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Analyzing Final Demand Components under Hypothetical Green Subsidy Scenarios in Iran's Agricultural Sector: Implications for Agricultural Product Quality

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Abstract

Green subsidies have been proposed as a policy instrument to encourage environmentally sustainable agricultural practices and potentially improve agricultural product quality. This study examines the potential effects of hypothetical green subsidy policies on final demand components and selected agricultural economic indicators in Iran using a Computable General Equilibrium (CGE) model. Since such a green subsidy has not been implemented as a specific agricultural policy instrument in Iran, the analysis is conducted as an ex ante counterfactual policy simulation. Three alternative subsidy scenarios—20%, 50%, and 100%—are simulated relative to the baseline equilibrium. The model is calibrated using Iran's Social Accounting Matrix (SAM), and simulations are conducted using the General Algebraic Modeling System (GAMS). The results indicate that agricultural gross national product and private consumption increase under all three scenarios, whereas agricultural investment decreases as the subsidy rate increases. Agricultural imports also increase across the scenarios, with larger increases at higher subsidy rates. These findings demonstrate heterogeneous effects across final demand components and indicate that a green subsidy does not automatically improve all agricultural economic indicators. The results suggest that green subsidies, if implemented, should be designed as targeted and conditional incentives linked to measurable environmental and product-quality criteria and accompanied by complementary measures to strengthen domestic production capacity and reduce excessive import dependence. Overall, the study provides an ex ante assessment of the potential economic effects and trade-offs associated with alternative levels of hypothetical green subsidy support in Iran.

Keywords green subsidy, final demand components, agricultural sector, product quality, computable general equilibrium (CGE) model.

1. Introduction

The agricultural sector, as one of the main pillars of Iran's economy, plays a significant role in ensuring food security, generating employment, and fostering sustainable rural development [4]. However, in recent decades, the

sector has faced several challenges, including declining product quality, unsustainable exploitation of natural resources, excessive use of chemical inputs, and increasing environmental pressures [9]. These challenges highlight the need to reconsider conventional agricultural support



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policies and explore alternative incentive mechanisms that can simultaneously promote agricultural productivity, environmental sustainability, and product quality.

One such policy instrument is the green subsidy, which in this study refers to hypothetical government financial support designed to encourage agricultural producers to adopt environmentally sustainable and quality-enhancing production practices. Unlike conventional agricultural subsidies, which are often linked to production levels or input use, green subsidies are conceptually associated with improvements in production practices, efficient use of natural resources, reduction of environmentally harmful inputs, and compliance with quality and environmental requirements [9,12]. Accordingly, the primary purpose of a green subsidy is not merely to increase agricultural output, but to create economic incentives for producers to move toward more sustainable production and higher-quality agricultural products.

In the agricultural sector, green subsidies can potentially support practices such as reducing the excessive use of chemical fertilizers and pesticides, improving soil and water management, adopting environmentally friendly technologies, and enhancing compliance with product quality standards [4,12]. By reducing the economic costs associated with adopting such practices, green subsidies may influence producers' production decisions and consequently affect the quality and composition of agricultural output. Improvements in product quality may, in turn, influence market demand by increasing consumers' willingness to purchase higher-quality products and enhancing the competitiveness of agricultural products in domestic and international markets [5,8].

It should be emphasized that the green subsidy policy considered in this study has not been implemented as a specific agricultural policy instrument in Iran. Therefore, the present study does not evaluate an existing subsidy program. Instead, it simulates alternative green subsidy policy scenarios for Iran's agricultural sector within a computable general equilibrium (CGE) framework. This counterfactual simulation approach makes it possible to examine the potential economic effects of introducing such a policy under different levels of government support and to provide *ex ante* evidence for policymakers before any potential implementation.

The potential effects of a green subsidy policy may extend beyond producers and production decisions and influence different components of final demand. In this study, final demand includes household consumption, de-

mand from processing industries, exports, and other relevant final uses of agricultural products. Improvements in agricultural product quality may encourage households to consume higher-quality products, motivate processing industries to use higher-quality agricultural raw materials, and strengthen the competitiveness of agricultural products in export markets, particularly where quality certification and environmental standards are increasingly important [5,7,8].

Given increasing consumer awareness of food safety and product quality, together with the growing importance of environmental and sustainability requirements in international agricultural trade, examining the potential effects of green subsidy policies on final demand is particularly important. An economy-wide assessment is especially relevant because changes in agricultural subsidies may generate effects that extend beyond the agricultural sector and influence production decisions, prices, household consumption, intermediate demand, exports, and other components of final demand.

In this study, the green subsidy policy is operationalized through three hypothetical policy scenarios corresponding to subsidy rates of 20%, 50%, and 100%. These scenarios represent alternative levels of policy support and are simulated relative to the baseline economic conditions of Iran. The scenarios are designed to examine how different degrees of hypothetical government support may affect agricultural production incentives, product quality, and the components of final demand. The green subsidy is incorporated into the CGE model as a simulated policy intervention that changes the economic incentives associated with agricultural production. Thus, the three scenarios do not represent historically observed subsidy rates in Iran; rather, they are counterfactual scenarios constructed to evaluate the potential effects of alternative policy intensities.

Accordingly, this study aims to analyze the potential effects of alternative green subsidy scenarios on the components of final demand in Iran's agricultural sector, with particular emphasis on their implications for improving agricultural product quality. By comparing the outcomes of the 20%, 50%, and 100% subsidy scenarios with the baseline situation, the study provides an *ex ante* assessment of the potential consequences of different levels of green subsidy support. The findings can assist policymakers in evaluating alternative agricultural support mechanisms and in designing policies that may simultaneously contribute to product quality improvement, environmental sustainability, and sustainable agricultural

development.

Analytical Approach: CGE Model

This study employs a Computable General Equilibrium (CGE) model to examine the potential economy-wide effects of hypothetical green subsidy policies on Iran's agricultural sector. The CGE framework is a well-established quantitative approach for evaluating economic policies because it captures interactions among production activities, households, government, markets, and the foreign sector, while also accounting for the feedback effects generated by changes in relative prices and resource allocation [3]. Unlike econometric approaches that rely primarily on historical time-series or cross-sectional observations, CGE models are grounded in microeconomic theory and provide a flexible framework for conducting counterfactual policy simulations. These models explicitly represent the economic behavior of major agents, including producers, consumers, government, and the foreign sector, and allow the researcher to examine both direct and indirect effects of policy changes throughout the economy. In this respect, CGE models provide a more comprehensive analytical framework than Input–Output (I–O) and partial-equilibrium models because they can capture market-clearing mechanisms, resource reallocation, price adjustments, and feedback effects across economic sectors [2].

In the present study, the CGE model is used to simulate a hypothetical green subsidy policy that has not yet been implemented as a specific agricultural policy instrument in Iran. Therefore, the analysis should be interpreted as a counterfactual policy simulation rather than an assessment of an existing subsidy program. The baseline equilibrium represents the existing economic structure and policy conditions, while alternative scenarios are constructed by introducing hypothetical changes in the relevant policy variables associated with green agricultural subsidies.

The green subsidy is modeled as a policy intervention intended to provide economic incentives for agricultural producers to adopt production practices that are consistent with environmental sustainability and improved product quality. In the model, the subsidy is represented through changes in the relevant exogenous policy parameters, thereby allowing its potential effects on producers' economic incentives, production decisions, prices, and demand components to be examined. Depending on the specific transmission mechanism specified in the model, the simulated subsidy can affect the cost structure and returns associated with agricultural production and consequently generate indirect effects throughout the economy. To evaluate different levels of policy support, three coun-

terfactual green subsidy scenarios are considered: 20%, 50%, and 100%. These rates do not represent historically observed or currently implemented subsidy rates in Iran. Rather, they are hypothetical policy intensities used to examine the potential response of the Iranian economy to alternative levels of green subsidy support. Each scenario is compared with the baseline equilibrium to identify the changes generated in agricultural production, product quality-related outcomes, and the components of final demand.

The CGE framework therefore enables the study to capture both the direct effects of the simulated green subsidy on agricultural producers and the indirect effects transmitted through changes in production costs, prices, household income, consumption, intermediate demand, exports, and other economic activities. This comprehensive framework provides a basis for assessing how alternative levels of hypothetical green subsidy support could influence the agricultural sector and its linkages with the broader Iranian economy.

Model Structure

The applied Computable General Equilibrium (CGE) model represents the Iranian economy as an open economy and captures the interactions among production activities, households, government, investment, savings, and international trade. The model is designed to determine a simultaneous economy-wide equilibrium in which markets are cleared through adjustments in prices and quantities. Accordingly, changes in agricultural policy can generate not only direct effects on agricultural production but also indirect effects through changes in input demand, household income, consumption, government revenue, investment, imports, exports, and relative prices.

The model consists of five main blocks: (i) production and factor demand, (ii) household and government behavior, (iii) savings and investment, (iv) international trade, and (v) market-clearing and price normalization conditions. These blocks jointly describe the behavior of the main economic agents and the equilibrium conditions of the economy [1,2].

$$VA_j = b_j \pi FD_{hj}^{\beta_{hj}} \quad (1)$$

At the upper level of the production process, gross output is formed by combining value-added and intermediate inputs, based on Leontief technology, which assumes fixed input proportions.

$$Y_j = \min \left(\frac{x_{ij}}{ax_{ij}}, \frac{VA_j}{ay_j} \right) \quad (2)$$

Based on these two stages, each sector optimizes its profit

function with respect to its production level, ultimately resulting in the following set of equations.

$$X_{ij} = ax_{ij} \cdot Y_j \quad (3)$$

$$VA_j = ay_j \cdot Y_j \quad (4)$$

$$FD_{hj} = \frac{\beta_{hj} PN_j}{W_h} VA_j \quad (5)$$

$$PS_j = ay_j \cdot PN_j + \sum ax_{ij} \cdot PQ_i \quad (6)$$

Households earn income by providing labor and capital. They allocate spending to maximize utility, subject to their budget. Net income is used to buy goods, pay taxes and save.

$$C_i PQ_i = \lambda_{ci} (\sum W_h FS_h - TAX_{dir} - SAV_{hoh}) \quad (7)$$

The government collects revenue from sales and income taxes, import duties, and oil exports. This income is allocated to public consumption and savings. Government demand is modeled like household demand, using fixed budget shares across goods and services.

$$TAX_{ind,j} = tx_j \cdot PS_j \cdot Y_j \quad (8)$$

$$TAX_{dir} = td \cdot \sum_h W_h FS_h \quad (9)$$

$$TARIFF_j = tx_j \cdot PM_j \cdot M_j \quad (10)$$

$$G_i \cdot PQ_i = \lambda_{gi} (TAX_{dir} + \sum TAX_{ind,j} + \sum TARIFF_j + E_{oil} - SAV_g) \quad (11)$$

The allocation of investment across sectors is governed by the overall investment level, which represents the combined pool of savings domestic (private and public) as well as foreign. Given that foreign savings are treated as external parameters, the exchange rate assumes a decisive role in shaping the trade balance.

$$SAV_{hoh} = s_{hoh} \sum_h W_h \cdot FS_h \quad (12)$$

$$SAV_g = s_g (\sum_i TAX_{ind,i} + \sum_i TARIFF_i + TAX_{dir} + E_{oil}) \quad (13)$$

$$SAVING = (SAV_h + SAV_{Gov} + SAV_f) \quad (14)$$

$$SAVING = INVEST \quad (15)$$

$$ID_i \cdot PQ_i = \mu_i \cdot INVEST \quad (16)$$

In CGE models with a small country assumption, world prices are considered fixed. Domestic and imported goods are combined as Armington composites, allowing for limited substitution. Likewise, goods for export and

local consumption are split using transformation elasticity, reflecting producers' flexibility in targeting different markets. Trade flows adjust based on relative price shifts, influencing import demand and export supply.

$$PE_i = pwe_i \cdot EXR \quad (17)$$

$$PM_i = pwm_i \cdot EXR \quad (18)$$

In computable general equilibrium (CGE) models for open economies, it's important to differentiate between imported goods, exported goods, and those produced for domestic use. The model assumes that imported and domestic goods are imperfect substitutes and together form a composite good known as the Armington good. Composite goods serve dual roles within the economy, functioning both as inputs in intermediate stages of production and as final consumption items. In line with the Armington assumption, imported and domestic goods are treated as imperfect substitutes implying that one unit of import cannot seamlessly replace its domestic counterpart. This imperfect substitutability is generally captured through a CES (Constant Elasticity of Substitution) functional form.

$$Q_i = \gamma_i (\alpha_{mi} \cdot M_i^{\rho_{mi}} + \alpha_{di} \cdot D_i^{\rho_{mi}})^{1/\rho_{mi}} \quad (19)$$

Q_i represents a composite good formed from domestic (D_i) and imported goods under the Armington specification. The function uses γ_i as an efficiency parameter, with α_{di} and α_{mi} as share parameters such that $\alpha_{di} + \alpha_{mi} = 1$ and both are non-negative. The substitution relationship is governed by ρ_{mi} , linked to the elasticity of substitution, which is computed through Equation [1].

$$h_i = \frac{-d(\frac{M_i}{D_i})}{M_i/D_i} / \frac{d(\frac{PM_i}{PD_i})}{PM_i/PD_i} \quad (20)$$

Given the utility maximization problem under the Armington assumption, the optimal demand functions for domestic (D_i) and imported goods (M_i) are derived. These appear as Equations (21) and (22), expressing demand in terms of:

$$M_i = (\frac{\gamma_i^{\rho_{mi}} \cdot \alpha_{mi} \cdot PQ_i}{(1 + \tau_{mi}) \cdot PM_i})^{1/1-\rho_{mi}} \cdot Q_i \quad (21)$$

$$D_i = (\frac{\gamma_i^{\rho_{mi}} \cdot \alpha_{di} \cdot PQ_i}{PD_i})^{1/1-\rho_{mi}} \cdot Q_i \quad (22)$$

PD_i represents the price of domestically produced goods.

It is assumed that exports can be imperfectly transformed into domestic production. This relationship between exports and domestic output is described using a Constant Elasticity of Transformation (CET) function, which captures the trade off between allocating goods for domestic use or export, depending on relative prices.

$$Y_i = \theta_i (\beta_{ei} \cdot E_i^{\rho_{ei}} + \beta_{di} \cdot D_i^{\rho_{ei}})^{1/\rho_{ei}} \quad (23)$$

In this framework, E_i denotes the value of exports, while θ_i represents the efficiency coefficient within the transfer mechanism. The parameters β_{di} and β_{ei} signify the respective shares in the transfer process, satisfying the condition $\beta_{ei} + \beta_{di} = 1$. Additionally, the components ρ_{ei} , D_i , and β_{ei} are constrained to be non-negative and collectively characterize the behavior of the transfer function. As a result of the profit-maximization framework, the respective supply expressions for exported and domestic goods emerge from the following set of equations.

$$E_i = \left(\frac{\theta_i^{\rho_{ei}} \cdot \beta_{ei} \cdot (tx_i + PS_i)}{PD_i} \right)^{1/1-\rho_{ei}} \cdot Y_i \quad (24)$$

$$D_i = \left(\frac{\theta_i^{\rho_{ei}} \cdot \beta_{di} \cdot (tx_i + PS_i)}{PD_i} \right)^{1/1-\rho_{ei}} \cdot Y_i \quad (25)$$

In the model, four key markets labour, capital, goods and foreign currency are cleared through price adjustments. Wages, interest rates, product prices and exchange rates flexibly adjust to ensure equilibrium across these markets. To guarantee a unique and stable solution, a price normalization rule anchors the general price index.

$$\sum_j FD_{hj} = FS_h \quad (26)$$

$$Q_i = C_i + G_i + ID_i + \sum_j X_{ij} \quad (27)$$

$$\sum_i pwe_i \cdot E_i + SAV_f = \sum_i pwm_i \cdot M_i \quad (28)$$

Due to the existence of infinitely many solutions with identical relative prices, a price normalization condition is imposed to ensure uniqueness. This equation fixes the general price index, allowing all other prices to adjust relative to this benchmark. Consequently, the model arrives at a single, well-defined equilibrium.

$$PINDEX = \sum_i \omega_i p_{Qi} \quad (29)$$

The model is calibrated with Iran's Social Accounting Matrix (SAM), providing a detailed representation of economic flows across major sectors. Key parameters like share coefficients and transfer rates are adjusted to

align production and consumption functions with base-year data, ensuring a consistent and realistic equilibrium.

Policy Scenario Design

Upon validating the model, simulations were carried out to assess the effects of green agricultural subsidies. The analysis explores changes in final demand across key sectors households, agro-processing, exports and food services while evaluating shifts in both the quality and composition of agricultural product consumption.

Results and discussion

This study draws on Iran's Social Accounting Matrix (SAM), compiled by the Parliament Research Center, which provides a comprehensive representation of economic flows based on an input-output structure. To ensure consistency with the benchmark economic conditions, the SAM is balanced using the RAS method. The calibrated CGE model is solved numerically, and all simulations and analyses are conducted using the General Algebraic Modeling System (GAMS).

One of the key applications of general equilibrium models is scenario-based simulation for assessing the potential effects of alternative policy interventions. In this study, the potential effects of a hypothetical green subsidy policy in Iran's agricultural sector are examined through four scenarios: a baseline scenario without the simulated subsidy and three counterfactual scenarios with subsidy rates of 20%, 50%, and 100%. The simulations are used to assess the effects of alternative subsidy intensities on the components of final demand, as well as selected agricultural economic indicators, including production, investment, consumption, and trade. Because the green subsidy policy has not been implemented as a specific agricultural policy instrument in Iran, the results should be interpreted as an ex ante assessment of its potential effects rather than as an evaluation of an existing policy.

Marginal Demand

The Social Accounting Matrix (SAM) provides information on the income generated by economic activities and the allocation of expenditures across different commodities and economic agents. Within the CGE framework, demand is determined through the interaction of household consumption, investment, government expenditure, intermediate demand, and international trade. At the household level, consumers allocate their disposable income across different commodities according to the specified consumption structure. In the open-economy component of the model, the Armington specification determines the composition of demand between domesti-

Table 1- Parameters and elasticity model

Function name			Agriculture	Industry	Services
Consumption function	Commodity share		0.6129	0.1224	0.2569
	Marginal propensity to consume of households		0.376	0.060	0.384
Value-added production function (Cobb-Douglas)	Transfer or performance		1.826	1.423	1.903
Marginal production function	Labor force	The share of factors	0.289	0.113	0.343
	Capital		0.711	0.887	0.657
	Agriculture	The share of intermediate inputs	0.211	0.386	0.016
	Industry		0.072	0.283	0.0313
	Services		0.017	0.595	0.076
Armington function (Composite goods)	The share of value added		0.3014	1.0716	0.606
	Elasticity of substitution		1.4	1.4	1.4
	The share of imports		0.032	0.161	0.252
	The transfer		1.642	1.976	1.515
Conversion function	Elasticity of conversion		1.2	1.2	1.2
	The share of exports		0.919	0.479	0.895
	The transfer		3.824	2.002	3.656

Source: Research Findings

Table 2- Marginal demand in the base scenario

	Agriculture	other sectors	Total
Export	35.431	835.262	870.693
Import	1498.541	4898.915	6397.456
Gross National Product	259.127	5157.686	5416.813
Private consumption expenses	1393.204	4202.092	5595.297
Investment expenses	272.021	586.287	858.309
Government consumption expenditure	54.107	940.772	994.880

Source: research findings

Table 3- Marginal demand in the 20% scenario

	Agriculture	other sectors	Total
Export	36.031	832.508	865.539
Import	1570.368	4593.708	6134.076
Gross National Product	304.697	4917.743	5222.440
Private consumption expenses	1397.512	4169.640	5567.152
Investment expenses	369.157	323.685	692.842
Government consumption expenditure	54.107	940.772	994.880

Source: research findings

cally produced and imported goods, assuming that these goods are imperfect substitutes.

In this study, the components of final demand include household consumption, investment, government consumption, and exports. These components represent expenditures on goods and services that are not directly used as intermediate inputs in the production of other

goods and services. Changes in the composition and level of final demand can therefore influence resource allocation, production decisions, prices, trade flows, and ultimately the structure of the economy.

The analysis of marginal changes in final demand under the simulated green subsidy scenarios provides an indication of how alternative levels of hypothetical policy sup-

Table 4- Marginal demand in the 50% scenario

	Agriculture	other sectors	Total
Export	36.095	831.940	867.997
Import	1571.883	4552.812	6124.695
Gross National Product	311.128	4902.860	5213.988
Private consumption expenses	1401.312	4170.222	5571.535
Investment expenses	370.110	309.137	679.244
Government consumption expenditure	54.107	940.772	994.880

Source: research findings

Table 5- Marginal demand in the 100% scenario

	Agriculture	other sectors	Total
Export	36.185	830.942	867.130
Import	1572.607	4542.568	6115.175
Gross National Product	320.716	4883.711	5204.420
Private consumption expenses	1408.607	4172.103	5579.711
Investment expenses	372.368	291.054	663.422
Government consumption expenditure	54.107	940.772	994.880

Source: research findings

port may affect demand for agricultural products relative to other sectors. Comparing the baseline with the 20%, 50%, and 100% subsidy scenarios allows the potential demand-side effects of the simulated policy to be identified and provides a basis for evaluating its implications for agricultural production and product quality.

The results presented in Tables 2–5 indicate that the simulated green subsidy scenarios generate different effects on the agricultural sector. Agricultural gross national product increases from 1,393.204 billion rials in the baseline scenario to 1,397.512, 1,401.312, and 1,408.607 billion rials under the 20%, 50%, and 100% subsidy scenarios, respectively. Compared with the baseline, these values represent increases of approximately 0.31%, 0.58%, and 1.11%, respectively.

Agricultural private consumption expenditure also increases under all three simulated subsidy scenarios. It rises from 272.021 billion rials in the baseline scenario to 369.157 billion rials under the 20% scenario, 370.110 billion rials under the 50% scenario, and 372.368 billion rials under the 100% scenario. This pattern indicates an increase in agricultural consumption demand following the simulated policy shock.

In contrast, agricultural investment expenditure decreases under the simulated subsidy scenarios. It declines from 858.309 billion rials in the baseline scenario to 692.842, 679.244, and 663.422 billion rials under the 20%, 50%, and 100% subsidy scenarios, respectively. Thus, the simulation does not indicate a positive effect of increasing the subsidy rate on agricultural investment. Rather, the

results suggest that the hypothetical green subsidy produces heterogeneous effects across different components of final demand.

Agricultural imports also increase across the scenarios, rising from 259.127 billion rials in the baseline scenario to 304.697, 311.128, and 320.716 billion rials under the 20%, 50%, and 100% subsidy scenarios, respectively. These changes correspond to increases of approximately 17.59%, 20.06%, and 23.77%, respectively, relative to the baseline. The simultaneous increase in agricultural output, consumption, and imports suggests that part of the additional demand generated by the simulated policy may be met through imported goods or inputs.

Overall, the simulation results indicate that the hypothetical green subsidy has positive effects on agricultural gross national product and private consumption, while agricultural investment decreases and imports increase. Therefore, a higher subsidy rate does not necessarily improve all economic indicators simultaneously. The results instead highlight the importance of considering the trade-offs among different components of final demand when evaluating alternative levels of green subsidy support.

Conclusion and Policy Recommendations

Improving the quality of agricultural products and promoting compliance with relevant standards are important components of sustainable agricultural development. Achieving these objectives requires coordination among producers, policymakers, regulatory authorities, quali-

ty-control institutions, and other stakeholders involved in the production, monitoring, distribution, and marketing of agricultural products.

This study examined the potential effects of a hypothetical green subsidy policy in Iran's agricultural sector using a CGE model. Since the proposed green subsidy policy has not been implemented as a specific policy instrument in Iran, the 20%, 50%, and 100% subsidy scenarios represent counterfactual simulations rather than evaluations of an existing policy. The results therefore provide an *ex ante* assessment of the potential economic effects of alternative subsidy intensities.

The simulation results indicate that agricultural gross national product increases under all three subsidy scenarios, rising from 1,393.204 billion rials in the baseline scenario to 1,397.512, 1,401.312, and 1,408.607 billion rials under the 20%, 50%, and 100% scenarios, respectively. Agricultural private consumption also increases across the simulated scenarios. At the same time, agricultural exports increase moderately, whereas agricultural imports increase more substantially. These findings suggest that the simulated policy could stimulate agricultural economic activity and demand, but it may also increase reliance on imported goods or inputs.

An important finding is that agricultural investment decreases under the simulated subsidy scenarios. Therefore, the results do not support the assumption that increasing the green subsidy rate automatically improves all economic indicators. Rather, the policy generates heterogeneous effects across different components of final demand. This finding highlights the importance of selecting an appropriate subsidy intensity based on a comprehensive assessment of economic benefits, fiscal costs, import dependence, and other policy objectives.

The results also indicate that the increase in agricultural imports is considerably larger than the increase in agricultural exports. Therefore, if a green subsidy policy were introduced in practice, complementary measures would be needed to strengthen domestic production capacity, improve productivity, and reduce excessive dependence on imported agricultural inputs. Such measures could include support for modern production technologies, efficient irrigation systems, improved seeds, soil management, and environmentally sustainable production practices.

With respect to product quality, the proposed green subsidy should preferably be designed as a targeted and conditional incentive. Eligibility for financial support could be linked to measurable criteria such as reduced use of chemical fertilizers and pesticides, efficient water consumption, adoption of environmentally friendly technologies, improvement of soil quality, compliance with

agricultural standards, and participation in quality-certification programs. Such a design would help ensure that public financial support contributes not only to agricultural production but also to environmental sustainability and product quality.

One potential application could be the gradual redirection of conventional agricultural input subsidies toward environmentally friendly inputs, such as organic or bio-based fertilizers. However, the economic and environmental effects of such a change should not be assumed in advance. Pilot implementation at a limited scale could be used to evaluate its effects on production costs, yields, farmers' income, resource use, product quality, and government expenditure before any broader policy implementation.

A gradual implementation framework is therefore recommended. In the first stage, pilot green subsidy programs could be introduced for selected crops, regions, or production systems. In the second stage, the economic, environmental, and quality outcomes of these pilots could be monitored using measurable indicators. In the third stage, successful interventions could be expanded based on empirical evidence. This approach would reduce policy risks and allow the subsidy mechanism to be adjusted according to observed outcomes.

The potential implications of international trade should also be considered. Although the model shows an increase in agricultural exports under all simulated subsidy scenarios, it also indicates a larger increase in agricultural imports. Therefore, the present results do not provide sufficient evidence to conclude that the policy would improve Iran's overall trade balance. Similarly, potential effects associated with WTO accession, foreign investment, or the balance of payments are beyond the direct scope of the present simulations and should be examined through additional policy and trade scenarios.

Finally, an important limitation of the present study is that the CGE model measures economic responses to the simulated subsidy shock but does not directly quantify changes in agricultural product quality or environmental performance. Consequently, the increases in agricultural output, consumption, or exports should not be interpreted as direct evidence of improved product quality. Future research should combine CGE analysis with farm-level and field-based studies to assess changes in indicators such as chemical-input use, soil and water quality, pesticide residues, production efficiency, certification, and farmers' income.

Overall, the findings suggest that a carefully targeted green subsidy policy has the potential to improve several agricultural economic indicators, particularly agricultural gross national product, private consumption, and exports. However, the simultaneous increase in imports

and decrease in investment demonstrate that the policy may also generate important trade-offs. Therefore, rather than adopting a uniformly higher subsidy rate, policymakers should consider a targeted, conditional, and evidence-based approach supported by pilot implementation, continuous monitoring, and complementary measures to improve productivity, product quality, and environmental sustainability.

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Consent for publication

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