G. Environmental impacts

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What does this type of evaluation tell us?

Household energy interventions can impact on the environment in two main ways:

- through emissions of air pollutants that can contribute to global warming and/or localized pollution; and
- through unsustainable use of wood as fuel, potentially contributing to deforestation and desertification, and through the use of manure as fuel, potentially contributing to loss of soil fertility.

Global environmental impact

Greenhouse gas (GHG) emissions from biomass burning account for over 70% of total emissions in Nepal, Sri Lanka and Vietnam. Although these figures are much higher than in most developing countries, there is growing interest internationally in addressing the contribution to global warming made by more than 2 billion people worldwide that rely on biomass for cooking and heating in their homes. Some desk studies have been undertaken which indicate that household energy interventions could have a significant impact on GHG emissions, and that improved cooking stoves could have their part to play.

The Clean Development Mechanism (CDM), part of the Kyoto Protocol, provides a framework for the international trading of carbon credits. This potentially opens up the possibility of funding for larger-scale household energy interventions which demonstrably result in reductions in GHG emissions.

Many different gases are thought to contribute to global warming. The methods listed in this section measure some or all of the following:

- carbon monoxide (CO);
- carbon dioxide (CO_2);
- methane (CH_4);
- other hydrocarbons; and
- suspended particulates of varying sizes (also know as aerosols).

Of these, only CO_2 and CH_4 are included within the Kyoto Protocol, but others such as CO and non-methane hydrocarbons (NMHC) are also believed to contribute to global warming. Gases can be assigned a global warming potential (GWP) value, relative to that of CO_2 (CO_2 GWP = 1). CO has a much higher GWP than CO_2, and CH_4 considerably higher still, making them more potent greenhouse gases. Aerosols affect the environment in more complex ways. Some, such as 'black carbon', have a global warming effect while others, such as organic carbon, are understood to have a cooling effect.

Emissions testing is not only carried out for assessing impacts on the global environment: it is also a useful way of comparing the combustion efficiency of different stoves, and the performance of stoves in different settings (e.g. laboratory versus users' homes). Emissions testing is not usually an effective way of assessing IAP or exposure, although it can give an indication of potential IAP levels.

Emissions can be expressed in terms of an emissions factor, namely grams emitted per unit activity. Examples include:

- g/kg wood burnt;
- g/MJ energy-delivered-to-the-pot ;
- g/meal; and
- g/cooking task.

What are the challenges in the assessment of global environmental impact?

Combustion is a complex process. Even though the methods for measuring emissions require sophisticated equipment, they can be used by non-specialized trained staff and generate data which are reasonably easy to analyse.

The source of biomass needs to be understood and considered, as this has an impact on the GHG contribution made by a stove. If wood is not harvested renewably (i.e. as much is grown as is burned) CO_2 emissions should be counted as GHG emissions. Even if biomass is harvested renewably, because combustion is never 100% efficient, it may still be necessary to consider certain products of incomplete combustion with global warming potential (e.g. organic compounds).

Local environmental impact

In settings, where ample fuel resources are readily available and can be harvested in a sustainable way, assessing local environmental impact may not be relevant. Yet, where fuel wood is scarce, demand for wood can lead to deforestation. In the context of an already unstable local environment this may add to land degradation and desertification. Many improved stoves programmes conducted in the past, e.g. the Chinese National Improved Stoves Programme, were set up to counteract such environmental pressures. A shortage of wood fuel can also force people to use manure as fuel, thus depriving fields of their natural fertilizer.

It is generally the poor who are most vulnerable to local environmental degradation such as desertification, loss of soil fertility and landslides caused by erosion. This makes understanding the impact on the local environment important for all organizations with poverty-reduction and human welfare objectives.

Local environmental impact can be assessed in two main ways:

- using questionnaires to determine fuel use, fuel sources and perceived trends and impacts on the local environment; and
- analysing data from stove performance tests in the context of local environmental conditions.

What are the challenges in the assessment of local environmental impact?

Measuring local environmental impact is generally considered to be difficult. The questionnaire methods are prone to subjectivity. The stove performance tests may provide accurate data on efficiency and wood use, but it is not easy to relate this to environmental impact. For example, a highly inefficient stove may have little impact on a robust environment, while even a highly efficient stove may have a grave impact on forest resources if used in an area of high population density with scarce forest resources.

Key questions

- By how much does the intervention lower emissions (e.g. CO_2, CO, methane, particulates) compared with traditional practices?
  - In the laboratory?
  - In users' homes?
- To what extent has the intervention led to reductions in deforestation, desertification or erosion pressures? Does the intervention involve a reforestation component and, if so, to what extent is it being implemented?
- Has the intervention impacted on soil fertility through reduced use of dung and crop waste as fuel?

Available methods

Currently, no ready-made tools are available for assessing the contribution that interventions make to improving local and global environments. Yet a number of existing methods can be adapted to inform this area of evaluation, most notably emissions measurement and fuel-use measurement and surveys.

The methods for measuring emissions can be divided into two categories: those which use a

hood (mostly not portable and therefore laboratory-based) and those which use probes to measure emissions either in the room (the chamber method) or in the smoke plume. It is also possible to estimate emissions drawing on prior scientific studies and secondary data. It is recognized that the objectives of many interventions and organizations do not include environmental protection, and that this aspect of evaluation may not be widely undertaken.

Table 9 Evaluating environmental impacts

ID	Method	Organization	Relevant section of method	Rating
C2, C3, C4, C5	All technology performance tests	Enterprise Works/VITA Household energy and health team, UCB	Can be used for estimating quantities of fuel used per house/village/programme	✎✎ ✎✎✎
G1	ARACHNE emissions monitoring (without hood)	Department of Civil and Environmental Engineering, University of Illinois	All	✎✎✎✎
G2	Emissions collection hood	Aprovecho Research Center	All	✎✎✎✎
Y2	Biomass energy conservation questionnaire	GTZ/ProBEC	All	✎

A – Adoption; B – Market development; C – Performance; D – Pollution levels and personal exposure; E – Health and Safety; F – Time and socio-economic impacts; G – Environmental impacts; Y – Generic methods.