Members of a group belonging to the Turkana community closing a steel ring kiln to prepare charcoal next to their village in Morungole, Turkana County, Kenya. The group has substantially transformed its livelihood, hacking down the invasive trees called Mathenge and turning them into charcoal.

Photo: Luis Tato/ FAO

Biomass for energy and forest landscape restoration

Especially in rural communities, millions of households rely on firewood or charcoal fires for heating and cooking. However, these so-called traditional bioenergy value chains are not sustainable, one of the many consequences of which is land degradation. Modern bioenergy is a solution to satisfy affordable energy demand while restoring forest landscapes. Exploiting this link provides several opportunities for energy and income generation, but the transition is not easy.

By Matteo Milani, Constance Miller and Maria Michela Morese

In some parts of the world, traditional wood energy remains the primary energy source for many households. In sub-Saharan Africa (SSA), more than 80 per cent of households in urban areas depend on firewood and charcoal (called woodfuel) for heating water and cooking, and wood energy value chains provide employment to millions of people. Woodfuel demand is expected to grow further because of population growth.

Traditional wood energy is unsustainable

Traditional wood energy value chains are not sustainable. Increasing energy demands have resulted in overharvesting and unregulated sourcing, leading to deforestation, loss of biodiversity and consequent landscape degradation. What's more, there is not only the problem of unsustainable harvesting of wood and other forest biomass, but also the inefficient conversion and final use of the fuel itself. The latter can cause a number of environmental and socio-economic problems, including higher greenhouse gas (GHG) emissions than other, 'cleaner' energy alternatives, indoor air pollution and related health repercussions, and limited access to modern energy that restricts development opportunities. Illegal logging of wood, unsustainable land management and conversion of forested areas to other uses are among the major drivers of forest land degradation, which is defined as a decrease in the vitality of the forest, which lowers its ability to provide goods and services. Such degradation affects forest-dwellers, Indigenous Peoples and those directly dependent on natural resources, and fuels climate change through increased GHG emissions and reduced carbon sinks. Degraded land is more exposed to wind, rain and floods, and may be unable to provide precious resources, compromising food security. In SSA, the registered deforestation rate is five times higher than the world average, severely endangering the resilience of lands and communities to climate change, while conditioning forest ecosystem productivity and biodiversity conservation.

Modern wood energy and forest landscape restoration

Reforming unsustainable woodfuel practices is one of many necessary measures towards forest landscape restoration (FLR), an activity designed to regain the ecological functionality of deforested or degraded forest landscapes. The process addresses ecological, social and economic functions of landscapes and related ecosystem goods and services, with the main purpose of increasing health and number of trees while restoring landscapes and their biological productivity.

Modern bioenergy generation offers multiple opportunities to contribute to and ben-

efit from FLR. The dedicated use of woody biomass for energy can stimulate demand for products from forest plantations and agroforestry. Several species of plants and trees such as poplars and willows, precious biomass energy sources, are even able to grow on marginal or unproductive lands, which can restore idle areas while sequestrating and storing CO_2, reducing soil contamination and improving soil health and crop yield. Such restorative solutions have tremendous energy potential. In SSA, 75 million hectares to be restored under the African Forest Landscape initiative could yield around six exajoules of primary bioenergy per year – according to the International Energy Agency (IEA), this amount would correspond to 23 per cent of Africa's total final energy consumption in 2019.

Modern wood energy supply chains apply circular economy principles to forest management, creating value from by-products, residues and waste at the last ring of the chain. For instance, forest and wood residues may be used to produce improved feedstocks for energy production such as pellets, briquettes and chips. In turn, biochar, a by-product of woody biomass gasification (the burning of biomass in limited oxygen at high temperature) can be used as organic fertiliser and CO_2 storage in the soil. This serves as soil amendment, offering a soilless substrate component for forest seedlings and recycling nutrients back into the soil, thus 'closing the loop' by enhancing the ecosystem on which the value chain depends.

Overall, securing supply for modern wood energy through restoring forests is a sustainable land management practice that avoids issues of land-use change and fosters food security and socio-economic development in unproductive areas. Benefits for FLR are direct, such as improved soil fertility, but also indirect, as modern wood energy reduces pressures on forest resources by embracing alternative feedstocks like food, crop or wood waste. Further advantages include reduced indoor air pollution through more efficient heating and cooking solutions, creation of income and job opportunities for farmers, and enhanced energy security and climate change resilience. Modern wood energy pathways tackle the main causes of forest landscape degradation while fighting its consequences and providing solutions for FLR.

While traditional wood energy value chains may have direct or indirect repercussions on forest landscapes, eradicating them abruptly is both difficult and inappropriate given that millions of people rely on them for both their energy needs and their livelihoods; the transition towards modern sustainable pathways must be gradual. One essential starting point is to tackle the general lack of awareness on the availability and benefits of modern wood energy value chains, beginning with information and awareness campaigns on social, economic and environmental potentials. To do so, different communication tools are crucial to inform various target groups including a technical audience, the general public and youth. In turn, local, national and international dialogues may stimulate collaboration and exchanges on a broad vision for the energy transition. The forestry sector and wood energy practitioners have often been drawn towards diverging priorities, with the latter focusing on issues of reliability and affordability of wood energy supply, and the former seeking investments towards restoration and sustainable management of forest landscapes. In fact, the two interests are synergistic. Establishing multi-stakeholder platforms – of public sector authorities as well as on-the-ground actors including NGOs, civil society and organisations of workers and academics – is a solution for uniting stakeholders with material resources and knowledge. This allows joint learning, training and capacity building activities to fuel informed, scientifically valid and sustainability-oriented interventions.

Conventional use of fuelwood is frequently associated with indoor air pollution and related health repercussions.

Photo: Jörg Böthling

> The transition towards modern sustainable pathways must be gradual

Successful policy and practical interventions require proper data on the state-of-the-art and potentials. Therefore, initiatives for creating this knowledge are also fundamental; for instance, campaigns to collect comprehensive georeferenced databases mapping domestic woodfuel supply potential, natural resources as well as all domestic enterprises, highlighting the most successful operations and technologies. Moreover, assessments of the current sustainability and potential for wood energy to contribute to FLR are key to comprehensively supporting legislators to make informed policy decisions. A number of frameworks exist for this purpose, such as the Global Bioenergy Partnership Sustainability Indicators, used to assess economic, social and environmental impacts of bioenergy.

A plurality and diversification of wood energy practices is an asset to manage forests sustainably and to meet demand increases. One way to accomplish this is to promote technological innovation for more efficient energy production methods such as pyrolysis and micro-gasification, where novel feedstocks, such as agricultural and forestry residues, are fully burnt and used for cooking energy, avoiding energy and income losses. This can be spurred by the creation of entrepreneurship

programmes, stimulating the market through financial incentives and generating socio-economic opportunities. Furthermore, subsidising the diffusion of locally-produced upgraded cooking stoves would fuel an internal market for improved feedstocks, generating additional income flows. Financial barriers could be further reduced by developing short wood energy value chains to reduce the number of intermediaries between consumers and producers.

Opportunities for producers and best practices

Producers certainly play a pivotal role in the transition towards modern wood energy value chains in synergy with forest landscapes. While policy interventions may help stimulate the transition, in many cases, wood energy practices that are positive for FLR can already be financially viable solutions for producers. For example, in Sri Lanka, smallholder farmers produce wood fuel from *Gliricidia sepium*, a nitrogen-fixing leguminous shrub that grows alongside food crops, dramatically increasing crop yields. Surplus wood is sold to power plants while the foliage is transformed into livestock feed and fertilisers, creating energy and income while regenerating the land. In Lebanon, pruning waste is usually burned on the spot, a cause of frequent forest fires. Instead, the waste can be used for energy production, while its collection reduces the risk of forest fires and resulting degradation. Moreover, excess wood and residues can be turned into compost, thus providing fertilisers as well as economically viable energy from waste. One example of this is a project implemented by the Al Shouf Cedar Society (ACS), an organisation set up in collaboration with the Lebanese Ministry of the Environment to manage the Shouf Biosphere Reserve. The project backed setting up a local bioenergy plant for the production of briquettes for cooking and heating from local waste materials from olive oil pressing, olive and fruit tree pruning, as well as the thinning and pruning of oak and pine forests. For the same heat volume, the cost of energy has been reduced by more than two thirds in comparison with fuel – the main energy source in the local households. This also has positive effects on the consumption and savings of the local population, and leads to less pollution and health problems through the use of diesel.

Even invasive species can become useful energy sources for producers, as the example of *Prosopis juliflora*, an invasive small tree in Kenya, locally known as 'mathenge', shows. To control the spread of Prosopis, it was excluded from a government ban on timber harvesting in all public and community forests. The tree is now used to produce firewood and charcoal, reducing pressure on indigenous woodlands and allowing their regeneration, increasing standing biomass, resilience and income of farmers. Improved kilns allow charcoal to be produced with lower costs and wood consumed, with a four times higher recovery rate compared to traditional methods. Prior to the ban, which was aimed at alleviating widespread drought, local communities in Baringo had produced charcoal from indigenous species, mainly *Acacia lahi*.

Summing up

Traditional wood energy value chains are unsustainable and have environmental, social, economic and health repercussions. However, they remain crucial to millions of people, and the dependence of rural economies on traditional wood energy will likely persist in the near future. Thus, a long-term vision is needed to facilitate a gradual transition towards modern wood energy supply chains aimed to restore rather than burden forest landscapes. The process starts by increasing awareness of the mutual benefits of sustainable wood value chains and FLR, highlighting their energy and income potentials. Relevant stakeholders should be brought together to align perspectives and share best practices. Hereby, collective trainings and capacity building activities are crucial to transmit long-lasting knowledge and science-based tools to measure and address sustainability concerns, and to provide technical support to policy-makers. Further interventions should stimulate technological innovation, to improve and diversify energy sources and practices, increasing socio-economic opportunities in the sector and motivating producers to adopt some of the countless wood energy processes that act in symbiosis with forest landscapes.

All in all, forest landscapes provide tremendous opportunities for income and modern energy generation, which, in turn, reduces pressure on natural resources and increases biodiversity and soil fertility, enhancing forest landscape restoration and creating value from by-products and waste.

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References: **www.rural21.com**

The Global Bioenergy Partnership

Founded in 2006, the Global Bioenergy Partnership (GBEP) has been making efforts towards bringing together stakeholders, and facilitating capacity building and stronger technological innovation. Supporting a transition towards modern wood energy and FLR is one of the Partnership's priorities. In SSA, GBEP organised three dialogues on "Wood Energy and FLR", covering both the international (Global Landscape Forum Accra 2019) and the national level (National Dialogues in Togo and Ghana), with active contribution by the UN Food and Agriculture Organization (FAO), the International Renewable Energy Agency (IRENA) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Extensive trainings and cross-cutting knowledge were delivered together with practical demonstrations on modern technologies and FLR strategies suited to the region. GBEP provided Togo and Ghana with tailored assessments of their FLR and wood energy sectors as well as ready-to-implement actions, strategies and take-home messages. Involved stakeholders played a crucial part in the holistic dialogues, which stimulated them to establish a permanent National Multi Stakeholder Working Group for continuous coordination and policy support.