Impact Report
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The positive impacts of biodigesters

A valuable climate and clean energy solution, biodigester technology provides the opportunity for households in rural areas to improve their lives and livelihoods by generating energy and fertilisers from easily digestible organic matters, mixed with water.

Over the last 35 years, both the technology and market development initiatives in the countries supported by SNV have generated intended and unintended (qualitative) impacts.

Biodigesters contribute to multiple Sustainable Development Goals (SDGs)

Access to renewable energy is a leading motive for farmers to install biodigesters. Yet, in some contexts, the benefits of bio-slurry as a high-value fertiliser have been the main reason farmers install biodigesters.

Bio-slurry improves soil fertility, resulting in higher crop yield in the short term and improved soil health in the medium to longer term. Given significant climate change mitigation benefits from biodigesters, carbon finance has become increasingly important as a source of income for biodigester promotion programmes.

The benefits of biodigester technology touch upon multiple areas, including the reduced need for biomass and reduced deforestation, the positive climate change mitigation impacts of using biogas as renewable energy, and the production of bio-fertilisers for better yields and soil health, contributing to food security and climate change.

Additional benefits include the positive gender and health impacts of clean cooking, improved hygiene through the use of toilets or latrines, as well as contributions to private sector development and improved household economics.

As such, biodigester technology provides great opportunities to contribute to multiple sustainable development goals, in one go.

Positive impacts of biodigesters

The productive impacts of biodigesters are measured in the amount of biogas and bio-slurry produced and in their usage. Hard figures that are representative of larger geographical areas may not always be available. Nonetheless, biodigesters have direct positive impacts on agricultural production, health, and outdoor environments (including deforestation), labour allocation (time savings), reduced drudgery for women and children, and job creation and savings. The climate impacts of biodigesters are multiple in terms of climate change mitigation, by replacing fuelwood and fossil fuels and adaptation, bio-slurry and bio-compost for improved crop yield as well as for soil health (with improved soil structure and water retention), resilience to extreme weather events, etc.

The precise productive and socioeconomic impacts differ per country and region according to market conditions, e.g., fuel and synthetic fertiliser prices, cost of construction materials, cost of transport, availability of subsidies, and access to carbon finance.

The impacts of biogas

The amount of biogas generated, depends, among other things, on the appropriateness of the feedstock and its quantity. Most biodigester programmes confirm that the **amount of other energy sources, such as fuelwood, LPG, and kerosene, will decrease with the introduction of the biodigester.** Biodigesters lead to savings in terms of time and money spent. Testimonies from the different SNV countries confirm these productive gains, but the indicators used differ per country and within countries and are thus, at times, hard to compare.

In the context of underserved remote rural areas, however, where energy consumption is generally low, an added source of energy may **increase the overall energy consumption** of households rather than entirely replace the energy sources commonly used. For example, biogas lighting will generate a new demand for lighting for uses such as learning in the dark of night. Where cooking is made easier, diets may change to include more laborious meals. Fuelwood, LPG and kerosene may continue to be used for smaller quantity specific purposes, such as meals requiring more cooking time (e.g., stewed meals), or for new ventures such as beer brewing or a small shop or restaurant.

The impacts of bio-slurry

Just like biogas, the amount and quality of bio-slurry depends is, amongst other things, dependent on the appropriateness and quantity of the feedstock and water. The bio-slurry can be used ideally, directly as a liquid to fertilise plants. It can also be collected in a compost pit, where other organic materials are added to produce compost in higher quantity. Where liquid bio-slurry or compost production exceeds the user's own needs, bio-slurry or bio-slurry enriched compost may be sold commercially as a liquid or dried organic fertiliser.

The effectiveness of a fertiliser depends on its nutritional value and the nutritional requirements of the plants. The **nutritional value of bio-slurry** varies widely, depending mainly on the type of animal feed or the manure used as feedstock for the biodigester. In general, "it can be stated that bio-slurry has proven to have **positive effects on yields** of grains, vegetables and fruits compared to not using any soil amendments and fertilisers at all".[1]

The percentage of biodigester owners using bio-slurry, either composted or applied directly, is found to be as high as 89% in some countries.

Research has well established that bio-slurry enriched compost has the best overall effect on chemical, physical and biological composition/characteristics of soil, meaning the overall soil fertility and soil health, in comparison to other fertilisers, namely, chemical fertiliser, farmyard manure, bio-slurry and simple compost.

The percentage of biodigester owners using bio-slurry, either composted or applied directly is found to be up to 89% in some countries, e.g., Kenya. The bio-slurry will reduce or replace the use of synthetic fertilisers, which are bought on the market. This leads to significant savings, especially where synthetic fertiliser use is common on crops. Thirdly, surplus bio-slurry may be commercialised, providing new additional income. In Burkina Faso, for example, "a number of farming households that adopted biodigesters did not use all of the compost for their own farms but instead sold the surplus compost, which turned out to be quite lucrative".

Time savings

Time savings from the foregone collection of fuelwoods, which biogas replaces, and faster/easier cooking and cleaning, are among the driving forces behind biodigester promotion programmes. These savings are gendered in that women and children generally have the responsibility of fuelwood collection, cooking and cleaning. Admittedly, additional time spent on the collection of animal dung and water for the biodigester needs to be factored in as well.

The time saving is dependent on the vicinity of fuelwood sources, which may be available for free or may have to be paid for. Context is key. The average time saving from foregone fuelwood collection varies per country, from around 30 minutes per day in Burkina Faso to over three hours per day in Nepal.

The net time saved has been used for productive or consumptive purposes. It can be used to engage in other, remunerative or non-remunerative, productive work, such as a new venture. The time can also be used constructively, enjoying more time with family and friends.

[1] DE GROOT & BOGDANSKI (2013), Bio-slurry = Brown Gold? A review of scientific literature on the co-product of biogas production. Environment and Natural Resource Management Working Paper No. 55. Food and Agriculture Organization (FAO), 45p.

Job creation

Biodigester promotion programmes create jobs through the construction or installation, maintenance and repair of the biodigesters. One fixed dome brick-and-mortar household biodigester typically takes 10 days to be constructed, by one skilled worker (the mason) and between two or three unskilled labourers.

Biodigester promotion programmes train individual masons and Biodigester Construction Enterprises in the particularities of biodigester construction and installation. Over time, all countries have trained hundreds of masons. The attrition rate of masons venturing into other areas outside the biodigester sector differs per country and is something to be surveyed as part of regular biodigester programme management. However, this attrition is not a loss to society. Masons often find more lucrative professions in construction businesses, as they are well trained in masonry and plumbing.

Gender and youth

Biodigester programmes impact gender relations and equality, youth inclusion, and financial inclusion. Some programmes have a women's empowerment or gender improvement strategy, action plan, and budget. Other programmes do not appear to have a gender strategy and do not monitor progress in this regard.

Women are not typically the formal owners of the biodigester installed in their family. Women are particularly involved in biodigester management training and in biogas use for cooking. Where net time is saved by replacing fuelwood collection and use with biogas production and use, these savings and reduced or avoided drudgery, particularly apply to women and children.

Indoor air pollution

Fuelwood and other dirty fuels like dung cake are important sources of indoor air pollution. Biogas is clean and renewable and is therefore associated with important improvements in the health of women and children, who spend a lot of time indoors while cooking in the kitchen. Again, context is key. For example, where biogas fully replaces fuelwood as a source of energy, the impacts on indoor air pollution will be much stronger than where stacking is practised: the complementary use of biogas to fuelwood. The impacts will be less where LPG or kerosene were already common as sources of cooking energy, as in Vietnam. The positive health impacts of biodigesters may be overestimated, where cooking tends to take place outside, e.g., in Burkina Faso.

The environmental impacts of biodigesters and biodigester promotion programmes relate both to indoor and outdoor environments.

Toilets and improved hygiene and safety

In most biodigester promotion programmes, existing or newly built toilets or latrines are connected to the biodigester. Where toilets are not common, the biodigester system reduces family health risks while contributing to preventing the hazards and risks of open defecation. Where toilets were already in use, the connection with the biodigester contributes to improved hygiene through reduced manipulation of excrement and reduced odour.

Adaptation to changing climates

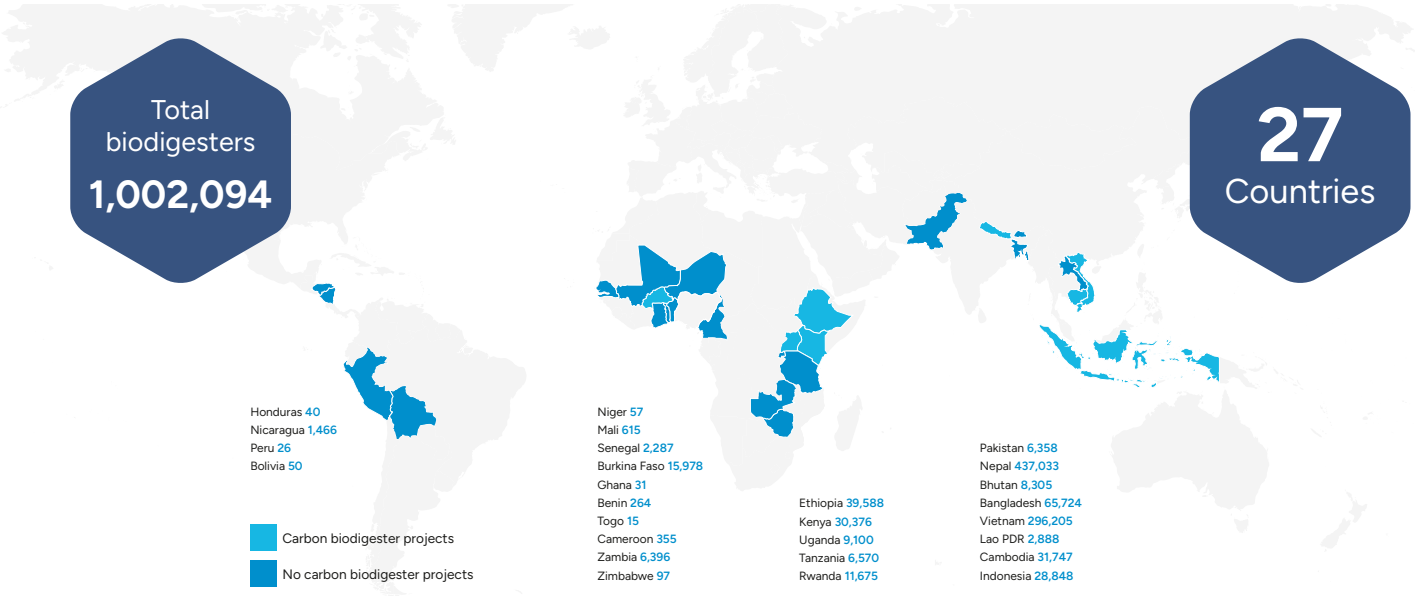
Besides improved yield, fertilising soils with organic materials makes agricultural crops more resilient to pests and diseases. Organically fertilised soils tend to provide a better soil structure, have more soil micro organisms, and have a higher water-absorbing capacity. This helps prevent and overcome or reduce the impacts of dry periods and droughts. Organic fertilisation is one of the key strategies available for adaptation to changing climates.

Climate change mitigation is even more straightforward than the climate change adaptation impacts of biodigesters. Climate change mitigation is measured as the reduction of CO_2 equivalents of greenhouse gas emissions from cooking. For example, the emission reduction range for a 6 m^3 biodigester could be between 2 and 8 tons of CO_2 equivalent of GHGs per year. The extent of the reductions depends on the starting situation (e.g., use, type of energy source, existing manure management practices, rate of deforestation in the vicinity, etc.) and thus is context specific.
The calculated climatic impacts of biodigester promotion programmes are key to carbon credits generated through carbon finance projects or programmes. Nepal, Cambodia, Vietnam, Indonesia, Ethiopia, Burkina Faso, Uganda, and Kenya have reportedly all received income from carbon credit/finance schemes.

Carbon market regulations are dynamic and continuously changing nationally and internationally. GIZ and South Pole recently developed a carbon market regulation tracker that provides information about the regulations that apply to each country.[2] New opportunities for carbon finance also arise with the recent adoption by the Conference of Parties (COP29) of the United Nations in Baku, in November 2024, where a deal was agreed to kick-start a global carbon credit trading system.[3]

SNV and biodigesters

SNV has been involved in the promotion of biogas and bio-slurry from biodigester technology for around 35 years. Whereas the technology itself was not new, its large-scale application in smallholder settings was an innovation in many countries. In the 1990s, SNV first supported a market-based national programme in Nepal, followed in the 2000s by multiple national programmes in South-East Asia and in the 2010s in various African and Latin American countries. The range of biodigester design types promoted includes brick-and-mortar biodigesters of various designs and sizes, for different uses, as well as ready-made or prefabricated biodigesters.



[2] See: https://www.goldstandard.org/carbon-market-regulations-tracker

[3] See: Reuters (23 November 2024), COP29 agrees deal to kick-start global carbon credit trading.

Biodigester technology is available in several design types. Traditional fixed dome biodigesters have been promoted for several decades and have seen incremental improvements. If installed and maintained properly, this reliable technology can last for more than 20 years. Still, it requires substantial time for construction and specific construction skills (in masonry and plumbing) to avoid defects such as cracking and leakages over time. Depending on the country, these fixed dome biodigesters may carry a different (higher or lower) initial cost than other, more temporary, prefabricated biodigesters. Prefabricated biodigesters have gained ground over the last few years. These have not yet reached a similar scale of adoption in some countries.

Impact achieved

SNV supported biodigester projects in 27 countries in Asia, Africa and Latin America have cumulatively installed 1,002,094 household biodigesters until 2022. Functionality rates of biodigesters in the different countries range between 80% to 95%, with few exceptions. Assuming 80% average functionality rate, these biodigesters are impacting the lives and livelihoods of 4,000,000 people[4] and the planet through climate change mitigation and adaptation. As of December 2024, SNV is implementing 11 biodigester or related programmes in 10 of 27 countries, meaning SNV has managed to exit two-thirds of these countries effectively. Thanks to the increasingly capable role of the private sector, the active role of government, donors, and increased funding from carbon finance, biodigester market development continued in most of these countries. In eight out of the 27 countries that received or still receive SNV support, carbon-financed biodigester programmes are still being rolled out.

The productive and socioeconomic impacts of the installation of biodigesters with livestock-holding households in remote rural settings result from:

- the production of two biodigester outputs: biogas and bio-slurry;
- the savings from not purchasing other energy sources, such as fuelwood, LPG, and kerosene;
- the savings on synthetic fertilisers, and the potential to sell bio-slurry or bio-compost;
- the potential to generate income and finance through the sale of carbon credits; and
- a net reduction in time and drudgery - thanks to less fuelwood collection, faster cooking, and easier kitchen and utensil cleaning.

Scaling up biodigesters

The positive impacts of the biodigester technology and biodigester programmes, combined with many opportunities in the market, make us hopeful that it will not take 30 years to reach another one million units. Now, we can expand and accelerate through the markets SNV helped to establish. We estimate the technical potential for household biodigesters to be over 150 million units: 100 million in Asia, 30 million in Africa, and 20 million in Latin America. Additionally, there is potential to install medium- to large-size biodigesters for businesses and public entities, particularly for businesses in dairy, poultry, abattoirs, industrial waste, and municipal solid waste.

Reaching the milestone of one million household biodigesters is a superb achievement, yet with an eye on the potential, we have only just scratched the surface. Our ambition reaches further:

By 2030, we aim to empower the lives and livelihoods of 50 million people, primarily from rural communities in low-income countries, by further developing and accelerating sustainable biodigester markets. This will contribute positively to human health, livelihoods, and soil and planetary health. This is an ambitious target, but it reflects the estimated cumulative figures from the 27 countries supported and additional countries SNV will support. Introducing prefabricated biodigesters and access to carbon finance could significantly accelerate the installation rate, further boosted by digitalisation initiatives.

[4] Taking a conservative functionality rate of 80% and average family size of five per family.

Uganda: Ready-made biodigesters

In Uganda, SNV recently conducted an in-depth analysis of the country's biodigester landscape, focusing on prefabricated biodigesters. The study sought to evaluate the market suitability for prefabricated biodigesters, considering supply, demand, and enabling environment factors, with the overarching goal of enabling the growth of the prefabricated biodigester sector. No comparison was made with brick-and-mortar biodigesters. Reportedly, today, up to 95% of biodigesters in Kenya and 50% of biodigesters in Uganda are prefabricated biodigesters.

The study concluded that prefabricated biodigesters offer promising solutions to environmental and energy challenges in Uganda. However, concerted efforts, such as awareness-creation programmes and innovative financing mechanisms, are needed to overcome existing barriers and realise their full potential in advancing sustainable development.

Source: SNV (2024), Prefab Biodigester Market Systems Development Assessment.
SNV & ASIGMA, Uganda. June 2024, 36p.

Zambia: Biogas power plant

In Zambia, SNV has supported large-scale biodigester installations. In 2022, for example, SNV provided technical support and training when the New Apostolic Relief Organisation constructed the Nkhundye Community Biogas Power Plant in Petauke district.

In total, five villages comprising 800 households received support to produce biogas for cooking, lighting, and driving a biogas-powered generator to pump water for animal watering and horticulture production. Around 20 households benefit from the biogas for cooking, while approximately 800 households have improved access to clean water supplied by a biogas-powered water pump. The infrastructure includes a biogas-propelled power plant, diesel generator, borehole, water reservoir, drip irrigation system, sprinklers, and 7.6 hectares of land.

Source: SNV (2024), Increasing Climate Resilience in Energy and Agriculture Systems and Entrepreneurship (INCREASE). SNV, May 2024, 47p.

Nepal: True system transformation

SNV has been partnering with the Government of Nepal since 1992 to promote biodigesters as a sustainable means to address issues relating to energy access, waste management and bio-slurry production as a high-value fertiliser, particularly in the country's rural areas. Supported by SNV, the Biogas Support Programme was launched in 1992 as a comprehensive platform for the market development of household-size biodigesters. The programme was implemented in four phases from 1992 to 2012. In 2010, SNV completed the programme handover to the Government of Nepal. By then, over 231,000 biodigesters had been installed in Nepal in cooperation with other development partners. By 2023, the number of biodigesters installed had increased to 450,000.

Despite SNV phasing out, the work continues, evidenced by Nepal's private sector-led market and functioning biodigesters. This impacts millions of people's lives while earning carbon revenue to continue the work. That is a true system transformation.

'Why did you come to me so late? If you had come 20 years earlier, my life would have been very different.'

A biodigester user in Nepal, reflecting with the biodigester construction company, after a few months, how the biodigester has impacted her life.
(see Celebrating one million biodigesters globally | SNV)

SNV is a mission-driven global development partner working in more than 20 countries across Africa and Asia. Building on 60 years of experience and together with our team of over 1,600 people, we strengthen capacities and catalyse partnerships that transform the agri-food, energy, and water systems, which enable sustainable and more equitable lives for all.

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SNV Impact that matters