European Cooperation in the field of Scientific and Technical Research

- COST -

Brussels, 22 November 2013

COST 060/13

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action FA1307: SUPER-B: SUstainable Pollination in Europe: joint Research on Bees and other pollinators

Delegations will find attached the Memorandum of Understanding for COST Action FA1307 as approved by the COST Committee of Senior Officials (CSO) at its 188th meeting on 14 November 2013.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action FA1307
SUPER-B: SUSTAINABLE POLLINATION IN EUROPE: JOINT RESEARCH ON BEES AND OTHER POLLINATORS

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4114/13 "COST Action Management" and document COST 4112/13 "Rules for Participation in and Implementation of COST Activities" , or in any new document amending or replacing them, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to integrate knowledge and develop methods to underpin sustainable pollination services in Europe.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 108 million in 2013 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of section *2. Changes to a COST Action* in the document COST 4114/13.

A. ABSTRACT AND KEYWORDS

SUPER-B Super B will bring together scientific and societal communities involved in the conservation and sustainable management of ecosystem services mediated by pollinators. >70% of our crops need insects for optimal pollination; these include many fruits, nuts, oil crops, fibres and vegetables with some producing no yield without insect pollination. The direct economic value of crop pollination by insects in the EU is >14 billion euro annually. Moreover, >80% of wild plant species benefit from animal pollinators for fruit and seed production, making pollination a key service for ecosystem and biodiversity maintenance. SUPER-B will combine scientific evidence (existing and new knowledge) and social feedback for developing conservation strategies for pollinators**.** Specifically, the Action will (1) identify the role of insect pollination in agriculture and other ecosystems; (2) clarify best practices for mitigation of pollination loss, and (3) compare and contrast important drivers of pollinator loss (wild and managed species). SUPER-B will contribute towards maintaining natural ecosystems and achieving sustainable use of pollinators in agricultural production**.** Its results are relevant to all European countries and will be disseminated to a wide community of beneficiaries (scientists, farmers, beekeepers, industry, policy-makers, NGOs and the public).

Keywords: Pollination services, bee declines, sustainable agriculture, biodiversity conservation, food security

B. BACKGROUND

B.1 General background

Food security is an important policy area and a major challenge for EU Member States and globally. The human population is growing continuously, which translates into an increasing demand for higher and more stable production of high quality food. *The food security challenge is often met by converting natural habitats to agricultural fields leading to a trade-off between food production and the natural environment and its associated ecology.* This land conversion can have negative impacts on biodiversity, ecosystems and the services they deliver to humanity, e.g. clean drinking water, pure air, fertile soils.

An alternative approach aims at optimizing crop production by balancing the inputs, e.g. fertilizers, agrochemicals, with ecosystem services. These ecosystem services include pest control by natural enemies, soil fertility and humidity, and crop pollination. These services have traditionally not been

considered as agricultural inputs at all, because they are often erroneously assumed to be provided 'for free' in landscapes supporting populations of service-providing organisms. However, agricultural intensification and fragmentation of natural habitats have led to erosion of these ecosystem services, resulting in threats to crop production and the need to mitigate their loss (e.g. hiring of honeybee colonies for crop pollination).

The degradation of ecosystem services is particularly evident for crop pollination services by insects, which are important to ~75% of global crops, including many fruits, nuts, stimulants, oil-seeds and vegetables. The contribution of animal pollination to crop production revenues in the EU has been estimated at more than 14 billion euro annually. This does not include pollination services required for seed production in fodder crops or for allotments and home gardens. In addition, ~80% of European wild plants rely on insect pollinators for their reproduction and these plant communities are essential as food for much of our wider biodiversity. Plant-animal communities are one of our main Natural Capitals for improving the green infrastructure of our cities and the wider countryside and are of high cultural and recreational value to many citizens. Well-functioning ecosystems, in turn, are central to our well-being through their contribution to the provision of ecosystem services, including water filtration, flood control, soil fertility, and clean air. Therefore, insect pollination is crucial and highly linked with other ecosystem services (provisioning, supporting, regulating and cultural).

At present there is no coherent response to the current threats to insect crop pollination service delivery and decline in wild plant pollination, which are both expected to increase with on-going and well-documented declines in abundance and diversity of wild pollinators, e.g. bees, flies, butterflies, and managed honeybees. Further compounding this is the greater demand for pollination services as the area of pollinator-dependent crops continues to rise due to increased demands for biofuels and locally produced fruits and vegetables. Moreover, changes in climate and other environmental threats will require adaptations to create more resilient food production systems. Research has made significant progress on honeybee health (e.g. FP 7 BeeDoc "BEes in Europe and the Decline Of honeybee Colonies"or former COST-ACTION COLOSS "Prevention of honeybee COLony LOSSes") on wild pollinator ecology (e.g. FP7 STEP: Status and Trends of European Pollinators), and on specific aspects of crop pollination (e.g. STEP and the recently funded FP7 LIBERATION "LInking farmland Biodiversity to Ecosystem seRvices for effective ecological intensification" and QUESSA "QUantification of Ecological Services for Sustainable Agriculture"), but integration of data on how wild and managed pollinator populations provide these services, while struggling to cope with severe threats such as diseases, pesticides and lack of diverse forage sources, is currently not available to both scientific and the societal sectors.

The SUPER-B Action will overcome these shortfalls by creating an inter- and transdisciplinary platform to assemble and implement an integrative, coherent network aimed at ensuring sustainable delivery of crop and wild plant pollination services by building healthy, diverse pollinator communities in Europe (and beyond; note that the EU is a net importer of food products, representing a trade deficit of more than 23 billion Euro annually). Such an Action is urgently required to provide benefits including: 1) Contributing to the European and global food security challenge; 2) Coordinating, and enhancing the impacts of on-going efforts currently distributed among many (inter)national projects; 3) Introducing standardisation of wild pollinator and crop pollination monitoring to allow comparable, reliable and repeatable assessments to be made; 4) Facilitating rapid action through sharing of methods, results and insights on the multitude, of currently disjointed, aspects of sustainable crop pollination; 5) Sharing lessons learned and best practices on pollination and biodiversity research and developing clear practical recommendations for policy and practice for a range of interested societal parties including farmers, food producers, wholesale and retail sectors and the wider society.
COST is the obvious choice for funding this network, which emphasises the formation of an extensive scientific-practitioner network to join on-going, but dispersed, research and management efforts, to set standards and define clear measures and to disseminate higher-level outcomes to relevant scientific disciplines, stakeholders in farming and policy-making. The European landscape contains many of the critical parts of the sustainable pollination challenge but requires a high level convening and coordinating mechanism to achieve maximum value from these currently disparate components.

B.2 Current state of knowledge

While the importance of insect pollination to production of some crops has been known for a long time, our knowledge of the role of this ecosystem service in food production remains incomplete. Recent scientific results show that three quarters of crop plants produce more or higher quality yields when animal pollinators are present, that both wild pollinators and managed honeybees are important in crop production, and that pollination services are more reliably delivered in landscapes with (semi-)natural elements close to crop fields, in organic farming systems, and when a diverse assemblage of pollinators is available. While managed honeybees are, for many crops, an easily managed resource and an excellent back-up option when wild pollinators are unavailable, current honeybee stocks are decreasing, while the area of flowering crops needing insect pollination is growing rapidly. In addition, relying heavily on only one species for pollination services is

vulnerable to failure should that species suffer severe declines. In short, both honeybee stocks and wild bee availability are insufficient to meet current and future pollination demands at least in some locations and for some crops.

Similarly, 80% of plants in Europe's (semi-)natural habitats depend on insects for pollination. The maintenance of these plant communities, as well as of the wider biodiversity (that consume plants, seeds and fruits), is therefore critically dependent on the same pollinators that are currently under threat and often declining.

In other words, both wild pollinators and managed bees are needed to pollinate our crops and wild plants. Furthermore, multiple pollination options will help increase yield levels and their stability, and will help improve the resilience of the agricultural system to environmental change.

Recent research has focused on declines in wild pollinators, and losses in managed honeybee colonies. Now, a long list of potential drivers of these declines exists including pesticides, land-use intensification, habitat destruction, lack of food and nesting resources and honeybee diseases. Some studies are starting to address synergies and trade-offs between pairs of drivers, but, when and how these are important to different pollinator groups is largely unexplored. Research on measures mitigating loss of both managed and wild pollinators has traditionally been strong in Europe, but relatively little is known whether, or how, such measures, contribute to improved pollination of crops and wild plants.

European researchers are frontrunners in the field, largely resulting from strong EU funded collaborative efforts of pollinator research (FP 6 ALARM "Assessing LArge-scale Risks for biodiversity using tested Methods" and FP 7 STEP, LIBERATION), and combined efforts to improve honeybee health (FP 6 BRAVE "Bee Research and Virology in Europe", BEESHOP "BEes in Europe and Sustainable HOney Production" and FP 7 BeeDoc) and stop colony losses (COST-ACTION COLOSS). Researchers from Member States outside these projects, and from North America and BRIC countries have contributed to many of these projects, highlighting the global importance of work originating from EU researchers.

The above projects have delivered world class science on several aspects of crop pollination, such as animal pollination needs of crops and quantifying global economic benefits from crop pollination, or issues related to crop pollination delivery, such as pollinator declines and drivers of pollinator change. However, a coherent approach towards sustainable crop pollination in Europe has, until now, not been conceived. This underlines the need for the formation of a new scientific network, well-suited for COST funding, bringing together the scientific and societal communities investigating wild pollinators and managed honeybees with relevant elements from agricultural economics, agronomy, ecology, environmental sectors, policy, land use decision makers etc.

The SUPER-B network will integrate, for the first time, results and perspectives from multiple disciplines to build a robust set of evidence-based conclusions and innovative solutions for the complex challenge of safeguarding crop pollination services for sustainable agriculture in the EU (for details see sections below).

B.3 Reasons for the Action

While food security is a global challenge, it is largely addressed at both national and local levels, with agricultural practices, science-to-practice policies, information sources and even scientific research often being country-specific. This is particularly true in the area of pollination, where, for example, a Belgian researcher cannot easily access scientific information on cherry pollination in Croatia, or a Portuguese nature reserve manager lacks up-to-date information on pollination of rare plants upon which to base management actions. Furthermore, although efficient pollination depends on both managed and wild pollinators, the scientific and societal communities tackling the two pollinator groups are largely separated. This leads to very inefficient transfer of integrative knowledge and use of resources. SUPER-B would be a science and technology that would improve sharing of experience, results and information between scientists, policy-makers and the agricultural and nature conservation sectors of the European countries and beyond. This is particularly urgent as the processes affecting crop pollination are becoming globally important, e.g. spread of pests and pathogens, international trade in managed pollinators such as honeybee queens and bumblebee colonies. In addition, climate change will significantly affect the current agricultural productivity in many areas of Europe, and force drastic changes in crop species and variety, agricultural practices and conservation planning. For all these challenges, sharing of scientific, technological and practical information between countries, regions and taxa will be mutually beneficial, will speed up scientific progress by focussing new research on emerging challenges, will lead to agricultural innovations and ultimately better agricultural production and food security while conserving biodiversity. Moreover, SUPER-B will provide an excellent forum for standardization and broad validation of integrative research methods that have partly been proven successful locally, and will contribute to a common database and/or information platform for scientific and other knowledge domains including best practices for (crop) pollination.

EXPECTED RESULTS:

1) The establishment and developments of novel crop pollination management guidelines to be incorporated as a recognised agricultural input for pollinator-dependent cropping systems; this will

be based on an initial analysis of stakeholder questions and needs.
2) An assessment of current crop pollination deficits, stability and resilience in major European crop species and varieties; along with standardised field and laboratory research methods for surveying and monitoring crop pollination success and wild pollinator communities;
3) The intensified use of managed bees, particularly bumblebees *(Bombus terrestris)* and mason bees *(Osmia bicornis* and *Osmia cornuta)* as effective and safe commercial crop pollination organisms;
4) A review of methods to effectively mitigate loss of pollination service for European crops, accounting for differences in landscape, farming system and uptake of measures;
5) The quantification of the relative contribution, individually and in combination, of factors driving declines in major crop and wild flower pollinators, with a focus on pathogens, nutrition, agrochemicals and human management;
6) Improved wild pollinator conservation practice, both the measures themselves and their uptake, and policy by inter- and trans-disciplinary actions ;
7) Providing robust evidence where current and emerging pollinator-related policies are lacking support (e.g. pesticide regulations).
Thus, the Action is aimed at both European economic / societal needs and scientific / technological advance.

MEANS:
Concerted Action of (multi-)national approaches of participating countries. The Action consists of several, now largely separated, research communities, namely those on wild bees/pollinators, on managed honeybees, and on agronomy. Other stakeholder groups that will be part of the Action include farmers, beekeepers, habitat managers, policy-makers, and agri-food business (both SMEs and larger companies). Cross-fertilization between stakeholder needs and scientific actions will be achieved by creating a dialogue with all stakeholders in dedicated workshops and through science-to-policy and science-to-practice dissemination activities. The Action will be implemented through annual conferences, summer training schools, short-term scientific missions, an active web-platform and social media. In this way SUPER-B will reach its main target: to integrate knowledge and develop and disseminate methods to underpin sustainable pollination services in Europe.

B.4 Complementarity with other research programmes

SUPER-B will become the platform where on-going and planned activities in this research area will

come together and where integration of results and knowledge will lead to best practices, training and policy advice on sustainable crop pollination. The coordinators and main partners of FP 7 STEP, BEEDOC, and LIBERATION have been fundamental in formulating SUPER-B and will be central to its success. Similarly, the coordinator and key partners of COST-ACTION COLOSS, now completed, are joined in SUPER-B, integrating the honeybee research community into the network. Moreover, there are some substantial national projects (e.g. UK IPI Crop Pollination, Dutch Bij-1 project) with relevant research activities, the coordinators of which are joined in SUPER-B. Finally, a large international GEF-UNEP project is active in six tropical countries, though of these only South Africa is a COST country. The South African partners as well as the FAO coordination team are already linked to SUPER-B. Each of the above projects addresses several aspects of pollinator biology and ecology or pollination of wild plants and crops; the key theme of one project, FP7 LIBERATION (but also FP7 QUESSA), is the integration of ecosystem services (including pollination) into sustainable agriculture. SUPER-B will build on this knowledge and activities and form a network to share findings, compile, integrate and disseminate information, and will form the basis for novel science, technology, risk assessment and practice developments.
While FP 7 BEEDOC (now completed) aimed at improving honeybee health and COST-ACTION COLOSS (now completed) standardized honeybee colony loss measures and brought the honeybee research community together, SUPER-B will go a step further and address aspects of pollination service delivery by honeybees as well as promote interactions between beekeepers and farmers in need of pollination services. FP7 STEP has looked at primary crop pollinators across EU crops, analysed their main environmental threats from local to continental scales and reviewed mitigation options for pollinator loss. SUPER-B will further build on the interactive effects of managed and wild pollinators on pollination delivery and use the information gathered and generated in STEP and other projects running worldwide to generate guidelines to implement an integrative Action aimed at ensuring sustainable pollination delivery in Europe.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The main objective of the Action is to integrate knowledge and develop methods to underpin sustainable pollination services in Europe

C.2 Objectives

1) Establish pollination service as a recognised agricultural input;
2) Identify synergies and trade-offs in service delivery between wild and managed pollinators;
3) Publish standardized methods for crop pollination, pollinator use and monitoring tools for scientific and societal communities that allows for comparison of countries and cropping systems; as well as best practices for managed pollinator use, particularly bumblebees and mason bees;
4) Provide an overview of methods to effectively mitigate loss of pollination services in different European crops and (semi-)natural habitats; identify how uptake of these methods can be improved;
5) Develop a pan-European standardized survey of driver impacts, including pathogen loads in managed and wild pollinators;
6) Ensure more reliable and stable pollination service delivery for European crops and wild plants.

C.3 How networking within the Action will yield the objectives?

The Action will achieve its aims by concerting the local, national and international knowledge from research and practice in the area of sustainable pollination. Specifically SUPER-B will:
1) Exchange scientific methods and societal knowledge for pollination service provision assessment, monitoring and prediction to allow for development of national activities;
2) Organize workshops to identify the contributions of pollinator species and communities to pollination, to develop standardized survey methods for (wild) bee pathogen loads, and pollinator monitoring;
3) Share protocols, and promote collaborative and coordinated actions among all stakeholders;
4) Develop R&D links between scientists, farmers, industry, conservationists and beekeepers;
5) Disseminate results and best practices to farmers, conservationists, beekeepers, scientists, industry, policy makers and the general public across Europe and beyond.
For these purposes, SUPER-B will organise two annual conferences that are linked to larger international meetings to attract broad participation and scientific dissemination, theme-specific training schools aimed at Early-Stage Researchers (ESRs), Short-Term Scientific Missions (STSMs) and develop an Action-specific website with open access area as well as a members only area for scientific discussion and exchange, which will be the information portal of the Action.

Means needed:
Person-power:
1) Most Action members lead research groups, including researchers, students and technicians.

They will actively participate to share local and national information with the Action platform and develop national approaches aligned with relevant elements of the SUPER-B sustainable crop pollination programme (e.g. field and laboratory work, questionnaire surveys)
2) Specialist members will be responsible for conducting distinct tasks within the Action (e.g. validate methods, compile information, identify stakeholders and dissemination targets)
3) Action members will train incoming ESRs and STSM researchers.

Equipment:
1) Research equipment and fieldwork sites will be provided by each Action member,
2) Molecular and other laboratory infrastructure for disease diagnosis will be provided by Action members,
3) Technical expertise will be provided by specialist members and could include international reference laboratories for bee disease, or agronomists and economists.

C.4 Potential impact of the Action

At the highest level, SUPER-B will contribute to increased European food security and strengthen the agri-food sector of the economy by increasing its competitiveness and making it more resilient to environmental change. By providing scientific evidence for the contribution of ecosystem services to agricultural production, SUPER-B will contribute to a number of the EU's strategic objectives: (1) 'A more resource efficient economy', (2) 'A more climate-resilient, low-carbon economy' and (3) 'A leader in research and innovation'. Furthermore, in their communication 'The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future' (COM(2010) 672 final), the EC states, 'The active management of natural resources by farming is one important tool to maintain the rural landscape, to combat biodiversity loss and contributes to mitigate and to adapt to climate change. This is an essential basis for dynamic territories and long term economic viability.' SUPER-B will provide integrative knowledge for the identification of how active management of natural resources by farming can enhance ecosystem services thereby contributing to the economic viability of rural societies.
At the practitioner level, the Concerted Action will result in benefits to various groups of actors and stakeholders (farmers, beekeepers, gardeners, see also below), including:
1) Better and more reliable insect pollination service delivery for European crops and wild plants;
2) Better assessment tools for crop pollination deficits from field scale to regional scales;
3) Understanding of the current and future pollinator needs for European crops, including the role of

wild and managed pollinators;
4) Novel and standardised methods for monitoring pollinator diversity and abundance and pathogen loads;
5) Scientific underpinning of sustainable strategies for mitigating loss of crop pollination;
6) Establishment of managed bumblebees and mason bees as safe alternative crop pollinators;
7) Longer-term R&D links in the field of crop pollination;
8) Improved wild pollinator conservation.
Immediate benefits will include:1) Coordinated and joint research activities between currently disjointed research and user communities ; 2) Duplication of efforts will be avoided; 3) Sharing methods, exchanging knowledge and integrating results within and between science and society will more rapidly advance our knowledge and improve delivery success.
Future Benefits:
1) Standardized methods will make comparative research and monitoring of crop pollinators and pollination possible;
2) Major advances in wild pollinator ecology and crop pollination;
3) Fewer crop losses through pollination deficit assessment methods;
4) More stable crop yields of high quality through better pollinator and pollinator habitat and resource management;
5) Sustainable crop production through recognition of biodiversity management as a valid management tool;
6) Establishment of a centralised evidence base for national and international policy to draw upon when developing instruments across different policy areas
This Action will contribute to the global challenge of securing the provision of sufficient, safe and healthy food to the human population of each of our countries. While agricultural policies have been addressed at the European level for decades, the contribution of crop pollination to European food production, and thus the management of wild and managed pollinators, has been largely neglected and has never been addressed in joint fashion. The expected long-term benefit of sustainable pollination services will contribute to safeguarding both agro-ecosystems and natural ecosystems. Therefore, European society will benefit not only from reduced costs of food production, but also from a better functioning ecosystems and a healthier environment.

C.5 Target groups/end users

All stakeholders that rely on insect-pollinated crops must be regarded as potential target groups for

our integrative approach and dissemination or end users of the expected results of SUPER-B. Major groups among them are the farmers that grow insect-pollinated crops, beekeepers, suppliers of pollination services, and their associations, researchers in applied agronomic fields as well as ecology and nature conservation, bee breeding companies (particularly those producing bumblebee colonies, who are all largely EU-based), seed producers (particularly those of insect-pollinated seeds and those producing seed mixes for flower strip mitigation measures), agro-chemical industry, food processing and retail industry, other SMEs, and policy makers at local to European level. Members of all of these groups are involved, or have been involved in, national or European bee-related research often ran by SUPER-B members. Members of most of these stakeholder groups have been involved in discussion around the preparation of this proposal. The Action will actively involve these (and other) stakeholders in SUPER-B from the start to guarantee a trans-disciplinary approach and that most effective dissemination pathways are transferred to bring high-quality knowledge to the end users.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action is required to coordinate the multiple and integrative research tasks detailed below, which are essential to understand how sustainable pollination service delivery by insects can move forward. As a result of declines in wild pollinators and managed honeybees across Europe, insect-pollinated crop production is under pressure and a better understanding of the extent of this problem and identification of the critical conditions for a more sustainable production of these crops is urgently needed. Declines of pollinators will also lead to lower reproductive success of 80% of wild plants, which in turn will have cascading effects through the entire food web and thus will have consequences for all components of biodiversity. Finally, healthy plant communities will help to maintain healthy pollinator communities, which in turn provide crop and wild plant pollination. Therefore, the impact of pollinator declines and pollination loss on wild plant communities will be an additional focus.

1. It is necessary to **understand how delivery of insect pollination services benefits different sectors of society**, and develop ways to better integrate pollination into farm, green space and land management. SUPER-B aims at including members of all COST countries to achieve a wide, comprehensive, European overview of pollinator-derived services.
2. Next, it is necessary to **know which pollinator taxa and species provide the services under which conditions** (e.g. for which crops and wild plants, and where in Europe) and how delivery of

these services can be improved. Super-B will develop standards for measuring populations and communities of target pollinating taxa and pollination services and will bring researchers, farmers, industry and policy-makers together to identify best practices for crop pollination management as well as knowledge gaps.

3. To design the path towards sustainable delivery of pollination services to crops (and wild plants), SUPER-B will compile existing and on-going studies to **review evidence of measures to mitigate pollination loss**. Such measures include, for example, promotion of managed bees (e.g. bumblebees, mason bees) for pollination, create pollinator habitats and resources, optimize the availability of managed honeybees for crop pollination.

4. Guaranteeing healthy pollinator populations for the future critically depends on **understanding the main drivers of change for wild pollinator communities and managed pollinators (e.g. honeybees, bumblebees, mason bees)**. SUPER-B will standardize monitoring protocols and compare laboratory and field assays for measurement of pollinators and drivers. Given that relative importance of drivers may vary locally and nationally, SUPER-B aims at involving members of all COST-Action countries and of all major communities (research, farming, agriculture, industry) to create a European overview and to increase our understanding of the context-dependency of main drivers of pollinator loss.

D.2 Scientific work plan methods and means

The research is organized in four separate Working Groups (WGs) each dealing with specific themes contributing to the main research tasks.

WG1: Benefits of pollination services

Working hypotheses:

1. Crop pollination is an important agricultural input which can add value to production

2. Wider benefits of pollinators and pollination as ecosystem service (providers) are poorly understood and undervalued

Tasks:

1. **Establish crop pollination as an agricultural input.** This task will bring together leading

agronomists, economists, beekeepers, biologists, ecologists, political advisors and social scientists from academia, industry and NGOs from non-academia to: (a) Quantify the relative contributions of insect pollination to crop production in a range of arable and fruit crops; (b) Understand the barriers and incentives to farmers embedding pollination into standard agricultural practices; (c) Develop key messages and case studies to underpin multi-media materials to enable pollination to be taken into account in European agriculture decision making.

2. **Establish the wider benefits of pollinators and pollination for ecosystem service provision**. Bees, butterflies, other insect pollinators, and flowers are valued by many individuals in their own right, and also for their contribution to green spaces in urban areas and the wider countryside. However, it is erroneously assumed that pollination services, which ensure the maintenance of biodiversity, are a free service that can be relied upon at all times. This task will review the evidence for the aesthetic, recreational and cultural values derived from pollinators and pollination services and explore ways to integrate pollination into the activities of land managers, conservationists, policy advisors, industry, planners and the general public.

Means:

In a series of workshops the above mentioned tasks will be addressed. Specifically the Action will:

1. Review and synthesise the latest evidence (e.g. FP7 LIBERATION and STEP projects), including outputs of SUPER-B WG2, on the benefits to agriculture of pollination in terms of crop yield, quality, stability and resilience; current research gaps will be identified.
2. Develop a set of evidence-supported recommendations for different stakeholder groups on how pollination can be integrated into their activities and how knowledge providers and knowledge users can build partnerships to achieve this (this will be a basis for the Action's Dissemination Plan).
3. Draw on leading expertise in economics, biodiversity conservation, psychology and landscape ecology to synthesise current knowledge and develop review paper(s) on the current understanding of the wider benefits of pollinators and pollination services to society. A workshop for specific stakeholders will examine the importance of pollination services for their activities and help map opportunities where known benefits exist, but these have not been fully recognised. Our target groups will be conservationists, (both GO and NGO), planners and land managers, and industry (e.g. tourism, agri-food). Similarly, local and national policy advisors will be brought together to discuss the potential benefits of specifically including pollinator and pollination services in policy areas including transport (e.g. rail and road verges), energy (biofuel crops), education (e.g. ways of introducing pollination into curricula), and rural and urban development (e.g. green infrastructure planning). This activity will also identify the key research and policy gaps around pollinator

biodiversity and wider environmental benefits.

WG 2. Pollination service delivery

Working hypotheses:

1. The identity of the main crop pollinator species varies greatly with crop, location and through time
2. The optimal placement, diversity and management of pollinators varies with crop, location and through time
3. Diversity of pollinators ensures stability of pollination service delivery
4. Pollination service delivery is affected by inter-specific interactions among wild and managed pollinators, as well as by shared diseases

Tasks:

1. Assess variability of main pollinators across different crops and regions. To maximize benefits of agricultural practices to enhance pollination service delivery, it is essential to identify what are the most effective species for pollinating main crops across several countries and to identify at what time of the season and day they are active. SUPER-B will bring together inventories of most important pollinators (managed and wild) for a vast number of major global crops and evaluate variability of the assemblage of important pollinators among such crops and through space and time.

2. Compile information on pollinator management practices. Optimal placement, density and location of managed pollinator species might vary across landscapes and crop systems. The Action will compile a list of management practices related to honeybee, bumblebee and *Osmia* spp. within farmland and relate that with the identity and geographical location of farms. This information will help to define practices that may optimize service delivery for specific crops. In addition, SUPER-B will review current protocols and identify best practices of honeybee management for crop pollination services.

3. Synthesize available evidence on the importance of pollinator diversity across crops and regions. Diversity of pollinators can play an important role on pollination delivery. SUPER-B will bring together all available evidence on the importance of pollinator diversity and describe the mechanisms beyond the pollinator diversity- pollination services relationship across crops and regions, and link such information with detailed information on crop and pollinator species traits. The outcome will be one of the inputs for WG1 workshops.

4. Identification of synergies and trade-offs in service delivery between wild and managed

pollinators. Wild and managed pollinators may interact when foraging on crops, potentially affecting each other's efficiency. Also high density of managed bees within crops may create an optimal medium for disease (of bee or crop) dispersal, potentially reducing pollination benefits from insects. SUPER-B will compile and review information on common threats and diseases transferred by managed and wild pollinators, as well as information of the effects of intra and inter-specific interactions between wild and managed pollinators.

Work plan:

1. Crop pollination studies from around the world will be identified based on existent literature and on-going meta-analyses projects (e.g. FAO-PIMS "Pollinator Information Management System", STEP, LIBERATION), and a list of species that make up the majority of pollination will be compiled. The Action will then estimate the total number of species needed to guarantee high levels of crop pollination through space and time.
2. A standardised monitoring protocol for best pollinator management practices will be established, based on information collected in the Action's workshops that involve the participation of beekeepers (focused on honey production or on crop pollination) and farmers.
3. A review of the importance of pollinator (functional) diversity across crops and regions, as well as on synergies and trade-offs in service delivery between wild and managed pollinators will be performed based on information gathered by the Action network from literature, in workshops and in conferences.

WG3 Mitigating pollination loss

Working hypotheses:

1. Measures mitigating pollinator loss will alleviate pollination loss.
2. Uptake rather than availability of measures limits effective mitigation of pollination loss.
3. Pollination mitigation strategies benefit from synergies between honey bees and wild bees.

Tasks:

1. Linking pollinator mitigation to pollination mitigation. Having healthy pollinator populations is essential for the provision of pollination services. In Europe, initiatives such as agri-environment schemes (e.g. flower strips, set-aside land) or bee ribbons (http://deventer.transitiontowns.nl/?py44) abound that aim to enhance honey bee health or revive depauperate wild pollinator communities. Yet very little is known about the impact of these initiatives on the provision of pollination services. If stakeholders aim to effectively safeguard the pollination services provided by honeybees, other

managed pollinators and wild pollinators, they need to know how measures aimed at promoting their abundance translate into the actual pollination services provided to crops.

2. Uptake *vs* availability of measures as the key to effective mitigation of pollination loss.

Recent reviews suggest that a range of effective instruments to mitigate pollination loss exist. Other studies suggest pollination deficits in many European countries. These findings suggest that uptake of measures is the main factor limiting mitigation loss. The Action aims to figure out (a) how honey bee deployment for crop pollination is affected by pollination fees, honey producing potential of crops, travel distance for beekeepers, and perceived threats to pesticide exposure and other social factors; and (b) how adoption of (sometimes) costly measures to promote wild pollinators depends on crop revenues and the quality of the surrounding landscape.

3. Mitigation measure synergies between managed and wild pollinators

Complementary service delivery by wild and managed bees seems to occur as the two groups have different preferences for crops, flight temperatures and forage locations (see task 4 in WG 2). However, in general it is not known whether the two groups of pollinators benefit from similar mitigation measures, such as habitat creation and flower strips.

Work plan:

1. Recently a number of studies have begun addressing how measures mitigating pollinator loss (such as establishing wildflower strips) affect crop pollination. The Action will bring together the (preliminary) results of these studies and explore common factors driving their success. For honey bees in particular, the effectiveness of measures improving bee health for enhancement of crop pollination services will be explored.
2. Existing reviews of measures mitigating pollination loss will be expanded and the Super-B network will be used to explore which measures are available in various parts across Europe and which measures are actually implemented. In particular, the relative importance of issues of money (e.g. pollination fee, establishment costs of flower strips), honey (honey producing potential of crops), or health (e.g. colony boosting capacity of crops, perceived threats of insecticide exposure) for the willingness of beekeepers to provide their honey bees for pollination services or the willingness of farmers to implement other mitigation measures on their farms will be examined. A better understanding of why people keep bees is important to identify when and how beekeepers can become pollination service deliverers.
3. The results of completed and on-going studies linking both wild and managed bee populations to landscape and habitat mitigation measures will be reviewed. Complementarity and possible interactions concerning whether and how different species benefit from measures such as habitat

and resource creation and flower strips, will be assessed and related to a range of environmental conditions likely to affect the bees and their pollination potential (e.g. temperature, neighbouring crop identity, quality of the landscape as forage and nesting habitat).

WG 4. Exchanging approaches between wild bee and managed bee studies to explore drivers of pollinator decline.

Working hypotheses:

1. Wild bee and managed bee populations differ in their dependencies on environmental conditions such as resource availability (e.g. forage, nesting sites), climate, pathogens, landscape structure, agrochemicals and human management
2. The impacts of major drivers of bee declines interact for both managed and wild bees

Tasks:

1. Determine whether managed and wild bee populations respond differentially to drivers, such as resource availability, climate, shared pathogens, landscape structure, agrochemicals and human management. Explore how scaling approaches, from individuals to populations, can inform our understanding of declines. This will show whether and to what extent managed bees can be used as an indicator for declines in wild bee populations, and vice versa.

2. Determine whether the major drivers identified in Task 1 act differentially across European climatic zones. Such information is key for effective context-dependent sub-regional management of both wild and managed bees.

3. Develop a modelling approach to predict how changes in major drivers and their interactions will impact wild and managed bee populations and the service provision of pollination. Predictions will enable appropriate planning to minimise negative impacts on pollinator populations and potentially manage their long-term stability and resilience.

Work plan:

1. Proxies for health in wild bee populations, such as body size, and standardized monitoring techniques, building on the ALARM and STEP EU-Framework Programmes, will be developed. Protocols for detecting pathogens in honey bees will be translated for standardised use in wild bees. Cost-effective methods for the qualitative and quantitative detection of agrochemicals, particularly neonicotinoids, in wild and managed bees will be produced. New mechanisms for detecting stress in wild and honey bees (e.g., stress physiology) will be explored. Methods and protocols for quantifying management of habitats (land abandonment vs. intensification) and honey bees (urban

honey bees, increases vs. declines in numbers of managed hives and beekeepers) will be explored. These topics will be addressed in workshops and dedicated STSMs.
2. These proxies and methods will be used, together with standardised measures of honey bee health and decline, to examine, across the European climatic range, impacts of nutritional resources (i.e., resource-rich vs. resource-poor sites), pathogens, agrochemicals and human management on bee health. These data will indicate whether honey bees can be used as indicators for wild bee population health. They will also inform the extrapolation of current honey bee models to wild bee populations, utilising scaling approaches to incorporate data from individuals through to populations, enabling the prediction of how future changes in drivers will impact wild and honey bee populations.

E. ORGANISATION

E.1 Coordination and organisation

Super-B will be organized using the standard features common to all COST Actions. The Management Committee (MC) will consist of maximum two nominated members from each country that has joined the Action by accepting the Memorandum of Understanding (MoU). The MC will elect an Action Chair and Vice Chair, and be the decision-making body of the Action. To promote smooth operations within the Action, the organization of Super-B will also include an Executive Committee (EC**)**, consisting of two elected members of the MC per WG, i.e. WG Coordinators, two Dissemination coordinators (responsible for Action publications, website, email list, and other dissemination tools), as well as the Action Chair and Vice-Chair (12 people in total). This core group will further nominate appropriate Action members to advice the EC members on specific aspects of the daily running of the Action. These may include:

- **Financial Coordinator –** responsible for COST reimbursement to Action members, and other financial matters.
- **Membership Coordinator(s) –**responsible for membership requests
- **Conference Coordinator(s)**
- **Meeting and Workshop Coordinator(s)**
- **Short-term Scientific Mission STSM Coordinator(s)**
- **Training School Coordinator(s)**

- **Early Stage Researcher (ESR) / gender equality adviser(s)**, including one Early Stage Researcher

The EC will ensure that the various COST Networking Tools are efficiently used by Super-B, and to act as direct points of contact for local organizers hosting Action events to ensure proper COST rules are followed (e.g. event scientific reports, reimbursements, etc.), thereby assuring Action success. Additional coordinators will be appointed from the MC to oversee further specific aspects of the network in case the need will arise.

Milestones

Several milestones throughout the Action period will regularly evaluate and promote the activities of Super-B. Publication milestones will be Open Access, wherever possible, posted on the Super-B website, plus communicated to Action members via the email list and to other interested stakeholders via social media.

- **Super-B website** will be constructed and will form the platform for internal network communication as well as dissemination of the Action's results to other stakeholders and the wider community.

- **Kick-off conference and MC meeting** – this event will stimulate the start of the Action's efforts by bringing together members to discuss and coordinate practical issues to realising the objectives of Super-B. Nominations/elections of EC members will take place at this event.

- **Annual conference and MC meetings**, including proceedings and minutes – hosted in conjunction with a major stakeholder event (e.g. EurBee or Apimondia conferences), will summarize the previous year's Action outcomes as well as discuss and coordinate the future year's endeavours. In addition, during the Action's meetings, members undertaking Short-Term Scientific Missions will also present their work. Because Early-Stage Researchers are heavily favoured participants of Short-term Scientific Missions, this will provide invaluable experience to individuals seeking to develop their scientific skills.

- **Annual COST monitoring progress reports** – using a standard COST template, these reports will detail scientific outcomes, events, and finances, of Super-B to COST, to

ensure that objectives are met in a timely fashion and that proper COST rules are followed.

- **Annual COST Action factsheets** – using a standard COST template, these factsheets will highlight major advances to the general public.

- **Annual Super-B 'Year in Review'** – these reviews will concisely summarize the Annual COST monitoring progress reports for Super-B members and other interested stakeholders.

- **Quarterly Super-B updates** – these updates, published every 4 months, will dynamically summarize Super-B efforts for both members and non-members. For example, past and on-going workshops, Short-Term Scientific Missions, and training schools will be highlighted, including photos of activities. Announcement for upcoming Action events will also be provided.

- **Super-B COST Event proceedings** (e.g. Workshops and Meetings, STSMs, Training Schools) – for each event, a proceedings will be compiled that includes a detailed schedule, abstracts of attendees, and summary of major outcomes. For conferences, meetings, and workshops, attendees seeking financial support will be required to submit an abstract summarizing their anticipated contribution to the event. This will ensure that stakeholders not present will be fully informed.

- **Others specific deliverables to be determined based on stakeholder needs and funding -** e.g. A compilation of methods papers on managing bumblebees or mason bees for pollination, pocket guides for rapid identification of pollinators or pollinator groups visiting specific crops or wild flowers.

E.2 Working Groups

Super-B will consist of four Working Groups:

1. Benefits of pollination services,

2. Pollination service delivery,

3. Mitigating pollination loss,

4. Drivers of loss.

Each Working Group (WG) will be led by two coordinators (see above) to ensure that specific scientific objectives and issues of the WG, as well as general objectives of the Action, are fulfilled. Coordinators for each WG will regularly liaise to ensure proper communication among working groups, which will be essential for SUPER-B success. Furthermore, coordinators will act as communication channels between the EC and Action members. Members of Super-B may belong to one or more WG, depending on the scientific interests and needs of the individual Action member, and each WG reserves the right to form sub- WG to meet a specific objective.

E.3 Liaison and interaction with other research programmes

Some Super-Bees will belong to or have been part of the FP 7 Consortia STEP, LIBERATION and BEEDOC, as well as the honey bee network COLOSS. This ensures a tight link with specific EU efforts to promote pollinators and pollination through research and networking, and ensures that a complementary approach is fostered to avoid redundancies in efforts. Super-B members are also coordinating or are tightly connected to other international efforts (e.g. the UK Insect Pollinator Initiative, Canadian Pollinator Initiative (CANPOLIN), BIP (Bee Informed Partnership) USA, the GEF-UNEP-FAO International Pollinator Initiative, Apimondia the world federation of beekeeping organizations, International Commission for Plant-Pollinator Research) to promote a concerted, global approach for sustainable pollination services.

E.4 Gender balance and involvement of Early-Stage Researchers

Super-B will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. Additionally, the Action will be committed to considerably involve ESRs. This will first be achieved by individual Action members, who must not discriminate against gender and career stage. Appointment of members to the EC will strongly consider gender and career stage to ensure these issues remain at the forefront. In particular, at least one individual of the EC, a Membership Coordinator, will be an ESR to ensure that interests of this valued group are always considered. If a gender imbalance becomes apparent, particularly in the EC/MC, Super-B will preferentially recruit members of the minority gender if they are better or equally qualified than their counterparts. Furthermore, because Super-B strives for capacity building in Europe to ensure sustainable pollination for the future by building a solid research foundation, the Action will preferentially finance ESRs at events, and actively promote

their participation in Short-Term Scientific Missions and Training Schools where they can develop their skills and where knowledge transfer from experienced researchers can occur.

F. TIMETABLE

The Action will take place for a period of four years.

Year 1	Development of the website, which will be maintained for the 4 years
Year 1	Initial stakeholder workshop to identify their main questions
Year 3	Policy stakeholder workshop
Year 1-4	Annual MC meeting at which last year's WG programs and dissemination activities will be reviewed and those of the coming year will be planned and discussed.
Year 1-4	At least one workshop and one training activity will be organized per WG each year
Continuous	STSMs and small scale meetings of research groups will be conducted ad hoc
Continuous	Communication between EC and SUPER-B members on activities, plans and dissemination activities

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BA, BE, BG, CH, DE, DK, EE, EL, ES, FR, HR, IE, IL, IT, LT, NL, NO, PL, PT, RO, RS, SE, SI, SK, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 108 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The main stakeholder groups that will be dissemination targets of SUPER-B (but some will also be involved in developing the research program and determine the dissemination tools to be used for effective dissemination and outreach) are:

1- Agronomists and farmers (one National farmers Union has already shown serious interest in SUPER-B)
2- Beekeepers and beekeeping organizations (several SUPER-B prospective members are part of beekeeping organizations, the SUPER-B chair is the president of APIMONDIA, the world federation of beekeeping organizations, making entry points easier).
3- Agro-food industry, food processing and retail industry including supermarkets.
4- EU agencies in food, agriculture and biodiversity areas (e.g., European Food Safety Agency, European Environment Agency, European Crop Protection Agency, Joint Research Centre). The EU-MAES working group on mapping and assessing ecosystem services seems a very relevant stakeholder that SUPER-B can liaise with concerning details on crop pollination services for EU crops.
5- Policy-makers at national, European levels and international levels (e.g. the EU DGs ENV, RTD, AGRI and REGIO, FAO, UNEP, CBD)
6- NGOs in biodiversity, nature conservation and agricultural domains (e.g. IUCN)
7- Organisations running citizen science or awareness raising projects involving pollinators
8- General public
9- SUPER-B research partners and their teams
10- Other scientific researchers from multiple disciplines

H.2 What?

I. Construct the SUPER-B **website** as the main communication and dissemination platform (all stakeholder groups)

II Create a **members-only website section** for SUPER-B communication and information sharing

III. **Outreach training for SUPER-B scientists** on how to communicate science to the public. This will dramatically increase the impact of SUPER-B science on societal stakeholders.

IV. Define main objectives and methods of SUPER-B dissemination activities in a **joint research-stakeholder agenda-setting workshop** at the end of year 1 of SUPER-B (all stakeholders)

V. **Workshop to identify policy opportunities** for pollinator and pollination management and communicate policy relevant outcomes from SUPER-B (stakeholders 4-6). Opportunities will be identified on the basis of fit to policy and timing of the policy cycle. For example, the recently published Green Infrastructure Strategy offers opportunities to link new knowledge on pollinators

and pollination with other policy areas such as nature conservation, transport and energy.

VI. Publish **guidance documents** (downloadable from website) for standard approaches to managing pollination and pollinators, including monitoring methods (stakeholders 1-4, 6-8)

VII. **Develop a partnership between professionals and farmers, beekeepers and relevant businesses** across Europe (stakeholders 1-4,6) as a route for trusted advice on pollinators and pollination management. Starting from a list of relevant organizations, SUPER-B country members will link-up to these organizations to enhance knowledge exchange for developing sustainable crop pollination practices. An international workshop will bring key international organizations and researchers together to set a dissemination agenda and identify entry-points for optimal communication effectiveness.

VIII. **Publish scientific results**, preferably in special issues of relevant scientific journals.

IX. **Raise awareness about the science of pollination** among scientists (stakeholders 9-10; e.g. through conference presentations), among stakeholders (stakeholders 1-7; e.g. through presentations at farmers and beekeepers days) and the general public (stakeholder 8; e.g. through popular talks and articles) in all countries supporting the SUPER-B Action.

H.3 How?

Super-B members will need to lead all actions mentioned under H2. A dedicated, professional dissemination partner will lead all dissemination activities. For some activities SUPER-B can build on dissemination activities and networks built by other projects (e.g. FP7 STEP, LIBERATION, COST Action COLOSS).

The Dissemination Coordinator(s) will annually present a dissemination plan to the SUPER-B Executive Committee, and this will be brought to the Management Committee meeting for discussion and approval.

SUPER-B will use for its dissemination several well-established networks, notably APIMONDIA, the world federation of beekeeping organizations for which the main applicant is the president of the commission for pollination and bee flora; EURBEE, that holds bi-annual meetings; the International Pollinator Initiative managed by FAO and ICPPR, the international Committee for Plant-Pollinator Research which holds bi-annual meetings as well [for more detail on SUPER-B dissemination see part II].