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The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa☆

Miyuki Iiyama[1], Henry Neufeldt[1], Philip Dobie[1], Mary Njenga[1,2], Geoffrey Ndegwa[1,3] and Ramni Jamnadass[1]

Woodfuel plays a critical role in energy provision in sub-Saharan Africa (SSA), and is predicted to remain dominant within the energy portfolio of the population in the coming decades. Although current inefficient technologies of production and consumption are associated with negative socio-economic and environmental outcomes, projected charcoal intensive pathways along with urbanization may further accelerate pressures on tree covers. This paper reviews the status of the woodfuel sector in SSA, and estimates the magnitude of impacts of increasing wood demand for charcoal production on tree cover, which will be obviously unsustainable under business-as-usual scenarios. Agroforestry, if widely adopted as an integrated strategy together with improved kilns and stoves, can have a significant impact to reduce wood harvest pressures in forests through sustainably supplying trees on farm. A systematic approach is required to promote multi-purpose agroforestry systems compatible with farmers' needs under local farming systems and current dryland socio-economic contexts.

Addresses
[1] World Agroforestry Centre, United Nations Avenue, Gigiri, Nairobi, Kenya
[2] University of Nairobi, Nairobi, Kenya
[3] University of Passau, Passau, Germany

Corresponding author: Iiyama, Miyuki (m.iiyama@cgiar.org)

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Introduction

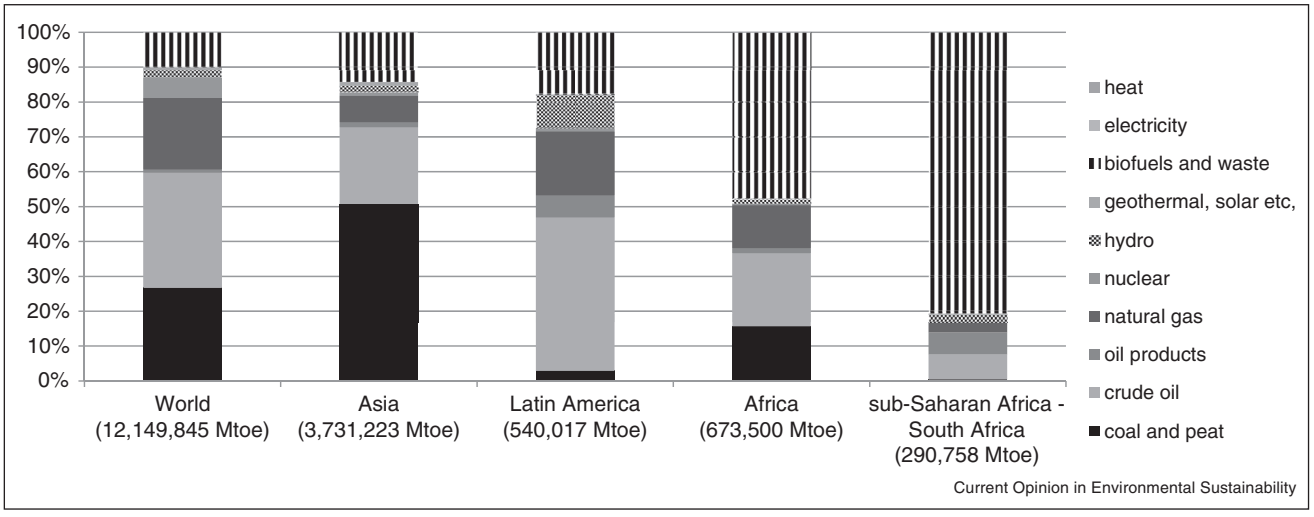
Although solid biomass accounts for only ~10% of primary energy supply globally, woodfuels continue to have a crucial and sometimes dominant role in energy provision in the developing world. Woodfuels account for >80% of primary energy supply in sub-Saharan Africa (SSA),[a] where >90% of the population rely on firewood and charcoal for energy, especially for cooking (Figure 1) [1,2•]. Indeed, SSA had the world's highest regional per capita woodfuel consumption in 2011 at an average of 0.69 m^3/year, compared with a global average of 0.27 m^3/year (Figure 2).

Although woodfuels dominate in the SSA region, the technologies of production and consumption are generally rudimentary and inefficient in wood use, leading to negative health, socio-economic, and the environmental outcomes [3•]. Indoor pollution caused by woodfuels burnt in inefficient stoves in badly ventilated cooking areas is a major cause of mortality from respiratory infections, with women and children suffering most, thus often labeled as the 'killer in the kitchen' [4••,5,6,7]. The scarcity of appropriate energy sources has led poor households to spend considerable time in woodfuel collection, time that otherwise could have been spent on more productive activities [8]. Lack of ready availability of other energy sources has also led to the burning of cow dung and/or crop residues that would be better used as fertilizers to support food production [9], to the burning of wood from tree species that were traditionally avoided because of their more harmful smoke [10], to the use of more polluting alternative fuels such as plastic [11] and to the giving up of cooking food properly altogether. Wide dependence on woodfuels harvested from forests and woodlands could significantly deplete these resources in SSA [2•,12].

Global policy debates on energy supply have mostly ignored woodfuels, but instead emphasized the need for the poor to gain access to 'modern' energy sources such as kerosene, liquefied petroleum gas (LPG) and electricity [13]. The reality is, however, that modern energy sources are unlikely to provide primary household energy needs for most of the poor in SSA for some decades yet, due to the fiscally unsustainable magnitude of the subsidies and infrastructure required to do so, and households' low incomes for fuel purchases [14,15•]. In

[a] In this paper, sub-Saharan Africa excludes South Africa, which for the region has an exceptionally high electrification rate. The following 42 countries in sub-Saharan Africa are covered: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Sudan (former), Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

Figure 1



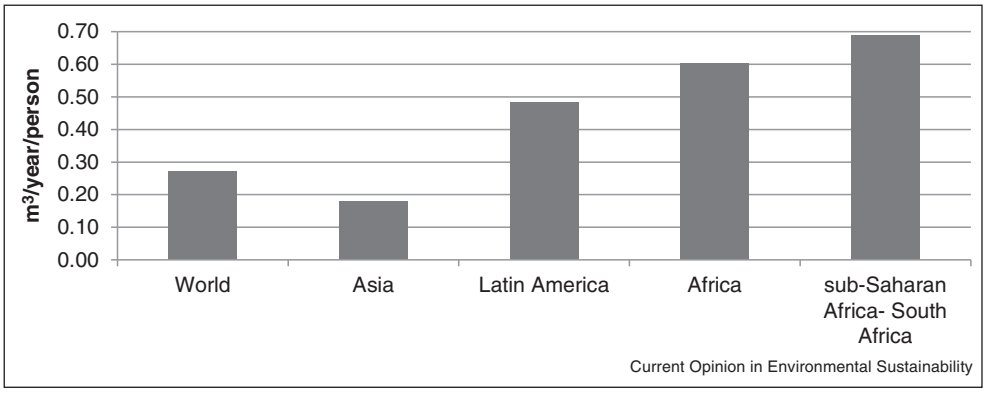
Regional comparison of contributions of different primary sources to energy supply in 2009.
Source: IEA Statistics (www.iea.org/stats/).

the coming twenty years or more, charcoal will be consumed by a wide range of socio-economic groups in SSA while firewood will remain important for the poorest who cannot afford charcoal [16••,17••]. Current trends may accelerate forest degradation [18].

Efforts to provide energy for all communities in SSA, at an acceptable environmental cost, mean little without recognizing the reality of the continued importance of woodfuels, and should support reform of the sector to make it more efficient and sustainable, rather than just discounting it in future planning [16••,17••]. Woodfuel production in agroforestry systems may provide a more sustainable alternative to collection from natural forest and woodlands, and could provide multiple benefits for smallholders, while limiting land degradation and deforestation, with possible net sequestration, raising incomes, and improving health and nutrition [18,19].

Few harmonized estimates exist on the future of the woodfuel sector in SSA to guide policy debates. The current review addresses how the woodfuel sector in SSA can meet the energy demands of the poor who will not benefit from modern energy supplies in the near future in ways that are sustainable and avoid serious health risks, and assesses the potential role of agroforestry. First, the current status of the woodfuel sector in the region with a particular focus on charcoal is considered, followed by the review on past unsuccessful approaches to promote woodfuel supply. Then a simple model to project wood demand for charcoal production and its impacts on tree cover under scenarios of the

Figure 2



Regional comparison of per capita woodfuel consumption in 2011.
Source: FAOSTAT (http://faostat3.fao.org/).