PROPOSED SUGAR SELF-SUFFICIENCY POLICY IN INDONESIA USING SYSTEM DYNAMIC

FINAL PROJECT

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UNIVERSITAS ANDALAS
PADANG
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As one of the requirements to complete the Bachelor's program in the Department of Industrial Engineering, Faculty of Engineering, Universitas Andalas

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APPROVAL PAGE

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ABSTRAK

Indonesia merupakan negara produsen tebu terbesar kedua di Asia Tenggara dengan total produksi mencapai 27.158.830 ton pada tahun 2023. Meskipun demikian, tingkat ketergantungan Indonesia terhadap impor gula masih sangat tinggi, yaitu antara 64,79% hingga 75,01%. Ketergantungan ini menyebabkan Indonesia rentan terhadap fluktuasi harga dan pasokan gula di pasar internasional, seperti kebijakan pembatasan ekspor dari India, kekeringan serta kebakaran lahan di Brasil, dan peningkatan harga gula global yang signifikan, terutama pada September 2024. Situasi ini menegaskan pentingnya upaya untuk mencapai swasembada gula guna menjaga ketahanan pangan nasional. Penelitian ini bertujuan untuk memberikan rekomendasi kebijakan strategis dalam rangka mencapai target swasembada gula Indonesia pada tahun 2030 melalui pendekatan sistem dinamis.

Pendekatan sistem dinamis dipilih karena mampu memodelkan sistem yang kompleks dan saling berkaitan, serta memungkinkan simulasi kebijakan dalam jangka panjang. Tahapan awal dilakukan dengan memahami sistem secara menyeluruh melalui pengembangan causal loop diagram *(CLD), kemudian dilanjutkan dengan pembangunan* stock flow diagram *(SFD) menggunakan perangkat lunak Powersim Studio 10. Estimasi parameter model dilakukan menggunakan data sekunder dari sejumlah sumber resmi dan terpercaya yang mencakup periode 2010 hingga 2022. Proses verifikasi dilakukan untuk memastikan bahwa struktur model, konsistensi satuan, dan parameter yang digunakan telah sesuai dengan karakteristik sistem dan data historis. Validasi dilakukan baik secara matematis, menggunakan nilai koefisien determinasi (R^2) dan* mean absolute percentage error *(MAPE), maupun secara substantif melalui masukan dari pakar akademisi dan praktisi. Hasil simulasi* current state *menunjukkan bahwa nilai* Self-Sufficiency Ratio *(SSR) tidak pernah mencapai 80%, yang mengindikasikan bahwa Indonesia belum mampu memenuhi kebutuhan gula nasional secara mandiri.*

Selanjutnya, dilakukan analisis sensitivitas terhadap tujuh variabel terkait produksi gula. Tiga variabel paling berpengaruh dipilih sebagai dasar penyusunan skenario kebijakan, yaitu peningkatan sugar content*, perluasan* state-owned plantation area*, dan peningkatan* state-owned productivity*. Hasil simulasi menunjukkan bahwa kombinasi skenario peningkatan* sugar content *dan* state-owned productivity *merupakan intervensi paling efektif, dengan nilai SSR mencapai 101,66% pada tahun 2030. Peningkatan* sugar content *dapat dicapai melalui revitalisasi pabrik gula, sementara peningkatan produktivitas dapat dicapai melalui intensifikasi berbasis* Good Agricultural Practices *(GAP). Oleh karena itu, penelitian ini menyimpulkan bahwa swasembada gula dapat dicapai melalui kebijakan intensifikasi yang terfokus pada sektor perkebunan milik negara yang lebih terkendali oleh pemerintah dan revitalisasi pabrik gula yang masih menggunakan teknologi tertinggal.*

Kata Kunci: *Gula, Kebijakan, Rantai Pasok, Swasembada, Sistem Dinamis*

ABSTRACT

Indonesia is the second-largest sugarcane producer in Southeast Asia, with a total output of 27,158,830 tons recorded in 2023. Despite this substantial production, Indonesia remains highly dependent on sugar imports, with the import ratio ranging between 64.79% and 75.01%. This heavy reliance on imports exposes the country to volatility in the global sugar market, such as India's sugar export restrictions, droughts and plantation fires in Brazil, and the significant increase in global sugar prices peaking with a 10.4% rise in September 2024. These conditions highlight the urgent need for Indonesia to achieve sugar self-sufficiency to strengthen national food security. This research is aimed at providing strategic policy recommendations to help Indonesia reach sugar self-sufficiency by 2030, using a system dynamic approach.

The system dynamic methodology is employed due to its strength in modeling complex and interconnected systems and its ability to simulate long-term policy impacts. The process begins with the development of a causal loop diagram (CLD) to understand the system structure, followed by the construction of a stock flow diagram (SFD) using Powersim Studio 10. Model parameters were estimated using secondary data obtained from various credible and official sources covering the period from 2010 to 2022. Model verification was conducted to ensure structural accuracy, dimensional consistency, and parameter reliability based on historical data. Validation was performed both quantitatively, using the coefficient of determination (R^2) and mean absolute percentage error (MAPE), and qualitatively, through expert input from academic and practitioner stakeholders. The baseline simulation (current state) showed that the Self-Sufficiency Ratio (SSR) never reached 80%, indicating Indonesia's ongoing reliance on imported sugar.

A sensitivity analysis is conducted on seven key production-related variables. The three most influential variables, sugar content, state-owned plantation area, and state-owned productivity, were selected for scenario development. Simulation results revealed that the combined scenario of increasing sugar content and state-owned productivity was the most effective intervention, raising the SSR to 101.66% by 2030. The improvement in sugar content can be achieved through sugar mill revitalization, while productivity gains can be realized through intensification strategies based on Good Agricultural Practices (GAP). Therefore, this study concludes that sugar self-sufficiency can be attained through focused intensification policies targeting state-owned plantations, which are more manageable under government control, and through the modernization of obsolete sugar milling infrastructure.

Keywords: Policy, Self-sufficiency, Sugar, Supply Chain, System Dynamic