Final report

for the CORE Organic Plus funded project

"Innovative design and management to boost functional biodiversity of organic orchards *EcoOrchard*"

Period covered: 1 January 2015- 31 May 2018

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1. Consortium

Project acronym:	EcoOrchard	**Project ID:**	314
Project title:	Innovative design and management to boost functional biodiversity of organic orchards		
Project website:	https://plen.ku.dk/english/research/organismal_biology/applied_entomology/ecoorchard/		
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Start of project	1 Jan 2015	End date of project:	31 Dec 2017
Duration in months:	**41**	New end date in case of a project extension:	31 May 2018

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[2)] PC = Project coordinator, WPL = Work package leader, WPCL = Work package co-leader, P = Participant

2. Summary

2.1 Post-term project summary suitable for web publication

Orchards are perennial cultures, and especially in organic fruit production it is essential to design and manage orchards in a way which favours predators and parasitoids over pests. Increasing plant biodiversity and habitats in such a way that beneficials are favoured is called Functional (Agro-)Biodiversity (FAB). The value of FAB for reducing pesticide use in fruit production is generally acknowledged, and many organic fruit growers try to increase it in spite of a shortage of information on FAB, economical and technical challenges and lack of situation-specific, detailed advice. To improve this situation, ECOORCHARD combined several complementary and goal oriented approaches: i) identifying and compiling still "unknown" methods already implemented by fruit growers to increase FAB in EU countries; (ii) elaborating suitable methods for collaborative application to monitor FAB on-farm and in scientific trials; (iii) conducting collaborative scientific trials with focus on the quantification of the effect of a new approach to install FAB-boosting flower strips in the inter rows and (iv) learning from each other and dissemination.

Knowledge and experience on FAB management from practitioners were collected by interviews of farmers and advisors and led to a description of 24 different FAB techniques, old and new, falling under different strategies including long-term ecological infrastructures, dynamic practices and to a lesser extent redesign techniques. Country differences were significant, but ecological infrastructures were the most implemented. On average farmers combined more than 4 techniques since 13 years, and emphasized a global approach to FAB expecting multiple Ecosystem Services beyond pest regulation (economic, environmental, agronomic and working conditions), reflecting also a need for more information about FAB. The European Biodiversity Orchard-Network at http://ebionetwork.julius-kuehn.de/ now includes 200 priority papers, reports and presentations on FAB, supplemented by material provided and developed by partners, and will be continued. A review of existing FAB research on creating floral resources for beneficials in apple orchards showed relatively few studies, of which cover crops and flower strips were most studied, while agroforestry methods were at the outset and only few studies before EcoOrchard included fruit damage and yield.

Methods for farmers and advisors own assessment of FAB services in orchards were selected based on performance criteria (time, materials and skill needed, information provided), and demonstrated in workshops/ on farm and a by a practical handbook on FAB assessment (available in 6 languages via EBIO-Network. In 2016 and 2017, 40 and 50 farmers tested at least one method each. The handbook was improved by experiences collected, and proved a valuable tool in communicating FAB to growers and advisors. Workshops, instructions and on farm demonstrations of methods, were appreciated and we experienced much interest to learn more about the biology and life cycle of the beneficials, important to make optimal use of them.

Two different flower mixtures fulfilling FAB criteria of mainly wild types were tested in seven countries. A complex mixture of 30 perennial herb species and 8 grass species and a simple mixture with ca half the number of species. Two types of field trials were set up considering botanical or entomological/botanical aspects of these two flower strips, testing both mixtures on the level of botanical aspects. We used shared field protocols and guidelines enabling analysis in a pan-European context, providing more valuable data than could be provided by single partners, and analysed the impact on natural pest control in relation to botanical resources (with and without flower strips). Flower strips significantly increased plant diversity in orchards, and increased the presence of natural enemies in the apple trees. This led to a higher control of key apple pests and a reduction in fruit damage. Although pest suppression and damage reduction may not be enough to use this conservation biological control strategy as a stand-alone practise, flower strips can contribute to a build-up of the resilience of the apple agroecosystem against pests, reducing the need for insecticide use and favouring conservation biocontrol.

We succeeded to adapt monitoring methods and practices for FAB orchard management to end-users needs and constraints, with the active participation of stakeholders and to disseminate project results within a strong, collaborative stakeholder network created in the project. Workshops in France, Sweden and Denmark were used for exchange of FAB perception and practices and disseminated results, while demonstrations or field visits were organised to widen the dissemination in partner countries.

Results and materials of the EcoOrchard project such as multilingual versions of the handbook in FAB assessment and FAB management are in the EBIO-Network, organic e-prints or the project homepage. Further five scientific manuscripts are in process.

2.2 Short process update of the whole project

The EcoOrchard project has achieved its objectives. Due to delayed start in some countries and intensive activities during field seasons 2015-2017 including establishing and conducting joint protocols, the review process of literature data was postponed to 2017. The joint protocols and shared guidelines mean that the project has achieved findings across partner countries, providing results not achievable by any individual partner. Two manuscripts are already submitted, while the review and another manuscript are under revision by EcoOrchard partners. The project has been sufficiently flexible to utilize opportunities as the option to arrange a workshop during the EcoFruit conference, which provided a great opportunity for shared feedbacks from stakeholders and potential future EBIO-Network participants. Concerning Milestone 2.3, as selection of methods were done in 2015 by three partners, and farmer and advisor participation was mostly done in 2016, with test and trial of FAB methods proposed, and we continued farmer and advisor validation of methods in 2017 according to stakeholder interest and perspectives of the tool. The field trials were conducted according to the original plan with establishment in 2015, although this was rather a challenge due to delayed funding in some of the partner countries. Consensus was made regarding protocols, conduction and evaluation of the field trials leading to high quality data set which is intended to be published in reputed journals. Additional efforts were made with writing two technical leaflets/booklets for advisors and farmers on FAB assessment and on FAB management in orchards, respectively, available in several different languages.

3. Main results, discussion, conclusions and fulfilment of objectives

3.1 WP0

WP0	**Project management**
WP leader: Lene Sigsgaard **Responsible partners**: UCPH (4 PM), FiBL (1 PM), JKI (0.5 PM), GRAB (1 PM), INRA (1 PM)	
Overall summary of main results, discussion and conclusions of WP1 The consortium agreement was completed with the assistance of the legal office of UCPH and participating institutions in the initial phase of the project. The midterm report was submitted according to schedule (report for first 18 months). The committee have had telephone/skype meetings every third month organized by UCPH. Work package leaders and co-leaders participated in these management meetings. The WP leaders have remained the same during the whole project, which has meant a lot for the continuity of the project, only the co-lead of WP4 was changed in late 2016, due to a change of position, but remained with SLU. The first annual meeting in Poland 23-25 November 2015 was arranged by Inhort and all partners were present. In addition, 2 visitors attended from the Crop Research Institute, Czech republic. The second annual meeting was 21-23 November 2016, hosted by JKI, Darmstadt. The final annual meeting was hosted by INRA/GRAB in Avignon from 20-22 November 2017. We held an open stakeholder workshop 22 November 2017, where interested stakeholders participated and included presentations of the project (translator aided) as well as presentations of stakeholder experiences from France and Sweden and following exchanges of questions and experiences. Exchanges among workshop participants about orchard design and redesign continued with a newly developed board game developed by INRA as part of the EcoOrchard project (Penvern, Chieze, Simon, 2018 at 13th European IFSA Symposium, 1-5 July 2018,	

Chania (Greece) link.

The project homepage was established in 2015, it was updated in 2016/17 and again May 2018 (https://plen.ku.dk/english/research/organismal_biology/applied_entomology/ecoorchard/).

WP0 (Lene Sigsgaard) participated in CORE Organic Research seminar in Bucharest, Bulgaria, 18 October 2016, presenting the EcoOrchard project and contributing to exchanges, and will also participate in CORE Organic final research seminar in Paris 9 October 2018.

A no-cost five month project extension period was applied for and granted due to four reasons: a) extensive field trials in wp3 ending only Oct 2017, b) collection of growers feedback in WP2 ending late 2017, c) maternity leave in two project partner teams (UCPH postdoc & INRA staff) affecting WP2 and 3, resp. WP1 and 4, d) a 4-mo delayed start of the JKI part of the project, delaying the PhD study, the literature review and the EBIO-network.

Within the new extended project period, project milestones and deliverables have been met. The review process of literature data was postponed to 2017. A draft review manuscript is under revision by EcoOrchard partners. The Ecofruit Workshop was not programmed initially, but was an additional activity, and gave the opportunity to have feedbacks from stakeholders and potential future EBIO-Network participants.

Report on the results obtained (A), and fulfilment of objectives (B)

A- results obtained: The consortium agreement was completed by month 3 with the assistance of the legal office of UCPH and participating institutions in the initial phase of the project.
The committee have had telephone/skype meetings every third month organized by UCPH. Work package leaders and co-leaders participate in these management meetings. Technical and legal challenges with skype, which is not permitted for use at the workplace in some countries (CH, D and F) has made us move to telephone meetings which have turned out to work very well and are also better able to handle more participants. Agenda and later minutes of committee meetings are made by the coordinator and sent to all partners as well as our CORE Organic monitoring person (Lieve De Cock) and also uploaded to our shared OneDrive folder.
The first annual meeting was arranged by Inhort and held in Poland 23-25 November 2015, all partners were present. In addition, Vladan Falta and Katarina Kovarikova, Dep.of Entomology, Crop Research Institute, Prague, Czech republic, participated as visitors.
The second annual meeting was hosted by JKI, Darmstadt 21-23 November 2016. All partners participated and in addition also from Univ. Prague, Katarina Kovariko
The final meeting was hosted by INRA and GRAB and held in Avignon 20-23 November 2017. On 23 November, we held an open workshop where interested stakeholders participated.

The UCPH project homepage was established shortly after the project start and has been updated last in May 2018: https://plen.ku.dk/english/research/organismal_biology/applied_entomology/ecoorchard/ .
The CORE Organic Plus webpage is: http://projects.au.dk/coreorganicplus/research-projects/ecoorchard/.

A no-cost five month project extension period was applied for and granted due to four reasons: a) extensive field trials in wp3 ending only Oct 2017, b) collection of growers feedback in WP2 ending late 2017 (as we decided to repeat farmers test of the revised FAB Handbook, c) maternity leave in two project partner teams (UCPH postdoc & INRA staff) affecting WP2 and 3, resp. WP1 and 4, d) a 4-mo delayed start of the JKI part of the project, delaying the PhD study, the literature review and the EBionetwork.

Within the new extended project period, project milestones and deliverables have been met. The review process of literature data was postponed to 2017. A draft review manuscript is under revision (summer

2018). The Ecofruit Workshop was not programmed initially, but is an additional activity. It was for us the opportunity to have feedbacks from stakeholders and potential future EBIO-Network participants.

B - fulfilment of objectives:
Objectives for the WP0 were met. The involvement and enthusiasm within the project team means that most partners have invested more time in the project than was budgeted, but there has also been very good synergies with the partner teams work and the ambitious objectives of the project. The development and use of joint protocols and guidelines required time and focus of the committee but was well invested.

3.2 WP1

WP1	**Tracking innovative and efficient practices and systems to improve on-farm management of functional biodiversity**

WP leader: JKI, INRA (initiating of data collection, data analysis)
Responsible partners: JKI, INRA, SLU, FIBL, GRAB, CRA-W, Inhort, Laimburg, UCPH, LPPRC (input of data, data analysis)

Overall summary of main results, discussion and conclusions of WP1

- A common questionnaire was developed, translated into each country language and performed by phone or face-to-face. In total, 55 advisors and 125 orchards managers mostly but not exclusively (85%) in organic farming with at least 50% of their orchard dedicated to apple trees and with various degree of experience and conviction about Functional Agrobiodiversty (FAB) in nine European countries were interviewed (i) to describe farmers' practices, (ii) to better understand their expectations towards FAB and (iii) to identify potential drivers of (non-) adoption. 24 FAB-techniques were described including local adaptations, from very popular and old-established ones (e.g. hedges and bird houses) to more marginal and recent ones (e.g. animal introduction and compost). These techniques fell under different strategies including long-term ecological infrastructures, dynamic practices and to a lesser extent redesign techniques. Ecological infrastructures were the most implemented ones ('Hedgerows' and 'bird or bat houses' were mentioned by approximately 50% of the farmers interviewed). Dynamic agricultural practices were less commonly associated to FAB and were implemented in a multifunctional approach. Deeper system redesign techniques are marginal and only implemented by "holistic farmers". On average, farmers combine more than 4 techniques implemented since 13 years (+/- 10 years) mostly during farmers' set up period (31%) or conversion period (45%). Farmers have difficulties to estimate the effectiveness of the FAB-techniques on pest regulation. In fact, they considered FAB-techniques as a whole and argued that assessment should consider not one specific FAB-technique but their combination. They also emphasized a very global approach targeting multiple species, including wild and cultivated biodiversity, and expecting multiple ecosystem services beyond pest regulation. Other considerations were economic, environmental, agronomic, working conditions (operational and well-being), and technical. A publication on the results is in preparation and selected output will be available at EBIO-Network portal.
- Results were presented and discussed with the scientific community in a workshop during the EcoFruit conference in 2016. The aim was to assess how Ecofruit participants, mostly advisors and researchers, may complete the empirical information we collected from the survey with more scientific and generic information. This workshop thus provided useful information for the EBIO-Network, on which FAB-techniques we need or should communicate on and how. It was also an original way to communicate on our projects, findings, and get participants feedbacks.
- Literature collection from all partners resulted in 200 priority papers, reports and presentations on functional agro-biodiversity. These references are available on the EBIO-Network portal. A

systematic review of scientific literature targeting research on particular strategies to create floral resources for biological control in pome fruit orchards resulted in 78 published studies during the time period 1987 – 2018. Thereafter, cover crops and flower strips were the most experimented measures, whereas studies on agroforestry concepts are still in the beginning. In general, only very few studies included effects of the various methods on fruit damage and yield at the end. This means that the results of the EcoOrchard field trials are quite unique and of high importance for further successful implementation of perennial flower strips as tool for boosting functional biodiversity. A publication on the results of the literature review is in preparation.

- The EBIO-Network portal (European Biodiversity Orchard-Network) is available at http://ebionetwork.julius-kuehn.de/. The current content has been supplemented by material provided and developed by partners during the project period (WP1, WP2, WP3) and will be continued also after the project. The publishing of stakeholders' data on the website is not feasible anymore since the General Data Protection Regulation came into force. But people can still register and will be connected to the Network. Communication on new contents of the website will be done via email. One constraint of the use of the website is the English language, which is not attractive to all stakeholders. Nevertheless, we think the EBIO-network is a good tool to bring results from European research on issues of functional biodiversity in orchard systems to a broader community.

Report on the results obtained (A), and fulfilment of objectives (B)

A- results obtained:

Results of the survey. The implemented FAB-techniques differ according to growers' personal knowledge and experiences. A total of 24 techniques were described and can be divided into 3 categories: long-term ecological infrastructures, dynamic agricultural practices adaptable from a season to another (e.g.: to adapt interrow mowing) and deeper system redesign requiring strong interactions with the production system (e.g.: crop diversification). There is a huge variability between countries. France distinguished from other countries by the number of FAB-techniques mentioned with proportionally less flower strips (FS) but a high proportion of hedges and more marginal techniques such as alternative practices (90% of the total number of occurrence of this technique), animal introduction (60%) or fruit diversification (VARI , 60%). In Germany, farmers mentioned more specific shelters such as wild bee houses (80%), raptor perches (60%) and vertebrate shelters but less row management techniques. Forty percent of the farmers who mentioned 'Insect shelters' and 'Service plants' were from Sweden where no redesign techniques were mentioned. Latvia distinguished by the little number of techniques mentioned relatively to the number of farmers interviewed. As in the other countries, most of them also mentioned 'Hedges', 'Flower Strips' and 'Bird or bat houses' but they proportionally mentioned more 'Interrow vegetal cover' (40%) and, contrary to Germany, no specific shelters. In Denmark, techniques occurrence follow the same general trend apart from the technique 'To reduce Pesticides' was never mentioned. Belgium distinguished by a high proportion of farmers mentioning 'To reduce pesticides' (30%), fruit and crop diversification. In Italy and Switzerland the number of interviews was too low to draw any conclusions. Nevertheless, in accordance with the study design targeting a diversity of situations rather than representativeness, these differences highlight the prominence of the context for FAB-techniques adoption.

These differences among countries are increased by the different farmers' perceptions of FAB. The pros and cons analysis reveals that farmers' expectations and fears stretch beyond pest regulation and crop protection to integrate other considerations: agronomical other effects (e.g. easier grass cover management vs competition with fruit trees), economy and environment (e.g. energy saving vs production reduction) and working environment (e.g. landscape quality vs drudgery) (Fig WP1.1).

Finally, this survey also reveals that farmers' assessment of these different FAB-techniques is mainly qualitative and depends on their own objectives. In fact, they express difficulties to rank them individually according to single criteria when technique combinations, long-term and multi-criteria

rankings should prevail. This point is emphasized by the lack of reference information available to growers and in relation to WP2 and WP4 of correct and easy to use monitoring/evaluation techniques available to farmers.

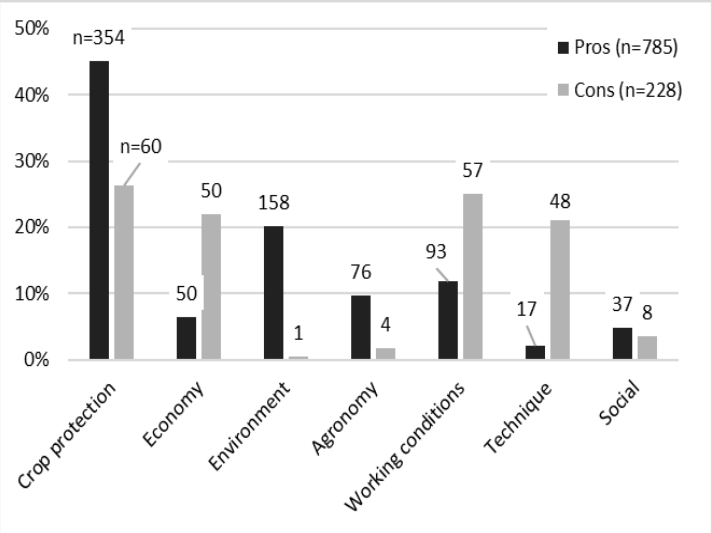


Figure WP1-1: Farmers assessment of pros and cons of FAB practices identified with the interviews

The results of this survey were presented at Ecofruit conference in 2016 and in an adjoining workshop to provide the participants with the collected information. The aim was to assess how Ecofruit participants, mostly advisors and researchers, may complete the empirical and situated information with more scientific and generic information. The workshop was organized in focus groups, each working on one of five different FAB-techniques: Flower strips, inter-row mowing, hedges, animal introduction, and wild bee houses. Focus groups worked on posters on which they could add their contributions to the different sections describing the FAB-technique from the information we collected with the interviews: a brief description, the main beneficials and pests targeted, local adaptations, implementation conditions, lists of limitations and interests, suggestions on how to reduce them, and references to go further. They argued regarding the benefits for pest regulation, e.g. for hedges for which they questioned the insect dispersion capacity. On the other hand, for the other FAB-techniques, they hardly discussed the list suggesting that the information collected by the interview was sufficiently exhaustive. They added many recommendations to improve benefits (especially for wild bee houses) and reduce limitations and finally provided much information on the condition for success. This exercise was therefore useful to collect on one side more experiences, i.e. empirical knowledge, on existing variants, success or failure stories, and on the other side, scientific feedbacks on their conditions for success and questions to assess their benefits. Scientists have discussed the definition of the FAB-techniques more, while advisors provided multiple variants and growers provided comments on the multiple targets, benefits or limitations.

Literature database: Selected papers for the Literature database in the EBIO-Network portal focus on (1) effect of habitat management in apple, (2) effect of different FAB-techniques on pest control and methodology, (3) conservation biological control, (4) plant selection for nutrition of beneficials. The database is available in Endnote format with all references with pdf for the EcoOrchard partners and as a searchable list at EBIO-Network portal. The collection contains also papers before the year 2010, because there have been many comparable activities during the 1990s. New papers will be added continuously.

Literature review The systematic literature search was performed in Web of Science with the following search string: TOPIC: ((((apple*) AND (Orchard*) AND ("cover crop*" OR "service crop*" OR "flower* crop*" OR "semi-natural" OR "floral*" OR "flower strip*" OR "flower margin*" OR "non-crop flower*" OR "non crop flower*" OR "intercrop*" OR "inter-crop*" OR "hedge*" OR "weed*" OR "vegetation" OR "wild plant*" OR "agro-forestry" OR "agroforestry" OR "*diversity") AND ("pest*")))), Timespan=1987 - 1996, 1997-2006, 2007-2016, 2007-2008, Search language=English. Some references of the EBIO-Network portal Database were added. The obtained abstracts were screened in order to decide if they fit to the general question (Managing floral resources for pest control in apple orchards). Suitable references were completed with full articles and sorted to particular categories (flower strip, cover crop, hedgerows, agroforestry, intercropping (different fruit trees), mowing regime, weed management) (Figure WP1-2). A publication on the results of the literature review is in preparation.

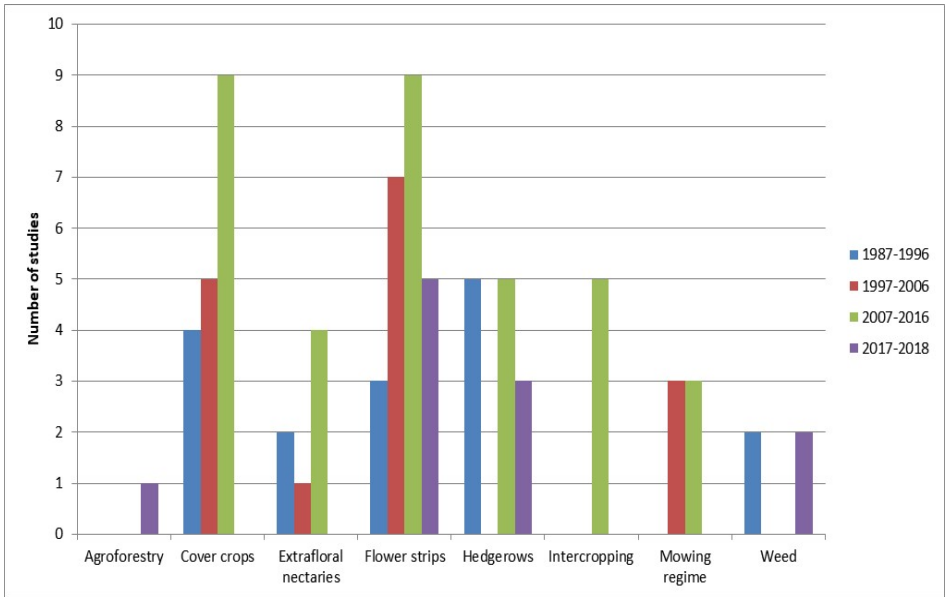


Figure WP1-2: Number of published studies used for the analysis of scientific literature on "Managing floral resources for pest control in apple orchards" since 1987.

EBIO-Network portal: The website was established under the JKI-domain, because this will allow maintaining it also after the end of EcoOrchard project. The content provides information from practice and research in short, attractive information tools (fact sheets, technical sheets, video, photos etc.). Links to EcoOrchard, but also to other similar research projects shall connect the scientific community. Stakeholders

are able to enter the network via a registration tool, but their data will not be published. Structure and layout of the website is finished; the provision of content is ongoing. Special attention on the website is given to 'Who's who' and 'Get connected' sections, also to facilitate the involvement of the farmers. Nevertheless, the English language set some constraint on successful dissemination**.** Download statistics of information material is as follows (on 21/06/18: Fact sheet "wild bees": 18x, Fact sheet "hoverflies": 624 x, IOBC Ideabook on ecological infrastructures (preview): 1461 x, SLU publication on habitat management (Nilsson et al: 1631 x).

B- fulfilment of objectives:

- Knowledge and experience on FAB management from practitioners and scientists was collected by different activities: (1) interviews of farmers, advisors, (2) published research in literature, (3) workshop. The FAB innovation among farmers and advisors from WP1 has been analysed and communicated by the project, positively aiding the inspiration for further innovation and experimental work and testing.
- English language set some constraint on dissemination of the EBIO-Network portal in the national farmer communities. Nevertheless, it is a good tool for gathering and distributing information on function agrobiodiversity in European orchards to interested parties, also in the future.

3.3 WP2

WP2	**Common methods for participatory assessment of functional biodiversity efficiency**
WP leader: FRANCOIS WARLOP (GRAB) **Responsible partners**: GRAB, UPCH, LAAPC	
Overall summary of main results, discussion and conclusions WP2 In 2015, several methods to assess functional biodiversity were chosen among main partners of WP2	

(GRAB, UPCH, LAAPC) and set up in 3 orchards, one in each of the 3 countries concerned (France, Denmark, Latvia). The objective in the beginning of the project was to compare methods for different performance criteria (time, material or skill needed, information provided etc.). Most interesting methods were then to be suggested to farmers for their 2016 trials. The assessment of methods led to selection of four methods: Visual observation, beating, corrugated cardboard and sentinel prey were considered as potentially feasible for farmers and presented to them during workshops (in France, Sweden, Denmark) or in the field directly. Sentinel prey was a technique requiring specific material from research, but pretty motivating for farmers as it gives a direct reading of predation rate in one's own orchard.
At the beginning of 2016 field season, practical handbooks were finalized and translated (in 7 languages from participating countries) by partners and proposed to interested farmers. Handbooks are also available on the EBIO-Network platform. Farmers involved were asked to choose at least one method to use by themselves in their own orchard. Partners would provide an initial training, and provide all material needed. The following year 50 farmers participated.
European network of fruit farmers involved with FAB therefore started in 2016, with 40 farmers the first year. Information on the network is accessible through a shared file: https://framacalc.org/ebion_network
A satisfaction survey was proposed by the end of season. The objective was not to collect FAB data, but to ask farmers about their feedback regarding the method(s), quality of information obtained, and final changes in practices, if any.

Report on the results obtained (A), changes to the original plan/ WP aims (B) and fulfilment of objectives (C)

A- results obtained:
At EU scale, 40 farmers agreed to participate in 2016, getting trained to functional biodiversity in order to better know it and possibly change their cultural practices. This number increased to 50 in 2017.

Two short didactic videos were realized

- in 2015 by INRA to help farmers & advisors (http://www.gis-fruits.org/Page-d-accueil/Actualites/Video-pedagogique-observer-la-biodiversite-fonctionnelle-et-aller-jusqu-a-l-evaluation)
- in 2017 by GRAB to show French farmers testimonies (https://youtu.be/Jw8PEg8DiQ8)

Table WP2.1 Adoption in 2016

		method(s) chosen			
country	**nb of farmers**	beating	predation card	cardboard band	visual
France	**5**	1	2	2	
Denmark	**2**	2			
Belgium	**4**	4		4	
Germany	**4**	1	2		2
Latvia	**6**	4	6	5	
Poland	**?**				
Sweden	**9**	1	9	1	5
Switzerland	**4**	4			4
Italy	**3**			1	3
Czech Rep	**3**	3	2	3	1
TOTAL	**40**	**20**	**21**	**16**	**15**

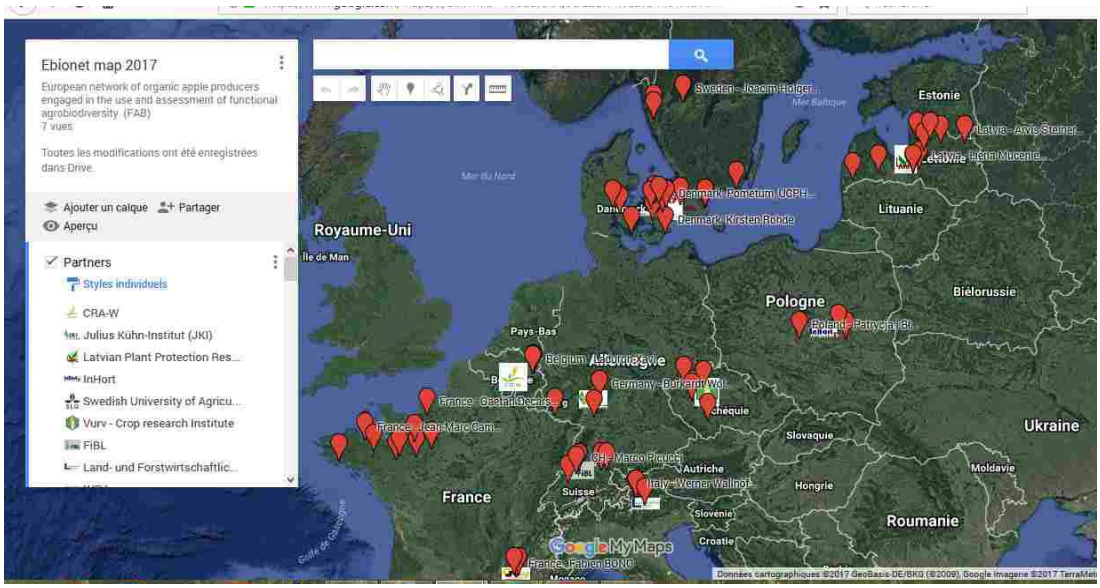
Table WP2.2 Adoption in 2017

		method(s) chosen			
country	**nb of farmers**	beating	predation card	cardboard band	visual
France	**12**	8	5	9	2
Denmark	**6**	3	3	5	1
Belgium	**4**	4		4	
Germany	**0**				
Latvia	**10**	8	7	10	1
Poland	**3**	2			3
Sweden	**5**		5		
Switzerland	**3**	1		3	
Italy	**3**			2	3
Czech Rep	**4**	4	4	4	1
TOTAL	**50**	**30**	**24**	**37**	**11**
	%	29.4	23.5	36.3	10.8

Table WP2.3 The objectives chosen by farmers when using the FAB methods.

objectives		**number 2016**	**number 2017**
agroecological infrastructure	flower strip	7	4
	hedgerow/wood	11	16
	bird and bat houses	3	
	insect hotels	1	
	pond	1	2
practice effect	mowing strategy	1	3
	old/new plantation	2	6
	different cultivars		1
	2 different orchards	1	2
treatment effect	bio/IPM	6	6
	defoliation	1	1
	sulfur use	1	
	low/high input		3
	Learn about NE on the farm	9	3
	Earwig dynamics	1	

Figure WP2.1 EU map of involved farmers was established :



After both field seasons, questionnaires brought interesting data from farmers and global positive feeling on relevance of the methods and protocol proposed to observe beneficials, their dynamics in the orchard, and "think twice" process before spraying.
About 20 questions were asked to apple growers, here are a few examples of answers in 2017 :

Did you do the monitoring yourself ?	91,7% yes
Perception of time required	89% fast to medium
Is the protocol easy to set up	94,4% yes
Did the handbook give enough information	91,2% yes
Was the method useful to increase your knowledge	86,1% yes
Have you changed your practices because of monitorings	**63,9% no**

Practices do not change so easily. We consider that time is also needed to help farmers practice FAB assessment, and be more able to judge if beneficials can replace pesticides.
A message to EcoOrchard associated farmers was sent in spring 2018 in order to convince them to go on with FAB assessments in their own interest, whereas partners could not be involve so closely with them after the project.
A technical paper will be written from these questionnaires, in order to give more precise details on farmers motivations and feedbacks.

B- fulfilment of objectives:

- Knowledge and experience on FAB monitoring on farm by practitioners has been achieved according to our objectives. The handbook on FAB assessment was improved by experiences collected in 2016 and 2017 and has proved a valuable tool in communicating FAB to growers.
- Farmers and advisors also very much appreciated workshops, instructions and on farm demonstrations of methods. We experienced much interest to learn more about the biology and life cycle of the beneficials, important to make optimal use of them

3.4 WP3

WP3	**New collaborative experimental trials and new orchards designing actions**

WP leader: FiBL, Lukas Pfiffner (leader); CRA-W, Laurent Jamar (co-leader)
Responsible partners: InHort, Dorota Kruczynska; JKI, Annette Herz; SLU, Mario Porcel and Marco Tasin; University of Copenhagen, Lene Sigsgaard; VZ-Laimburg, Markus Kelderer

Overall summary of main results, discussion and conclusions of WP3

We have developed and tested two different flower mixtures fulfilling our functional-agro biodiversity (FAB) criteria. Mainly ecotypes (wild forms) of selected dicotyledon and grass species were sown. We have developed a mixture of 30 perennial herb species, supplemented by eight grass species, in order to meet the following criteria for implementing flower strips in the alleyways of apple orchards: (i) attractive to the natural enemies in focus, (ii) not attractive to pest insects and voles, (iii) flowering sequentially throughout the crop season, (iv) short growing with small rosettes to tolerate repeated mulching, (v) tolerant to machine traffic (vi) bi-annual to perennial, (vii) tolerant to nutrient rich orchard soil conditions, (viii) competitive to other weeds and (ix) tolerant to shady lighting conditions. Thus we have a basic and complex mixture which have been tested in our field trials in seven European countries. Two types of field trials were set up considering botanical or entomological/botanical aspects of these two flower strips. We have tested both mixtures on the level of botanical aspects (plant species richness, herbs, grasses and FAB-species establishing) under the specific condition of orchards (nutrient rich soils, shaded by trees, greatly altered by machinery). We have used common assessment field protocols in all field trials to enable an overall analysis in a pan-European context, providing more valuable data than could be provided by single partners. We have installed these field trials in seven partnering countries (B, CH, DK, D,

I; PL, S), analysed the impact on natural pest control in relation of the botanical resources (with and without flower strips). Accordingly we have developed specific assessment field protocols and guidelines for entomology, botany and management practices

Conclusions: There was a clear evidence that flower strips can significantly increase the plant diversity in orchards. In particular, the number of species and ground cover by FAB plants and herbs in herbs in general, which are important for the promotion of agrobiodiversity, have increased. The selected plant species are shown to be suitable for use in apple orchards throughout Europe. This is an important prerequisite for the provision of multiple benefits for farmers as natural pest-control as well pollination (not tested, experiences based on plant species used). Therefore, this diversification is worth to be considered in national agri-environmental programs. We found that the frequency and timing of mulching flower strips must be carefully aligned with the stage of development of beneficial arthropods so that they will not be physically harmed and their habitat and food resources will not be destroyed. The right balance for the right time for mulching must be determined by observing the population of beneficial arthropods over the years. This could pose a new challenge for farmers. Under which floor management many sown flower species of this mixture may survive in the long-term remain unclear due to the limited investigation period of three years. Therefore, further investigations in the future are necessary to clarify mid-term impact on botanical issues.

Our entomological studies show at a wide continental scale that the use of perennial flower strips in the alleyways of apple tree rows increase the presence of natural enemies on the trees (fig. 3a). This increase leads to a higher control of key apple pests and a reduction in fruit damage (fig. 3b). Density of aphids correlates with the abundance of natural enemies (fig. 3c). Although pest suppression and damage reduction may not be enough to use this conservation biological control strategy as a stand-alone practise, flower strips can contribute to a build-up of the resilience of the apple agroecosystem against pests, reducing the need for insecticide use and favouring conservation.

We can provide plant composition of the flower strips adapted to different European countries and recommendations for implementation and management in practise (including technical leaflet in eight languages). Due to the variable occurrence of different natural enemy taxa within and between the seasons, it is important to provide resilient, perennial flower strips and continuous supply of flowers throughout the crop season that provide nectar and pollen, enhance alternative prey to bridge gaps of low pest abundance and offer shelter and overwintering sites to augment natural enemies. Our results support the integration of perennial flower strips in organic apple orchards to promote natural enemies of agricultural pests.
Although the observed reduction in fruit damage may not support the use of this conservation biological control strategy as a stand-alone practise, our study supports the role of functional agrobiodiversity as a way to reduce insecticide use in orchards. Sown flower strips can significantly enhance natural enemies and create a positive loop leading to a more resilient and ecologically sound production system. Perennial plant communities in the flower strips can evolve and populations of resident natural enemies may increase over the years, potentially increasing pest control. The potential for pest control in orchards with perennial flower strips, shown in our study, could therefore be even greater in the following years. However, the seed mixture in this study was therefore not only developed to promote beneficial arthropods, but also to last for eight to ten years under orchard conditions in different climatic regions of Europe. We found as a bottleneck for the on-farm implementation the availability of regional seed mixtures. This is not guaranteed in various European countries as we have found e.g. in Poland and Italy. Further possible obstacles are missing of adapted machinery on-farm, the availability of native seed mixtures (ecotypes). However, new mulching devices have been developed during the last years which are best adapted to manage orchard understorey sparing flower strips and making it possible to adapt mulching heights (e.g. brands as Humus and Aedes).

Report on the results obtained (A), and fulfilment of objectives (B)

A- results obtained:

Out of the 116 recorded plant species, 112 were found in flower strips (FS) and 81 in control plots. Plant communities were dominated by perennial plants at all sites. Plots with flower strips showed a significantly higher species richness in comparison to control plots (fig WP3.1). In particular, species richness of herbs, grasses and FAB plant and the cover of herbs and FAB plants (fig. WP3.2) were significantly higher within flower strips. Sowing flower mixtures in the alleyways of organic apple orchards increased plant diversity in the second and third year after sowing on average by 43 % compared to the spontaneous orchard vegetation.

1)

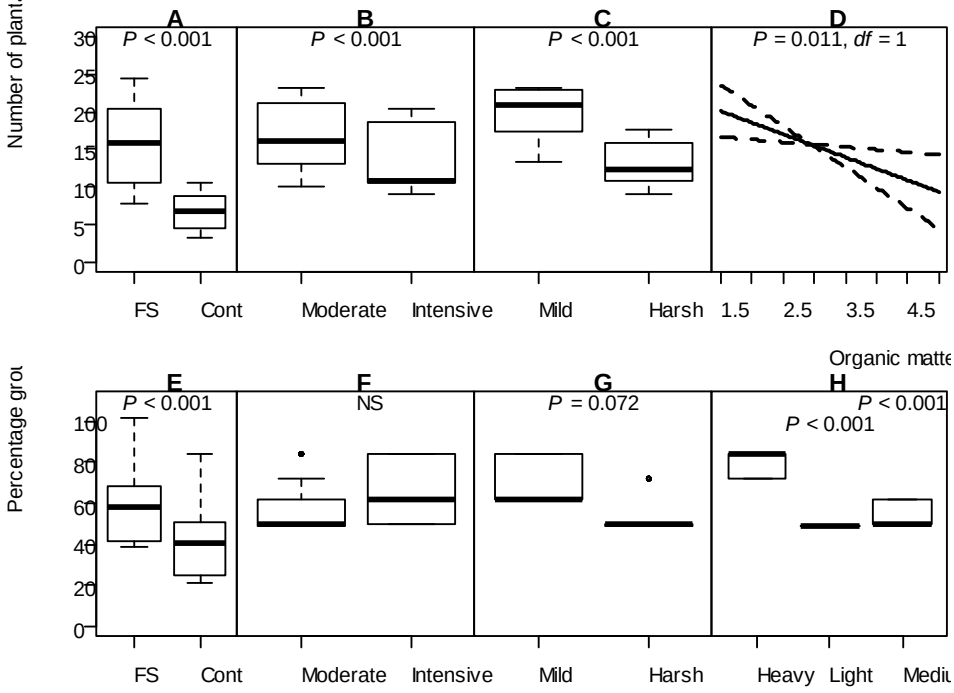
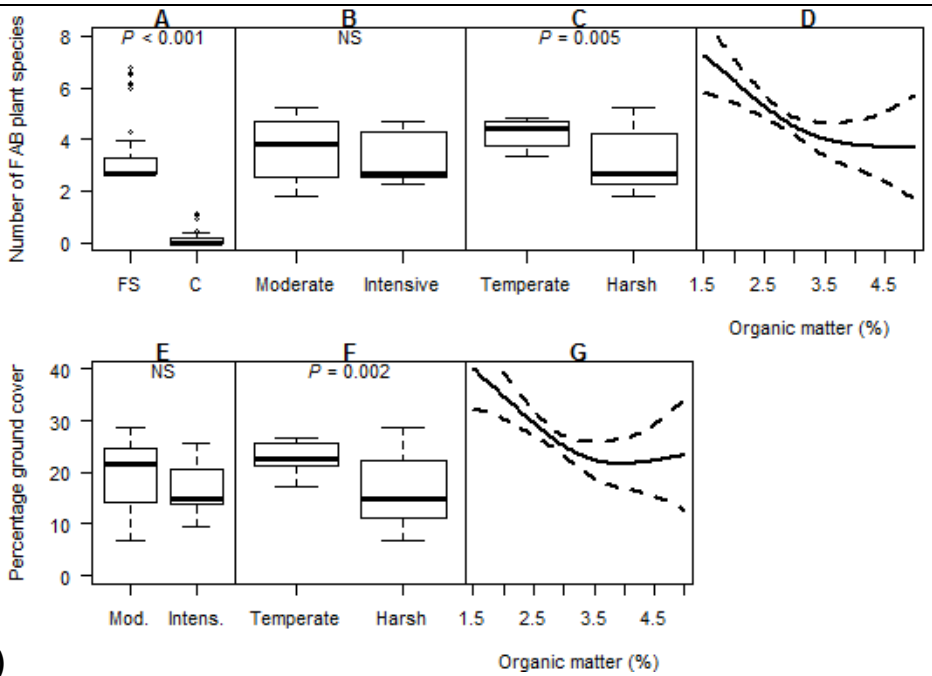


Fig. WP3.1 Fitted values of (A-D) the number of plant species and (E-H) ground cover. Figures A and E show the difference between flower strips (FS) versus control plots (Cont), B and F moderately versus intensively mulched flower strips, C and G flower strips in harsh versus mild climate, D the relation to organic matter, and H flower strips grown on different soil types. In figures A-C and E-H, the boxes represent the interquartile range from the first to the third quartile, the lines across the boxes indicate the median, the whiskers show the quartiles ± (1.5 × the interquartile distance) and the circles indicate outliers. The dashed lines in figure D indicates the 95%-confidence interval. P-values in figure H indicate differences in ground cover compared to heavy soil.



2)

and WP3.2 Fitted values of (A-D) the number of FAB plant species and (E-G) ground cover. Figure A shows the difference between flower strips (FS) versus control plots (Cont), B and E moderately versus intensively mulched flower strips, C and F flower strips in harsh versus mild climate, and D and G the relation to organic matter in the soil. In figures A-C and E-F, the boxes represent the interquartile range from the first to the third quartile, the lines across the boxes indicate the median, the whiskers show the quartiles ± (1.5 × the interquartile distance) and the circles indicate outliers. The dashed lines in figures D and G indicate the 95%-confidence interval.

Positive effects of FS with higher number of natural enemies on trees were found in both years and at all visual assessments (fig. 3a) and less damaged apples after 2nd fruit drop, at harvest differences were diminished by farmer's thinning. This suggests that the specifically designed flower mixtures consistently promoted natural enemies. This is an important criterion for pest control throughout the season in perennial orchards. Syrphids as important predators of the rosy apple aphid and generalist predators, such as spiders, Miridae and Anthocoridae were also significantly enhanced by flower strips compared to the control plots without FS. In contrast to Syrphidae and Chrysopidae, the number of Coccinellidae, whose larvae and adults are also important predators of aphids, was not significantly enhanced by flower strips. Despite a positive relationship between the presence of aphid colonies and natural enemies, the infestation of *D. plantaginea* did not differ significantly between the two treatments. From 2016 to 2017, the number of codling moth decreased more and fruit damage increased less in the flower strip plots compared to the control plots.

On plant community level, multivariate analysis revealed significant dissimilarities in the plant communities between the two treatments mediating by covariables as climate, soil type, soil pH and mulching regime. The differences were related strongly to the sown species in the flower strips. Most distinguishing species of the plant community were forbs including two legumes species and only one grass species. Not sown resident plants species were mainly responsible for differences observed in significant covariables as climate and soil type indicating a great influence of site condition as we have expected.

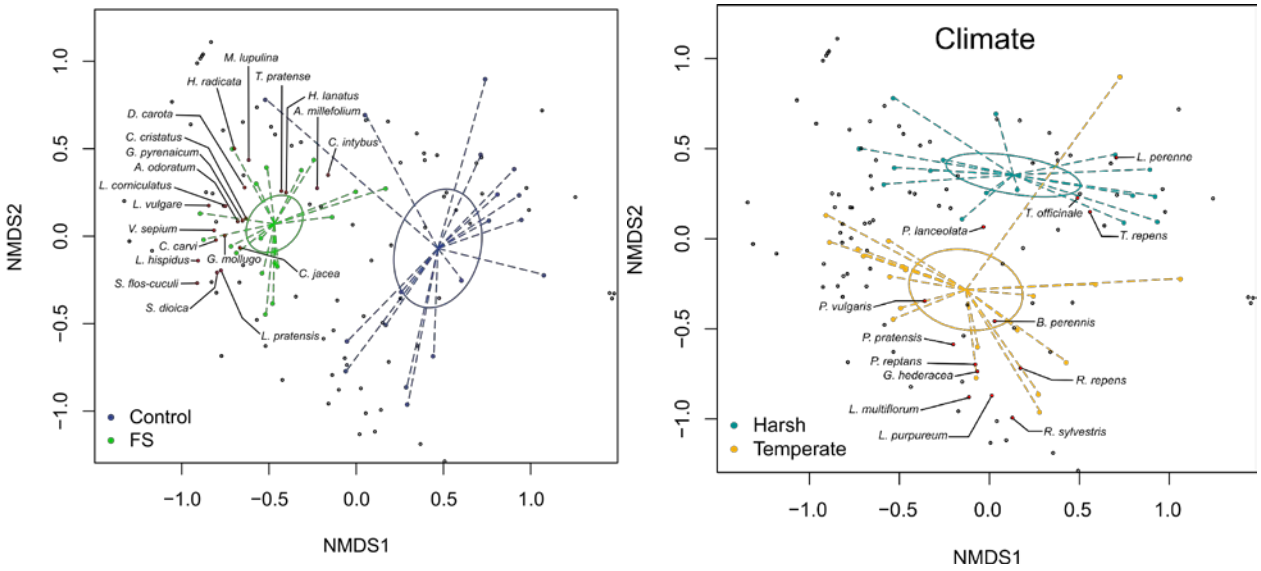


Fig. WP3.3. Non-metric multidimensional scaling (NMDS) representation in two dimensions of the plant community associated to the flower strips and the control (a) and the plant communities associated to harsh and temperate climates (b) (both, stress = 0.115). The Bray-Curtis distance was used a dissimilarity measure. Bigger circles indicate the position of individual plots and smaller circles the position of the plant species. Plots belonging to the same group are connected by dashed lines that intersect at the centroid. Ovals represent the standard deviation of plots from the same group. Plant species represented with red circles and labelled with their name were detected with the Boruta algorithm as important in the separation of the groups represented. The plant communities of the two treatments were significantly different (PERMANOVA, $P < 0.001$).

Incidence of codling moth varied considerably between countries and over the two assessment years. The number of larvae, cocoons and pupae was higher in Northern countries. In contrast to these countries, where *C. pomonella* has one generation per year, the single assessment per season may have underestimated the population in Southern countries, where two generations per year can occur. In addition, pest control with insecticides is less intensive in the northern countries than in southern ones, possibly allowing for larger populations of codling moths at a landscape scale. The number of larvae, cocoons and pupae dropped more from 2016 to 2017 in the flower strip plots compared to the control plots indicating a positive control effect of the flower strips. The relative fruit damage caused by codling moth (H) in 2017 was higher than in 2016 due to frost in April 2017. But the increase in relative fruit damage from 2016 to 2017 was lower in the flower strip plots compared to the control plots. While predators can control eggs and young larvae, other larval stages of codling moth are more susceptible to parasitism. A disadvantage of our study is that parasitoids could not be included in the assessment of natural enemies.

The higher abundance of various natural enemy taxa in the flower strip plots compared to the control plots indicates the potential of flower strips to promote natural enemies for pest control. Nevertheless, fruit damage by aphids after the second fruit drop was reduced in the flower strip plots. The climatic variations during the two assessment years revealed the importance of resilient flower strips. Weather conditions in spring 2016 were rather rainy in some countries, resulting in significantly fewer natural enemies during pre-flowering in 2016 than in 2017.

Analysing our experiences with the applied monitoring methods, we found that sentinel-prey cards were unsuitable to reflect the activity of natural enemies.

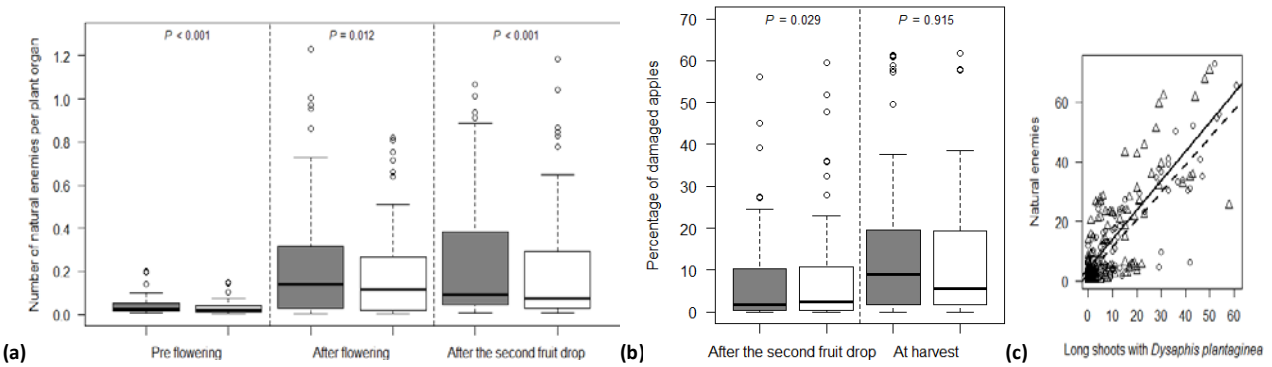


Fig WP3.4 (a) Fitted values of the number of natural enemies per flower cluster (pre flowering), fruitlet cluster (after flowering) or long shoot (after the second fruit drop) on trees in the FS plots (grey bars) and control plots (white bars). (b) Fitted values of the percentage of apples damaged by *D. plantaginea* in the FS plots (grey bars) and control plots (white bars). Dates of (a) and (b) were analyzed separately. (c) Fitted values of the total number of natural enemies on 60 assessed long shoots (after the second fruit drop) per plot in relation to the number of *D. plantaginea* colonies. Triangles indicate the number of natural enemies on fruitlet clusters in the FS plots and circles in the control plots. The lines (solid line = flower strip, dashed line = control) indicate the relationship between natural enemies and aphids ($Z_{1,248} = 4.56$, $P < 0.001$).

B- fulfilment of objectives:

We have fulfilled our objectives according our research plan. Development and testing of new flower strips using shared field protocols , installed field trials, monitoring and recordings of field success. We have successfully performed the field trials on station or on-farm in seven partner countries.
Based on the 3-year field studies and sharing of previous experiences we have written a technical leaflet for farmers in eight languages (Spanish the 9th). This is an additional milestone in this WP. There we have discussed main aspects of implementation of flower strips in apple orchards, on-farm the possible seed mixtures, the management of flower strips (FS), benefits and limitations of FS necessary restrictions in plant protection management, and necessary machinery. Moreover, we have written two papers for peer-reviewed journals and have analysed the data in a detailed manner using generalized linear or additive mixed models. They have already been submitted.

3.5 WP4

WP4	**Common methods for participatory assessment of functional biodiversity efficiency**

WP leader: Marc Tschamitchian, INRA; co-lead Mario Porcel/Marco Tasin, SLU
Responsible partners: UCPH, Lene Sigsgaard; FIBL, Lukas Pfiffner, GRAB, Francois Warlop; CRA-W, Laurent Jamar; Inhort, Dorota Kruczynska, JKI, Annette Herz; Laimburg, Markus Kelderer; LPPRC, Janis Jasko

Overall summary of main results, discussion and conclusions of WP1

WP4 has been designed in a strong participative line. We assumed that to favor the development of functional agrobiodiversity monitoring methods, we have first to make clear why and how agricultural stakeholders (farmers and advisors) could be interested in biodiversity monitoring methods, and then in the functions that this biodiversity fulfils. To achieve this goal, WP4 has been organized along three successive steps. The first step aims at collecting and sharing farmers' practices to monitor functional agrobiodiversity. It has been implemented by gathering farmers, advisors and researchers in a workshop. The second step aims at testing some of these methods in the field and in real production situation, a test achieved by the farmers. The third step aims at sharing farmers' points of view on the monitoring methods they implemented, in a final workshop. These steps have been implemented in three different countries, France, Denmark and Sweden, in a (almost) similar pattern (especially the workshop organizations).

The results obtained in WP4 are therefore manifold.
The first result is an identification of farmers' needs in terms of functional agrobiodiversity, which goes from simply getting acquainted with it to revealing and measuring its benefits.
The second result obtained is a list of farmers' practices to monitor FAB, the covering of which is larger than the initial focus on natural regulations.
The third result is the assessment of these FAB monitoring technics by the farmers who tried them on their farm during one season. In some cases, the assessment has been that the farmer could not find the time to implement any (or a given) technic.
The fourth main result organizes these monitoring techniques into programmes adapted to the different needs of farmers and to the different effort they are ready to consent to apply these techniques.

Discussion
The diversity of farmers' needs reveals a larger picture than the entry point. The initial goal was centred on the regulation service provided by FAB. However, although directly asked what FAB represents to them, farmers proposed a much wider panorama, altogether. Their answers of course relate to FAB definition, and also covers the services it fulfils, but are not limited to regulations. Some answers also cover the topic of management and some relate to organizational dimensions of FAB monitoring or preservation, either organization of natural and cultivated elements on a farm or beyond, either organization of management practices at the landscape level (acting both on cultivated and not cultivated parts of the landscape).
The multifunctionality of FAB, which has often been mentioned by farmers, has many consequences. First, it means that the goals of the monitoring techniques proposed must be made clear to the farmer who need to know in which context he uses it and what it will be useful for, key elements in their choice to implement a technique according to their own assessments expressed during the third step of the WP. Second, it means the FAB monitoring is not compulsory for some farmers, because the services they await do not need monitoring or do not call for tailoring management practices. However, when FAB is expected to play on pest regulations, it calls for specific monitoring aiming at qualifying the regulations themselves more than the FAB itself, when possible. The predatory cards proposed by WP2 raised a lot of interest in this situation, because they directly allow to quantify the activity of predator insects, while their abundance does not (meaning that counting is less relevant). Traps or beating also raised farmers' interest (although they only allow identification and counting), because they are easier to implement and also have a visual dimension -, they reveal the predator for the farmer to see, thus providing confirmation of their existence (strangely enough, the predator cards do not offer this service, what is revealed is the regulation service, not the provider).
The assumption we had made that the use of FAB cannot be favoured without clarifications of the goals and expectations of farmers or advisors therefore seems to be confirmed.
The choice of a collaborative research setup has had several consequences. The range of proposed FAB monitoring technics obtained is rather large, and covers more than the sole goal of its use to regulate the pests in an orchard. Farmers may have a more integrated view of FAB, and propose monitoring technics accordingly. Working with farmers therefore has driven the WP4 to modify its original goals which was limited to favouring FAB monitoring to help farmers tailor their pest management practices.

Conclusions
The collaborative mode has been rich and responsive, and has opened the initial scope and goals.
Concerning the monitoring technics, the results obtained are complementary to those proposed by WP2 in so far that the portfolios produced in WP4, some of which include the methods proposed by WP2, offer a context of use for these methods and can provide explanations on their relative adoption by farmers. To achieve such a result, a joint analysis of some of the results of WP1 has been necessary (to identify farmers attitudes).

Report on the results obtained (A), and fulfilment of objectives (B)

A- results obtained:

The first result is an identification of farmers' needs in terms of functional agrobiodiversity. These needs range from the necessity to reveal what this functional agrobiodiversity is (insects, plants…) and where it lies to assessing the services it fulfils. Indeed, some farmers are not ready to rely on FAB to manage their orchard pests, either because they suffer little from the pests, either because their confidence in natural regulations is limited. They mainly express a need to *see* the FAB, what it is and what it does. But some are more confident, on the basis of their own experience or educational learning, and they clearly call for tools that will characterize the regulations themselves, with sometimes less interest to FAB in itself (which species, abundance…). Revealing these needs also revealed that FAB, according to some farmers, is not only a question of regulating pests, but also a question of other services (soil functions, aesthetics…).

The second result obtained is a list of farmers' practices to monitor FAB. During the first workshop, farmers and advisors exposed the technics that each of them used, how and when (location of observations, frequencies…), but also why (to compare two plots, to grasp the dynamics of a pest…). This list includes some of the technics presented in the scientific literature selected in WP2 such as beating or traps. Most of these technics have been described formally in a leaflet, based on the farmer's description and revised by an advisor or a researcher in the project (D4.1 and D4.2).

The final results elaborate on the previous ones. Not all the technics gathered in this collaborative process aim at the very same goal or provide the details. They have been organized in portfolios adapted to the different needs of farmers, more precisely to the different farmers' attitudes towards FAB. These attitudes have been identified with WP1, based on the surveys. These attitudes range from passive, where the farmer observes interactions between the orchard and its environment but does attempt to modify these interactions to a multifunctional attitude where the farmer uses FAB to achieve several goals among which pest control. Intermediate attitudes are either naturalist (farmer acting to preserve or restore the FAB) or regulatory where the farmer deliberately uses FAB to control pests. Obviously, monitoring technics only revealing the FAB composition are not sufficient for multifunctional or regulation farmer. The portfolios that have been built with the farmers in the second workshop address each of these attitudes, proposing dedicated monitoring technics taking into account the information they yield and the effort that is necessary to implement them.

B- fulfilment of objectives:

The goals of WP4 was to adapt monitoring methods and practices for FAB orchard management to end-users needs and constraints, with the active participation of stakeholders and to disseminate project results within a strong, collaborative stakeholder network created in the project.

The first part of the goal, adapting FAB monitoring methods with the active participation of farmers has obviously been largely achieved, both in terms of monitoring technics proposal and in terms of farmers' participation. In the three countries where the workshops have been held the participation has been satisfactory, and farmers have been motivated enough to come to the second workshop a year later. In some of the organizing countries, the advisor, researcher organizing the workshops expressed, fears that the farmers would not participate or find the exchanges organized in the workshops. These fears were in fact unfounded and finally unverified. Dissemination of these results have been achieved to these farmers through their participation to the workshop. Some of the attendees were advisors, which was deliberately chosen as a way to ensure a wider dissemination. Demonstrations or field visits have also been organised to widen the dissemination.

The final goal of the WP4 was to analyse the participation modes and the learning processes of the involved stakeholders. This analysis is still in process, based on the observations made during the 2x3 workshops. A first step of this analysis, based on the French case, is proposed in a communication to the 2018 IFSA conference.

4. Milestones and deliverables status

[1)] Measured in months from the project start date (month 1)

Deliverable No.	Deliverable name	Link to the document	Planned delivery month[1)]	Actual delivery month[1)]	Reasons for changes/delay and explanation of consequences
D 0.1.	Consortium agreement		6	3	Restricted access to agreement
D 0.2.	Annual project meetings		12,24,36	11, 23, 35	Meetings held, and minutes provided by coordinator
D 0.3	Mid-term and final report		18, 41	19, 43	completed
D 1.1.	Workshop for presenting analysis results	link	15	13	Done. Workshop was held at Ecofruit Conference in February 2016
D 1.2	EBIO-Network platform online	https://ebionetwork.julius-kuehn.de	18	14	Done. Thematic portal is online now, but content delivery is ongoing (depending on input of partners and results of the project) and will be continued also after projects end.
D 2.1	Collection of methods	Report with restricted access to partners	M4/M12	M5/M12	Methods for 2015 were proposed in May, whereas they were discussed and selected in November 2015 for year 2016
D 2.2	Selection of most relevant methods	http://bit.ly/290TWnS FAB handbooks	M12/M24	M12/M24	Selection of methods for 2016 was achieved during annual meeting in November 2015.
D 2.3	Analysis of field data	FAB assessment handbook	32	42	Delivery delayed as we decided to repeat farmers testing of FAB methods in 2017, validating the FAB assessment handbook
D 3.1.	Plans of field trials	see full report	2	3	The final plans on-farms needed time to locate and define
D 3.2	Qualitative report of field trials	See full report WP3	13	14	
D 3.3	Intermediate qualitative report from each trial	Report with restricted access to partners	25	25	
D 3.4	Final qualitative and quantitative report on the field collaborative trial	Pls refer to Annex 3c and 3d	36	36	

	results				
D 4.1	Leaflet describing the monitoring methods		15	15	Confidential, only for members of the consortium
D 4.2	Revised leaflets		30	36	In the form of a series of mails with French growers
D 4.3	On-site visits and forums		36	36	
D 4.4	Outreach publications		36	42?	Some months delayed due to maternity leaves

Milestone No.	**Milestone name**	**Planned delivery month[1)]**	**Actual delivery month[1)]**	**Reasons for changes/delay and explanation of consequences**
M0.1	Consortium agreement	6	6	
M0.2	Annual project meetings	12,24,36	11, 23, 35	
M0.3	Mid-term and final report	18, 36	19	
M1.1.	Network of organic growers established	6	9	Interviews were finished with delay due to field season
M1.2	Interviews and field visits performed	12	9	Interviews were finished, analysis is finished, publication is in preparation
M1.3	Review of literature data, research projects etc.	12	36	Literature data collection was finished in month 9, systematic review on particular topic (floral resources) is finished, publication is in preparation
M2.1	Inventory survey of existing methods	3	3	
M2.2	Set up of method evaluation in experimental network (2015)	M4/M16	M5/M17	Longer discussions between partners with no consequence for field work
M2.3	Set up of methods in limited and larger growers network (see 2017 EU Map)	4/16	17/17	Set up in growers plots was not achieved in 2015 for time reasons, their commitment was started in 2016
M2.4	Fields trials completed	21	21 and 33	We decided to repeat farmers field trials in 2017 based in farmer interest in using the FAB assessment handbook
M 3.1.	Plans of all field trials	2	2	
M 3.2	Field trials are established	5 or 10	5	
M 3.3	Assessment protocols for field trials are set, trained, ready to apply	11	12	
M4.1	Workshops to demonstrate the selected methods	15	From 12 to 15	
M 4.2	Workshop to evaluate the selected monitoring methods	27	27	

[1)] Measured in months from the project start date (month 1)

5. Publications and dissemination activities

5.1 List extracted from Organic Eprints

Project description :

{Project} EcoOrchard: *EcoOrchard. Innovative design and management to boost functional biodiversity of organic orchards.* Runs 2015 - 2017. Project Leader(s): Sigsgaard, Assoc Prof Lene, University of Copenhagen .

{Project} ECOORCHARD_Germay: *Innovative Maßnahmen zur Föderung der funktionellen Biodiversität im ökologischen Kernobstanbau.* [Innovative design and management to boost functional biodiversity of organic orchards; subproject of the German partner.] Runs 2015 - 2017. Project Leader(s): Herz, Dr. Annette, Julius Kühn-Institut, D-Darmstadt.

Newspaper or magazine article:

Telfser, Josef and Kelderer, Markus (2016) Das Projekt Ecoorchard. *Südtiroler Landwirt*, 24 June 2016, 70, p. 62.

Telfser, Josef and Kelderer, Markus (2015) Bio-Vielfalt für gesunde Anlage. *Südtiroler Landwirt*, 3 March 2015, 69, p. 57.

Warlop, Francois (2015) Projet européen Eco-Orchard Biodiversité : quels auxiliaires dans mes pommiers ? *Arboriculture Fruitière*, 30 June 2015, p. 1.

Herz, Annette; Sharifova, Hadil; Penvern, Servane; Sigsgaard, Lene; Warlop, Francois and Pfiffner, Lukas (2017) EBIO-Network – a new knowledge platform on functional agrobiodiversity in European Orchards. *Core Organic Newsletter*, May 2017, pp. 1-4.

Sigsgaard, Lene; Herz, Annette; Warlop, Francois; Pfiffner, Lukas and Tchamitchian, Marc (2016) EcoOrchard -Innovative design and management to boost functional biodiversity of organic orchards. *CORE Organic News*, 4 May 2016, p. 1.

Hämmerli, Franziska (2018) Buon abbinamento: mele e fiori. *Bioattualità*, 2018 (7), pp. 10-11

Hämmerli, Franziska (2018) Gutes Duo: Äpfel und Blumen. *Bioaktuell*, 2018 (7), pp. 12-13.

Hämmerli, Franziska (2018) Un bon duo: Pommes et fleurs. *Bioactualités*, 2018 (7), pp. 12-13.

Handbook, technical guideline:

D'Yvoire, Caroline; WARLOP, FRANCOIS; Świergiel, Weronika; Sigsgaard, Lene and Porcel, Mario (2016) Booklet of simplified methods for the monitoring of functional biodiversity in organic orchards. , http://ebionetwork.julius-kuehn.de/. *Note: the technical paper/ booklet was updated in 2017 and has been translated to 6 languages available via EBIO-Network*

WARLOP, FRANCOIS; D'Yvoire, Caroline; Świergiel, Weronika; Sigsgaard, Lene and Porcel, Mario (2017) Manuel des méthodes simplifiées pour suivre la biodiversité fonctionnelle en vergers de pommiers. , http://ebionetwork.julius-kuehn.de/.

{Tool} *PRÆSENTATIONSHÅNDBOG MED ENKLE METODER TIL OPGØRELSE AF FUNKTIONEL BIODIVERSITET I ØKOLOGISKE FRUGTPLANTAGER.* Creator(s): D'Yvoire, Caroline; WARLOP, FRANCOIS; Świergiel, Weronika; Porcel, Mario; Jacobsen, Stíne K. and Sigsgaard, Lene. Issuing Organisation(s): GRAB, France, SLU, Sweden, University of Copenhagen, Denmark. (2017)

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Bandes fleuries vivaces – un outil pour améliorer le contrôle des ravageurs en vergers. 2018 edition. Guide technique. L'Institut de recherche de l'agriculture biologique (FiBL), CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Daudzgadigo ziedošo augu joslas – riks kaiteklu ierobežošanas uzlabošanai abelu stadijumos. 2018 edition. FiBL, CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Flerårige blomsterstriber – et værktøj til bedre skadedyrskontrol i æbleplantager. 2018 edition. Teknisk vejledning. FiBL, CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Franjas de flores perennes – una herramienta para mejorar el control de plagas en frutales. 2018 edition. Guía técnica. FiBL, CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Pasy kwiatowe – narzedzie pomagajace regulowac populacje szkodników w sadach jabloniowych. 2018 edition. Poradnik techniczny. FiBL, CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Perennial flower strips – a tool for improving pest control in fruit orchards. 2018 edition. Technical guide. Research Institute of Organic Agriculture (FiBL), CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Cahenzli, Fabian; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Strisce fiorite perenni – uno strumento per facilitare il controllo dei parassiti nei meleti. 2018 edition. Istituto di ricerche dell'agricoltura biologica (FiBL), CH-Frick.

Pfiffner, Lukas; Laurent, Jamar; Fabian, Cahenzli; Maren, Korsgaard; Weronika, Swiergiel and Lene, Sigsgaard (2018) Mehrjährige Blühstreifen – ein Instrument zur Förderung der natürlichen Schädlingsregulierung in Obstanlagen. Merkblatt. Forschungsinstitut für biologischen Landbau (FiBL), CH-Frick.

Conference paper, poster etc.

Fernique, Sarah; Penvern, Servane; Cardona, Aurélie; Ahrenfeldt, Erica; Grebeau, D.; Jamar, Laurent; kruzynska, Dorota; Matray, Silvia; Ozoliņa-Pole, Laura; Ralle, Baiba; Sigsgaard, Lene; Steinemann, Beatrice; Świergiel, Weronika; Telfser, Joseph; Warlop, Francois and Herz, Annette (2016) Organic farmers' reality to manage functional agrobiodiversity in European organic apple orchards. In: Foerdergemeinschaft Oekologischer Obstbau e.V. (FOEKO). (Ed.) *Organic farmers' reality to manage functional agrobiodiversity in European organic apple orchards*, Foerdergemeinschaft Oekologischer Obstbau e.V. (FOEKO) Traubenplatz 5, D-74189 Weinsberg E-Mail: foeko@foeko.de www.foeko.de, Weinsberg, pp. 268-269.

Herz, A.; Matray, S.; Sigsgaard, L.; Penvern, S.; Tchamitchian, M.; Warlop, F.; Pfiffner, L.; Kelderer, M.; Kruczynska, D.; Ozoliņa-Pole, L.; Jasko, J.; Jamar, L. and Porcel, M. (2017) EcoOrchard und EBIO-Network - Strategien für mehr funktionelle Biodiversität im Kernobstanbau. [EcoOrchard and EBIO-Network -

Strategies for more functional biodiversity in pome fruit growing.] In: *Entomologentagung 2017 in Freising: Abstract of poster*, p. 101.

Herz, Annette; Drexler, Nils; Matray, Silvia and Veekmann, Oliver (2017) Nutrition ecology of Ascogaster quadridentata (Hymenoptera, Braconidae) and its host in apple orchards. Poster at: 5th International Entomophagous Insects Conference, Kyoto, Japan, October 16-20, 2017. [Completed]

Herz, Annette; Penvern, Servane; Fernique, Sarah; Matray, Silvia and WARLOP, FRANCOIS (2016) Workshop: Enhancement of functional biodiversity. Workshop at: Ecofruit - 17th International Conference of Organic Fruit-Growing, Stuttgart Hohenheim, 15.02.-17.02.16. [Completed]

Jacobsen, Stíne K. (2017) Functional agrobiodiversity for pest control in apple. Poster at: Danish OIKOS Annual Meeting, Copenhagen University, 10/03/2017 - 11/03/2017.

Jacobsen, Stíne K. and Sigsgaard, Lene (2016) Functional agrobiodiversity - a novel approach to optimize pest control in fruit production. Poster at: Seminar: Future of crop protection, University of Copenhagen, Denmark, 28-10-2016.

Jacobsen, Stine K. and Sigsgaard, Lene (2017) Functional agrobiodiversity - a novel approach to optimize pest control in fruit production. Poster at: NJF Seminar 493, Riga, Latvia, 30/1-31/1, 2017.

Jamar, Laurent; Song, Janghoon; Lambert, Kevin and Lateur, Marc (2016) Functional agrobiodiversity in apple and pear pest management in Belgium. [Agrobiodiversité fonctionnelle pour la gestion des ravageurs en verger de pommes et poires en Belgique.] In: Reubens, Bert and Marchand, Fleur (Eds.) *Bridging gaps between principles and practices in agro-ecology*, GIRAF-FNRS-UGent-ILVO, pp. 37-39.

Kruczyńska, Dorota; Lisek, Jerzy; Sekrecka, Małgorzata; Soika, Grażyna; Bielicki, Paweł; Sigsgaard, Lene and Pfiffner, Lukas (2017) Rośliny przywabiające faunę pożyteczną w sadach. [Plants which attract the beneficial organisms in orchards.] Poster at: Green Days - Międzynarodowe Dni Zieleni, Nadarzyn, Poland, 2017.04.07-09.

Kruczyńska, Dorota; Sekrecka, Małgorzata; Lisek, Jerzy; Soika, Grażyna; Bielicki, Paweł; Sigsgaard, Lene and Pfiffner, Lukas (2017) Innowacyjne metody zwiększania „funkcjonalnej bioróżnorodności" w sadach. [Innovative methods for increasing 'functional biodiversity' in orchards.] Poster at: 57. Sesja Naukowa Instytutu Ochrony Roślin - Państwowego Instytutu Badawczego, Poznań, Poland, 2017.02.09-10.

Kruczyńska, Dorota; Sekrecka, Małgorzata; Soika, Grażyna; Lisek, Jerzy; Bielicki, Paweł; Sigsgaard, Lene and Pfiffner, Lukas (2017) Pożyteczna entomofauna w sadzie ekologicznym z pasami kwiatowymi. [Useful entomofauna in organic orchards with flower strips.] Poster at: XIX Konferencja Naukowa "Rolnictwo Ekologiczne - stan obecny i perspektywy rozwoju", Poznań, Poland, 2017.10.11-13.

Lindhard, Hanne; Maren, Korsgaard; Merete, Edelenbos and Vibeke, Langer (2017) Kernefrugt - Bedre økonomi frugtproduktionen gennem management og produktinnovation. Speech at: Økologi Kongressen 2017, Kolding, 30. november 2017.

Matray, Silvia; Herz, Annette; Pfiffner, Lukas and Sigsgaard, Lene (2017) Das Projekt EcoOrchard: Förderung der funktionellen Agro- Biodiversität im Ökologischen Obstbau. Poster at: 14. Wissenschaftstagung Ökologischer Landbau, Campus Weihenstephan, Freising-Weihenstephan, 7. -10. März 2017.

Matray, Silvia; Herz, Annette; Pfiffner, Lukas and Sigsgaard, Lene (2016) EcoOrchard.Innovative design and management to boost functional biodiversity of organic orchards. In: *Tagungsband 60. Deutsche Pflanzenschutztagung*.

Matray, Silvia; Herz, Annette; Pfiffner, Lukas and Sigsgaard, Lene (2015) Ecoorchard - Innovative design and management to boost functional biodiversity of organic orchards. Poster at: 34. Tagung des DPG-/DGaaE-Arbeitskreises "Nutzarthropoden und entomopathogen Nematoden", Hannover, Germany, 30.11.15-01.12.15. [Completed]

Matray, Silvia; Herz, Annette; Warlop, Francois; Pfiffner, Lukas and Sigsgaard, Lene (2017) Funktionelle Agro-Biodiversität im Obstbau. [Functional agro-biodiversity in apple orchards.] Poster at: Öko-Feldtage 2017, Frankenhausen, 21-22.06.2017.

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Ozoliņa-Pole, Laura; Ralle, Baiba; Salmane, Ineta; Warlop, Francois and Sigsgaard, Lene (2017) Functional agrobiodiversity techniques to support beneficial organisms in apple orchards of Latvia. Speech at: 59th International Scientific Conference of Daugavpils University, Daugavpils, Latvia, 06.-07.03.2017.

Ozoliņa-Pole, Laura; Salmane, Ineta; Ralle, Baiba; Warlop, Francois and Sigsgaard, Lene (2017) Funkcionālās agrobioloģiskās daudzveidības pasākumu novērtēšanas metodes ābeļu dārzos Latvijā. [Methods to evaluate functional agrobiodiversity in apple orchards in Latvia.] Poster at: 75. LU Zinātniskā konference, bioloģijas sekcija, zooloģijas apakšsekcija, Riga, 03.02.2017.

Porcel, Mario; Lene, Sigsgaard; Mark, Tchamitchian; Servane, Pernvern; Francois, Warlop; Lukas, Pfiffner; Laurent , Jamar; Annette, Herz and Mark, Lateur (2015) EcoOrchard - Innovative design and management to boost functional biodiversity of organic orchards. Power point presentation at public stakeholder seminar 2015.04.21 organized by EPOK centre for organic production and consumption, Swedish University of Argicultural Sciences, Alnarp, Sweden. [Completed]

Ralle, Baiba; Ozoliņa-Pole, Laura; Herz, Annette; Penvern, Servane; Warlop, Francois; Porcel, Mario; Tchamitchian, Marc; Pfiffner, Lukas; Jamar, Laurent; Kruczynska, Dorota; Korsgaard, Maren; Kelderer, Markus and Sigsgaard, Lene (2016) Functional agrobiodiversity (FAB) in apple pest management in Latvia: what do we know? In: *RPD Abstracts "3rd international scientific conference „Sustainable Fruit Growing: From Plant to Product" and 4th European Workshop on Seabuckthorn EuroWorkS 2016", Vol.2*, RPD Science, Dobele, 2, p. 44.

Ralle, Baiba; Ozoliņa-Pole, Laura; Warlop, Francois; Herz, Annette; Penvern, Servane; Porcel, Mario; Tchamitchian, Marc; Pfiffner, Lukas; Jamar, Laurent; Kruczynska, Dorota; Korsgaard, Maren; Kelderer, Markus and Sigsgaard, Lene (2016) Funkcionālā agrobioloģiskā daudzveidība un tās paaugstināšanas pasākumu novērtēšanas metodes: 2015.gada rezultāti. [Functional agrobiodiversity and its efficiency evaluation methods: results form 2015.] Poster at: Līdzsvarota lauksaimniecība, Jelgava, Latvia, 2016.02.25.-26. [draft]

Sigsgaard, Lene (2017) Functional agrobiodiversity for control of pests. In: *Nordic Association of Agricultural Scientists NJF report*, 11 (2).

Sigsgaard, Lene (2018) Blomsterstriber og naturlige fjender - forsøg og observationer i æble. Speech at: Kernefrugt Temadag, GartneriRådgivningen A/S, Odense, 30. Januar 2018.

Sigsgaard, Lene; Warlop, Francois; Herz, Annette; Tchamitchian, Marc; Porcel, Mario; Kelderer, Markus; Jamar, Laurent; Korsgaard, Maren; Ralle, Baiba; Penvern, Servane; Pfiffner, Lukas and Weibel, Franco (2016) Innovative design and management to boost functional biodiversity of organic orchards. Poster at: Ecofruit 2016, Hohenheim, DE, 15-17/02/2016.

Sigsgaard, Lene; Pfiffner, Lukas; Penvern, Servane; Tchamitchian, Marc; WARLOP, FRANCOIS; Herz, Annette; Kelderer, Markus; Jamar, Laurent; Kruzynska, Dorota; Korsgaard, Maren; Tasin, Marco and Jasko, Janis (2018) Functional agrobiodiversity in apple orchards. In: *ECE 2018, XI EUROPEAN CONGRESS OF ENTOMOLOGY*, p. 30.

Warlop, Francois; Penvern, Servane; Weibel, Franco; Herz, Annette; Porcel, Mario; Tchamitchian, Marc and Sigsgaard, Lene (2015) Innovative design and management to boost functional biodiversity of organic orchards : the ECOORCHARD project. Poster at: INNOHORT 2015, Avignon, 8-12 June 2015.

Weronika, Swiergiel; Mario, Porcel; Joakim, Pålsson and Marco, Tasin (2017) Konceptuell modell Övervakningsmetoder för naturliga fiender i relation till skadegörarförekomst, biologi och metodernas styrkor och svagheter. [Monitoring methods for natural enemies in relation to pests, biology and the strengths and weaknesses of different methods.] In: *Trädgårdskonferensen 2017*. [Completed]

Weronika, Swiergiel; Märta, Johansson; Marco, Tasin; Joakim, Pålsson and Mario, Porcel (2017) Praktiska erfarenheter med blomsterremsor i äppelodling från forskning & praktik. Lecture at: Trädgårdskonferensen, Linköpling, Sweden, 2017-10-24. [Completed]

Proceedings:

Sigsgaard, Lene and Jacobsen, Stine K. (2017) Functional agrobiodiversity –a novel approach to optimize pest control in fruit production. In: Begg, Graham; Bianchi, Felix; Birch, Nick; Gerowitt, Bärbel; Holland, John; Lupi, Daniela; Moonen, Camilla; Ramsden, Marc and Rijn, van, Paul (Eds.) *IOBC-WPRS Bulletin*, International organisation for Biological Control-Western Palearctic Regional Section, Darmstadt, 122, pp. 26-28.

Sigsgaard, Lene; Warlop, Francois; Herz, Annette; Tchamitchian, Marc; Pfiffner, Lukas; Kelderer, Markus; Jamar, Laurent; kruzynska, Dorota; Korsgaard, Maren; tasin, Marco and Ozoliņa-Pole, Laura (2017) EcoOrchard – collecting existing knowledge and generating new knowledge on functional biodiversity of organic orchards. In: Begg, Graham; Bianchi, Felix; Birch, Nick; Gerowitt, Bärbel; Holland, John; Lupi, Daniela; Moonen, Camilla; Ramsden, Marc and Rijn, van, Paul (Eds.) *IOBC-WPRS Bulletin*, International organisation for Biological Control-Western Palearctic Regional Section, Darmstadt, 122, IOBC-WPRS Bulletin, pp. 147-150.

Research facility description

Herz, Annette; Matray, Silvia; Sharifova, Hadil; Wolck, Anja; Sigsgaard, Lene; Penvern, Servane; Fernique, Sarah; Tchamitchian, Marc; Warlop, Francois; Pfiffner, Lukas; Kelderer, M.; Kruczynska, Dorota; Ozoliņa-Pole, Laura; Jamar, Laurent and Morcel, Mario (2016) EBIO-Network: a web-based platform for knowledge sharing on functional agrobiodiversity in organic apple production. In: *EBIO-Network: a web-based platform for knowledge sharing on functional agrobiodiversity in organic apple production.*

Papers mentioning EcoOrchard

Mathiasen, Helle and Korsgaard, Maren (2016) På jagt efter flere nyttedyr. [Hunting for more beneficial insects.] *Gartnertidende*, 19 May 2016, 2016 (7), pp. 20-21.

Bisgaard, Annemarie (2017) Naturlige fjender er velkomne. . Online at http://www.gartnertidende.dk/frugtbaer/nyheder/2017/naturlige-fjender-er-velkomne#.Wv64dORlKUk, accessed on: 23 May 2017.

Serikstad, Grete Lene (2018) Biodiversitet er viktig i økologisk frukt- og bærdyrking. [Biodiversity important in organic fruit and berry production.] *Økologisk landbruk*, March 2018, 37 (1), pp. 21-23.

Serikstad, Grete Lene (2017) Biodiversitet som støtte i fruktdyrkinga. [Biodiversity support in fruit growing.] *Norsk Frukt og Bær*, December 2017, 20 (6), pp. 12-14.

Liebl, Boris; Ahrens, Kerstin; Bruder, Vera; Greiner, Ramona; Henryson, Ann-Sofie; Hermanowski, Susanne; Knoll, Maximilian; Kasperczyk, Nadja; Kreß, Isabell; Schäfer, Freya; Spiegel, Ann-Kathrin; Tennhardt, Lina; Varzic, Biljana; Veller, Carsten and Wilbois, Klaus-Peter (2018) Auf Augenhöhe: Wissenstransfer zwischen Forschung und Praxis der ökologischen und nachhaltigen Land- und Lebensmittelwirtschaft (Teilprojekt des FiBL Deutschland e.V.). [On a par: Knowledge transfer between science and practice in organic and sustainable farming and food production.] FiBL Deutschland e.V., D-Frankfurt.

Deposited, awaiting revision in Organic Eprints

Sigsgaard, Lene (2017) IPM strategier. [IPM strategies.] *Momentum*, 2 June 2017 (2), pp. 16-19.

Sigsgaard, Lene; Warlop, Francois; Pfiffner, Lukas and Herz, Annette (2018) New tools to manage and assess orchard Functional Agrobiodiversity (FAB). *CORE Organic Plus news*, 27 August 2018, p. 13134.

5.2 Additional dissemination activities

(List of dissemination activities not uploaded in Organic Eprints)

Oral presentations

Cardona, Aurélie, Penvern, Servane, Tchamitchian, Marc, 2018. Researchers, advisors and growers working together to design monitoring methods for functional agro-biodiversity. 13. European IFSA Symposium (2018-07-01-2018-07-05) Chania (GRC).

Herz, Annette, L. Ozoliņa-Pole, F. Warlop, S. Penvern, M. Porcel, M. Tchamitchian, L. Pfiffner, L. Jamar, D. Kruczynska, M. Korsgaard, M. Kelderer, L. Sigsgaard 12/6/16, "Innovative design and management to boost functional biodiversity of organic orchards" Großes Theater - kleine Welten:- Biodiversität: 1000 Arten für den Pflanzenschutz, - Rund um den gesunden Apfel, Poster / oral presentation, open house presentation

Herz, Annette, Pfiffner, Lukas, Francois Warlop, Servane Penvern, Sigsgaard, Lene et al. 2018. EcoOrchard: Boosting agro-biodiversity in European apple orchards oral presentation. 17th January 2018. BioBeurs, Trade on biological products (consumers, producers, farmers, researchers, 40 attendees)

Herz, Annette, Silvia Matray, Simon Feiertag (2018) Exhibition stand with EcoOrchard information desk (video, leaflet, etc.). Biofach Nuremberg, 13.-17.02.18

Jacobsen, S.K. 2017. Functional agrobiodiversity for pest control in apple. Oral presentation 11.03.2017 OIKOS 2017 meeting, Copenhagen. (scientists, 120)

Jamar, Laurent, Marc Lateur. 2015. How to increase the resilience of the agro-ecosystem orchard to diseases and pests? Arboriculture Pratiques alternatives aux produits phytos -Effet de la gestion des litières de feuilles en automne sur le développement de la tavelure du pommier: Comment accroître la résilience de l'agroécosystème verger face aux maladies et ravageurs? Oral presentation 5-2-15 De la recherche à l'action en Agriculture biologique, Gembloux Belgium

Jamar, Laurent 15/3/16 "Innovative design and management to boost functional biodiversity of organic orchards." Biodiversité fonctionnelle : quel impact sur les bioagresseurs ? oral presentation, Journée technique, Normandie, Tour en Bessin

Jamar, Laurent 10/6/16 A visit of the experimental orchard was organized, oral presentation, National Organic Week, http://www.apaqw.be/Semaine-Bio/Qui-Quoi.aspx?Qui=50

Jamar, Laurent, 19/6/18, Presentation of WP3 results in Paris, during a technical day dedicated to flower strips : https://wiki.itab-lab.fr/muscari/?Rendu

Fernique, Sarah, S. Penvern 2016 Favoriser la biodiversité fonctionnelle dans les vergers de pommiers oral presentation, Rencontres Vergers Durables, n°9, 9/1/16

Kelderer, M., J.Telfser. 2016. Experimentation 2016. Versuchstätigkeit 2016 – EcoOrchard. Oral presentation. 02.02.2016. Bioland Seminar, Ritten, Italy (advisors, growers)

Korsgaard, Maren, Lene Sigsgaard. 2017. Open house arrangement about EcoOrchard, Protecfruit and FAB. 17May2017. UCPH and EcoAdvice (growers, advisors, journalists, scientists, 18 participants)

Dorota Kruczyńska, Dorota, Elżbieta Rozpara, Małgorzata Sekrecka. 2017. EcoOrchard - Innovative design and management to boost functional biodiversity of organic orchards. Innowacyjne metody zwiększania „funkcjonalnej bioróżnorodności" w ekologicznych sadach jabłoniowych. Oral presentation, practical work in the orchard 2017.08.17. workshop for ERASMUS students (students, researchers 36)

Kruczyńska, Dorota, M. Sekrecka, J. Lisek, G. Soika, P. Bielicki, L. Sigsgaard, L. Pfiffner and EcoOrchard team 2017. Innovative methods for increasing 'functional biodiversity in orchards. Innowacyjne metody zwiększania „funkcjonalnej bioróżnorodności w sadach. Poster 2017.02.9-10 57. Naukowa Sesja Instytutu Ochrony Roślin (57th Science Session Institute of Plant Protection State Research Institute. Presentation of the poster "Innovative design and management to boost functional biodiversity of organic orchards"), Poznań, Poland (for Researches, advisors)

Kruczyńska, Dorota, Małgorzata Sekrecka, Jerzy Lisek, Paweł Bielicki 2017. Practical aspekts of flower strips in apple orchards. How to use the methods for biodiversity evaluation. Praktyczne aspekty pasków kwiatowych w sadach jabłoniowych. Jak korzystać z metod oceny różnorodności biologicznej. Oral presentation and practical application of methods for the assessment of biodiversity, 2017.06.05. Workshop organized in InHort Experimental Orchard dedicated organic fruit production. Nowy Dwór, Poland (organic farmers, advisors, 21 participants). Abstract and photo report are available on www.inhort.pl .

Jerzy Lisek 2017. Plants which attract the beneficial organisms in orchards. Rośliny przywabiające faunę pożyteczną w sadach. oral presentation 2017.04.7-9. Green Days - Międzynarodowe Dni Zieleni, Nadarzyn, Poland (Farmers, advisors, researches, 50 attendees)

Jerzy Lisek. 2017. EcoOrchard - Plants which attract the beneficial organisms in orchards EcoOrchard – rośliny przywabiające faunę pożyteczną w sadach. oral presentation 2017.06.08. XX Dni Otwartych Drzwi Instytutu Ogrodnictwa, Dąbrowice, Poland (farmers, advisors, researchers, board of agriculture, media, 80 participants)

Matray, Silvia, Herz, Annette, Feiertag, Simon 2018. EcoOrchard: Boosting agro-biodoversity in European apple orchards. Exhibition 14-18. February 2018 Biofach, Trade on Biological products, organic production (consumers, producers, farmers, researchers

Matray, Silvia, Herz, Annette; Pfiffner, Lukas, Warlop, Francois and Sigsgaard, Lene 2017. EcoOrchard: Boosting agro-biodiversity in European apple orchards. Oral presentation 8-10.11.2017. Young Scientists Meeting, Siebeldingen (scientists, 70 participants)

Ozoliņa-Pole, Laura. 2016. Plant protection in organic apple orchards. Augu aizsardzība bioloģiskajos ābeļu stādījumos. Oral presentation 11.04.2016. Workshop organized by LPPRC "Funkcionālās agrobioloģiskās daudzveidības potenciāls augu aizsardzībā bioloģiskajos ābeļu stādījumos"

Ozoliņa-Pole, Laura 2017. Methods for evaluating functional agro-biodiversity and their usefulness for assesing the pest and beneficial levels in apple orchards Funkcionālās agrobioloģiskās daudzveidības novērtēšanas metodes un to pielietojamība derīgo un kaitīgo organismu uzskaitei ābeļu stādījumos. Oral presentation12.04.2017. Workshop organized by LPPRC "Videi draudzīga augu aizsardzība bioloģiskajos un integrētajos augļu dārzos." (farmers, general public)

Ozoliņa-Pole, Laura 2017.Methods for evaluating functional agro-biodiversity and their usefulness for assesing the pest and beneficial levels in apple orchards Funkcionālās agrobioloģiskās daudzveidības novērtēšanas metodes un to pielietojamība derīgo un kaitīgo organismu uzskaitei ābeļu stādījumos. Oral presentation 12.04.2017. Workshop organized by LPPRC "Videi draudzīga augu aizsardzība bioloģiskajos un integrētajos augļu dārzos." (farmers, general public)

Ozoliņa-Pole, L.,I. Salmane, B. Ralle, F. Warlop, L. Sigsgaard. 2017. Methods to evaluate functional agrobiodiversity in apple orchards in Latvia. Funkcionālās agrobioloģiskās daudzveidības pasākumu novērtēšanas metodes ābeļu dārzos Latvijā. Poster prensentation 03.02.2017. 75. LU Zinātniskā konference, bioloģijas sekcija, zooloģijas apakšsekcija (national conference in Latvian) (scientists, 50 participants).

Pfiffner, Lukas, Sigsgaard, Lene; Warlop, Francois; Herz, Annette; Tchamitchian, Marc; Porcel, Mario; Kelderer, Markus; Jamar, Laurent; Korsgaard, Maren; Ralle, Baiba; Penvern, Servane; Weibel, Franco 26/6/16 "Innovative design and management to boost functional biodiversity of organic orchards" Wildblumenvielfalt für "Buur und Natur", Poster / oral presentation, open house presentation

Pfiffner, L, F. Cahenzli, C. Daniel, B. Steinemann, I. Giordano, A. Häseli, F. Weibel 22/1/16 "Enhancement of apple orchards with functional biodiversity", Aufwertung von Obstanlagen mit funktioneller Biodiversität oral and ppt presentation, Bioobstbautagung FiBL 22. Januar 2016, Frick.
https://www.fibl.org/fileadmin/documents/de/fibl-kurskalender.pdf

Lukas Pfiffner, F. Cahenzli, C. Daniel, B. Steinemann, I. Giordano, A. Häseli, F. Weibel 2017 Enhancement of apple orchards with functional biodiversity. Aufwertung von Obstanlagen mit funktioneller Biodiversität oral and ppt presentation 22.6. 2017, FiBL Tagung, Marcelin.

L. Pfiffner, F. Cahenzli, C. Daniel, B. Steinemann 2017. Flower strips in apple farming systems to boost pest control. Funktionelle Biodiversität in Niederstamm-Obstanlagen. oral and ppt presentation. 14.12. 2017, Bio-Obsttagung in Steiermark/Austria.

Lukas Pfiffner, Sigsgaard, Lene; Warlop, Francois; Herz, Annette; Tchamitchian, Marc; Porcel, Mario; Kelderer, Markus; Jamar, Laurent; Korsgaard, Maren; Ralle, Baiba; Penvern, Servane; Weibel, Franco 26/6/16 "Innovative design and management to boost functional biodiversity of organic orchards" Wildblumenvielfalt für "Buur und Natur", Poster / oral presentation, open house presentation.

Baiba Ralle. 2016. Methods to evaluate measures taken to increase functional agro-biodiversity. Funkcionālās agrobioloģiskās daudzveidības paaugstināšanas pasākumu novērtēšanas metodes. 11.04.2016. Workshop organized by LPPRC "Funkcionālās agrobioloģiskās daudzveidības potenciāls augu aizsardzībā bioloģiskajos ābeļu stādījumos". Oral presentation.

Baiba Ralle. 2016. Use of traps in organic apple orchardsLamatu izmantošana bioloģiskajos ābeļu stādījumos. Oral presentation 11.04.2016. Workshop organized by LPPRC "Funkcionālās agrobioloģiskās daudzveidības potenciāls augu aizsardzībā bioloģiskajos ābeļu stādījumos"

Elżbieta Rozpara, Dorota Kruczyńska, Małgorzata Sekrecka. 2017. Ecological methods of apple production. Produkcja jabłek metodami ekologicznymi. Oral presentations demonstration of flower strips 2017.09.05. Workshop organized in InHort Experimental Orchard dedicated organic fruit production. Nowy Dwór, Poland (organic farmers, advisors, media, 115 particiants). The abstract and photo report are available on www.inhort.pl

Ineta Salmane. 2016. Measures for incereasing functional agro-biodiversity. Funkcionālās agrobioloģiskās daudzveidības paaugstināšanas pasākumi. Oral presentation. 11.04.2016 Workshop organized by LPPRC "Funkcionālās agrobioloģiskās daudzveidības potenciāls augu aizsardzībā bioloģiskajos ābeļu stādījumos".

Sekrecka, Małgorzata. 2017. A useful entomofauna in organic orchard with flower stripes. Pożyteczna entomofauna w sadzie ekologicznym z pasami kwiatowymi". Oral presentation 2017.10.11-13, 19th Scientific Conference „Organic farming - current state and development prospects", (International researches, advisors).

Sigsgaard, Lene, Stine Kramer Jacobsen, Jørgen Eilenberg, Bernhardt M. Steinwender 13 Feb 2016 "New knowledge about natural enemies of pests in apple orchards" Ny viden om naturlige fjender af skadedyr i æble, oral presentation and ppt. Temadag Økologisk æble- og pæredyrkning Gartnerirådgivningen, Odense, 13 januar 2016.

Sigsgaard, Lene, Korsgaard, Maren 15 Apr 2016 "More beneficial insect in the orchard from innovative design and management and methods to assess natural control"Flere nyttige insekter i plantagen ved innovativ design og pasning samt metoder til vurdering af "naturlig bekæmpelse" workshop, oral presentation w ppt, field demonstration, Pometum, UCPH (growers, advisors, scientists, 13 participants)

Sigsgaard, Lene, Marc Tchamitchian, Servane Penvern, François Warlop. Presentation to French stakeholders of Ecoorchard results. INRA, 22 Nov. 2017. (ca 50 participants) http://www.grab.fr/restitution-du-projet-ecoorchard-22-nov-2017-avignon-84-9672

Sigsgaard, L. 2017. Field demonstration day with an organic growers group: FAB and flower strips with demonstration of FAB techniques and principles, oral. 02JUN2017 (7 participants)

Sigsgaard, L. 2017. Prevention in IPM. Forebyggelse i IPM. Oral presentation. 25 October 2017. Debate meeting 'Fremtidens afgrøder uden kemi' at UCPH (scientists, advisors, students, farmers with education in agricultural sciences, 38 participants)

Sigsgaard, L. 2017. Can we manage without pesticides? Kan vi helt undvære pesticider? Oral presentation 24 October 2017 (12-17). Debate meeting about the future of Danish horticulture in the Danish parliament building (growers, horticultural students and horticultural workers, industry (energy, others), politicians, grower organisations, total ca 100)

Soika, Grażyna (2017). The role of beneficial organisms in limiting the population of apple-aphid. Rola fauny pożytecznej w ograniczaniu populacji mszycy jabłoniowo-babkowej. oral presentation 2017.04.7-9, Green Days - Międzynarodowe Dni Zieleni, Nadarzyn, Poland (Farmers, advisors, researchers, 50 attendees)

Swiergiel, W, Joakim Pålsson, Märta Johansson (2017) Field demonstration day: FAB and flower strips 2017.08.30 SLU and Fylkesmannen i Hordaland from Norway (10 participants, Growers, researchers, advisors, agricultural board)

Penvern, S., Dufils, Arnaud; Cardona, Aurélie; Tchamitchian, Marc; Warlop, François 12/3/15 "What are the tools and practices to foster FAB for apple organic growers in Europe?" Quels outils et pratiques en faveur de la biodiversité fonctionnelle chez les arboriculteurs bio d'Europe? Oral presentation, Rencontre Technique Agriculture Biologique fruits Ctifl-ITAB

Poster presentation

L. Jamar and all partners 2017 Management to boost functional biodiversity in orchard. Des aménagements pour favoriser la biodiversité fonctionnelle en verger. Poster prensentation 15&16 octobre 2017. BioXpo, Brussels Expo (scientists, advisors, growers, consumers)

Proceedings

Jamar L., Lateur M. 2015. Mieux vaut prévenir que guérir, le cas des cultures pérennes, l'arboriculture :"1ère JOURNEE « DE LA RECHERCHE A L'ACTION EN AGRICULTURE BIOLOGIQUE » La gestion des maladies, des parasites et des ravageurs : oral presentation and publication in the proceedings : http://www.cra.wallonie.be/fr/conferences/1ere-journee-de-la-recherche-a-laction-en-agriculture-biologique, 5 February 2015 in GEMBLOUX Belgium, 10p

University lectures

Lukas Pfiffner. 2016. Functional Biodiversity to improve Pest Control in Organic Cropping System. Lecture in Master Agricultura Ecológica, University of Barcelona, Facultad de Biología. 4.3.2016

L. Pfiffner, H.J. Schärer, H. Luka. 2017. Functional Biodiversity to improve Pest Control in Organic Cropping System. Lecture in Master Agricultura Ecológica, University of Barcelona, Facultad de Biología. 28.4.2017

Lukas Pfiffner. 2018. Functional Biodiversity to improve Pest Control in Organic Cropping System. Lecture in Master Agricultura Ecológica, University of Barcelona, Facultad de Biología. 11.3.2018

Lene Sigsgaard 2015-2017. The project has been presented in lectures and used in theoretical exercises in the MSc courses: 'Biological control' and 'Insects in agricultural and horticultural crops', and strips demonstrated as part of field excursion 2016 and -17 in the BSc course on conservation 'Faunaens vilkår I kulturlandskabet'

Journal

Herz, Annette 2017. "Mehr blühende Vielfalt in Obstanlagen hilft Nützlingen" 4 I 2017 Agrargewerbe intern I Saft und Wein.

Baiba Ralle 2016. Functional agro-biodiversity- what is it? Funkcionālā agrobioloģiskā daudzveidība- kas tas ir? Dārzs un Drava,3-4 (676-677):48-49. popular article 2016

Webpages

{Project} EcoOrchard. Innovative design and management to boost functional biodiversity of organic orchards. Project homepage at University of Copenhagen. Updated May 2018 https://plen.ku.dk/english/research/organismal_biology/applied_entomology/ecoorchard/

{Project} **Funktionelle Agro-Biodiversität zur Aufwertung von Bioapfelanlagen. EcoOrchard - ein EU-CORE Organic Plus Projekt.** http://www.fibl.org/de/schweiz/forschung/nutzpflanzenwissenschaften/pb-projekte/eco-orchard.html and engl. short Version: http://www.fibl.org/en/projectdatabase/projectitem/project/1041.html

{Project} The infrastructure for the **EBIO-Network** platform with exchange of data between stakeholders can be accessed on http://ebionetwork.julius-kuehn.de/ . *Note: Leaflets, videos and other information generated during EcoOrchard are available from this website and will be updated also in the future.*

{Project} Facebook group for future possible knowledge sharings : https://www.facebook.com/groups/1997035963876838/

Videos

In order to demonstrate the FAB monitoring methods selected in WP2, a movie has been created, and used during the workshops of WP4. It has been posted on Youtube :

- *in a French language version:*
- *in English language version as well:*

Another video (French subtitled English) shows how farmers get involved and interested in FAB self-assessment.

- http://www.arboriculture-fruitiere.com/content/biodiversite-quels-auxiliaires-dans-mes-pommiers
- http://www.gis-fruits.org/Page-d-accueil/Actualites/Video-pedagogique-observer-la-biodiversite-fonctionnelle-et-aller-jusqu-a-l-evaluation

Lukas Pfiffner. 2018. Perennial, multifunctional flower strips to boost natural pest control in apple orchards https://www.youtube.com/watch?v=gVEuYT1r4ns interview for a farmer newsportal – Bauernzeitung 2018 (for advisors, growers)

A design board

The design board "*design the orchard of the future*" presented at EcoOrchard final meeting in Avignon. The EcoOrchard list of FAB-techniques and funds from Eco-Orchard were used to design it. The board is still in development and an English version should be produced soon. Till now no leaflet has been written to present it.

5.3 Further possible actions for dissemination

List publication/deliverables/activities arising from the project that have been planned in the future

- Herz et al . *working title*: "Managing floral resources in apple orchards for pest control: experiences and future directions" . Literature review. Submission expected by November 2018. (Annex 3a)
- Penvern et al *working title:* "Farmers expectations and management of functional agro-biodiversity for pest management in European organic apple orchards." Interview survey, submission expected October 2018. (Annex 3b)

- Cahenzli et al. *Working title*: "Perennial flower strips for pest control in organic apple orchards - A pan-European study". Submitted and accepted with major revisions (Annex 3c)
- Pfiffner et al.: *Working title*: "Design, implementation and management of perennial flower strips to promote functional agrobiodiversity in organic apple orchards: a pan-European study". Near submission (Annex 3d)
- Cardona et al. *Working title yet to be decided.* Findings from wp4. Still in early phase. To be completed by end of 2018
- Warlop et al. WP2 field data are still under analysis, and a technical paper is to be issued during autumn 2018, exploring how farmers committed in FAB self-assessment, and which methods they chose according to their objectives.

  The first four scientific manuscripts are included in Annex 3 (a-d)

  A CORE Organic News about the FAB Handbook and the FAB technical guideline has been published

  In addition a professional journal (Réussir Fruits et Légumes) has heard of EcoOrchard and has planned 2 articles, one in the September issue (INRA team has post-proofed it), one in October or November issue. The first is on the results of the EcoOrchard survey, but also on the fact that the proposed techniques should be adapted to the farmers points of view on FAB, a result of the second workshop in WP4. The second will present results on flower strips. These 2 papers are not authored by us, but by Réussir F&L staff, after interviewing us.

List publications/deliverables arising from your project that Funding Bodies could consider disseminating

- Both our handbooks/technical leaflets are important to get disseminated to growers and advisors, they have been translated by our teams already, and are already available on EBIO-Network and on Organic Eprints, and they do serve an even wider audience. *The technical guideline is currently being translated to Norwegian also*

- The EBIO-Network is a valuable source of information that can be useful for advisors and growers and could be disseminated widely.

Indicate publications/deliverables that could usefully be translated (if this has not been done, and indicate target language)

- The design board "*design the orchard of the future*" The board is still in development and an English version should be produced soon. Till now, no leaflet has been written to present it.

5.4 Specific questions regarding dissemination and publications

Website
The project web site is up-to-date (2018):
http://plen.ku.dk/english/research/organismal_biology/applied_entomology/ecoorchard/

End users/ main-users of the research results –dissemination activities

Growers:
Technical journals, handbooks, workshops and meetings, open house arrangements, demonstration, videos of FAB techniques, field visits, personal contact and mail updates for growers involved with the project.

EBIO-Network is a resource, but the language (English) can mean that some growers will rely on their advisors to use the network. **Field visits** were organized for farmers at fall season, after harvest in 2016 in France, Denmark, Sweden and Switzerland and involved farmers gave their feedback at those occasions for discussion among stakeholders on perspectives.

Advisors:
Technical journals, handbooks, workshops and meetings, conferences, proceedings, open house arrangements, demonstration, field visits, homepages, videos of FAB techniques, personal contact and mail updates for advisors involved with the project as well as EBIO-Network, homepage, scientific papers

Scientists:
Technical journals, workshops and meetings, conferences and a conference workshop, proceedings, open house arrangements, demonstration, field visits, homepages, personal contacts. EBIO-Network, homepages, scientific papers.

Students:
Students at levels from BSc to PhD were reached by the project through university courses, individual assignments and by being involved with the project as well as from homepages, EBIO-Network, technical and scientific papers

Consumers/ general public:
Informative articles, workshops and meetings, open house arrangements, demonstration, field visits, homepages, personal contacts, as well EBIO-Network, scientific papers.

Industry:
Technical journals, workshops and meetings, open house arrangements, field visits, personal contacts with specific relevant groups such as producers of machinery and seeds for wildflower strips (WP3), EBIO-Network, homepages, scientific papers.

Funders:
Midterm and final reports will be provided to funders and publications are uploaded and made available through organic eprints.

Further for funders available other dissemination
Technical journals, open house arrangements (invitation), personal contacts, EBIO-Network, homepages, scientific papers

6. Project impact

Growers: The project has targeted this group specifically, and has built on, further developed and also expanded the ten partners' existing networks of growers. The use of field visits, open house, educational meetings and workshops have all worked well. Especially workshops are good at developing common knowledge across groups of growers, advisors and scientists about FAB. Growers have been very interested to test on their own simple methods to assess FAB techniques, and we look forward to learn from their experiences. The draft handbook from WP2 has been very well received by growers, who find that more such material is needed; also here we will collect their input after the end of season 2016 (questionnaire available). Also the first video has been well received and we aim that the EBIO-Network will also be of use to growers as from the **EU mapping** of involved farmers for EBIO-Network platform. Those growers with experiments/own trials in relation to WP2, WP3 and WP4 we have had frequent communication with and we also see that there are challenges in implementing FAB –simply learning to establish and to manage

interrow flower strips is an important aspect for growers. We notice a growing interest of organic farmers in FAB-implementation (especially new plant-mixtures, and the adapted management schemes and necessary machinery). Farmers were also an important part of the stakeholder workshop in connection with our final project meeting, and the board 'game' for orchard design has a great potential for workshops, training and teaching.

Advisors: At the beginning of the project, it was realised that in all countries to varying extent advisors/ extensionists are important in advising/interacting with growers in FAB establishment and assessment, and they have been involved both in interview survey and workshops and invited to open house and field visits arranged. Again our consortium members already collaborate closely with advisory service and as an additional strength EcoAdvice, Gefion are partners of the EcoOrchard project, helping to keep focus on advisors as a key group. The workshop at the Ecofruit conference was an addition to the planned project and also involved advisors. Both EcoOrchard homepage and especially EBIO-Network target advisors. The handbooks can also be of use to advisors in communicating with growers. In Poland we utilized the annual meeting to also invite local scientists, growers and advisors for a half day with us, for short presentations, discussions and an excursion to one of the experimental sites, and this was very useful.

Scientists: Our colleague scientists are reached through personal contacts, conferences and workshops, and through the proceedings, posters, articles and next scientific papers resulting from the project. Most of us are involved in other orchard studies with other scientists so there is also an informal communication flow and some good synergies as for example with the PROTECFRUIT project in Denmark, or MUSCARI project in France.
The workshop at the EcoFruit 2016 conference was a very good venue for discussion with colleagues in the FAB field. Several teams have contacted us about participating somehow in the EcoOrchard project, and during the first annual meeting a team from Crop Research Institute, Czech Republic participated.

Students: Students are the future advisors, scientists, administrators. They learn of the EcoOrchard project through relevant courses such as Biological control (MSc course, UCPH) and about insects in agriculture and horticulture (MSc course, UCPH). MSc students are also directly involved with the project as part of their theses so far at INRA, GRAB, JKI (BSc thesis June 2017) and UCPH (2 MSc theses, Aug 2016).
At GRAB a Czech PhD student (Katarina Kovarikova) spent 2 weeks at spring 2016 to learn about methods and field work, and a PhD student with Chinese stipend, Xueqing He, is doing her research partly under the EcoOrchard project at UCPH from Sept 2016 and visited SLU, the Swedish partner May-August 2018 as part of the collaboration in EcoOrchard.

Consumers/ general public: These groups we reach mostly indirectly through written and electronic media but also at open house arrangements. The public has great interest in more healthy fruit and when our first results from experiments are ready we can provide more informative material to this group. Consumers also benefit from landscape management achieved by farmers implementing flower strips.

Industry: For growers to successfully implement FAB techniques the methods, tools and products need to be in place and here national seed companies providing regional wild plant seed-mixtures, and machine industry who can make appropriate field equipment are important prerequisites. Especially through WP3 communication with these parts of industry are ongoing (e.g. Humus machineries). Also plant breeders, biocontrol industry and others are important and are in our network and/or involved in other projects with consortium partners.

Decision makers/ administrators (ministries, other):
Nowadays many national action plans to reduce pesticides in cropping systems are on-going or in planning. Therefore, novel approaches of FAB to make cropping more resilient to pests and less dependent of pesticides by enhancing key-antagonists are greatly welcomed by many decision makers. Especially in high-input crops as orchards it would be desirable to reduce pesticide-input. Furthermore, decision-makers are also aware of the conflict between intensive agricultural management and increasing loss of biodiversity.

Therefore management techniques which favour (functional) biodiversity in agricultural systems are urgently needed and will hopefully be implemented in "greening" and other agroenvironmental measures launched and supported by authorities, in order to motivate more farmers to FAB.

Funders: The collaboration between the EcoOrchard-consortium and the funding bodies (both EU as well as national ones) worked smoothly and very cooperative due to intensive information and feedback politics. Therefore, due to the well going performance of the project, funders may have a satisfying feeling on the proper financing of the "right" proposal and receive new ideas for further calls.

7. Added value of the transnational cooperation in relation to the subject

In many European countries, apple orchards are landscape-dominating agricultural systems. Due to their perennial cultivation, their management affects the nature, flora and fauna, thus biodiversity, in a region in a substantial way. Depending on the management system this effect can be significant. Organic orchards allow higher levels of biodiversity due to lower input of pesticides and are therefore suitable targets for measures with the aim to increase functional (agro-) biodiversity (FAB). By carrying out the research on a transnational basis, EcoOrchard could test measures to improve FAB in this important agroecosystem on a wide European range. First tools for management of FAB were developed mainly at regional/national scale (e.g. by "Vergers durables", "FOEKO") and discussed and interpreted in international forums (IOBC-WPRS WG " Integrated Fruit Production", "Landscape ecology", "Ecofruit"-Conference). But the EcoOrchard project brought together major actors of these groups across Europe allowing exchange and transfer of knowledge from practice to theory and vice versa. From this fundament the development of new methods and designs for FAB was made. The target pests (rosy apple aphid, codling moth) are of European wide concern and cause economic loss in organic fruit production across the Northern, Central and Southern Europe, where the applicant institutions are based. By combining the different fields of expertise ranging from advisory service over agriculture, weed science, plant pathology to pest ecology and crop protection, EcoOrchard could optimize the process of developing methods and designs economically as well. At the same time our collaborative experiments in several countries ensured that methods were developed which were applicable across diverse management systems, landscapes and countries, ranging from intensively managed agricultural landscapes (Denmark, Belgium (Wallonia), Germany, France) to landscapes with more natural vegetation or higher structural diversity (Switzerland, Poland, Latvia). Partners have together developed shared protocols so data collected in the EcoOrchard project could be analyzed across countries allowing a cross-country understanding of FAB practices, methods and impacts. This high degree of collaboration in various European regions creates the perspective for European wide adoption and efficient application of the results in organic fruit farms. The stakeholder platform EBIO-Network has opened a forum for the exchange of ideas, documentation of results and recommendations for the fruit growing practice. The consortium is linked to main target groups of scientists, growers, advisory services and consumers through direct partnership and through established collaborations and networks. These target groups have been directly involved in the project through participation in EBION and were and are brought together on the European level as unique opportunity.

8. Suggestions for future research

Results from the project point to the relevance for future research in several areas, of which we would like to point to the below four areas:

a) Insect-plant dynamics as a driver of ecosystem services from insects, accentuated by their key economical contribution to agriculture
b) Agroforestry: how could orchards use of flower strips be further optimized for improved ecosystemic services, and how may orchard re-design be used to further improve productivity and

resilience. How could flower strips be more intricated with trees, perhaps under trees. Effects on competition/synergies and multi-services.

c) Landscape ecology. What is the impact of resources outside the orchard, the orchard size and the surrounding landscape structures on main natural enemies? How does the impact of inter-row flower strips in the orchard vary depending on the structure of the surrounding landscape?
d) Longer term studies of perennial flower strips as a FAB structure and their durability (can high plant diversity be maintained over several years), aiming at identifying their long-term development and the long-term effects on natural enemies, pollinators and pests, as well as FAB

Annex 2: Recommendations to the CORE Organic consortium in relation to launching and monitoring of future transnationally funded research projects

We were very pleased with having a contact person, and Lieve de Cock is very helpful for us as an advisor and to help us be in good time also with aspects related to the monitoring. Lieve also did a nice job of introducing the organic eprint to the team, but still it would be very helpful if it could be made easier to upload material to organic eprint, at present the import function does not work well. That being said we agree that it is a good way to increase visibility and overview of the dissemination.

The opportunity to work together across countries and disciplines under the CORE Organic is a very good one, and Functional AgroBiodiversity is an area that is strongly benefitting from collaboration across countries bringing teams, people and knowledge together.

For us the joint protocol and shared guidelines have meant that we could achieve higher quality of our work than would have been possible for a single team with a limited budget, and such Pan-European studies are of a higher value. Therefore, we find that real joint research should be a priority of future calls. It is our experience that such a process takes time, and this should be included in project planning and budgeting.

More time was put into the project by partners, than is reflected in the cost overview. Such time was typically invested by permanent staff and by dedicated postdocs and PhDs. Utilizing and finding synergies with other projects and with activities such as teaching and training has helped manage this workload. It is important to support future projects to utilize synergies.

Annex 3: EcoOrchard Scientific Manuscripts

3a. Herz et al . *working title*: "Managing floral resources in apple orchards for pest control: experiences and future directions" . Literature review. Submission expected by October 2018.
3b. Penvern et al *working title:* "Farmers expectations and management of functional agro-biodiversity for pest management in European organic apple orchards." Interview survey, submission expected October 2018.
3c. Cahenzli et al. *Working title*: "Perennial flower strips for pest control in organic apple orchards - A pan-European study". Submitted and accepted with major revisions
3d. Pfiffner et al.: *Working title*: "Design, implementation and management of perennial flower strips to promote functional agrobiodiversity in organic apple orchards: a pan-European study". Near submission

Annex 4: EcoOrchard technical guideline, English version

Pfiffner L, Jamar L, Cahenzli F, Korsgaard M, Swiergiel W, Sigsgaard L (2018). Perennial flower strips – a tool for improving pest control in fruit orchards. 2018, Merkblatt Nr. 1096, 16p. Edts. FiBL, SLU, CRAW, VKST, UCPH www.fibl-shop.org