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AN ANALYSIS OF NTMS MEASURES ON INDONESIAN BANANA AND PINEAPPLE EXPORTS IN SELECTED ASEAN, EAST ASIAN, AND MIDDLE EASTERN COUNTRIES

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Abstract

Background: Increasing Indonesia's banana and pineapple exports is part of an effort to promote fresh and processed fruit. Banana and pineapple exports face several challenges, especially in conforming to food safety requirements in destination markets.
Purpose: The objective is to describe Non-tariff measures (NTMs) measures (i.e.SPS and TBT), and their impact on Indonesian banana and pineapple exports.
Design/methodology/approach: In this study, we analyze the effect and impact of NTMs measures using the gravity model by including the variable of NTMs measures.
Findings/Result: This analysis finds that SPS measures have a trade-promoting impact on Indonesian banana and pineapple exports in export markets. In contrast, TBT measures have a trade-impeding impact on Indonesian banana and pineapple export. Ad valorem tariff-equivalents (AVEs) of SPS measures are higher than those of TBT. The AVEs of SPS measures are relatively higher than import tariffs in pineapple export markets. Food safety policies (i.e. SPS and TBT) are still more protective in the export markets of both commodities.
Conclusion: Increasing Indonesia's banana and pineapple exports requires alignment and adjustment of NTMs in export markets. Increasing farmer partnerships with similar large companies to implement good production practices will help accelerate compliance with standards to improve market access.
Originality/value (State of the art): This study specifically examines the impact of non-tariff measures on Indonesian bananas and pineapples in export markets and considers the magnitude of market barriers down to the 6-digit HS code level by measuring the tariff equivalent of NTMs barriers.

Keywords: banana, non-tariff measures, pineapple, food safety, destination markets

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INTRODUCTION

Indonesian fruit exports make the largest contribution to horticultural exports. Efforts to increase export volumes, especially fresh fruits, to several trading partner countries are often faced with trade barriers in the form of Non-tariff measures (NTMs) in export destination countries. The application of NTMs has become a major issue in global trade (Niu et al.2018). Free trade and economic regionalization have reduced tariffs, but the number of NTMs has increased significantly. In addition, stricter food safety standards have been implemented in developed countries, particularly for imports of agricultural products from developing countries and emerging markets.

NTMs measures in many countries are a prominent new fact in many recent free trade agreement (FTA) negotiations (Walmsley & Strutt, 2021). The main problem with NTMs measures is their unclear effects on trade. The trade-deterring effects of NTMs are particularly worrisome for trade, although they can be positive or negative in theory. Empirical studies have found that the impact can vary from impeding trade to increasing demand. Other studies have shown trade-deterring effects (Disdier et al. 2008). However, other studies show a positive (demand-enhancing) impact of NTMs (Xiong and Beghin, 2014; Shepotylo, 2016; Wongmonta, 2025). NTMs regulate trade in products through controls on quality rather than price and quantity. NTMs are thought to protect consumers, but the enforcement of product standards can also be disguised protectionism and add extra compliance costs for exporters. A negative impact related to NTMs measures refers to a percentage change in prices; thus, there is a chance of an upward shift in prices due to compliance costs or switching to higher-quality suppliers. However, the positive effect of NTMs as a trade facilitator is related to the reduction of quality uncertainty. If NTMs measures are informative to consumers, then signaling higher product quality may increase import demand (Cadot et al.2013).

NTMs policies affect trade, so that caused reducing benefits between country pairs. Export destination countries that apply NTMs aim to protect domestic producers by limiting imports, improving product quality, and protecting the Health and Safety of products used by consumers. However, until now, NTMs have been an important issue as an obstacle to international trade for Indonesia, which exports many horticultural commodities, particularly fruits. The increasing number of NTMs affects the trade flows of agricultural products from developing countries. Policies related to food quality and safety are in place but often exceed multilaterally accepted regulations. Compliance costs are sometimes higher outside developed countries because of the lack of infrastructure and services, which are more expensive, have longer lead times, or must be outsourced to the country of export. In addition, NTMs measures can reduce the competitive advantage of countries exporting agricultural products.

According to the Indonesian Bureau of Statistics (BPS) data, the increase in Indonesian banana and pineapple production was relatively significant in the period 2014 to 2022, namely 4.34 percent and 8.28 percent, respectively. Indonesia's exports of horticultural products in 2023 reached USD 466.5 million, 50.44 percent of which came from bananas and pineapples (fresh and processed), and in their fresh form only accounted for 3.25 percent (UN, 2025). In the 2014-2018 period, Indonesia's banana exports increased by 124 percent, but decreased by -10.53 percent in the 2019-2022 period. Likewise, pineapple exports increased by 357 percent in the 2014-2018 period, and decreased by -17.74 percent in the 2019-2022 period. During the same period, the increase in SPS (Sanitary and Phytosanitary) measures in destination countries was relatively faster than in the previous ten years. Bananas faced 14–18 SPS items in the Chinese and South Korean markets, as well as 3–15 TBT (Technical Barriers to Trade) items. Pineapples are also subject to the same stringent provisions, with 2–18 SPS items in the Japanese and South Korean markets, as well as 1–5 TBT items. Meanwhile, more stringent provisions are found in the Middle East market, with 19–22 SPS items and 5–6 TBT items. Several items in the SPS measures on banana and pineapple exports in the Middle East and East Asian export markets include the prohibition of products infected by any pests; sanitary certificates, no contaminants and microbiological composition of food, storage conditions; food and agricultural standards; hygiene; and certification of conformity, coloring agents, and solvent residues. Meanwhile, several items in TBT measures on banana and pineapple commodities include testing and inspection requirements; registration, packaging, food quality traceability; conformity; technical requirements; labeling regulations and marking systems and their inspection, and quantity verification. Middle Eastern export destinations generally do not impose import

tariffs, but they impose high levels of NTMs (i.e. SPS and TBT). The increasingly stringent policies on food safety standards and compliance with technical provisions since 2016 in many export destination countries are a challenge for Indonesian exporters. Fruits' economic potential could occupy a position after the plantation subsector if it can be developed through modern business units, high farmer participation, and proper management to be accepted in the export market. The fruit export market has more stringent regulations and compliance requirements than the domestic market. More informative studies are needed to understand the barriers fruit exporters face in destination countries to improve market access.

This study contributes to more complete information on Indonesian fruit exports (i.e. bananas and pineapples) and the barriers faced in destination countries. Indonesia still lacks a few studies on the effects, impacts, and quantification of non-tariff barriers on fruit commodity exports up to the 6-digit HS code level, particularly in this study on bananas and pineapples. The assessment of market entry barriers caused by the imposition of NTMs has been the most important barrier in recent years. These barriers can be a starting point for accelerating harmonization and have implications for the readiness and compliance of production practices, as well as packaging and labeling requirements. Increased market participation and compliance with standards are key to expanding exports of Indonesian fruits (i.e. bananas and pineapples). Studies on the effect of NTMs measures on Indonesia's agricultural exports are available, such as previous studies (Rindawati and Kristriana, 2018; Khaliqi et al. 2018; Tristi et al. 2021). The effect of NTMs on exports has been widely discussed, but the impact of barriers (tariff equivalents) is rarely analyzed. NTMs (i.e. SPS and TBT) measures often exceed multilaterally accepted regulations. Compliance costs are also higher in low-income countries, as export infrastructure and services are more expensive or outsourced to export destination countries, reducing the competitive advantage of agricultural commodities.

The problem-solving approach in this study uses a gravity model with the main theory from Anderson and van Wincoop's (2003) approach. The derivation of the model considers the situation of multilateral resistance factors of country pairs, trade shares, and economic size to assess the impact of NTMs measures (i.e. SPS and TBT) up to 6-digit HS codes, so that it can be analyzed at the commodity level (i.e. banana and pineapple).

The tendency of many countries to impose barriers in the agricultural sector in the form of NTMs may impact Indonesian fruit exports. In addition, many of the barriers imposed on Indonesian fruit products are commodities with HS codes 0803 and 080430, namely bananas, and pineapples. These fruits are the most exported fruits in Indonesia. The implementation of NTMs raises concerns about trade, including Indonesian fruit exports. The penetration and market access of Indonesian fruit exports must meet the quality and food safety requirements of the destination countries. Based on these conditions, this study aims to identify NTMs measures and their effect on Indonesian fruit exports to destination countries. This study aims to obtain an overview of the effect of NTMs measures (specifically, SPS and TBT) on Indonesian banana and pineapple exports in destination markets and the impact of NTMs measures (AVE of NTMs) on Indonesian banana and pineapple exports in destination markets.

METHODS

This study is devoted to the impact of NTMs (i.e. SPS and TBT) on Indonesia's banana and pineapple exports to various export destinations using data from 2014 to 2022. The panel data used consists of a time series of 2014-2022 and a cross-section of 7 to 9 export destination countries with bananas and pineapples. Data were obtained from various sources, including the Indonesian Bureau of Statistics (BPS), United Nations Comtrade, World Bank, World Trade Organization, Center d'Etudes Prospectives et d'Informations International, and Trade Analysis Information System. The study observed SPS and TBT measures changes in export destination countries for Indonesian fruits from 2014 to 2022 using six-digit HS codes. SPS and TBT data based on TRAINS. Export and import tariffs were obtained from the WTO and UN Comtrade. Tariffs are the most favored nation (MFN) simple averages. GDP based on constant prices (2015) was obtained from the World Bank.

Categories of NTMs as trade facilitators (quantity increases) and trade reducers (quantity decreases) through a net change in the market (Levantis and Fell, 2019). In this study, we do not use dummies as controllers to handle the fixed effects for exporters and importers but follow a methodology similar to the gravity equation model as in (4). Outward multilateral resistance (OMR), which is in the exporting country,

is $(\sigma_k\text{-}1)\ln\prod_i^k$ proxied using a weighted trade cost (distance) approach that captures the notion of multilateral barriers between the two countries, as follows:

$$OMR_{ik} = \sum_j \left[\tau_{ijk}\left(\frac{x_{ijk}}{\sum_j x_{ijk}}\right)\right]$$

This is consistent with the findings of other researchers (Anderson and van Wincoop, 2003; Xiong and Beghin, 2014; Cadot et al. 2018; Bier & Bergstrand, 2009; Dolabella, 2020). In this study, inward multilateral resistance (IMR), which is $(\sigma_k\text{-}1)\ \ln P_j^k$ for importers in country j, is estimated using a proxy approach of distance between country pairs as trade costs and aggregate expenditure as a condition referring to the remoteness of the importing country (Bacchetta et al. 2012), as follows:

$$IMR_j = \sum_i \frac{\tau_{ij}}{Y_i/Y_W}$$

Specifically, SPS_{ijk} and TBT_{ijk} variables are calculated based on counts the number of measures *Nm* that the importer country *j* imposes on product *k* (HS 6-digit line), adding up those corresponding to different NTMs (SPS and TBT) subcategories *l* for fruit destination countries as follows:

$$SPS_{ijk} = \sum_k Nm_{jk}^{SPS} \quad \text{and} \quad TBT_{ijk} = \sum_k Nm_{jk}^{TBT}$$

The model construction in this study adapts previous studies based on the gravity model with a theoretical framework and combines model development from previous studies (Heid et al. 2021; Cadot et al. 2018; Herman, 2022; Xiong and Beghin, 2014). In this study, the trade flow equation can be derived from optimal consumption decisions in the destination country, production decisions in the origin country, and trade frictions between countries (Anderson and van Wincoop, 2003):

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y^k \sum_{j=1}^C \left\{\frac{\tau_{ij}^k}{P_j^k}\right\}^{1-\sigma_k} \frac{E_i^k}{Y^k}} \left\{\frac{\tau_{ij}^k}{P_j^k}\right\}^{1-\sigma_k} \qquad (1)$$

$P_j^k = \left\{\int_{v\in v_i^k}^{\sim} [\tau_{ij}^k p_i^k]^{1-\sigma_k} dv\right\}^{\frac{1}{1-\sigma_k}}$ price index. The trade flow equation from country *i* to country *j* (X_{ij}^k); Total expenditure in country *i* on sector *k* (E_i^k); Total expenditure in country *i* on sector *k* (E_j^k); Number of exporters of sector k in country *i* (*C*); Income received from total sales to all destination countries in sector *k* (Y_i^k); Total world output in sector *k* (Y^k); Inter-country trade costs in sector *k* (τ_{ij}^k); Elasticity of substitution in consumption in country *j* (σ). Furthermore, equation (1) derived from the Andersen and van Wincoop model can be decomposed into a gravity equation structure as follows.

$$X_{ij}^k = \underbrace{\frac{Y_i^k}{Y^k}}_{S_i = \frac{Y_i}{\sum_k X_{kj}}} \underbrace{\frac{E_j^k}{\sum_{j=1}^C \left\{\frac{\tau_{ij}^k}{P_j^k}\right\}^{1-\sigma_k} \frac{E_i^k}{Y^k}}}_{M_n = \frac{X_n}{\sum_k \frac{\phi_{nk} Y_k}{\Omega_k}}} \underbrace{\left\{\frac{\tau_{ij}^k}{P_j^k}\right\}^{1-\sigma_k}}_{\phi_{ni}}$$

The structure of the gravity equation (1) is equivalent to a structure of the gravity equation $X_{ni}=((Y_i/\Omega_i)(X_n/\phi_n))\ \phi_{ni}$ and $\Phi_n=\sum\phi_{nk}\ Y_k/\Omega_k$; $\Omega_i = \sum\phi_{ki}X_k/\Phi_k$ (Head and Mayer, 2014). The factor reflects (Si) the ability of exporter *i* to supply to all markets in the destination country. M_n is reflective of all market characteristics in the destination country that drive imports from multiple partner countries. Country n's bilateral access to exporter i is captured within the constraints of $0 \leq \phi_{in} \leq 1$ which combines all components that incur trade costs to measure the overall impact on trade flows. Furthermore, by doing the definition:

$$\prod_i^{k\,1-\sigma_k} = \sum_{j=1}^C \left\{\frac{\tau_{ij}^k}{P_j^k}\right\}^{1-\sigma_k} \frac{E_j^k}{Y^k} \quad \text{and} \quad P_j^{k\,1-\sigma_k} = \sum_{j=1}^C \left\{\frac{\tau_{ij}^k}{\prod_i^k}\right\}^{1-\sigma_k} \frac{E_i^k}{Y^k}$$

so that another form of the total export equation in sector k (1) can be derived into a gravity model as follows (Anderson and van Wincoop, 2003):

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y^k} \left\{\frac{\tau_{ij}^k}{\prod_i^k P_j^k}\right\}^{1-\sigma_k} \qquad (2)$$

Equation (2) relates bilateral exports to market size ($Y_i^k E_j^k / Y^k$) and frictions in trade flows ($\tau_{ij}^k / \prod_i^k P_j^k$). The components $\prod_i^{k1\text{-}\sigma k}$ and $P_i^{k1\text{-}\sigma k}$ are the outward and inward multilateral resistance (MR), respectively, consistent with the aggregate bilateral trade costs and losses borne by producers and consumers of each trading country. Bilateral costs are related to a few factors such as the imposition of a tariff (tar_{ijk}), distance ($Dist_{ij}$), real exchange rate ($REXC_{ij}$) cultural similarities, border, and NTMs regulation in the country pairs. Using the gravity model approach, we can parameterize the bilateral cost (τ_{ij}^k) as (3).

$$\tau_{ij}^{k} = (tar_{ijk})^{a1}(Dist_{ij})^{a2}(REXC_{ij})^{a3}\,(e)^{a4Cultureij}\,(e)^{a5Borderij+a6NTMijk} \quad (3)$$

By doing proxied with by and consideration of resource abundance factors, namely country of origin income (GDP_i) and fruit production ($PrFruit_i$), then substituting equation (3) into (2) in the form of conversion to logarithm, we obtain the bilateral trade equilibrium as (4).

$$lnX_{ijk} = -lnY^{k} + (lnY_i^{k} - (\sigma_k\text{-}1)ln\textstyle\prod_i^{k}) + (lnY_i^{k} - (\sigma_k\text{-}1)lnP_j^{k}) + (1\text{-}\sigma_k)a1ln(1+tar_{ijk}) + (1\text{-}\sigma_k)a2lnDist_{ij} + (1\text{-}\sigma_k)a3REXC + (1\text{-}\sigma_k)a4Culture_{ij} + (1\text{-}\sigma_k)a5Border_{ij} + (1\text{-}\sigma_k)a61NTM_{ijk} + b1GDP_i + b2PrFruit_i + b1 \quad (4)$$

The first term lnY^k is simply a constant, it is equal to world GDP, but for estimation purpose it can simply as a coefficient multiplied by a constant term. The next term, $\{lnY_i^k - (\sigma_k\text{-}1)ln\prod_i^k\}$ represents a complete set of exporter fixed effect. The same is true for the importer side, $\{lnY_i^k - (\sigma_k\text{-}1)lnP_j^k\}$ where is a full set of importer fixed effects. In terms of the panel data literature, this approach can be seen as solving for all unobserved sources of heterogeneity that are constant for a given exporter across all importers, constant for all importers, and constant for a given importer across all exporters. Equation (4) is the conceptual form of the gravity model that considers the income of the destination market, the factor endowment of the home country, the effect of trade costs between country pairs, and the impact of stringent NTMs measures in both countries. At some point, the importing country stringencies (the number of NTMs becomes larger), resulting in increased trade flows (import demand) due to the benefits of product signaling information or improved product quality related to health and environmental safety related to NTMs regulations. However, the stringencies of NTMs regulations often results in additional costs faced by foreign players. These additional barriers can be a burden, depending on whether they are used to enforce equally stringent regulations in their home market, as the country has harmonized many NTMs with trading partners. If there is a significant difference in regulation or a large difference in stringency, it may have the effect of reducing trade flows as imports are temporarily held back or diverted to other destination markets. Then, we estimate the banana export gravity equation model (5), pineapple export gravity equation (6), and the following:

$$EXP_{ijp} = exp\begin{bmatrix} \beta_0 + \beta_1 GDP_{jt-1} + \beta_2 MRT_j + \beta_3 MRT_i + \beta_4(1+tar_{ijpt-1}) + \beta_5 SPS_{ijp} \\ + \beta_6 TBT_{ijp} + [\beta_7(1+tar_{ijp-1}) + \beta_8 SPS_{ijp} + \beta_9 TBT_{ijp}]\frac{\sum_i^N x_{ijpt-1}}{\sum_i^N\sum_j^N x_{ijpt-1}} \\ + [\beta_{10}(1+tar_{ijpt-1}) + \beta_{11} SPS_{ijp} + \beta_{12} TBT_{ijp}]\frac{\sum_j^N x_{ijpt-1}}{\sum_i^N\sum_j^N x_{ijpt-1}} + \beta_{13} REXC_{ijt-1} \\ + \beta_{14} GDP_{it-(t-1))} + \beta_{15} PRODPIS_{it-(t-1))} + \beta_{16} COMBOR + \beta_{17} RELEIG \end{bmatrix} + \varepsilon_{ijp} \quad (5)$$

$$EXP_{ijn} = exp\begin{bmatrix} \beta_0 + \beta_1 GDP_{jt-(t-1))} + \beta_2 MRT_j + \beta_3 MRT_i + \beta_4(1+tar_{ijn}) + \beta_5 SPS_{ijnt-1} \\ + \beta_6 TBT_{ijnt-1} + [\beta_7(1+tar_{ijn}) + \beta_8 SPS_{ijnt-1} + \beta_9 TBT_{ijnt-1}]\frac{\sum_i^N x_{ijnt-1}}{\sum_i^N\sum_j^N x_{ijnt-1}} \\ + [\beta_{10}(1+tar_{ijn}) + \beta_{11} SPS_{ijnt-1} + \beta_{12} TBT_{ijnt-1}]\frac{\sum_j^N x_{ijnt-1}}{\sum_i^N\sum_j^N x_{ijnt-1}} + \beta_{13} REXC_{ijt-1} \\ + \beta_{14} GDP_{it-(t-1))} + \beta_{15} PRODNAS_{it-(t-1))} + \beta_{16} COMBOR + \beta_{17} RELEIG \end{bmatrix} + \varepsilon_{ijn} \quad (6)$$

Where p is bananas; n is pineapples; EXP_{ijk} is the amount of Indonesian fruit exports to destination countries (bananas and pineapples); GDPI is Indonesia's real gross domestic product; tar_{ijk} is the ad valorem tariff for fruit commodities in the destination country; Factor endowments are characteristics of exporting countries according to the comparative advantage approach (Leamer, 1990), which in this study consists of domestic fruit production (PRODPIS and economic size of the exporting country (GDPI); REXC is real exchange rate of Rupiah; The model includes common border (COMBOR) and religious similarity variables (RELEIG); β_i are parameters; $(\sum_i x_{ijk})/(\sum_i\sum_j x_{ijk})$ is the export share of Indonesian fruits; $(\sum_j x_{ijk})/(\sum_i\sum_j x_{ijk})$ is the import share of Indonesian fruits in the destination country; and ε_{ijk} is the error term.

The PPML method can be used for gravity models accompanied by zero data in the presence of heteroscedasticity (Silva and Tenreyro, 2006). The PPML estimation method with high-dimensional fixed effects (ppmlhdfe) is more likely to produce robust and more efficient model estimation results for panel data with heteroscedasticity problems. The command ppmlhdfe makes it easy to include all the fixed effects you need. The method used is robust to separation problems and statistical convergence (Correia et al. 2020). To reduce the potential endogeneity bias between the dependent variable and the policy variable, it is solved by the choice of lagged market share variables, import tariffs, or NTMs measures (Ghodsi et al. 2016).

In calculating ad valorem tariff-equivalents (AVEs) by category of NTMs by estimating the magnitude of tariff cuts that result in the same change in trade as the removal of a particular category of NTMs, the change in quantity of trade attributed to AVEs is equal to the change in quantity of trade caused by the removal of NTMs. This is conceptually in line with some previous studies (Fell and Duver, 2023). The AVEs for SPS and TBT for Indonesian exports of commodity *k* (banana

and pineapple) to export markets are obtained through equation (7 and 8).

$$AVE_{ijk.SPS} = exp\left(\frac{\left(\beta_5 + \beta_8 \frac{\Sigma_i^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}} + \beta_{11} \frac{\Sigma_j^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}}\right) SPS_{ijk}}{\beta_4 + \beta_7 \frac{\Sigma_i^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}} + \beta_{10} \frac{\Sigma_j^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}}}\right) - 1, \quad (7)$$

$$AVE_{ijk.TBT} = exp\left(\frac{\left(\beta_5 + \beta_8 \frac{\Sigma_i^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}} + \beta_{11} \frac{\Sigma_j^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}}\right) TBT_{ijk}}{\beta_4 + \beta_7 \frac{\Sigma_i^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}} + \beta_{10} \frac{\Sigma_j^N x_{ijk}}{\Sigma_i^N \Sigma_j^N x_{ijk}}}\right) - 1, \quad (8)$$

As shown in Figure 1, a research framework is presented to outline the analysis of increasing Indonesian banana and pineapple exports associated with destination country NTMs policies and multilateral resistance factors, which affect exports. Using an export gravity model, the impact of NTMs policies on Indonesian banana and pineapple exports is analyzed. Market barriers to exports of both commodities are also explored by measuring ad-valorem SPS and TBT tariffs within the data period.

RESULTS

A descriptive overview of the data used in this study is shown in Table 1. It also provides information on the method of measuring variables, sources of data collected and export destination countries.

The estimation results of the banana and pineapple export model show that most of the independent variables are statistically significant (Table 2). The import tariff (TARJ) shows a significant downward effect on banana exports. The variable representing the endowment factor of banana exporting countries, namely the banana production (PRODPIS) is significant, and the economic size of exporting countries (GDPI) is significant on Indonesian banana exports. As Table 2 shows, SPS measures are significant and influence the increase in Indonesian banana exports in destination markets. More SPS provisions and enforcement positively affect the volume of Indonesian banana exports. Instead, TBT are also quite significant and influence the decrease in Indonesian banana exports in destination markets. The results of other studies show that SPS have an impact on increasing exports of agricultural commodities and TBT have an impact on decreasing exports (Fell and Duver, 2023). In addition, a study on Chinese exports found an increasing impact of technical NTMs (SPS and TBT), while non-technical NTM categories showed a hindering impact on final product exports (Timini and Conesa, 2019). However, other studies have shown the opposite effect of NTMs (Lim, 2024; Wood et al. 2017). Technical standards and regulations result in trade barriers or increased demand. Negative effects are caused by increased costs for exporters, while positive effects are related to product quality and safety. More informative quality signals increase import demand.

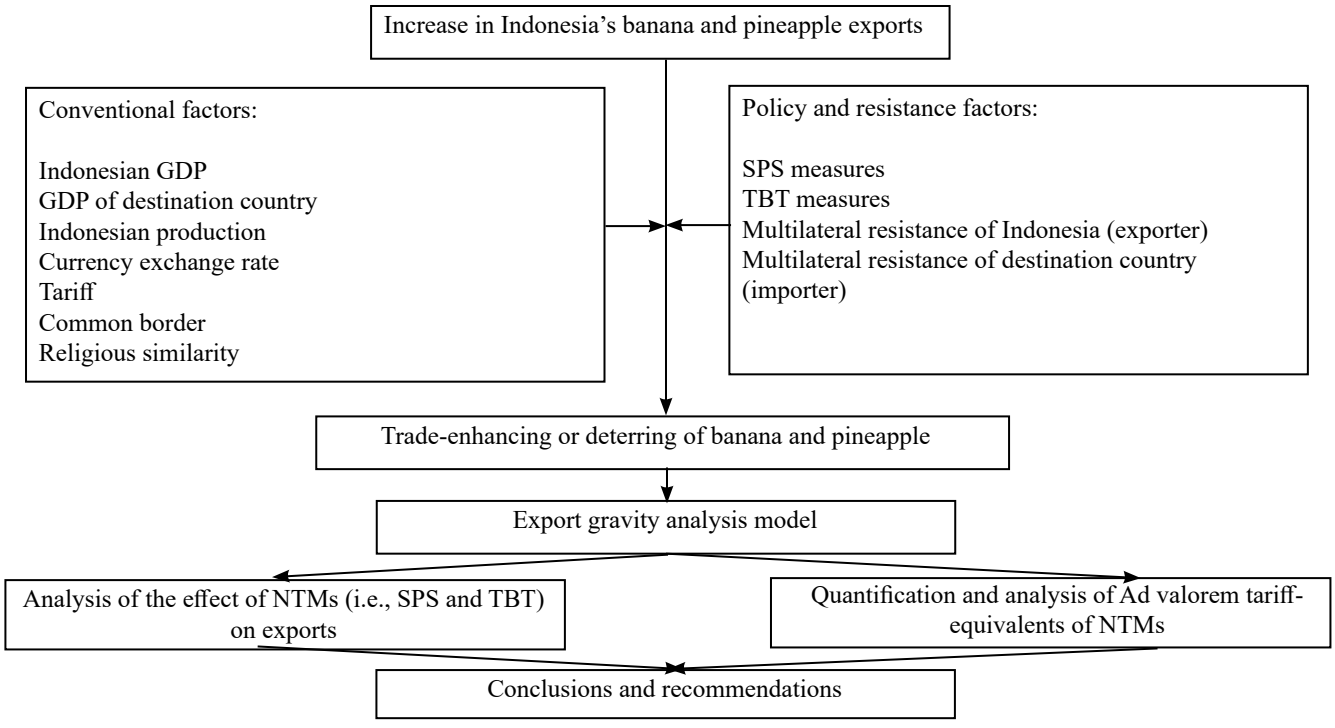

Figure 1. Research Framework of Indonesia's banana and pineapple export analysis using the gravity model

Table 1. Descriptive statistics

Variables	Variable Description	Descriptive Statistics	Source
EXP_{ijp}	Quantity of banana exports from country i to country j (tons). (Export destinations are Japan, South Korea, China, Malaysia, Singapore, Saudi Arabia, Oman, Qatar, and the United Arab Emirates).	Mean: 865.49; Min: 0; Max: 9787.63; Obs: 81	Indonesian Statistics (BPS)
EXP_{ijn}	Quantity of pineapple exports from country i to country j (tons). (Export destinations are Japan, South Korea, Singapore, Saudi Arabia, Oman, Qatar, and the United Arab Emirates).	Mean: 1033.04; Min: 1; Max: 11752.71; Obs: 63	Indonesian Statistics (BPS)
tar_{ijp}	Ad valorem tariff for banana in the destination country (percent)	Mean: 0.0770; Min: 0; Max: 0.3; Obs:81	WITS
tar_{ijn}	Ad valorem tariff for pineapple in the destination country (percent)	Mean: 0.0730; Min: 0; Max: 0.3; Obs: 63	WITS
MRTJ	Inward multilateral resistance for importers in the destination country: $MRTj=\sum i\tau ij/(Yi/YW)$	Mean: 104090.10; Min: 95594.03; Max: 114238.10; Obs: 81	Own estimation
MRTI	Outward multilateral barriers for exporters from the country of origin: $MRTi=\sum j[\tau ijk\ (xijk/(\sum jxijk))]$	Mean: 4.33; Min: 0.005; Max: 30.24; Obs: 81	Own estimation
GDPJ	Destination country real gross domestic product at constant prices (2015)	Mean: 2383.66; Min: 74.95; Max: 16325; Obs: 81	World Bank
GDPI	Indonesia's real gross domestic product based on constant prices (2015)	Mean: 978.59; Min: 820.83; Max: 1122.28; Obs: 81	World Bank
PRODPIS	Banana production in country of origin (thousand tons)	Mean: 7671.78; Min: 6862.56; Max: 9245.42; Obs:81	Indonesian Statistics (BPS)
PRODNAS	Pineapple production in country of origin (thousand tons)	Mean: 2144070; Min: 1396153; Max: 3203775; Obs: 63	Indonesian Statistics (BPS)
$\sum_i x_{ijp}/\sum_i\sum_j x_{ijp}$	the export share of Indonesian bananas (Own estimation)	Mean: 0.1100; Min: 0;Max: 0.9774; Obs:81	Indonesian Statistics (BPS)
$\sum_i x_{ijn}/\sum_i\sum_j x_{ijn}$	the export share of Indonesian pineapples (Own estimation)	Mean: 0.1374; Min: 0;Max: .8189; Obs: 63	Indonesian Statistics (BPS)
$\sum_j x_{ijp}/\sum_i\sum_j x_{ijp}$	Import share of Indonesian bananas in destination countries (Own estimation)	Mean: 0.0295; Min: 0 Max: .9029; Obs: 81	UN Comtrade
$\sum_j x_{ijn}/\sum_i\sum_j x_{ijn}$	Import share of Indonesian pineapples in destination countries (Own estimation)	Mean: 0.0371; Min: 0; Max: 0.3091; Obs: 63	UN Comtrade
REXC	The real exchange rate of Rupiah	Mean: 3401.54; Min: 10.81; Max: 10498.18; Obs: 81	IMF
SPSijp	Calculated based on counts the number of measures Nm that the importer country j imposes on the banana product k (HS6-digit line), adding up those corresponding to different NTMs subcategories l for the banana destination countries. $SPS_{ijp}=\sum_k Nm_{jpl}^{SPS}$	Mean: 11.87 Min: 0; Max: 22; Obs: 81	TRAINS
SPSijn	Calculated based on counts the number of measures Nm that the importer country j imposes on the pineapple product k (HS6-digit line), adding up those corresponding to different NTMs subcategories l for the pineapple destination countries. $SPS_{ijn}=\sum_k Nm_{jnl}^{SPS}$	Mean: 12.88; Min: 0; Max: 22; Obs: 63	TRAINS
TBT_{ijp}	Calculated based on counts the number of measures Nm that the importer country j imposes on the banana product k (HS6-digit line), adding up those corresponding to different NTMs subcategories l for the banana destination countries. $TBT_{ijp}=\sum_k Nm_{jpl}^{TBT}$	Mean: 3.59; Min: 0; Max: 15; Obs: 81	TRAINS
TBT_{ijn}	Calculated based on counts the number of measures Nm that the importer country j imposes on the pineapple product k (HS6-digit line), adding up those corresponding to different NTMs subcategories l for the pineapple destination countries. $TBT_{ijn}=\sum_k Nm_{jnl}^{TBT}$	Mean: 2.96; Min: 0; Max: 6; Obs: 63	TRAINS
COMBOR	Common border	Mean: 0.22; Min: 0; Max: 1; Obs: 81	Own composition
RELEIG	Religious similarity	Mean: 0.51; Min: 0; Max: 1; Obs: 81	Own composition

Table 2. Estimation results of Indonesian banana and pineapple exports

	Banana export model			Pineapple export model		
Variables	Models 1	Models 2	Models 3	Models 4	Models 5	Models 6
Const	-0.7222	-0.3202	-3.8887***	2.4171***	2.2436***	2.7822***
	-10.969	(0.8066)	-10.214	(0.4186)	(0.3678)	(0.7733)
GDPJ(t-1)	0.1808**	0.0791	0.0870*			
	(0.0738)	(0.0556)	(0.0496)			
GDPJ(t-(t-1))				0.1162***	0.0981***	0.1014***
				(0.0097)	(0.0148)	(0.0175)
MRTJ			0.00003***			-0.00000
			(0.00001)			(0.00000)
MRTI		0.0580***	0.0575***		0.00008	0.00008
		(0.0222)	(0.0215)		(0.00005)	(0.00006)
TARJ				-5.7850**	-5.2375**	-5.4633**
				-24.026	-21.745	-22.168
TARJ(t-1)	2.2771*	1.7389*	2.2732**			
	-11.846	(0.9977)	(0.9384)			
SPSJ	0.0259*	0.0417***	0.0339***			
	(0.0154)	(0.0113)	(0.0118)			
TBTJ	-0.0260	-0.0271*	-0.0425***			
	(0.0219)	(0.0144)	(0.0136)			
SPSJ(t-1)				0.0703**	0.0691**	0.0725**
				(0.0315)	(0.0289)	(0.0288)
TBTJ(t-1)				-0.1900**	-0.1838***	-0.2001***
				(0.0789)	(0.0660)	(0.0685)
(IMPS´TARJ) (t-1)	-0.2026	39.516	80.276	62.8344***	62.9971***	60.6392***
	-14.647	-55.216	-51.718	-204.310	-182.702	-187.263
(IMPS´SPSJ) (t-1)	-0.1250***	-0.1170*	-0.1424**	-0.3947	-0.4161	-0.4378
	(0.0263)	(0.0651)	(0.0660)	(0.3016)	(0.3106)	(0.2863)
(IMPS´TBTJ) (t-1)	0.1115**	0.0575	0.0741	19.500	20.586	2.1351*
	(0.0484)	(0.0856)	(0.0810)	-13.417	-13.739	-12.748
(EXPS´TARJ) (t-1)	55.087	0.9686	-10.9410***	-39.414	-37.456	-34.743
	-64.178	-13.920	-38.664	-28.543	-27.269	-28.063
(EXPS´SPSJ) (t-1)	0.1215**	0.0480	0.0763	0.0586	0.0323	0.0235
	(0.0533)	(0.0618)	(0.0565)	(0.0449)	(0.0583)	(0.0576)
(EXPS´TBTJ) (t-1)	-0.1014	-0.0549	-0.0205	-0.0615	-0.0688	-0.0301
	(0.0712)	(0.0633)	(0.0556)	(0.2351)	(0.2560)	(0.2576)
REXC(t-1)	0.0676	0.0464	0.0660	-0.4671*	-0.5161*	-0.5064*
	(0.0825)	(0.0643)	(0.0577)	(0.2814)	(0.2866)	(0.2761)
GDPI(t-(t-1))	2.0698*	1.6903*	1.7912*	2.5022**	2.6120**	2.5284*
	-11.348	(0.9998)	(0.9957)	-12.613	-13.204	-13.450
PRODPIS(t-(t-1))	1.4719**	1.2447**	0.2751			
	(0.6701)	(0.6188)	(0.6140)			
PRODNAS(t-(t-1))				0.8756**	0.9945***	0.9455***
				(0.3487)	(0.3247)	(0.3464)
COMBOR	0.5128***	0.7734***	0.6432***	-1.5322**	-1.3482***	-1.8076**
	(0.1645)	(0.1546)	(0.1744)	(0.5839)	(0.5072)	(0.7384)
RELEIG	-0.0758	-0.0897	-0.0477	-1.5872**	-1.4613**	-1.3774**
	(0.1065)	(0.0951)	(0.1060)	(0.6622)	(0.5938)	(0.6141)
AIC	400.95	373.52	369.31	268.44	269.22	271.03
BIC	439.06	414.01	412.19	302.47	305.38	309.31
Statistics robust to heteroskedasticity						
Pseudo R^2	15.72	22.45	23.86	28.27	28.64	28.70

Note: ***p<.01, **p<.05, ***p<.1, and standard error in parentheses

The model of pineapple exports from Indonesia to 7 destination countries, namely Japan, South Korea, Singapore, Saudi Arabia, Oman, Qatar, and UAE with time series from 2014 to 2022. As shown in Table 2, the model estimated using ppmlhdfe is more feasible in the presence of heteroscedasticity problems, resulting in robust and more efficient model estimates. The problem of detected serial correlation can be handled by robust variance covariance estimation (vce) or by clustering. The estimation results show that import tariffs (TARJ) have a significant negative effect on pineapple exports. Variables that represent the (PRODNAS) have a significant increasing effect on Indonesian pineapple exports. Most pineapple exporters are large (corporate) players, while small-scale farmers need to partner with large players to carry out good production practices according to export market standards.

As Table 2 shows that SPS measures influence the increase in Indonesian pineapple trade in destination markets. Although the number of provisions and enforcement of SPS is increasing, it still has an increasing effect on Indonesian pineapple exports. Pineapple export destinations, especially in the Middle East, have shown a tightening of SPS measures in the last 9 years. Furthermore, Indonesian pineapple export destination countries in East Asia still experience the imposition of a relatively high number of SPS measures, especially in South Korea. According to theory, NTMs can either stimulate or be a barrier to trade (Swinnen, 2017). Increased agri-food trade parallels SPS, which can have a dual impact (catalyst or barrier). SPS acts as a catalyst for most importers from developing countries, whereas there is no evidence for developed countries (Santeramo and Lamonaca, 2022). The effect of SPS as trade promotion on aggregate agricultural exports has been reported in other studies (Fiankor et al. 2020). Instead, SPS were shown to have a negative impact on exports in the case of Norwegian seafood (Medin, 2019). However, there is also a negative effect of SPS (Wood et al. 2017; Wood et al. 2019; Medin, 2019).

In addition, the imposition of TBT measures has had the effect of reducing Indonesia's pineapple exports. Other studies have also shown that TBT measures influence trade diversion (Fell and Duver, 2023). Other studies have concluded that differences in regulations and standards, preferences, food production capacity, and technology contribute to variations in the assessment of the effects of NTMs (Santeramo and Lamonaca, 2019). The Fulfillment of TBT measure requirements by Indonesian pineapple exporters is still a problem for increasing pineapple exports. It takes several years to prepare and meet food processing standards for labeling, quality, packaging, being free of hazardous materials, coloring, and required certification. Exporters must work hard to fulfill these TBT provisions if they want to gain market access.

Figure 2 shows the AVEs estimates of SPS and TBT in Indonesian banana export markets in destination countries (models 3). The AVEs of TBT in banana export destination countries from Indonesia amounted to -1.94 percent in the period 2014 to 2016, then increased in the 2017 to 2019 period by -13.10 percent, and in the last 3 years increased again to -11.45 percent. On average, the AVEs for TBT are considered relatively low at around -7.97 percent from 2014 to 2022, thus indicating that compliance with TBT has a trade-enhancing impact on the volume of Indonesian banana exports. At the same time, import tariffs have been reduced under the free area framework. The compliance requirements of the TBT provisions have most likely been met, and Indonesian banana exporters have been able to adjust to the export market.

As Figure 2, the AVEs for SPS measures faced by Indonesian banana exporters in the 2014 to 2016 period was 5.72 percent, increased to 61.84 percent in the 2017 to 2019 period, and in the last three years (2020 to 2022) slightly decreased to 33.94 percent. Indonesia's banana export volume has decreased in the last three years. This may be due to increasingly stringent SPS in export destination countries. Initially, from 2014 to 2016, the small AVEs for TBT can be interpreted as an equivalent stimulus. Negative AVEs for TBT are equivalent to the value of subsidies received by exporters.

The increasingly stringent TBT requirements (large number of items) and the policy drive to increase exports encouraged the government to provide various certification documents, licenses, training, and testing facilities, including market information, to facilitate banana exporters in opening market access. Indonesia's challenge in exporting bananas is the fulfillment of provisions and compliance that are still like an additional trade cost, mainly complying with substance restriction policies for food safety. On average, the AVEs for SPS measures were assessed to be relatively high at around 26.14 percent over the period 2014 to 2022, indicating a trade barrier effect on banana

exports. For example, in the case of cavendish banana export requirements for the Japanese market, exporters must prepare food safety and environmental documents (i.e. health certificates, phytosanitary certificates), as well as technical export documents such as certificates of origin, packing lists, export notices, bills of lading, and shipping instructions (Santi et al. 2023). Exporters must also adjust other provisions in export destination countries such as labeling, residue limits, and other specific regulations. The issue of conforming to quality and food safety standards is an important concern for the Indonesian banana industry if it wants to open up greater market access. Adapting to quality standards is easier for large exporters but requires additional time and cost for medium and small exporters. Greater market access is possible if all export agents are able to adapt their products to regulations in export markets and better ensure assurance for consumers in other countries.

As shown in Figure 3, the AVEs for TBT measures faced by Indonesian pineapple exporters (estimated from models 6) in the 2014 to 2016 period amounted to 5.70 percent, increased to 10.43 percent in the 2017 to 2019 period, and in the last three years (i.e., 2020 to 2022) increased again to years (i.e., 2020 to 2022) increased again to 15.51 percent. Indonesia's pineapple export volume has decreased in the last 3 years. A challenge in pineapple exports is compliance, which remains an additional cost of trade, especially regarding specifications and quality standards, as well as environmental protection that accompanies the export process. On average, the AVE for TBT measures is relatively high at around 10.57 percent, thus indicating that the provisions of TBT have a trade-impeding impact on the volume of Indonesian pineapple exports. The negative AVE for TBT measures implies that there is an equivalent subsidy in the Indonesian pineapple export process. Increasingly stringent TBT (high number of items) and policy encouragement to increase exports, encourage the government to provide various certification, licensing, training, and testing document facilities including market information to facilitate pineapple exporters in opening market access in export destination countries.

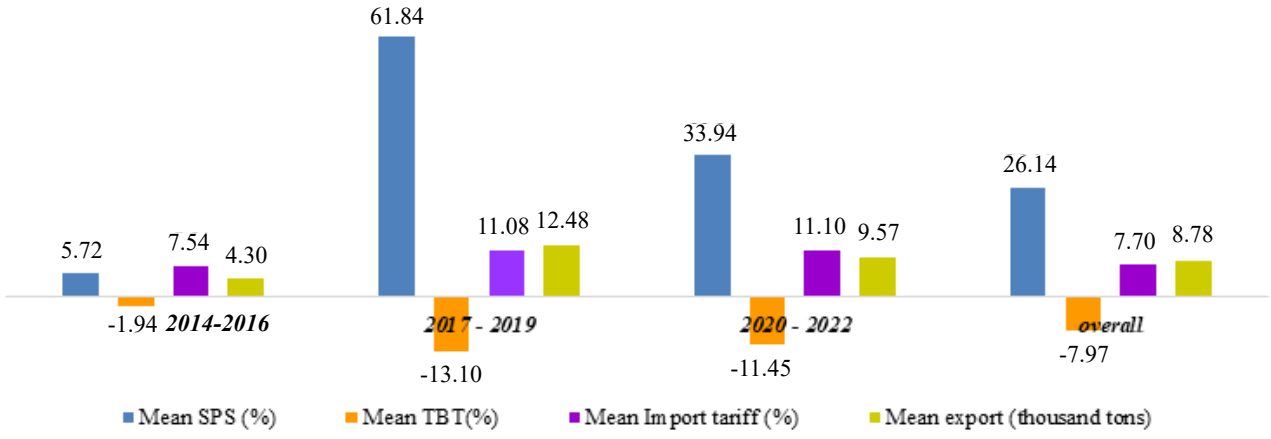

Figure 2. AVEs of NTMs, import tariffs, and Indonesian Banana export volumes (2014 to 2022 Period)

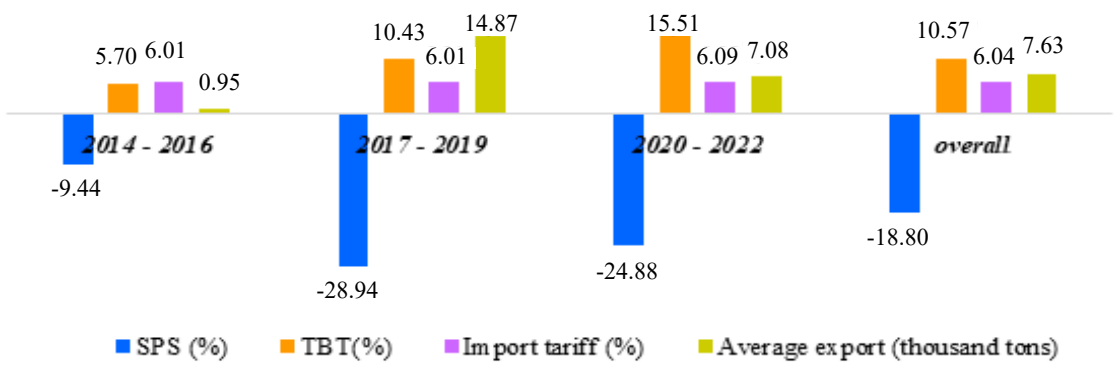

Figure 3. AVEs of NTMs, import tariffs, and Indonesian pineapple export volumes (2014 to 2022 Period)

The AVEs for SPS measures in pineapple exports from 2014 to 2016 was -944 percent, increased to -28.94 percent in the 2017-2019 period, and the last three years (i.e., 2020-2022) increased again to -24.88 percent. On average, it is still quite high, at around -18.80 percent for the period 2014 to 2022. Negative AVEs for SPS are equivalent to the value of subsidies received by exporters. The challenge in pineapple exports is the fulfillment of provisions and compliance, which are still an additional cost in trade, especially compliance with substance restrictions for food safety, certification, and quarantine in exports. Indonesian pineapple exporters may have been able to adjust to product standards in destination countries, but negative AVEs indicate subsidized export promotion assistance. Overall, this suggests that SPS measures have a trade-enhancing impact on the volume of Indonesian pineapple exports.

In comparison, other studies such as (Grant et al. 2015) state that SPS treatments reduce US exports of 9 types of fresh fruits and vegetables. The results of studies by (Shang and Tonsor, 2019; Rezitis et al. 2024) found that SPS measures have a significant and negative impact on trade in meat and pork commodities, as well as beef. Another study reported that SPS decreased the export value of Indonesian cocoa products, while TBT was not significant for cocoa trade (Darhyati et al. 2017). Quality factors and understanding non-tariff barriers in building Indonesia's agricultural export competitiveness (Novianti et al. 2024). The negative impact of SPS and TBT was also found on Indonesian tuna exports to destination countries (Rindawati and Kristriana, 2018). However, other researchers have reported trade-enhancing effects, such as the positive impact of SPS and TBT on Sri Lankan mango exports (Wickrama et al. 2024). Another finding is that restrictive SPS measures positively impact on Thai fruit exports to the Chinese market and facilitate trade (Wongmonta, 2025).

Furthermore, a study conducted by (Cadot and Gourdon, 2016) also found that food and agricultural products have higher AVEs. The AVE for the group of horticultural and vegetable products with 2-digit HS codes (i.e., 6-14) is 10.3% for SPS and 8.1% for TBT. Exporting countries are concerned that SPS and TBT are so stringent for food and agricultural products that they impose additional costs. These barriers are still considered to deter foreign competitors and protect domestic agriculture. The results of other studies also show that SPS act more as trade barriers than catalysts. (Grant et al. 2015). However, SPS are only a barrier to trade in the early years in export destination countries. The negative impact of SPS will diminish with experience in the global market and the barrier will disappear after two to three years. In addition, negative impacts of SPS on exports of agricultural products related to food safety, pest and disease protection have also been found in other studies (Zhang et al. 2021; Wood et al. 2019; Wood et al. 2017). However, there are different findings that SPS and TBT have a positive effect on Vietnamese agricultural exports to the EU (Hien et al. 2022).

A decrease in Indonesia's banana and pineapple exports in 2020 to 2022 compared to the previous period (i.e., 2017 to 2019) is very likely to occur due to the increasing number of NTMs regulatory items, especially SPS and TBT, in destination countries. From 2017 to 2019, SPS and TBT in destination countries increased compared to the previous period, with increasingly stringent implementation levels in subsequent years. Exporters, particularly bananas and pineapples, are faced with increasingly stringent entry barriers in the form of NTMs in destination countries. As a result, in the last 3 years, there has been a decline in the volume of Indonesian banana and pineapple exports to export markets. Indonesian banana and pineapple exporters need to adjust to and meet NTMs standards in destination markets. If the NTMs are to protect food safety and quality, then the fulfillment efforts will result in increased demand; however, if they are to protect the destination market, they create trade problems and must be renegotiated.

Managerial Implication

The market potential for bananas and pineapples (fresh and processed) in the Middle East is relatively large, but food safety and technical requirements are also relatively strict for imported food. A number of items in the SPS provisions in the Middle East are very similar between countries in the region, namely plant disease infection-free; process and conformity of food products; quality management; sanitary certificates; inspection requirements; microbiological composition information; transportation and refrigeration conditions; food and agricultural standards; hygiene; conformity certification; prohibition of the adding of any coloring matter; and solvents residue limits.

Furthermore, for TBT provisions in the Middle East, there are also many similarities between countries, namely testing requirements; inspection requirements; registration, inspection, testing, packaging, traceability and quality of food; technical requirements; complete authorization requirements in importing products; labeling regulations and controls; and quantity verification. Next, East Asian countries show a little more leniency, but they still conduct strict inspections of imported products. A number of items show many similarities, but there are fewer provisions than in the Middle East, both SPS and TBT provisions.

For Indonesia, increasing market access for horticulture (such as bananas and pineapples) requires meeting and adapting to the SPS and TBT requirements of export destination countries. The government and exporters can conduct regular trade lobbying and discuss it with the competent authorities in the destination country. The results of the lobbying can be implemented on how to reorganize at the producer level (farmers), processing units, packing, transportation, and storage / cooling, which are in accordance with food safety standards in the destination country. To increase Indonesia's horticultural exports (i.e. bananas and pineapples) is possible through additional participation of the actors, specifically farmers or farmer groups. The potential for small-scale banana and pineapple production in the form of individuals and farmer groups in Indonesia is still promising. The problem is how to transform them to be connected to the global supply chain as acceptable suppliers to the export market. Expanding export participation for small-scale actors is possible through partnerships with large-scale actors, to realize good production and post-harvest practices according to export market standards.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Indonesia is very concerned about encouraging an increase in horticultural exports, especially bananas and pineapples. Efforts to increase export market access are challenging. Many export destination countries have implemented food safety standards and technical trade standards adopted from international standards as well as additional standards according to the interests of each destination country. Some destination countries have reduced import tariffs within the framework of free trade but replaced them with NTMs. The Middle East have a relatively high number of NTMs, as well as in China and South Korea.

SPS measures have the effect of promoting trade in Indonesian bananas and pineapples to destination countries. Conversely, regulating the number of TBT measures has the effect of discouraging trade in Indonesian bananas and pineapples to export destination countries. Compliance with TBT requirements by Indonesian banana and pineapple exporters remains an issue to increase pineapple exports. It takes time to prepare and meet several items such as labeling standards, quality, packaging materials, product life, coloring, certification, and compliance with required international trade standards. Banana and pineapple exporters will have to work hard to fulfill these TBT provisions if they want to open market access.

Recommendations

Policy implementation to increase Indonesian banana and pineapple exports (both fresh and processed) can be done through a combination of two ways, namely: first, by adjusting to the application of NTMs measures including SPS and TBT provisions in destination countries, and second, by increasing the participation of farmers and/or their groups through partnerships.

Important points in the adjustment and implementation of practical standards accepted by destination markets include production processes, harvest and post-harvest processes, labeling and packaging, as well as storage and refrigeration. In addition, strong government support in terms of transportation, testing, certification, and quarantine also needs to be encouraged which is always adjusted to the provisions of the destination market for horticultural products. In addition, production actors in Indonesia are mostly small and medium-scale farmers. Increasing partnerships with large-scale actors to implement good production and post-harvest practices will encourage their participation in increasing banana and pineapple exports.

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