How-it-works brief

RESEARCH PROGRAM ON Livestock

CGIAR

Assessing the environmental impacts of livestock production using the CLEANED approach

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KEY MESSAGES

- CLEANED calculates the environmental footprint of livestock systems and value chains in terms of land requirements, productivity, economics, soil impacts (e.g., erosion, N balance), greenhouse gas emissions (GHGe) and water impacts.
- Livestock production activities significantly impact the climate and environment, such as land and soil, water and biodiversity. This tool allows users to assess these impacts and how they would change through the introduction of new technology or an altered livestock production model.
- The tool is easy-to-use and keeps data input requirements to a minimum. Input data is related to the livestock production system and not necessarily the whole farm. The rapid results from the tool provide evidence (in quantitative terms) for decision-making and planning purposes.
- Results generated from the tool can help policy makers, scientists, project managers and development partners design sustainable livestock intensification pathways.

INTRODUCTION

CLEANED officially stands for Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chains.

It is a desktop application tool that quantifies the environmental footprints of livestock systems and value chains. In contrast to its long name, it is designed to provide rapid results in a data scarce environment. With a few clicks of a button, it calculates the land and water requirements, soil health impacts, carbon sequestration and greenhouse gas emissions (GHGe) associated with different types of livestock enterprises and estimates positive or negative changes as a result of different intervention scenarios. The tool is most useful in the design and planning phase of projects, initiatives or programs that look into farm level interventions because it allows users to understand impacts and trade-offs, and to better design sustainable livestock systems.

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Bekelech Belcachew uses harvesting water techniques on her farm in Hosana, Ethiopia, allowing her to use water resources more efficiently.
Photo Alliance of Bioversity International-CIAT/Georgina Smith

THE CHALLENGE

Globally, livestock production generates more than 40% of agricultural GDP and is among the fastest growing agricultural sectors. Livestock are important agents for nutrient cycling, especially through converting forages and crop residues into manure. In the developing world, the sector improves livelihood resilience.

However, livestock and associated feed production poses a threat to ecosystems through GHGe, land degradation and deforestation, water pollution and depletion, nutrient mining and erosion, as well as biodiversity loss. As demand for livestock products continues to rise, there is a pressing need to develop interventions to reduce the environmental footprint of livestock production. According to the United Nations Food and Agriculture Organization (FAO), production of animal protein is expected to grow by around 1.7% per year between 2010 and 2050, with meat production projected to rise by nearly 70%, aquaculture by 90% and dairy by 55%.

The CLEANED tool was therefore designed specifically to help users plan the most sustainable interventions. It assesses the trade-offs in different contexts and from divergent livestock management practices.

WHAT ARE THE BENEFITS OF USING CLEANED?

Its simplicity, minimum data entry, flexibility and adaptability for local systems all make CLEANED an excellent decision-making tool during various stages of planning farm-scale interventions. By quickly evaluating the impacts of a wide range of interventions, users are able to select sets of promising interventions to be discussed and assessed further. The rapid ex-ante assessment allows users to find better intensification pathways that result in reduced environmental footprints. Results from the tool can be scaled to regional and national levels thus reducing unnecessary costs and time.

Production of animal feed often has the biggest environment impact in livestock farming systems. CGIAR researchers are working with farmers in East Africa to identify appropriate forage feed varieties that can provide benefits with minimal natural resource use.

Photo Alliance of Bioversity and CIAT/Georgina Smith

Nelly Adhiambo is a dairy farmer in Busia, Kenya, who has seen the productivity of her cows grow as a result of growing improved forages on her farm. Photo Alliance of Bioversity and CIAT/Georgina Smith

HOW CLEANED WORKS

CLEANED has been designed to adapt to a poor data environment. It is especially suited for developing countries where relevant data to assess environmental impacts can be scarce. In such cases, data is collected locally from secondary data sources and through expert opinion for use in the assessments. This differentiates CLEANED from other existing tools that are generally knowledge-intensive and require significant time and input data.

Use of the tool involves two processes:

1. **Collecting and inputting the baseline data**–farm location, seasons, livestock production systems, feed baskets, farm inputs, amount of precipitation etc.

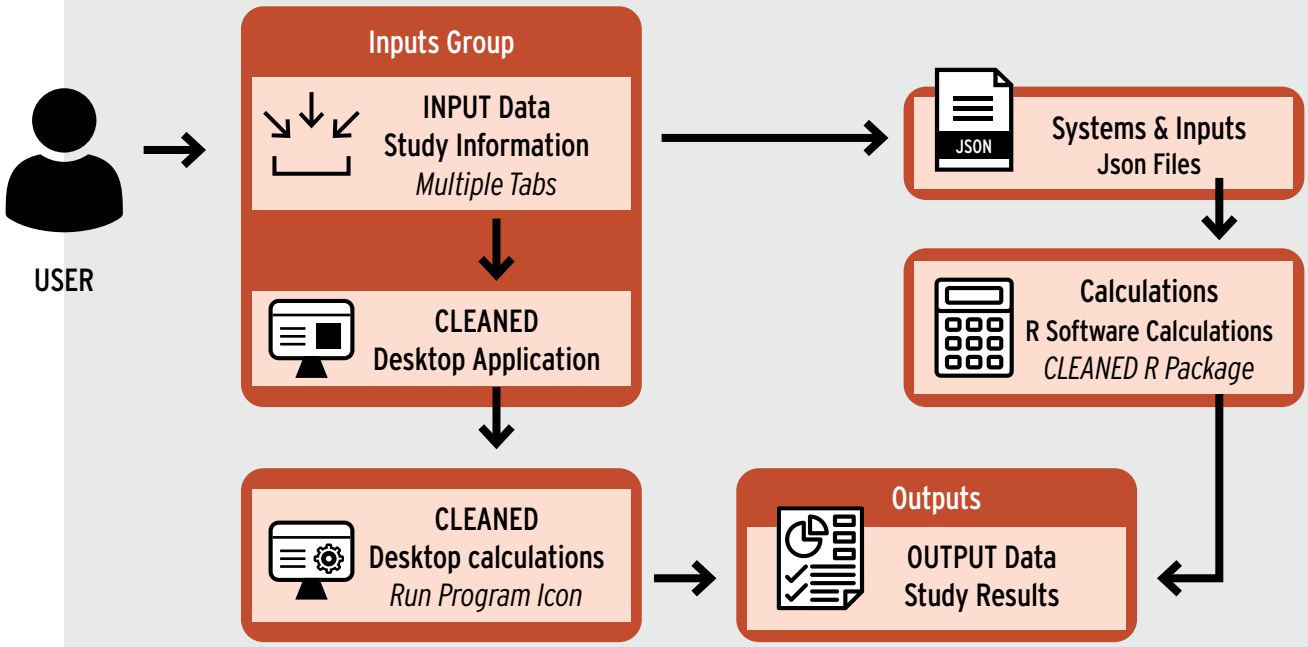
2. **Data analysis and generation of reports for different scenarios** of how the livestock production systems might change. The user has two pathways to follow; either to run calculations on the desktop interface[1] using Run program icon or proceed to R software calculations. The output is the same on either of the pathways.

Resources used in the entire CLEANED process include costs for building technical capacity for users, data collection/field survey and time to carry out the assessments and generating reports (typically between two and four weeks). Where input data is readily available, assessments usually take a maximum of five working days.

1) The purpose of the desktop interface is to run the R model and is meant for users without R or Java Script Object Notation (JSON) knowledge. The results tab in the CLEANED Desktop application shows the results of the assessments.

CGIAR researchers are finding solutions to enable livestock systems to generate livelihood and nutrition gains, at a lower cost to the environment.
Photo Alliance of Bioversity and CIAT/Georgina Smith

Figure 1 The CLEANED data process



WHO IS THE TOOL BUILT FOR?

The tool can be applied to a wide range of projects and can be used by anyone interested in livestock enterprises including scientists, students, development partners, policy makers and project managers. Researchers from the CGIAR Research Program on Livestock have used CLEANED in various countries around the world, such as:

• **In the southern highlands of Tanzania** – the tool was used to assess the environmental impacts of improved feeding as a livestock intensification pathway in smallholder farms.

• **In Western Kenya** – the non-governmental organization Send a Cow (SAC) partnered with the International Center for Tropical Agriculture (CIAT) to use the tool to assess the land requirement for a dairy cow in western Kenya under different feeding regimes and explored the trade-offs of these feeding strategies.

• **In Nicaragua** – in collaboration with FAO, CLEANED was used to assess the environmental impact of intervention scenarios to guide public and private investments (see case study below).

• **In Ethiopia** – at a workshop led by the Stockholm Environment Institute (SEI), the tool enabled participants to appreciate the tradeoff between increasing production and productivity, and maintaining or reducing environmental impact.

CLEANED can integrate data from multiple sources–from farmers, experts, NGOs, researchers and local governments–which is practical in countries where data availability is limited.
Photo Alliance of Bioversity and CIAT/Georgina Smith

What animals eat is critically important: CGIAR researchers have generated evidence that undernourished animals produce higher yields of greenhouse gas emissions. In this photo: livestock graze at ILRI's Kapiti research station and conservancy in Kenya. Photo ILRI/Paul Karaimu

PRIORITIES

There are a growing number of programs and partners already using CLEANED. Efforts are ongoing to scale up use of the tool to equip countries, national agricultural research services (NARS), NGOs and other organizations to design and implement more sustainable livestock system interventions. These efforts include:

1) Increasing awareness of the tool

The Tropical Forages Program team at the Alliance of Bioversity International and International Center for Tropical Agriculture has developed a CLEANED workbook as a core training material and continue to create awareness and conduct trainings on the tool for wider adoption. Affiliated research, policy and development professionals have already been trained, so they can now carry out assessments independently and can train others on the tool. Building local capacity will help promote wider buy-in to results within their locality. A post training survey show 100% confidence level of participants to use the tool in designing resilient and low emission pathways for the smallholder farmers.

2) Disseminating the new, improved CLEANED

The CLEANED R package is now integrated with a user-friendly desktop application tool for quick analyses. The calculations were also updated to be fully aligned with the latest Intergovernmental Panel on Climate Change (IPCC) guidelines. The new package and web interface together support opportunities for scaling up to regions and countries.

CONCLUSION

As the global population continues to increase, so will the demand for livestock products. Although livestock production provides livelihoods for billions of people around the world and contributes to food and national security, it also negatively affects land, water, and biodiversity resources. In addition, livestock production and associated fodder production contribute to global warming and pollution. According to the most recent Intergovernmental Panel for Climate Change (IPCC) estimates, the FAO determined that global livestock production accounted for 14.5% of all anthropogenic GHGe's . CLEANED was developed to produce rapid multi-dimensional environmental impact assessments of livestock transformation in mixed crop-livestock farming systems in developing countries.

The CLEANED tool provides an alternative to other tools and approaches for assessing environmental impacts of crop and livestock value chains, that are generally more knowledge-intensive, require significant time and data input, and usually only assess short-term impacts at field and farm scales. CLEANED allows users to assess impacts of new technologies or system interventions. This helps to ensure that initiatives aiming to improve incomes and food security in livestock value chains have a minimum environmental footprint, while lifting people out of poverty.

CASE STUDY: Strengthening Sustainable Dairy and Beef Value Chains in Nicaragua

A swathe of degraded pastureland in Nicaragua.
Photo Alliance Bioversity and CIAT/Rein Van der Hoek

Nicaragua's livestock sector is the largest in Central America with 200,000 smallholder farmers generating 75% of their income from dual-purpose (milk and meat) cattle farming. The productivity and product quality of Nicaraguan smallholder cattle farmers is affected by a lack of sufficient infrastructure, combined with often sub-optimal production practices. Inadequate pasture management has caused soil degradation and feed deficiencies, issues which have been exacerbated by climate change. New approaches are needed to improve environmental integrity.

The CLEANED approach was applied by the Livestock and Fish CGIAR Research Program, in partnership with local partners Instituto Nicaragüense de Tecnología Agropecuaria (INTA) and Universidad Nacional Agraria (UNA), to carry out a rapid, ex-ante assessment of

different potential interventions to enhance Nicaragua's dual-purpose cattle value chains. The environmental impacts of the two intervention strategies were compared to the environmental impacts of traditional extensive livestock systems. The objectives of this project were to:

1. Improve the competitiveness and income of small-scale cattle farmers by creating and strengthening sustainable dairy and beef value chains,
2. Increase access to high-quality products for poor consumers,
3. Diversify products for national and regional markets, and
4. Reduce the environmental footprint of the livestock enterprises.

Based on local data and expert opinion, three scenarios were designed and tested:

1. TRADITIONAL EXTENSIVE SYSTEM: as practiced by most livestock farmers and characterized by low stocking rates, low productivity, and very low external inputs.
2. SILVO-PASTORAL SYSTEM: introduces a silvo-pastoral component (3 ha) and improved pasture management practices leading to increased stocking rates and increased production per animal.
3. SEMI-INTENSIVE SYSTEM: based on the silvo-pastoral scenario but with the addition of improved pastures and improved cattle breeds.

Animals in a silvopasture, which is an integrated system that combines trees, forage plants and livestock together.
Photo Alliance of Bioversity and CIAT/J. Miles

Table 1 Intervention scenarios

Herd composition and level of production						
	i. Traditional scenario		ii. silvo-pastoral scenario		iii. Semi-intensive scenario	
Livestock category	Number	Annual milk production (kg/animal/yr)	Number	Annual milk production (kg/animal/yr)	Number	Annual milk production (kg/animal/yr)
Traditional cattle	8	700	12	1000	-	-
Improved cattle	-	-	-	-	15	1400
Other adult cattle	14	-	8	-	10	-
Calves	8	-	9	-	10	-

Feed basket						
	i. Traditional scenario		ii. silvo-pastoral scenario		iii. Semi-intensive scenario	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
Traditional pastures	100%	40%	90%	35%	40%	10%
Improved (Brachiaria) pastures					50%	25%
Maize - crop residues		10%		10%		10%
Napier grass (Pennisetum purpureum)		50%		35%		35%
Leucaena leucocephala (tree legume)			10%	20%	10%	20%

The differences between these systems were assessed in terms of soil health and GHGe. The major source of GHGe in all scenarios was methane from enteric fermentation (76% in the traditional and 66% in the semi-intensive scenario), followed by nitrous oxide from manure (16% in the traditional and 11% in the semi-intensive scenario). The transition from traditional to silvo-pastoral systems resulted in a decrease of GHGe intensity from 10.7 to 6.7 kg CO2 eq. per kg of fat-protein converted milk. In the semi-intensive systems this is projected to further decrease to 5.1 kg (Tier 2, IPCC). The intervention strategies are projected to reduce the GHGe intensity. The introduction of trees results in carbon accumulation. This carbon accumulation is highest in the semi-intensive scenario (2 t CO2 eq./ha/year)

Figure 2 Greenhouse Gas emissions for the three scenarios

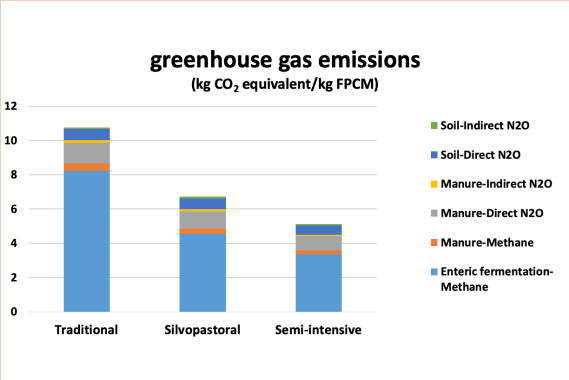
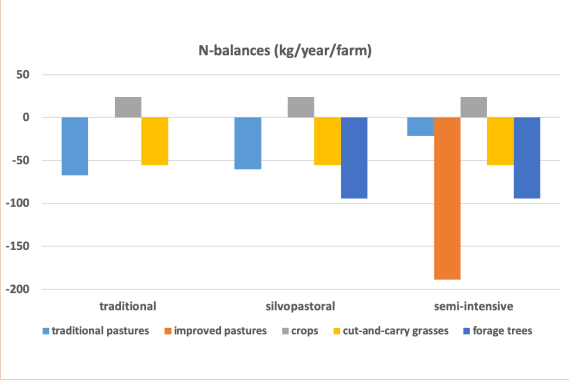


Figure 3 N-balances for the three scenarios



So far, adoption rates of the practices and technologies in both the silvo-pastoral and semi-intensive scenarios have been low due to a lack of incentives (markets) and enforcement of policies. The Alliance is undertaking further assessments with FAO to examine the extent that CLEANED results will influence policy decisions in Nicaragua (e.g., guiding policy decisions and stimulating public and private sector investments).
The hope is that these CLEANED results, together with emphasis to adopt more sustainable practices, will make Nicaragua shift towards a sustainable intensification pathway.

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Partners

- Alliance Bioversity International and CIAT
- International Livestock Research Institute
- Commonwealth Scientific and Industrial Research Organization (CSIRO)
- Stockholm Environment Institute (SEI)

Want more?

To learn more about CLEANED:

https://ciat.cgiar.org/ciat-projects/environmental-assessments-of-livestock-systems-using/

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