

SOY AND AGROECOLOGY: BUILDING A BRIDGE

TO THE MAINSTREAM MARKET

Findings and recommendations.

1. What is agroecological soy production and why is it important?

Biodiversity conservation and climate resilience are key priorities.

Unsustainable agriculture and food systems are exerting an extreme pressure on natural resources. Drivers linked to agriculture account for 70% of the projected loss of terrestrial biodiversity¹ while agriculture, forestry and land-use related activities accounted for approximately 23% of total net anthropogenic emissions of GHGs between 2007-2016². The increasing recurrence of droughts, floods, and new pests shows that our food system must become more sustainable and resilient³.

A transition is needed towards sustainable food systems. The application of agroecological principles and practices have an important role to play in this.

A key question that is addressed in this paper is how to build a bridge between an "agroecological niche" and "mainstream" large-scale high input (merely GM) soy production.

Box 1: Going beyond deforestation and conversion-free: work with instead of against nature

Agroecological practices in farming add value on top of halting deforestation and setting aside High Conservation Value areas, as agroecological practices will enhance the value of the full farm from a biodiversity conservation and climate resilience perspective.

Benefits of agroecological production systems:

- 1. Improve biodiversity, as agroecological systems enhance and conserve species and genetic diversity, and improve ecological processes. They also (should) support ecological connectivity in the landscape which reduces habitat fragmentation for a range of wild plant and animal species.
- 2. Reduce harm from agrochemicals, as agroecological systems rely more than industrial agriculture on ecosystem services⁴ and less on external inputs like agrochemicals, the (over) use of which cause harm to biodiversity, soil, water and air³.
- 3. Improve climate smart practices and increase resource efficiency, through e.g. less fossil energy use, better carbon storage in soil and direct use of soy for human food.
- 4. Reduce vulnerability and improve socio-economic resilience. Through crop and product diversification and land use integration, the system become more resilient to pest outbreaks and weather events. Also, farmers become less vulnerable for price volatility, single crop losses or other market dynamics.

These elements are elaborated in chapter 2.

¹ An average of around 25% of species in assessed animal and plant groups are threatened suggesting that around 1 million species already face extinction. See: IPBES (2019), a summary for policy makers of the IPBES Global Assessment report on biodiversity and ecosystem services, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

² See: https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf

³ EC (2020), A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system, Brussels, COM (2020) 381, European Commission

⁴ such as internal water and nutrient availability and on natural pollinators and pest control species

Box 2: What is agroecology?

FAO⁵ defines agroecology as an integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of food and agricultural systems. Agroecology seeks to optimize the interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system.

FAO has defined 10 key elements or principles of agroecology, which are interlinked and interdependent: (1) diversity, (2) co-creation and sharing of knowledge, (3) synergies, (4) efficiency, (5) recycling, (6) resilience, (7) human and social values, (8) culture and food traditions, (9) responsible governance and (10) circular and solidarity economy.

The 10 principles of agroecology (see Box 2) were approved by the FAO Council in 2019 and provide guidance to achieve the transformation towards environmentally, socially and economically sustainable agriculture and food systems⁵. They provide a pathway to protect nature, manage agriculture in ways that enhance the richness of biodiversity and restore the ecosystem functions of degraded systems, by applying a holistic and interconnected set of ecological and social concepts to the design and management of food and agricultural systems.⁶

A more practical definition that zooms in on the more technical agricultural and ecological aspects is the following:

Agroecology integrates ecological principles and biodiversity management into farming systems with the aims of increasing the multi-functionality and *total* farm productivity, while reducing dependency on external inputs, and sustaining or enhancing ecosystem services⁷.

Farmers can adapt the wide range of practices that agroecology offers, see Figure 1, on next page, to their specific context and location^{8,9}.

⁵ FAO (2019), The 10 Elements of agroecology: guiding the transition to sustainable food and agricultural systems, Food and Agricultural Organization of the United Nations

⁶ WWF 2021. Farming with biodiversity. Towards nature-positive production at scale. WWF International, Gland, Switzerland ⁷ Virginia, A., M. Zamora, A. Barbera, M. Castro-Franco, M. Domenech, E. De Gerónimo, J.L. Costa (2016), Industrial agriculture and agroecological transition systems: A comparative analysis of productivity results, organic matter and glyphosate in soil, In: Agricultural systems, vol.167 (103-112)

⁸ FAO (2019), The state of the world's biodiversity for food and agriculture, FAO Commission on genetic resources for food and agriculture.

⁹ Sinclair F. et al (2019), The Contribution of Agroecological Approaches to Realizing Climate-Resilient Agriculture, World Agroforestry, Bangor University and CGIAR, Rotterdam and Washington, DC

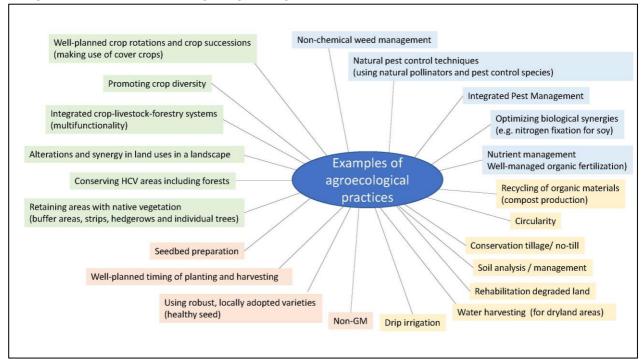


Figure 1: Examples of the wide range of agroecological practices that farmers can adopt.

Some well-known examples of agroecological practices in soy are no-till or conservation tillage¹⁰, natural pest control, integrated pest management or crop rotations¹¹.

Note that organic and agroecological production systems, and their practices, have many similarities but they are not necessarily comparable¹². Organic farming systems that are managed as monocultures which are in turn dependent on external biological inputs are, for example, not necessarily based on agroecological principles¹³. Industrial agriculture can also make use of (a limited number of) agroecological practices (see also Box 3).

Box 3: Some definitions

- Non-GM means no genetically modified organisms (GMOs) are used in production. Non-GM (GMO-free), does, however, not necessarily mean responsible if it comes to deforestation/conversion or pesticide use.
- Industrial agriculture refers to various modes of farming that are alike to industrial processes in their scale and
 task segregation and seek to derive productivity gains from specialization and intensification of production¹⁴.
 Industrial agriculture can be GM or non-GM.
- Organic farming is a production system that sustains agricultural productivity by avoiding or largely excluding synthetic fertilizers and pesticides. The use of GMOs is prohibited in organic production.

¹⁰ No-till can be a component of industrial farming systems but also of agroecological practice when combined with natural control mechanisms for managing insect pests, pathogens and weeds and therefore reducing the need of further artificial interventions.

¹¹See for example: Parmentier S. (2014), Scaling-up agroecological approaches: what, why and how? Oxfam

¹² See for example: Migliorini P. and Wezel A. (2017), Converging and diverging principles and practices of organic agriculture regulations and agroecology. A review, In: Agronomy for Sustainable Development volume 37, Article number: 63 (2017)

¹³ See for example: SOCLA (2012), A contribution to discussions at Rio+20 on issues at the interface of hunger, agriculture, environment and social justice, SOCLA's position paper, prepared by M.A. Altieri

¹⁴ IPES-FOOD (2016), From uniformity to diversity: a paradigm shift from industrial agriculture to diversified agroecological systems, International Panel of Experts on Sustainable Food systems.

2. Essential benefits and ingredients of agroecological production

2.1 Improve biodiversity through agroecological practices

A core principle of agroecological production systems is their diversity, which is key to ensure food security while conserving, protecting and enhancing the value of natural resources. Agroecological practices that contribute to increasing on-farm diversity include, for example, integrated crop-livestock-forestry systems (see Box 4), promoting crop diversity or retaining areas with native vegetation, including individual trees⁵, see also

Box 4: Integrated crop-livestock-forestry systems in Argentina

In many places in Argentina, where soils are more fragile than in the agricultural core zone, the Pampas, it is still common to rotate agricultural crops, including soy, with pasture for livestock. In such rotation, there is pasture for 4-5 years followed by a 4-5-year rotation cycle of agriculture. The pasture cycle increases biodiversity and restores soil fertility, while parts of the grains (with higher energy content than pasture) are used to feed the cattle in that rotation system, adding value to grain production and diversifying risk to farmers. Moreover, in the Chaco region, beef and agriculture can also be combined with forest management. There, forest provides timber and non-timber products and high-quality forage. The forest also gives shadow, thereby protecting the cattle and soil moisture from high temperatures 15, 16.

Benefits of agroecological practices:

⇒ A larger crop diversity

Between 1996 and 2016, GM soybean production in Argentina increased from 6 to 16.9 million ha¹⁷ (comparable to the size of Tunisia), making soybean rise from 25% to 42% of the total cropped surface in Argentina. This increase was made mainly at the expense of cattle production, and competing summer crops¹⁸. This shift means that, while crop rotation has been reduced, soybean has become the dominant crop with more than half of the cultivated land, leading to less crop diversification. Furthermore, agricultural expansion has resulted in deforestation and conversion, and in a further fragmentation of native forests¹⁹.

A beneficial practice to change this would be to diversify crop cultivation in well-planned crop rotations and successions while retaining areas with native vegetation. Note that increasing crop diversity would mean, in the case of the European Union, an introduction of more protein-rich grain legumes (such as soy) as they currently account for only 2 to 3% of the arable area²⁰.

⇒ Building natural species richness.

Agroecological practices promote diversity and increase natural species richness. For example, a study in Canada²¹ compared the bat and the bat prey abundance (i.e., insects) between organic and conventional soybean fields and found a larger species abundance at the organic farms. A more

¹⁵ Martinez, U. and Maria Eugenia Periago (2020), personal communication, Fundación Vida Silvestre, Argentina

¹⁶ Borrás M., Manghi E., Miñarro F., Monaco M., Navall M., Peri P., Periago M.E., Preliasco P. (2017) Acercando el Manejo de Bosques con Ganadería Integrada al monte chaqueño. Una herramienta para lograr una producción compatible con la conservación del bosque. Buenas prácticas para una ganadería sustentable. Fundación Vida Silvestre Argentina.

¹⁷ MAGyP (2020), Estimaciones Agrícolas, Ministerio de Agricultura Ganadería y Pesca, see:

http://datosestimaciones.magyp.gob.ar/reportes.php?reporte=Estimaciones

¹⁸ P. Phélinas and J. Choumert (2017), Is GM Soybean Cultivation in Argentina Sustainable? Journal 'World Development' Vol. 99, pp. 452–462, 2017

¹⁹ CBD (2020), Convention on Biological Diversity, see: https://www.cbd.int/countries/profile/?country=ar

²⁰ See: Donau Soja (2019), Best practice manual for soybean cultivation in the Danube Region, Version 28.3.2019, Vienna, Austria and https://www.donausoja.org/en/about-us/the-association/europe-soya-declaration/

²¹ J. E. Put, G.W. Mitchell and L. Fahrig (2018), Higher bat and prey abundance at organic than conventional soybean fields, In: Biological Conservation, (226)

generic meta-analysis of literature from 2005²² indicates that organic farms have about 30% higher species richness and 50% higher abundance of organisms than conventional farms.

⇒ Higher natural genetic diversity.

In the last several decades, industrial agriculture has affected genetic diversity by using only a reduced number of plant varieties and through the replacement of native varieties with GMOs^{12,13}, leading to a risk that DNA will become more similar between individuals of a species. Other concerns around the use of GM crops include the increased use of toxic herbicides linked to GM crop cultivation, the increased herbicide resistance of weeds and the risk for remnants of toxic herbicides in harvested products²³. The area under GM-soy production increased to approximately 76% of the global soy cultivation area in 2017²⁴. Agroecological practices aim to introduce a higher natural genetic diversity of crops, which is crucial for plants being able to adapt to new environments.

⇒ Improving the ecosystem services on and around the farm by increasing diversity

By planning and managing diversity, agroecological approaches enhance the provisioning of ecosystem services - including pollination, soil health, water, pest and disease control - upon which agricultural production depends^{5,19}. Diversification also includes the integration of land uses in a landscape. The annual rotation of soy with sunflower, sorghum and wheat in Bolivia leads to increased soil fertility, for example, as soy and sorghum accumulate nitrogen, which is beneficial for the following crops to be used. An additional advantage is that the sorghum can be used to feed the animals resulting in more balanced diets²⁵.

In Argentina, alternation in time and space between agriculture and pastures for livestock (which are much more biodiverse than one single crop) was common practice up to the 80s, and it is still common in more fragile soils, see Box 4. But, in the better soils of the Pampas, the transition to agriculture since then has reduced those extensive pasture areas, which had a water regulating role, resulting in a rise of water levels and more frequent flooding^{26,27}. Similar effects have happened in the Chaco and in the Espinal ecoregions (situated between the Pampas and the Chaco) where forests and native vegetation provided the same ecological service of water regulation. In drier regions, the rise of groundwater levels provokes the accumulation of salt in the topsoil. It has been estimated that crop lands in those regions must be mixed with at least 30% of forests cover to avoid soil salinization²⁸.

2.2 Reduce harm from agrochemicals through agroecological practices

Agroecological systems are not intensive in their use of chemical inputs, like industrial fertilizers or pesticides, as they rely on ecosystem services and natural resources, such as on internal water and nutrient availability or natural pollinators and pest control species^{13,29}. Integrated Pest Management

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²² Bengtsson, J., Ahnstro¨m, J., Weibull, A.C (2005), The effects of organic agriculture on biodiversity and abundance: a meta-analysis, In: Journal of Applied Ecology, (42)

²³ See for example: Miyazaki J., A. Bauer-Panskus, T. Bøhn, W. Reichenbecher and C. Then (2019), Insufficient risk assessment of herbicide-tolerant genetically engineered soybeans intended for import into the EU, Environmental Sciences Europe, vol. 31)

²⁴ IUCN Netherlands and IDH (2019), the European Soy Monitor, Researched by B. Kuepper and M. Riemersma of Profundo, commissioned by IUCN National Committee of the Netherlands and the Sustainable Trade Initiative.

²⁵ M.A. Crespo (2021), personal communication with Probioma, based in Bolivia

²⁶ Bertram, N. y Chiacchiera, S. (2013). Ascenso de napas en la Región Pampeana: ¿Consecuencia de los cambios en el uso de la tierra? Informe Técnico. Instituto Nacional de Tecnología Agropecuaria. Recuperado de https://inta.gob.ar/sites/default/files/script-tmp-inta napas miz 13.pdf

²⁷ Jayawickreme, D. H., C. S. Santoni, J. H. Kim, E. G. Jobbagy, and R. B. Jackson. 2011. Changes in hydrology and salinity accompanying a century of agricultural conversion in Argentina. Ecological Applications, 21(7).

²⁸ Amdan, M. L. 2020. Cámbios en los procesos ecohidrológicos como consecuencia de la transformación del paisaje en el Chaco semiárido en Argentina. Tesis doctoral, Facultad de Agronomía, UBA. Recuperado de http://ri.agro.uba.ar/files/download/tesis/doctorado/2020amdanmarialaura.pdf

²⁹ IUCN (2017) Internal position paper on agroecology

(IPM) is a transition approach that encourages the use of alternative, natural pest control techniques, while the use of chemicals should be strongly reduced³. Crop rotation, timely and high-quality soil tillage and seedbed preparation are also some of the practices for successful weed management¹⁹.

Benefits of agroecological practices:

Turning the tide: an alternative pathway to deal with herbicide resistance of weeds and Rust Intensive soy cultivation consumes large amounts of pesticides - which includes herbicides and fungicides³⁰. A significant increase in its application has been observed, especially since the introduction of GM soy²³. In theory, the use of GM technology enables a lower use of pesticides^{31,32}. There is, however, also evidence that the use of herbicide-resistant GM crops has led to more frequent applications of herbicides to eliminate weeds, driving the development of herbicide-resistant 'superweeds'²³, while resulting in declining insect populations. Increased weed resistance to the non-selective herbicide glyphosate has resulted in recent years in an increasing use of the highly toxic herbicide paraquat and – also environmentally damaging - alternatives such as 2,4-D, Diquat and Glufosinate^{33,34}. While the use of Paraquat is prohibited in Europe, Paraguay and (recently) in Brazil³², its use is still allowed in Argentina and Bolivia.

Box 5: Facing increased resistance

The trend of increased herbicide resistance of weeds has been especially documented with regard to genetically modified (GM) crops, and particularly monocultures associated with the 'Roundup Ready' model of herbicide-tolerant crops and accompanying glyphosate treatments¹³. In Argentina, most of the mapped weeds (monitored by AAPRESID on department level) have increased their presence between 2013 and 2015 with 10 to 50%³⁵ while the environmental impact due to additional application of herbicides as a result of weed resistance increased with 30%³⁶. Current practice to kill resistant weeds, in for example Argentina, is to change to a different mix of herbicides or to increase the doses. An example of this is the replacement of the herbicide glyphosate, facing increased resistance of weeds, with the highly toxic herbicide paraquat³⁷. Producers also make changes in their rotation by including other traits (e.g., rotating GM with non-GM) or other crops, which changes the type of herbicides that need to be used^{14,38}.

Weed management through alternative glyphosate mixtures and glyphosate trait combinations³⁷ (see Box 5) or the continuous and increasing use of the same groups of fungicides to control Asian rust (see Box 6) is not going to be enough to keep up with the capacity of weeds or foliar diseases to evolve

 $^{^{30}}$ Fungicides target fungi and their spores. Herbicides control weeds. There are also other types of pesticides, including insecticides or disinfectants.

³¹ Klumper, W. and Qaim, M (2014), A meta-analysis of the impacts of genetically modified crops, PLoS One, 9, http://dx.doi.org/10.1371/journal.pone.0111629: The study includes soybean, found that GM technology has led to a 37% decrease in the use of chemical pesticides

³² Kamali, F.P., Miranda P.M. Meuwissen, Imke J.M. de Boer, Corina E. van Middelaar, Adonis Moreira, Alfons G.J.M. Oude Lansink (2017), Evaluation of the environmental, economic, and social performance of soybean farming systems in southern Brazil, Journal of Cleaner Production, vol. 142.

³³ European Union (2021), The use of pesticides in developing countries and their impact on health and the right to food, a study requested by the European Parliament's Committee on Development: The most likely substitutes for Paraquat are Diquat and Glufosinate. However, both are considered less effective for pest control

³⁴ Neumeister L. (2016), Chemical alternatives to paraquat use in soybean, WWF Germany, March 2016: Toxic Load Indicator (TLI): Glyphosate, 63; Glufosinate-ammonium 75, Paraquat 88, Diquat dibromide 90. This means that these 3 alternatives are from 19% to 43% more harmful to environment than Glyphosate, measured by the TLI.

³⁵ AAPRESID (2016), Nuevos mapas de malezas resistentes y tolerantes de Argentina, http://www.aapresid.org.ar/blog/nuevos-mapas-de-malezas-resistentes-y-tolerantes-de-argentina/

³⁶ AAPRESID (2017), Impacto ambiental de las malezas resistentes y tolerantes, http://www.aapresid.org.ar/rem/wp-content/uploads/sites/3/2017/05/REM-Aapresid-Impacto-ambiental-de-malezas.pdf

³⁷ Neumeister L. (2016), Argentina alone imported in 2014 around 7.500 tons of paraquat. Brazil's 2017 decision to ban Paraquat took effect in September 2020. Before that time, Paraquat in Brazil was especially used in moistier regions for combating the weeds that have become resistant to Glyphosate but also to desiccate the beans just before the harvest.

³⁸ Green J.M. (2016), The Rise and Future of Glyphosate and Glyphosate-Resistant Crops: Glyphosate and glyphosate-resistant crops, Pest Management Science, 74 (8)

resistance. It is a race against nature. Alternative (non-chemical) methods for weed control must be developed and encouraged. Agroecological approaches can contribute to this as they focus on the development of robust cropping systems that *prevent* the development of outbreaks of pests, weeds and diseases, e.g., through the principles of IPM or well-planned crop rotation.

Box 6: Growing problems with the Asian soybean Rust: IPM as a successful approach to control the disease

Growing problems with diseases such as the Asian soybean rust have been observed in most soybean growing regions, except in Europe¹⁹. In Brazil, the main factors leading to rust epidemics are the large soy cropped surface and the continued monoculture³⁹. Due to the still limited availability of resistant varieties to soybean Asian rust, this disease is reason for the consumption of the major part of the fungicides sprayed in Brazil. This significantly raises the production cost and the risk of environmental and human health impacts by contamination^{38,40}. In addition, some pathogen populations have shown increased tolerance to certain fungicides. In recent years, successful efforts have been made in the adoption of Integrated Pest Management, aiming to control Asian Rust. Examples are the use of tolerant cultivars, earlier planting, rotation of crops, the use of early maturing varieties, or prohibiting planting soybean during certain periods of the year⁴¹.

⇒ Less environmental and health damage

The spraying of glyphosate (see Box 5) has been at the centre of a long-standing debate over direct and indirect health effects on humans, animals and microbial life in water and soil²³. In a study in the Pampas (Argentina), between 20 and 50% of the glyphosate was still found in the soil after 60 days of application⁴². Paraquat dichloride is the pesticide with very high fatality rates (meaning deaths of humans and animals) worldwide and very toxic³⁶, but it is still being used in Argentina or Bolivia, for example, often also as a result of glyphosate resistance of weeds. Other environmental damaging herbicides are also still widely used.

Non-chemical weed management significantly reduces the negative impacts that agrochemicals have on the environment. A study on soybean farming systems in southern Brazil³¹ shows that the restrictive use of pesticides in the organic soy system leads to noticeably lower risk on humans and eco-toxicity compared to the conventional (GM) system.

2.3 Contribute to a climate-smart and resource efficient economy through agroecological practices

Although not all climate-smart practices follow agroecological principles, many agroecological practices are classified as climate-smart because they contribute to climate adaptation and mitigation.

Some of the factors contributing most significantly to greenhouse gas (GHG) emissions, and thus to climate change, are closely associated with industrial modes of farming. This includes the impact of large-scale deforestation¹³ and ecosystem conversion. Industrial agriculture is also linked to the use of

³⁹ Da-Rosa, C.R.E. Spher, C.R., Liu, J.Q. (2015), Asian Soybean Rust Resistance: An Overview, Plant Pathology & Microbiology, http://dx.doi.org/10.4172/2157-7471.1000307

⁴⁰ Cattelan, A.J. and A. Dall'Agnol (2017), The rapid soybean growth in Brazil, OCL Journal, 25(1), D102, https://doi.org/10.1051/ocl/2017058

⁴¹S.H. Furlan, F.K. Carvalho, U.R. Antuniassi (2018), Strategies for the Control of Asian Soybean Rust (Phakopsora Pachyrhizi) in Brazil: Fungicide Resistance and Application Efficacy, Outlooks on Pest Management 29(3):120-123, DOI: 10.1564/v29_jun_05

⁴¹ The SOM content increased from 4,9 in an industrial system to 5,6% in a transition agroecological system, See also (Virgina et al, 2016)6.

fossil fuel inputs (e.g., for machinery) and agrochemicals, that result in GHG emissions. Diversified and less intensive conversion-free systems can deliver major GHG savings.

Benefits of agroecological practices:

⇒ Improving the capacity of the soil to serve as a carbon sink

Agroecological systems contribute to higher levels of soil organic matter (SOM), as also confirmed in a study from the Pampas, Argentina, where the transition from an industrial towards an agroecological system (including soy in the rotation) resulted in higher levels of SOM⁴¹. This again improves the ability of the soil to serve as a carbon sink, and consequently its potential for carbon sequestration^{43,44}.

Box 7: Energy and GHG efficiency of different production systems

Differences in characteristics and management practices between conventional (GM, non-GM) and organic soybean farming systems result in different yield levels and energy use (linked to input levels) and consequently to differences in the CO₂ emissions emitted. However, the findings are mixed.

- According to a study on soybean farming systems in southern Brazil³¹, the conventional soy farming
 has a relatively higher productivity, but also uses substantially more energy because of inputs. This
 results in higher GHG emissions (per tonne of soybean) compared with the organic system, which
 demands more labor than the conventional system.
- Studies in Canada⁴⁵ and in Brazil^{30,46} confirm that the organic farming system has, in most cases, a lower cumulative energy demand and lower emission of GHGs than its conventional counterparts. There are exceptions, as shown in a Korean study of intensive smallholder farming⁴⁷, when energy use is relatively high (e.g., for mulch film) and yields are relatively low⁴⁸.
- In the earlier mentioned study in Southern Brazil³¹, the conventional GM system uses less energy compared with the non-GM conventional system, because it needs less inputs and has higher yields. Nonetheless, increased herbicide resistance of weeds may change this equation. A study on GM soy in Argentina¹⁷ reveals positive impact on yields and cost reductions compared to non-GM. But at the same time, it finds that "GM soy economic success" leads to employment reduction in agriculture (as GM soy farming demands less labor), leads to deforestation, and to an increment in short-term land rental contracts with a negative impact on crop rotations. While there's no clear consensus about the impact of GM soy cultivation on soil health and GHG emissions, a study in Brazil⁴⁹ found that more CO₂ is released from soils to which glyphosate had been added compared to soils without added glyphosate.

⁴³ Aguilera, E., Lassaletta, L., Gattinger, A., Gimeno, B.S. (2013), Managing soil carbon for climate change mitigation and adaptation in Mediterranean cropping systems: A meta-analysis, Agriculture, Ecosystems & Environment, 168, 25–36. doi:10.1016/j. age

⁴⁴Next to that, it also improves soil physical properties, the availability of nutrients and water conservation properties

⁴⁵ Pelletier, N., Arsenault, N., Tyedmers, P. (2008), Scenario modeling potential eco-efficiency gains from a transition to organic agriculture: life cycle perspectives on Canadian canola, corn, soy, and wheat production, In: Environ.Manag. (vol.42)

⁴⁶ Guareschi, R.F.; Martins, Marcio dos Reis; Sarkis, L.F.; Alves, B.J.G.; Jantalia, C.P. et al (2019), An analysis of energy efficiency and greenhouse gas emissions from organic soybean cultivation in Brazil, Semina: Cie^ncias Agrárias, Londrina (v.40)

⁴⁷ Lee, K.S., Young Chan Choe (2019), Environmental performance of organic farming: Evidence from Korean small-holder soybean production, In: Journal of cleaner production

⁴⁸ Note that intensive and small-scale farming in Asia is much less energy efficient than large scale farming usual in America and Europe, regardless the organic/conventional system.

⁴⁹ Araujo, A.S.F., Monteiro, R.T.R., Abarkeli, R.B. (2003), Effect of glyphosate on the microbial activity of two Brazilian soils. In: Chemosphere (vol.52)

⇒ Resource-efficiency and promoting a circular economy is a key principle.

Diversified and less input-intensive systems are a key characteristic of agroecological systems⁵ and reduce the amount of fossil fuel inputs, agrochemicals and energy uses (and therefore GHG emissions) related to conventional agriculture³¹. Further in the supply chain, the direct processing of the soybean into food is considerably more resource-efficient than when processed for feed for animal production, because less energy and water is needed while there is no protein loss⁵⁰. Provided that comparable yields are realized, this also makes it possible to free and protect - through strong land use planning and legislation - more space for nature⁵¹.

Reduce vulnerability and attain socio-economic resilience through agroecological practices

Climate change calls for measures to protect plants better from emerging pests and diseases and extreme weather events. Agroecological systems are more resilient to extreme weather events such as floods, drought, hurricanes and landslides⁵²

Benefits of agroecological practices:

Agroecology promotes land use, crop and genetic diversity, integration between land uses (e.g., agroforestry), synergies in food systems (e.g., crop-livestock) and the production of a wide range of less homogeneous products. This also creates multiple sources of production, income and livelihood¹³. Agroecological approaches thus enhance the long-term socio-economic resilience of producers⁵.

⇒ Biodiversity plays a key role in delivering resilience

The Argentine economy is highly dependent on agricultural production, especially soy, which has resulted in a conversion of ecosystems. This limits the country's ability to face severe weather shocks and results in a higher vulnerability of Argentina's agricultural sector to rainfall variability 17, especially in dry areas like Chaco. An example of this is the steep production decline in Argentina in 2017/18 (22% reduction in corn and 33% in soy production). This was caused by a sequence of extreme climate events: floods during sowing, severe droughts and floods again during harvest season⁵³. Industrial agriculture and land-use change (deforestation and grasslands loss) represents 37% of greenhouse gases (GHG) emissions in Argentina⁵⁴. While crop and product diversification reduce economic risks, on-farm biodiversity management (e.g. restoration and conservation of corridors, grasslands and forest management) has a key role to play in climate change mitigation and adaptation. A study reveals that nature-based solutions for climate change, including sustainable agriculture and on-farm biodiversity management, can provide 37% of the necessary CO₂e mitigation to meet the Paris Agreement between now and 2030, and 20% of the mitigation up to 2050, plus several co-benefits such as soil productivity and water supply⁵⁵.

governance measures remain key, but it may help to give more space to such governance in face of scarce resources ⁵² De Schutter (2011), a report by the UN Special Rapporteur on the Right to Food

⁵⁰ DSF (2019), Deutscher Sojaförderring und Taifun Tofuprodukte, https://www.sojafoerderring.de/nach-der-ernte/soja-verarbeitung/ ⁵¹ This lowering of consumption and pressure on resources does not automatically lead to more sustainable land use, for which good

⁵³ Bolsa de Cereales de Buenos Áires (2018), Campaña 2017/18: Evaluación del impacto económico de la sequía. Actualización. Instituto de Estudios Económicos. Bolsa de Cereales de Buenos Aires. See:

http://bibliotecadigital.bolsadecereales.com.ar/greenstone/collect/bolcer/index/assoc/HASH7d28.dir/Evaluacion%20Impacto%20e conomico%20sequia%20act.pdf

⁵⁴ Secretaría de Ambiente y Desarrllo Sustentable de la Nación (2019). Inventario Nacional de Gases de Efecto Invernadero. https://inventariogei.ambiente.gob.ar/files/inventario-nacional-gei-argentina.pdf

⁵⁵B. W. Griscom, J. Adams, P. W. Ellis, R. A. Houghton, et al (2017), Natural Climate Solutions. Proceedings of the National Academy of Science (PNAS), 114 (44) 11645-11650. https://doi.org/10.1073/pnas.1710465114

⇒ Biodiversity plays a key role in delivering long-term productivity

By planning and managing diversity, agroecological approaches enhance the provisioning of ecosystem services, which has a positive impact on crop productivity – especially in the long term. Various studies in Argentina^{56,57} highlight the benefits of crop rotation on yields and underline the risks of the long-term reduction of soil quality in the practice of monoculture. In a study in the Pampas, Argentina⁶, the transition from an industrial towards an agroecological system (including rotation in soy) resulted in more stable yields partly due to higher levels of soil organic matter, especially in those years where environmental conditions were less favourable.

⇒ Improving the socio-economic resilience of farmers

Agroecological production systems reduce the dependency on external resources and reduce economic risk⁵ as farmers rely less on costly external inputs¹³. Farmers are also less vulnerable compared to single crop production, which can have large economic impacts in case of unexpected yield drops or variable yields⁵. Farmers are also less dependent on price volatility and other market dynamics through diversification of income sources.

Box 8: Marginalization of smallholders in Bolivia

Smallholder farmers in Bolivia compete with large-scale farmers that have relatively more land and financial and technical resources. They are officially or unofficially bound to input providers and/or processing companies. Smallholders in soybean-growing areas, and their production systems, are being absorbed by the industrial soy production system, which means that their choice becomes further limited by the related structures of input suppliers, buyers, and modes of production⁵⁸. Creating more diversity in the landscape and improving small holders' economic autonomy would increase their resilience.

⁵⁶ Bacigaluppo, S., Bodrero, M., & Salvagiotti, F (2009), Producción de soja en rotación vs monocultivo en suelos con historia agrícola prolongada. In: Soja (Vol. 42).

⁵⁷ Rotolo, G. C., Montico, S., Francis, C. A., & Ulgiati, S. (2015), How land allocation and technology innovation affect the sustainability of agriculture in Argentina Pampas: An expanded life cycle analysis. In: Agricultural Systems, (vol.141)

⁵⁸ Jacobi, J. Stellah Mukhovi, Aymara Llanque, Horacio Augstburger, Fabian Ka¨ser, Claudia Pozo (2018), Operationalizing food system resilience: An indicator-based assessment in agroindustrial, smallholder farming, and agroecological contexts in Bolivia and Kenya, In: Land Use policy (vol.79)

3. Key considerations for taking a holistic view on yield and economics

A more holistic and long-term approach is needed rather than only focusing on short-term yield and economics when the benefits and limitations of agroecological and industrial food production are compared and discussed.

Agroecology and yield increase to meet future food demand

For tackling future challenges such as food demand, it is key for (agroecological) soybean production systems to increase yields and have an efficient use of inputs, land and water without increasing their environmental impact.

- Increasing productivity is important as it may spare land while also meeting demands for food.
- This scenario should also include sufficient safeguards to protect nature against unbridled agricultural expansion so land can indeed be used for nature conservation or forest protection.
- Sustainable intensification should look at the *total* farm productivity of the land (and not only at the yield increase from one single crop), and also consider the additional value generated by sustaining or enhancing ecosystem services ^{6,59}, while reducing dependency on external inputs.

Agroecological practices and economic performance (compared to alternative systems)

At farm level, profitability ultimately determines whether agroecological practices are adopted by farmers, or not. This is determined in part by cost and price levels, including premiums.

Studies in Greece⁶⁰, Argentina⁶¹, Brazil⁶² and China, among others, have specifically looked at the economic performance of organic soybean production compared to conventional (non-GM or GM and non-GM) soybean production. Three of these four studies show a (probable) positive result for organic soy production.

- The economic performance at farm level is largely influenced by on-farm yield levels and efficiency (see also Box 7), but also by input costs and commodity prices.
- Costs of inputs, such as agrochemicals, can be substantial for conventional production systems ⁶³.
 However, organic systems have higher labor requirements ⁶⁴ which affects the operational costs ⁶⁵.
- A transition towards the production of agroecological soybean production will be promoted by an increased global demand and higher prices for such products.

⁵⁹ Garbach, K. et al (2016), Examining multi-functionality for crop yield and ecosystem services in five systems of agroecological intensification, International Journal of Agricultural Sustainability

⁶⁰ Karidogianni S., I. Roussis, K. Tsimpoukas, P. Papastylianou, D. Bilasis (2019), Comparative Technical and Economic Analysis of Organic and Conventional Soybean Production in Greece, In: UASVM Horticulture, vol. 76(1). This study showed a higher margin for organic soybean compared to conventional (non-GM) soybean, especially due to a higher premium

⁶¹ A study in the Pampas (Argentina) learns that the transition agroecological system had lower production costs than an Industrial Agricultural System, due to the use of agroecological principles⁶

⁶² A study in Brazil shows that organic farming systems had a 60% probability to be more profitable compared to the conventional (non-GM and GM) systems, despite higher costs, because of the price premiums paid for organic products³¹

⁶³ Li-wei, T. Feike, J. Holst, C. Hoffmann, R. Doluschitz (2015), Comparison of energy consumption and economic performance of organic and conventional soybean production - a case study from Jilin province, China, In: Journal of integrative agriculture. The study shows that the production costs per hectare where 33% higher and the net income 25% lower in the organic compared to the conventional production system.

⁶⁴ For conventional production, the costs for inputs may be high and substantially impact on economic returns

⁶⁵ Conventional production may result in a better economic performance due to lower operation costs (e.g., lower labor requirements).

Both are defined in a global market. Price and premium differences exist between the type and end market of soybean production, with higher prices for organic non-GM soybean production⁶⁶, but this market should expand to generate real incentives at scale.

• Putting an economic value on traditionally non-paid for benefits (e.g., biodiversity, carbon benefits) while on the other hand putting a cost on the loss of co-benefits will further encourage this transition.

The feasibility of agroecological practices on large-scale farms

A gradual approach: Integrating the principles and tools in current management while building up knowledge and experience

A key question for writing this paper has been: how to build a bridge between an "agroecological niche" and "mainstream" large-scale high input (merely GM) soy production? While small farms likely view organic and/or agroecological practices as an alternative to improve their profitability, large-scale farmers (both GM and non-GM) may have less incentives to do so because of economies of size and impacts on field operations and labor requirements⁶⁷.

Examples of large-scale commercial farming that follow the principles of agroecology, however, do exist, for example in the Americas and in Europe⁶⁸. In Argentina, for example, agroecological approaches and their benefits on large-scale farms were studied for pastoral-based livestock^{69,70}. Another well-known example in Argentina is a 650 ha agroecological farm in Buenos Aires that has successfully been applying agroecological principles for over 30 years now^{71,72}.

Agroecology can provide large-scale farms the principles and tools and knowledge to make efficient use of the available natural resources and ecosystem services, so that the reliance on external inputs can gradually decrease⁷³. Some of these practices are already uptaken by larger farms (e.g., IPM) and promoted under standards such as the RTRS, Donau / Europe Soja or Pro Terra. Another key pathway to support the transition to agroecology in large-scale farming is the management of carbon, nutrient, and water cycles beyond the scale of single farms to landscapes and regions, sometimes referred to as *circular agriculture*^{67,74}. Mainstreaming incentives and technical innovations for producers, mobilizing resources to upscale them, while building up knowledge and experience⁶⁷, is needed to enable a full transition towards agroecology in large-scale farming.

⁶⁶ According to estimates, EU soy farmers could charge a premium of €80 to €120 per ton of non-GM soybeans. Organic soy earns double this premium²³. Price premiums are thus attractive.

⁶⁷ Studies on organic farming learn that one of the reasons may be that organic crop systems substitute chemicals with field operations and labor. While organic farming may provide relatively more jobs, and consequently improves and benefits the local economy from a social (employment) point of view relatively more compared to mechanized GM and non-GM farms; this same labor intensity may also lead to higher production costs for large- scale farms and may hinder them from shifting to alternative production systems³¹ ⁶⁸ Kleijn, D., Bommarco, R., Fijen, T. P. M., Garibaldi, L. A., Potts, S. G., and van der Putten, W. H. (2019). Ecological Intensification: bridging the gap between science and practice. Trends Ecol. Evol. 34, 154–166. doi: 10.1016/j.tree.2018.11.002

⁶⁹ Jacobo, E., N Cadaviz, U. Martinez Ortiz, R. Golluscio, y A. Rodriguez. 2019. Uso de indicadores ambientales y económicos para evaluar la sustentabilidad de dos establecimientos ganaderos de la Cuenca del Salado, Argentina. En Agroecología em foco. Editora Poisson. ISBN 978-85-7042-080-0. Pgs 173-177.

⁷⁰ Martinez Ortiz, U., E. Jacobo, P. Cañada, y M. Sobredo. 2018. Desempeño económico de sistemas ganaderos en la Depresión del Salado. En: Modelización económica en el sector agropecuario. 7º Taller Internacional: La modelización en el sector agropecuario. Vicien C., G. Petri y M. M. Di Paola (Eds). ISBN 978-987-42-8438-9. Buenos Aires, pgs 70 - 102

⁷¹ http://www.fao.org/agroecology/detail/en/c/443569/

⁷² Carrasco, N., E. Cerdá, Zamora, M y M. S. González Ferrin. 2014. El caso del establecimiento "La Aurora", en B. Juárez: estrategias productivas y socioculturales. Jornada «La viabilidad de los inviables». Instituto de Economía y Sociedad en la Argentina Contemporanea, Universidad Nacional de Quilmes. ISSN 2408-4700

⁷³ P. Tittonelli, G. Gervasio Piñeiro, L. A. Garibaldi, S. Dogliotti, H. Olff, E.G. Jobbagy (2020), Agroecology in Large Scale Farming—A Research Agenda, Front. Sustain. Food Syst., 18 December 2020

⁷⁴ Hoes, A.C., Roel, J., van Berkum, S., and Poppe, K. (2018). Towards Sustainable Food Systems. A Dutch Approach. Wageningen: Wageningen University.

4. Recommendations

Actions are needed from all stakeholders involved in the soy value chain to make the required transition towards a sustainable agricultural production system where agroecological practices are further 'mainstreamed'. Such a transition takes place at farm level, landscape level and at systems level with conducive policies, technological or institutional innovations enabling farmers to change. Of course, demand and technical as well as financial support for this transition are key.

Producers: work towards stronger agroecological practices and share knowledge

- Promote the uptake of agroecological practices as it will improve resilience of the production system and give intrinsic benefits from a safety, health and economic perspective⁷⁵;
- Support knowledge exchange to share best practices and lessons learnt
- Strengthen producer networks so as to strengthen the capacity and autonomy of producers⁵.

Certification standards: bring sustainability to a next level while raising the bar

- Bridge the gap between sustainability requirements for the mainstream large-scale high-input soy
 market and the "agroecological niche" market by promoting harmonization among and/or further
 integration of agroecological practices into the best-in-class standards (RTRS non-GM, ISCC (nonGM), Proterra, Donau Soja / Europe Soja, and possibly others).
- Raise the bar, and/or harmonize requirements on criteria for sustainable practices including agroecological practices, specifically on:
 - Replacing the use of agrochemicals by non-chemical alternatives, starting with phasing out the most toxic and environmentally damaging ones on short notice, like Paraguat⁷⁶.
 - o Maintaining and improving on-farm biodiversity
 - Measures to reduce the carbon footprint on-farm, including measures for carbon sequestration (e.g., incorporation of crop residues, no tillage)
 - o Requirements on Integrated Pest or Crop management (IPM or ICM), and what a plan for this should at least include and deliver.
 - o Requirements in procedures and in verification related to the level of assurance
- Promote diversification and integrated farming systems by extending the scope of the certification standard to 'beyond soy'. An example of this is the RTRS Standard (under approval) for responsible corn production⁷⁷.
- Monitor the impact of measures including agroecological practices to enlarge the evidence base.
 Monitoring of impact is a requirement for ISEAL members, of which RTRS is a Community Member.
 This can be done together with other stakeholders (such as knowledge institutions) to inform the market and producers of its benefits.

Downstream market players: raise the bar and translate commitments into actions

• Translate the various commitments and dialogues on conversion-free sustainable soy into demand and tangible action plans⁷⁸.

⁷⁶ For example, agrochemicals, especially the more harmful ones, have a clear health risk for producers and are often costly as well.

⁷⁶ RTRS forbids the use of paraquat in soy production since 2021. For Proterra, it depends on the importing country. Producers shall have a progressive reduction program. Under Donau Soja, only substances are allowed that are approved in the EU (Paraquat is prohibited). Under ISCC, Chemicals WHO 1a and 1b are not allowed and should be phased out until January 2023. Paraquat is currently not forbidden.

⁷⁷ To be launched in 2021

⁷⁸There are still poor standards of production in soy exporting regions and only a limited percentage of the imported soy to Europe can be labelled "deforestation free". Of the 18 FEFAC-SSG compliant standards, just eight can be considered 'verified deforestation free' and only 13% of the soy imported to Europe could be considered deforestation-free in 2017²³. This pleads for the promotion for a larger uptake of these 'best in class' schemes.

- Raise the bar and require upstream value chain compliance with the 'best in class' certification schemes with high social and environmental standards, while further stimulating their agroecological requirements.
- Include agroecological principles in CSR and sourcing policies, see for example the Unilever regenerative agriculture principles⁷⁹.
- Provide producers with a longer term guarantee for demand and/or an (extra) premium paid for their product, also to compensate for the additional agroecological measures they take⁸⁰.
- Overcome the price gap of the physical value chain, by innovative chain of custody and IT solutions such as mixing agroecological and certified mainstream responsible soy in the physical value chain, and as such *literally* bridging the gap in (now separated) trade chains.
- Dedicate sufficient R&D (and resources) to agroecological research and innovative solutions, and to upscaling them. For example, to further develop and upscale biological methods of weed control or robust non-GM seed varieties that are resilient to certain diseases or climate change, as is currently done by PROBIOMA in Bolivia⁸¹.
- Imagine the value for your business of a story of soy with real value added, necessary to support the costs of transition to conversion-free soy with more agroecological practices.

Governments in producing countries: create the enabling environment to support frontrunners and a transition to a more deeply sustainable agricultural sector

- Systematically ban 'worst practices' such as the use of harmful agrochemicals (e.g., Paraquat) or the further conversion and degradation of natural ecosystems.
- Reform policies in the agricultural sector to create an enabling environment that supports sustainable agricultural models. This includes reforms in related policy fields, such as trade or landuse planning, that may hamper the uptake of sustainable practices^{82,83,84}.
- Promote the already existing best practices and policies⁸⁵ that can scale up this good practice to support more structural changes.
- Establish the underlying enabling conditions needed for a sustainable agricultural sector, such as land-use planning, enforcement of policies and laws and promoting tenure constructions that incentivize good practices that benefit the long term⁸⁶.
- Recognize the outcomes delivered by agroecological approaches and change economic support and incentives in such way that they support a transition towards a more sustainable agricultural

⁸⁰ Not all soy certified under deforestation-free schemes were sold under the premium labels in the past years. As a result, it hasn't delivered the financial incentive to producers that would stimulate further investment. The various commitments and dialogues established at the downstream end of the supply chain towards deforestation-free soy were not translated into demand²³.

⁷⁹ Unilever (2021), The Unilever regenerative agriculture principles with implementation guides

⁸¹ PROBIOMA (in Bolivia) has for example started a small-scale pilot process with PROBIOTEC where some non-GM soybean varieties are being agroecologically reproduced on PROBIOTEC farms, with the objective to have high quality non-GM seeds available for larger farms

⁸² CFS (2020), policy recommendations on agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition (DRAFT), Committee on World Food Security: Policies that provide subsidies for unsustainable practices tend, however, to lock agriculture systems into unsustainable pathways. Policies can also be guided by the drive to increase production levels and revenues.

⁸³ Governments are often reliant on the incomes they receive from soybean production and trade. With a share of 30.7% of total exports, the soybean sector in Argentina makes, for example, a positive contribution to the country's trade balance⁶

⁸⁴ Crespo M.A. (2018), In Bolivia, public policies prioritize for example the production of export crops at the expense of local and diversified production (see: Case 1: Microbial biocontrol agents as an agroecological contribution to food security and sovereignty in Bolivia)

⁸⁵ An example is the National Policy of Agroecology and Organic Production in Brazil¹² or the EU 'From farm to fork strategy'. This Strategy aims amongst others to have at least 25% of the EU's agricultural land under organic farming by 2030. Also, the Commission will take additional action to reduce the overall use and risk of chemical pesticides by 50% and the use of more hazardous pesticides by 50% by 2030³

⁸⁶ For example, an increasing number of short-term contracts, an aspect of the "modelo sojero" in Argentina, is suspected of having further reduced incentives to implement good practices such as rotational cropping that contribute to the long-term preservation of land resources⁶ and maintain soil quality²³

- sector and agroecological practices. Examples are subsidies for set-aside or rewilding programs, incentives for good agricultural practices or payments of ecosystem services, but also disincentives for damage, such as payments for water pollution or taxing agrochemical inputs⁸⁷.
- Organize, advice and train on agroecology to producers to support them in the adoption of agroecological practices, by the government and in partnership with other organizations (private sector, NGOs, knowledge organizations).
- Support non-GM (traditional) seed banks and field trials to conserve and further build robust varieties suitable for specific conditions, as for example established by the NGO Probioma⁸⁸ in Bolivia for the production of vegetable protein for human consumption.
- Strengthen the capacity of national institutions and producer networks to build knowledge on agroecological practices.
- Support landscape and jurisdiction-wide approaches to go beyond-farm level and to integrate agroecological practices across the landscapes.

Governments in Europe: create the enabling environment to support frontrunners and a transition to a more deeply sustainable agricultural sector

- Promote a shift in incentives to support a transition towards more sustainable products and towards healthy and sustainable consumer choices and diets.
- Support the protein transition, to create a better balance between animal and plant protein consumption by humans (40-60% or even 30-70 %). Higher prices are paid for soy for human consumption, facilitating the uptake of agroecological practices.
- Promote the sustainable production of protein crops, including soy, to diversify the cropping systems in Europe, which are currently dominated by cereals¹⁹.
- Require that products are legally produced and conversion-free through a strong implementation of the EU Policy and legislation to 'protect and restore the world's forests'89.
- Promote consistency between governmental measures and other tools, to take full advantage of synergies from a mix of different measures.
- Within that context, promote "best-in-class" certification and verification standards against internationally agreed criteria as examples to set minimum criteria in government standards and as tools for proving compliance within a larger set of tools for verification of compliance.
- Accelerate sustainable agricultural production through the support and implementation of the EU
 Taxonomy Regulation, which lists the protection and restoration of biodiversity and ecosystems as
 an explicit target.
- Establish trade agreements that include provisions on sustainable production including conversion-free production, the conservation of high conservation value areas, and the abolishment of harmful pesticides and other harmful practices.
- Support producing countries in making the shift to not only deforestation/conversion-free but also towards more agroecological soy, by supporting field programs, and supporting market linkages (e.g., with vegetarian as well as feed producers).

⁸⁸ In Bolivia, the NGO Probioma has a strategic alliance with the company PROBIOTEC to work on the recovery and multiplication of non-transgenic soybean varieties for the production of vegetable protein for human consumption. See also: https://web.probioma.org.bo

⁸⁷ Taxing agro-chemical will make external inputs more expensive and will make nature-based alternatives more attractive economically. See: Kleijn D., R. Bommarco, T.P.M. et al (2019), Ecological Intensification: Bridging the Gap between Science and Practice, In: Trends in Ecology & Evolution, vol. 34, Issue 2, February 2019, Pages 154-166

⁸⁹ See also: van Dam, J., van den Hombergh, H., Hoefsloot., H. and Jezeer, R. (2019), Key pointers for an ambitious EU deforestation-free action plan. Policy Brief, Tropenbos International and IUCN Netherlands.

• Practice green diplomacy to other major producing countries such as China, including collaborative learning, such as the leading partnership between Europe and China on the development of protein crops led by Donau Soja⁹⁰.

Financial institutions: create investment conditions and financial structures that support agroecological practices:

- Fully integrate nature-related considerations into their decision-making, and channel investments towards sustainable and diversified agroecological production systems, while diverting finance from non-sustainable practices.
- Create and adopt alternative financing conditions, which rely less on avoiding short termeconomic risk (through high inputs), but more on the long-term resilience of conversion-free and agroecological agricultural systems.
- Explore innovative finance and business models (payments for environmental services, green bonds, carbon credits, and others), together with the market and 'best in class' standards, that reward farmers for reducing their inputs or for maintaining/enhancing the ecosystem services on their land, including water security, pollination, maintenance of genetic diversity and carbon sequestration.

Knowledge institutions: contribute to solving technical solutions and research

- Contribute to identifying, systemizing and sharing best practices⁹¹ among interested producers and their networks; by building on existing research programs and knowledge networks⁹² and further strengthening them.
- Provide support to producers to remove certain bottlenecks, and develop technical and socioeconomic solutions, towards the adoption of agroecological practices.
- Allocate sufficient research (and investment) to agroecological research⁹³ and develop a
 dedicated research agenda to gain better insight in the economic and yield performance of
 agroecological production systems, for example, including in large-scale farming⁶⁷, under different
 conditions.

NGO's: Build awareness, support the frontrunners and advocate for urgent action

- Support producers to introduce agroecological practices and strengthen movements in support of agroecological approaches.
- Bridge research and policy gaps by on-the-ground knowledge: share lessons learnt and best practices.
- Support the development and upscaling of niche markets for conversion-free /agroecological/ organic soy production in important soy consuming and producing countries.
- Raise public awareness about the urgent need to make a transition towards sustainable food systems, in which the application of agroecological principles and practices is promoted and help

⁹⁰ See: https://www.donausoja.org/en/research/research-projects/china-europe-partnership/

⁹¹ Pessoa K. (2018), De la soya hácia la agroecología: agriculturas en disputa, In: Letras Verdes. Revista latinoamericana de Estudios socio ambientales, p.29-53: At this moment, best practices and examples do exist but are often not systematized due to the heterogeneous nature of agroecological experiences

⁹² The National Agricultural Technology Institute (INTA) in Argentina has conducted for example several research projects related to agroecology and has established an Agroecology Network¹³.

⁹³ CFS (2020), policy recommendations on agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition (DRAFT), Committee on World Food Security: Despite their potential and promising results, agroecological approaches, tend to be under-researched worldwide and investment has been severely limited when compared to other innovative approaches.

build a bridge for the current production models to improve. This includes creating awareness to consumers about the need for a change in their consumption patterns towards more environmental-friendly products.

- Advocate for action from governments, companies and financial institutions to raise the bar to conversion-free /agroecological/ organic soy.
- Changes in consumption patterns towards more environmental-friendly products (e.g., organic food) can influence farming practices all over the world, while public concerns can be a strong driver of political will to promote agroecological practices, directly or indirectly.

Reference: IUCN NL & Universidad de Buenos Aires (2021) Soy and agroecology: building a bridge. Authors J. van Dam, H. van den Hombergh and U. Martinez Ortiz. Amsterdam: IUCN National Committee of the Netherlands

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Contacts:

Jinke van Dam & Heleen van den Hombergh, IUCN National Committee of the Netherlands & Ulises Martinez Ortiz, Universidad de Buenos Aires - Facultad de Agronomía

Heleen.vandenHombergh@iucn.nl & omartine@agro.uba.ar