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Sustainability of Garlic Development in East Lombok Regency, West Nusa Tenggara

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Abstract: This research is intended to evaluate the degree of sustainability of garlic development in East Lombok Regency as well as finding levers for its sustainability. the government is determined to achieve self-sufficiency in order to ensure the food security and independence of the garlic commodity The research was carried out using the Descriptive Survey Method, namely research carried out by collecting data and information about certain situations or conditions with the aim of describing and interpreting a phenomenon. Data collection used interview methods and online questionnaires for 45 farmer respondents spread across Sembalun District as the main garlic producer in West Nusa Tenggara. Sustainability evaluation analysis was carried out using farmers' subjective approaches to four dimensions, namely ecology, economics, social, and policy. The research results concluded that the majority of garlic farmers (78%) stated that garlic development had a low level of sustainability and only 22 percent stated that it was moderately sustainable. The three dimensions with a low sustainability category were the economic dimension (0.40), ecology (0.29), and policy (0.27). Meanwhile, the social dimension was in the medium category with a sustainability index (SI) of 0.55. However, overall, the sustainability index was in the low category (SI= 0.37).

Keywords: East Lombok; Garlic; Sustainable

Introduction

Sustainability has become a central issue in every world development activity since the launch of the global Millennium Development Goals (MDGs) agenda which was followed by the Sustainable Development Goals (SDGs). This means that the achievement of each country's development goals, both micro and macro scales, must be seen from a sustainability perspective (Obaideen et al., 2022; Clegg et al., 2024). Sustainable development is defined as development to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (Love, 2016). So, the essence of this concept is that social, economic and environmental goals must support each other and be related in the development process. If not, there will be a "trade off" between goals (Zhu et al., 2022; Mensah, 2019). As mentioned by Campbell et al. (2018) and Stringer et al. (2020), balancing trade-offs is crucial because related to consumption and production so we need transformative action for farmers and other actors. Sustainable agricultural development studies (sustainability impact assessments) integrate at least the three pillars of sustainable development in a balanced manner.

This study not only analyzes the social, environmental and economic dimensions but also discusses the interrelations between these pillars (Bockstaller et al., 2015; Purvis et al., 2019). In the last five years, the issue of sustainable agricultural development in Indonesia, especially garlic, has received serious attention from agricultural economic researchers (Hariyanto et al., 2022; Saptana et al., 2021). As the largest importer of garlic, where more than 580.000 tonnes or 95% of domestic consumption is met by imports, Indonesia is in a very risky situation (Purba et al., 2022). This is because the world garlic market structure tends to approach monopoly with China

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controlling around 86% of world garlic production and trade. As a result, if there is a production shock (supply shock) which causes China's garlic production to plummet, Indonesia will have difficulty meeting domestic garlic needs. Therefore, in accordance with the mandate of the food law, the government is determined to achieve self-sufficiency in order to ensure the food security and independence of the garlic commodity.

Policies to increase garlic production are regulated in the Minister of Agriculture Regulation (Permentan) concerning the Development of Strategic Horticultural Commodities. However, in contrast to the development of two other strategic horticultural commodities (chilies and shallots) which are carried out through an approach of increasing added value and product competitiveness, the development of garlic commodities is carried out through increasing planting area and production (Permentan 46/2019). The program to increase planting area and production, among others, was carried out in East Lombok Regency, as one of Indonesia's main garlic development centers. This development involves various parties, namely: the central government, the NTB provincial government, the East Lombok Regency government, business actors who import garlic, and farmers. Moreover, one of the programs that is being implemented as an effort to increase garlic production in Sembalun District is the UPLAND Program by the Ministry of Agriculture through assistance with production facilities and infrastructure, capital and institutions.

Figure 1 presents the development of harvest area, production and productivity of garlic in East Lombok Regency during the 2013-2020 period. Harvested area and garlic production continue to increase in line with the government's target to achieve self-sufficiency with the highest production in 2019 reaching 172 thousand tons as a result of an increase in harvested area which reached 1.45 hectares. However, after that production and harvested area decreased. This raises questions about the sustainability of garlic development considering that East Lombok Regency is one of Indonesia's main garlic production centers with the highest productivity (Waryanto et al., 2019).

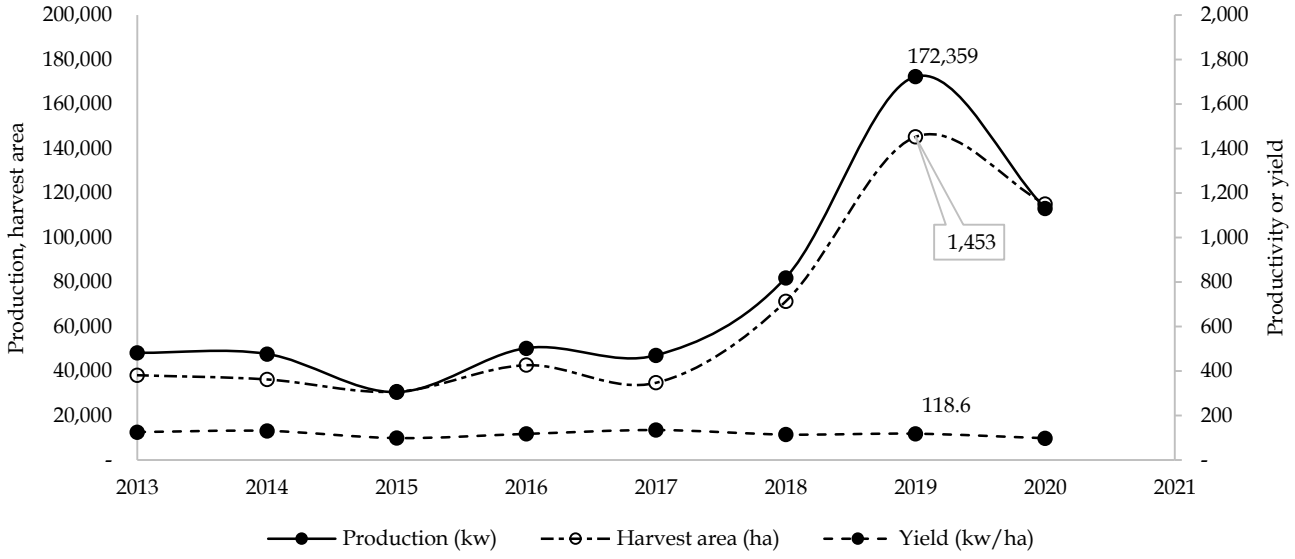

Figure 1. Development of production, harvested area and productivity of garlic in East Lombok Regency in 2013-2020

Method

The research was carried out using the Descriptive Survey Method, namely research carried out by collecting data and information about certain situations or conditions with the aim of describing and interpreting a phenomenon. So, this method is not just an activity of collecting data and tabulating it but also analyzing, interpreting, comparing and identifying relationships between variables. The data and information collection application of this method according to Zhang et al. (2017), can use questionnaires filled out online, offline, face to face or telephone which produces different data variants.

Data Types and Sources

The research uses two types of data, namely primary data and secondary data. Primary data was obtained through interviews with garlic farmer respondents who had partnered with importers or were independent garlic farmers. Apart from that, primary data was also obtained from other stakeholders such as the East Lombok Regency Agriculture and Plantation Service, companies (importers), and the Ministry of

Agriculture as policy maker. Secondary data was obtained from various documents published by the Village, District, Agriculture and Plantation Services and other related agencies, the Regional Disaster Management Agency, and the East Lombok Regency Central Statistics Agency (BPS) in the form of village profiles, monographs, agricultural census books, reports research results, and other documents regarding statutory regulations, main tasks and strategic management plans owned by each relevant agency.

Determining Locations and Respondents

The research was conducted in Sembalun District, which is the main center for garlic development in East Lombok Regency as well as one of the national garlic productions centers. Of the six villages in Sembalun District, 2 villages were determined as research locations using purposive sampling because farmers who partner with importers are generally located in Sembalun Village and Sembalun Lawang Village. Respondents in this research are farmers who have planted or are currently planting garlic in the 2022 planting season, either independently or in partnership with importers. The number of respondents was determined by quota at 45 people consisting of 30 partner farmers and 15 independent farmers. Determining partner farmer respondents uses data from farmers surveyed in the 2020 planting season so that changes in responses can be seen by comparing with previous data. Fifteen independent or independent farmer respondents were determined accidentally due to the unavailability of data that could be used as a sampling frame.

Analysis Techniques

The analysis was carried out by calculating the garlic business sustainability index based on four dimensions of sustainability, namely ecological, economic, social and policy. Each dimension consists of 5-7 variables, attributes or constituent factors. The use of this single index makes it very easy for researchers and readers to understand the sustainability of garlic development programs and agricultural activities as a whole. The index preparation stage is to transform ordinal data from using a Likert scale to interval data using the Method of Successive Interval (MSI) through the following stages (Ningsih & Dukalang, 2019): Calculating the frequency of observations for certain categories; Calculate the proportion for each category; From the proportions obtained, the cumulative proportion for each category is calculated; Calculate the Z value (normal distribution) of the cumulative proportion; Determine the Z limit value (probability density function value on the Z abscissa) for each category with the formula:

$$\delta(Z) = \frac{1}{\sqrt{2\pi}} e^{\left(\frac{z^2}{2}\right)}, -\infty < Z < +\infty \quad (1)$$

with π = 3.14 and e=2.71

Calculate the scale value (average interval) for each category

$$Scale = \frac{lower\ limit\ density - upper\ limit\ density}{area\ below\ the\ upper\ limit - area\ below\ the\ lower\ limit} \quad (2)$$

Calculate the score value (transformed value) for each category using the equation:

$$Score = scale\ value + |scale\ value_{min}| + 1 \quad (3)$$

After all ordinal data has been transformed into interval data, a sustainability index is prepared whose value is between 0 and 1. A value of 1 means sustainability is at a satisfactory level while a value of 0 means unsatisfactory. There are two equations for calculating the sustainability index in this study according to the direction of ordinal data. Equation 1 is used if a high score on ordinal data indicates more sustainability while equation 2 is used if vice versa.

$$Sustainability\ index(SI) = 1 - \frac{[Maximum\ value] - [X]}{[Maximum\ value - Minimum\ value]} \quad (4)$$

$$Sustainability\ index\ (SI) = 1 - \frac{[X] - [Maximum\ value]}{[Minimum\ value - Maximum\ value]} \quad (5)$$

The level of sustainability of the problems studied is then grouped based on three sustainability classifications as presented in table 1 below.

Table 1. Category of sustainability level of garlic development

Level of sustainability	Index range (SI)
Low	0.00 ≤ SI ≤ 0.41
Moderate	0.41 < SI ≤ 0.68
High	0.68 < SI ≤ 1.00

Result and Discussion

Sembalun District, East Lombok Regency is one of the main garlic production centers in Indonesia. People in this region have been growing garlic for a long time. Supported by appropriate agro-climate and sufficient farmer experience, Sembalun proves as a mainstay center for national garlic production. Figure 2 shows some photos of farming and trading of garlic in the reaserch area.

Figure 2. Garlic farming in Sembalun, East Lombok Regency

Status of Sustainability of Garlic Development

Evaluation of the sustainability of garlic development in order to achieve self-sufficiency is carried out in four dimensions, namely ecological, economic, social, and policy. Ecological dimension is sequentially arranged by a number of attributes, namely agro-climatic suitability, land slope, land height, erosion rate, and land productivity for the ecological dimension. The economic dimension consists of the attributes of product selling price, availability of seeds, access to capital, market access, and availability of labor. The social dimension consists of the attributes of the number of farming households, age of farmers, farmer organizations, access to policies, and access to government assistance. Lastly, the policy dimension which consists of policies related to seeds, fertilizer, pesticides, credit, irrigation, extension, as well as the basic price of government purchases.

Calculation of the sustainability index (SI) uses equations (1) and (2). The results are then grouped based on index value categories as presented in table 2. From this table, it can be seen that 78 percent of garlic farmers (35 people) stated that garlic development had a low level of sustainability (SI = 0.33) and only 22 percent (10 people) said that it was moderately sustainable (SI = 0.50). This result is related to student (Maryati et al., 2023) who stated that the Entrepreneural Behaviour Index of garlic farmers in Sembalun was relatively low, which mean has impact on the sustainability of garlic farming in Sembalun District. However, the sustainability index is in the low category with an average value of 0.37.

Table 2. Descriptive statistics on the level of sustainability of garlic development

						N
Sustainability Level *(SI)*	Min.	Max.	Mean	Std. dev.	Farmers	(%)
Low ($0.00 \leq SI \leq 0.41$)	0.25	0.41	0.33	0.04	35	78
Moderate ($0.41 < SI \leq 0.68$	0.42	0.61	0.50	0.06	10	22
Overall	0.25	0.61	0.37	0.09	45	100

Meanwhile, the sustainability status of garlic development for each dimension varies greatly. From the social dimension, the sustainability of garlic farming is in the medium category with a sustainability index of 0.55. The other three dimensions are in the low sustainability category, namely economics (0.40), ecology (0.29), and policy (0.27). Table 3 and figure 3 below present information about the level of sustainability of garlic development based on each dimension.

Table 3. Status of sustainability of garlic development in various dimensions

Dimensions of sustainability	Indeks (SI)	Sustainability category
Ecology	0.29	Low
Economy	0.40	Low
Social	0.55	Moderate
Policy	0.27	Low
Combined	0.37	Low

Ecological Dimension

From the ecological dimension, a number of sustainability levers that contribute dominantly are the suitability of the agroclimate for garlic cultivation activities and fairly high land productivity as shown in Figure 3. This research is in line with Falo et al. (2016), that agroclimate and the height of the land can be important variables in supporting the sustainability of garlic farming. Furthermore, Sopian et al. (2020) also mentioned that the location which in highland suit for garlic farming such as in Ciwidey, Bandung., is worthy of being endevored economically.

The research results of Mahmudah et al. (2021) shows that garlic productivity in Sembalun District reached 12.8 tonnes per hectare, higher than the national average productivity of 8 tonnes per hectare. Meanwhile, another factor that needs to be maximized is reducing the level of erosion (Ye et al., 2023), especially on sloping land, while the land height factor cannot be changed because the varieties planted require a minimum height of 800 meters above sea level. Soil erosion caused by agricultural activities seriously threatens sustainable agricultural development where soil erotion can reduce soil quality and the productivity of agricultural ecosystem, losing organic matter and nutrient of topsoil (Mufan et al., 2021). On the other

hand, the clearing in new land on sloping plains (terracing) continues to be carried out to increase land and garlic production without thinking about the waste produced (Puspitasari et al., 2024). This is important to consider to maintain the sustainability of garlic cultivation development as a result of the waste produced (Jacob-John et al., 2021).

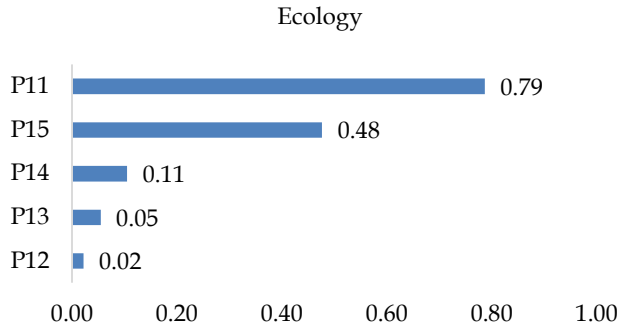

Figure 3. Attributes of sustainability of garlic development in the ecological dimension

Attribute
P11 Agro-climatic suitability
P12 Land slope
P13 Height of land
P14 Rate of erosion
P15 Land productivity

Economic Dimensions

In Sembalun District, most of population had a job related to agricultural sector, especially as garlic farmer. The status of sustainability of garlic farming may affect the farmer household income needs, which may further lead to unemployment (Sui et al., 2021). In the economic dimension, a number of factors that act as levers for sustainability are fairly broad market access, especially for the provision of seeds through government purchases. This is because the development of garlic requires a large number of seeds because the national need for seeds still depends on imports. Mardiana et al. (2021), mentioned that the government need to empower certified garlic seed producer so garlic local production can increase in East Lombok. Moreover, local garlic produced in Sembalun District has its charm with its strong taste and good health properties, one of the processed garlic products produced as medicine in Sembalun is Black Garlic. Black garlic is garlic that is fermented until it is black and has benefits in curing cholesterol (Juniantari et al., 2023).

Apart from that, the availability of sufficient labor and access to capital through the people's business credit scheme (KUR) also plays a role in the sustainability of garlic farming as seen in Figure 4. However, a number of important factors that hinder the sustainability of the development of garlic farming are the price of seedswhich relatively expensive about IDR 40.000- IDR 45.000 (Danasari et al., 2023) while the selling price of the product is relatively cheap. Furthermore, result showed by Wang et al. (2022), that market price affect emergy input and the overall sustainability for garlic farming in China. The average cost of producing garlic is around Rp. 6,000 per kilogram while the selling price is around Rp. 9,000 per kilogram with fluctuations between Rp. 4,000-16,000 per kilogram. This was also explained by Kiloes et al. (2024), the low selling price of garlic is one of the risks in garlic farming for garlic farmers in Indonesia even though the input prices for garlic production are not cheap, such as the process of seeds, fertilizers, and pesticides.

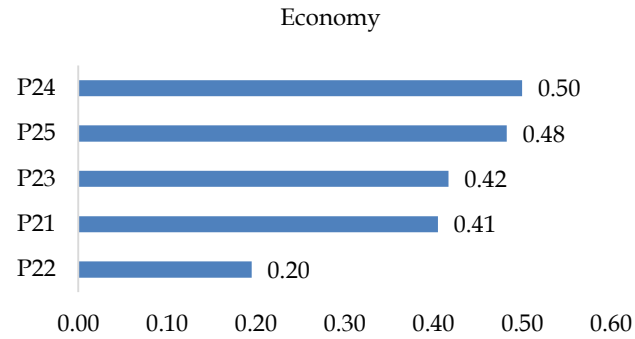

Figure 4. Attributes of sustainability of garlic development in the economic dimension

Attribute
P21 Product selling price
P22 Affordability of seeds
P23 Access to capital
P24 Market access
P25 Labor availability

Social Dimension

The social dimension has a relatively high level of sustainability with a medium sustainability category. A number of factors that act as leverage are the number of farmers who are members of the organization. Around 89 percent of farmers join farmer groups either as administrators or members, and only 11 percent did not join groups. This is related to the ease of getting access to government assistance such as seeds and other production facilities. According to Siswadi et al. (2019), farmers who join a farmers group will help them to adopt information and technology especially related to garlic cultivation, either through training or counselling (Liu et al., 2022).

Moreover, as mentioned by Kurniawan (2020) and Kaur et al. (2023) that garlic farmers need strong institutions, especially in adopting innovation strategies in the use of appropriate technology and post-harvest garlic. So that, the institution through facilitator can

assisting farmers in the technology adoptiom process and ensuring the information and knowledge (Yusuf et al., 2022). Apart from that, the large number of households who cultivate it and the relatively young age of the farmers also play a role in the sustainability of the garlic business. However, a number of these factors are not effective enough to influence garlic development policy as can be seen from the low role of access factors in policy in Figure 5.

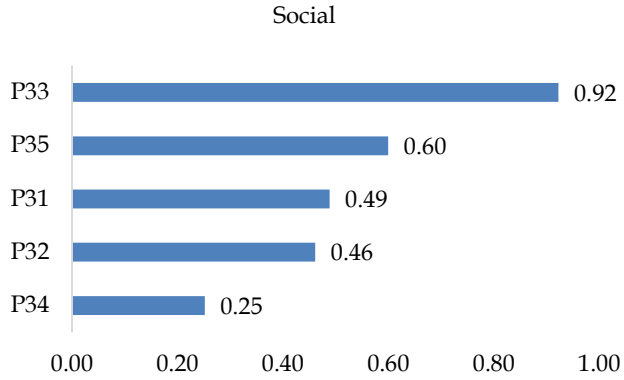

Figure 5. Attributes of sustainability of garlic development in the social dimension

Attribute
P31 Number of garlic farming households
P32 Farmer's age
P33 Farmer organizations
P34 Access to policies
P35 Access to government assistance

The low level of sustainability in acess to policies (P34) shows the lack of role and function of an institution whereas to achieve sustainability a comprehensive model is needed, especially in overcoming conflicts arising from resource competition. In research (Obersteiner et al., 2016), explain that sustainable consumption and production policies are the most effective policies in minimizing trade-offs. Institutions play a role in mediating problems that occur in production centers with the government, especially in achieving sustainability of local garlic production and consumption (Pardian & Noor, 2019).

Policy Dimensions

Overall, the sustainability of garlic development in the policy dimension has the lowest index value (0.27). A number of policy factors hinder the development of garlic, especially the absence of price incentives for garlic products produced by farmers, such as the government's basic price or basic purchase price (HPP). Without a price support policy, it is difficult for the garlic produced by farmers to compete with imported garlic (Septiana et al., 2022). Furthermore, government policies related to production facilities such as fertilizer, seeds and pesticides are not in favor of garlic farmers. Meanwhile, policies related to irrigation, credit interest (KUR) and extension, although relatively good, are not sufficient as levers of sustainability in this dimension. The sustainability index for the last three factors is in the moderate category as shown in Figure 6.

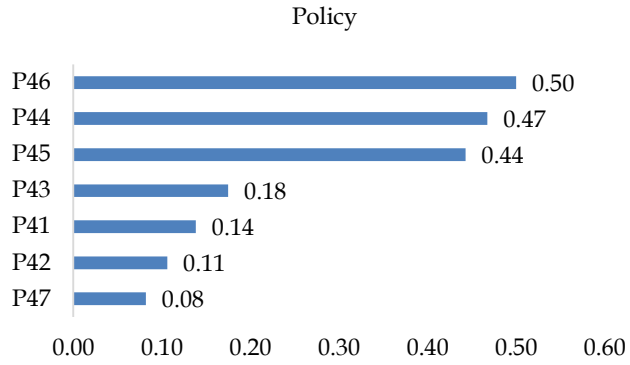

Figure 6. Attributes of sustainability of garlic development in the policy dimension

Attribute
P41 Policies related to seeds/seedlings
P42 Policies related to fertilizer
P43 Policies related to pesticides
P44 Policies related to loan interest/KUR
P45 Policies related to irrigation
P46 Policies related to extension
P47 Policies related to Prices/COG

Based on research by Ayuningtyas et al. (2019), the status of garlic development in Temanggung District also showed a less sustainable, it because local garlic is difficult to access market due to the price of local garlic is more expensive than garlic import. In an effort to develop national garlic farming, the role of policy in supporting garlic farming in Indonesia is needed. Not only import policies but policies that concern matters of production input prices that are more directed at the welfare of farmers. As mentioned by Tanumihardjo et al. (2020) to improve food and nutrition security must address sustainable agricultural productivity and the incomes of smallholder farmers, especially garlic farmers in this case. Therefore, that price stabilization policy (P47) is needed so the selling price of garlic in under the purchasing power of the sommunity but profitable for farmers to keep planting. As well as price policy, subsidy dependency (especially for fertilizer and pesticide) is important to reach the sustainability of garlic development, the government can help to reduce the the production cost so farmer have interested in garlic farming (Yovirizka & Haryanto, 2020).

Conclusion

Based on the analysis of research results, it can be concluded that 78 percent of garlic farmers assess garlic development as having a low level of sustainability and only 22 percent say it is moderately sustainable. From the social dimension, the sustainability of garlic farming is in the medium category with a sustainability index of 0.55, while the other three dimensions are in the low sustainability category, namely economics (0.40), ecology (0.29), and policy (0.27). In the social dimension, a number of factors that act as levers are the large number of farmers who are members of farmer group organizations. This is related to the ease of getting access to government assistance such as seeds and other production facilities. The Ministry of Agriculture as a technical agency responsible for increasing production and welfare of garlic farmers often clashes with the duties and responsibilities of the Ministry of Trade to stabilize prices. When garlic production is insufficient, The Ministry of Trade is encouraged to open the tap for garlic imports to protect consumers from high price increases. The problem is that the realization of imports often occurs when the garlic harvest is entering, which causes local garlic prices to plummet because they are unable to compete with imported garlic. As a result, farmers have difficulty selling their crops at a reasonable price. Therefore, the role of the Coordinating Ministry for the Economy is very important in coordinating the Import Approval (PI) policy carried out by the Ministry of Trade so that it is in sync with the policy of providing Horticultural Product Import Recommendations (RIPH) issued by the Ministry of Agriculture. This weak policy coordination tends to victimize farmers.

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Author Contributions
Conceptualization: A. Z; methodology: A. Z, A; validation: A; formal analysis: A. Z; investigation: A; resources: A. Z: data curation: A; writing—original; A. Z; draft preparation: A. Z; writing—review and editing: A. Z, I.F. D; visualization: A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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