

Annex 9: Agriculture Sector Fact Sheet – Agroforestry (adaptation)

Sector	Agriculture
Category	Land Management
Adaptation needs	Enhance the resilience of agricultural production not only to current climate variability but also to long-term climate change
Technology Name	Agro-forestry (adaptation)
How this technology contributes to adaptation	Agro-forestry can improve the resilience of agricultural production to current climate variability as well as long-term climate change through the use of trees for intensification, diversification and buffering of farming systems. Trees have an important role in reducing vulnerability, increasing resilience of farming systems and buffering agricultural production against climate-related risks. Trees are deep rooted and have large reserves, and are less susceptible than annual crops to inter-annual variability or short-lived extreme events like droughts or floods. Thus, tree-based systems have advantages for maintaining production during wetter and drier years. Second, trees improve soil quality and fertility by contributing to water retention and by reducing water stress during low rainfall years. Tree-based systems also have higher evapo-transpiration rates than row crops or pastures and can thus maintain aerated soil conditions by pumping excess water out of the soil profile more rapidly than other production systems if there is sufficient rainfall/soil moisture (Martin and Sherman, 1998). Trees can reduce the impacts of weather extremes such as droughts or torrential rain. For example, a combination of Napier Grass and leguminous shrubs in contour hedgerows reduced erosion by up to 70 per cent on slopes above 10 per cent inclination without affecting maize yield in central Kenya (Mutegi et al, 2008). Research has also demonstrated that the tree components of agro-forestry systems stabilize the soil against landslides and raise infiltration rates (Ma et al, 2009). This limits surface flow during the rainy season and increases groundwater release during the dry season.

Background/Notes, Short description of the technology option sourced from ClimateTechWiki, Seminars, etc	Agro-forestry is an integrated approach to the production of trees and of non-tree crops or animals on the same piece of land. The crops can be grown together at the same time, in rotation, or in separate plots when materials from one are used to benefit another. Agro-forestry systems take advantage of trees for many uses: to hold the soil; to increase fertility through nitrogen fixation, or through bringing minerals from deep in the soil and depositing them by leaf-fall; and to provide shade, construction materials, foods and fuel. In agro-forestry systems, every part of the land is considered suitable for the cultivation of plants. Perennial, multiple purpose crops that are planted once but yield benefits over a long period of time are given priority. The design of agro-forestry systems prioritizes the beneficial interactions between crops, for example trees can provide shade and reduce wind erosion. According to the World Agro-forestry Centre, “agro-forestry is uniquely suited to address both the need for improved food security and increased resources for energy, as well as the need to sustainably manage agricultural landscapes for the critical ecosystem services they provide” (http://www.worldagroforestrycentre.org/research/overview). There are a broad range of classifications for Agro-forestry systems. These include: structural classification (composition, stratification and dimension of crops); to classification based on the dominance of components (such as agriculture, pasture, and trees); functional (productive, protective or multi-purpose); ecological; and socio-economic. Generally, however, agro-forestry systems can be categorized into three broad types: agrosilviculture (trees with crops), agrisilvipasture (trees with crops and livestock) and silvopastoral (trees with pasture and livestock) systems. Agro-forestry is appropriate for all land types and is especially important for hillside farming where agriculture may lead to rapid loss of soil. The most important trees for incorporating into an agro-forestry system are legumes because of their ability to fix nitrogen and make it available to other plants. Nitrogen improves the fertility and quality of the soil and can improve crop growth. Some of the most common uses of trees in agro-forestry systems are: • Alley cropping: growing annual crops between rows of trees • Boundary plantings/living fences: trees planted along boundaries or property lines to mark them well. • Multi-strata: including home gardens and agroforests that combine multiple species and are particularly common in humid tropics such as in South East Asia • Scattered farm trees: increasing a number of trees, shrubs or shaded perennial crops (such as coffee and cocoa) scattered among crops or pastures and along farm boundaries. Any crop plant can be used in an agro-forestry system.
--	---

	Agro-forestry can also play a vital role in improving food security through providing a means for diversifying production systems. “By integrating trees in their farms and rangelands, farmers reduce their dependency on a single staple crop or having sufficient grass for their animals. For example, if a drought destroys the annual crop, trees will still provide fruits, fodder, firewood, timber and other products that often achieve high commercial value. A study of 1,000 farmers from 15 districts in Kenya found that fruit trees contributed 18 per cent of crop revenue, and tea and coffee contributed an additional 29 per cent of revenue (Place and Wanjiku, 2006). A study in Zimbabwe concluded that indigenous fruits provided higher returns to labor than annual crop production (Mithoefer and Waibel, 2003). A study from Nepal on the impact of agro-forestry on soil fertility and farm income showed that agro-forestry intervention nearly doubled farm productivity and income.” Source: Neufeldt et al, 2009
--	---

Implementation assumptions, How the technology will be implemented and diffused across the subsector?	To plan for the use of trees in agro-forestry systems, considerable knowledge of their properties is necessary. Desirable information includes the uses: the climatic adaptations of the species, including adaptations to various soils and stresses; the size and form of the canopy as well as the root system; and the suitability for various agro-forestry practices. The selection of crops also requires knowledge of uses, adaptation, and market opportunities (Martin and Sherman, 1998). It is also important to understand how trees and crops interact. In simultaneous agro-forestry systems, trees and crops can share above-ground and below-ground space. Trees and crops interact in many ways, leading to both positive and negative effects on the growth of both trees and crops. These processes, which are very complex, are related to light, water, nutrients and wind. These processes also affect the soil itself. There are also indirect interactions, for instance related to pests and diseases. Cycling of soil organic matter, nutrients and water are processes that are central to understanding the interactions in agro-forestry systems. Knowledge is also required about the main laws and decrees that influence the management of natural resources. It is important to understand the concept of tree and land tenure, including both the formal legal system and the traditional tenure systems and to be familiar with policies related to land use, soil and vegetation, and socioeconomics, including trade and market policies. An understanding of national, regional and local development plans and programs relevant to agro-forestry and natural resource management is also required. The policy and legal framework is of great importance for the sustainable management of natural resources. Local government and forestry authorities should be lobbied to simplify the legal processes for commercialization of native wood and non-timber products grown in agro-forestry systems. Increased adoption of agro-forestry should be supported by government through finance. Research and training is required to match high value agro-forestry species with the right agro-ecological zones and agricultural practices (Neufeldt et al, 2009). The implementation of the agro-forestry farming approach should be accompanied by the organization of farmers into cooperatives in order to improve their capacity to negotiate better prices for their goods and avoid paying a percentage of their profits to intermediaries. Joining cooperatives gives farmers the status of organized producers, facilitating access to larger markets and organic and fair trade certification. As a result, farmers' income can rise significantly.
---	--

Costs	In Eritrea, a large-scale five-year agro-forestry project led by the Ministry of Agriculture aimed at creating healthy and well-managed forest plantations withstand the impacts of climate change was presented as part of the country's NAPA strategy. The project had a total cost of just over US\$5 million. Project components: Infrastructure/civil works (roads, offices, community nurseries); equipment and supplies (field and office supplies, hand tools, pumps, vehicles, etc); community development support; and maintenance costs, etc.. Source: UNFCCC, 2008a. A DFID funded project in Belize is estimated at US\$188,000.00 for two years and entails the growing and purchase of 30,000 cacao seedlings for planting of initial 70 acres in natural broadleaf forest in Southern Belize.
Country social development priorities	Growth and Sustainable Development Strategy 2014 – 2017 addresses “Economic resilience” derived from increasing agricultural production in a sustainable way.
Country economic development priorities – economic benefits	National Agenda for Sustainable Development (2013). Agro-forestry can provide a more diverse farm economy and stimulate the whole rural economy, leading to more stable farms and communities. Economic risks are reduced when systems produce multiple products.
Country environmental development priorities – environmental benefits	A National Adaptation Strategy to Address Climate Change in the Agriculture Sector (June 2015) Agro-forestry approach prioritizes conservation and rehabilitation measures such as watershed rehabilitation and soil conservation. These systems also make also more efficient use of land. Either the cover crop or the covered crop can be legumes, which enhance the quality of the soil through the nitrogen fixing nodules.
Social benefits	Improve food security and livelihoods. Reduced vulnerability of crops to climate variation and climate change. Agro-forestry offers opportunity for family involvement on the farms, including women.
Other considerations and priorities (such as market potential)	Market potential is high because agroforestry systems are applicable for almost any size of farm. It is particularly suitable for the subsistence farmer who has a greater variety of crops to harvest and market throughout the year.
Capital costs (per facility)	A Department for International development (DFID) funded project in Belize is valued at US\$188,000.00 over two years for an initial establishment of a total of seventy acres of agroforestry cultivation. Plans are to expand to an additional 70 acres each year. No land costs are incurred because special arrangement was made with the Forest Department for use of lands within a protected area. (C. Hope, 2015, personal discussion). The DFID determined that this was compatible with sustainable forest management practices.

...

Operational and Maintenance costs (per facility)	Low. Operations will include an additional 70 acres planted each year at the same cost. As a new ongoing project, such costs are not yet available. The crop under cultivation is cacao, and this requires very little maintenance, only to remove the occasional dead leaf.
Daily supply capacity per facility	This depends on the crops cultivated and the yields that are obtained from each crop. In the Belize case the production is seasonal. A mature cacao farm in southern Belize can yield between 300 and 350 pounds of nuts per acre (Toledo Cacao Growers' Association, 2015).
Up scaling potential	Easy. Agroforestry system can easily be expanded. It is also a highly efficient use of available land, requiring low levels of investment and maintenance.