

Resolution of the international research and practice conference “Polycultures and Permaculture”

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Policy recommendations to promote biodiversity-based agriculture

Agricultural systems cover approximately 40% of the land surface of the Earth and thus have a significant biospheric impact (Lescourret, Magda et al., 2015). This impact will only increase as the population grows by an additional two billion by 2050 and requires 30% more food production globally than is produced at present (Wezel et al., 2014). Ideally, these challenges would be met through the sustainable intensification of agriculture.

Notwithstanding the gains of contemporary industrial agriculture, there have also been numerous drawbacks due to dependence on intensive management and on the availability of scarce and non-renewable resources, and consequently their negative impact on ecosystems (Altieri et al., 1983; Duru et al., 2015; Raghavan et al., 2016). Agriculture sector is one of the biggest greenhouse gases emitters (from 10 to 35% of total greenhouse gas emissions in Europe and about 9% in the USA (Eurostat, 2015; USEPA, 2015)). Modern industrial agriculture results in the simplification of the structure of the environment, replacing diversity with a small number of varieties for its major crops with declining species richness, and decreasing trait and functional diversity in general, thus increasing the vulnerability associated with genetic uniformity (Altieri, 1999). In this sense it is high risk.

Progress towards a more low-risk agriculture is required (Altieri et al., 1983), that will be compatible with ecosystem preservation (halting the loss of biodiversity and degradation of ecosystems) and resistance to climate change (Lescourret, Dutoit et al., 2015; Wezel et al., 2014). This is emphasized in Europe’s common agricultural policy (CAP), in Biodiversity Action Plan for Agriculture, and in the United Nations Report on agroecology and the right to food (De Schutter, 2014; European Commission, 2001; Grant, 1997).

Diversified agricultural practices can provide numerous ecosystem services — the benefits human populations derive, directly or indirectly, from ecosystem functions — such as increased biodiversity, improved control of pests, diseases and weeds, better and more stable soil health, reduced soil erosion, improved water and nutrient management and increased resilience of the agroecosystem (Rosa-Schleich et al., 2019). Even in intensified farming, most (potential) pests are not controlled by pesticides but natural predators, and wild pollinators are crucial for crop yield, what becomes increasingly important in view of observed honeybee decline and promoted cultivation of pollinator-dependent biofuel crops (Breeze, 2014; Tscharntke et al., 2005).

No till perennial agriculture systems can serve as an efficient CO₂ sinks capable of conserving up to 0.5–1.5*10⁹ tons of C annually on a global scale (Hajjar et al., 2008). In addition, polyculture systems – simultaneous cultivation of several crops in the same space – produce on average 38% more gross energy and 33% more gross incomes whilst using 23% less land (Smith et al., 2017).

Implementation of agrobiodiversity protection measures capable to increase food and biofuel production to meet the needs of increasing human population with the fossil fuel decline and in line with nature protection and restoration under increased anthropogenic pressure and the need to mitigate and adapt to climate change requires intersectoral (government, scientists, farmers, NGOs) and international cooperation.

We defined the following key points summarizing recent findings and successful approaches to guide decision makers:

1. Developing **regional land use approach – mosaic landscape** compatible with nature conservation and provisioning of ecosystem services (e.g. average level of pest control was 46% lower in homogeneous landscapes dominated by cultivated land, as compared with more complex landscapes (Rusch et al., 2016)).

a. Grounded in ecosystem approach based on enhancing structural and successional landscape heterogeneity and connectivity. It should consider:

i. Appropriate biodiversity protection measures for different land use categories.

Natural reserves and natural parks must be buffered by extensively used agricultural lands employing measures to meet special requirements of naturally occurring, in particular endangered species, including scientifically defined minimum size of habitat (Zander and Kächele, 1999).

Minimum proportion of natural and semi-natural habitats (apart from subsidiary crops¹) is required for biodiversity conservation and provisioning of ecosystem services. It is defined as 5% in research literature (Tschardt et al., 2005), as well as in EU Common Agriculture Policy as the size of Ecological Focus Areas²) and must be ensured by identifying and protecting biodiversity hotspots and converting degraded and low productivity agricultural lands into semi natural habitats. It should account for intensity of agriculture production, in particular the percentage of aggregated monoculture lands (e.g. enhanced need for pollination and biocontrol services, preventing leakage of agricultural chemicals, inadequate provisioning of forage and habitat for wildlife).

Increasing landscape connectivity via protecting and establishing of biocorridors (multifunctional windbreaks and hedgerows, set aside land, road verges, riparian buffer zones (recommended width range from 3 m (nutrient filter) to 24 m (preserving high floral diversity) and up to 144 m (preserving bird diversity) (Lind et al., 2019)) and small heterogeneous “stepping stone” habitats for parasitoids and other small useful insects and spiders which profit from locally good conditions (including solitary trees, tree shrub and grassland patches with area of tens of square meters scattered among the fields (Knapp and Řezáč, 2015)). Since biocorridors must occupy a significant proportion of agriculture lands, their management must be compatible with extensive perennial agriculture production (diversified and bioenergy forestry, extensive organic horticulture, forest farming, and silvopasture systems). Efficient biocorridors require specific management (minimum width, fencing, animal passages for safe road crossing *etc.*), as well as consideration of both positive and negative effects of spillovers between natural and agricultural ecosystems.

Ensuring equal distribution of natural and semi-natural habitats rather than their net area (Pe'er et al., 2014).

b. Consider local socioeconomic limitations (e.g. availability of work force for adoption of labor intensive cropping systems), and problems (e.g. pollution, erosion) (Chopin, Pierre et al., 2017).

c. Provide fiscal support for growers to implement, as well as research funding to develop and promote polyculture strategies, since intercropping and recommended rotation schemes are often less profitable and more management intensive in a short-term prospective compared to continuous cultivation of valuable cash crops. Efficiency of polyculture schemes in sustaining agroecosystem services and local biodiversity depend (an this agroecosystem measures should be evaluated based on)

¹ Subsidiary crop — crop which is sown primarily for their ecological function, that do not necessarily provide any commercial harvest (such as green manure, cover crops, catch crops *etc.*).

² Though subsidiary crops and short-rotation coppice are presently permitted measures for the Ecological Focus Areas, they are less efficient in provisioning benefits for biodiversity that natural vegetation.

- functional crop diversity (e.g. an increase from one to three dominating crop types equated to an average 33% rise in biological control of aphids (Redlich et al., 2018)), creation of heterogeneous and permanent habitats and continuity in forage resource provisioning for the wildlife organisms.
2. Preferred support for **integrated diversified farming practices** (permaculture, organic agriculture, regenerative agriculture, carbon farming, climate smart agriculture, conservation agriculture, holistic farming, forest farming etc.) and approaches (rotational grazing, diversified forestry *etc.*) rather than for particular operations (Rosa-Schleich et al., 2019).
 - a. Acknowledging perennial **tree-based agricultural systems** (resolving legal and administrative separation between agriculture and forestry and between conservation practices and commercial production practices) (Fagerholm et al., 2016).
 3. Meticulous **research** of public and social costs, **informing** general public, and efforts in achieving **social transformation** (considering the value, protection and enhancing ecological services as common, non-market goods) must **precede** to any cardinal **regulatory change in land use and support schemes for farmers** and land owners (Zander and Kächele, 1999).
 4. Appropriate systems of scientific **indicators (biodiversity indexes) and decision-making models** must be used to define land use approaches and payments for ecosystems services, as well as efficiency of agroecosystem measures.
 - a. Both models and indicators must:
 - i. Be defined as a consent- or compromise between different groups of stakeholders (social scientists, economists, agronomists, ecologists, farmers) (Zander and Kächele, 1999).
 - ii. Link different aspects of ecological, economic, and social dimensions, integrate micro (farm) and macro (regional) levels (van Ittersum et al., 2008).
 - iii. Be relevant to farm type, scale, and landscape (Duru et al., 2015).
 - b. Indicators have to meet the following criteria:
 - i. Be measurable at low cost (Zander and Kächele, 1999).
 - ii. Be relatively simple and user friendly, whenever possible, for monitoring by trained farmers (e.g. flower color index, butterfly abundance, landscape structuring degree, patch diversity index (Tasser et al., 2019)).
 - c. Models have to meet following criteria:
 - i. Be relevant for the farm type and size (Chopin, P. et al., 2019)
 - ii. Focus on cascades of processes and functions rather than on specific indicators to define areas of complementarity and efficient points of intervention (Nilsson et al., 2017).
 - iii. Be internationally harmonized yet appropriate for local institutional environment (Reidsma et al., 2011).
 - iv. Be regularly revised to investigate effect of errors in complex models (Zander and Kächele, 1999).
 5. **Subsidies (payments for ecosystem services)** should:
 - a. Discourage destruction of natural systems (e.g. conversion of permanent species rich grasslands into species poor swards, conversion of heathlands and peatlands into arable lands (Vogt and Englund, 2019)).
 - b. Favor long-term support schemes, particularly targeted at establishment of perennial vegetation (Rosa-Schleich et al., 2019).
 - c. Be result vs. action oriented (Tasser et al., 2019).
 - d. Be restricted to the appropriate spatial scale (Chopin, Pierre et al., 2017).
 - e. Encourage cooperation between farmers towards land stewardship (Kolinjivadi et al., 2019).

- f. Compensate for possible risks of crop failure in complex experimental systems (Garibaldi et al., 2019).
6. **Resource sharing to developing countries** via implementation of bioregional agrobiodiversity protection strategies (enabling development of shared models, classifications and indicators), focused international funding schemes (e.g. primarily targeted at shared resources of international importance, such as protection of watersheds, buffer zones around natural reserves and national parks, biodiversity hotspots, establishment of strategic biocorridors throughout the agricultural landscapes). In corrupted societies with poor institutional capacity such funding should be preferably managed by donor countries or by international organizations in collaboration with local NGOs. Ecological tax for unsustainable agriculture producers and carbon subsidies should be considered by developing countries as possible funding sources for agroecological measures, as well as selling or leasing land at reduced cost (or free provisioning for restoration agriculture projects), reduced rates for governmental loans, government procurement of agriculture produce *etc.* Latter measures should serve as prerequisites for the international funding to developing countries.
7. **Education and sustainable agriculture extension services are not sufficient** in developed countries, and almost lacking in developing countries, for sufficient implementation of biodiversity protection schemes in agriculture. It should be based on extensive networking between farmers, other producers, academia and NGOs.

See supporting video [“Mosaic landscape”](#)

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Additional comments

<p>Dr. Melissa Vogt, Editor of 'Sustainability Certification Schemes in the Agricultural and Natural Resource Sectors', Independent researcher, Australia</p>	<p>Point 5 about subsidies should: "can include also payment for already established ecosystems and not only newly developing". It could be included in the point about result versus action orientated. 1a can include 'enhancing structural and successional 'SYSTEM' and landscape heterogeneity and connectivity.</p>
<p>Dr. Hans R Herren, President, Millennium Institute (Washington DC) and Biovision Foundation (Zurich, Switzerland), United States</p>	<p>Need for 30% more food. We do produce enough on a global scale, but what is needed now is to produce more locally where there is a deficit, Africa in particular, while less and better quality needs to be produced in EU and North America. There is enough evidence that this can be done with agroecological practices.</p> <p>I am not supportive of the term "Sustainable Intensification", why not just use Agroecology or Ecological / Eco-functional Intensification. Note also that these terms are very different and not interchangeable. I suggest to use Agroecology, which is well defined, and encompasses all aspects from production to consumption.</p>

Conference participants

