Factors affecting sustainability of increasing mango export: an application of MICMAC method

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Abstract. Mango is one of the world’s favourite tropical fruit. Currently, Indonesia is only able to export 0.1% of the total mango production. This condition is ironic because Indonesia is the fifth mango producing country in the world. This study aims to identify key variables that can affect the sustainability of increasing mango exports. The identification of variables that could influence the increase in mango exports was carried out through focus group discussions (FGD). Then the variables were analyzed with the Matrix of Cross Impact Multiplications Applied to a Classification (MICMAC). The result of MICMAC analysis shows that government support and capital are the influence variables, which are the main indicators that can trigger an increase in mango exports. Mango exporting farmer groups is a relay variable that indicates that this is sensitive and unstable in efforts to increase mango exports, this shows that interventions in these variables will impact the system as a whole. Thus, the strategic priority in increasing mango exports threefold is the empowerment of mango exporting farmer groups through government support in increasing access to exporters with partnership schemes, infrastructure development assistance such as irrigation networks and Good Handling Practices facilities. Besides, capital assistance for additional production inputs to produce export quality mangoes.

1. Introduction
Exports are one of the driving forces of national economic growth. To achieve this, one of the strategic programs of the Ministry of Agriculture is the Triple Export Action or Gerakan Tiga kali Lipat Ekspor (Gratieks). Through this strategic program, it is hoped that from 2020 to 2024, exports of agricultural products will gradually increase three times. One of the fruit commodities that Gratieks targets is mango. Mango (Mangifera indica L.) is the world’s favourite fruit whose world demand trend continues to increase, especially in the United States, Canada, European Union and even Asian markets, including China. It is estimated that the international fresh mango trade will be worth 1.799 billion USD in 2029 [1]. Mango considered to be one of most consumed fresh fruit in the world, with production taking place in more than 100 countries [2]. Mango is a tropical fruit tree that originated from Southeastern Asia but is currently being cultivated worldwide in regions with tropical and subtropical climates. The Mango cultivation area has significantly extended in the last decades [3]. In 2018 Indonesia was ranked 5th as the largest mango producer in the world, with production reaching 2.6 million tons, but the number of mangoes exported was less than
0.1% of its total production, which only reached 2,567 tons, with destination countries exports are Thailand, Timor Leste and the United Arab Emirates, Singapore, Malaysia, Oman, Kuwait, Saudi Arabia, Qatar, China, Kuwait, Oman, Pakistan and Hong Kong [1].

Indonesia is still facing the problem of the very limited number of export-quality mangoes. Another problem is that the quality of mangoes has not been able to meet foreign market standards (size, fruit skin colour, uniformity of ripeness), and there is no guarantee of continuous export supply [4]. There is still a lack of quality assurance and safety standards, especially free of fruitflies and pesticide residues. Supply problems that cannot be met because mango production does not meet export standards. The causes that the production does not meet export standards is mainly because mango plantations are not designed to produce export commodities. Most of the mango production in Indonesia is still cultivated conventionally with technology and simple maintenance management that has not been specifically planned to produce quality fruit, especially at the home garden scale. Most of farmers also have not implemented off-season mango cultivation technology to deal with the problem of shifting seasons that result in delays or crop failures. Other constraints are fruit quality that does not match consumer demand or importing countries, the amount of production is still relatively low, and there is no guarantee of production continuity [4,5]. Based on information from exporters, even though the demand for Arumanis mango is high, only a few Arumanis mangoes meet export quality because lack of mango can meet the criteria of fine appearance, 350-400 gr/fruit weight, and 90% maturity level.

In order to increase the export volume and competitiveness of Indonesian mangoes, it is necessary to identify the key variables in increasing mango exports and analyze the relationship between these variables. This study aims to analyze the key variables that affect Indonesia’s mango exports and formulate recommendations for strategies to increase mango exports in the international market.

2. Materials and methods

The identification of variables that can affect the increase in mango exports is carried out through focus group discussions (FGD) conducted with stakeholders related to mango exports. The FGD was conducted in March 2020, with FGD participants including officials from the Directorate General of Horticulture, Post-Harvest Center, Agricultural Quarantine Agency, Indonesian Center for Agriculture Socio Economic and Policy, researchers from the Indonesian of Tropical Fruit Research Institution, Cirebon District Agriculture Office, mango farmers and researchers from the Indonesian Center of Horticulture Research and Development. In addition to FGDs, this study also conducted interviews with representatives of stakeholders involved in the system under study to assess key variables. the assessment resulted in a cross-impact MDI (matrix of direct influence) matrix score. The score value is processed by MICMAC software to analyze the role of variables in increasing mango exports, namely by analyzing the strength of the influence of one variable on other variables.

MICMAC (Matrix of Crossed Impact Multiplications Applied to a Classification) analysis is one of the structural analysis methods. MICMAC has the advantage of building interactions between these key variables by grouping them into influencing variables and dependent variables), either directly through the matrix of direct influence or indirectly through the matrix of direct and indirect influence [7]. MICMAC analysis has been commonly used to search for sustainability variables or indicators. The purpose of Micmac compared to other structural methods is that it allows for grouping and determining the hierarchy of strategic variables of a system and knowing their mutual effects. This feature is very useful in the policy-making process because it will direct the focus of the policy, considering that policy focus often leads to irrelevant variables failing [6].

The operation of the Micmac method consists of several stages, namely (1) problem definition, identification of internal and external variables; (2) assessment of the relationship between variables
according to the level of influence and dependence, which was assessed with a rating scale: 0 = no effect, 1 = weak influence, 2 = moderate effect, 3 = strong influence, and P = potential. The results of the assessment will qualify the intensity of influence between variables into groups of direct influence, indirect influence and potential influence [5]. The results of the MICMAC will group the variables into four quadrants (Figure 1).

Based on [7] in quadrant I, namely the influence variables or what is called the determinant variables, it describes variables that are very influential with little dependence. This variable is a crucial element in the system because it can act as a key factor. In quadrant II, relay variables are variables that are influential but highly dependent. These variables are often categorized as factors that describe the instability of a system. Finally, the quadrant is a dependent variable or outcome variable. This variable is characterized by high dependence and is sensitive to changes in the influencing variable and relay variable. Furthermore, quadrant IV is excluded variables or autonomous variables, small influence and small dependence. It is said to exclude because it will not stop a system from working.

| Influence variables | Relay variables |
|---------------------|----------------|
| IV                  | Depending variables |
| Exclude variables   |                |

**Figure 1.** Variable equity in MICMAC [7].

3. Results and discussion

Based on the FGD’s result, 16 variables have been identified as key variables related to the increase in mango exports (Table 1). These variables represent several dimensions: the economic dimension, the institutional dimension, the technological dimension, the social dimension, and the environmental dimension.
Table 1. Key variables in increasing mango exports.

| Variables                                                                 | Short label | Dimension   |
|---------------------------------------------------------------------------|-------------|-------------|
| Certified commercial mango plantation/registered                           | Sertfarm    | Institutional|
| Number and capacity of exporters                                          | Excap       | Institutional|
| Export infrastructure (roads, postharvest handling)                       | Exinf       | Institutional|
| Government support for exports (regulation, export promotion, production inputs, market access, capital) | Gov         | Institutional|
| Export requirements                                                       | Req         | Institutional|
| Mango exporting farmer groups                                             | Group       | Institutional|
| Farmers’ access to exporters                                              | Access      | Institutional|
| Amount of export quality mango production                                 | Production  | Economy      |
| Export mango price                                                        | Price       | Economy      |
| Farmer’s capital                                                          | Capital     | Economy      |
| Mango tree rental                                                         | Rental      | Economy      |
| Implementation of GAP/suggested technology                                 | GAP         | Technology   |
| Export mango varieties                                                    | Var         | Technology   |
| Application of postharvest technology for export                          | Posttech    | Technology   |
| Mango farming scale                                                       | Scale       | Social       |
| Mango land conversion                                                     | Landconv    | Environment  |

![Figure 2. MICMAC analysis result.](image-url)
The results of the MICMAC analysis classified the 16 variables into four groups of variables, namely influence variables, relay variables, depending variables, and excluded variables (Figure 2). In quadrant I influence variables are variables that are very influential with little dependence. This variable is a crucial element in the system because it can act as a driving factor of the system. These variables are government and capital. In the strategy of increasing mango exports, the role of the central and local governments is very much needed, especially in terms of administrative facilitation assistance following the requirements of export destination countries, diplomatic assistance and export promotion. The government also needs to facilitate the preparation of site-specific Standard Operating Procedures for mango cultivation, implementation of GAP and GHP, and registering plantations. Besides that, it is also through the support of production infrastructure, especially irrigation and postharvest facilities, and assistance related to pest/disease control which is a priority for export standards [8,9], namely technology to overcome fruit flies. The role and intervention of the government is needed in an effort to create a better mango supply chain, because good supply chain management will provide opportunities to better respond to market dynamics both international and domestic [10].

Another determinant variable is farmer’s capital. The amount of capital ownership of farmers is a factor that can determine the production of export-quality mangoes because it affects the inputs provided by farmers in cultivation, especially irrigation and fertilization, which can affect fruit size, as well as the use of pesticides. One of the export market levels is through access to credit for small-scale mango farmers [10]. In the application of technology to produce off-season mangoes, large capital is needed because the cost of farming is doubled for maintenance, but many farmers feel the results because the price of fruit is high [11]. Financing facilities with affordable interest rates are needed to finance mango farmers in applying appropriate technology for cultivation in accordance with GAP, and to rejuvenate old mango trees that are no longer productive [8].

In quadrant II the variable is influential but has a high dependence. The relay variable is the most important variable and requires maximum attention from policy makers. From a systems perspective, the variables located in this quadrant are process elements that will greatly determine the output [6]. The variable located in this quadrant is the mango exporting farmer group. To increase mango exports, the role of exporting farmer groups is very important in producing export-quality mangoes because the quantity and quality of mangoes produced by farmers are strongly influenced by the behaviour of mango farmers in their farming activities [12]. Besides that, the role of exporting farmer groups is very important because their position is as a decision-maker in mango farming, so the sustainability of this mango exporting farmer group is very dependent on the incentives received from mango export activities. Farmers often do not pay attention to the quality of mangoes because there is no price incentive for improving fruit quality due to the treatment of cultivation innovations that have been carried out. This is because the marketing of mangoes for both local and export markets is carried out through traders with a slashing system, and even if it is done based on grading, it is the collectors who determine the standard so that the standard price applied is the collector’s price standard. Thus, to strengthen the position of farmers in the mango trade, it is necessary to form a farmer corporation that handles mango marketing.

Variables in quadrant III are dependent variables or outcome variables. These variables are characterized by high dependence and are sensitive to changes in influence variables and relay variables. This variable is a descriptive indicator of system evolution [6]. These variables are the application of GAP, certified gardens, application of postharvest technology and export mango production. The application of GAP and certified gardens are variables related to producing export quality mangoes. The lack of availability of export-quality mangoes is related to the majority of mango cultivation being garden plants or in narrow and scattered land, not using quality seeds, low technical skills and managerial capabilities of farmers, and low GAP mastery. Even if mangoes are cultivated in gardens, these mango gardens are not designed to produce mango commodities for export. Generally, they are not especially cared for, which causes the quality of the fruit to
vary. Thus the application of GAP and plantation registration is needed to produce export quality mangoes. This garden registration is useful for ensuring that mango fruit products produced by the garden are cultivated according to standards so that the product can be accepted in various markets, including the export market [11].

The application of mango harvest and post-harvest technology needs to be intensified, so that farmers are able to improve the quality of mangoes to meet export quality standards [8]. The application of harvest and postharvest technology is needed to overcome the spots on the skin of the fruit, the presence of insects and diseases that are still involved in the fruit, the level of maturity, and chemical contamination are also obstacles to efforts to increase mango exports. Mango categorized as the perishable product has a weakness, namely the relatively short shelf life of only 10-12 days after harvest and encourages companies to sell the product immediately, so that Good Handling Practices (GHP) are needed to maximize mango processing. The purpose of implementing GHP is to maintain quality, improve competitiveness, reduce crop loss/damage, extend product shelf-life, maintain product freshness, increase usability, increase added value, and handle products against fruit fly attacks with Hot Water Treatment (HWT). This effectively controls fruit fly eggs at a temperature of 46.10°C for 60 minutes [1].

The four dependent variables are dependent and sensitive to support from the government, capital and exporting farmer groups because the implementation of GAP and plantation registration requires support and assistance from the government. According to Akrong et al. [11], intensive training to empower smallholders enables them to understand and meet the export market requirements. The gap in farmers’ knowledge about the quality of mangoes for export and cultivation techniques to improve the quality of mangoes is the main obstacle to increasing Indonesia’s mango exports. Thus the formation of exporting farmer groups is expected to reduce the gap, as, according to farmer groups play a very important role in marketing to improve quality in the cultivation and handling of crops.

In quadrant IV there are variables of export mango prices, business scale, export terms, mango tree rental activity, number of exporters, land conversion, export infrastructure, and export mango varieties. small and small dependence on increasing mango exports [7]. Variables in this position have little influence on the dynamics of the system if special handling is carried out. Thus, although it is relatively difficult to change and can be ignored if policymakers have adequate resources, managing these variables will greatly support the success of increasing mango exports [6]. For example, on the price variable, where price stability is a factor related to the behaviour of farmers in various farming activities. Efforts are needed to ensure price stability received by farmers so that farmers are more motivated to increase productivity and yield quality [12]. The behavior of farmers who rent out their mango trees can spur agricultural intensification through the use of modern inputs, which is expected to increase mango production [14].

4. Conclusion

This study has identified key variables that can be prioritized in efforts to increase mango exports and can focus policies on variables contained in the determinant and relay quadrants that have a strong influence on other variables. These variables are government support and capital are the influence variables, which are the main indicators that can trigger an increase in mango exports. In addition, mango exporting farmer groups is a relay variable that indicates that this is sensitive and unstable to increase mango exports. This condition shows that interventions in these variables will have an impact on the system as a whole. Thus, the strategic priority in increasing mango exports threefold is the empowerment of mango exporting farmer groups through government support in increasing access to exporters with partnership schemes, infrastructure development assistance such as irrigation networks and Good Handling Practices facilities. Besides, capital assistance for additional production inputs to produce export quality mangoes.
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