Operational and Economic Evaluation of Biodiesel (B20) in Heavy-Duty Transport in Honduras

Axell Gavarrete[1*], *Maria Celeste* Parada-Acosta[1]

[1]Faculty of Engineering, Universidad Tecnológica Centroamericana, (UNITEC), Honduras

Abstract. In Honduras, the volatility of conventional diesel prices and its heterogeneous nature have increased the operating costs of heavy-duty transport, thereby affecting its performance. This justifies the evaluation of renewable alternatives compatible with the existing fleet. In this context, an indicative evaluation of the use of biodiesel as a partial substitute for conventional diesel in articulated trucks was conducted, focusing on the B20 blend (20% biodiesel, 80% conventional diesel) in a logistics company (HOCORA Transport), with a focus on performance, costs, and emissions. B100 biodiesel was obtained from BIOSA/COINSU, and B20 blends (and, when available, B12.5) were prepared. GHG Emissions were estimated using TTW/WTW emission factors tabulated for blending ratios. Four trips with B20 averaged 1.95 km/L, while two trips with B12.5 reached 2.14 km/L; the cost per kilometre with B20 ranged between 9.36-15.07 HNL/km and with B12.5 between 9.15-9.91 HNL/km, highlighting the influence of route, load, and traffic rather than the percentage of biodiesel.

1 Introduction

In 2019, Honduras showed reliance on fossil fuels in the energy sector [1]. The transport sector is one of the main sources of fossil fuels in Honduras, particularly in the heavy-duty truck segment. There is a high dependence on fossil diesel, which has had a significant impact on the country's economy, due to the volatility of international oil prices, as well as on public health and the environment due to the polluting emissions associated with its combustion. Similarly, the quality of diesel distributed in Honduras has high levels of sulphur and other types of impurities that impair engine performance, increasing maintenance costs for trucks in heavy-duty transport fleets.

In response to this situation, biodiesel has emerged as a renewable and biodegradable alternative, obtained from vegetable oils, animal fats, or recycled oils. The use of biodiesel blends with fossil diesel, such as B20 (20% biodiesel and 80% fossil diesel), promises the possibility of reducing greenhouse gas emissions and stabilizing operating costs without the need for technical modifications to conventional diesel engines. However, its implementation

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* Corresponding author: axellcontreras@unitec.edu

in Honduras is limited by the lack of awareness of the technology, negative perceptions among transporters, and the lack of government incentives to promote its everyday use.

Multiple studies have analysed the performance of biodiesel in different transportation sectors. [2] assessed emissions from biodiesel blends in heavy-duty vehicles, observing significant reductions in particulate matter, albeit with marginal increases in nitrogen oxides. [3] reported successful experiences in public transport in Canada and the United States, with minimal adaptations to commercial truck engines. Brazil reports sustained consumption of biodiesel in mandatory blends, which has reduced dependence on fossil diesel imports [4] . [5] emphasizes the positive effect of B20 blends in reducing carbon monoxide and sulphur dioxide emissions compared to conventional fuels.

Similar to the studies mentioned before, this article also evaluates the use of biodiesel (B20) in vehicles with the difference that is been applied to heavy-duty Transport in Honduras.

1.1 Context

In Honduras, the main fuel source used in cargo hauling trucks is fossil diesel. Consequently, the operating costs of logistics companies increase in parallel with the price of fossil fuels. Their volatility is largely determined by global geopolitical conditions.

This context is forcing the transportation industry to seek alternatives, focusing on affordable options that do not require technical interventions that add costs to its already strained financial situation and are more environmentally friendly compared to fossil diesel. In the geographical context, Honduras has a territory with high agricultural potential for the cultivation of African palm, its oil being one of the most used in the production of biofuels, of around 540 thousand hectares, estimating only 200 thousand hectares are necessary to supply the country's total diesel consumption according to [6].

Renewable fuel consumption in Honduras has stagnated due to social, governmental, and commercial factors. Furthermore, as a new technology with little information about it among the Honduran population, it faces negative connotations and myths about its use in diesel vehicles. This leads to misconceptions, such as the notion that biodiesel causes damage to the mechanical components of these vehicles. The purpose of this project is to evaluate the use of a B20 biodiesel blend (20% biodiesel and 80% fossil diesel) in trucks belonging to a heavy-duty transportation company (HOCORA Transport). The use of biofuels, even on a small scale at the beginning, is a major step toward meeting the country's environmental goals and a significant contribution to reducing greenhouse gas emissions that affect public health and the environment.

1.1.1 Biodiesel

Biodiesel is defined as a liquid fuel generated from renewable materials, such as vegetable oil or animal fat. Many diesel engines can run on certain percentages of biodiesel, and it is assumed that the useful life of these engines can be doubled by using this fuel. The European Union accounted for approximately 89% of global biodiesel production in 2005. By 2010, the United States is expected to become the largest biodiesel producer in the world. This represents a global biodiesel consumption of approximately 18%, with Germany being the second largest producer [7].

American engine manufacturer Detroit Diesel, the leading producer of diesel engines for Heavy Duty trucks, supports biodiesel as a renewable fuel and its use in the various engine models it offers, under certain percentages in its blends with conventional diesel and it is shown in Table 1.

Table 1. Biodiesel fuel blends allowable by Detroit Diesel

Engine	Model Year	Maximum Biodiesel Blend
DD Engine Family	2024 and later	20% CARB certified / 5% US EPA certified
	Prior to 2024	5%
MBE900/4000 Engines	All model years	5%
S60 Engines	2004 and later	20%
	Prior to 2004	5%

Source: Own elaboration using data from [8]

1.1.2 Operational Performance in Logistics

The operational performance of heavy-duty trucking in logistics is linked to specific fuel consumption, load capacity adaptation, and operating conditions. According to [9]fuel consumption in articulated vehicles varies significantly depending on the weight being transported. To estimate this performance, models are used that consider parameters such as GVW (Gross Vehicle Weight), trip topography, and load utility.

2 Methods

Commonly used tools and techniques were used to collect and manage data: spreadsheets and word processors (Microsoft Excel and Word) to organize, analyse, and write data; Google Earth and Google Maps to locate facilities and measure distances; and the Forza Secure Logistics Webtrack GPS platform to extract traces and mileages from the trips made by the monitored unit.

The materials included a sealed 200-liter metal drum to store the B100, a commercial vehicle (small truck) for transport, the survey head (Freightliner Series 60), a 20-L portable tank, a lever pump for transfer (approximate flow rate of 0.3 L per pump), a metal funnel, a dipstick to measure the level in inches inside the truck's tank, and a control table that converts inches to gallons based on tank capacity. The population and study site were located at the HOCORA Transport company (San Pedro Sula, Cortés), in a tropical environment (≈26.5 °C average annual temperature). The B100 supply was obtained from BIOSA, a division of COINSU in Río Blanquito (Choloma); UTM coordinates were documented for both locations, as well as the proximity of the biodiesel plant to the COINSU offices for logistical purposes.

The study methodology was carried out in three operational blocks. First, biodiesel production: B100 was purchased from BIOSA (due to the lack of commercial blends in the country), stored in a drum, and transported to the site; the blends were prepared and supplied directly to the truck's tanks using the pump, the 20 L tank, and the funnel. Second, fuel measurement: The dipstick was inserted into each tank to read inches, converted to gallons using the control table, and then to litres (1 gal = 3.785 L), considering that the TCI4860 unit has two 100-gallon tanks. Third, fuel efficiency and consumption estimates: each trip mileage was obtained from the Forza GPS using position reports filtered by start/end date and time; this was used to calculate the fuel economy (FE) and derived metrics for each trip.

$$FE = \frac{D}{L} \tag{1}$$

Where:

- D = distance travelled [km]
- L= Fuel consumed [L]

Consumption was calculated based on the difference between the initial fuel and final fuel, using the dipstick measurement method and fuel control table. Consumption per 100 kilometres was obtained using the reciprocal formula for FE performance [10]

$$L/100\,KM = \frac{100}{FE} \tag{2}$$

Where:

- FE = Fuel economy [km/L]

The weight of the load being carried influences the vehicle's performance and final fuel consumption throughout the journey. To calculate the number of litres consumed by the vehicle, the weight and distance of each leg of the journey were detailed for each trip, using the GPS tool and documents provided by the transport company describing the product that was transported and its weight in kilograms. This calculation was developed with the aim of comparing the actual measured consumption of the vehicle with European fuel consumption standards. Based on the breakdown of weights and distances per section, the average payload N was calculated with equation 3, which is necessary for calculating the specific energy consumed. When transporting several shipments on a round trip, the payloads of each individual shipment must be added together [11].

$$Average\ payload\ N = \frac{\Sigma\,(W \cdot d)}{\Sigma\,d} \tag{3}$$

Where:

- W = weight [t]
- D = distance per section [km]

Specific energy consumption E depends on the vehicle (primarily the size of the vehicle) and the average payload of the trip being made. This parameter is shown in equation 4.

$$E = A + B \cdot \frac{N}{C} \tag{4}$$

Where:

- A = Empty vehicle consumption [L/100 km]
- B = Difference between a fully loaded vehicle and a loaded vehicle [L/100 km].
- N = Average payload [t]
- C = Payload capacity (maximum payload) [t]

The parameters A, B, and C used correspond to the values for an articulated truck with a gross vehicle weight (GVW) of 24 to 40 tons. These values will depend on the type of road travelled, whether flat or mountainous terrain and are shown in Table 2.

Table 2. Parameters A, B, and C for typical trucks in Europe.

Parameter	**Mountainous**		**Flat terrain**		
	A	**B**	**A**	**B**	**C**
	L/100 km	**L/100 km**	**L/100 km**	**L/100 km**	**Ton**
Truck < 7.5 t GVW	13.0	1.4	12.9	1.2	3.5 t
Truck from 7.5 to 12 t GVW	16.9	3.2	16.6	2.4	6.0 t
Truck from 12 to 24 t GVW	19.3	4.2	18.7	2.9	12.0 t
Articulated truck from 24 to 40 t GVW	22.7	14.4	21.5	8.2	26.0 t

Source: [11]

Diesel consumption during trips is calculated based on average consumption [L] per 100 kilometers traveled and the distance traveled by the truck [11]. Using specific energy consumption, the fuel consumption of actual loads was calculated.

$$F = D \cdot \frac{E}{100} \tag{5}$$

Where:

- D = Distance travelled by the vehicle (round trip, including empty trips) [km]
- E = Specific energy consumption [L/100 km]

The calculation of fuel consumption F is recommended if measured consumption values for the transport service are not available, but actual information on load utilization and the percentage of empty trips made by vehicles is available [11]

The price of the biodiesel-conventional diesel blend for each supply was calculated by adapting the formula for weighted average prices according to [12]

$$P = \frac{P_{B100} \cdot L_{B100} + P_d \cdot L_d}{L_{B100} + L_d} \tag{6}$$

Where:

- P = Final price of the fuel blend (biodiesel + conventional diesel)
- P_{B100} = Unit price of pure biodiesel, known as B100
- L_{B100} = Liters of pure biodiesel used in the blend
- P_d = Unit of price of conventional petroleum diesel
- L_d = Liters of conventional petroleum diesel used in the blend
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Using the price results for each supply, the fuel cost per kilometre was determined. The annual cost formula was modified for use with the prices and yields for each trip made [12].

$$Cost = \frac{FE}{P} \tag{7}$$

Where:

- FE = Fuel economy
- P = Price of the blend [HND]

3 Results and analysis

Since ready-to-use B20 is not sold in Honduras, the study used B100 purchased from COINSU and prepared the blends on-site with conventional diesel. Procurement required a sealed ~52-gal metal drum and a light truck for transport. The distance from the site to the plant (HOCORA Transport ↔ BIOSA/COINSU) required travel of $\approx$28.6 km each way and $\approx$57.5 km round trip, which adds a logistical externality to the use of biofuel in San Pedro Sula and surrounding areas. Figure 1 shows a explain of the distance took into consideration with the GPS.

Fig 1. Visual representation of the HOC-V1 journey route.

Source: Own Elaboration

The measurement section systematized each load by reading the dipstick and converting it to useful volume and consolidated a summary of measurements and trips in chapter-specific tables. Based on these route maps, the set of six trips (HOC-V1 to HOC-V6) was established, and the energy performance and consumption indicators used in the subsequent analysis were calculated for each trip.

3.1 Fuel Efficiency and Consumption

The results show marked heterogeneity between trips. Based on the calculations per trip, fuel efficiency (FE) ranged between 1.50 and 2.51 km/L, with costs per kilometer consistent with the blend price of each fuel. In figures: HOC-V1 recorded 2.10 km/L and HOC-V2 1.50 km/L, while the best performances were observed in HOC-V5 (2.51 km/L) and HOC-V6 (2.31 km/L). The resulting fuel cost per km ranged between ≈9.15 and 15.07 HNL/km, being higher in the lower FE sections. These variations are explained by the effects of gross vehicle weight, road conditions, traffic, driving style, and vehicle condition.

Averaging by fuel type, the four trips with B20 achieved 1.95 km/L and 53.09 L/100 km, while the two trips with B12.5 averaged 2.14 km/L and 41.59 L/100 km. Although B12.5 has a higher price per liter, the routes—predominantly rural and with less congestion—produced lower specific consumption, which translated into better fuel efficiency and more stable costs per km (≈9 – 10 HNL/km).

3.2 Costs and Prices: Direct Effect and Substitution Hypothesis

The cost of each fuel supply was documented with invoices from UNO and TEXACO stations and combined with the COINSU B100 price to obtain the effective fuel price. In the three fueling events analyzed, the resulting prices were B20: 22.50 HNL/L (July 29) and 22.61 HNL/L (July 31); B12.5: 22.91 HNL/L (August 6). At the micro level (per fill-up), the savings compared to 100% diesel were marginal: 190.33 HNL, 126.89 HNL, and 259.38 HNL, equivalent to ≈2.26% of the comparable total cost in those three events.

To assess a sustained adoption scenario, a counterfactual estimate was constructed for applying B20 during June – July 2025 to the TCI4860 vehicle. With 994 gal supplied in the two-month period and assuming COINSU's pricing policy (≈10 HNL/gal less than diesel), the aggregate savings would have been 1,978.35 HNL (2.59%), or ≈ 2 HNL/gal. Conservatively extrapolating consumption patterns to 60 supplies/year, the estimated annual savings would be around 11,870 HNL for a single vehicle, with cumulative potential when scaled up to the fleet. This results are shown in Figure 2.

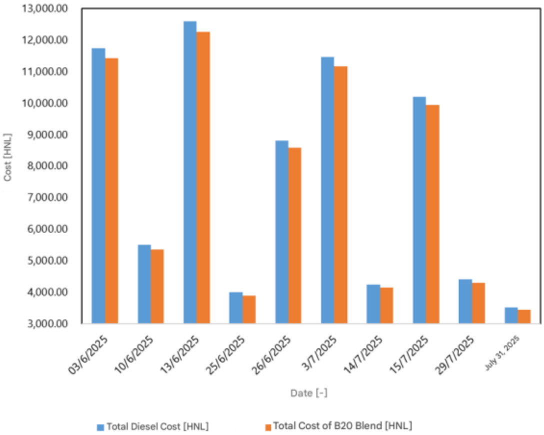

Fig. 2 Estimated cost of B20 vs. actual cost of diesel in June and July 2025.

Source: Own elaboration

3.3 GHG Emissions: TTW and WTW

The emissions inventory is reported in TTW (tank-to-wheels) and WTW (well-to-wheels) frames following conversion factors based on volumetric blending ratio. For B20, TTW emissions per trip were higher as distance traveled and fuel consumption increased; The extreme case was HOC-V2, consistent with being the longest trip, and the total TTW of the four trips with B20 added up to 998.38 kg CO_2e. With B12.5 (approximated with B10 factors for percentage proximity), the two trips together reached 1,089.17 kg CO_2e, with HOC-V6 standing out due to its greater length and a kg CO_2e/km ratio $\approx$ 1.038.

In WTW, the total of the four trips with B20 was 1,310.65 kg CO_2e, with HOC-V2 remaining the largest contributor; for B12.5, 10% proximity factors were applied, in accordance with the guidelines used in the chapter. These results are consistent with the operating pattern (distance and consumption) and with the relative benefit of incorporating biodiesel under the adopted reduction factors.

Based on the overall trip mix, the operating mix and context matter as much as the price per liter. In urban/interurban cycles with more stop-and-go traffic, B20 showed no advantage in fuel efficiency over B12.5; however, on fast-moving rural routes, lower congestion allowed for better utilization of fuel energy, resulting in lower specific consumption and lower cost per km, even though the unit price of the mix was slightly higher. In terms of direct costs, the unit savings of B20 compared to pure diesel were small over the short-term horizon analyzed, but the bimonthly scenario suggests that the temporal accumulation of small savings—plus the internalization of fuel consumption reductions—can justify gradual fleet adoption if accompanied by logistics management (supply, downtime, and routes) and operational optimization (load, driving style).

Conclusions

Throughout the study, the use of biodiesel in a Freightliner Columbia truck (Series 60 engine) from the Transportes HOCORA fleet was field tested using a blend of B20 and B12.5 produced from B100 and commercial diesel (TEXACO, UNO).

In terms of performance, the average fuel consumption (FC) with B20 was 1.95 km/l, ranging from 1.50 km/l (HOC-V2) to 2.42 km/l (HOC-V3). With B12.5, the values recorded were 2.51 km/l (HOC-V5) and 2.31 km/l (HOC-V6). The main technical limitation lay in the B20 limit recommended by the engine manufacturer (Detroit Diesel) for the Series 60 from 2004 onwards, allowing higher blends only with mechanical modifications.

In monetary terms, the total cost of supplies amounted to 24,911.58 HNL, with a recorded saving of 576.6 HNL; this saving is marginal at the level of three loads and becomes essentially symbolic when applied to the rest of the fleet and the year. The pilot, based on his experience in the United States, recommended the systematic use of biodiesel due to its properties that promote lubrication of injector needles. Despite the limitations of the mix and supply, the study provides a useful basis for future research and to promote the decarbonization of Honduran transport, paving the way for new fuel-efficient technologies.

References

1. A. R.-D. H. V. María Parada, “Green hydrogen assessment through the cost-benefit and potential generation study in Honduras,” *Innovare,* no. https://doi.org/10.69845/innovare.v14i1.425, 2025.
2. R. W. A. I. J. &. H. R. R. McCormick, “Effects of Biodiesel Blends on Vehicle emissions: Fiscal Year 2006 Annual Operating Plan Milestone 10.4,” *National Renewable Energy Laboratory,* vol. https://doi.org/10.2172/894987, 2006.
3. O. &. A. N. A. Ogunkunle, “A review of global current scenario of biodiesel adoption and combustion in vehicular diesel engines. Energy Reports,” vol. 5, no. https://doi.org/10.1016/j.egyr.2019.10.028, p. 1560–1579, 2019.
4. International Energy Agency, “Demand of biogasoline and biodiesel, 1980–2022,” no. https://www.iea.org/data-and-statistics/charts/demand-of-biogasoline-and-biodiesel-1980-2022, 2024.
5. E. A. R.-H. J. S. A. P. &. M. B. J. Llanes Cedeño, “Producción e impacto del biodiesel: Una revisión,” *Innova research journal,* no. https://www.redalyc.org/articulo.oa?id=737881326005, 2017.
6. International Renewable Energy Agency (IRENA), no. https://www.irena.org/publications/2023/Apr/Renewables-Readiness-Assessment-Honduras, 2023.
7. A. Demirbas, “ Importance of biodiesel as transportation fuel. Energy Policy,” no. https://doi.org/10.1016/j.enpol.2007.04.003, p. 4661–4670, 2007.
8. Detroit Diesel Corporation / Daimler Trucks North America , “anuary Biofuel Statement. Detroit Diesel Corporation.,” no. https://dtnacontent-dtna.prd.freightliner.com/content/dam/public/dtna-servicelit/ddc/pdfs/Lube_Oil_Coolant/2025%20Jan%20B, 2025.
9. P. S. G. Z. Z. W. Y. &. Y. L. Fan, “Fuel consumption estimation in heavy-duty trucks: Integrating vehicle weight into deep-learning frameworks.,” no. https://doi.org/10.1016/j.trd.2024.104157, 2024.
10. N. I. o. S. a. T. (NIST), “NIST Guide to the SI - Appendix B.8 Factors for units listed alphabetically,” 2016.
11. M. K. W. &. C. Schmied, “Guide on calculating GHG emissions for Freight Forwarding and logistic services,” no.

https://www.clecat.org/media/CLECAT_Guide_on_Calculating_GHG_emissions_for_freight_forwarding_and_logistics_services.pdf, 2012.

12. U.S. Energy Information Administration (EIA). , “Wholesale Electricity and Natural Gas Markets Data. U.S. Energy Information Administration.,” no. https://www.eia.gov/electricity/wholesale/, 2025.