrease when the number of worked hours increases. Consequently, an annual use of 150 hours, which is the average for agricultural machines, would result in an hourly cost reduction equal to 4 €/h.
The rent cost of the machine varies depending on the company that shall perform the service. Specialized commercial companies usually offer rent **without** the machine operator, while the rent **with** the operator can be provided either by subcontractors or by any farm operating **agro-mechanical activities**[67].

The rent price is calculated by adding to the operating cost the share for fixed charges and the firm profits, amounting to a total 26.50% of the operating costs.
The costs for transporting smaller devices and transportable equipment by trucks carrying less than 35 quintals are not recognized in the items of the rent price list for regional public works of the Aosta Valley.
The rent price without the operator is calculated only for a commercial company. In the current local context, where a supply chain does not exist, it is unlikely that such a specific machine may be rented for 120 hours per year. For the sake of prudence, therefore, we assume that a rented pull type seed harvester could work for 90 hours per year.
Consequently, the rent price, including its transport, of a pull type seed harvester without the operator was estimated from 26.74 €/h to 34.85 €/h with an average value of about 31.00 €/h.

		Calculation	Min (€/h)	Max (€/h)
A	Hourly cost		21.14	27.55
B	Fixed charges	15% of A	3.17	4.13
C	Firm profit	10% of A+B	2.43	3.17
Rent price without the operator		A+B+C	26.74	34.85

In comparison, the specific item included in the price list of the province of Trento (year 2014), concerning the rent without the operator of a pull type seed harvester (seed stripper) with rotation either upwards or downwards depending on the height of the herbaceous vegetation (> or < 50 cm), amounts to 39 €/h.
In case of renting an operated equipment, instead, it is necessary to provide a "level II skilled worker" to operate the seed harvester.

67 Article 5 of the Legislative Decree No. 99, dated 2004, defining agro-mechanical activities such as those provided by farms to third parties, through the use of mechanical equipments, related to farming operations, arrangment and maintenance of agro-forestry lands, etc.

		Calculation	Agro-mechanical activities (€/h)	Subcontracting (€/h)
A1	Hourly cost		20.16	21.14
A2	Operating labour		11.24	30.80
B	Fixed charges	15% of A	4.71	7.79
C	Firm profits	10% of A+B	3.61	3.86
	Rent price with the operator	**A+B+C**	**39.72**	**63.59**

This service may be offered either by a farm executing agro-mechanical activities or by a commercial subcontractor, with significant price differences related with manpower costs.
The following table presents the price for renting an operated pull type seed harvester, including its transport and manpower, depending on the type of service provider.

In this case, to limit the manpower costs, renting the operated equipment is sustainable only if its annual use is appropriate, i.e. at least 120 hours per year.

7.2 Production cost of preservation mixtures

Methods to estimate costs

In order to determine the cost of production of preservation mixtures[68], the companies or potentially producing structures present in the examined territories were identified, and two main types of donor sites were considered: permanent meadows, evaluated in the Aosta Valley, and subalpine pastures, assessed in Savoy.
The data acquired during the tests, integrated with the ones of other authors were computed in the calculation[69]. All charged unit prices refer to the year 2014, more precisely to July, wherever possible. All costs related with the production process are described below, differentiated by type of company and product. The costs of production per product unit and per unit area were determined from the total costs.

Calculation of the cost of production

Variable (or **specific**) costs, which represent the costs incurred only for the seed production process, such as the purchase of technical equipment, fuel, combustibles, consumer goods and services, were estimated according to the quantities used and the unit prices applied.
Common fixed costs are the production factors used in all the company's production processes, whenever present. The **common direct costs** were estimated, simplifying, through a partition coefficient identified according to criteria such as machine use times, amount of land or space used for the process, etc. All the **common indirect costs** were calculated based on a percentage of allocation established according to specific criteria.
Allocated fixed costs are the costs of the family labour force, estimated based on hours worked in the production process, and the executive work, allocated pro rata. Interests on working and advanced capital were added to them, estimated considering an interest rate equalling 5%, while the interest on real estate was calculated by applying a 1% rate for land and 1.5% for buildings.

Reference parameters

Based on the experiences acquired during the Alp'Grain project, the individual operating steps of the production process were identified, and the parameters to be used were defined (working times, workers, implements, buildings, production) in order to calculate the cost of production of mixtures intended to be sold.

68 Adorni *et al.,* 2012, Bagnod *et al.,*2013; Borsotto *et al.,*2013; Montanaro & Ceccarelli, 2014. **69** Scotton *et al.,* 2012a; Malaval & Dupin, 2013.

A	VARIABLE COSTS	Specific costs	- temporary labour - purchase of raw materials (manure etc.) - irrigation water - mechanisation related with the process - rental - processing costs - other direct costs (packaging materials) - marketing
B	FIXED COSTS	Common direct costs	- permanent labour - agricultural mechanisation (ordinary maintenance, fuel, lubricants, combustibles, electricity, insurance, amortisation) - buildings (ordinary maintenance, insurance, amortisation or rents)
C		Common indirect costs	- corporate fixed charges - drinking water - land rents - duties and taxes - other indirect costs
D		Allocated costs	- family labour force - executive work - interests related with the working capital - interests related with real estate
TC		TOTAL COSTS	TC = A+B+C+D
Ca		Cost of production per unit area (ha)	Ca = TC/surface used
Cp		Cost of production per product unit (kg)	Cp = TC/production

Operating steps

- Transport of the implements to the donor site
- Collection of brush harvested seeds
- Drying of brush harvested seeds
- Cleaning of brush harvested seeds
- Packaging for their marketing

Working time and operators

- **Transport and preparation times** vary between 1.5 and 2 hours per collection site and depend on the distance between the company's facilities and the donor site (an average 30 minutes for sites located near the central valleys -50 km daily- and 60 minutes for lateral valleys or high altitude areas -80 km daily), to which about 15 to 20 minutes are added per site for **downtimes** due to other causes (delays, breakdowns, etc.).
- **Harvesting times** include **on-site preparation times** (loading and unloading machines, hooking to the tractor) and the **effective harvesting times** (including manoeuvres, refuelling, maintenance, on-field adjustments, product unloading).
- Harvesting times for **permanent meadows** were estimated to be **8 h/ha**, as the

Operation	Period of works	Manpower
Transport and preparation times	1.5 to 2 h/donor sites	1 skilled worker
Mixture collection from permanent meadow	8 h/ha	2 skilled workers
Mixture collection from subalpine pastures	4 h/ha	2 skilled workers
Drying and manual cleaning	4 h/q dry mixture	2 skilled workers
Drying and mechanical cleaning	2 h/q dry mixture	1 skilled worker
Mixture packaging	10 min./mixture sack	2 skilled workers

donor sites are generally located in areas characterized by high land fragmentation, which do not allow the individual farmer to manage unified and adequately sized surfaces. The plots are small, have irregular shape and have various obstacles (terrace cultivation, rows, trees, complex accesses), which slow the harvesting. Furthermore, the heterogeneous sward forces to adjust the height of the brush during the harvest and the amount of collected material, rich in leaves and stems, requires emptying the hopper about every 30 minutes.

- Harvesting times for **subalpine pastures** were estimated to be 4 h/ha (the data obtained in the harvesting test carried out in France was averaged with those of other similar experiences[70]). Large areas, regular shapes and absence of obstacles that reduce downtimes during the harvest generally characterize these sites. The low and regular sward does not require any adjustment to the height of the brush, allowing for faster passages of the machine, and the material collected, cleaner and less abundant, reduces the times needed to empty the hopper per unit area.
- **Packaging times** were estimated to be 10 minutes per 20 kg sack, and include emptying the mixture stocked in big bags into the bagging machine, either manual or semi-automatic bagging, sack sealing with a bag sewing machine and storing.

The agricultural land varies depending on the type of company that harvests local seed: individual farmers should have enough grassland surfaces to justify renting a machine, while the associated farmers should produce enough mixtures to make the required investments (buildings, implements, machines) cost-effective.

Evaluation of the average annual production

The amount of mixtures obtained from permanent grasslands was estimated from the data of the tests carried out in the Aosta Valley, while for subalpine pastures the data collected in France was averaged with those reported by other authors, related with experiments conducted in the Alps and in the Pyrenees. In particular, Malaval & Dupin (2013) report yields ranging from 3

70 Dupin *et al.*, 2014.

Equipment and plants needed for a commercial supply chain

	Value as new (€)	Duration (years)	Annual amortisation (€)
Equipment transportation			
1 truck with a useful payload higher than 10 q and up to 26 q	60,000	15	4,000
Harvesting			
1 4 wheel driving tractor – 30 to 50 HP	35,000	15	2,333
1 pull type seed harvester	15,000	15	1,000
Processing			
1 drying plant	40,000	20	2,000
1 thresher	18,000	15	1,200
Packaging for sale			
1 semi-automatic bagging machine	10,000	20	500
1 bag sewing machine	2,000	10	200

Buildings

Spaces	Surface (m^2)
Warehouse for packaging and storage	40
Shelter for the machinery	50
Drying surfaces	30
Total	**120**

Agricultural land useful for harvesting

Species-rich grasslands	Individual farmers	Associated farmers
Permanent meadows (ha)	3	15
Subalpine pastures (ha)	8	30

to 63 kg/ha, with an average of about 21 kg/ha, for meadows located between 1200 and 1700 m above sea level, and 3 to 4 kg/ha for subalpine pastures (1700-2000 m above sea level).
For this evaluation, a collection surface was considered in accordance with current agricultural realities and adequately sized so that the purchase (or rental) of the specialized machinery and the investments are affordable.
Table 22 presents the seed production in species-rich **permanent meadows** either as rough brush harvested seeds or after manual cleaning or after threshing.
The production of brush harvested seeds of species-rich **subalpine pastures**, divided into the same categories, is shown in Table 23.
In the tests conducted at La Plagne, 14.0 kg/ha of brush harvested seeds were collected with the pull type seed harvester, while with the self-propelled outdoor vacuum the yield was considerably higher (40.5 kg/ha). To the purposes of commercial production, it is essential to achieve **yields of at least 20 kg/ha of rough brush harvested seeds**.
The materials collected from subalpine swards, shorter and more uniform than hay meadows, contain less impurities and, consequently, the waste resulting after the cleaning stages is lower. Therefore, percentages of 90% after manual cleaning and 75% after threshing were established as guidelines.

Potential producing companies in the area

All evaluations about the cost of production of preservation mixtures depend on the type of product offered and the type of company, which can belong to one of these three categories:

A. **farms** that manage donor sites and collect seeds;
B. **processing firms**, which dry, clean and store the brush harvested seeds;
C. **commercial firms**, responsible for selling the mixtures.

These three figures may be combined with each other, depending on the context in which they operate.
Realistically, in a **local or interregional context** such as the one examined in this project, the companies working in the field may be configured as follows:

1) a **farmer** that harvests seeds (A) and sells them with a contract to the company that produces the mixtures;
2) a **seed company** that processes and sells mixtures (B+C);
3) a **farmers' association** that harvests, processes and sells the mixtures (A+B+C).

Table 22 - Seed production in permanent meadows.

Product	% material after cleaning	Yield (kg/ha)	Production on 15 ha (kg)
Rough brush harvested seeds		112	1675
Mixture after manual cleaning	73%	82	1230
Mixture after threshing	55%	62	930

Table 23 - Seed production in subalpine pastures

Product	% material after cleaning	Yield (kg/ha)	Production on 30 ha (kg)
Rough brush harvested seeds		20	600
Mixture after manual cleaning	90%	18	540
Mixture after threshing	75%	15	450

Types of companies and their costs of production

Type 1 – Harvesting farm

Type 1 is represented by farmers (either breeders or forage grower) that have suitable land, managed extensively, are equipped with adequate implements, manage the farm with family labour, possess farm buildings and, in the case of breeders, produce more forage than they need for their livestock[71].

This type of farm is common throughout the territory of the Aosta Valley and is also present in the mountains of Savoy, Haute Savoy and Isère.

In particular, type 1 farms in the Aosta Valley show the following structural features:

- **livestock farm**, with an average agricultural area of 26.7 ha, of which 6.8 are under irrigation (15% of the farmland), its implements in some cases are oversized (114.5 kW), its herd is composed of 22 LUs, the farm engages 1.7 work units, mainly employing family labour[72];
- **forage growing farm**[73], characterized by an average agricultural areas of 5.4 ha of permanent meadows, or 15.9 ha of pastures, and with its own implements.

The farms in Savoy, Haute Savoy and Isère included in type 1 have the following structural features:

- **livestock farm situated in mountain areas**, undertaking agro-environmental measures for preserving grassland flower species (measure "*Prairies fleuries*")[74], generally with low-intensity management of their grassland areas (stocking rate: 1.2 LUs/ha).

For the production of preservation mixtures, these farm type must have at least **3 hectares of permanent meadows or 8 hectares of subalpine pastures**, must be equipped with a tractor, a vehicle to transport the materials and a barn that can used during the harvest period, and must have two workers, preferably the farmer and a family member, for the harvest.

71 Francesia *et al.*, 2008, Madormo *et al.,* 2012. **72** Borsotto, 2013. **73** Processed by Census of agriculture 2010. **74** Nettier *et al.,* 2011.

Calculation of the cost of production for the harvesting farm

COST OF PRODUCTION OF PRESERVATION MIXTURES (€)	Permanent meadow	Subalpine pasture
SPECIFIC COSTS		
Fuel + machine lubricants	56.12	137.94
Rental	768.00	992.00
COMMON DIRECT COSTS		
Machine maintenance	271.92	225.99
Insurance	185.24	153.95
Amortisation	458.86	381.36
Building maintenance	78.11	66.38
COMMON INDIRECT COSTS		
Corporate fixed charges	108.77	90.40
ALLOCATED COSTS		
Family labour force (transport, harvesting, drying)	611.04	630.40
Interests on the working capital	271.92	225.99
Interests on real estate	555.73	755.65
TOTAL COSTS	3,365.70	3,660.06
Cost of production per hectare	1,121.90	457.51
Cost of production per kg of mixture	**13.70**	**25.42**

Criteria used for calculating the cost of production of the harvesting farm

ITEM	CRITERIA
Percentage share allocated to farm buildings and implements	50% for meadows - 20% for pastures
Partition coefficient of the common costs	27% for meadows - 56% for pastures
Fuel + machine lubricants	Quantified according to the consumption - 10 km/l pick up and 17 l/ha tractor (data ENAMA[75]) + 3% amount of fuel
Rental	Rent without the operator of a pull type seed harvester: 31 €/h
Machine maintenance	5% on the value of the machines assigned to the process
Insurance	2% on the value of the machines assigned to the process and 0.5% on the value of the buildings assigned to the process
Amortisation	3% on the value of the buildings assigned to the process
Building maintenance	0.5% on the value of the buildings assigned to the process
Corporate fixed charges	Estimated value: 2% of the total gross production allocated pro rata and partition coefficient
Family labour force (transport, harvesting, drying)	Allocated costs of 8 €/h[76]
Interests on the working capital	5% on the value of the working capital assigned to the process
Interests on real estate	1% (land) and 1.5% (buildings) on real estate value assigned to the process

The farm is part of the supply chain of local seeds as a **seed collector** for third parties by virtue of a **sales contract** for the collected product. The cultivation techniques (fertilization, irrigation etc.) require no changes compared to the usual ones used for forage production. The collection of brush harvested seeds concerns farmland, with the use of the tractor and manpower of the farm and **rental of a pull type seed harvester**. The purchase of the machine is not considered to be convenient, as the size of the farm and the short operating time do not allow an annual use that is economically profitable. According to the contract, the brush harvested seeds can be sold as soon as collected to the seed company, which will carry on all further processing, or they can be dried and cleaned manually in the farm before selling.

If the farm collects seeds and sells them in bulk to the seed company, the cost of production are slightly lower (11.36 €/kg for brush harvested seeds from meadows and 24.71 €/kg for brush harvested seeds of subalpine pastures). This management is, however, conceivable only in the area where the seed company's drying centre is located within 50 km from the donor site.

The cost of production changes substantially depending on the type of mixture produced. Rental is the item having the greatest impact (a cost of a rented pull type seed harvester without the operator was assumed to be equal to 31 €/h).

Type 2 – Seed company that processes and sells mixtures

Type 2 is represented by **companies that produce** propagation material (for example, seed companies) that have buildings and specific machines to produce mixtures and that establish purchase contracts with seed harvesting farms.

Currently this type of farm does not exist in the Aosta Valley, while in the French Northern Alps there are some firms already operating in the Isère department.

In the production of preservation mixtures, this type or farm requires producing a commercially suitable amount for a **demand that is not only local**, in order to meet the operating expenses for the structures, equipment and manpower, and to build a purchasing network that is economically attractive.

75 Ente Nazionale per la Meccanizzazione Agricola.

76 Bagnod *et al.,* 2013.

Calculation of the cost of production for the seed company

COST OF PRODUCTION OF PRESERVATION MIXTURES (€)	Permanent meadow	Subalpine pasture
SPECIFIC COSTS		
Raw material purchase	69,586.54	54,000.00
Fuel + machine lubricants	162.89	52.36
Other costs	277.20	127.50
COMMON DIRECT COSTS		
Permanent labour	1,280.91	623.82
Combustible	202.10	64.96
Electricity	156.80	50.40
Insurance	797.50	797.50
Amortisation	405.00	405.00
Machine maintenance	1,825.00	1,825.00
Buildings maintenance	67.50	67.50
COMMON INDIRECT COSTS		
Corporate fixed charges	500.00	500.00
ALLOCATED COSTS		
Interest on the working capital	1,825.00	1,825.00
Interest on real estate	135.00	135.00
TOTAL COSTS	77,221.45	60,474.04
Cost of production per hectare	1,544.43	604.74
Cost of production per kg of mixture	**25.07**	**40.32**

Therefore, such a firm must handle a quantity of approximately **30 q** of preservation mixtures of **permanent meadows**, and **15 q** of preservation mixtures of **subalpine pastures**, must be equipped with a drying plant and adequate implements (thresher, bagging and sewing machine) and an adequately sized building. In addition, the firm must be able to deal with administrative procedures (permit applications and record keeping) and with commercial ma-

Criteria used to calculate the cost of production of the seed company

ITEM	CRITERIA
Percentage share allocated to firm buildings and implements	25%
Fuel + machine lubricants	Quantified according to the consumption - 2 l/h thresher + 3% amount of fuel
Other costs	Consumable packaging materials
Permanent labour	Allocated cost of 11.24 €/h
Combustible	Quantified according to the consumption - 3 l/q (data ENAMA)
Electricity	Quantified according to the consumption - 1 kW each 10 kg of material
Insurance	2% on the value of the machines assigned to the process and 0.5% on the value of the buildings assigned to the process
Amortisation	3% on the value of the buildings assigned to the process
Machine maintenance	5% on the value of the machines assigned to the process
Building maintenance	0.5% on the value of the buildings assigned to the process
Corporate fixed charges	Estimated value: 2% of the total gross production allocated pro rata
Interests on the working capital	5% on the value of the working capital assigned to the process
Interests on real estate	1% (land) e 1.5% (buildings) on real estate value assigned to the process

nagement (relations with suppliers and sales to customers).
The company is part of the supply chain of local seeds as a firm that produces seed mixtures and subscribes purchase contracts with the collectors of local seeds, whose price is to be established in relation to the costs of production and the type of mixture.
The cost of production changes substantially according to the type of mixture produced. The item that has the greatest impact is purchasing brush harvested seeds (a cost of 15 €/kg was assumed for the brush harvested seeds of meadows and 30 €/kg for the brush harvested seeds of subalpine pastures).

Type 3 – Farmers' organisation

Type 3 consists of an economic entity (for example, an association, a consortium or a cooperative) gathering a **group of farmers** and managing the production of preservation mixtures.
The associated farmers provide their farm implements (tractor) and farmland, harvest the seeds with their own farm's manpower and possibly the support of the other members, who receive compensation for their work.
The farmers' organisation manages the buildings, machinery and specific installations, in addition to managing the marketing of mixtures. The organisation may also process mixtures collected by non-members (harvesting farmers). Furthermore, this organisation, **of an agricultural nature**, may also carry-out agro-mechanical activities related with the collection of brush harvested seeds, and to the expansion and maintenance of agro-forestry land.
In this association, the farmers manage their business jointly: they produce mixtures, deal with administrative activities, sell their production and possibly the one purchased from third parties and pay all management costs.
The type association must manage at least **15 hectares of permanent meadows** or **30 hectares of subalpine pastures**, be equipped with a vehicle in order to transport the machines, have the necessary implements, facilities and properly sized buildings to manage the production.

Calculation of the cost of production for the farmers' organisation

COST OF PRODUCTION OF PRESERVATION MIXTURES (€)	Permanent meadow	Subalpine pasture
SPECIFIC COSTS		
Fuel + machine lubricants	592.26	760.95
Other costs	82.93	40.50
COMMON DIRECT COSTS		
Permanent labour (transport, harvesting, drying, packaging)	3,097.69	3,019.63
Machine maintenance	3,759.75	3,759.75
Combustible	60.47	21.65
Electricity	46.91	16.80
Insurance	1,773.90	1,773.90
Amortisation	1,620.00	1,620.00
Building maintenance	270.00	270.00
COMMON INDIRECT COSTS		
Corporate fixed charges	500.00	500.00
ALLOCATED COSTS		
Interests on the working capital	3,759.75	3,759.75
Interests on real estate	810.00	810.00
TOTAL COSTS	15,781.40	16,352.92
Cost of production per hectare	1,052.09	545.10
Cost of production per kg of mixture	**17.13**	**36.34**

Criteria used to calculate the cost of production of the farmers' organisation

ITEM	CRITERIA
Percentage share allocated to farm buildings and implements	100%
Fuel + machine lubricants	Quantified according to the consumption: 17 l/ha tractor (data ENAMA) + 2 l/h threshing machine + 4 km/l for truck + 3% amount of fuel
Other costs	Consumable packaging materials
Permanent labour	Allocated costs of 11.24 €/h
Machine maintenance	5% on the value of the machines
Combustible	Quantified according to the consumption: 3 l/q (data ENAMA)
Electricity	Quantified according to the consumption: 1 kW each 10 kg of material
Insurance	2% on the value of the machines and 0.5% on the value of the buildings
Amortisation	3% on the value of the buildings
Building maintenance	0.5% on the value of the buildings
Corporate fixed charges	Estimated value: 2% of the total gross production
Interests on working capital	5% on the value of the working capital
Interests on real estate	1% (land) and 1.5% (buildings) on real estate value

Also here the costs of production of the two mixtures are significantly different. The items having the greatest impact are maintenance of implements and labour costs.

Factors affecting the costs of production

The distribution of costs changes widely according to the types of companies, which have different operating schemes: farmers make use of subcontractors, manage different production processes and use only their farm capital; the seed company buys the raw materials totally from third parties; the farmers' organisation is only aimed to the production of local seeds.

Consequently, the **specific costs** are represented mainly by subcontracts for farmers (23 to 27% of total costs), by the purchase of raw materials for the seed company (89 to 90% of total costs), and fuel for the organisation (4 to 5% of total costs).

Common costs (direct and indirect) represent up to 30% of the total costs for the farmer and 6% for the seed company, while they represent the most important item for the farmers' organisation, as they include all expenses related with manpower and use of machines, installations and buildings (about 66% of the total costs).

Finally, the **allocated costs** are around 44% of the total costs for the farmer (family labour and interests on farm capital), 2.5% for the seed company and just under 29% for the organisation.

The costs incurred and the quantities handled in the different farm types affect the cost of production per kilogram of mixture.

The data compared shows that the mixtures produced by farmers have a lower cost compared with the other cases, since the product is not still ready to be sold. The costs are calculated to estimate the **delivery price** to a processing centre, or to assess the reseeding costs carried out by the same farmer on his own land. It is possible to compare the mixtures ready to be placed on the market offered by a seed company and those offered by a farmers' organisation.

Cost of production for seed mixtures from the three types of firm

The differences between the two amounts depend essentially on the firm organisation: seed companies are not directly involved in harvesting, but have to buy their raw materials from harvesting farms, while the farmers' organisation manage the entire supply chain, from harvest to sale, based on adequately dimensioned structures, shared machines and equipment,

	Permanent meadow (€/kg)	Subalpine pasture (€/kg)
Harvesting farm	13.70	25.42
Seed company	25.07	40.32
Farmers' organisation	17.13	36.34

manpower and donor sites managed by its members.

7.3 Comparison between market prices of preservation mixtures

The costs of production estimated previously allow to establish the prices of the mixtures. The sale price depends also on whoever sells the product: the direct sale from producers excludes business brokerage and can offer affordable prices, which may be less than those of a commercial company. To establish the price of local seed it is necessary to know the local market prices of similar products, in order to know the minimum and maximum limits that allow to receive a **fair return** and still be **competitive**.

The preservation mixtures, due to their **ecological characteristics** and **production conditions**, may have a higher mark-up that ensures proper remuneration of the agricultural product, without the risk of going out of business.

So far, in Italy and in France no preservation mixtures are available in the market, but some recent experiences allow to assess the prices of local seeds. Among these, the price list of the Province of Trento (2014) quantifies at 35 €/kg the "Supply of brush harvested seeds obtained from nutrient-poor or modestly fertilized grasslands (<50 kg of nitrogen per ha and per year)".

In Switzerland, seed companies offer "Mixtures for ecological compensation or for hay meadows rich in biodiversity" at about 30 €/kg and "Mixtures for seeding of buffer zones along rivers, wooded boundaries, trails, roads" at prices ranging from 50 €/kg to 65 €/kg.

In France there are only 4 seed companies trading native wild seed mixtures, whose price can reach 100 €/kg.

By comparison, the regional price list for the execution of public works in the Aosta Valley contains only the item "Seed mixtures", distinguished according to their use "for farmland" (5.66 €/kg) and "for ecological restoration" (9.41 €/kg), without any further information regarding their floristic composition and the required percentages.

According to the technical and economic results obtained during the Alp'Grain project, it is believed that **preservation mixtures** obtained from species-rich **permanent meadows** should be placed in the seed markets at a price ranging from **25** to **30 €/kg**, while those obtained from species-rich **subalpine pastures** should have a price between **40** and **50 €/kg**, with higher amounts for specific mixtures for priority habitats.

7.4 Income statements for farms producing mixtures

Farms are the main producers of brush harvested seeds, because they manage species-rich grasslands, being potential donor sites.

For the farmer the collection of local seeds may become an interesting activity that, in the frame of a local supply chain, could integrate its main production with a new product.

Two typical cases were examined to calculate differences in gross margin and net income related with the production process of preservation mixtures:

- case 1 – dairy farm of medium-size (25 ha of grasslands), livestock at the farm all year long, milk processing plant, forage self-sufficiency, suitable machinery and family labour forces;
- case 2 – forage growing farms (former dairy farm) with 3 hectares of grasslands, machinery and buildings on the farm and family labour force.

The farmland used for the production of local seed was assumed to be equal to **3 ha of permanent grasslands** for both kinds of farms, with productions per hectare of rough brush harvested seeds of 112 kg and a selling price of **15 €/kg** for

dried and coarsely cleaned seeds, and **25 €/kg** for the preservation mixture.
The balance sheets were prepared in accordance with the accounting methods based on on-farm surveys and using the application "Simplified INEA balance sheet", a free access IT application with prior user registration, able to manage all the technical, economic, capital and financial data of the farm.

Case 1

The farm, due to its characteristics and the availability of permanent meadows, can choose to collect seeds on its own (type 1) or join a farmers' organisation (type 3). The comparison of the income statements shows that, despite an increase in variable costs related to the production process, the added value increased by 0.5% and 2% respectively.
The farm gross margin improves if the farm invests a larger area for seed production; for example, with an area of five hectares, the seed harvesting farmer collecting on his own would increase the added value by 3%, while as a member of a farmers' organisation, he would benefit from more substantial increases in the gross product (+ 10%), a 5% reduction in costs and would increase its added value nearly 7%.

INCOME STATEMENT ITEMS (YEAR 2013)	Current state (€)	Harvesting farm		Member of a farmers' organisation	
		Amount (€)	Variazione (%)	Conto (€)	Variazione (%)
Farm gross product	73,500	77,175	+5.0	78,125	+6.3
Premiums and contributions	7,600	7,600	-	7,600	-
Total farm revenue	81,100	84,775	+4.5	85,725	+5.7
Variable costs	23,864	27,229	+14.1	27,364	+14.7
Added value	57,236	57,546	+0.5	58,361	+2.0
Fixed costs	30,028	30,028	-	30,028	-
Net product	27,209	27,519	+1.1	28,334	+4.1
Net income	56,409	56,719	+0.5	57,534	+2.0

Case 2

The farm, due to its smaller size, collects seed on its own with a rented brush harvester, since it cannot incur the membership fees of a farmers' organisation. Comparison of the income statements shows an almost doubled farm gross product and a significant increase in variable costs, compared to an increase of the added value of almost 19%, however corresponding to barely more than 300 €.
Also in this case, an increase of the available area for seed collection would enable the farmer to increase his gross product further, reduce the costs and raise the added value.

INCOME STATEMENT ITEMS (YEAR 2013)	Current state (€)	Harvester farm	
		Amount (€)	Variation (%)
Farm gross product	4,200	7,875	+87.5
Total farm revenue	4,200	7,875	+87.5
Variable costs	2,550	5,915	+132.0
Added value	1,650	1,960	+18.8
Fixed costs	100	100	-
Net product	1,550	1,860	+20.0
Net income	3,750	4,060	+8.3

Chapter 8
Analysis of the demand for preservation mixtures

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Analysis of the demand for preservation mixtures

The presence of a demand for local seed is the necessary condition to create a supply chain. It is therefore essential to estimate the potential market for preservation mixtures, by analysing the current demand and the expected one.
In order to quantify the demand, a survey was carried out among users of seeds in the Aosta Valley and in the French Northern Alps, such as national and regional parks, ski resorts, national, regional and municipal public bodies, private companies and land improvement consortiums. Information was collected regarding the operating seeding techniques, the areas seeded during the past years, the surfaces to be sown in the coming years and the quantities and type of seed used.

8.1 Demand in the Aosta Valley

In the Aosta Valley the survey involved eighteen users, including public bodies (departments of Agriculture and Natural Resources) and private entities: ski resorts, contractors, land improvement syndicates and farms).
The survey was divided into five parts:

1. scheduled seeding activities;
2. seeding activities already realised;
3. management of the seeding activities;
4. revegetation techniques;
5. demand for local seed.

Based on an analysis of the information collected, a general framework of the demand for seed was outlined.

- The main users of seed are: local administrations, commissioning public works in the region; land improvement syndicates, entities implementing agricultural layout adjustment and agricultural land improvement; ski resorts, as managers of the slopes, and farms performing farmland reclamation.
- The work schedule for the next two years amounts to about 70 hectares and consists mainly of: agricultural land improvement at altitudes between 500 and 1000 m above sea level; deposits of materials from excavations; slope restorations; construction of rural trails and of new ski slopes. Some of the scheduled works will affect about eight hectares in areas inside, or close to, the Natura 2000 sites.

Scheduled works	Surfaces (ha)
Agricultural land improvement	33.1
Public works (traffic)	15.5
Slope restoration	7.4
Ski slopes (construction and maintenance)	7.2
Rural trails	5,4
Other (construction site areas, paths, etc.)	1.3
Total	**69.8**

- The users contacted reseeded, during the period 2008-2013, over 235 hectares, of which almost 90% were for agricultural land improvement and 5% for the construction of rural trails.

Realised works	Surfaces (ha)
Agricultural land improvement	210.3
Traffic	11.6
Maintenance	8.0
Ski slopes	4.4
Environmental rehabilitation	2.3
Construction site areas	0.3
Total	**236.9**

- The seeding activities are part of complex projects, which require structural works and levelling of land, usually performed by

contractors, in the context of public tenders, and directed by external supervisors.

- In all cases, commercial seed mixtures were used for seeding. Some users carried out tests on locally collected grass sod slabs.
- Depending on the type of work performed, these seedings were performed with mechanical sowing means (agricultural land improvement), hydroseeding (slope restorations) or manual seeding, for small sized or high altitude reseeding.
- On average, the users were quite satisfied of the results of past seedings. Among the problems encountered, they mentioned insufficient ground cover, especially in nutrient-poor soils, proliferation of weeds (*Chenopodium, Melilotus, Rumex*), prevalence of certain species (for example, clover) than others, excessive presence of species not listed in the labels of mixtures, such as alfalfa.
- The majority of the contacted users expressed their interest in using local seed for the scheduled seeding works, as they believe that it is more suitable for alpine environments, can ensure successful cover and hinder the growth of infesting weeds. They also believe that its origin and quality are guaranteed. Many are convinced that using local seed can promote the preservation of biodiversity, and that it is important to use it within the protected areas. Beside many positive aspects, different users expressed some doubts, such as the need to assess the quality, productivity and cost effectiveness of local seeds compared to commercial ones, and they underlined some critical organisational issues, such as the difficulty to obtain the material according to the timing of the construction sites, and the difficulty of the contractors in handling the material. Finally, it was noted that there are currently no specific funds or obligations for the use of local seeds.

Based on data collected from the survey and on direct knowledge, it is possible to estimate that during the next few years the **total area to reseed in the Aosta Valley** will be around **60 to 80 ha/year**, of which about 10% could affect sites within the Natura 2000 network. Since the usual seed rate for commercial mixtures is in the order of 200 kg/ha, the seed requirements to sow these surfaces would be around 12 to 16 t/year. Because the literature and the experience of the Alp'Grain project with local seeds recommend seed rates of about 100 kg/ha, these same surfaces could be reseeded with about **6 to 8 t/year of preservation mixtures**.

The current demand for local seeds is concentrated within the Natura 2000 areas, where there is an obligation, in case of seeding due to small damages to the sward, to use mixtures of site-specific species and varieties. In areas with "Mesophile grasslands" habitats[77], interseeding non-native species is forbidden.

The potential demand is given by all those who plan to carry out seeding activities in the region during the coming years and who are in conditions to:

- use preservation mixtures;
- be economically encouraged to employ local seeds;
- buy the necessary quantities;
- obtain the seed supply within their working schedules.

Based on the potential offer described above, and estimating an annual local production of about 900 kg of mixtures for the preservation of permanent meadows and 450 kg for the preservation of subalpine pastures, a **demand for seed** to revegetate about **12 hectares**, of which 9 ha of permanent meadows and 3 ha of pastures, corresponding to **15 to 20% of the potential demand**, could be met.

77 Habitats involved: 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*) and 6520 Mountain hay meadows.

8.2 Demand in the French Northern Alps

In France, the survey involved seventy users, of different public bodies: National Forests Office (*Office national des forêts - ONF*) - Departmental Service for Restoration of Mountain Areas (*Service départemental de la restauration des terrains en montagne*), Chamber of Agriculture (*Chambre d'agriculture*), Alpine Economic Society (*Société d'Economie Alpestre - SEA*) and municipalities; private (ski resorts) and Electricity of France (*Électricité de France - EDF*), the largest producer and supplier of energy in France.
The survey was conducted in two stages: first, a questionnaire was distributed to all users designed to record the surfaces to be revegetated annually in the departments of Haute Savoy, Savoy and Isère, the type of activities scheduled and the amount of seed purchased.
Later, four ski resorts were contacted, where a more structured questionnaire composed of six parts was distributed:

1. general information regarding the ski resort;
2. seeding techniques used;
3. land use and revegetation objectives;
4. costs and results of the revegetation;
5. seed used;
6. use of local seed.

From the analysis of the information collected, a general framework of the demand for seed was drawn.

- The main users of seed are the ski resorts, municipalities and public and private organisations such as parks, ONF and SEA.
- The scheduled works for the next two years consist mainly of farmland or construction site areas arrangements, installation of irrigation systems and canals, slope restorations.
- In the period 2008-2012, the contacted users seeded every year about 680 ha of land at elevations above 1000 m, of which over 90% was related to ski slopes.
- The ski resorts only sow commercial mixtures, while the other users employ commercial seeds in 75% of the cases and in the remaining 25% they use local seed in the form of green or dry hay and hay flower.
- The ski resorts seed directly in 55% of the cases; all the other users outsource the work to contractors.
- Mechanical seeding is the most widely used method in agricultural land improvement, while hydroseeding is mainly used on ski slopes.
- In many cases the sites to be revegetated are fertilized with compost or other organic amendments.
- In most cases, the sowing has to be repeated several times.

Users	Surface (ha)
Ski resorts	624
Municipalities	28
Various organisations (parks, ONF, SEA)	27
TOTAL	**679**

According to the collected data, in the next few years the **total area to be reseeded** in the mountain areas of the Northern Alps can be estimated to be around **600 to 700 hectares/year.** The demand for commercial seed of forage species would be approximately 120 to 140 t/year while using preservation mixtures, whose seeding rate is less, about 60 to 70 t/year would be needed.
Based on the supply described previously, a possible annual seed production of about 3000 kg of preservation mixtures of permanent meadows, and 1500 kg of mountain pastures might be enough to revegetate about **40 hectares**, of which 30 ha of permanent meadows and 10 ha of pastures, representing **5 to 6% of the total potential demand**. The amounts supposed should fill the demand of parks, public organisations (ONF, SEA) and municipalities almost entirely.
In the future, demand and supply in the North-Western Alps could consolidate and possibly expand, but only if certain conditions are met:

- a simpler and less binding legislation concerning the use of preservation mixtures;
- identification of cross-border and interregional regions of origin;
- availability of large donor sites and not limited only to Natura 2000 sites;
- presence of companies that can manage quantities of mixtures that meet the demand suitably.

Chapter 9
Possible structure of preservation mixtures supply chain

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Possible structure of preservation mixtures supply chain

There are no production supply chains of local seeds currently in the North-Western Alps, while in other parts of Europe (French Pyrenees, Austria, Germany and Switzerland) specific supply chains were organised to produce local seeds in order to support local ecological restoration activities.
The supply chain for the preservation mixtures that can be developed in the North-western regions of the Alps is a **short supply chain**, because its production-distribution-use configuration is based on the geographical proximity of the collection and revegetation sites, and on a limited number of operators (harvester, processor-seller).
Given the conditions of production, the characteristics of these mixtures and the size of the demand, it seems unlikely that specialized seed farms may be interested in entering the market of directly harvested preservation mixtures, because the composition of these mixtures is more difficult to control and is subjected to large fluctuations.

9.1 The actors

The actors that could take part in this type of supply chain are distinguished as: internal actors directly involved in the production (farmers, farmers' organisations, seed companies, users) and external actors that contribute to the establishment and existence of the supply chain (public administrations, research centres, local authorities).
The technicians, contractors, farmers, clients, individuals and the media need to be properly trained and informed about the advantages and disadvantages of using local seeds, in order to contribute to the preservation of biodiversity and of plant genetic resources.

Internal actors

Farmers
The farmers, either single or associated, are the people involved in the collection of seeds, as managers of species-rich grassland. Within the supply chain, they act as harvesters of the raw material, thanks to contracts with seed companies or farmers' organisations.
The farmers participating in the supply chain are interested in differentiating their products, using their farm resources (land, machinery, buildings) to gain an economic advantage.

Farmers' organisations
The association of farmers is an organisational model that can manage the entire production process of the supply chain, from collection to marketing.
The farmers associate themselves, according to the form of company they may consider most suitable (cooperative, association, syndicate, society) in order to create a legal entity capable of dealing with the production and sale of preservation seeds.
The association must provide for investments in terms of land, buildings and equipment, which, however, can be supplied by individual farmers, reducing the initial expenses.
The organisation must ensure technical and logistical support to users thanks to its specialized staff, able to choose the appropriate donor sites, find the most suitable mixture in the seeding works and plan the harvest according to the buyer's demand for local seed.
This agricultural organisation could also expand its commercial offer by purchasing a part of the harvested seeds by non-associated farmers and offering agro-mechanical services, such as seed harvesting and sowing for third parties.

Seed companies

The seed companies carry on the conditioning, packaging and sale of the mixtures. These operators buy the brush harvested seeds directly from farmers, through production contracts, and process them for the purposes of sale (drying, cleaning, packaging, storage). They are organised with their own technical staff, which can assist the harvester in choosing the type of brush-harvested seeds to be collected and the collecting period, and sales staff.

Users

The demand for preservation mixtures is expressed by the end users (contractors, ski resorts, farms) and the clients commissioning revegetation works (public administrations, parks, local authorities and land improvement syndicates).

The users should be encouraged to use local seeds, and furthermore, they should receive technical and logistic support so that the preservation mixtures bought may be suitable for the site to be revegetated, and be provided according to the working schedules.

External actors

The external actors play a key role in supporting the supply chain of local seeds from a regulatory, financial, technical and operating point of view.

Public authorities

The public authorities (State, Departments, Regions, and Municipalities) are called to legislate on the subject, in order to make the supply chain feasible.

The current legislation contains technical, procedural and quantitative restrictions and does not encourage operators to produce preservation mixtures to be sold. There are also several open issues that are an obstacle for the organisation of a supply chain.

The market for preservation mixtures can be activated only after the producers have obtained a specific authorization from the proper authorities, which can be granted only in those States and Regions that have defined their **regions of origin**. In France, mapping of the regions of origin was approved in 2014 while, so far, the Italian regions have not yet proceeded to define them.

Once the conditions imposed by law have been met, it is believed that the supply chain of preservation mixture can be activated only with the support of public authorities, by means of:

- transposition of Directive 60/2010/EU to a legislation implemented by the autonomous Italian Regions and Provinces in order to adapt it to the specific local needs;
- obligation to use local seeds within the sites of the Natura 2000 areas;
- encouragement, including economic support, for the use of local seeds in those areas where biodiversity is a valuable element to be protected, using tools such as the Rural Development Programmes and the Sector Programmes.

Territorial bodies

All territorial bodies directly concerned with the preservation of biodiversity and of natural resources are invited to plan specific actions in order to encourage, promote and support the use of local seeds. Moreover, it is a duty of these bodies, as far as they are concerned, to stimulate public authorities to implement specific political and technical measures to support the preservation of the natural environment and the maintenance of rural areas.

Research centres

Research institutions have the task of providing technical and scientific support to the preservation seed supply chain and to its various actors, continuing their studies, disseminating their results and promoting the appropriate use of local seeds in order to safeguard the biodiversity and preserve plant genetic resources.

9.2 Supply chains for preservation mixtures

Currently, it is possible to conceive different supply chains for the production, processing, sale and use of preservation mixtures.

Reutilisation

The reutilisation of preservation mixtures does not imply economic or commercial exchanges, and therefore should not be considered an effective supply chain. However, from a practical point of view, reutilisation is an **operating mode** that meets the **farm demand of local seeds** and promotes their use for agricultural purposes.

At present, the seeds directly harvested by farmers from their grasslands can certainly be used to sow their own land subject to earthworks. Their reutilisation in the farm does not fall within the legal framework of Directive 2010/60/EU and, therefore, there are no geographical limits, quantitative restrictions, obligations or authorization procedures to be observed.

This organisational model involves:

- farmers, who are both collectors as well as users;
- public authorities, that support seeding with the brush harvest seeds;
- territorial bodies and research organisations that train the farmers in collection and reutilisation techniques.

The preconditions to be fulfilled to encourage the reutilisation are:

- presence in the area of seed harvester rental services;
- inclusion of the sowing with directly harvested seeds in the works that can be subsidised by public bodies.

The reutilisation can succeed if the farmers have surfaces suitable for collection, rely on adequate technical assistance and perceive a technical and economic advantage in using local seeds.

Local supply chain

According to the current situation, described in the previous chapters, it is possible to assume that in the near future a local supply chain for preservation mixtures may appear, as a niche offer meeting the demand for local seed for revegetation activities in the sites of the Natura 2000 network, to restore natural and semi-natural habitats.

In a second step, the local supply chain could expand on a regional scale. In this case, the offer should be structured and spread throughout the territory, being able to provide quantities of preservation mixtures sufficient for medium-sized grassing operations (one to five hectares per site).

Naturally, the local supply chain must be organised in accordance with the current regulations: the producers of mixtures must follow the procedures, obtain the necessary permits, rely on suitable premises and the minimum equipment needed to produce the seed to be sold and, especially, need to harvest and process seeds from donor sites that are located within source areas officially designated by the States or by the Regions.

In this case, the preconditions to be met are:

- identification of the regions of origin and the source areas;
- establishment of a farmers' organisation in the territory;
- obligation to use preservation mixtures in the Natura 2000 sites and in the high nature value farmlands and forests;
- inclusion of the items related with the use of preservation mixtures in the regional price lists;
- introduction of the use of local seeds in those projects that can be subsidised by public bodies.

The organisational model may initially require involvement of the following actors:

- a farmers' organisation, properly structured to manage the entire production process from harvest to sale;
- end users, who commission or perform re-

vegetation activities in protected areas;
- local authorities (Parks, Municipalities), that ensure enforcement of all the preservation measures.

At a later stage, the supply chain may be enlarged to other subjects, such as:
- individual farmers, who provide the brush harvested seeds to the organisation;
- all users of local seed (public authorities, contractors, farms, individuals);
- local governments, which provide financial support for seeding activities performed with brush-harvested seeds.

The local farmers' organisation can produce **mixtures that are site-specific for the habitats to be restored**, choosing the appropriate donor sites, while the users can schedule and plan their sowing in collaboration with the producer. Proximity between the actors and the geographical closeness of the sites are two aspects that guarantee the quality of the mixtures offered and the success of the revegetation.

Interregional and cross-boundary supply chain

An interregional or cross-border supply chain in the North-Western Alps should be based on the presence of a certain number of seed companies or properly structured farmers' organisations, that may be able to meet the demands of those users who perform **large-sized grassing operations** (up to thirty hectares each).

The preconditions that the supply chain must meet are:
- definition of the authorization procedures related to cross-border marketing;
- local presence of seed companies interested in processing and marketing mixtures of directly harvested local seeds or, otherwise, one or more farmers' organisations located in the region of origin;
- specific recommendations from the public authorities and the territorial bodies to use local seeds in all ecological restoration operations performed in mountain areas.

The organisational model envisages the involvement of:
- a network of seed harvesting farmers spread throughout the territory concerned;
- medium-sized seed companies, located nearby or within the region of origin;
- a wide range of users who need large quantities of preservation mixtures.

The interregional/cross-border supply chain should rely on a **wide network of harvesting farms**, offering **mixtures for all major habitats** in the region of reference, to meet the demand of the users, providing appropriate seeds and the quantities needed for the revegetation sites.

References

- Adorni M., Piazza C., Ottolini E., Donati M. (2012). Progetto Life+ 2007 "Pianura Parmense" AZIONE C1 Produzione ed impiego di sementi da specie ed ecotipi di piante erbacee dei prati stabili storici, relazione finale. Provincia di Parma. Retrieved February 14, 2015, from http://www.ambiente.parma.it/page.asp?IDCategoria=2934&IDSezione=18942&ID=508787
- Agostinetto L., Barella L., Dimartino S., Francescato V., Antonini E. (2007). La produzione di biomasse legnose a scopo energetico, Approfondimenti tecnici di filiera. Veneto Agricoltura. Retrieved February 14, 2015, from http://www.venetoagricoltura.org/basic.php?ID=1438
- Assirelli A., Pignedoli S. (2005)a. C.R.P.A. notizie n. 5/2005. Costo di esercizio delle macchine agricole, 1a parte. Retrieved February 14, 2015, from http://www.agrifidire.it/nqcontent.cfm?a_id=2735&tt=test_www&sp=testcrpa&print_in=1
- Assirelli A., Pignedoli S. (2005)b. C.R.P.A. notizie n. 6/2005. Costo di esercizio delle macchine agricole, 2a parte. Retrieved February 14, 2015, from http://www.agrifidire.it/nqcontent.cfm?a_id=2735&tt=test_www&sp=testcrpa&print_in=1
- Bagnod G., Chenal G., Mazzarino S. (2013). Aspetti economici, organizzativi e di mercato legati alla coltivazione e alla trasformazione di alcune piante officinali in Valle d'Aosta. Institut Agricole Régional, Aosta.
- Baskin C.C. & Baskin J.M. (1998). Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, San Diego.
- Bassignana M., Curtaz A., Curtaz F., D'Amico M., Filippa G., Freppaz M., Icardi M. (2011). Manuale tecnico dei miglioramenti fondiari in zona montana. Institut Agricole Régional, Aosta.
- Bornard A., Bassignana M. (2001). Typologie agro-écologique des végétations d'alpages en zone intra-alpine des Alpes nord-occidentales. Cemagref Grenoble, IAR Aoste.
- Borsotto P. (2013). L'agricoltura in Valle d'Aosta caratteristiche strutturali e risultati aziendali, Report 2013. Collana RICA Quaderni. Retrieved February 14, 2015, from http://www.rica.inea.it/public/download/commenti_risultati_contabili/2011_221.pdf
- Borsotto P., Marchetti N., Pila C., Santangelo M., Sturla A., Trione S. (2013). I costi di produzione di anemone, ranuncolo, margherita, piante aromatiche, acacia, ginestra e ruscus nel Distretto Florovivaistico del Ponente Ligure – INEA, Roma.
- Bovio M. (2014). Flora vascolare della Valle d'Aosta. Repertorio commentato e stato delle conoscenze. Société de la Flore Valdôtaine, Aosta.
- Caillet-Bois D., Würth B., Benz R., Stäheli B. (2014). Promozione della biodiversità nell'azienda agricola – Esigenze di base e livelli qualitativi – AGRIDEA Lausanne.
- CBNPMP (Conservatoire botanique national des Pyrénées et de Midi-Pyrénées) (2014). Flore-locale & messicoles. Des signes de qualité nationaux pour les filières de production et de commercialisation des plants et de semences sauvages - Compte-rendu d'activité 2012-2014. Retrieved February 14, 2015, from http://www.fcbn.fr/ressource/bilan-du-programme-2012-2014-flore-locale-messicoles
- CPS (2009). Recommandations pour la production et l'utilisation de semences et de plants de fleurs sauvages indigènes, version 3. Secrétariat CPS. Retrieved February 14, 2015, from https://www.infoflora.ch/fr/assets/content/documents/recommandations_pltes_sauvages_D_F/Recommandations_fl.sauvages.pdf
- Curtaz A., Talichet M., Barni E., Bassignana M., Masante D., Pauthenet Y., Siniscalco C. (2011). Specie esotiche invasive e dannose

nei prati di montagna. Institut Agricole Régional, Aosta.
- De Natale F., Pignatti G. e Trisorio A. (2014). Aree agricole ad alto valore naturale - Approccio della copertura del suolo in Valle d'Aosta. Rete Rurale Nazionale - Task Force Monitoraggio e valutazione. Retrieved February 14, 2015, from http://www.reterurale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/u%252Fn%252Fi%252FD.d6d0bd1b1e37a2fcf389/P/BLOB%3AID%3D13563
- Dupin B., Malaval S., Coueron G., Cambecedes J., Largier, G. (2014). Comment reconstituer la flore en montagne pyrénéenne? Un guide technique de restauration ecologique. Avec la collaboration de Dantin G. (Amidev), Prud'homme F., Berges C., Corriol G. (CBNPMP), Conservatoire botanique alpin des Pyrénées et de Midi-Pyrénées, Bagnéres de Bigorre.
- FAO (2014). Grassland species profiles. Retrieved February 19, 2015, from http://www.fao.org/ag/agp/AGPC/doc/gbase/Default.htm
- Feucht B., Rieger E., Tamegger C., Jahn F., Jongepierová I. (2012). Agricultural production of seeds from regional provenance. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova, 33-38.
- Francesia C, Madormo F., Tarello C., Vernetti-Prot L. (2008). Sostenibilità del sistema zootecnico valdostano. Aspetti economici, sociali e ambientali. Institut Agricole Régional, Aosta.
- Géni'Alp (2014). Génie végétal en rivière de montagne. Retrieved February 19, 2015, from http://ouvrage.geni-alp.org/content/t%C3%A9l%C3%A9chargements
- Golińska B., Goliński P., Chalupová P. (2012). Selection of donor sites. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova,, 8-12.
- Gonseth Y., Wohlgemuth T., Sansonnens B., Buttler A. (2001). Les régions biogéographiques de la Suisse - Explications et division standard. Office fédéral de l'environnement, des forêts et du paysage (OFEFP). Retrieved February 14, 2015, from http://www.bafu.admin.ch/publikationen/publikation/00207/index.html?lang=fr
- Hauwuy A., Folliet X., Moyroud P., Fleury P. (1991). Utilisation de la typologie des prairies de fauche des Alpes du Nord. Fourrages 128, 397-406.
- Hefter I., Baasch A., Jünger G., Scotton M. (2012). Donor site databases and information systems of nature-oriented greening measures. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova, 13-16.
- ISTAT (2010). 6° Censimento generale dell'agricoltura. Retrieved February 14, 2015, from http://censimentoagricoltura.istat.it/
- Jeangros B., Amaudruz, M. (2005). Dix ans d'observations sur la phénologie des prairies permanentes en Suisse romande. Revue Suisse Agricole 37 (5), 201-209.
- Jeannin B., Fleury P., Dorioz J.M. (1991). Typologie des prairies d'altitude des Alpes du Nord: méthode et réalisation. Fourrages 128, 379-396.
- Jouglet J.P., Bernard Brunet J., Dubost M. (1982). Phénologie de quelques espèces des pelouses subalpines et alpines du Briançonnais, Fourrages 92, 67-89.
- Kirmer A., Mann S., Stolle M., Krautzer B., Graiss W., Halsgrüber P., Ševčiková M., Scotton M. (2012). Techniques for the establishment of species-rich grasslands. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova, 43-58.
- Koch B., Schiess-Bühler C., Stäheli B. (2010). Pour obtenir des prairies riches en espèces – Mais où sont les fleurs… AGRIDEA. Retrieved February 14, 2015, from http://www.agridea.ch/publications/publications/environnement-paysage/herbages/pour-obtenir-des-prairies-riche-en-especes/
- Krautzer B. (1997). Entwicklung und Erhaltung standortgerechter Gräser und Leguminosen für die Grünlandwirtschaft und den Landschaftsbau Im Alpenraum. Abschlussbericht des Projektes 2923.

- Krautzer B., Wittmann H. (2006). Restoration of alpine ecosystems. In: Restoration Ecology. Van Andel, J. & Aronson, J. (eds.), Oxford, Blackwell.
- Madormo F., Vernetti-Prot L., Francesia C. (2012). Un set di indicatori utili nell'analisi predittiva della sostenibilità delle aziende zootecniche valdostane. Quaderno SOZOOALP 7, 163-174. Retrieved February 14, 2015, from http://www.sozooalp.it/fileadmin/superuser/quaderni/quaderno_7/19_Madormo_SZA7.pdf
- Malaval S., Dupin, B. (2013). Restauration écologique de pelouses et prairies : brosser pour conserver, in: Nature Midi-Pyrénées (ed.). 2013. 4èmes Rencontres Naturalistes de Midi-Pyrénées - Actes du colloque tenu à Albi (Tarn) 31/01-02/02/2013. Nature Midi-Pyrénées, Toulouse. Retrieved February 14, 2015, from http://www.naturemp.org/IMG/pdf/rencontres_naturalistes_2013_actes.pdf
- Montanaro C., Ceccarelli L. (2014). I costi di produzione del frumento – ISMEA Roma. Retrieved February 14, 2015, from http://www.ismeaservizi.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/5067
- Nettier B., Dobremez L., Sérès C., Pauthenet Y., Orsini M., Kosmala L., Fleury P. (2011). Préservation de la biodiversité par les éleveurs :atouts et limites de la mesure agro environnementale « Prairies fleuries ». Fourrages, 208, 283-292.
- Niqueux M., Arnaud R. (1981). Peut-on prévoir la date d'épiaison des variétés de graminées? Fourrages 88, 39-56.
- Pluess A.R., Schütz W., Stöcklin J. (2005). Seed Weight Increases with Altitude in the Swiss Alps between Related Species but Not among Populations of Individual Species. Oecologia 144(1), 55–61. Retrieved February 14, 2015, from http://www.ncbi.nlm.nih.gov/pubmed/15800741
- Roumet J.P., Pauthenet Y., Fleury Ph. (1999). Tipologia dei prati permanenti della Valle d'Aosta. Institut Agricole Régional, Aosta.
- Scotton M., Dal Buono C., Timoni A. (2012)a. Seed production in semi-natural grasslands. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova, 17-20.
- Scotton M., e Piccinin L. (2003). Seed production of mountain permanent meadows. Grassland Science in Europe 8, 67-70.
- Scotton M., Kirmer A., Krautzer B. (2012)b. Practical handbook for seed harvest and ecological restoration of species-rich grasslands. CLEUP, Padova.
- Scotton M., Piccinin L., Coraiola M. (2010). Metodi di rivegetazione in ambiente alpino. Restauro ecologico per la difesa del suolo contro l'erosione. Ente Parco Naturale Paneveggio Pale di San Martino. Quaderni del Parco 10.
- Scotton M., Rieger E., Feucht B., Tamegger C., Jahn F., Ševčiková M., Semanová I., Krautzer B., Graiss W., Halsgrüber P., Kirmer A., Stolle M. (2012)c. Techniques for harvesting seeds and plant material in species-rich grasslands. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova, 21-32.
- Trisorio A., De Natale F., Pignatti G. (2013). Le aree agricole ad alto valore naturale in Italia: una stima a livello regionale. Agriregionieuropa anno 9 n. 33. Retrieved February 14, 2015, from http://agriregionieuropa.univpm.it/en/node/3547
- Wieden M., Feucht B., Tischew S., Halsgrüber, Krautzer B., Graiss W. (2012). Quality standards for native seeds regarding nature conservation. In: Practical handbook for seed harvest and ecological restoration of species-rich grasslands edited by Scotton M., Kirmer A., Krautzer B. CLEUP Padova, 70-75.

Annexes

List of acronyms

CRA - Council for research and experimentation in agriculture (I)
National Research and Experimentation organisation with general scientific competence in agriculture, agro-industrial, forests and fish matters.

CRA-SCS - Center for experimentation and certification of seed (I)
CRA-SCS is delegated by the Ministry for Agricultural and Forestry Policies in Italy (MiPAAF) to control, test and certify seed products.

CTPS - Permanent Technical Committee for Selection (F)
The CTPS is composed by representatives of all stakeholders in the seed industry in France, of environmental associations and consumers; it plays a role of advice and support to the Ministry of Agriculture in the preparation and execution of the policy regarding the seed sector.

Gnis - National inter-professional organization for seeds and planting materials (F)
A body delegated by the French Ministry of Agriculture to quality control and certification of seeds and planting material of agricultural species, the GNIS is divided into 8 sections, which represent all sectors of the supply chain: creation, production, multiplication , distribution and use of seed.

HNVF - High Nature Value Farmland
Areas where agriculture is the main land use and maintains or is associated with the presence of many species and habitats, or species of Community interest.

MiPAAF (I)
Ministry for Agricultural and Forestry Policies in Italy.

SAC - Special area of conservation (Directive 92/43/EEC)
Site of Community importance designated by the State, in which conservation measures are applied to maintain or restore, in a favourable preservation status, natural habitats and/or species populations for which the site is designated.

SCI - Site of Community importance (Directive 92/43/EEC)
A site that contributes significantly to the maintenance of a natural habitat type or a species and that may also contribute significantly to the coherence of Natura 2000 and the maintenance of biological diversity.

SIR - Site of Regional Natural Interest (I)
Geographically defined and limited area that significantly contributes to maintaining or restoring a natural or semi-natural habitat type or species of regional interest.

SOC - Official service for control and seed certification (F)
Technical service of Gnis, SOC must propose to the CTPS and apply technical regulations on production, control and certification approved by the Ministry of Agriculture. It is the body that ensures the quality of certified seed produced in France.

SPA - Special protection area (Directive79/409/EEC)
Protection area, identified by the State, which contributes to the maintenance of suitable habitats for wild bird populations.

List of those species whose name has been changed

Current name[78]	Previous name
Avenella flexuosa	*Deschampsia flexuosa*
Bellidiastrum michelii	*Aster bellidiastrum*
Bistorta officinalis	*Polygonum bistorta*
Bistorta vivipara	*Polygonum viviparum*
Bromopsis erecta	*Bromus erectus*
Chamaenerion angustifolium	*Epilobium angustifolium*
Dactylorhiza majalis	*Dactylorhiza latifolia*
Drymocallis rupestris	*Potentilla rupestris*
Elytrigia repens	*Elymus repens*
Euphrasia officinalis	*Euphrasia rostkoviana*
Helictochloa versicolor	*Avenula versicolor*
Hieracium caesioides	*Hieracium rionii subsp. caesioides*
Loncomelos pyrenaicus	*Ornithogalum pyrenaicum*
Lotus corniculatus subsp. alpinus	*Lotus alpinus*
Lotus corniculatus subsp. corniculatus	*Lotus corniculatus*
Pilosella lactucella	*Hieracium lactucella*
Rumex alpestris	*Rumex arifolius*
Rumex alpinus	*Rumex pseudoalpinus*
Schedonorus arundinaceus	*Festuca arundinacea*
Schedonorus pratensis	*Festuca pratensis*
Scorzoneroides autumnalis	*Leontodon autumnalis*
Scorzoneroides helvetica	*Leontodon helveticus*
Silene latifolia	*Silene alba*
Taraxacum sect. Ruderalia	*Taraxacum officinale*
Trisetaria flavescens	*Trisetum flavescens*

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