

Brasília, March 30, 2026.

Contribution to the COP30 Presidency Roadmap for Transitioning Away from Fossil Fuels in a Just, Orderly and Equitable Manner

Submitted by: Brazilian Corn Ethanol Association (Unem)

Date: March 2026

Responding to: *Questions (b) What potential levers, whether economic, financial, institutional, social or technological, exist for accelerating the implementation of the transitioning away commitment? and (d) How can a just, orderly and equitable transition best reflect the diverse realities of countries at different stages of development and with different degrees of dependence on fossil fuels?*

The topics to respond the questions above are: Energy Transition: supply-side perspective, Technological Solutions and innovation pathways, Just Transition and differentiated pathways.

Introduction: Rethinking the Food-Fuel-Feed Nexus in the Energy Transition

The global transition away from fossil fuels is one of the most urgent challenges of our time. However, it cannot be pursued in isolation from other pressing concerns, such as food security, rural livelihoods, and equitable development. For decades, the debate around crop-based biofuels has been framed as an inevitable trade-off — fuel or food (Ahmed et al., 2021; Malins, 2023). This contribution argues that this framing is outdated and that real-world innovations, particularly in the Brazilian agricultural system, demonstrate how energy and food security can be achieved simultaneously and synergistically. The Brazilian second-crop corn ethanol system is a compelling case study of a just, orderly, and equitable energy transition pathway that deserves global attention and replication where conditions allow (Moreira et al., 2020; Gurgel et al., 2024).

A truly inclusive transition roadmap must recognize that different countries have different agricultural resources, technical capabilities, and developmental needs. Countries like Brazil, which have vast agricultural land and advanced crop management technology, as well as growing renewable energy infrastructure, low-carbon crop-based biofuels — produced sustainably — are one of the most viable and immediate ways to decarbonize the transport sector without displacing food production or compromising land integrity.

The Brazilian Second Crop System: A Land-Saving Innovation

The cornerstone of Brazil's corn ethanol model is the double-cropping system primarily practiced in the state of Mato Grosso. This system accounts for approximately 50% of Brazil's second-crop corn production (CONAB, 2026). In this system, second-crop corn is planted between January and April of the same year as the soybean harvest, using no-till methods directly over the soybean residue (Novaes et al., 2022; Nóia Junior and Sentelhas, 2019). This practice does not require clearing new land or competing with the preceding soybean crop. In fact, it improves soil health, reduces erosion, and optimizes resource use across the agricultural production cycle (EMBRAPA, 2019, 2020; Novelli et al., 2023; Cherubin et al., 2025).

Over the past two decades, this model has undergone a remarkable transformation. Between the 2000/01 and 2025/26 harvest seasons, Brazil increased the area dedicated to second-

crop corn by approximately 15.5 million hectares while decreasing the area dedicated to first-crop corn by 6.5 million hectares. About 2.5 million hectares of corn that were previously grown as a single crop were freed up for planting as a second crop, allowing the land to be used for other agricultural purposes. Second-crop corn's share of Brazil's total corn production rose from 60% in the 2013/14 season to nearly 80% in the 2024/25 season. Total national corn production grew by 73% during this period, reaching 138 million tons in the 2025/26 season (CONAB, 2026). This growth was not achieved at the expense of food availability. Rather, it represents a systemic gain in agricultural efficiency, made possible by advances in precision farming, crop succession management, and the development of high-yield varieties (Khan et al., 2022).

Corn ethanol production capacity reached 10 billion liters during the 2025/26 harvest season. Projections by the Instituto Mato-Grossense de Economia Agropecuária (IMEA) estimate that this capacity could increase to 22.5 billion liters by the 2034/35 harvest season (IMEA, 2026). Even at this level of production, the amount of corn dedicated to ethanol production would represent a only a small share of the national corn supply. This demonstrates that corn can be used for ethanol while still meeting the food and feed demands of domestic and international markets.

Corn Use in Ethanol vs. Food and Feed Systems

One of the most persistent misconceptions in the food versus fuel debate is the assumption that producing biofuel necessarily displaces food production. In Brazil, however, the data consistently refute this claim. During the 2024/25 season, corn used for ethanol production accounted for only 16% of the total national demand for corn, while animal feed accounted for 41%, and exports accounted for 34% (Céleres, 2025; IMEA, 2026). Therefore, the Brazilian corn ethanol industry operates as a minority user of the national corn supply.

An economic analysis by Justus et al. (2024) confirms that the entry of corn ethanol plants into the Brazilian market did not create a statistically significant upward pressure on domestic corn prices. In Mato Grosso, the epicenter of corn ethanol production, corn supply increased by 90% between the 2017/18 and 2025/26 seasons. Throughout this period, exports and interstate consumption continued to grow, even as internal ethanol demand expanded substantially (IMEA, 2026b). This dynamic reflects the productivity gains of the second crop corn system, which increases the available supply without requiring new land conversion.

The evidence clearly shows that concerns about food security should not be used to categorically restrict crop-based biofuels without examining the agricultural systems in which they are produced. Any credible, just transition framework must include context-sensitive assessments that distinguish between expansionary monocultures and integrated double-cropping systems.

Fuel for Food: How Corn Ethanol Strengthens the Food Chain

Beyond the issues of land availability and supply, the corn ethanol system introduces a powerful circularity into the food-energy system by also producing Dried Distillers Grains (DDG), a high-protein animal feed co-product. For every ton of corn processed for ethanol, approximately 355 kilograms (kg) of DDG and 17 kg of technical corn oil are generated. In the 2025/26 season, the total estimated production of co-products for animal nutrition from corn ethanol was 5 million tons, along with 377 million liters of technical corn oil (IMEA, 2026).

DDG has become the most cost-effective source of crude protein in the animal feed market in Mato Grosso, reaching a price of R\$3.13/kg of crude protein by early 2026 — significantly lower than soybean meal (R\$3.93/kg) and cottonseed (R\$4.87/kg) (IMEA, 2026). This price dynamic has driven the intensification of beef, dairy, poultry, swine, and fish farming by providing cheaper, more efficient feed formulations that reduce the need for extensive pastureland (Antunes et al., 2025; Lima Junior et al., 2022). According to Gurgel et al. (2024), this intensification effect has freed up approximately 50,000 hectares for reforestation or reduced deforestation, contributing to Brazil's compliance with its Forest Code obligations.

The "fuel for food" concept precisely captures this relationship: the bioenergy system strengthens food production rather than competing with it. Ethanol production stimulates regional economies, generates employment across the agricultural, industrial, and logistical sectors, and, critically, improves the household income and food access of the most vulnerable populations. Gurgel et al. (2024) documented substantial increases in food consumption and welfare improvements of low-income families in Brazil's Midwest region that were directly linked to the expansion of the corn ethanol industry. This evidence challenges the narrative that biofuels harm the food security for poorer populations. Under the right institutional and agricultural conditions, biofuels can support food security.

Indirect Land Use Change (ILUC) and the Multi-Cropping Argument

A thorough analysis of crop-based biofuels must address the issue of Indirect Land Use Change (ILUC), which involves the displacement of food production and subsequent pressure on natural ecosystems. For Brazilian second-crop corn ethanol, the ILUC evidence is particularly favorable and warrants special consideration in international regulatory frameworks. Moreira et al. (2020) calculated an ILUC factor ranging from -7.4 to +0.4 gCO₂eq/MJ for second-crop corn ethanol, reflecting the land-saving characteristics of the system. Compared to the carbon intensity of gasoline (87.4 gCO₂eq/MJ) and considering a direct emissions carbon footprint of 18–28 gCO₂eq/MJ, the climate benefit of substitution is clear (Moreira et al., 2020; ANP, 2026).

Negative ILUC values can be explained by three interconnected mechanisms: the expansion of second-crop corn over consolidated soybean areas with no remaining high-carbon stock, the use of eucalyptus chips for cogeneration with associated land-use efficiency gains, and the substitution of conventional animal feed with DDG, which reduces the need for dedicated grain production and the pressure on new agricultural frontiers (Moreira et al., 2020; Gurgel et al., 2024). CORSIA, the international Carbon Offsetting Mechanism for Aviation developed by the International Civil Aviation Organization (ICAO), has recognized a specific non-modeling approach for multi-cropping regions. This approach results in an ILUC value of 9.1 gCO₂eq/MJ for second-crop corn, which is lower than the threshold used in key regulatory frameworks (CORSIA, 2025; Novaes et al., 2026).

Despite this evidence, the current regulatory approaches of the European Union under the Renewable Energy Directive (RED III), specifically the methodology for classifying high-ILUC-risk established under Delegated Act EU 2019/807 (European Commission, 2019), have not fully incorporated the reality of multi-cropping in Brazilian corn production. Technical assessments of the 2014–2021 expansion period attribute area expansion to the first crop of corn, while qualitatively acknowledging the second crop's land-free character. However, the quantitative results do not consistently reflect this premise, creating methodological inconsistencies that penalize a sustainable production system. Therefore, the COP30 Presidency Roadmap should

advocate for regulatory frameworks sensitive to regional production patterns that reward land-saving innovations rather than applying undifferentiated global criteria.

Technological and Institutional Levers for a Just and Differentiated Transition

Brazil's experience with corn ethanol exemplifies several institutional and technological strategies that are directly relevant to the COP30 Roadmap. Launched in 2020, the *RenovaBio* program provides market-based incentives for decarbonizing Brazil's transportation sector. It does so by issuing carbon intensity certificates (CBIOS), which reward producers with lower lifecycle emissions (BNDES, 2025). This instrument has been pivotal in mobilizing private investment in the corn ethanol sector and aligning production incentives with environmental performance. Brazil's biofuel regulatory framework was further expanded by the *Fuel of the Future Law* (Law 14.993/2024) which established mandates for Sustainable Aviation Fuel (SAF) and created the *ProBioQAV* program (Câmara dos Deputados, 2024). International certification schemes, such as ISCC, provide transparent traceability mechanisms that address fraud and mislabeling concerns that have plagued some feedstock markets. The ISCC issued the first Low ILUC Risk Certification to a Brazilian producer of second-crop corn ethanol (ISCC, 2024).

These governance tools, developed through decades of institutional learning, are replicable policy instruments that can help countries scale up bioenergy in a credible manner. The investment and operational phases of the corn ethanol sector have generated tens of thousands of direct, indirect, and induced jobs, particularly in previously underserved agricultural regions of central Brazil. In this context, a just transition is not about moving away from fossil fuels; it is also about building industrial capacity in regions that have historically depended on commodity agriculture and offering rural communities more diversified and resilient futures.

Recommendations for the COP30 Roadmap

The COP30 Presidency Roadmap for Transitioning Away from Fossil Fuels should acknowledge that integrated food-energy systems, such as Brazil's second-crop corn ethanol model, are a type of transition lever that encompasses economic, technological, social, and institutional aspects. These systems do not fit neatly into a "supply-side" or "demand-side" framework because their value lies in the synergies they create across sectors, including energy, food, feed, and land use. Regulatory frameworks that evaluate biofuels solely through the lens of land competition or price volatility — without considering multi-cropping, co-product generation, or regional agricultural specificity — may discourage models that advance the climate agenda and the Sustainable Development Goals.

The Roadmap should advocate for the adoption of context-sensitive ILUC methodologies that recognize that multi-cropping systems are structurally distinct from the expansion of single-crop bioenergy, as well as international carbon accounting frameworks that reward negative or near-zero ILUC values through appropriate market mechanisms. The Roadmap should also affirm the principle that countries at different stages of agricultural and technological development should have the flexibility to implement transition pathways that best suit their resource endowments and institutional capacities. For tropical agricultural economies like Brazil, properly governed and certified low-carbon crop-based biofuels, constitute a legitimate, scalable, and socially beneficial pillar of the transition away from fossil fuels.

References

Ahmed, F., et al. (2021). Systematic Review on Effects of Bioenergy from Edible versus Non-Edible Feedstocks. *Renewable Energy Reviews*, comprehensive analysis of 224 studies.

ANP (2026). Agência Nacional do Petróleo, Gás Natural e Biocombustíveis. Painel Dinâmico de Certificações de Biocombustíveis RenovaBio. <https://www.gov.br/anp/pt-br/centrais-de-conteudo/paineis-dinamicos-da-anp/paineis-dinamicos-do-renovabio/painel-dinamico-de-certificacoes-de-biocombustiveis-renovabio>

Antunes et al. (2025). Inclusion of dry or wet fiber plus solubles or high protein distillers grains to replace flint corn, whole cottonseed, and soybean meal in diets for finishing Nellore bulls. *Transl Anim Sci*. 2025 Jun 13;9:txaf079. doi: 10.1093/tas/txaf079. PMID: 41103358; PMCID: PMC12527253. BNDES (2025). Bioethanol: fast track to mobility decarbonization. Coordination between BNDES and CGEE. Rio de Janeiro, 2025, iv, 416 p. ISBN: 978-65-87493-6-0. Available at: https://www.bndes.gov.br/wps/wcm/connect/site/cd0b3dfd-baed-4445-850d-48471b78d93a/BIOETHANOL_BOOK_preprint_version.pdf?MOD=AJPERES&CVID=pF.N6KY

Câmara dos Deputados (2024). Lei nº 14.993, de 8 de outubro de 2024. Lei do Combustível do Futuro. <https://www2.camara.leg.br/legin/fed/lei/2024/lei-14993-8-outubro-2024-796443-norma-pl.html>

Céleres (2025). Balanço de oferta e demanda de milho no Brasil. Comunicação pessoal.

Cherubin et al. (2025). Long-term effects of crop diversification on soil health, crop yield and resilience of tropical agroecosystems. *Journal of Environmental Management*, 392, 126845. <https://doi.org/10.1016/j.jenvman.2025.126845>

CONAB (2026). Companhia Nacional de Abastecimento. Series Históricas. Available at: <https://www.gov.br/conab/pt-br/atuacao/informacoes-agropecuarias/safras/series-historicas>

CORSIA (2025). CORSIA supporting document. CORSIA Eligible Fuels – Life Cycle Assessment Methodology. Version 7. June 2025. Available at: https://www.icao.int/sites/default/files/environmental-protection/CORSIA/Documents/CORSIA%20Eligible%20Fuels/CORSIA_Supporting_Document_CORSIA-Eligible-Fuels_LCA_Methodology_V7.pdf

EMBRAPA (2019). Empresa Brasileira de Pesquisa Agropecuária. Milho - BRS 015 Farináceo Branco - Portal Embrapa. <https://www.embrapa.br/en/busca-de-solucoes-tecnologicas/-/produto-servico/6048/milho---brs-015-farinaceo-branco>

EMBRAPA (2020). Empresa Brasileira de Pesquisa Agropecuária. Tecnologias de produção de soja. Londrina: Embrapa Soja. <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/223209/1/SP-17-2020-online-1.pdf>

European Commission. (2019). *Commission Delegated Regulation (EU) 2019/807 of 13 March 2019 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council as regards the determination of high indirect land-use change-risk feedstock for which a significant expansion of the production area into land with high carbon stock is observed and the certification of low indirect land-use change-risk biofuels, bioliquids and biomass fuels*. Official Journal of the European Union, L 133, 1–20. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R0807>

Gurgel *et al.* (2024). Contribution of double-cropped maize ethanol in Brazil to sustainable development. *Nat Sustain* 7, 1429–1440. <https://doi.org/10.1038/s41893-024-01424-5>

IMEA (2026). Instituto Mato-Grossense de Economia Agropecuária. Relatório mensal de mercado do etanol. Janeiro de 2026.

IMEA (2026b). Instituto Mato-Grossense de Economia Agropecuária. Relatório Oferta e Demanda Milho. Edição 02 de março de 2026. https://imea.com.br/imea-site/arquivo-externo?categoria=relatorio-de-mercado&arquivo=ofd-milho&numeropublicacao=44&_gl=1*1I97bfx*_ga*MjExMDI0MjlxNS4xNzcyMjExMTg3*_ga_243H7NMKPD*_czE3NzMwNzIxODIkbzZkZkdE3NzMwNzIxOTkkaJQzJGwwJGgwa

ISCC (2024). First ISCC Low Land Use Change Risk Certificate Issued. Retrieved from <https://www.iscc-system.org/news/first-iscc-low-land-use-change-risk-certificate-issued>

Justus *et al.* (2024). Did the entry of the corn ethanol industry in Brazil affect the relationship between domestic and international corn prices? *GCB Bioenergy*, 16, e13181. <https://doi.org/10.1111/gcbb.13181>

Khan *et al.* (2022). Challenges and perspectives on innovative technologies for biofuel production and sustainable environmental management. *Fuel*, v. 325, p. 124845.

Lima Junior et al. (2022). Effects of wet distillers bran plus solubles and corn oil in diets containing flint corn grain and citrus pulp for finishing Nelore bulls. *Livestock Science*, Volume 255, January 2022, 104774, <https://doi.org/10.1016/j.livsci.2021.104774> Malins, C. (2023). The Fat of the Land: The Impact of Biofuel Demand on the European Market for Rendered Animal Fats. Technical analysis of feedstock competition and market dynamics.

Moreira *et al.* (2020). Socio-environmental and land-use impacts of double-cropped maize ethanol in Brazil. *Nature Sustainability*, 8. <https://www.nature.com/articles/s41893-019-0456-2>

Nóia Júnior, R.S., Sentelhas, P.C., (2019). Soybean-maize succession in Brazil: impacts of sowing dates on climate variability, yields and economic profitability. *Eur. J. Agron.*103, 140-151. <https://doi.org/10.1016/j.eja.2018.12.008>

Novaes et al. (2026). Dealing with the ILUC risk of biofuel production for the energy transition, *Energy Policy*, Volume 210, 115035, ISSN 0301-4215, <https://doi.org/10.1016/j.enpol.2025.115035>

Novaes et al. (2022). Brazil's agricultural land, cropping frequency, and second crop area: FAOSTAT statistics and new estimates. Available at: <https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1140492/1/Novaes-Brazil-agricultural-2022.pdf>

Novelli *et al.* (2023). Diversified crop sequences to reduce soil nitrogen mining in agroecosystems. *Agriculture, Ecosystems and Environment*. Volume 341, 1 January 2023, 108208, <https://doi.org/10.1016/j.agee.2022.108208>