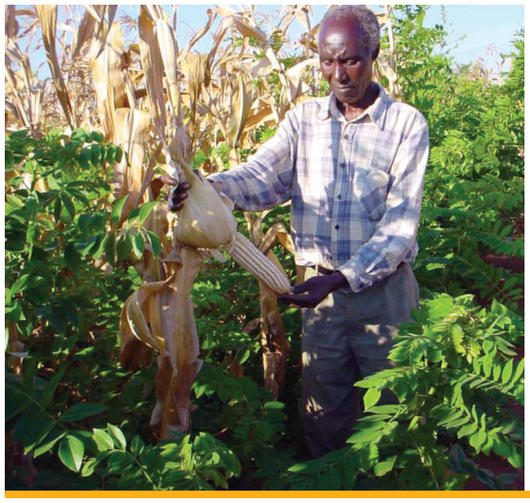

Climate & Development Knowledge Network

INSIDE STORIES on climate compatible development

December 2011

Key messages

- Production of staple crops is under increasing risk in Africa because of climate change and depleting soil fertility. The potential consequences for food security are dire.
- Modern methods of agroforestry and "conservation agriculture with trees" are employing age-old indigenous practices of natural fertilisation with dramatic effects.
- Intercropping trees in annual food crop and livestock systems helps retain water in soils during droughts and prevents landslides and erosion during heavy rain.
- The capacity for these practices to also retain and store carbon in soils means that the potential climate change mitigation benefits of wide-scale evergreen agriculture in Africa are large and globally significant.
- The challenge of spreading the knowledge and uptake of evergreen agriculture and other "climate-smart" agriculture practices is being taken on as a priority by regional governance bodies in Africa.
- Payments for carbon and other ecosystem and social impact services may be one means to fund the practical on-farm research, testing and knowledge transfer needed for adoption on a wide scale.
- The costs of measurement, reporting and verification for carbon markets can be prohibitive and new methods are needed.
- Supported NAMA (nationally appropriate mitigation actions) programmes of evergreen agriculture could be a new approach and play a key role in African low carbon development strategies.

Author: Murray Ward[1], GtripleC

The case for Evergreen Agriculture in Africa: Enhancing food security with climate change adaptation and mitigation in Zambia

Climate change vulnerability and food insecurity often have common root causes. Accordingly, measures that address these causes can reduce both problems at once. This is especially important for the many countries in sub-Saharan Africa that face truly daunting agricultural challenges, as outlined below.

- **Food security, as in most developing countries, depends on local food production. By 2050, Africa needs to produce much more food than at present[2] to avoid potentially widespread starvation among an expected population of 1.8 billion – this against a background of decades of declining food production per capita and stagnant cereal yields.**
- **Maize, the most widely grown crop in Africa, is the basis for food security throughout much of the continent. However, maize yields average only about 1 tonne per hectare (ha), compared with cereal yields of 2.5 tonnes in South Asia and 4.5 tonnes in East Asia.**
- **Even a moderate decline in harvests can be devastating for household food security. Climate change is a critical concern, with declining or more erratic rainfall likely to result in lower production and less predictable harvests.**
- **Under current production methods, major crops – such as maize, sorghum and cotton – often deplete the soil of its nutrients. Yet most small landholders are unable to afford sufficient mineral fertiliser to replenish their soils (fertiliser costs have doubled since 2007).**
- **As populations have increased, land holdings have decreased in size. Many farmers, unable to leave any of their land fallow, are forced to grow the same food crops year after year on the same plot of land, without adequate fertilisation or soil replenishment. The consequences of this land degradation are low yields, persistent poverty and widespread malnutrition.**

Evergreen agriculture in Zambia

In Zambia, the average maize yield is 1.1 tonnes per ha. More than two thirds (69%) of smallholders farm without mineral fertilisers, and almost three quarters (73%) fail to produce enough maize to sell in the market. Between 2000 and 2008, a variety of factors – including low soil fertility, drought and late planting – led to Zambian farmers abandoning one third of the area under maize before they were able to harvest.

Since the mid-1990s, Zambia's Conservation Farming Unit (CFU) and the World Agroforestry Centre have been pioneering "evergreen agriculture" solutions to address these perennial problems. Evergreen agriculture is defined as the integration of particular tree species into annual food crop

CDKN helps developing countries to design and deliver climate compatible development. When decision makers in government, business and civil society speak to us about their aims and needs, they often ask about 'best practice' in other countries or, indeed, mistakes to avoid. What are the leading innovations in integrating climate change planning with economic growth strategies and poverty reduction? What are the biggest challenges faced along the way: institutional, financial, political, technical? This paper is one of a series of policy briefs that explore the 'Inside stories on climate compatible development': briefing papers that aim to answer these questions.

systems. By sustaining a green cover on the land throughout the year, the intercropped trees: maintain vegetative soil cover; bolster nutrient supply through nitrogen fixing and nutrient cycling; generate greater quantities of soil organic matter; improve soil structure and water infiltration; produce additional food, fodder, fibre and income; enhance carbon storage both above and below ground; and allow more effective conservation of above- and below-ground biodiversity.

This brief discusses two evergreen agriculture farming systems being used in Zambia: maize agroforestry and conservation agriculture with trees. Both of these systems tackle the need to replenish soils in affordable ways using natural fertilisers – in short, re-employing age-old indigenous knowledge practices.

Maize agroforestry

The tree species *Faidherbia albida* shows great promise in increasing maize yields. An indigenous acacia-like tree that is widespread throughout the continent, its pods and leaves are used as protein-rich livestock fodder, its bark as a medicine, and its wood for construction, fuel and charcoal. Particularly promising, however, is a unique feature whereby it drops its leaves at the beginning of the rainy (growing) season and does not begin to regrow them until the following dry season. This means that the trees do not compete with the crops for light, nutrients or water during the growing season. It also means that the fallen leaves become a rich source of nitrogen, providing fertilisation to nearby soils and food crops. Cattle seeking shade under the trees also contribute manure.

Differences in maize growth and productivity under a *Faidherbia albida* tree (background) versus outside the canopy (foreground) with the same management practices applied and zero inorganic fertilisation. Photo: D. Garrity

The results of these so-called fertiliser trees can be dramatic. In Zambia, recent observations by the CFU in the 2008 growing season found that unfertilised maize yields in the vicinity of *Faidherbia* trees averaged 4.1 tonnes per ha, compared with 1.3 tonnes in areas beyond the tree canopy.

Agronomists recommend that farmers establish 100 *Faidherbia* trees per ha of maize field in a grid pattern to facilitate normal field crop operations. As the trees mature and develop a spreading canopy, they should be gradually thinned to about 25 trees per ha. The result is a sustainable and productive maize farming system in an agroforest of *Faidherbia* trees. The trees can live from 70 to 100 years, providing intergenerational benefits for a farm family, with a very modest initial investment.

By 2011, it is expected that over 240,000 ha of smallholder farmland in Zambia, involving over 160,000 farmers, will have been newly planted with *Faidherbia*. This represents about 10% of the country's maize-growing land.

Conservation agriculture with trees

This approach combines cropping techniques with nitrogen-fixing fertiliser trees and bushes, including *Faidherbia* and other genera such as *Gliricidia* and *Tephrosia*. The CFU has trialled and introduced these techniques since 1996. More than 150,000 families now practice them.

The three main principles for practicing conservation agriculture with trees are: (1) that the soil should be disturbed as little as possible, e.g. by the use of "planting basins" where mineral, animal and natural fertilisers are applied and seeds planted in the same locations every year; (2) that the soil should be covered in organic matter in the forms of crops, crop residues and trees or bushes compatible with crops; and (3) that farmers should rotate and diversify their crops, making particular use of leguminous crops such as cowpeas, beans and pigeon peas, as well as cover crops and trees that replenish soil fertility during the off season.

One key benefit of these methods of evergreen agriculture is that intercropped woody annuals and perennials such as *Gliricidia* and *Tephrosia* cover the crop field after harvest, manufacturing organic nitrogen fertiliser and suppressing weeds (so cutting down on manual labour) during the dry season.

Scaling up successes

While the results and potential for these agroforestry systems in Zambia (and other African countries) are impressive, their success needs to be put into context. Currently *Faidherbia* trees are found on less than 2% of Africa's maize area, and on less than 13% of its sorghum and millet area. The complete evergreen agriculture system is still very much under development. A vigorous programme of practical research and farmer testing is urgently needed at regional, national and local scales.

The key elements of such a programme would be to provide quality tree seeds in sufficient amounts (about 4-5 times the current supply), a massive scale-up of extension services to disseminate the knowledge (which requires training the trainers, the involvement of NGOs and adequate course materials) and supportive policy frameworks (e.g. that provide incentives for these natural fertilisation methods that are at least equal to subsidies provided for mineral fertilisers). These elements then can underpin an overall evergreen agriculture investment strategy rolled out in national campaigns.

Evergreen agriculture and climate change adaptation and mitigation

Trees on farms help people adapt to climate change by reducing vulnerability to climate impacts, including the effects of weather extremes such as droughts or heavy rain. Root systems and higher levels of organic matter in soils increase water retention. Root systems also stabilise the soil against landslides and reduce erosion. The ability of agroforestry to generate more income also raises the adaptive capacity of smallholders.

Evergreen agriculture is also increasingly recognised for its mitigation potential. Tillage and seeding methods that minimise soil disturbance reduce soil carbon losses, and soil carbon is also built up through root systems and through the leaves as they are used for fertiliser. Evergreen agriculture systems accumulate carbon both above and below ground in the range of 2–4 tonnes C per ha per year. Although individual projects may produce small results, using these techniques in Africa there is potential in aggregate to sequester large and globally significant quantities of carbon dioxide (CO_2) – up to 50 billion tonnes over the next 50 years[3]. For comparison, current annual global greenhouse gas emissions are about 45 billion tonnes of CO_2-equivalent. This needs to fall to around 20 billion tonnes by 2050 to maintain a reasonable chance of limiting global temperature increases to 2°C[4].

Involvement of national and international institutions

Regional governance bodies are beginning to recognise the pioneering work of a number of specialist organisations, such as Zambia's Conservation Farming Unit, the World Agroforestry Centre and the African Conservation Tillage Network. The Africa Union's New Partnership for Africa's Development (NEPAD) is now building a broad alliance with governments and international and local partners to establish evergreen agriculture throughout sub-Saharan Africa.

Agroforestry examples featured prominently in the discussion at the September 2011 Climate-smart agriculture: Africa – a call to action ministerial conference convened by the South African government. As described there, "The Climate Smart approach aims to sustainably increase agricultural productivity and build resilience to environmental pressures, helping farmers to adapt to climate change, while at the same time reducing greenhouse gas emissions. This can be achieved through climate-smart practices that increase the organic soil matter and improve water-holding capacity. This also makes yields more resilient and reduces erosion, helping to mitigate climate change."

The challenge will now be to see these high-level supportive statements translated into the policies and institutional support needed at the local level. Furthermore, such policies must support evergreen agriculture that can be tailored to the needs of individual countries, as well as local areas within countries.

Payments for carbon and other ecosystem services

Agroforestry systems can sequester much greater quantities of carbon, above and below ground, than agriculture systems without trees. This is particularly true for farms with fertiliser trees such as *Faidherbia* and *Gliricidia*. But there has been limited recognition (locally and internationally) for the "global good" co-benefits, as well as other local ecosystem and social services, that agroforestry can provide. Although there is increasing interest in biocarbon funds that could help finance agroforestry projects, such as the World Bank's Biocarbon Fund, the development of biocarbon projects has been constrained by the complex rules set by buyers, high transaction costs and poor governance.

African countries' failure to attract carbon finance through the Clean Development Mechanism (CDM) is well documented and is a subject being taken up by African governments and non-governmental organisations. Regional initiatives attempting to address this include the Common Market for Eastern and Southern Africa proposed carbon market.

Most biocarbon projects in Africa are related to forestry: afforestation and reforestation, reduced/avoided deforestation and forest degradation (REDD), and various aspects of sustainable forest management. However, because of the challenges facing forest projects in the CDM, most biocarbon projects are selling their carbon in the voluntary carbon market. This carbon market may also provide means for the other ecosystem and social impact services to be valued. But projects are still mostly in the formative stages and only a small number have reached the point of actually selling carbon and placing money in the hands of landholders. Moreover, voluntary carbon markets have relatively low volumes of demand and exhibit low prices so are currently limited in their ability to effect significant change.

In addition to these general challenges for biocarbon projects, agroforestry projects are more complex, given the significance of below-ground sequestered carbon – which is more challenging to measure and confirm its permanence. A key issue is striking a balance between the accuracy and the cost of measurement, reporting and verification methods for terrestrial carbon sequestration.

A new window of international support

United Nations Framework Convention on Climate Change (UNFCCC) negotiations on "REDD+" and nationally appropriate mitigation actions (NAMAs) may lead to an important new window of support for countries in Africa like Zambia.

NAMAs may become a more viable, direct and timely approach for targeting support to where it is most needed, as a given NAMA can seek specific finance, technology and capacity-building support tailored to national circumstances. Carbon markets, in contrast, provide just a carbon finance component – which is currently highly uncertain.

A next step could be the preparation of NAMA programmes for evergreen agriculture, consistent with national sustainable land management policy frameworks that can set out the needs for investment, financing and capacity-building support. The widespread adoption of such programmes could play a key role in Africa's low-carbon development strategies.

Lessons and Implications

- Modern science-based methods that incorporate traditional indigenous knowledge can dramatically increase crop yields in Africa. Experience to date in Zambia and other countries in sub-Saharan Africa shows that, with the start-up support of extension services, farmers will adopt these evergreen agriculture practices once they see results proven through successful field trials and understand the obvious benefits to their own communities.

- Wide-scale uptake requires an active national campaign. A major capacity-building effort is needed and will require financial and policy support. Engaging local farmer organisations will be crucial to implementing new practices and achieving high levels of uptake.

- Carbon markets are one possible source of finance, but thus far the support to farmers has been limited. Currently the costs of measurement, reporting and verification methods can be prohibitive. Further work is needed by specialist groups to develop low-cost but acceptably accurate methods that can be applied at broader scales.

- A new opportunity for support could be national NAMA programmes that employ evergreen agriculture methods. These can be a key element of land-based, low-carbon development strategies. This is currently a focus of the UNFCCC and countries are being encouraged to develop and register NAMAs.

References and resources

The following primary resource documents have provided the main factual detail for this brief:

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World Agroforestry Centre (2009) *Creating an Evergreen Agriculture in Africa*, World Agroforestry Centre, Nairobi, Kenya.

Associated web resources:

World Agroforestry Centre – www.worldagroforestry.org

Zambia Conservation Farming Unit – www.conservationagriculture.org

Other references and resources:

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UNEP (2010) *The Emission Gap Report* "Reducing emissions from deforestation and degradation, and enhancing forest carbon stocks in developing countries.

Endnotes:

1. Principal consultant, Global Climate Change Consultancy. (www.GtripleC.co.nz)
2. Some recent widely-reported estimates are that up to twice as much is needed, although this is argued by others who view this as an alarmist promotion for genetic engineering and industrial agriculture production methods.
3. Garrity and Verchot, (2008).
4. UNEP, (2010).

About CDKN

The Climate and Development Knowledge Network (CDKN) aims to help decision-makers in developing countries design and deliver climate compatible development. We do this by providing demand-led research and technical assistance, and channelling the best available knowledge on climate change and development to support policy processes at the country level.

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Front cover:
Gliricidia managed as a coppice shrub in maize fields.
Photo: D. Garrity, World Agroforestry Centre
Editing, design and layout:
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This document is an output from a project funded by the UK Department for International Development (DFID) for the benefit of developing countries. However, the views expressed and information contained in it are not necessarily those of or endorsed by DFID, which can accept no responsibility for such views or information or for any reliance placed on them. This publication has been prepared for general guidance on matters of interest only, and does not constitute professional advice. You should not act upon the information contained in this publication without obtaining specific professional advice. No representation or warranty (express or implied) is given as to the accuracy or completeness of the information contained in this publication, and, to the extent permitted by law, the Climate and Development Knowledge Network's members, the UK Department for International Development ('DFID'), their advisors and the authors and distributors of this publication do not accept or assume any liability, responsibility or duty of care for any consequences of you or anyone else acting, or refraining to act, in reliance on the information contained in this publication or for any decision based on it.