

Agroforestry Network

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Achieving the Global Goals through agroforestry



SwedBio
A programme at Stockholm Resilience Centre

focali.se
Forest, climate & livelihood research network

AGROFORESTRY
SVERIGE

NIRÁS



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Front cover: Loransi Mukarutagwenda and Domitila Mukanyirigira from Gasabo District, Rwanda are members in a farmers' cooperative. Together with the other members they run a tree nursery. They are preparing seedlings to be planted on their neighbours' farms. Loransi and Domitila are two of many farmers that have been trained in agroforestry around Lake Victoria. Photographer: Lisa Brunzell, Vi-skogen.

Photography:

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Smallholder farmers produce around half of the world's food, but many are living in poverty and suffer from food insecurity and malnutrition. Agroforestry can help address many of the challenges that smallholder farmers are facing. Margaret Muchanga in Kenya has been trained with support from Vi-skogen. She is one of many successful agroforestry-farmers.

WHAT IS AGROFORESTRY?

Agroforestry can be described as systems and technologies where trees are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence¹. Other related terms to describe agroforestry are polycultures and forest gardens. What they all have in common is the link between trees and agricultural activities². Agricultural land with more than 10% tree cover is defined as agroforestry³. Estimates show that more than 43% of agricultural land can be counted as agroforestry⁴.

Agroforestry is not new, but widespread in developing countries. Estimates from 2004 suggests that about 1.2 billion people rely on agroforestry to help feed themselves and their families⁵.

Globally, almost 50% of the land surface suitable for vegetation (forests for instance) has been converted to agricultural land⁶. About two-thirds out of the agricultural land is used for grazing and one-third for cropland⁷. Most of the current expansion occurs in the tropics, where 80% of all land transformed into agricultural land used to be forested. Agroforestry is especially widespread in South East Asia, Central America and South America⁸.

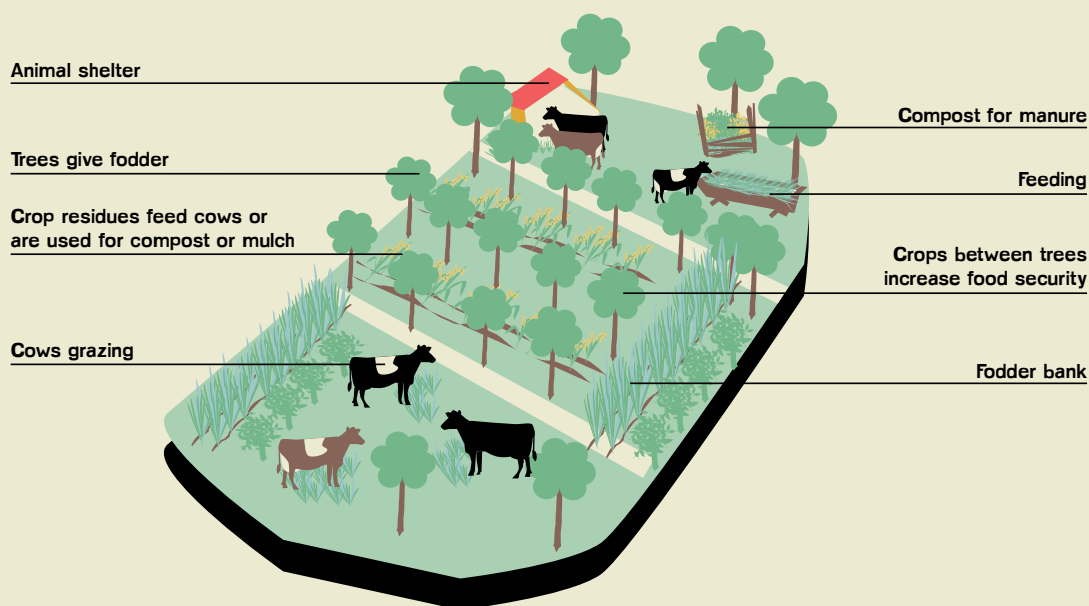


Illustration of an agroforestry system where trees are used on the same land as agricultural crops and animals (Wekesa & Jönsson, 2014).
Credit: Vi-skogen.

1. HLPE, 2017
2. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)
3. Zomer et al., 2014
4. HLPE, 2017
5. The World Bank, 2004
6. Zomer et al., 2016
7. FAOSTAT, 2017
8. Zomer et al., 2014

WHO IS THIS PAPER FOR?

This paper is mainly aimed at policy- and decision-makers in OECD foreign aid donor countries. Another target group is international institutions concerned with development cooperation, climate change budgets, policies and strategies, within the broader context of implementing the 2030 Agenda for Sustainable Development.

OECD countries and international institutions in particular have a large responsibility to ensure that foreign aid and climate finance streams that flow into developing countries are supporting projects that accelerate the transition to a sustainable society. Agroforestry is a key farming approach that contributes to multiple goals at the same time, which makes it an investment well made.

This paper is based on the evidence found in the agroforestry review: [*Scaling up Agroforestry: Potential, Challenges and Barriers. A review of environmental, social and economic aspects on the farmer, community and landscape level*](#) by the Agroforestry Network.

The Agroforestry Network's paper lays out evidence for how agroforestry as a land use system will help us achieve nine out of the 17 Global Goals. This paper focuses specifically on four of the goals: *Goal 1 and 2: No poverty and Zero hunger; Goal 13: Climate action; and Goal 15: Life on land.*

The purpose of this paper is to provide policy- and decision-makers with evidence-based information about agroforestry, helping them take well-informed decisions that will contribute to the Global Goals for Sustainable Development. Agroforestry Network's aim is to ensure that agroforestry is at the forefront of policymaking as a key approach to help achieve the Global Goals.

Why? Because agroforestry is a widespread and growing land use system that brings real benefits for people living in poverty whilst at the same time helping to mitigate and adapt to climate change, as well as increasing biodiversity and supporting ecosystems – the very systems on which life on Earth depends.



Benta Muga and John Oruko has transformed their farm in Kisumu, Kenya by using agroforestry practices, planting trees and crops together. Photos are from the same place and season, but from year 2014-2017 and show their farm changing over time.

KEY CONCLUSIONS

1. **Agroforestry as a land use system can contribute to achieving at least nine out of the 17 sustainable development goals (SDG):**



2. **Agroforestry is a key tool for both climate mitigation and adaptation**, as trees help store large amounts of carbon and agroforestry practices are a way for farming women and men to increase their resilience to climate-related shocks and erratic weather.
3. **Agroforestry fights poverty and hunger**, as the approach can contribute to higher yields and a more diverse livelihood, which means a multitude of ways to make ends meet for smallholder farmers living in poverty. Agroforestry, if done right, can lead to less reliance on one crop while improving soil fertility, which are important aspects for increasing food security.
4. **Agroforestry can increase biodiversity**, as trees in agroforestry systems provide a habitat for multiple species, provide a “buffer zone” against deforestation and can act as a “green corridor”, allowing species to migrate across landscapes which is important for their survival.
5. **Agroforestry can strengthen women control over resources and free up women’s time.** An example is that implementing agroforestry means you can spend less time walking long distances looking for firewood in the forests. As this traditionally is looked upon as a woman’s job, accessing firewood at the doorstep can increase women’s (and men’s) personal safety, and provide more time for income-generating activities.
6. **If done right, more women and men can benefit from agroforestry practices**, for instance by contributing to exchange of knowledge about which trees to plant and managing trade-offs such as which density of trees is the optimum for a fully beneficial system.
7. **For agroforestry to reach its full potential, barriers need to be addressed at all levels.** Policy- and decision-makers can contribute by making visible and promoting agroforestry projects and policies, for instance by 1) finding ways to adequately identify, classify and report on agroforestry projects, 2) by increasing finance to agroforestry projects and 3) by increasing knowledge and cooperation among key stakeholders, including supporting more demand-driven, participatory research and knowledge exchange.



RECOMMENDATIONS

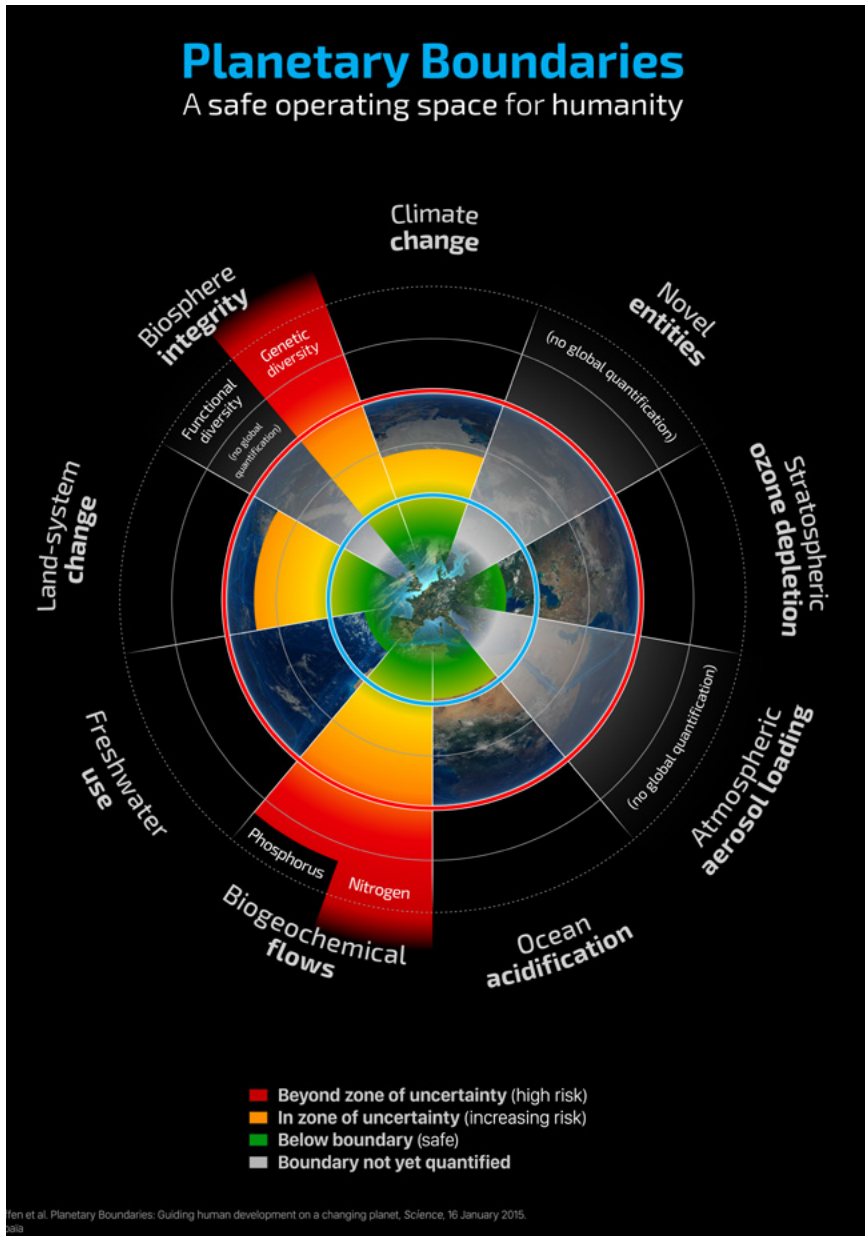
The Agroforestry Network's main conclusion is that agroforestry is still not receiving the attention it deserves due to the prevailing land use management separation between forestry and agriculture.

To overcome these barriers, OECD donor countries and international institutions should consider the following recommendations:

- 1. Make agroforestry visible**, by exploring policy changes to include agroforestry, for instance in foreign aid strategies, advisories and budgets. A starting point is to make it easier to identify if development cooperation includes support to agroforestry.
- 2. Increase funding to agroforestry projects.** Countries and institutions should consider increasing finance to agroforestry programmes, for instance through their development cooperation.
- 3. Increase knowledge and cooperation among key stakeholders** by sharing lessons learnt from agroforestry projects and practices as well as showing how the approach can be feasibly scaled up.
- 4. Support more demand-driven, participatory and inclusive research**, especially studying the socioeconomic aspects and addressing impacts at larger spatial and longer temporal scales.
- 5. Integrate policy-making across sectors** and overcome the historic separation of forestry and farming.
- 6. Consider longer funding cycles.** A scale-up of agroforestry would benefit from longer funding cycles from international and national investors and donors, and new funding mechanisms involving other stakeholders such as investors in sustainable development. Furthermore, since scale-up processes are based on innovation, funders of projects must be able to take on the risk of project failures.
- 7. Connect to the climate agenda and report progress.** As countries are committed to fulfilling their National Determined Contributions (NDC) under the United Nations Framework Convention on Climate Change (UNFCCC), supporting agroforestry projects makes sense from both a mitigation and adaptation standpoint.
- 8. Ensure policy instruments and investments that put small-scale farmers, and especially women, at heart.** This includes clarifying tree tenure, right to land, and carbon rights, as they are fundamental to motivate women and men to implement agroforestry.
- 9. Promote that existing agricultural land shall have more than 10% tree cover.**

INTRODUCTION

Globally, humans live and consume as if we had 1,7 earths at our disposal⁹. Our activity has pushed us over four out of our nine planetary boundaries: Climate change, loss of biosphere integrity, land-system change, and altered biogeochemical cycles (phosphorus and nitrogen)¹⁰. To put it bluntly, if humans were a bank customer, our account would be in the red, and most likely frozen due to poor management.



Steffen et al. Planetary Boundaries: Guiding human development on a changing planet, Science, 16 January 2015.

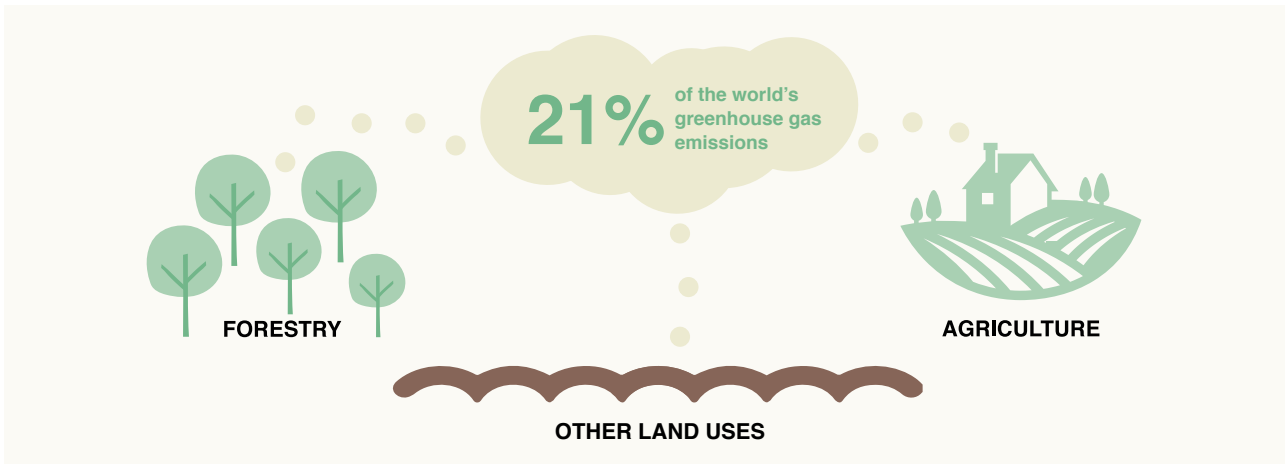
The nine planetary boundaries (Steffen et al. 2015). Credit: F. Pharand-Deschênes /Globoïa

Climate change is the biggest challenge of our time, and the world's leaders are in agreement; we must keep a global temperature rise this century well below 2 degrees Celsius¹¹. This needs to be realized, while at the same time preparing to sustain around 9.8 billion people by 2050¹².

Today, agriculture, forestry and other land uses stand for 21% of the world's total greenhouse gas emissions¹³, with unsustainable agricultural practices and deforestation further fuelling emissions. Additionally, the conversion of forests to agricultural land is the major reason for biodiversity losses¹⁴. Many of the countries expected to be severely affected by climate change are located in the tropics, with large parts of their populations dependent on agriculture¹⁵.

9. Global Footprint Network
 10. Steffen et al., 2015
 11. [The Paris Agreement](#)
 12. UN Department of Economic and Social Affairs, 2017

13. FAO, 2016a
 14. Scales & Marsden, 2008
 15. Hertel & Rosch, 2010



Agriculture, forestry and other land uses are large emitters of greenhouse gases.

Today, smallholder farmers with less than 5 ha of land, produce around half of the world's food¹⁶, but many of them are living in poverty and suffer from food insecurity and malnutrition. Women are particularly at risk in this equation, as women are more likely than men to report food insecurity, women are disproportionately impacted by climate change, and women living in poverty often depend on common pool resources and are therefore especially affected by their depletion¹⁷.



Smallholder farmers play an important role in food production.

In response, countries all around the world are redirecting their compass to align with the Global Goals for Sustainable Development – 17 goals to achieve an end to extreme poverty, inequality and climate change

by 2030. From citizens and civil society groups, companies and organisations, to academia, cities and national governments, everybody has a role to play in ensuring that humanity can thrive within our planetary boundaries and enjoy our full human rights. Our own generation, as well as future ones, will judge today's policy- and decision-makers by how smart decisions and how much effort was pooled into reaching the Global Goals.

In order to feed a growing population, combat climate change, and preserve biodiversity, there is a need to develop agriculture systems that are truly sustainable in all aspects; social, economic and environmental. Sustainable agriculture with agroforestry is a pathway towards this.

As policy- and decision-makers are looking for projects, strategies and methods that will help propel us towards achieving the Global Goals, the Agroforestry Network would like to assist by shining a light on a land use system that can help achieve at least nine out of the 17 goals: Agroforestry.

In this paper arguments are laid out for why agroforestry should be at the top of policy- and decision-makers' minds, as we navigate towards a sustainable future.

16. Ricciardi et al., 2018

17. UN Women, 2017b

BACKGROUND

Throughout human history, mixing trees and crops has been a common way to produce food.

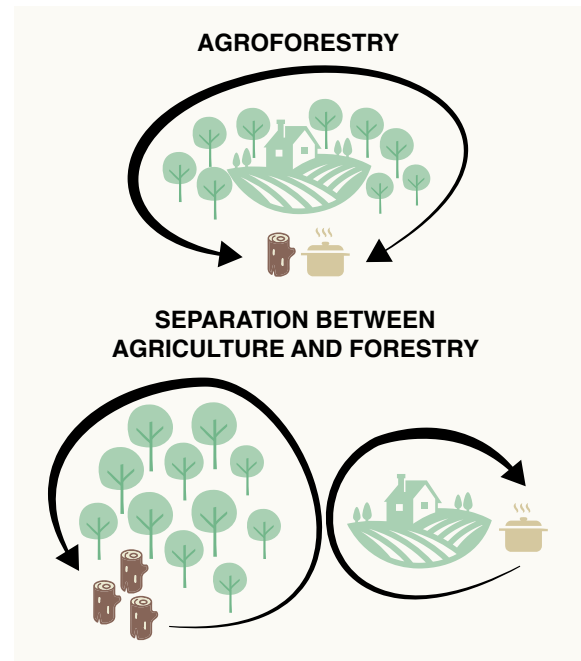
However, during the past centuries agriculture (food production) and forestry (timber production) have been separated into two different disciplines, with different and sometimes conflicting objectives. The result has been that in many countries, agriculture and forestry are often compartmentalised in strategies and policies relating to development cooperation. In both sectors, a focus has been high-yielding monocultures depending heavily on large amounts of agro-chemical and fertilizer input. These systems are increasingly questioned for their negative impact on the environment, and on people's health and livelihoods¹⁸.

Today, the importance of agroforestry for a sustainable food production is increasingly acknowledged, amongst others by international

instruments and institutions such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), the Food and Agriculture Organisation of the United Nations (FAO) and the World Bank¹⁹.

However, there is a “perfect storm” brewing. The demand for food is expected to increase as population numbers grow. At the same time, climate change is taking a firmer hold, making farming more difficult and unpredictable for smallholder farmers, resulting in increased poverty and food insecurity.

It is estimated that the planet will have to sustain around 9.8 billion people by 2050²⁰. A larger population together with changing consumption patterns is expected to create a massive demand for food, feed, fuel and fibre²¹. The pressure on agricultural land is likely to increase the prevalence of conflicts between biodiversity conservation and agricultural production, especially in sub-Saharan Africa and South America²².



Agriculture (for food production) and forestry (for timber production) have been separated into two different disciplines with different and sometimes conflicting objectives.

Our world will need to sustain



**9.8
billion
people
by 2050**

A larger population and changing consumption patterns is expected to create a massive demand for food, feed, fuel and fibre.

Smallholder farmers are key to feeding a growing population.

It is estimated that smallholders with less than 2 ha produce 30-34% of the world's food, and farms with less than 5 ha between 44-48%²³. Meanwhile, many smallholders are living in poverty, suffer from food and nutrition insecurity, and do not have access to irrigation systems, machinery or agro-chemicals, making them more directly dependent on ecosystem services²⁴. Smallholder farms provide livelihoods for almost 2 billion women and men, and are key to ensuring food security for many in the world living in poverty²⁵.

18. [Scaling Up Agroforestry: Potential, Challenges and Barriers. Agroforestry Network, 2018](#)

19. FAO, 2013; Agroforestry Network, 2017

20. UN Department of Economic and Social Affairs, 2017

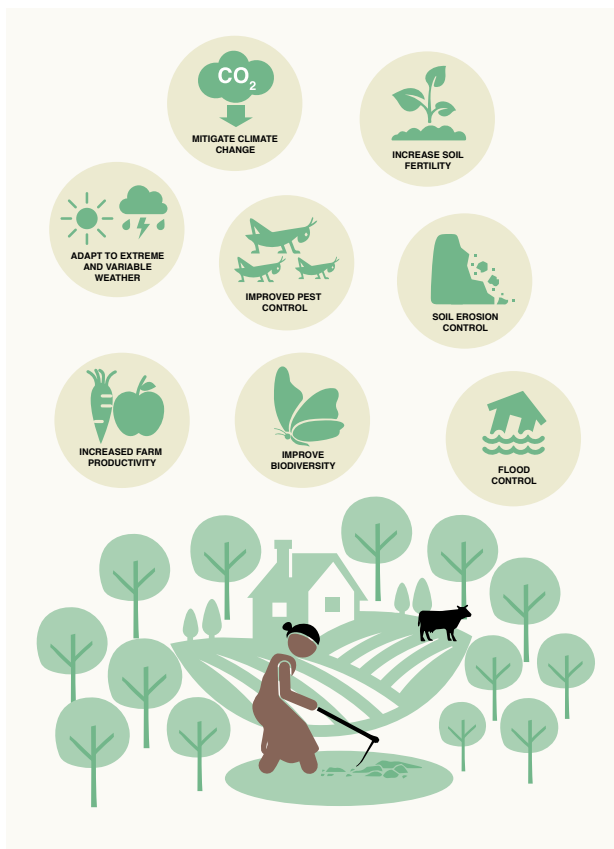
21. Alexandratos & Bruinsma, 2012

22. Laurance et al., 2014

23. Ricciardi et al., 2018

24. CFS, 2016

25. HLPE, 2013



Agroforestry is a land management system with multiple benefits.

Agroforestry is a promising land management system

that can help address many of the challenges that smallholder farmers are facing. The approach has the potential to mitigate climate change, help farmers adapt to extreme and variable weather, increase tree-related ecosystem services (such as biodiversity, increased soil fertility, soil erosion control, flood control and pest control), and at the same time increase farm productivity without large amounts of external inputs such as conventional fertilizers and chemicals for pest management²⁶.

Even though agroforestry is a widespread practice

in developing countries, the visibility of these practices at the donor country level and in international institutions is low. An analysis by CGIAR shows that 23 countries mention agroforestry as a mitigation priority, and 29 as adaptation priority for achieving their unconditional Nationally Determined Contributions (NDC) commitments under the UNFCCC²⁷.

In Sweden – a key donor country and the 7th largest donor in terms of official development assistance (ODA)²⁸ – none of the global guiding strategies currently recognise agroforestry. Agroforestry-related projects would be classified either as agriculture or forestry, however data on how much of development funds are spent on agroforestry is very limited. The Agroforestry Network's initial analysis shows that during 2017, only 6 projects related to agroforestry have been financed through the *Strategy for support to Swedish organisations in the civil society*. The total budget for these projects was 23 MSEK²⁹, out of the total strategy budget for 2017 of approximately 1.78 billion SEK³⁰. When all Swedish aid is included in this analysis using OpenAid, Sweden has financed in total 18 agroforestry-related projects globally during 2017 with a budget of 34 MSEK³¹, less than 0,1% of Sweden's total ODA budget. However, as the OpenAid data also includes core support to for example multi-lateral organisations such as the Green Climate Fund (GCF), the Global Tenure Facility and support to the Consortium of International Agricultural Research Centers (CGIAR) systems, the specifics of how that money is spent is not stated in the data. This exemplifies the issue at hand – it is almost impossible to find out how much is spent on agroforestry projects today, as agroforestry is not reported separately or visible in funding strategies or easy to trace in project documentation.

At the international institutions level, as an example, 37% of the approved GCF projects 2015–2018 indicate an agroforestry or similar tree-related component as part of the overall project. However, agroforestry might be a small part of a larger project. Agroforestry is also mentioned in the GCF funding proposal template, signaling that the fund sees agroforestry as potential result area to finance.

26. [Scaling Up Agroforestry: Potential, Challenges and Barriers. Agroforestry Network, 2018](#)

27. Richards et al., 2016

28. OECD, 2017

29. Sida. www.cso.sida.se (Accessed March 2018)

30. Sida. <https://www.sida.se/English/partners/our-partners/Civil-society-organisations/About-cooperation-with-civil-society/Support-through-Swedish-organisations-with-framework-agreement/> (Accessed August 2018)

31. Sida. <https://openaid.se/sv/aid/sweden/world> (Accessed March 2018)

AGROFORESTRY AND THE GLOBAL GOALS

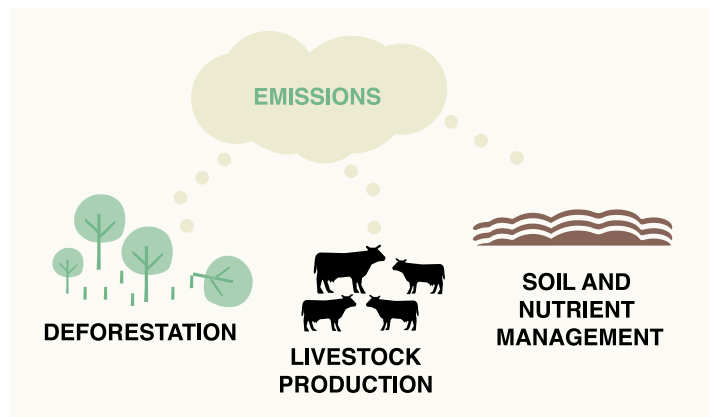


GLOBAL GOAL 13: COMBATING CLIMATE CHANGE AND ITS IMPACTS

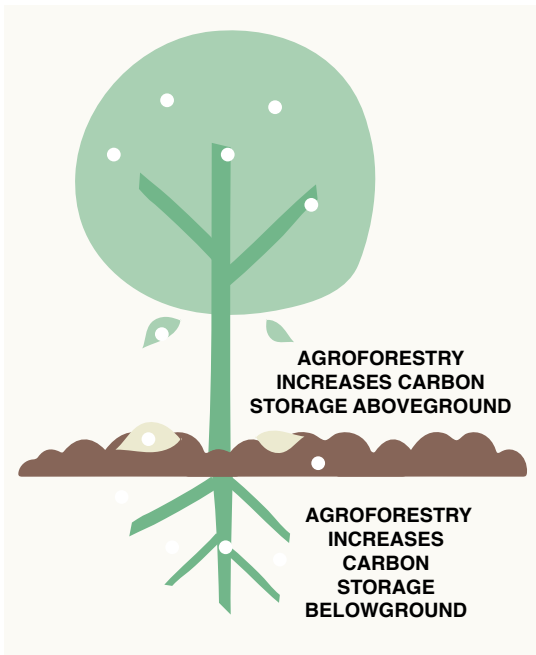
Agriculture, forestry and other land uses are large emitters of greenhouse gases, estimated to account for 21% of the world's total emissions. Emissions stem from

deforestation, livestock production and soil and nutrient management³². While being a source of emissions, agriculture is also negatively impacted by climate change, resulting for instance in decreasing crop yields³³. Africa is highly vulnerable to climate change with its high population growth and with 70% of its population being farmers mostly depending on rain-fed agriculture³⁴.

In terms of mitigation potential, trees on agricultural lands are not generally accounted for when global and national carbon budgets are determined³⁵ but accepted as a Clean Development Mechanism (CDM) used to offset emissions from higher income countries. Even though it is difficult to estimate the above- and belowground carbon storage, studies show that agroforestry increases carbon storage aboveground in biomass, and belowground



Emissions from agriculture, forestry and other land uses.



Agroforestry increases carbon storage.

through enhanced root production, organic material from roots incorporated into the soil, and litter fall³⁶. Agroforestry stores more carbon than pastures and fields with annual crops, but less than forested areas³⁷. Storage potential is also greater around the equator and is greater in humid climates than in arid and semiarid climates³⁸. Cautious estimates indicate that agricultural land converted to agroforestry has the potential to annually sequester 27.2 ± 13.5 tons $\text{CO}_{2,\text{eq}}$ per ha, at least for the first 14 years after establishment³⁹. The global mitigation potential, based on the assumption that 20% of the world's 630 million ha of unproductive agricultural land is suitable for agroforestry, then becomes 3.4 ± 1.7 billion tons $\text{CO}_{2,\text{eq}}$ per year⁴⁰. Total annual global greenhouse gas emissions in 2016 were estimated at about 51.9 billion tons $\text{CO}_{2,\text{eq}}$ ⁴¹.

32. FAO, 2016a
33. IPCC, 2014
34. IPCC, 2014
35. Zomer et al., 2016
36. Kim et al., 2016

37. Nair et al., 2009
38. Nair et al., 2009
39. Kim et al., 2016
40. Kim et al., 2016
41. UNEP, 2017

Agroforestry also provides an opportunity to improve resilience to climatic changes and shocks

such as droughts and floods. Agroforestry means a more diverse farm and types of produce, which can help to reduce vulnerability of the livelihoods of farmers. Trees also provide several ecosystem services such as erosion-, flood- and pest control⁴². Furthermore, trees improve the micro-climate by shading crops and cooling the surrounding air by increasing the transpiration⁴³. Agroforestry can therefore help buffer climate extremes, expected to become more common in the future⁴⁴.

Even though current research is still in its early stages, studies from Africa and Vietnam indicate that agroforestry has positive results on yields during climate shocks such as extreme droughts or floods⁴⁵. Several studies also show that rural farmers use tree products, such as fruits and nuts, as a coping mechanism during periods with extreme droughts or floods⁴⁶.



Mitigation potential for agroforestry.



Agroforestry can improve resilience to climatic changes and shocks, such as droughts. Agroforestry means a more diverse farm, which can help to reduce vulnerability of the livelihoods of farmers. Left: Degraded land. Right: Crops intercropped with trees.

42. Verchot et al., 2007; Mbow et al., 2014
43. Ellison et al., 2017
44. Mbow et al., 2014
45. Sileshi et al., 2008; Sileshi et al., 2011, Sileshi et al., 2012; Nguyen et al., 2013
46. Ong et al., 2015



CASE STUDY:

KENYA AGRICULTURAL CARBON PROJECT (KACP): ADAPTATION, MITIGATION AND LIVELIHOOD IMPROVEMENT

The Kenya Agricultural Carbon Project is a real success story that has helped 29,497 farmers improve food security and adapt to climate change. Over 8 years, crop yields have increased with more than 150% and 329,049 tons of CO_{2,eq} has been sequestered and stored in soil and trees.

In total, the project involves 1,730 farmer groups with 29,497 smallholder farmers on 21,965 ha of land in western Kenya. The farmers in the area had seen their yields decline and the environment degrade after years of unsustainable agricultural practices.

The main economic incentive for the farmers is increasing yields. The project has shown that by using Sustainable Agricultural Land Management practices (SALM), e.g. agroforestry, mulching, use of cover crops and green manure, yields increased with over 150% in all agro-ecological zones in 8 years, resulting in improved food security.

Savings among farmer families have also increased along with a greater resilience to a wide range of shocks, including climate change impacts. Other results include increased knowledge about climate change and increased access to firewood, fruits and fodder from trees.

The project is a partnership backed by the World Bank, where Vi Agroforestry trains the farmers involved in different SALM practices to increase the organic content in the soil. Increased content of organic matter improves yields, provides resilience to droughts and heavy rains, limits erosion, and stores carbon, for which the farmers receive payment. The generated carbon credits are purchased by the World Bank's BioCarbon Fund and private companies.

In 2017, the project was able to verify that 329,049 tons of CO_{2,eq} had been sequestered and stored in the soil between 2009-2017. The project ends in 2030 and then the sequestered amount of carbon is expected to be 2 million tons.

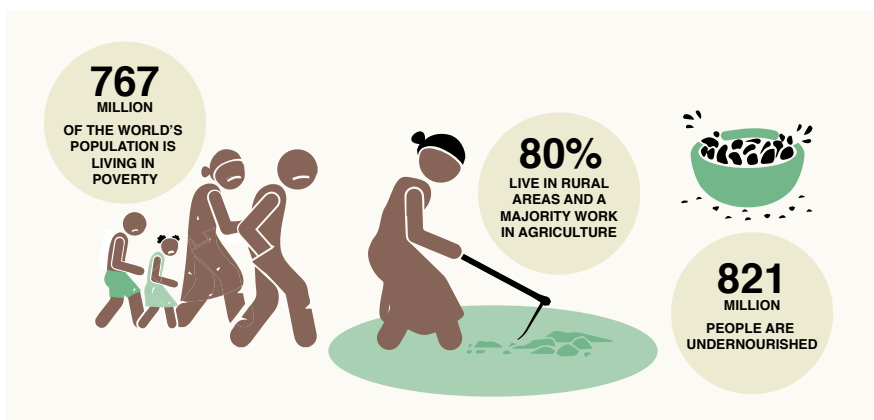
Sources: World Bank (2017), World Bank (2014), Vi Agroforestry (2016), Öborn et al. (2017), Vi-skogen (2017).



GLOBAL GOALS 1 AND 2: ENDING POVERTY AND HUNGER

It is estimated that 767 million of the world's population is living in poverty, whereof 80% live in rural areas and a majority work

in agriculture⁴⁷. In 2017, around 821 million people were undernourished. This was the third year in a row showing a rise in world hunger. Undernourishment “hot-spots”, where a high proportion of people live in chronic hunger, are sub-Saharan and Eastern Africa.⁴⁸ However, it is not just about having little or no food to eat. Globally, around two billion people suffer from so called “hidden hunger”, meaning lacking micronutrients. Lack of iron, iodine, vitamin A and zinc are the most common micronutrient deficiencies causing serious health problems⁴⁹. To be food secure means having availability and adequate access at all times to sufficient, safe, nutritious food to maintain a healthy and active life⁵⁰.



A large number of people are today living in poverty and 821 million are undernourished. Women are more likely than men to report food insecurity and also disproportionately impacted by climate change.

Agroforestry contributes to food security in multiple ways.

Having access to trees and the ecosystem services that multifunctional landscapes provide, is important for smallholder farmers, as trees provide fodder, food, fuelwood, financial opportunities and soil fertility. Studies show that during periods of low yields, many farmers, and

especially women, rely on forest products for food and additional income⁵¹. Agroforestry also contributes to nutritional security as the diversification provides farmers with a more varied diet⁵². Forest products are also important to reduce malnutrition, as they are rich in nutrients, fibres and proteins⁵³.

In general, studies show that agroforestry increases crop yields⁵⁴, which is vital to food security. Studies also show that planting nitrogen-fixing trees can increase yields up to several hundred percent⁵⁵. However, crop yields can also be affected negatively if the density of trees is too high, which can lead to crops competing with trees for nutrients, light and water⁵⁶. An optimum tree distribution increases the groundwater formation and can result in less surface runoff and fewer floods⁵⁷.

Although agroforestry is proven to increase yields, there is more research needed to assess the impact agroforestry has on household income from the farm. However, early studies indicate that farmers using agroforestry systems earn more cash from improved yields and sales of tree products⁵⁸.

In addition, being able to feed and maintain livestock is crucial for smallholder farmers.

Studies show that using fodder shrubs is a suitable agroforestry practice as it competes only marginally with crops⁵⁹.

47. World Bank, 2016

48. FAO et al., 2018

49. Sunderland et al., 2013

50. World Food Programme, 2018

51. FAO et al., 2017

52. Nyaga et al., 2015

53. FAO, 2013

54. Branca et al., 2013

55. Akinnifesi et al., 2009

56. Akinnifesi et al., 2009

57. Ilstedt et al., 2016

58. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)

59. Kuyah et al., 2016



CASE STUDY: FOOD SECURITY IN SRI LANKAN HOMEGARDENS

Homegardens – covering more than 13% of Sri Lanka's land areas – are privately owned land areas close to homesteads, and a traditional agroforestry system common in Sri Lanka dating back centuries. Homegardens existing both in agricultural and urban settings constitute a majority of Sri Lanka's total annual crop and timber production.

Homegardens strengthen livelihoods, food security and access to nutritional food for people living in poverty, especially when food supplies are inadequate or unreliable. Homegardens also increase resilience to a wide range of shocks, including climate change impacts. While harvests might go up and down seasonally, keeping a large number of crop, tree and animal species helps to ensure a steady supply of food.

Homegardens can help fill nutritional gaps and contribute to a more complete diet, as even a small plot can supply a variety of fruits and vegetables at a relatively low cost. For instance, urban homegardens in Sri Lanka produce an estimated 50–60% of the leafy vegetables, and 20% of all the vegetables consumed by the households. Excess produce can be sold or exchanged for other items.

Homegardens also produce cash crops, support animal rearing, and trees for fruit and timber used for subsistence farming. The most valuable benefit is to help protect households from soaring food prices and harvest failures and thereby helping to tackle poverty.

Recently published research synthesising articles on Sri Lankan homegardens, showed that 78% of articles highlighted direct, or indirect, positive effects on food security. In total, 51% of the articles showed indirect positive impact on aspects relating to food security, including ecosystem services, soil, carbon uptake and economic impacts. In addition, 27% of the articles showed direct impact on food security such as number of edible crops produced, production of food trees and crops, and nutritional supply of vitamins and carbohydrates.

Even though farmers in Sri Lanka are entitled to land that enables households to grow gardens they can pass to their children and grandchildren, homegardens in Sri Lanka face various other challenges, for instance urbanization that causes land fragmentation and loss of agricultural knowledge and labour.

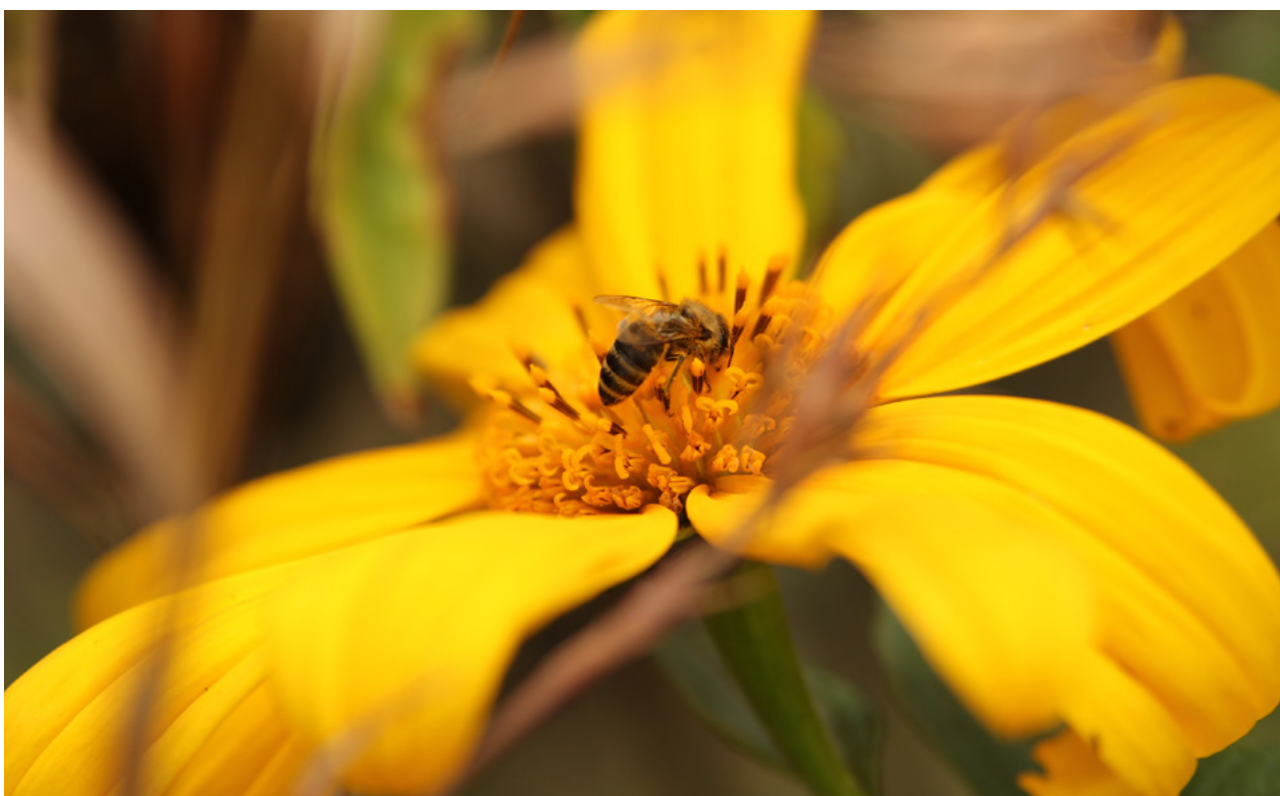


GLOBAL GOAL 15: HALTING BIODIVERSITY LOSS

Forests hold more than 75% of the world's terrestrial biodiversity⁶⁰.

Turning forests into agricultural land is the major reason for biodiversity losses in tropical regions, where most of the world's biodiversity reserves are found⁶¹. High population growth rates⁶² and international trade of commodities such as soy, beef and palm oil are largely responsible for agricultural expansion in these regions⁶³. This deforestation increases the greenhouse gas effect, since trees absorb carbon dioxide. The drivers of tropical deforestation have become increasingly commercialised and globalised in recent decades; commercialised as the agents of deforestation have shifted from smallholders clearing forest for subsistence farming to large-scale agricultural corporations clearing for profits; globalised as the agricultural commodities produced on the cleared land are increasingly destined for export rather than domestic markets⁶⁴.

Biodiversity is crucial to global food production and food systems resilience, especially in the light of climate change, but is at risk due to the growing demand for food and biofuel⁶⁵. Agroforestry systems play an important role in mitigating biodiversity loss, as these systems provide habitat for a richer variety of species compared to agricultural fields with annual crops⁶⁶. However, species that can live in a wide range of environmental conditions are better suited to agroforestry systems than others. Some species thus risk disappearing if forests are converted to agroforests⁶⁷.



In a fragmented landscape, agroforestry systems are important habitats for pollinators, and more pollinators can mean increased yields.

60. FAO, 2016b

61. Scales & Marsden, 2008

62. Scales & Marsden, 2008

63. Sembres et al., 2017

64. Focali Brief 2015:03

65. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)

66. Jose, 2012

67. Scales & Marsden, 2008

Koyi Sarungi has planted a wide variety of agroforestry tree species on his farm in Kenya.





Biodiversity contributes to food and nutrition security of rural farmers. If one crop fails, biodiversity such as crop diversity on the farm or in the landscape, offers opportunities and alternatives for food and income. A diverse landscape can also be more resilient to climate change and other shocks. In addition, trees provide shelter for species essential to food production, for instance bees and natural enemies to pests⁶⁸.

Planting trees on agricultural lands can also help reduce deforestation by providing bioenergy, timber and other forest products on farmer fields. Agroforestry also provides a range of ecosystem services such as erosion control and flood mitigation, that benefit the surrounding landscape and thus prevent habitat degradation⁶⁹.

Agroforestry helps to create “buffer zones” around the forests protecting the biodiversity therein as well as it provides species with so called “ecological corridors” that help species migrate and spread from one habitat to another, ensuring their survival⁷⁰.

The types of trees that are planted also affect biodiversity. In tropical regions, farmers tend to plant exotic fast-growing trees, but several studies point out that there are many benefits to using native trees that sometimes are as fast-growing as exotic ones⁷¹. Studies show that agroforestry can decrease the effects of pests, compared to monocrops, by increasing the number of natural predators to pests and reduce the density of the target crop, thus reducing the likelihood that a destructive insect will find it⁷². However, if the wrong combination of trees is planted, trees can also become pest-hosts in-between growing seasons. It is therefore important to disseminate knowledge widely on which trees are best suited to agroforestry as well as investing in more research⁷³.

As more forests disappear, so do pollinators such as bees. As much as around 35% of crops depend on insect pollination⁷⁴. In a fragmented landscape, agroforestry systems are therefore important habitats for pollinators⁷⁵, and more pollinators can mean increased yields, especially important for small-scale farmers who depend directly on the natural systems⁷⁶.

68. HLPE, 2017

69. Jose, 2012

70. Scales & Marsden, 2008

71. Jose, 2012

72. Pumariño et al., 2015; Ratnadass et al., 2012

73. Pumariño et al., 2015; Ratnadass et al., 2012

74. HLPE, 2017

75. HLPE, 2017

76. Garibaldi et al., 2016

CASE STUDY:

CAN BANANA PLANTATIONS PLAY A ROLE IN PRESERVING THE ATLANTIC FOREST?

The agricultural expansion is posing a threat to the integrity of Brazilian ecosystems. Despite efforts from both the government and non-governmental organisations, a significant portion of the ecosystems are still not protected. However, implementation of agroforestry on smallholder banana farms in the Torres Region has shown to promote biodiversity and could play a significant role in preserving the Atlantic Forest. These ecological farming systems have a considerably better environmental performance compared with conventional banana production systems.

In a study by André Luiz Gonçalves (2008), it was found that the biodiversity in agroforestry banana plantations can be similar to the forest fragments of the Atlantic Forest. The eight farms in the study had 118 different tree species belonging to 37 families, compared to the forest fragments with 114 species in 44 families. This similarity between the farms and the forest gives an indication of the role these systems might have in conservation. As the Atlantic Forest is a highly fragmented area, agricultural management practices that retain trees within the system, particularly in areas close to forest patches, may contribute to maintaining these forests.



The palmito tree can play a crucial role in forest conservation, while its açai pulp also provides a potential source of income.

The agroforestry farms also contained several endangered and vulnerable tree species, which accentuates the role these farms play in preserving biodiversity. One common species found among the farms was palmito (*Euterpe edulis*), a characteristic species of the Atlantic Forest and recognized as a keystone species with a crucial role in forest conservation. It also has promising economic potential for smallholders through the extraction of the palm heart and the production of açai pulp.

If some of the agroforestry practices adopted by ecological farmers were extended to the whole area under banana plantation in southern Brazil, approximately 150,000 ha, a number of environmental services could be enhanced. For instance, the planting of a few native trees within the banana plots and on the edges of the plantations could have positive implications for biodiversity conservation and for the integrity of the whole system, without compromising productivity and fruit quality. Some of these trees would provide habitat for birds and insects and would play an important role in increasing soil organic matter, forming windbreaks for the banana trees and protecting watersheds, among other environmental benefits. These advancements would favour the banana plantations as well as the overall ecosystem health, demonstrating that some synergistic relationships between agriculture and environmental enhancement are possible.

CONTRIBUTING TO OTHER GLOBAL GOALS

Agroforestry is a growing approach that has potential to contribute to many of the Global Goals. While this report has paid more detailed attention to some of the goals with a more direct link to agroforestry, there are also other examples of synergies to be found if possible trade-offs are carefully managed. Below is a short description of how agroforestry is linked to five more goals.

GOAL 3: Ensure healthy lives and promote well-being for all at all ages

Target 3.9: Reduce illnesses and death from hazardous chemicals and pollution



Agroforestry systems contribute real health benefits to farmers. One example is the potential of reduced pest control with chemical pesticides, which has negative effects on the surrounding environment and on human health. The effects of pests and diseases on crops can be reduced in agroforestry systems, especially for perennials⁷⁷. However, the risk of pests and diseases can increase if the wrong combination of trees and crops is chosen⁷⁸.

GOAL 5: Achieve gender equality and empower all women and girls

Target 5A: Equal rights to economic resources, property ownership and financial services



Agroforestry can have a positive impact on women's empowerment, participation and rights to economic and natural resources. Although 43% of the agricultural workforce in lower income countries are women⁷⁹, women represent just 13% of agricultural land holders⁸⁰. Agroforestry is in many ways a land management system that is suitable to support women and reduce gender inequalities. As an example, traditionally, women often carry the responsibility for fetching fuel wood. By implementing agroforestry, women spend less time and walk shorter distances looking for firewood in the forest as they can access firewood at home. This also means increased personal safety, more time for income-generating activities such as picking fruits and other tree products to sell. A study in Kenya showed that women spent on average 130 hours per year collecting firewood, while women that harvested fuelwood on their farms spent 36 hours per year on this task⁸¹.

Agroforestry can provide unique opportunities for women to play a central role in food production and value chains despite limited access to e.g. land. However, sensitivity to how local relations of power, tenure and ethnicity influence control over value chains and a voice in decision-making is important in policy formulation or projects aimed at increased gender equality. Without this sensitivity, an unintended consequence can be that men take over parts of a value chain when the profitability from the products increases⁸².

77. Pumariño et al., 2015; Ratnadass et al., 2012

78. Pumariño et al., 2015; Ratnadass et al., 2012

79. FAO, 2011

80. UN Women, 2017

81. Mugo, 1999

82. Westholm & Ostwald, 2018

GOAL 6: Ensure availability and sustainable management of water and sanitation for all
 Target 6.4: Increase water-use efficiency and ensure freshwater supplies
 Target 6.6: Protect and restore water-related ecosystems



On a regional and continental scale, trees are important for the formation of rain as landscapes with forests produce more water vapour and increase the relative humidity. Climate models predict that large-scale deforestation could decrease rainfall with as much as 30% in some regions⁸³. Additionally, an intermediate density of trees can maximize groundwater recharge in conditions that are common across much of the seasonally dry tropics. Without the trees these tropical soils lose their larger pores and much of the water is not able to enter deep into the soils⁸⁴. Therefore, agroforestry has an important role to play when it comes to counteracting the effects of deforestation by ensuring more tree coverage on already deforested land and thereby contributing to more rainfall. In addition, agroforestry can improve the use of rainwater and produce more “crop per drop”⁸⁵.



GOAL 7: Ensure access to affordable, reliable, sustainable and modern energy for all



Today, 2.4 billion people depend on firewood to cook food. Deforestation is making it more difficult for people, often women and girls, to get access to firewood, having to walk further to find it. Agroforestry can reduce pressure on forests, as it provides bioenergy, timber and other forest products for farmers at home.

GOAL 12: Ensure sustainable consumption and production patterns

Target 12A: Support developing countries’ scientific and technological capacity for sustainable consumption and production



As the remaining forests in the world are threatened by a growing demand for food, feed, fibre and fuel, women and men in developing countries will face additional challenges, especially in a changing climate. Agroforestry is a promising land management system that can improve farmers’ livelihoods while reducing pressure on forests, thus contributing to more sustainable production patterns.

83. Ellison et al., 2017.

84. Ilstedt et al., 2016

85. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)

BARRIERS TO SCALING UP AGROFORESTRY

This paper has shown that there is untapped potential for agroforestry to improve people's lives and well-being, as well as contribute to biodiversity and tackle climate change. Moving forward, what are the barriers preventing agroforestry from becoming more widespread and scaled-up?

There are several barriers at the farm level and at the national policy level in developing countries. At the farm level, analysis show that there are few **value chains** developed for agroforestry products and for connecting them to consumers and the market. The **slow return on investment** in agroforestry is also problematic, as many farmers, especially women, do not have access to capital, credit or secure tenure of their land⁸⁶.

In most countries, policies, land-use planning and rural development programmes emphasise high input (e.g. machinery, inorganic fertilizers and irrigation) **monocultures** as the primary tool for development and there is a need for increased knowledge on agroforestry in the land management sector⁸⁷.

The most apparent obstacle in **policies and institutional environments** (such as government agencies) is that agroforestry is simply invisible. This is true in both foreign aid donor countries as well as in developing countries. Policies for agriculture and forestry exist separately, but so far, they are lacking for agroforestry in most countries, except for India where an agroforestry policy was adopted in 2014⁸⁸. Ministries for forestry, rural development, environment, trade and agriculture are common, but their work is rarely coordinated and thus **agroforestry falls between two stools**. Even when agroforestry is recognized and included in a policy, little work has been done so far to harmonize it with other policies and no governmental body takes the lead for implementation⁸⁹. This creates numerous **legal, economic and social barriers**, preventing the potential of agroforestry to be fully exploited⁹⁰.



Agroforestry practiced on a smallholder farm in Kenya. Food crops such as banana and cassava is intercropped with fodder trees.

86. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)
87. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)

88. Down To Earth, 2014
89. [Scaling Up Agroforestry: Potential, Challenges and Barriers, Agroforestry Network, 2018](#)
90. FAO, 2013

Grevillea tree nursery in Kisumu, Kenya.



RECOMMENDATIONS

To overcome these barriers, OECD donor countries and international institutions countries should consider the following recommendations:

1. Make agroforestry visible.
2. Increase funding to agroforestry projects.
3. Increase knowledge and cooperation among key stakeholders.
4. Support more demand driven, participatory and inclusive research.
5. Integrate policy-making across sectors and overcome the historic separation of forestry and farming.
6. Consider longer funding cycles.
7. Connect to the climate agenda and report progress.
8. Ensure policy instruments and investments that put small-scale farmers, and especially women, at the heart.
9. Promote that at least 10% of all existing agricultural land shall be covered by trees.

NOTES

Agroforestry Network. 2018. Scaling Up Agroforestry: Potential, Challenges and Barriers. <http://agroforestrynetwork.org/wp-content/uploads/2018/09/Scaling-up-agroforestry-Potential-Challenges-and-Barriers.pdf>

Agroforestry Network. 2017. News. <http://agroforestrynetwork.org/news/> Accessed 1 October 2017.

Akinnifesi, F.K., Ajayi, O.C., Silechi, G., Chirwa, P.W. & Chianu, J. 2010. Fertiliser trees for sustainable food security in the maize-based production systems of East and Southern Africa.

Alexandratos, N. & Bruinsma, J. 2012. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO.

BioCarbon Fund. 2017. Kenya Agricultural Carbon Project. <http://www.biocarbonfund.org/node/82> Accessed 19 September 2017.

Branca, G., Lipper, L., McCarthy, N. & Jolejole, M.C. 2013. Food security, climate change, and sustainable land management. A review. *Agron. Sustain. Dev.* 33:635–650

CFS. 2016. Connecting smallholders to markets - Policy recommendations. Global Strategic Framework for Food Security & Nutrition (GSF).

DownToEarth. 2014. India becomes first country to adopt an agroforestry policy. <http://www.downtoearth.org.in/news/india-becomes-first-country-to-adopt-an-agroforestry-policy-43518>. Published 14 feb 2014.

Ellison, D., Morris, C.E., Locatelli, B., Sheil, D., Cohen, J., Murdiyarso, D., Gutierrez, C., Noordwijk, Van M., Creed, I.F., Pokorny, J., Gaveau, D., Spracklen, D.V., Bargaues Tobella, A., Ilstedt, U., Teuling, A.J., Gebrehiwot, S.G., Sands, D.C., Muys, B., Verbist, B., Springgay, E., Sugandi, Y. & Sullivan, C.A. 2017. Trees, forests and water: Cool insights for a hot world. *Global Environmental Change.* 43: 51–61.

FAO. 2011. The state of food and agriculture, Women in agriculture: Closing the gender gap for development. Food and Agriculture Organization of the United Nations. Rome. ISBN 978-92-5-106768-0.

FAO. 2013. Advancing Agroforestry on the Policy Agenda: A guide for decision-makers. Agroforestry Working Paper no. 1. Food and Agriculture Organization of the United Nations. Rome.

FAO. 2016a. The state of food and agriculture - Climate change, agriculture and food security. Food and Agriculture Organization of the United Nations. Rome. ISBN 978-92-5-109374-0.

FAO. 2016b. State of the world's forests - Forest and agriculture: Land-use challenges and opportunities. Food and Agriculture Organization of the United Nations. Rome. ISBN 978-92-5-109208-8.

FAO. 2017. Regional Overview of Food Security and Nutrition in Africa 2016. The challenges of building resilience to shocks and stresses. Accra.

FAO, IFAD, UNICEF, WFP & WHO. 2017. The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. Rome, FAO.

FAO, IFAD, UNICEF, WFP and WHO. 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO. Licence: CC BY-NC-SA 3.0 IGO.

FAOSTAT. 2017. Land Use. <http://www.fao.org/faostat/en/#data/EL> Accessed 6 April 2018.

Focali Brief 2015:03, ISBN: 978-91-86402-35-8, December 3, 2015. <http://www.focali.se/filer/Focali%20brief%202015-03%20Consumption%20Trade%20and%20Tropical%20Deforestation.pdf>

Garibaldi, L. A. (Auteur de correspondance), Carvalheiro, L. G., Vaissière, B., Gemmill-Herren, B., Hipolito, J., Freitas, B. M., Ngo, H. T., Azzu, N., Saez, A., Astrom, J., An, J., Blochtein, B., Buchori, D., Chamorro-Garcia, F. J., Oliveira da Silva, F., Devkota, K., Ribeiro, M. d. F., Freitas, L., Gaglianone, M. C., Goss, M., Irshad, M., Kasina, M., Filho, A. J. P., Kiill, L. H. P., Kwapong, P., Parra, G. N., Pires, C., Pires, V., Rawal, R. S., Rizali, A., Saraiva, A. M., Veldtman, R., Viana, B. F., Witter, S., Zhang, H. (2016). Mutually beneficial pollinator diversity and crop yield outcomes in small and large farms. *Science*, 351 (6271), 388–391. DOI: 10.1126/science.aac7287 <https://prodinra.inra.fr/record/350372>

Global Footprint Network, press release 27 June 2017. <https://www.footprintnetwork.org/2017/06/27/earth-overshoot-day-2017-2/>

Gonçalves, A.L., 2008. Ecological Agriculture in the Torres Region of Rio Grande Do Sul, Brazil: Tradeoffs or synergies. A Dissertation. Presented to the Faculty of the Graduate School of Cornell University.

Hertel, T.W. & Rosch, S.D. 2010. Climate change, agriculture and poverty. Policy Research Working Paper 5468. Washington, DC: World Bank

- HLPE (High Level Panel of Experts on Food Security and Nutrition). 2013. Investing in smallholder agriculture for food security. A report by the High Level Panel of Experts on Food Security and Nutrition. HLPE Report No. 6. Rome. (www.fao.org/3/a-i2953e.pdf).
- HLPE (High Level Panel of Experts on Food Security and Nutrition). 2017. Sustainable forestry for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- Ilstedt, U., Bargaúes Tobella, A., Bazié, H.R., Bayala, J., Verbeeten, E., Nyberg, G., Sanou, J., Benegas, L., Murdiyarsu, D., Laudon, H., Sheil, D. & Malmer, A. 2016. Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics. *Scientific Reports*. 6:21930.
- IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- Jose, S. 2012. Agroforestry for conserving and enhancing biodiversity. *Agroforest. Syst.* 85:1–8.
- Kim, D-G., Kirschbaum, M.U.F. & Beedy, T.L. 2016. Carbon sequestration and net emissions of CH₄ and N₂O under agroforestry: Synthesizing available data and suggestions for future studies. *Agriculture, Ecosystems and Environment*. 226: 65–78. DOI: 10.1016/j.agee.2016.04.011.
- Kuyah, S., Öborn, I., Jonsson, M., Dahlin, A.S., Barrios, E., Muthuri, C., Malmer, A., Nyaga, J., Magaju, C., Namirembe, S., Nyberg, Y. & Sinclair, F.L. 2016. Trees in agricultural landscapes enhance provision of ecosystem services in sub-Saharan Africa. *International Journal of Biodiversity Science, Ecosystem Services & Management*. 12(4): 255–273.
- Laurance, W.F., Sayer, J. & Cassman, K.G. 2014. Agricultural expansion and its impacts on tropical nature. *Trends in Ecology & Evolution*. 29(2):107–116.
- Mattsson, E., Ostwald, M., Nissanka, S.P. 2017. Food security in Sri Lankan homegardens – what does science tell us? *Focali Brief* 2017:01, Gothenburg. <http://www.focali.se/en/articles/artikelarkiv/food-security-in-sri-lankan-homegardens-2013-what-does-science-tell-us>
- Mbow, C., Smith, P., Skole, D., Duguma, L & Bustamante, M. 2014. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Current Opinion in Environmental Sustainability*. 6:8–14.
- Mugo, F.W. 1999. The effects of fuelwood demand and supply characteristics, land factors, and gender roles on tree planting and fuelwood availability in highly populated areas of Kenya. PhD thesis, Cornell University, New York, USA.
- Nair, P.K.R., Kumar, B.K. & Nair, V.D. 2009. Agroforestry as a strategy for carbon sequestration. *J. Plant Nutr. Soil.* 172: 10–23. DOI: 0.1002/jpln.200800030
- Nguyen, Q., Hoang, M.H., Öborn, I. & van Noordwijk, M. 2013. Multipurpose agroforestry as a climate change resiliency option for farmers: an example of local adaptation in Vietnam. *Climatic Change*. 117:241–257
- Nyaga, J., Barrios, E., Muthuri, C.W., Öborn, I., Matiru, V., Sinclair, F.L. 2015. Evaluating heterogeneity in agroforestry adoption and practices within smallholder farms in Kenya. *Agriculture Ecosystem and Environment* 212, 106–118.
- Öborn I, Wekesa A, Natongo P, Kiguli L, Wachiye E, Musee C, Kuyah S, Neves B. 2017. Who enjoys smallholder generated carbon benefits? In: Sara Namirembe, Beria Leimona, Meine van Noordwijk, Peter Minang (eds.), *Co-investment in ecosystem services: global lessons from payment and incentive schemes*. World Agroforestry Centre, Nairobi. Chapter 7, 1–10. (http://www.worldagroforestry.org/sites/default/files/Ch7_Smallholder%20carbon_ebookB-DONE.pdf)
- OECD, 2017. <http://www.oecd.org/dac/financing-sustainable-development/development-finance-data/> and <http://www2.compareyourcountry.org/oda?cr=oecd&lg=en> (Accessed August 2018)
- Ong, C.K., Black, C.R. & Wilson, J. (eds). 2015. *Tree-Crop Interaction - 2nd edition Agroforestry in a changing climate*. CPI Group (UK) Ltd, Croydon. ISBN-13: 978 1 78064 511 7
- Paris Agreement. <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
- Pumariño, L., Waldesemayat Sileshi, G., Gripenberg, S., Kaartinen, R., Barrios, E., Nyawira Muchane, M., Midega, C. & Jonsson, M. 2015. Effects of agroforestry on pest, disease and weed control: A meta-analysis. *Basic and Applied Ecology*. 16:573–582.
- Ratnadass, A., Fernandes, P., Avelino, J. & Habib, R. 2012. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review. *Agron. Sustain. Dev.* 32:273–303.
- Ricciardi, V., Ramankuttya, N., Mehrabia, Z., Jarvisa, L., Chookolingoa, B. 2018. How much of the world's food do smallholders produce? *Global Food Security* 17, p 64–72.
- Richards M, Bruun TB, Campbell B, Gregersen LE, Huyer S, Kuntze V, Madsen STN, Oldvig MB, Vasileiou I. 2016. How countries plan to address agricultural adaptation and mitigation: An analysis of Intended Nationally Determined Contributions. CCAFS dataset version 1.2. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). (Illustration shared under the licence CC BY-NC-ND 3.0)

- Scales, B.R. & Marsden, S.J. 2008. Biodiversity in small-scale tropical agroforests: a review of species richness and abundance shifts and the factors influencing them. *Environmental Conservation*. 35 (2):160–172
- Sembres, T., Trevisan, A., Gardner, T., Godar, J., Lake, S. and Mardas, N. (2017). Scaling up deforestation-free production and trade with jurisdictions. In N. Pasiiecznik and H. Savenije (eds) *Zero Deforestation: A Commitment to Change*. ETFRN News no. 58. <https://www.sei.org/publications/scaling-up-deforestation-free-production-trade-jurisdictions/>.
- Sida. www.cso.sida.se (Accessed March 2018)
- Sida. <https://www.sida.se/English/partners/our-partners/Civil-society-organisations/About-cooperation-with-civil-society/Support-through-Swedish-organisations-with-framework-agreement/> (Accessed August 2018)
- Sida. <https://openaid.se/sv/aid/sweden/world> (Accessed March 2018)
- Sileshi, G., Akinnifesi, F.K., Ajayi, O.C. & Place, F. 2008. Meta-analysis of maize yield response to planted fallow and green manure legumes in sub-Saharan Africa. *Plant and Soil*. 307: 1–19.
- Sileshi, G.W., Akinnifesi, F.K., Ajayi, O.C. & Muys, B. 2011. Integration of legume trees in maize-based cropping systems improves rain-use efficiency and yield stability under rain fed agriculture. *Agricultural Water Management*. 98: 1364–1372.
- Sileshi, G.W., Debusho, L.K. & Akinnifesi, F.K. 2012. Can integration of legume trees increase yield stability in rain-fed maize cropping systems in Southern Africa? *Agronomy Journal*. 104: 1392–1398.
- Steffen et al. 2015. Planetary Boundaries: Guiding human development on a changing planet. *Science* Vol. 347 no. 6223
- Sunderland, T., Powell, B., Ickowitz, A., Foli, S., Pinedo-Vasquez, M., Nasi, R. & Padoch, C. 2013. Food security and nutrition: The role of forests. Discussion Paper. CIFOR, Bogor, Indonesia.
- UN Department of Economic and Social Affairs, World Population Prospects: The 2017 Revision https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf
- UNEP (2017). The Emissions Gap Report 2017. United Nations Environment Programme (UNEP), Nairobi.
- UN Women 2017. Turning promises into action: gender equality in the 2030 agenda for sustainable development. <http://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2018/sdg-report-fact-sheet-global-en.pdf?la=en&vs=3554>
- Verchot, L.V., van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., Mackensen, J., Bantilan, C., Anupama, K.V. & Palm, C. 2007. Climate change: linking adaptation and mitigation through agroforestry. *Mitig. Adapt. Strat. Glob. Change*. 12:901–918. (Figure used: Copyright Springer 2007 and reprinted with the permission of Springer under the license number: 4194230911266.)
- Vi-skogen. 2017. KACP VCS Monitoring Report 3rd period. Nairobi, Kenya.
- Vi Agroforestry 2016. Kenya Agricultural Carbon Project (KACP) project description.
- Wekesa, A. & Jönsson, M. 2014. Sustainable Agriculture Land Management – A Training Manual. Vi Agroforestry, Stockholm. (Illustrations used with permission from Vi Agroforestry.)
- Westholm, L. & Ostwald, M. 2018. Women and food production in multifunctional landscapes. Gender issues in contemporary research on agriculture for food security - Knowledge gaps and key issues across the AgriFoSe2030 themes. 5-7. <https://www.slu.se/globalassets/ew/org/andra-enh/uadm/global/agrifose/outputs/briefs/agrifose-gender-brief-2018-1.pdf>
- World Bank. 2004. Sustaining forests: a development strategy. The World Bank. Washington D.C. ISBN: 0-8213-5755-7
- World Bank. 2014. Kenyans Earn First Ever Carbon Credits From Sustainable Farming. <http://www.worldbank.org/en/news/press-release/2014/01/21/kenyans-earn-first-ever-carbon-credits-from-sustainable-farming> Accessed: 19 September 2017.
- World Bank. 2016. Poverty and shared prosperity: Taking on Inequality. International Bank for Reconstruction and Development. ISBN: 78-1-4648-0979-8 <http://www.worldbank.org/en/publication/poverty-and-shared-prosperity>
- World Bank. 2017. Kenya Project Boosts Maize Production and Climate Change Benefits. <http://www.worldbank.org/en/news/feature/2017/07/18/kenya-project-boosts-maize-production-and-climate-change-benefits> Accessed: 19 September 2017.
- World Food Programme. 2018. What is food security? <https://www.wfp.org/node/359289> Accessed 24 March 2018.
- Zomer, R.J., Trabucco, A., Coe, R., Place, F., van Noordwijk, M. & Xu, J.C. 2014. Trees on farms: an update and reanalysis of agroforestry's global extent and socio-ecological characteristics. Working Paper 179. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.
- Zomer, R.J., Neufeldt, H., Xu, J., Ahrends, A., Bossio, D., Trabucco, A., van Noordwijk, M. & Wang, M. 2016. Global Tree Cover and Biomass Carbon on agricultural Land: The contribution of agroforestry to global and national carbon budgets. *Nature Scientific Reports*. 6:29987. DOI: 10.1038/srep29987. (Illustrations shared under the licence CC BY 4.0.)

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