

The importance of non-crop vegetation in fruit

Venue: Web Interaction CDG HOS -
Fruit & vegetable sector 25 09 2020

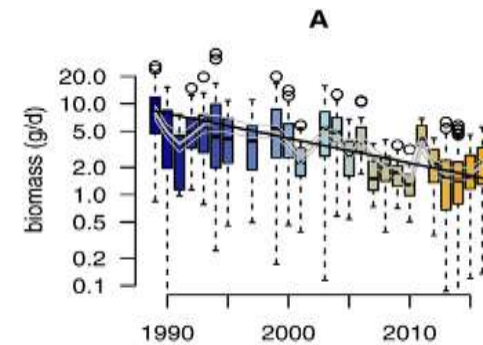
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Intensified agriculture

- In Denmark 61% cultivated
- Larger fields, fewer hedgerows, narrower field margins, fewer trees, fewer footpaths etc.
- Fewer and more fragmented nature areas
- Eutrofication with nitrogen (ca 12 kg/ha deposition in Denmark)
- Use of pesticides



75% reduction in insect biomass
in 27 year in German nature
areas (*Hallmann et al. PLOS 1, 2017*)



Lack of food in the agricultural landscape in Denmark as illustrated by dropping honeybee hive weight gain in July

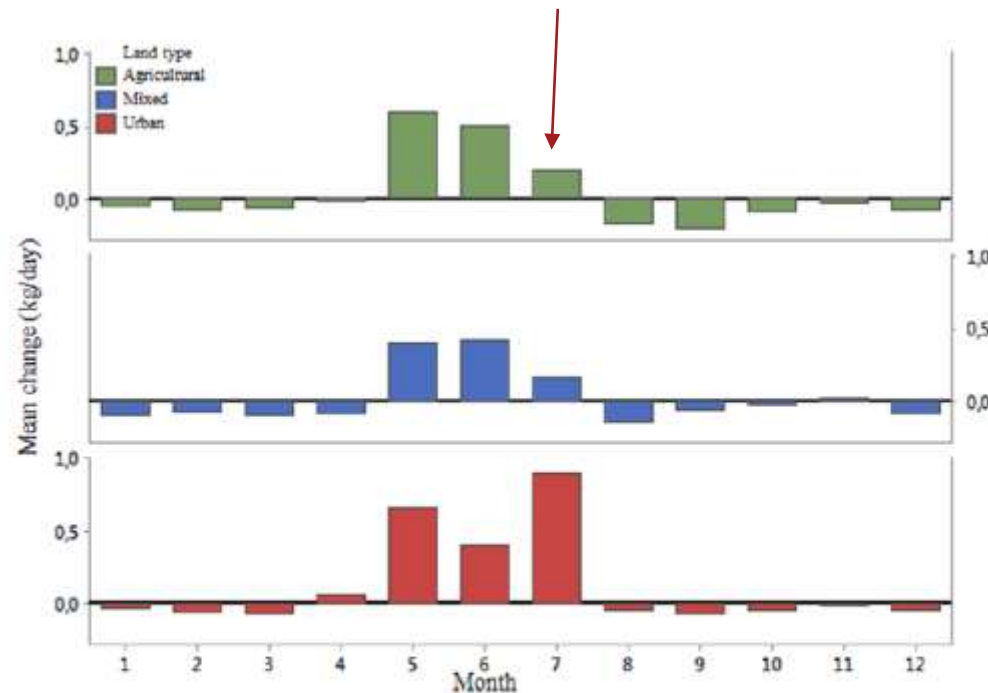


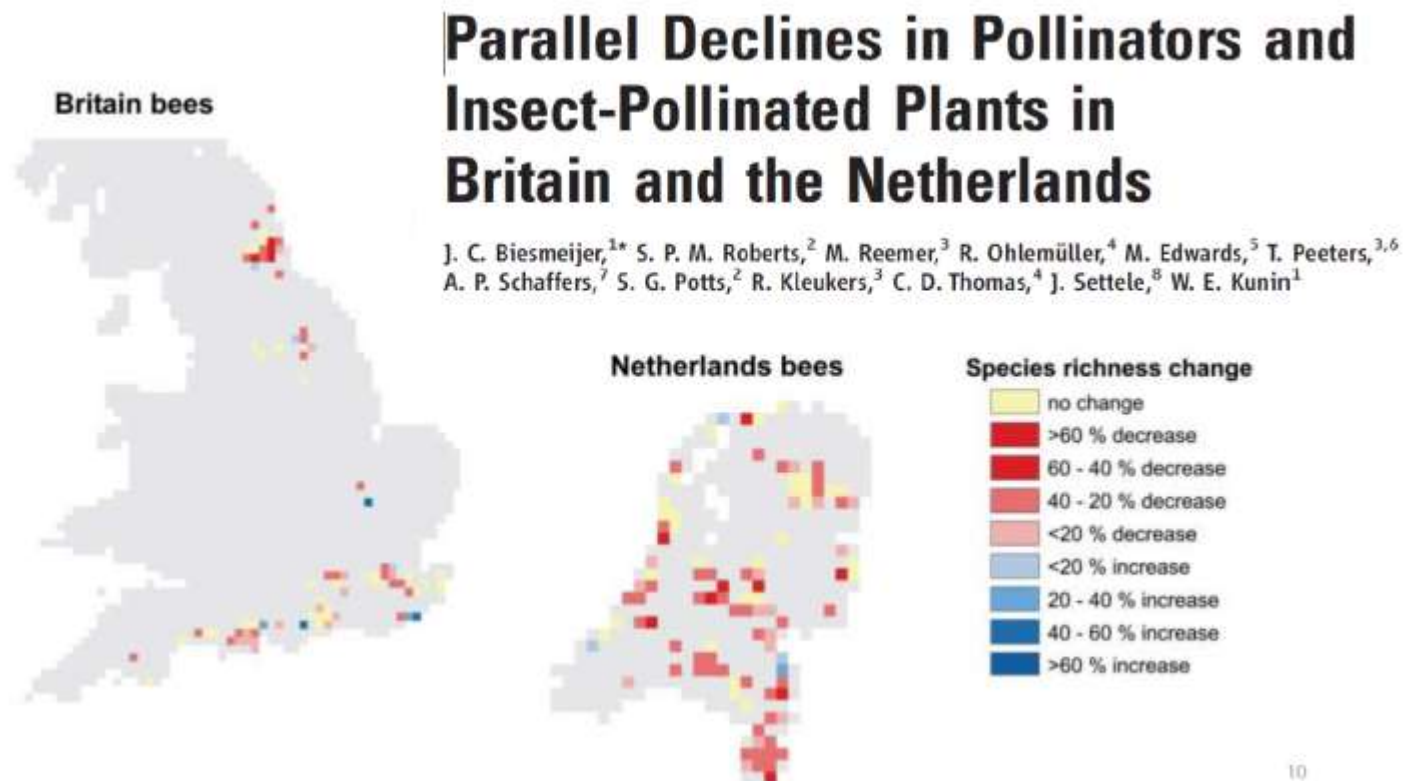
Fig 10. Average monthly change in weight, in kg/day, by landscape type for a 1km radius circle around the hives.

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Lecocq et al. 2015

Consequences

- Decline in natural enemies and natural biological control
 - Natural biocontrol has an estimated world value of 400 USD/year (Constanza et al..)
- Decline in pollinators and pollination services
 - Pollination services estimated value in apple
- Risk of lower yield → Need to support natural enemies and pollinators on farm

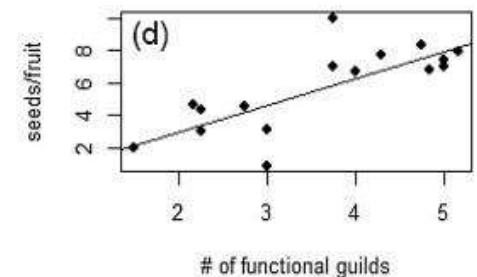
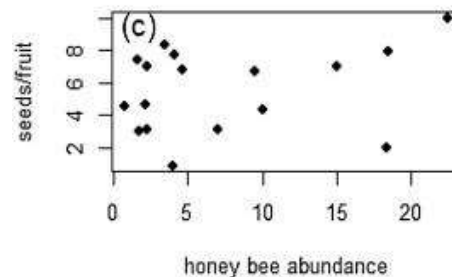


Insecticides and beneficials value in apple orchards

- France 5-15 insecticide sprays/y, half w. pheromone disruption (Sauphanor, 2009)
- UK 5 insecticide sprays/y (Garthwaite et al, 2012) -- ca 400 euro/ha
- Phytoseiid predatory mites and Common Earwig, *Forficula auricularia* eliminate the need for 1–2 acaricide sprays and 2–3 insecticide applications per annum (Cross et al. [2015](#)).
- Estimated pollinator contribution to apple yield 60%, per ha 10.600 £ (Garrat et al. 2013).

Perennial orchards offer a habitat for a more abundant and diverse community of organisms –*Potential to utilize*

- Diverse natural enemies functional group → improve biocontrol
- Diverse pollinator functional groups → better pollination in apple (Blitzer et al. 2016) – and sweet cherry (Eerarts et al 2019)



Blitzer et al 2016

Requirements of natural enemies and pollinators

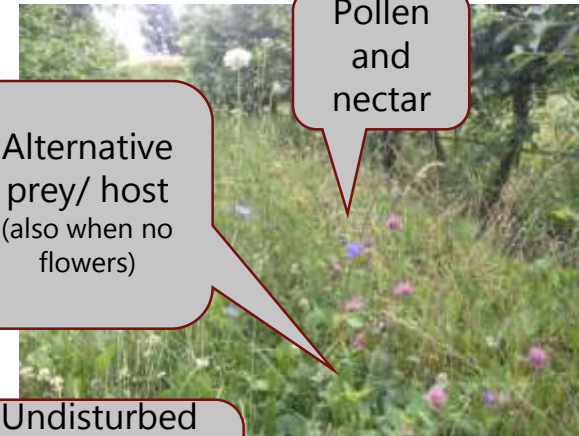
Both

- **Flowers all season** (pollen, nectar)
ex: wild bees, *adult lacewings*, *parasitic wasps*, *syrphids*, *ladybirds**, *spiders* (pollen in web)
- **Undisturbed soil**
- **Connectivity of populations**
- **Minimised use of insecticides**

Natural enemies also need:

- **Alternative prey in periods when few pests in trees**
 - In hedgerow, flower strips etc

ex *carabids*, *rove beetles*, *syrphid larvae*, *predatory bugs*



Pollen
and
nectar

Alternative
prey/ host
(also when no
flowers)

Undisturbed
soil for nests
and
overwintering



*2-spotted ladybird survives >50 days (up to 150 d) on nectar (He, Sigsgaard, 2019)

Distances between resources, nest and shelter



Predatory mites and parasitoids only move short distances



Fotos: JKI; INRAE

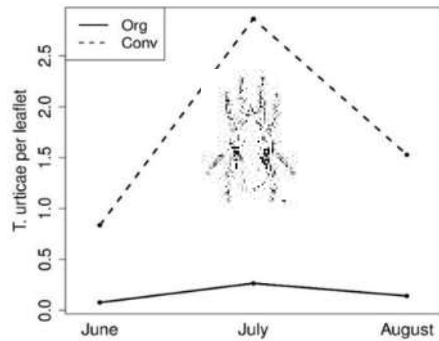
Distances between resources, nest and shelter



Spiders, predatory bugs, ladybirds, lacewings and solitary bees can move longer and bumblebees 1-2 km or more...

.. But with cost in energy and lower reproduction

Effect of crop management on pests



Jacobsen et al. 2019

Strawberries – 2 studies from Denmark

Ratio predatory mite: spider mite 9.5 times higher in organic than conventional (1 y study, 5 paired sites). (Jacobsen et al. 2019)

Strawberry tortricid *Acleris comariana* infestation 5 times higher in conventional than organic (3 y study, 7 paired sites). Higher parasitoid diversity in organic. No difference in yield potential (Sigsgaard et al 2013)

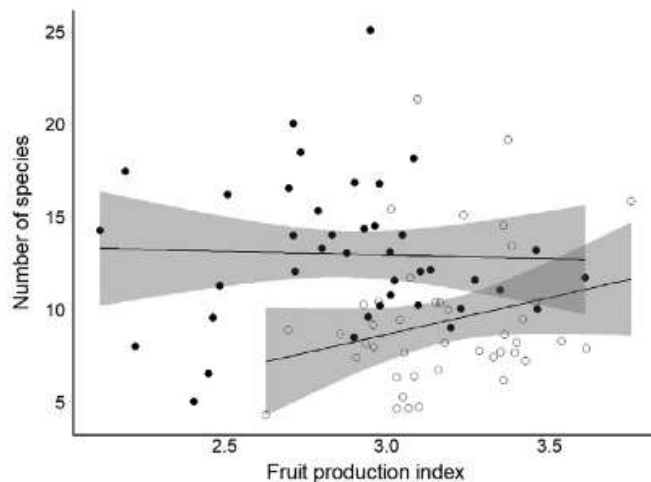


FIGURE 4 Partial residuals, prediction lines, and confidence bands between species richness of beneficial arthropods and the fruit production index (log10-transformed), for organic (●) and IPM (○) orchards

A cross-European study -Apples

Organic yield on average 48% lower than in IPM, but orchards supporting pollinators and natural enemies could reduce the gap (Samnegård et al 2019)

Non-crop vegetation effects on natural enemies in apple orchard –A review

Short term interventions

- Reduced mowing -> more diverse natural enemy community – understudied
- Cover crops – *Select high value flowers* (eg. *Alyssum*). More natural enemies did not always lead to sufficient reduction of pest numbers or lower fruit damage

Longer term

- Perennial flower strips → *select high-value flowers*. Flower strips offer a promising agri-environmental scheme attracting also generalists (spiders, Anthocoridae and Miridae) important in early season control
- Hedges -important source of natural enemies - better pest control near hedgerows

Intercropping/ agroforestry – understudied –expected high potential

Some important points

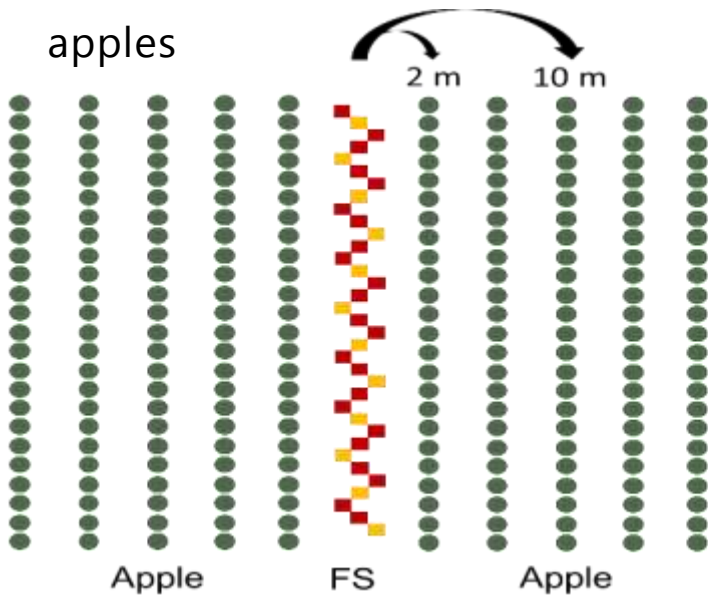
Most studies short 1-3 y

On farm effects more clear on less mobile natural enemies –landscape scale more important for more mobile species (not included in review)

Only 16/66 studies included measurement of yield (ie fruit damage)

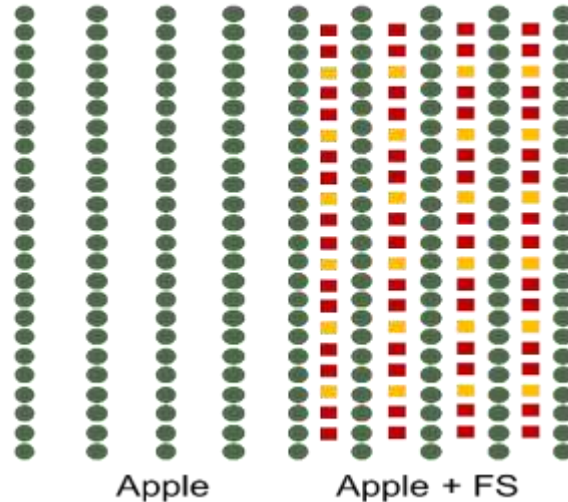
Functional agrobiodiversity implementation –flower strips

Flower strip (FS) replacing a row of apples



Sigsgaard 2014, Jacobsen et al in prep.

Flower strips in the interrows of apple trees



EcoOrchard

Belgium

Germany

Italy

Poland

Sweden

Switzerland

Denmark

France

Latvia



Perennial, native flower strips to improve pollination and biological control

Plants that support beneficials (examples)

Cumin



Wild carrot



Oxeye daisy



Lotus corniculatus



Yarrow



Red clover



Seed mixture:

*Native,
perennial.*

Criteria:

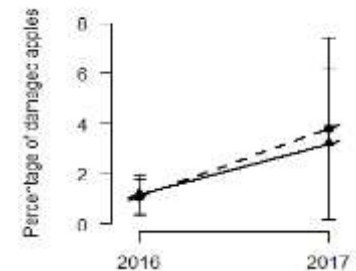
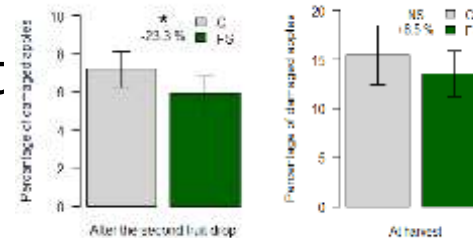
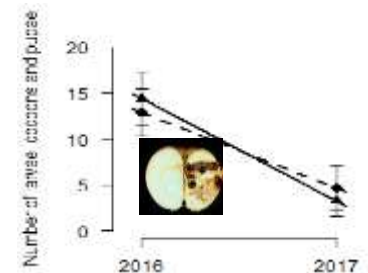
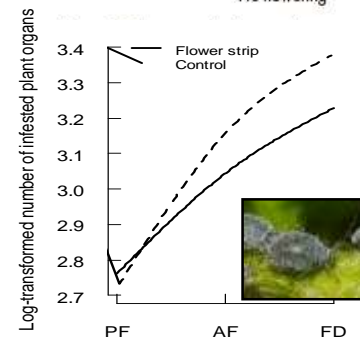
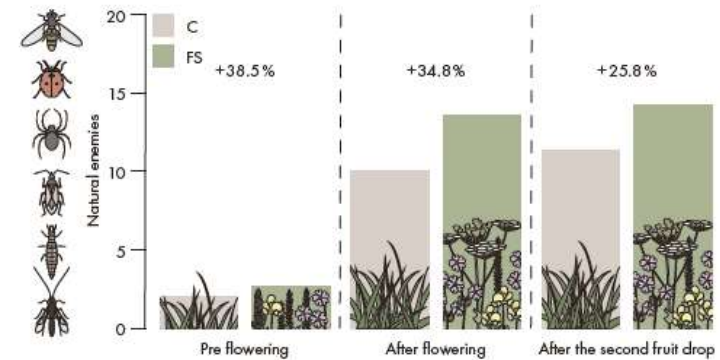
- **Value for natural enemies and pollinators**
- *Long flowering time,*
- *Size*
- *Tolerance to traffic*
- *Tolerance to cutting*
- *Last ++ years*
- *Not host to pests*

Results from EcoOrchard project -2015-18

Interrow flower strips :

- More natural enemies
- Fewer pests
- Lower percent damaged fruit

Promotion of aphid natural enemies during the season

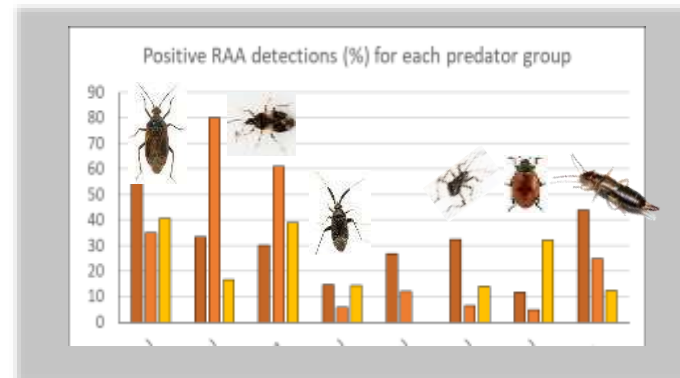
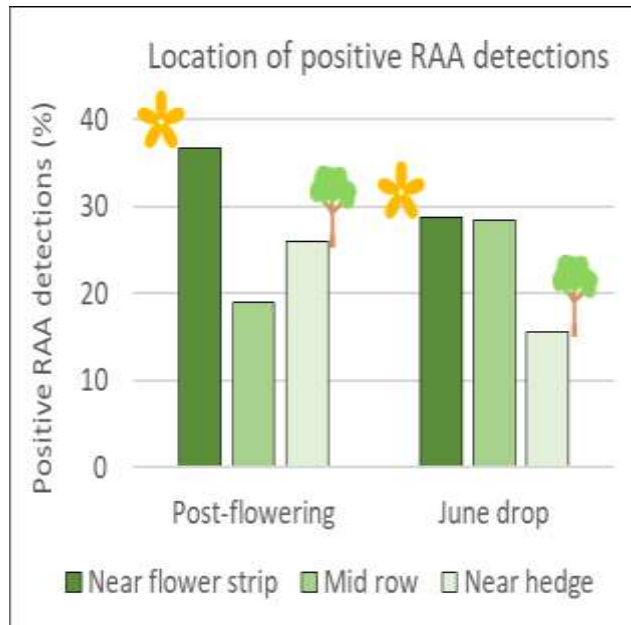


Cahenzeli et al 2019
Pffiffner et al 2019

A 5-year study

- Perennial flower strips (*Tanacetum vulgare* L., *Chrysanthemum maximum* Ramond, *Aster tongolensis* Franchet, *Achillea millefolium* L.) in Canadian IPM orchard treated with pesticides on an as needed basis
- Plum curculio (weevil) decreased nearly to $\frac{1}{4}$ within 2y after sowing flower strips, while only halved in control. After 3y insecticide treatments were applied and the infestation by this pest remained less than 0.5%.
- Flower strips reduced plant bugs significantly
- Results against apple maggot (a fruitfly) inconclusive
- No effect found on apple sawfly.
- Codling moth and spring and summer Lepidoptera stayed at low and similar densities across treatments, possibly due to secondary effects of chemical treatments.
- Effect on yield (from 1992 to 1997):
 - % damaged apples in the experimental block decreased from 95.2% to 9.2%.
 - % damaged apples decreased only from 67.9% to 32.5% in the control block

Gut analysis to identify predators and their response to hedgerow and flower strip



Blueberries –effect of wild flower plantings -4y

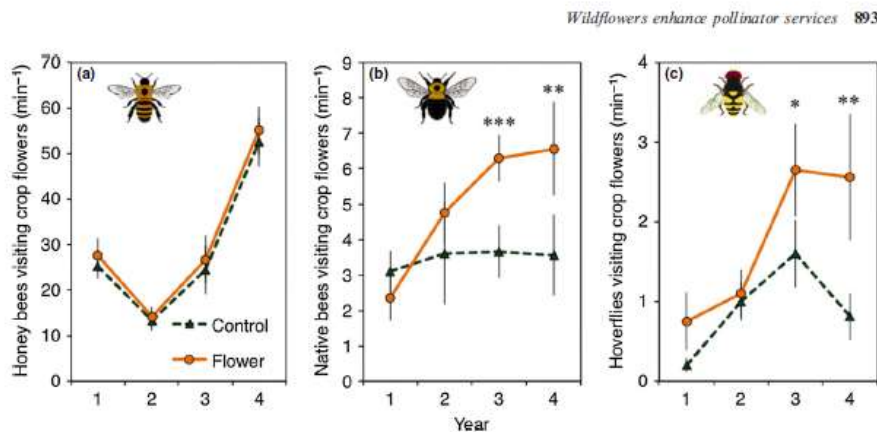


Fig. 1. Mean \pm SE abundance of (a) honeybees, (b) wild bees and (c) hoverflies observed visiting blueberry flowers during 15 min observational samples. Asterisks indicate levels of significance (* P < 0.05, ** P < 0.01, *** P < 0.001) for difference between control and flower treatments.

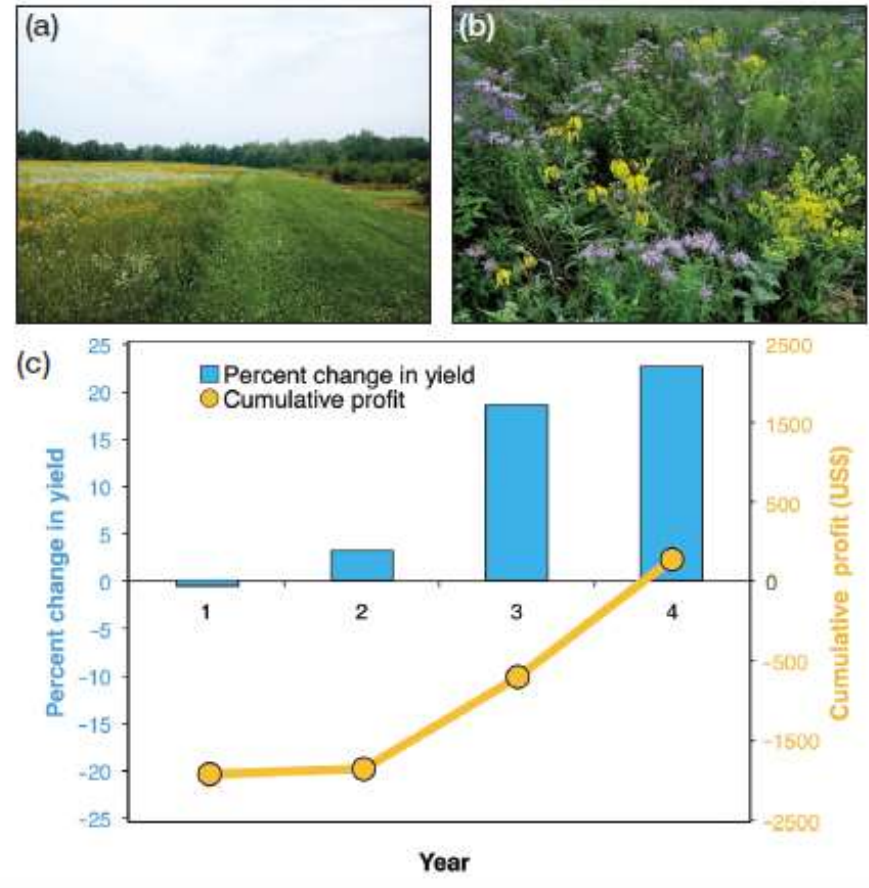
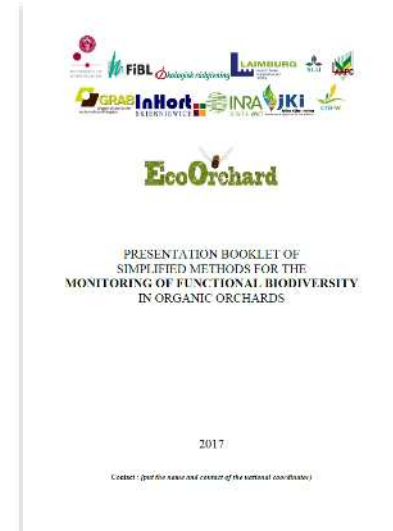
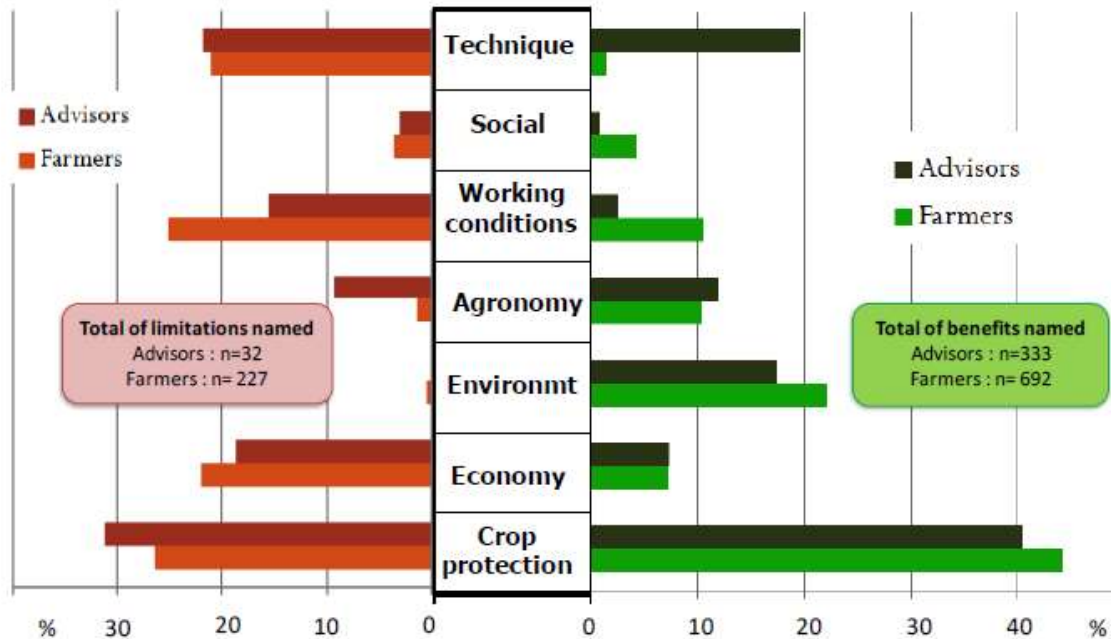


Figure 6. Plantings of native wildflower species selected for support of pollinators enhance blueberry yield and profit in Michigan. (a) Planting in midsummer with blueberry on the right. (b) Close-up of a mature planting with a mix of flower forms, species, and colors, with blueberry in the background. (c) Percent change in blueberry yield (blue bars) between fields adjacent to wildflower plantings and fields without plantings. The gold line (cumulative profit) shows that the initial cost of establishment in the first year was paid for by the fourth year when higher yield resulted in a profit (Blaauw and Isaacs 2014). In Garibaldi et al 2014

Blaauw and Isaacs 2014

Motivation for FAB among advisors and farmers in organic apples (9 countries)



Warlop et al 2017

Expect multiple services from each FAB technique

See FAB qualitatively

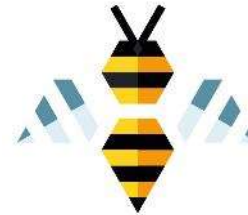
farmers mentioned in average 1,58 +/-1,7 limits and 6,65 +/-3,8 benefits

Status and some of the challenges

- 16% better pest control with flower strips across crops (*Global review .. Albrecht et al 2020*)
- Too few studies that include yield effects –and yield is affected by many other factors such as soil and management

- More biological information needed to guide choice of non-crop vegetation and design of orchards for optimal effect
- Practical methods to assess and implement Functional agrobiodiversity on farms
- Integration with other strategies such as pheromone disruption

Thanks to



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Homepage:

http://plen.ku.dk/english/research/organismal_biology/applied_entomology/

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