

CLEANED eXtRa: MODEL IMPROVEMENTS

Tool Development is Led by The Alliance of Bioversity
International and the International Center for Tropical
Agriculture (ABC) together with International Livestock
Research Institute (ILRI)

Technical Report

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1. Introduction

The Alliance of Bioversity International and the International Center for Tropical Agriculture boasts itself as a center for agricultural research and innovation. The alliance has developed several tools to transform food systems and landscapes so that they can sustain the planet, drive prosperity, and nourish people in a climate crisis. CLEANED (Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chain) is one of the decision-making tools in the intersection of livestock and environment. The tool is designed to work in data-scarce environments (Low- and middle-income developing countries) to quantify the environmental footprints of livestock systems and value chains along pathways of land and water requirements, soil health impacts, carbon sequestration, greenhouse gas emissions (GHGe) and a partial cost-benefit analysis to support decision-making. You can read more on the framework behind the model development [here](#).

The model is a culmination of work over several years from experts across different disciplines and organizations and initial funding from the CLEANED LVCs project funded by the Bill and Melinda Gate Foundation (DCE23232) and further supported by the BBSRC (BB/L026503/1) and the CGIAR Research Program on Livestock. Since its inception, the model has changed progressively to imbue user efficiency and remain abreast in the event of diversifying livestock value chains. CLEANED excel built version is now on its third version and perhaps the last version to be developed on excel. Going forward, the model will run on a desktop application. R model scripts have been developed and a graphical user interface is in place. The new model is known as CLEANED eXtRa and has similar objectives as CLEANED X.

CLEANED eXtRa modifications include:

- Greenhouse gas (GHG) computations updated with the latest IPCC guidelines of 2019.
- CLEANED eXtRa is fixed with an in-built help button that is fully resourced with online support documents that link users to guidance materials and online datasets. Users have the opportunity to familiarize themselves with the CLEANED tool and model version.
- The model is shipped with example databases – “base” and “empty” databases. The “base” database contains pre-set study site descriptions that enable users to clone and modify the existing database to suit their site-specific descriptions. The “empty” database comes along with column labels only and thus the user has the discretion to add new study site descriptions from scratch and adapt it to their geographical context and attributes through editing.
- New livestock characteristic “average annual wool (kg)” is added to compute energy requirements for wool production by sheep and goats.
- The user can enjoy an unlimited number of seasons to be assessed within a given livestock enterprise, including an infinite number of feed items to be assessed per single run.
- The new model is fitted with automatic data quality assessment checks to enhance the credibility of the outputs.
- New livestock characteristic “number of hours of work per day by an “animal” is added to compute daily energy requirements for work by all livestock species used for draught power.
- Addition of new pig characteristics such as the live weight of piglets at weaning age (kg/head) and the live weight of piglets at birth (kg/head) that are key IPCC inputs for estimating N-retention from pigs. There is also a

new livestock variable "number of Piglets relying on milk" a key input when estimating the energy required for lactation for lactating/pregnant sows.

- The assessments now factor in the off-farm land requirements for roughages and concentrates including the area required to produce imported concentrates.
- Water use calculations are computed based on two methods (i) Kc values and (ii) literature – the results also account for water used off-farm for feed production.
- Operationalization of SOC and Biomass indicators to analyse the annual carbon stock changes in soils and biomass

2. Detailed summary modifications

Entity	Target section	CLEANED X	New CLEANED eXtRa improvement	Status
1	Crop parameters	Main Product Dry Yield (t DM/ha) is a product of Main product Fresh Yield (t FW/ha) and Main product DM content fraction	Main product Fresh Yield (t FW/ha) deleted and replaced by Main Product Dry Yield (t DM/ha) which is now a user input	Done
		Crop residue Dry Yield (t DM/ha) is a product of Crop residue Fresh Yield (t FW/ha) and Crop residue DM content fraction	Crop residue Fresh Yield (t FW/ha) deleted and replaced by Crop residue Dry Yield (t DM/ha) which is now a user input	Done
2	Feed parameters	The model can assess up to 6 seasons and 10 feed items per single run	The user has an unlimited number of seasons and feeds items to assessment per single run	Done
3	GHG emissions	GHG emissions computations based on IPCC guidelines of 2006	GHG emissions computations based on the latest IPCC guidelines of 2019	Done
		Methane manure emissions, methane enteric fermentation emissions, and N excretion rates were calculated based on Tier 1 and 2 values	Methane manure emissions, methane enteric fermentation emissions, and	Done

			N excretion rates calculated based on Tier 2 values only	
4	Livestock parameters		Addition of live body weight of sheep and goat at 1 year old or slaughter (live weight) if slaughtered prior to 1 year of age – A user input to computing daily energy requirements for growth in sheep and goats	Done
			The new livestock variable "number of Piglets relying on milk", is a key input when estimating the energy required for lactation for the lactating/pregnant sows	Done
			A new variable is "mature body weight of an adult animal"	Done
			Inclusion of new livestock variables "live body weight of	Done

			piglet at weaning and live body weight of piglet at birth " both used as key IPCC inputs in estimating N retention from the Pigs	
			A new variable "Number of hours of work per day by an animal" calculates ME requirements for daily work for all livestock species used to pull loads	Done
			A new variable "Average annual wool (kg)", is a key input in computing ME requirements for wool production in sheep and goats	Done
5	Model and Source code	Operationalized on macro-enabled Excel spreadsheet using VBA coding	Desktop application developed using Qt5, cross-platform software that supports the creation of modern UIs & applications for multiple screens. The	Done

			desktop application is integrated with R model scripts for calculations.	
6	General layout	The model is divided into four sections (Inputs, results, parameters, and calculations sheets)	The CLEANED UI is divided into two main tabs (Enterprise/sce nario description and study results tabs). However, the "Enterprise/sce nario description tab" is further divided into sub-tabs that outline a general description of farm characteristics, livestock characteristics, livestock production practices and livestock feeding	Don e
		The user interacts directly with model calculations	The calculations are scripted and integrated into the graphical user interface. This has greatly minimized errors arising	Don e

			from user interference with key mathematical formulas used in the computation process.	
			The application comes along with model settings and help menus that allow users to configure and manage the CLEANED application operating system while also seeking guidance through the help tab.	Partly done
			Inputs section of CLEANED X renamed to "Enterprise/scenario description tab"	Done
		The model is divided into six results sheets including a seventh summary sheet	All results are viewed in the "study results tab"	Done
		Livestock numbers and whereabouts, and livestock parameters exist in separate sections (inputs and livestock parameters sections respectively)	Livestock numbers and whereabouts, and livestock parameters are combined under one tab – the "Livestock"	Done

			tab	
		crop areas and residue management, and crop inputs are in the input section (feed production) of the model and separately from feed and crop parameters sheets	crop areas and residue management, crop inputs, feed and crop parameters are all collated under one tab – the "Feed production" tab	Done
		Study information, farm inputs, seasons and value chain losses are all part of the general farm description, but Economic and Area parameters are not	A new farm tab includes Economic and Area parameters as part of the general farm descriptions.	Done
		Livestock feeding is just a section of the inputs sheet of the model	Livestock feeding appears as a new separate tab but as part of the enterprise description	Done
7	Data quality controls and checks		The new model is integrated with automatic data entry control and plausibility checks for data entries. The model cannot run without key inputs such as seasons, livestock, and feeds. Two checks are	Partly done

			being imposed (i) feasibility of daily dry matter intake compared to the animal body weights, (ii) a check to ensure that the number of days for the defined seasons adds up to 365 days.	
8	Language	English	Support up to three languages (English, French and Spanish)	Pending
9	Scenario comparison	Sensitivity runs are done manually and in a separate excel summary sheet	A new function called "Differences. R" is created in the R model scripts to enable the user to select output files needed for comparison and with just a click of a button, the model returns a table with differences.	Done
10	Data visualization	Data is visualized through a customized set of Ms excel in-built charts	Outputs are visualized using ggplot 2 making it easier to analyse and explain	Partly done

			datasets using a customized visualization such as geombars, points, lines, boxplots, and wrap facets among others. This is made possible through the creation of a plotting function that reads and visualizes the data.	
1 1	Navigational aids		Meld with improved navigational aids – freezing the first column of livestock and feed production tabs as well as switching between layouts	Partly done
1 2	Crop area and residue management		Addition of cut and carry fraction of the feed items	Done
1 3	Fertilizer bought		Addition of a new variable, “% of Nitrogen” in each fertilizer bought	
1 4	Crop inputs	The user can only distribute the fraction of manure used as fertilizer for each feed item	The user can distribute both	

			the fraction of manure used as fertilizer and the amount of inorganic N used for each feed item.	
15	Degree of assessments	Estimates farm-level environmental footprints	Inclusion of an out-scaling module. This saves time and resources required to assess individual farms within an extensive geographical area.	Pending
16	Comparison of feed baskets	Comparison of feed basket quality between different livestock feeding practices is not enabled. A user is required to do a separate comparison analysis manually	The model compares changes in feed basket quality in the event of altered feeding practices. This is enabled through the creation of additional scripts in the function "differences. R" to check the average CP, DE, ME, and DM contents of the feed items in different seasons and return a percentage change or	Pending

			absolute values.	
17	SOC and Biomass indicators	SOC and Biomass are inoperative	Operationalization of carbon stock changes in soil and biomass	Done
18	Water use calculations	Calculations based on the ratio of actual crop evapotranspiration to reference crop evapotranspiration	Water use calculations now include both Kc estimates and literature. Secondary data on water use is disaggregated by grey, green, and blue water usage for feed production	Done

3. Conclusion and Recommendations

CLEANED model development is a continuous process and requires collaborative effort to make it a success. From its inception to date, a lot has changed. Many suggestions and inputs to improve the model have been borrowed from the Alliance and ILRI teams as well as recommendations arising from the recently conducted CLEANED OICR survey. CLEANED refinement is still an ongoing process and this strongly affirms why some of the noted improvements are yet to be effected at the time of writing this report. However, it is anticipated that all improvements highlighted in this report will be addressed as soon as possible. The new modifications will go a long way to give

the model a new look and solidify its effectiveness to be a reliable tool for ex-ante assessments. Improved end-user efficiency is a clear indication that the model developer intends to expand the reach and ensure that anyone with little knowledge of livestock systems can capitalize on the pre-set farm descriptions to conduct forecasted environmental assessments. The addition of a help button is now a game-changer for users as it will significantly aid users in connecting to useful online resources outside the application. A change in layout has greatly improved user navigation. It is much easier to switch between two major tabs as opposed to many sections and excel sheets imposed under the excel version. The automation of scenario comparison and feed basket quality differences will remarkably reduce the level of effort required to do manual comparisons thus enhancing tool efficiency. GHG accounting is imperative to understanding farm-level intensities and it aids in finding viable and yet sustainable solutions for enhancing adaptive capacity and mitigation pathways for the livestock farmers. This explains why the new model is tailored to account for the latest IPCC Tier 2 emission factors that are more context-specific and accurate. The data quality controls and checks are increasing the credibility of the CLEANED outputs by filtering unwanted data and keeping inputs to a minimum. The extension of assessments to include landscape assessments saves time and resources. It further gives a wider buy-in to the results, informs investment priorities and may apprise regional agricultural or environmental policy gaps. Therefore, this report recommends an expeditious process to incorporate the pending CLEANED improvements to jump-start the operationalization of the model.