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Short communication

Under which conditions would a wide support be likely for a Multilateral Environmental Agreement for pollinator protection?

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ABSTRACT

The Nagoya Protocol (2010) demonstrated that Multilateral Environmental Agreements (MEA) are still achievable. Pollination services are essential for biodiversity, agriculture, ecosystem services and human well-being, but in jeopardy as The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) confirmed. In 2016, thirteen mostly European countries established the Coalition of the Willing on Pollinators. This group of forerunners increased to twentyone members. Recently, the European Union (EU) decided to join in 2018. What would be necessary to move forward towards a Multilateral Environmental Agreement for pollinator protection during the next three or four Conferences of the Parties (COP) of the Convention for Biological Diversity (CBD)? Current approaches for pollinator protection mostly require subsidies or donations, they are not scalable and might limit the number of countries promoting a multilateral agreement. This paper suggests a mix of four strategies and low-cost policy measures across sectors. They would be affordable even for Low Income Countries (LIC), but require addressing certain research gaps to set the stage for policymakers.

1. Lack of cross-disciplinary research on pollinators

Mostly entomologists and ecologists conducted the profound assessment on pollination within The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES; IPBES, 2016). The IPBES report covers the topic in a much more interdisciplinary way than previous publications of smaller teams (e.g. Allen-Wardell et al., 1998), including e.g. agriculture, biodiversity, valorization and responses to risks. In particular, the chapter on socio-cultural values broadens the view on pollinators.

Potts et al. (2016a) clearly stated "a mismatch […] between scientific evidence of impacts and conservation, and management responses". This is correct, but not surprising, as the impressive biophysical knowledge base has not been complemented by an adequate volume of research on management of pollinators by farmers, communities and governments, who should play a major role in pollinator protection according to environmental literature (e.g. IPBES, 2016; Potts et al., 2016b; McCracken et al., 2015; Rose et al., 2015; Mayer et al., 2011; Allen-Wardell et al., 1998). The lack of complementary research on these stakeholders can hamper pollinator protection. In particular, (1) socio-economic and policy research analyzing the human factor, and (2) participatory agricultural research measuring the net economic impact of habitat enhancement measures might be required to build a common purpose for pollinator protection beyond environmentalists.

Only a few studies give insight into farmers', villagers' and politicians' knowledge on pollinators (e.g. Christmann et al., 2017; Hanes et al., 2013; Munyuli, 2011; Kasina et al., 2009), though knowledge is basic for sustainable use and protection. Very little is published on farmers' readiness to enhance habitats without rewards (Christmann et al., 2017).

Applied agricultural research pays high attention to production factors like water, seeds, soil and pests, but very little to the production factor pollination in general and even less to wild pollinators (Fijen et al., 2018; Christmann et al., 2017; Blaauw and Isaacs, 2014; Christmann and Aw-Hassan, 2012; Klein et al., 2007), maybe because the Food and Agriculture Organization of the United Nations FAO (1994) does not classify beneficial wild species living on farm (e.g. wild bees, flies and worms) as livestock.

Different to some managed pollinators (honeybees, purchased bumblebees or *Osmia* species) wild pollinators are a common resource. The wild species provide most of the pollination services (Nabhan and Buchman, 1997). However, scientists working on common resources like e.g. Elinor Ostrom and schools following her approach focus e.g. on rangelands, forests, water and fish resources (e.g. CAPRI, 2010; Meinzen-Dick et al., 2002; Ostrom, 1990), but rarely on pollinators.

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Also, poverty research did not work on the impacts of loss of wild pollinators; research on the impact of biodiversity loss on poverty rarely reflects pollinators as essential part of biodiversity; pollinator research rarely refers to poverty as a result of pollinator loss (IPBES, 2016; Roe et al., 2014; Partap and Ya, 2012; TEEB, 2011). The broad range of impacts of pollinator loss on coupled human and natural systems is not yet studied, but as pollination services are necessary for many other ecosystem services (ES) to some extent, pollinator loss can cause simultaneous degradation of various ES, which might cause interlinked poverty spirals and major risks for humankind and peace. Noteworthy, more detailed research on pollinator-loss induced degradation and poverty spirals might develop arguments for policymakers across sectors to promote pollinator protection.

2. Challenges in developing policies for the protection of wild pollinators

Wild pollinators can benefit from some other policies, e.g. on organic farming (Azzu et al., 2016; Dicks et al., 2016; Rose et al., 2015). They are rarely object to specific national policies and policy research, very few countries launched national pollinator strategies, e.g. the United Kingdom (UK; Defra, 2015), France (Gaddoum and Roux-Fouillet, 2016) and Netherlands (MoA, 2018). However, current approaches focus on sponsored events and information campaigns, rewards for farmers and environmental stakeholders ready to engage (Dicks et al., 2016; Defra, 2015). Therefore, they are too costly for adoption by Low and Middle Income Countries (LIC, MIC).

Pollinator loss and protection are management issues, so socio-economic and policy research are pivotal (Gemill-Herren et al., 2014). Suggesting pollinator protection by policies might require a shift from suggesting environmental enhancement measures (IPBES, 2016; Potts et al., 2016b; Allen-Wardell et al., 1998) to the point of view of policymakers. Politicians might prefer financially feasible options to address a recognized urgent problem in a way that allows demonstration of benefits to voters.

Hallmann et al. (2017) estimate a seasonal decline of 76%, and mid-summer decline of 82% in flying insect biomass over the 27 years of study in Germany. Land use changes seem to be the most crucial threat. Even protected areas undergo massive insect and pollinator decline (Hallmann et al., 2017). Most wild pollinators work in a small area of approximately 50-2,000 m radius of the nest (Garibaldi et al., 2014; Kohler et al., 2008; Ricketts et al., 2008) and depend on these small habitats, but they sustain biodiversity and ES in nearly the entire terrestrial area of our planet. Climate change and other human impacts cause degradation and pollinator decline globally (IPBES, 2016). Increasingly, pollinators require humans to protect and enhance habitats at the farm and landscape level all over the terrestrial areas (Christmann and Aw-Hassan, 2012). Therefore, low-cost or self-sustaining approaches are essential (Christmann et al., 2017; Christmann and Aw-Hassan, 2012).

A Multilateral Environmental Agreement (MEA) for pollinator protection might be an urgency regarding the overarching importance of pollinators and the risks for environmental, social and economic well-being in case of pollinator loss: (1) 87 of 115 most important food crops for direct human consumption require or benefit from pollinators (Klein et al., 2007); (2) 87% of all flowering plants need pollinators (Ollerton et al., 2011); (3) cross-pollination enhances genetic diversity (MA, 2005) and thus the development of genotypes potentially better adapted to climate change (Christmann and Aw-Hassan, 2012; Parmesan, 2006); (4) most ES rely at some, but to different extent on pollinators, namely the percentage of ES provided by these 87% of flowering plants. Loss of pollinators might cause simultaneous interlinked poverty spirals in dimensions not yet conceived.

Stress factors and potential environmental enhancement measures are well described (e.g. Allen-Wardell et al., 1998; Potts et al., 2016b), whereas economically feasible instruments and policy strategies to realize them are rare.

3. A low cost policy framework for pollinator protection might require four strategies

Based on longterm professional experience in environmental governance in different national and international organisations, four policy strategies including 13 activities are suggested to realize most of the environmental enhancement measures highlighted by Potts et al. (2016b). The cross-sector policy mix allows broad pollinator protection also in LIC. Potential actors are identified for each action to enhance the practicability.

The suggested pathway for policymakers towards a MEA for pollinator protection has the main heading: Pollinator protection is urgent, but not costly; it quickly pays-off for farmers, communities and governments.

Low cost options are important for policymakers as funds for the protection of biodiversity compete with many other funding requirements. Rewards for farmers (Potts et al., 2016b) are not feasible for the majority of countries. Even e.g. the European Union (EU) might not be able to pay all farmers in the EU e.g. for seeding wildflower strips or compensate them for sustaining diverse field edges. The German Federal Agency for Nature Conservation (BfN) demonstrated in its review of the EU Common Agricultural Policy (CAP), that funds for biodiversity protection in agricultural lands are not sufficient to sustain biodiversity of insects and strongly suggested changes in the funding schemes (BfN, 2017). MIC might not be ready to broadly subsidize pollinator protection. For LIC like Eritrea, Benin or Haiti it is impossible. Payments for Ecosystem Services (PES; Potts et al., 2016b) might not be scalable globally. Who can organize so many PES groups, monitor protection and guarantee payments in all terrestrial areas under anthropogenic stress?

Product certification, recommended by Potts et al. (2016b) is promising from environmental governance perspective and might have even higher impact concerning biodiversity protection and poverty alienation (Tayleur et al., 2018; van der Sluijs and Vaage, 2016). UK, for instance uses “Fair to Nature: Conservation Grade” (Dicks et al., 2016). In June 2017, Xerces-Society launched a “Bee better certified” stewardship (https://beebettercertified.org/) in the United States of America (USA). Stewardships are economically self-sustaining after some time. The development of an international stewardship for pollinator protecting agriculture is an objective of a project of the International Climate Change Initiative (IKI, 2017). Nevertheless, stewardships can only add incentives for some producers, as the majority of global consumers might not be able or ready to pay more. Broad protection might require an agricultural approach with inherent incentives for farmers, villagers and governments to protect pollinators.

4. Strategy 1: Provide knowledge on pollinators to all social groups in a cost-effective way

If farmers do not recognize wild pollinators and their nests, if they do not know the habitat requirements of at least the most important species and the pollination demand of their crops, or if they regard only honeybees as pollinators (Christmann et al., 2017; Hanes et al., 2013; Kasina et al., 2009; Munyuli, 2011) they might not be able and ready to protect wild pollinators. Knowledge is the basic prerequisite for protection and sustainable use of pollinators by farmers, consumers, landusers, local and national governments (Allen-Wardell et al., 1998), in particular if there are no funds to pay rewards.

The most cost-effective and efficient way might be provision of basic knowledge on pollinators in all elementary and secondary schools. Schools can have higher reputation than specific stakeholders organizing events. As humankind depends on the services of pollinators, we can regard knowledge on pollinators as important as literacy, mathematics and religion/ethics, so coverage by curricula would be

justifiable.

Activities:

1

1 Include pollinators, their importance, value and habitat requirements into curricula of primary and secondary schools (30 h for each type of school incl. observation *in situ*) and provide teachers with necessary materials (Ministry for Education).
2 Promote broadcasts of mass media on pollinators, their importance, value and habitat requirements (Ministry for the Environment, Ministry for Communication, media).

Both options can complement each other and would benefit from first assessing available knowledge by randomized surveys.

Strategy 1 is basic for success of the other three strategies.

5. Strategy 2: Protect pollinators in agricultural lands by demonstrating the economic benefit for farmers

It is indispensable for pollinator protection to reduce agricultural chemicals, diversify farming systems and sustain pollinator nests in the ground (BfN, 2017; Potts et al., 2016b). How to convince farmers to do so? Is it realistic that farmers should "create uncultivated patches of vegetation such as field margins with extended flowering periods" (Potts et al., 2016b)? Field margins are often scarce or not available at all in agro-industrial landscapes (Feltham et al., 2015). Farms are business entities mostly giving priority to high income (Christmann et al., 2017). They tend to maximize the use of land, their capital to produce crops to generate income; they reject wildflowers, which they regard as weeds potentially spreading into their fields (Christmann et al., 2017).

Building on The Economics of Ecosystems and Biodiversity (TEEB) approach (TEEB, 2010), the Farming with Alternative Pollinators (FAP) approach (Christmann et al., 2017; Christmann and Aw-Hassan, 2012) takes above preferences into consideration and focuses on creating inherent incentives based on habitat enhancement by marketable plants and other measures. According to FAP-projects in Uzbekistan (Christmann et al., 2017) and Morocco (IKI, 2017) it is possible to get the active commitment of farmers for flowering field margins and flowering strips in larger fields, if (1) the plants for habitat enhancement are marketable (other crops, spices, forage, medicinal plants, berries etc.) and do not promote spread of weeds and (2) the farmers know the average net income gain (per surface) induced by the habitat enhancement measures. For this purpose FAP-fields with enhanced pollinator habitats are compared to control fields (monoculture) concerning insect diversity and net income (Christmann et al., 2017). FAP fields have higher pollinator and predator diversity and abundance, but less pests than control fields according to experience in Uzbekistan (Christmann et al., 2017) and Morocco (IKI, 2017). The net income from FAP fields is much higher per surface, because the main crop has higher productivity and better quality than in control fields; the habitat enhancement zone provides additional income. The incentive is inherent to the approach, rewards are gratuitous. If the main crop is attacked by pests or diseases, the habitat enhancement zone buffers against income loss as can be seen from experiments in Uzbekistan (Christmann et al., 2017) and Morocco. After realizing the income gain, farmers start to experiment with other main crops as well. The approach proved replicability. FAP can enhance pollinator habitats for pollinator-dependent crops in an economically self-sustaining way.

However, for the reduction of pollinator decline corridors are necessary also within and between large fields of pollinator independent crops. Settele et al. (2015) demonstrated economic benefit of habitat enhancement strips even for rice cultures.

Introduction of FAP in agricultural and common areas simultaneously contributes to the development of pollinator inventories, which are requested by environmentalists (Potts et al., 2016b).

Activities:

1

1 Identify some agro-ecologic benchmark countries, invest for some years in FAP-research to create incentives for farmers (identify participatory optimal habitat enhancement plants and average income gain for different crops and ecosystems; develop low cost options for nesting support; identify the impact of FAP on pest control) (international donors, e.g. the International Fund for Agricultural Development (IFAD), the German Federal Ministry for Economic Cooperation and Development (BMZ), the United States Agency for International Development (USAID)).
2 Broadly introduce FAP in many countries and communicate the additional net income gain for farmers by mass media and national extension services (Ministry for Agriculture, Ministry for the Environment, Ministry for Communication, mass media).
3 Develop and enforce obligatory farming practices including flowering strips of marketable plants in predefined distances (Ministry for Agriculture, Ministry for the Environment).
4 Develop and promote stewardships for pollinator protecting agriculture and honeybee products (national and international NGOs).

6. Strategy 3: Protect pollinators in common lands by demonstrating the benefit of collective action for farmers, villages, local business and regional government

Pollinator corridors in landscapes are essential for pollinator protection (Potts et al., 2016b). According to scientists working on collective action to preserve common resources (e.g. Christmann and Aw-Hassan, 2015; Christmann et al., 2014; CAPRI, 2010; Meinzen-Dick et al., 2002; Ostrom, 1990), this requires a knowledgeable local community, governance arrangements and "networking social capital" (Adger, 2003). Broad voluntary action to establish corridors in common lands is not realistic unless (1) the protagonists understood the importance of pollinators and corridors, (2) know the probable income gain or benefit for themselves, their peer group or local community, and (3) have a social guarantee or high probability that the corridors will not be destroyed by humans or by grazing animals, but the protagonists can harvest them. Even if the time and expenditure for corridor establishment would be rewarded, an agreement on governance tools is needed: who decides where to establish a corridor, who decides on seeds/seedlings, who cares that the corridor will not be grazed, who will get the harvest, who will care that the plants of the corridor will not spread into private lands, who monitors and sanctions in case of destruction. A corridor of different thistles for instance might withstand livestock, but nearby farmers might not accept seeding thistles. A corridor of e.g. blackthorn and raspberry might be accepted based on a governance agreement on harvesting rights.

Collective action of villagers to establish corridors (e.g., berries, wild fruits, medicinal and forage plants) on common lands becomes more probable after the majority of farmers in a region experienced the economic benefit of pollinator protection in private land (fields, orchards, gardens) (Christmann and Aw-Hassan, 2012). The incentive is inherent and the activity can be realized by well informed and already engaged farmers driven by the common interest of having a high diversity of pollinators in their fields or gardens. The benefit from corridors and thus the common purpose can be strengthened by combination with ecotourism or beekeeping or e.g. by assessing the impact on pest control.

Activities:

1

1 Develop governance tools for corridor establishment in common lands, test and communicate the long-term benefit for the community (farmer associations, NGOs, regional or local government,

research organisations).
2 Combine pollinator protection and (eco)tourism, promote ecotourism to enhanced sites with high pollinator diversity (municipalities, regional government, tourism companies, local NGO and hotel associations).
3 Organize yearly contests for communities with best practice for pollinator protection with landscape approach (Ministry for Tourism, Ministry for the Environment).
4 Develop and enforce obligatory regulations for habitat protection and connectivity for spatial planning in rural and urban areas (Ministry for the Environment, institute for cadaster).

7. Strategy 4: Induce drive for national pollinator protection policies across sectors on national and global level

National assessments in a few MIC and LIC serving as benchmark countries on (1) regions with pollinator deficit and (2) the economic value of pollination for the country can demonstrate, that pollinator protection is necessary for the economic development of these countries and the wellbeing of their people. The results can be used to convince national governments to protect pollinators by cross-sector strategies.

Activities:

1

1 Develop cross-sector policy measures for pollinator protection. Such policy instruments can include above mentioned instruments like curriculum change or recommended farming practices, but also ban of hazardous chemicals, monitoring of pollinator diversity, conservation act for existing landscape architecture relevant for pollinators or ban of import of managed pollinators for greenhouse production (pilot countries, e.g. member countries of the Coalition of the Willing, national and international research organizations).
2 Join the Coalition of the Willing on Pollinators (national governments).
3 Initiate and promote a MEA for pollinator protection at the next COP CBD (2018, 2020) (Coalition of the Willing on Pollinators, FAO International Pollinator Initiative (IPI)).

8. Let us use the unique chance set up by high attention through the IPBES report and the establishment of the Coalition of the Willing on Pollinators

Despite the “paramount importance” of pollinators (Allen-Wardell et al., 1998), within the prevailing political culture politicians might promote a MEA only, if the realization seems to them financially feasible and applicable by few strategic political activities. The suggested cross-sector policy mix and introduction of FAP might be more affordable for LIC and MIC than the strategies for pollinator protection developed in industrialized countries.

The increasing number of countries joining the Coalition offers opportunities to test the suggested approach in many countries simultaneously. The IKI project (IKI, 2017) shall build such a model in Morocco as benchmark country and outscale the results to six countries. The cross-sector policy mix shall be feasible also for LIC. If more stakeholders would start likewise in different continents, a MEA for pollinator protection might be achievable within three or four COPs of CBD. A MEA induces national regulations and can enhance protection significantly, as e.g. the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Ramsar Convention on Wetlands of International Importance and the Convention on the Conservation of Migratory Species of Wild Animals demonstrate. The recent Nagoya Protocoll (2010) shows that MEAs are still achieveable in a multipolar world.

FAO, in charge of IPI and thus challenged to act coherently, might trigger more agricultural research on wild pollinators by revising the FAO definitition of livestock. FAO might take the lead in knowledge exchange on cross-sector policies and in the development of a MEA.

“Urgent and unprecedented environmental and social changes challenge scientists to define a new social contract. This contract represents a commitment on the part of all scientists to devote their energies and talents to the most pressing problems of the day” (Lubchenco, 1998). Nearly 20 years after the Sao Paulo Declaration on Pollinators (1999) and thirteen years after the Millennium Ecosystem Assessment (2005) a MEA for pollinator protection is long overdue. Climate change will increasingly charge its tribute to the biodiversity of pollinators same as the accumulation of chemicals in soil and water (Goulson, 2014), therefore the coming COPs CBD should put a MEA for pollinator protection on top of its agendas.

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References

Adger, W.N., 2003. Social capital, collective action and adaptation to climate change. Econ. Geogr. 79 (4), 387–403.
Allen-Wardell, G., Bernhardt, P., Bitner, R., Burquez, A., 1998. The potential consequences of pollinator declines on the conservation of biodiversity and stability of crop yields. Conserv. Biol. 12, 8–17.
Azzu, N., Coates, d., Graub, B., Gemill-Herren, B., 2016. Pollination and evolving global policy processes. In: Gemill-Herren, B. (Ed.), Pollination Services to Agriculture. Earthscan, London and New York, pp. 261–277.
BfN, 2017. Bundesamt für Naturschutz (2017) Agrar-Report 2017. Biologische Vielfalt in der Agrarlandschaft. (Accessed 11 September 2018). https://www.bfn.de/fileadmin/BfN/landwirtschaft/Dokumente/BfN-Agrar-Report_2017.pdf.
Blaauw, B.R., Isaacs, R., 2014. Flower plantings increase wild bee abundance and the pollination services provided to a pollinator-dependent crop. J. Appl. Ecol. 51, 890–898.
CAPRI, 2010. Resources, Rights and Cooperation: A Sourcebook on Property Rights and Collective Action for Sustainable Development. International Food Policy Research Institute, Washington, DC.
Christmann, S., Aw-Hassan, A.A., 2012. Farming with alternative pollinators (FAP) – an overlooked win-win-strategy for climate change adaptation. Agric. Ecosyst. Environ. 161, 161–164.
Christmann, S., Aw-Hassan, A., 2015. Enhancing the collective ability to adapt to rapid glacier loss: the case of mountain communities in Tajikistan. Clim. Change 133 (2), 267–282.
Christmann, S., Aw-Hassan, A., Rajabov, T., Rabbimov, A., 2014. Collective action for common rangelands improvement: a climate adaptation strategy in Uzbekistan. Soc. Nat. Resour. 28 (3), 280–295. https://doi.org/10.1080/08941920.2014.933927.
Christmann, S., Aw-Hassan, A., Rajabov, T., Khamraev, A.S., 2017. Farming with Alternative Pollinators increases yields and incomes of cucumber and sour cherry. Agron. Sustain. Dev. https://doi.org/10.1007/s13593-017-0433-y.
Defra, 2015. National Pollinator Strategy: Implementation Plan. (Accessed 24 May 2018). https://www.gov.uk/government/publications/national-pollinator-strategy-2014-to-2024-implementation-plan.
Dicks, L., Vaughan, M., Lee-Mäder, E., 2016. Developing incentives for farmers to support pollinators: contrasting approaches from Europe and the United States. In: Gemill-Herren, B. (Ed.), Pollination Services to Agriculture. Earthscan, London and New York, pp. 216–234.
FAO, 1994. Definition and Classification of Commodities. (Accessed 14 June 2017). http://www.fao.org/waicent/faoinfo/economic/faodef/fdef16e.htm#16.2.
Feltham, H., Park, K., Minderman, J., Goulson, D., 2015. Experimental evidence that wildflower strips increase pollinator visits to crops. Ecol. Evol. 5, 3523–3530.
Fijen, T.P.M., Scheper, J.A., Boom, T.M., Janssen, N., Raemakers, I., Kleijn, D., 2018. Insect pollination is at least as important for marketable crop yield as plant quality in a seed crop. Ecol. Lett. 21 (1), 1704–7013. https://doi.org/10.1111/ele.13150.
Gadoum, S., Roux-Fouillet, J.-M., 2016. Plan national d’actions « France Terre de pollinisateurs » pour la préservation des abeilles et des insectes pollinisateurs sauvages. Office Pour les Insectes et leur Environnement – Ministère de l’Écologie, du Développement Durable et de l’Énergie (Accessed 11 September 2018). http://www.insectes.org/opie/pdf/3993_pagesdynadocs570e1d6156925.pdf.
Garibaldi, L.A., Carvalheiro, L.G., Leonhardt, S.D., Aizen, M.A., 2014. From research to action: enhancing crop yield through wild pollinators. Front. Ecol. Environ. 12, 439–447.
Gemill-Herren, B., Aidoo, K., Kwapong, P., Martins, D., Kinuthia, W., Gikungu, M., Eardley, C., 2014. Priorities for research and development in the management of pollination services for agriculture in Africa. J. Pollinat. Ecol. 12, 40–51.
Goulson, D., 2014. Pesticides linked to bird declines. Nature 511, 295–296.
Hallmann, C.A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans,

W., Müller, A., Sumser, H., Hörren, T., Goulson, D., de Kroon, H., 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLOS ONE 12. https://doi.org/10.1371/journal.pone.0185809.
Hanes, S.P., Collum, K.K., Hoshide, A.K., Asare, E., 2013. Grower perceptions of native pollinators and pollination strategies in the lowbush blueberry industry. Renew. Agric. Food Syst. 30, 124–131.
IKI, 2017. Conservation of Pollinator Diversity for Enhanced Climate Change Resilience. International Climate Initiative (IKI) (Accessed 16 September 2018). https://www.international-climate-initiative.com/en/nc/details/project/conservation-of-pollinator-diversity-for-enhanced-climate-change-resilience-17_IV_065-2887/?source=single.
IPBES, 2016. In: Eardley, C., Freitas, B.M., Kevan, P.G., Rader, R. (Eds.), Individual Chapters and Their Executive Summaries of the Thematic Assessment on Pollinators, Pollination and Food Production (deliverable 3(a)), (Accessed 16 December 2016). http://www.ipbes.net/sites/default/files/downloads/pdf/3a_pollination_individual_chapters_20161124.pdf.
Kasina, M., Kraemer, M., Martius, C., Wittmann, D., 2009. Farmers' knowledge of bees and their natural history in Kakamega district, Kenya. J. Apic. Res. 48, 126–133.
Klein, A.-M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., 2007. Importance of pollinators in changing landscapes for world crops. Proc. R. Soc. B 274, 303–313.
Kohler, F., Verhulst, J., Klink, R., Kleijn, D., 2008. At what spatial scale do high-quality habitats enhance the diversity of forbs and pollinators in intensively farmed landscapes? J. Appl. Ecol. 45, 753–762.
Lubchenco, J., 1998. Entering the century of the environment: a new social contract for science. Science 279, 491–497.
MA, 2005. Millennium Ecosystem Assessment. Ecosystems and Human Well-Being: Biodiversity Synthesis. World Resources Institute, Washington, D.C.
Mayer, C., Adler, L., Armbruster, W.S., Dafni, A., Eardley, C., Huang, S.-Q., Kevan, P.G., Ollerton, J., Packer, L., Ssymank, A., Stout, J.C., Potts, S.G., 2011. Pollination ecology in the 21st century: key questions for future research. J. Pollinat. Ecol. 3, 8–23.
McCracken, M.E., Woodcock, B.A., Lobley, M., Pywell, R.F., 2015. Social and ecological drivers of success in agri-environment schemes: the roles of farmers and environmental context. J. Appl. Ecol. 52, 696–705.
Meinzen-Dick, R., Knox, A., Place, F., Swallow, B. (Eds.), 2002. Innovation in Natural Resource Management. Johns Hopkins University Press, Baltimore.
MoA, 2018. NL Pollinator Strategy "Bed & Breakfast for Bees" (2018). Ministry of Agriculture, Nature and Food Quality, The Hague, Netherlands (Accessed 6 June 2018). file:///C:/Users/User/Downloads/DEF+webversie+Nat+Bijenstrategie+ENG_jan+2018%20(2).PDF.
Munyuli, T., 2011. Farmers 'perceptions of pollinators' importance in coffee production in Uganda. Agric. Sci. 3, 318–333.
Nabhan, G.P., Buchman, S.L., 1997. Services provided by pollinators. In: Daily, G. (Ed.), Nature's Services. Island Press, Washington DC, pp. 133–150.
Ollerton, J., Winfree, R., Tarrant, S., 2011. How many flowering plants are pollinated by animals? Oikos 120, 321–326.
Ostrom, Elinor, 1990. Governing the Commons. Cambridge University Press, Cambridge.
Parmesan, C., 2006. Ecological and evolutionary responses to recent climate change. Annu. Rev. Ecol. Evol. Syst. 37, 637–669.
Partap, U., Ya, T., 2012. The human pollinators of fruit crops in maoxian county, Sichuan, China. Mt. Res. Dev. 32, 176–186.
Potts, S.G., Imperatriz-Fonseca, V., Ngo, H.T., Aizen, M.A., 2016a. Safeguarding pollinators and their values to human well-being. Nature 540, 220–229.
Potts, S.G., Imperatriz-Fonseca, V., Ngo, H.T., Aizen, M.A., 2016b. The Assessment Report on Pollinators, Pollination and Food Production. Summary for Policymakers. IPBES, Bonn (Accessed 16 September 2018. https://www.ipbes.net/summary-policymakers-thematic-assessment-pollinators-pollination-food-production.
Ricketts, T.H., Regetz, J., Steffan-Dewenter, I., Cunningham, S.A., 2008. Landscape effects on crop pollination services: are there general patterns? Ecol. Lett. 11, 499–515.
Roe, D., Fancourt, M., Sandbrook, C., Sibanda, M., Giuliani, A., Gordon-Maclean, A., 2014. Which components or attributes of biodiversity influence which dimensions of poverty? Environ. Evid. 3 (3).
Rose, T., Kremen, C., Thrupp, A., Gemill-Herren, B., 2015. Policy Analysis Paper: Mainstreaming of Biodiversity and Ecosystem Services With A Focus On Pollination. FAO, Rome (Accessed 16 September 2018). http://www.fao.org/3/a-i4242e.pdf.
Settele, J., Spangenberg, J.H., Heong, K.L., Burkhard, B., 2015. Agricultural landscapes and ecosystem services in South-East Asia—The LEGATO-Project. Basic Appl. Ecol. 16, 661–664.
Tayleur, C., Balmford, A., Buchanan, G.M., Butchart, S.H.M., Walker, C.C., Ducharme, H., Green, R.E., Milder, J.C., Sanderson, F.J., Thomas, D.H.L., Vickery, J., Tracewski, L., Phalan, B., 2018. Where are commodity crops certified, and what does it mean for conservation and poverty alleviation? Biol. Conserv. 217, 36–46.
TEEB, 2010. In: Kumar, P. (Ed.), The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations. Earthscan, London, Washington.
TEEB, 2011. In: Brink, Pten, Kettunen, M., Vakrou, A., Wittmer, H. (Eds.), TEEB – The Economics of Ecosystems and Biodiversity for National and International Policymakers. Earthscan, London, Washington.
Van der Sluijs, J.P., Vaage, N.S., 2016. Pollinators and global food security: the need for holistic global stewardship. Food ethics 1, 75–91.