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FOOD AND AGRICULTURAL SECTOR IN INDONESIA'S ECONOMIC GROWTH DURING COVID-19 PANDEMIC: AN ARDL APPROACH

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FOOD AND AGRICULTURAL SECTOR IN INDONESIAN ECONOMIC GROWTH DURING COVID-19 PANDEMIC: AN ARDL BOUND TESTING APPROACH TO COINTEGRATION

***Purpose*:** Global-scale financial crises, whether originating from the financial sector itself or other fields such as the zoonotic disaster, in the form of the spread of a virus that has resulted in mortality and significant economic contraction, are occurring more frequently and are expected to continue to occur in the future. This study aims to look at the impact of the crisis, in this case, the COVID-19 pandemic, on the role of the food and agricultural sector in Indonesia's economic growth.

***Methodology/*Approach:** Utilizing the ARDL bound test to cointegration approach, we want to find out the effect of COVID-19 on: (i) the relationship between agriculture and economic growth, (ii) the relationship between food and beverage manufacture and economic growth, and (iii) the causality relationship between agriculture, food and beverage manufacture and economic growth.

***Results*:** The results of the study revealed that the COVID-19 pandemic had not affected the role of the food and agricultural sector in Indonesia's economic growth. In the long run, the three variables (agricultural output, output of food and beverage manufacture, and economic growth) have a dynamic relationship (two-way causality). However, only agriculture and economic growth have a bi-direction causality in the short run. In contrast, food and beverage manufacturing has one-way causality to economic growth and agriculture.

***Originality/Scientific Novelty*:** This research is the first (at least for Indonesia) to analyze the impact of COVID-19 on the food and agriculture sector using an econometric operations approach with time series statistical data, which includes data during the pandemic. Thus the parameter test results have a more useful predictive ability.

***Practical Value/Implication*:** The study results have augmented the empirical evidence on the importance of the food and agriculture sector as a pillar of the economy in facing crises. We have seen this phenomenon in the 1998 and 2008 financial crises. Therefore, strengthening the agro-industrial system is a logical choice as a mitigation measure. Therefore, strengthening the agro-industrial system is a logical choice as a mitigation measure.

***Key Words*:** food and agricultural sector; agriculture, food and economic growth; financial crisis; COVID-19 pandemic and agriculture; Indonesian economic.

Introduction and Review of Literature. Globalization, which has made countries interdependent, has contributed to global economic prosperity through trade liberalization and capital transfer ([1]; [2]; [3]). However, on the other hand, globalization also risks vulnerability to economic shocks. Close economic linkages have resulted in an immediate contagion effect, where a financial/economic crisis/shock in one country has harmful transmission in various countries without distinguishing between developing and advanced economies ([4]; [5]). As a result of its negative impacts, some critics question globalization [6]. Financial crises have occurred more frequently and at shorter intervals [7]. Between 1901-1990 (in 90

years), 11 financial crises occurred, but in the last 30 years (1991-2019), the world has experienced 18 financial crises, 11 of which occurred in the 21st century (2001-2019). As [8] points out, the next financial crisis is imminent – we do not know where it is coming from.

The financial crisis no longer originates solely from the financial sector itself but also from external factors in the form of a zoonotic disaster in the form of the spread of a virus which results in mortality and significant economic contraction ([9]; [10]). The world has witnessed the development of Flu since the Spanish Flu in 1918, followed by the Asian Flu (1957), Hong Kong Flu (1986), Bird Flu (H5N1 and H7N7) since 1997, SARS (2002), Mexican Flu (H1N1) in 2009 and then Corona (COVID-19) in 2020 and 2021. Biological disasters, in this case, the spread of viruses in the form of various types of Flu, show a high frequency and the emergence of new types of viruses quickly. On that basis [11, p. 15] warns that "the flu pandemic is at our doorstep."

The COVID-19 pandemic is a disaster in almost all fields, including ([12]; [13]; [14]; [15]): health, environment, social and global economy. Likewise, the pandemic has unevenly impacted industries and businesses, affecting the workforce and individual economies. Close-contact industry and service are the most affected areas, e.g. [6]. To stop the spread of the virus through personal contact, almost all governments in the world have implemented quarantine measures which include [16]: school closure, workplace closure, cancellation of public events, restriction of public gatherings, restriction on internal movements, and international travel control. The lockdown measures and mobility restrictions have created economic stress, which has resulted in a pandemic-induced recession and considerable job losses and, subsequently, income shortfalls [14].

Various sectors have implemented work-from-home recommendations to limit the spread of the Covid-19 virus. However, working from home cannot be applied to the food and agriculture sector because, in various stages of its operations, this sector requires the presence of workers on site regularly. Thus the pandemic will shock the supply and demand side of the market through disruption in at least one of the five phases of the food supply chain [12], including agricultural production, postharvest handling, processing, distribution/retail/services, and consumption. In the production phase, farmers in developed countries experience a situation that contrasts with farmers in developing countries, especially in Asia. In European countries, Canada, and the United States, farmers are generally unable to carry out their activities due to the lack of seasonal workers for the cultivation of non-food crops such as fruits and vegetables that rely on hired labor for planting and harvesting ([13]). In Asian countries such as India, dominated by small farms, the impact of the pandemic on agricultural production has been minimal as available labor from family members has become plentiful. Lockdowns have forced migrant workers, as well as small-scale shopkeepers, to close their businesses and return home in the form of reverse migration [18]. This phenomenon is more popularly known as de-urbanization in Pacific Island Countries [19]. Furthermore, most small farmers run their farms like usual, i.e., continue to grow the same crops with no change in input use [20].

Disruptions in the distribution phases are felt in all countries for two reasons, domestically due to travel restrictions, and internationally, various countries have closed their borders to prevent the spread of the virus. In a looser form, the mandatory two-week quarantine for people from abroad. This has reduced exports, especially perishable agricultural products such as fruit and vegetables. Disruptions in the procurement of agricultural products as raw materials in the food processing industry have hampered the production of food ingredients that disrupt the global food system [21]. So that [14] believes that distribution disruption–especially agri-food products - can potentially be as damaging as the pandemic itself.

Various studies have concluded that COVID-19 negatively affects agriculture across all four pillars of food security - availability, access, utilization, and stability/reliability [22]. The reason is that the pandemic has threatened people's food security worldwide and could double the acute hunger caused by war-induced conflict and climate change [18]. Thus the COVID-19 pandemic has fully exposed the vulnerability of the global agri-food system to shocks and stresses [13]; in other words, the COVID-19 pandemic has put the global food supply system under the most vigorous test [18].

Indonesia is no exception from the impact of COVID-19. Its proximity with China and the close interconnectedness of government, business, and personal fellow ASEAN has resulted in very high mobility of capital, goods, and persons across countries in ASEAN. Even if the discovery of virus transmission is relatively slow, and the spread concentration is in Java and some big cities outside Java, this is more due to Indonesia's geographical condition, an archipelago. The Indonesian government has also implemented various restrictions to stem the transmission of the virus internally and externally from abroad. This step will cause a shock to the economy, including the food and agriculture sector.

The food and agriculture sector is one of the key sectors within the economy of Indonesia. This sector contributed around 20% to GDP in 2019 (prior to the COVID-19 pandemic), where the agricultural sector has decreased while the food and beverage manufacturing sector has increased to offset the decline agricultural sector. Nevertheless, agriculture's overall contribution to GDP is more significant because agricultural sectors rely on agricultural inputs to contribute added value to the economy. Apart from food and beverage manufacturing, sectors related to agriculture include food services and eating and drinking places. USA's experience, agricultural food, and related industry contributed about ten times the output of America's farms to GDP [23]. Apart from that, for most Indonesian households, farming, and plantations remain vital income generators. In 2022 the agricultural sector provided jobs to approximately 40.6 million Indonesians, representing 30% of the country's total labor force. Thus, agriculture is still the sector that contributes the most to employment, followed by the wholesale and retail, industry, and eating and drinking sectors, 19%, 14%, and 7%, respectively.

Given the strategic position of the food and agriculture sector in Indonesia, it is essential to understand the impact of the COVID-19 pandemic on this sector. The research results are a provision to address the possibility of external turmoil both

caused by the financial crisis and due to zoonotic disasters that have increasingly shaken the world economy recently and are likely to occur again.

So far, various studies on the impact of COVID-19 on agriculture are mostly in the form of literature reviews both at the global level such as [12], [22] and [17] and more specific cases at the country level such as [24] for the United States, [25] for Turkey, and [26] for India. Research employing econometric analysis is still very limited to cross-section data from primary data collection, so it cannot provide long-term predictions such as [13] which compares the impact and response of adaptation in the US, Norway and China; [21] which examines agricultural resilience in California with special attention to agricultural marketing aspects; [18] in India; and [27] in Nigeria. This study is the first (at least for Indonesia) to use time-series data, which includes 11 observations quarterly during the COVID-19 pandemic, the first quarter of 2020 to the third quarter of 2022 (Q1 2020 to Q3 2022) using a dummy variable can include more than 30 observations. Hence, it is feasible to carry out econometric operations properly.

The purpose of the article. This study aims to assess the impact of COVID-19 on the role of the food and agriculture sector on economic growth in Indonesia with a specific formulation: to find out the causality relationship between the output of the agricultural sector, the output of food and beverage manufacture and the economic growth of Indonesia during the COVID-19 pandemic.

Method. To analyze the role of the food and agriculture sector in economic growth, we decompose the food and agriculture sector into agricultural output (Agri), and food and beverage manufacturing output (FnB); Gross Domestic Product (GDP) represents economic growth. Studies to uncover the causal relationship between GDP and its constituent variables (pseudo-supply-side analysis: agricultural and economic growth) have been conducted by [28] for North Cyprus and [29] for Tunisia. Observations during the COVID-19 pandemic use dummy variables with a value of 1, i.e., the first quarter of 2020 to the third quarter of 2022, while data before 2020 is zero. Quarterly data on GDP, agricultural output (Agri), and food and beverage manufacturing output (FnB) are available in "*Statistik Ekonomi Keuangan Indonesia*"(Indonesian Economic and Financial Statistics) published monthly by Bank Indonesia (Central Bank of Indonesia). All data are in billions of Rupiah (IDR) at constant prices (2010=100) and transformed into logarithm form. The analysis covers eight years (2015 - 2022) with 31 quarters.

The cointegration and error correction model is superior to the traditional regression method to determine the effect of one variable on another. The reasons include [30]: (i) cointegration techniques test the long run theoretical relationship between variables and Granger causality between variables, while traditional regression techniques only make assumptions about the theoretical relationship between variables, (ii) financial variables are mostly non-stationary. Thus, ordinary regression operations on such variables will yield spurious results, given that statistical tests such as t-ratio and F-statistics are statistically not valid when applied to non-stationary variables. Performing regression operations in the differential form of these variables would solve one problem, but regressing the variables in their differential form would effectively eliminate the long-term trend. Thus, differential

regression variables only capture short-term, cyclical, or seasonal effects. Regression in differential form does not test for long run or theoretical relationships, (iii) the data empirically prove causality in cointegration, whereas in traditional regression, causality is only a presumption.

This study employs the autoregressive distributed lag (ARDL) bound test to cointegration. The ARDL approach is an OLS-based dynamic econometric model. This model is considered superior for small samples and does not require stationary variables to be of the same order as long as they are in I(0) and I(1) ([31]; [32]). The ARDL model can generate a dynamic error correction (ECM) model that integrates short-run dynamics and long-run equilibrium through a simple transformation. This advantage has made the ARDL bound test to cointegration increasingly popular and widely used recently, including [33], [34], [35], and [36]. According to [32], the ARDL bound test approach gives efficient and reliable results once a single equation cointegration relationship exists between variables. The Granger procedure also tests the direction of causality in vector error correction (VECM) models. If a set of variables is cointegrated, they are guaranteed to have an error correction term (ECT). The advantage of VECM is the reintroduction of information lost due to different time series. This step is crucial for investigating short-run dynamics and long-run equilibrium.

In equation (1), lag p represents the long-run equation, where p is the period required for the independent variable (Xt) to affect the dependent variable (Yt). Thus the effect of changes in the independent variable on the dependent variable will appear in the period $p + 1$ [37].

$$\begin{aligned} Yt &= \alpha + \beta 0\, X_t + \beta 1\, X_{t-1} + \beta 2\, X_{t-2} + \ldots + \beta p\, X_{t-p} + \pi_t \\ &= \alpha + \sum_{j=0}^{p} \beta 1\, X_{t-i} + \pi_t \end{aligned} \quad (1)$$

The first step in operating the ARDL bound test to cointegration is to examine a long-run relationship between all the variables in the estimated equation [32]. Equation (2) presents the long run relationship between economic growth and the food and agriculture sector:

$$GDP_t = \beta + \emptyset 1\, Agri_t + \emptyset 2\, FnB_t + DUM + \varepsilon_t \quad (2)$$

The ARDL bound test to cointegration model, which is an unrestricted ECM (error correction model) for equation (2), is formulated in equation (3).

$$\begin{aligned} \Delta\, GDPt = {} & \beta_{01} + \gamma_{11}\, Agri_{t-1} + \gamma_{21}\, FnB_{t-1} + \sum_{i=1}^{p} \emptyset 1i\, \Delta Agri_{t-i} + \sum_{i=1}^{q} \emptyset 2i\, \Delta FnB_{t-i} \\ & + \sum_{i=1}^{r} \emptyset 3i\, \Delta GDP_{t-i} + DUM + \varepsilon_{1i} \end{aligned} \quad (3)$$

p, q and r are the optimal lags of the ARDL models. The bound testing procedure tests the joint F-statistic of the null hypothesis of no cointegration:

Ho: $\gamma 11 = \gamma 21 = 0$, against the alternative Ha: $\gamma 11 \neq \gamma 21 \neq 0$

If the F-statistic is greater than the upper critical bound (UCB), there is cointegration, according to [32]. Suppose the F-statistic value lies between a lower critical value (lower critical bound = LCB) and a higher critical value (UCB). In that case, the decisions about long-term relationships are inconclusive, and a value smaller than LCB means that there is no long-term relationship (see, e.g., [38]; [39]). In case there is evidence of a long-run relationship (cointegration) between the variables, equations (4) and (5) display the steps to estimate the long-run and the short-run models.

$$GDPt = \beta 1 + \sum_{h=1}^{p1} \gamma_{1h}\, GDP_{t\text{-}h} + \sum_{i=1}^{q1} \gamma_{1i}\, Agri_{t\text{-}i} + \sum_{j=1}^{r1} \gamma_{1j}\, FnBt\text{-}j + DUM + \varepsilon_{1t} \quad (4)$$

$$\Delta\, GDPt = \beta 2 + \sum_{h=1}^{p2} \gamma_{2h}\, \Delta\, GDP_{t\text{-}h} + \sum_{i=0}^{q2} \gamma_{2i}\, \Delta\, Agri_{t\text{-}i} + \sum_{j=0}^{r2} \gamma_{2j}\, \Delta\, FnB_{t\text{-}j} + DUM + \psi\, ECTt\text{-}1 + \varepsilon_{2t} \quad (5)$$

where ψ is the coefficient of error correction term (ECT), representing the variable's adjustment speed to long-run equilibrium after a shock.

Results and Discussion. This section first describes the spread of COVID-19 in Indonesia, followed by the condition of the food and agriculture sectors during the pandemic. Next is the presentation of the linkage analysis between the agricultural sector, the food and beverage manufacture, and economic growth using the ARDL approach. The ARDL approach performs the following steps: unit root test, cointegration test, and causality analysis.

COVID-19 Spread in Indonesia. Various efforts have been made to prevent the entry of COVID-19, especially at cross-country entry points such as ports and airports, but Indonesia could not isolate itself from the COVID-19 pandemic. The first case was confirmed on 2 March 2020, and the first case of death occurred on 11 March 2020, coinciding with WHO declaring COVID-19 a global pandemic. In just one month, all 34 provinces in Indonesia reported the spread of this virus. Up to Q3 2022, Indonesia went through three different major infection waves which are closely related to virus mutations with different variants, namely: Q1 2021 (the Alpha Wave) reached the peak in the fourth week of January, Q3 2021 (the Delta Wave) second week of July, and Q1 2022 (the Omicron Wave) second week of March [40].

The Indonesian government declared COVID-19 as a non-natural disaster on 14 April 2020 through Presidential Decree No. 12. On that day, the total number of cases reached 4,839, with 400 deaths and daily deaths at 60. In addition to mitigation measures through mobility restrictions and health campaigns such as wearing masks, washing hands with soap and keeping a distance/avoiding crowds, the government also launched a program called national economic recovery with components of basic food assistance, wage subsidies, pre-employment cards, etc., including subsidized online shopping fees, which aim to drive the economy and maintain food security for the less fortunate, incredibly informal sector workers who have practically stopped their activities. In 2020 there will be 56.64% of the workforce working in the informal sector.

As a result of the pandemic, between 2020 and 2022, labor statistics show that the formal sector contracted by 6%. The informal sector experienced an increase of

15.6%, indicating that the various economic recovery programs launched by the government have played a more significant role in boosting economic activity in the informal sector, including opening up opportunities for those laid off in the formal sector to start businesses in the informal sector.

Vaccination, a permanent solution to the COVID-19 pandemic, had only begun to be implemented in Indonesia on 13 January 2021, with the target that each resident will receive four vaccine doses. When the vaccination started, the number of infected cases had reached more than 850,000, with a death toll of 25,000 people. Until the end of 2022, 87.5% of the population have received one vaccine dose, and 73.5% have been fully vaccinated (two doses). Overall, 160 thousand people died, and 6.65 million were infected [41].

Indonesia's Food and Agriculture Sector During the COVID-19 Pandemic. Overall, Indonesia's economy went into recession in Q2 2020 when there was little understanding of COVID-19, so information on mitigation measures needs greater consistency. For example, the health ministry stated that healthy people do not need to wear medical masks. Only sick people and health workers should wear masks. In the face of this misunderstanding, various local governments took measures, some even implementing lockdowns by closing inter-regional roads and main urban roads up to curfew. This step paralyzed economic activity, while on the other hand, the government's economic recovery policies are still formulating, especially related to the target group and its distribution mechanism. Year-on-year, in Q2 2020, Indonesia's GDP contracted by 5.32%. GDP continues to recover, but until Q3 2022, GDP growth is below the pre-pandemic trend, as shown in figure 1.

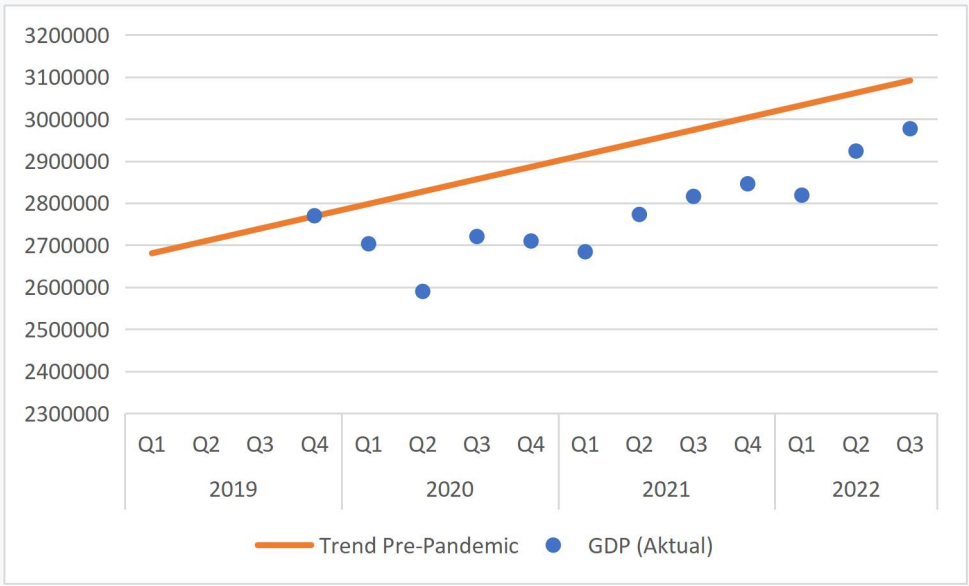

Figure 1. Indonesian Economic Growth During COVID-19 Pandemic Compared to Its Pre-Pandemic Trend

Source: Author's own estimation.

The agricultural output shows a seasonal oscillatory pattern. In the second quarter of each year, production peaks, then decline and reach the lowest point in the fourth quarter to increase the following quarter again. This pattern applies pre-

pandemic and does not change during the pandemic. This seasonality applies to the five main agricultural sub-sectors: food, horticulture, plantation, livestock, and fisheries. Table 1 presents the growth of agricultural output per subsector per year (y-o-y) and a quarter on quarter (q-o-q).

Table 1

Agricultural Output Growth per Subsector, Indonesia 2019 – 2022 (in %).

Year	Quarter	Food		Horticulture		Plantation		Livestock		Fisheries	
		y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q
2019	Q1	-6.02	73.49	6.18	7.06	3.36	-0.03	7.87	8.84	5.66	1.88
	Q2	5.05	10.70	6.06	23.79	4.50	28.14	7.70	4.22	5.59	-0.26
	Q3	-4.73	-11.27	12.38	6.96	4.96	10.41	7.69	0.49	5.68	1.90
	Q4	-1.08	-41.95	4.92	-25.99	5.23	-25.60	7.86	-5.38	5.50	1.88
2020	Q1	-10.25	57.40	2.61	4.70	3.97	-1.22	2.68	3.62	3.52	-0.03
	Q2	9.24	34.74	0.94	21.78	0.18	23.46	-1.90	-0.43	-0.63	-4.26
	Q3	7.24	-12.89	-1.23	4.66	0.68	10.97	-0.24	2.19	-1.03	1.50
	Q4	26.06	-31.76	7.85	-19.18	1.14	-25.26	-1.88	-6.93	1.06	4.03
2021	Q1	12.24	40.14	3.27	0.26	2.17	-0.22	2.12	7.84	-1.31	-2.37
	Q2	-7.97	10.48	1.85	20.10	0.32	21.23	6.74	4.08	9.69	6.41
	Q3	-5.66	-10.71	-5.22	-2.60	8.33	19.83	-2.47	-6.63	4.55	-3.25
	Q4	-13.96	-37.77	3.80	-11.50	2.28	-29.44	-5.24	-9.58	8.99	8.44
2022	Q1	-0.08	62.74	3.31	-0.20	-0.24	-2.68	6.92	21.69	-0.51	-10.89
	Q2	1.11	11.81	1.23	17.67	0.68	22.35	3.56	0.81	2.73	9.87
	Q3	-7.97	-18.73	5.56	1.57	2.74	22.28	7.40	-3.17	6.38	0.19

Source: Author calculation.

Table 1 indicates that Indonesian agricultural production has not been affected by the COVID-19 pandemic as experienced by Asian agriculture in general ([18]; [20]). Overall, GDP growth in the agricultural sector follows the pre-pandemic trend. Every second and third quarter is above the trend, and the fourth and first quarters are below the pre-pandemic trend, as shown in Fig. 2.

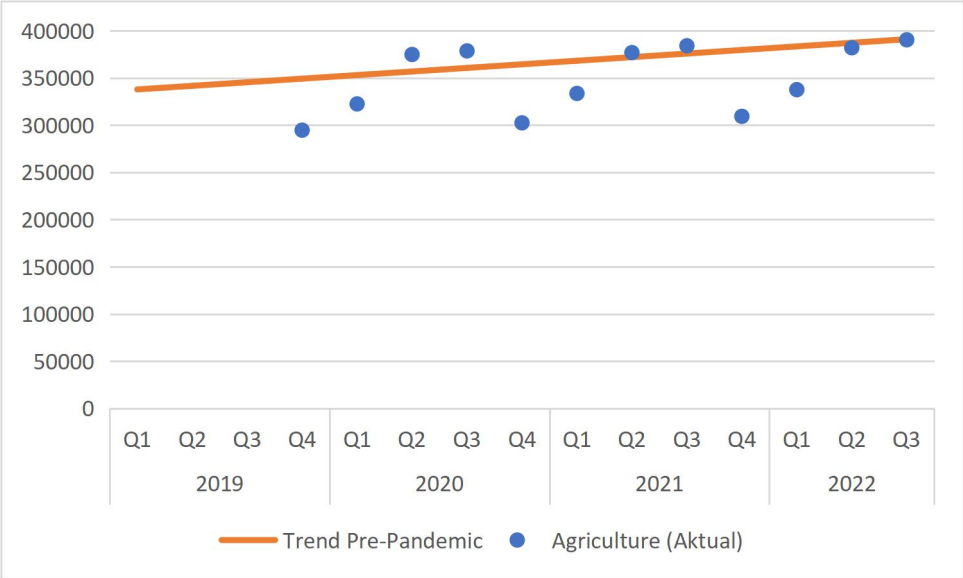

Figure 2. Indonesian Agricultural Output Growth During Pandemic COVID-19 Compared to Its Pre-Pandemic Trend

Source: Author calculation.

As reported by various studies e.g. [6], restrictive measures to contain the COVID-19 spread have disrupted economic activity in the service and manufacturing sectors which are close-contact-related. Food and beverage manufacture at a certain level also belongs in this category. Likewise, during a pandemic, this sector has always recorded positive growth (year-on-year), which has continued since Q1 2014. Meanwhile, quarter-on-quarter growth tends to follow the seasonal pattern of the agricultural sector as a supplier of raw materials, which posted negative growth in the 4th quarter of each year. Food and agriculture exports experienced positive growth (year-on-year) during the pandemic after experiencing pressure throughout 2018-2019 due to the USA-China trade war. Likewise, quarter-on-quarter growth contracted in six of the 11 quarters observed. Thus, trade barriers such as closing borders and quarantining for two weeks at ports also impact Indonesia's exports even though they mainly non-perishable goods such as CPO (crude palm oil) and crumb rubber. Quarter 3 2022 Indonesian food and agricultural exports posted growth of 34.81% (quarter-on-quarter) and 12.36% (year-on-year). Indonesia's GDP growth, along with its selected components, including agricultural output, food and beverage manufacturing, and food and agricultural exports, is presented in table 2.

Table 2

Indonesia's GDP Growth and Selected Sectors, 2018-2022 (in %)

Year	Quarter	GDP		Agriculture		Food and Beverage		Food and Agric. Export	
		y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q
2018	Q1	5.06	-0.41	3.34	16.41	12.77	-0.77	-9.54	-10.39
	Q2	5.27	4.21	4.74	10.02	8.39	4.46	-4.59	-8.28
	Q3	5.17	3.09	3.67	3.21	8.10	3.45	-0.35	14.03
	Q4	5.18	-1.69	3.92	-21.39	2.74	-4.20	-10.01	-4.00
2019	Q1	5.07	-0.52	1.86	14.10	6.77	3.13	-13.65	-14.01

	Q2	5.05	4.20	5.33	13.77	7.99	5.65	-13.22	-7.81
	Q3	5.01	3.05	3.06	0.99	8.33	3.78	-13.49	13.68
	Q4	4.96	-1.74	4.24	-20.48	7.95	-4.54	3.70	15.08
2020	Q1	2.97	-2.41	-0.02	9.43	3.94	-0.70	9.96	-8.82
	Q2	-5.32	-4.19	2.15	16.24	0.22	1.87	7.85	-9.59
	Q3	-3.48	5.05	2.17	1.01	0.66	4.23	11.40	17.42
	Q4	-2.17	-0.40	2.63	-20.13	1.66	-3.59	26.30	30.47
2021	Q1	-0.70	-0.94	3.45	10.31	2.45	0.07	38.42	-0.07
	Q2	7.07	3.31	0.53	12.95	2.95	2.37	59.19	3.98
	Q3	3.51	1.55	1.43	1.92	3.49	4.78	74.86	28.98
	Q4	5.02	1.06	2.28	-19.46	1.23	-5.69	27.53	-4.85
2022	Q1	5.01	-0.95	1.19	9.14	3.75	2.56	15.53	-9.47
	Q2	5.44	3.72	1.37	13.15	3.68	2.30	7.50	-3.24
	Q3	5.72	1.82	1.65	2.20	3.57	4.67	12.36	34.81

Source: Author Calculation.

The Nexus of Agricultura, Food and Beverage Manufacture and Economic Growth. The ARDL bound test will be employed to estimate the effect of agricultural output, the output of food and beverage manufacture on economic growth, and their causal relationship. Applying the ARDL bound test to the cointegration approach, it is necessary first to perform the unit root test. This test ascertains that no variables are stationary in order two, I (2), or more. So far, there has yet to be a consensus on the most superior unit root test tool. Therefore this study uses three different test tools, namely ADF (augmented Dicky-Fuller), ERS (Elliot-Rothenberg-Stock), and PP (Phillips-Perron), respectively, with and without trend. The ADF is the most prevalent unit root test tool, while the ERS unit root test is more favorable for small sample sizes, and the PP unit root test is more robust in the error term process ([43]; [44]). Table 3 displays the test results. All variables are stationary at I(0) or I(1), so the next step in the ARDL bound test can be performed.

Table 3

Unit Root Test Result

Variable	ADF		ERS		PP	
	C	C, T	C	C, T	C	C, T
LGDP	-0.9729	-3.1037	-0.1810	-2.8811	-1.5009	-3.0738
LAgri	-2.9544*	0.2921	-0.3969	1.8497	-4.3143***	-8.0966***
LFnB	-2.3351	-1.2824	-0.2768	-0.2337	-2.3121	-3.1994
Δ LGDP	-7.4852***	-7.3663***	-4.8218***	-7.0551**	-7.4959***	-7.5695***
Δ LAgri	-0.7670	-69.8297***	2.0478	-2.7940	10.6932***	-10.4437***
Δ LFnB	-1.6672	-2.6433	-0.2592	-1.9916	-8.1541***	-8.9162***

Source: Author's calculation.

Note: *, ** and *** significant level $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively C = constant and T = trend.

The ARDL bound test, as formulated in equation (4), produces the results that there is cointegration in all three equations (table 4).

Table 4

Results of ARDL Cointegration test

Estimated models	Optimal lag length	F-bound test	Decision
GDP | Agri, FnB, DUM	(1,0,1,0)	13.7166	Cointegration
Agri | GDP, FnB, DUM	(1,1,1,0)	18.8684	Cointegration
FnB | GDP, Agri, DUM	(1,0,0,0)	18.4200	Cointegration
	Significant (finite sample, n = 30)		
		Lower bound, I(0)	Upper bound, I(1)
	10%	2.676	3.586
	5%	3.272	4.306
	1%	4.614	5.966

Source: Author estimation.

Table 4 shows that the F-bound test's value lies above the upper critical bound I (1) and is significant at a 99% confidence level for all three equations. Table 5 presents the results of ARDL regression and error correction regression (ECM) as in equations (4) and (5). In the long run, agricultural and food and beverage manufacturing output positively and significantly impact economic growth. However, in the short run, only agriculture has a causal relationship with economic growth. The system will return to long-run equilibrium in the event of a short-run shock, with an adjustment speed of 48.60% per quarter.

Table 5

Results of Coefficient Estimation of Long- and Short-run Economic Growth Equation

ARDL Regression Dependent variable: GDP, ARDL (1,0,1,0)			ECM Regression Dependent variable: Δ GDP		
Independent variable	Coefficient	t-statistic	Independent variable	Coefficient	t-statistic
GDP_{t-1}	0.5140	3.6549***	Δ Agri	0.1022	5.8433***
Agri	0.1022	2.2085**	ECT	-0.4860	-8.9450***
$Agri_{t-1}$	0.0634	2.0717**			
FnB	0.2320	2.0549**			
DUM	-0.0124	-1.6012			
R2 = 0.9731 F-stat = 173.9342 *** Residual diagnostic: there is no heteroskedasticity, serial correlation, autocorrelation, or partial correlation.					

Source: Author calculation.

Note: ***, **, and * are significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

The stability test of the economic growth model, as presented in table 5, is stable according to CUSUM and CUSUMSQ stability tests. Figure 3 presents the test result.

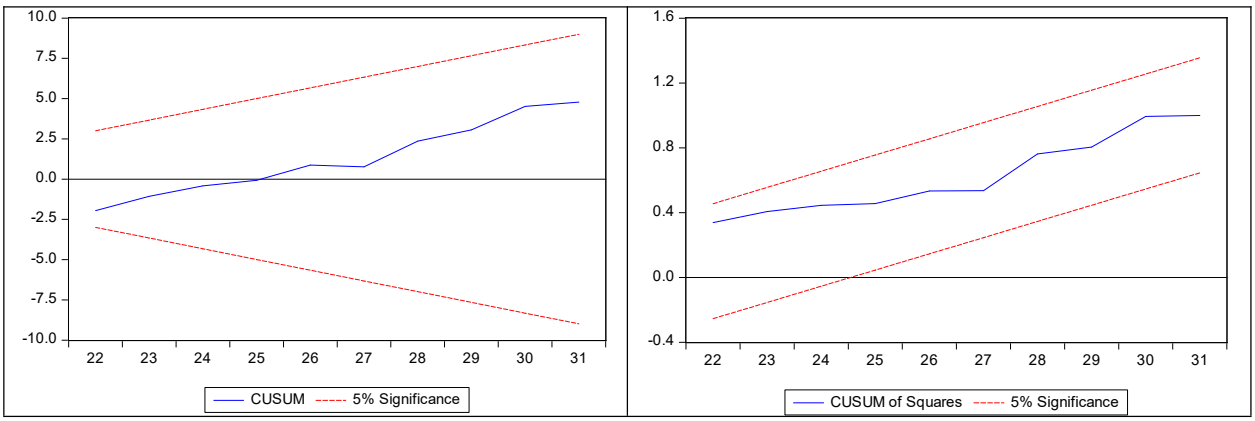

Figure 3. Stability test of Economic Growth Model

Source: Author calculation.

Note: CUSUM is the cumulative sum of recursive and CUSUMSQ is the cumulative sum of squares of recursive residuals.

The presence of cointegration in a model indicates that at least one independent variable has a causal relationship with the dependent variable. The analysis continued by operating the ARDL-Granger test. Table 6 exhibits the results. The three variables have a long-run causality relationship, and the causality between them is a bi-directional (dynamic relationship). In all three equations, there is no significant impact of COVID-19, as the coefficient of DUM (dummy variable represented the situation during the COVID-19 pandemic) is not significant. However, in the short run, only agriculture has a causal relationship to economic growth (GDP). Meanwhile, economic growth and food and beverage manufacture have a causality relationship to agriculture in the short- and long-run. In contrast, the causal relationship between agriculture and economic growth to food and beverage manufacture only appears in the long run.

Table 6

ARDL-Granger Causality Analysis

Dependent variable	ARDL optimal lag	Short run causality (t-stat of Wald-test)				ECT
		Δ GDP	Δ Agri	Δ FnB	DUM	
Δ GDP	(1,0,1,0)	-	0.1022**	0.2320	-0.0124	-0.4860***
Δ Agri	(1,1,1,0)	1.5431**	-	1.5321***	0.0323	-1.1971***
Δ FnB	(1,0,0,0)	0.5631	0.2037.	-	0.0063	-0.4976***

Source: Author calculation

Note: ***, **, and * are significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

Notably, the ECT of the agricultural equation is above one, which reflects the seasonal pattern of production in Indonesia's agricultural sector to produce an adjustment pattern to an oscillatory shock. According to [45 p. 339], The error correction term with a coefficient of -1 to -2 means that it does not converge monotonically to the equilibrium path directly, but rather the error correction process fluctuates around the long-run value in a dampening manner. Once this process is complete, convergence to the equilibrium path is quick. Figure 5 displays the short-run causal relationship between variables according to the information in Table 6.

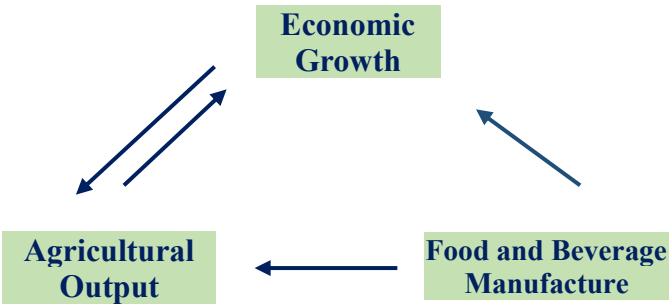

Figure 5. ARDL-Granger Causality of Agricultural Output, Output of Food and Beverage Manufacture and Economic Growth

Analysis suggests that the COVID-19 pandemic did not disrupt the role of the food and agriculture sector in Indonesia's economic growth. Agriculture and economic growth have bi-directional causality in the short and long run. Meanwhile, in the short-run, the food and beverage industry has one-direction causality to agriculture and economic growth. In contrast, in the long run, the three variables have a dynamic relationship (bi-directional causality). Thus, the food and beverage industry exhibits different behavior from other manufacturing sectors. According to [16], it must take a double hit in the form of disruptions to the supply of raw materials and capital goods, and logistics shortages.

Furthermore, [16] also pointed out that in Asia, the pandemic hit less agriculture in China, Indonesia, and Lao PDR. In comparison, the Asian financial crisis in 1997/1998 took about 20 quarters for the Indonesian economy to return to pre-crisis levels, while the COVID-19 crisis took only six quarters to reach pre-pandemic levels. Thus, facing the COVID-19 pandemic, the Indonesian economy not only did not fall too profoundly (Indonesia's Q2 2020 GDP contracted by 4.4%, far below the economies of Thailand, Singapore, Malaysia, and the Philippines, which contracted by 9.2, 9.6, 9.9, and 14.3% respectively), but also recovered quickly.

Several factors have supported the Indonesian economy not to fall too deeply in the face of the crisis, which is categorized by many as the worst crisis of all time after the great depression of the 1920s (e.g. [46]). One of the contributing factors is the character of Indonesia's agricultural sector, which has been the driving force of the economy in times of crisis, as it was in previous financial crises, namely in 1998 and 2008. One of its functions is to become a rescue anchor in a crisis. During times of crisis, most laborers, especially low-skill laborers, will shift to the agricultural sector [47]. The economic recovery is also inseparable from rapid progress in the health sector, including global cooperation in developing vaccines, cheaper tracing techniques with rapid results so that the treatment of infected people can be faster, either by self-isolation or isolation in hospitals, and the application of better therapies [6]. This, coupled with the results of intensive campaigns such as using masks in public places, social distancing, and hand washing, has successfully controlled COVID-19 in two years.

In addition to positive developments for the benefit of public health, the Government of Indonesia has also implemented various policies that balance health and the economy. These include choosing large-scale social restrictions over lockdown and sorting out different levels of social restrictions depending on the development of COVID-19 across Indonesia [16]. The budget disbursed for COVID-19 management also reflects a balance between public health and the economy, covering (i) health, (ii) social protection by providing living assistance to poor and near-poor families, and (iii) protecting businesses from mass bankruptcy, especially MSMEs (Micro, Small and Medium Enterprises). These three aspects were handled simultaneously at the national level and by local governments whose funds came from the central government. All these measures cost IDR 1,645.45 trillion from 2020 to 2022 [48], which has increased government debt by 52% between 2019 and July 2022 from IDR 4,779.26 trillion to IDR 7,733.99 trillion ([42]; [49]). However, the steps taken by the government are in line with the domestic demand-led-growth nature of the Indonesian economy ([50]; [51]), so the most effective policy for this is to stimulate domestic consumption growth as the driving force of the economy rather than pumping exports, especially in conditions of disruption of global supply chains due to obstacles to the mobility of goods and people.

The strategy for developing agriculture-based industries to meet domestic needs and fill foreign demand (exports) has shown more resilient results (at least experienced a faster recovery) even though, in normal times, it has not shown spectacular growth. Thus, building a solid agro-industry system for sustainable contribution to the economy as one engine of growth [52] is one of the mitigation steps to face a crisis that will surely come.

Conclusion. The COVID-19 pandemic has not disrupted the role of the food and agriculture sector in Indonesia's economic growth, which in the long run shows a dynamic causality (bi-direction causality) between the agricultural sector and economic growth, between the food and beverage manufacture and economic growth and between the agricultural sector and the food and beverage manufacture. In the short run, there is a bi-directional causality between the agricultural sector and economic growth and one direction causality from the food and beverage manufacture to the agricultural sector and economic growth. Indonesia's agricultural sector, heavily influenced by seasonality, shows an oscillating pre-pandemic output pattern. This pattern has also not been disrupted by the COVID-19 pandemic so that the quarterly down and up cycles are still visible during the pandemic as they were before the pandemic. Indonesia's economy has recovered faster than other ASEAN countries due to the rapid progress in the global health sector and the effectiveness of the Indonesian government's policies in maintaining a balance between health and economy in handling COVID-19, also helped by the role of the agricultural sector which is the driving force in times of crisis as happened in the 1998 and 2008 crises. During these two crises, the agricultural sector absorbed labor, especially unskilled labor who lost their livelihoods due to the crisis.

Due to the vital role of the agricultural sector as a provider of employment and a source of livelihood for tens of millions of Indonesians and being a temporary shelter

during times of crisis, strengthening the agro-industry system will be a mitigation step in facing future crises.

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II. SUBMISSION ACKNOWLEDGEMENT
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ср, 22 лют. 2023 р. о 13:54 Dr. Jongkers Tampubolon <jtampubolon@yahoo.com> пише:

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>
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Thank you for your kind cooperation.

With warm regards,

==========
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Yours sincerely,
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III. RESULTS OF PRELIMINARY REVIEW (REVISION REQUIRED)

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Based on the results of preliminary review, your article needs improvement:

1. The entire article is on a gray background that needs to be removed.
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3. In fig. 1,2 it is necessary to sign scales with units of measurement.
4. Check the sequence of references to sources in the text, references to sources 17 and 42 are not placed sequentially.
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Yours sincerely,
Prof. Kucher

Best regards,
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IV. SUBMISSION OF REVISED MANUSCRIPT (RESPONSE TO PRELIMINARY REVIEW)

March 28, 2023

(No Subject)

From: Dr. Jongkers Tampubolon (jtampubolon@yahoo.com)

To: editor.are.journal@gmail.com

Date: Tuesday, March 28, 2023 at 10:19 AM GMT+7

Dear Prof. Kucher.

Editor-in-Chief

of Agricultural and Resource Economics E-Journal

Thank you for the preliminary review of our manuscript entitled, "Food and Agricultural Sector in Indonesian Economic Growth during Covid-19 Pandemic: An ARDL Bound Testing Approach to Cointegration".

In the attachment, we submit improvements to the manuscript in accordance with your suggestions.

We thank you for your cooperation.

With warmest regards

==========

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REVISED MANUSCRIPT (1ST ROUND)
March 28, 2023

JEL: Q13; C32; 047

Jongkers Tampubolon

University of HKBP Nommensen
Indonesia

FOOD AND AGRICULTURAL SECTOR IN INDONESIAN ECONOMIC GROWTH DURING COVID-19 PANDEMIC: AN ARDL BOUND TESTING APPROACH TO COINTEGRATION

Purpose: Global-scale financial crises, whether originating from the financial sector itself or from other fields such as zoonotic disasters, in the form of the spread of viruses that result in death and significant economic contraction, are increasingly frequent and are expected to continue to occur in the future. This study aims to assess the impact of the crisis, in this case, the COVID-19 pandemic, on the role of the food and agriculture sector in Indonesia's economic growth.
Methodology/Approach: Utilizing the ARDL bound test to cointegration approach, we want to find out the effect of COVID-19 on (i) the relationship between agriculture and economic growth, (ii) the relationship between food and beverage manufacture and economic growth, and (iii) the causal relationship between agriculture, food and beverage manufacture and economic growth.
Results: The results of the study revealed that the COVID-19 pandemic had not affected the role of the food and agricultural sector in Indonesia's economic growth. In the long run, the three variables (agricultural output, output of food and beverage manufacture, and economic growth) have a dynamic relationship (two-way causality). However, only agriculture and economic growth have a bi-direction causality in the short run. In contrast, food and beverage manufacturing has uni-direction causality to economic growth and agriculture.
Originality/Scientific Novelty: This research is the first (at least for Indonesia) to analyze the impact of COVID-19 on the food and agriculture sector using an econometric operations approach with time series statistical data, which includes data during the pandemic. Thus, the parameter test results have a more useful predictive ability.
Practical Value/Implication: The study results have augmented the empirical evidence on the importance of the food and agriculture sector as a pillar of the economy in facing crises. In the future, it is necessary to further study agricultural resilience by subsector. In addition, it is advisable to further study the impact of the government's safety net program in the form of basic food assistance and subsidizing delivery costs for online shopping to encourage growth from the demand side that keeps farmers producing and serving demand through contactless marketing.
Key Words: food and agricultural sector; agriculture, food, and economic growth; financial crisis; COVID-19 pandemic and agriculture; Indonesian economy.

Introduction and Review of Literature. Globalization, which has made countries interdependent, has contributed to global economic prosperity through trade liberalization and capital transfer ([1]; [2]; [3]). However, on the other hand, globalization also risks vulnerability to economic shocks. Close economic linkages have resulted in an immediate contagion effect, where a financial/economic

crisis/shock in one country has harmful transmission in various countries without distinguishing between developing and advanced economies ([4]; [5]). As a result of its negative impacts, some critics question globalization [6]. Financial crises have occurred more frequently and at shorter intervals [7]. Between 1901-1990 (in 90 years), 11 financial crises took place, but in the last 30 years (1991-2019), the world has experienced 18 financial crises, 11 of which occurred in the 21st century (2001-2019). As [8] points out, the next financial crisis is imminent – we do not know where it is coming from.

Financial crises no longer only originate from the financial sector itself, but also from external factors such as zoonotic disasters in the form of the spread of viruses that result in death and significant economic contraction ([9]; [10]). The world has witnessed the development of Flu since the Spanish Flu in 1918, followed by the Asian Flu (1957), Hong Kong Flu (1986), Avian Flu (H5N1 and H7N7) since 1997, SARS (2002), Mexican Flu (H1N1) in 2009 and then Corona (COVID-19) in 2020 and 2021. Biological disasters, in this case, the spread of viruses in the form of various types of Flu, show a high frequency and the emergence of new types of viruses quickly. On that basis [11 p. 15] warns that "the flu pandemic is at our doorstep." Thus, a zoonotic disaster such as the COVID-19 outbreak is not accurately called a black swan event [12] and therefore it is necessary to prepare measures to deal with its reoccurrence in the future ([13]; [14]).

The COVID-19 pandemic is a disaster in almost all fields, including ([15]; [16]; [17]; [18]): health, environment, social, and global economy. Likewise, the pandemic has unevenly impacted industries and businesses, affecting the workforce and individual economies ([12]; [19]). Close-contact industry and service are the most affected areas, e.g. [6]. To restrain, the spread of the virus through personal contact, almost all governments in the world have implemented quarantine measures which include e.g. [20]: school closure, workplace closure, cancellation of public events, restriction of public gatherings, restriction on internal movements, and international travel control. The lockdown measures and mobility restrictions have created economic stress, which has resulted in a pandemic-induced recession and considerable job losses and, subsequently, income shortfalls ([21]; [19]; [17]).

Various sectors have implemented work-from-home recommendations to limit the spread of the Covid-19 virus. However, working from home cannot be applied to the food and agriculture sector because, in various stages of its operations, this sector requires the presence of workers on site regularly. Thus, the pandemic will shock the supply and demand side of the market through disruption in at least one of the five phases of the food supply chain [15], including agricultural production, postharvest handling, processing, distribution/retail/services, and consumption. In the production phase, farmers in developed countries experience a situation that contrasts with farmers in developing countries, especially in Asia. In European countries, Canada, and the United States, farmers are generally unable to carry out their activities due to the lack of seasonal workers for the cultivation of non-food crops such as fruits and vegetables that rely on hired labor for planting and harvesting [16]. In Asian

countries such as India, dominated by small farms, the impact of the pandemic on agricultural production has been minimal as available labor from family members has become plentiful. Lockdowns have forced migrant workers, as well as small-scale shopkeepers, to close their businesses and return home in the form of reverse migration [22]. This phenomenon is more popularly known as de-urbanization in Pacific Island Countries [23]. Furthermore, most small farmers run their farms like usual, i.e., continue to grow the same crops with no change in input use [24].

Disruptions in the distribution phases are felt in all countries for two reasons, domestically due to travel restrictions, and internationally, various countries have closed their borders to prevent the spread of the virus (in a looser form, the mandatory two-week quarantine for people from abroad). This has reduced exports, especially perishable agricultural products such as fruit and vegetables. Disruptions in the procurement of agricultural products as raw materials in the food processing industry have hampered the production of food ingredients that disrupt the global food system [25]. So that [17] believes that distribution disruption–especially agri-food products - can potentially be as damaging as the pandemic itself.

Various studies have concluded that COVID-19 negatively affects agriculture across all four pillars of food security - availability, access, utilization, and stability/reliability ([26]; [19]; [27]]. The reason is that the pandemic has threatened people's food security worldwide and could double the acute hunger caused by war-induced conflict and climate change [22]. Thus, the COVID-19 pandemic has fully exposed the vulnerability of the global agri-food system to shocks and stresses [16] which before the arrival of the covid-19 pandemic was already facing serious threats in the context of global food and nutritional security [19]; in other words, the COVID-19 pandemic has put the global food supply system under the most vigorous test [22].

Indonesia is no exception from the impact of COVID-19. Its proximity with China and the close interconnectedness of government, business, and personal fellow ASEAN has resulted in very high mobility of capital, goods, and persons across countries in ASEAN. Even if the discovery of virus transmission is relatively slow, and the spread concentration is in Java and some big cities outside Java, this is more due to Indonesia's geographical condition as an archipelago. The Indonesian government has also implemented various restrictions to stem the transmission of the virus internally and externally from abroad. This step will cause a shock to the economy, including the food and agriculture sector.

The food and agriculture sector is one of the key sectors within the economy of Indonesia. This sector contributed around 20% to GDP in 2019 (prior to the COVID-19 pandemic), where the agricultural sector has decreased while the food and beverage manufacturing sector has increased to offset the decline agricultural sector. Nevertheless, agriculture's overall contribution to GDP is more significant because agricultural sectors rely on agricultural inputs to contribute added value to the economy. Apart from food and beverage manufacturing, sectors related to agriculture include food services and eating and drinking places. USA's experience, agricultural

food, and related industry contributed about ten times the output of America's farms to GDP [28]. Apart from that, for most Indonesian households, farming, and plantations remain vital income generators. In 2022 the agricultural sector provided jobs to approximately 40.6 million Indonesians, representing 30% of the country's total labor force. Thus, agriculture is still the sector that contributes the most to employment, followed by the wholesale and retail, industry, and eating and drinking sectors, 19%, 14%, and 7%, respectively.

Given the strategic position of the food and agriculture sector in Indonesia, it is essential to understand the impact of the COVID-19 pandemic on this sector. The research results are a provision to address the possibility of external turmoil both caused by the financial crisis and due to zoonotic disaster that has increasingly shaken the world economy recently and is likely to occur again.

So far, various studies on the impact of COVID-19 on agriculture are mostly in the form of literature reviews both at the global level such as [15], [27], [29], and [30] and more specific cases at the country level such as [31] for the United States, [32] for Turkey, and [33] for India. Research employing econometric analysis is still very limited to cross-section data from primary data collection, so it cannot provide long-term predictions such as [16] which compares the impact and response of adaptation in the US, Norway, and China; [25] which examines agricultural resilience in California with special attention to agricultural marketing aspects; [22] in India; and [34] in Nigeria. This study is the first (at least for Indonesia) to use time-series data, which includes 11 observations quarterly during the COVID-19 pandemic, the first quarter of 2020 to the third quarter of 2022 (Q1 2020 to Q3 2022) using a dummy variable can include more than 30 observations. Hence, it is feasible to carry out econometric operations properly.

The purpose of the article. This study aims to assess the impact of COVID-19 on the role of the food and agriculture sector on economic growth in Indonesia with a specific formulation: to find out the causal relationship between the output of the agricultural sector, the output of food and beverage manufacture and the economic growth of Indonesia during the COVID-19 pandemic.

Method. To analyze the role of the food and agriculture sector in economic growth, we decompose the food and agriculture sector into agricultural output (Agri), and food and beverage manufacturing output (FnB); Gross Domestic Product (GDP) represents economic growth. Studies to uncover the causal relationship between GDP and its constituent variables (pseudo-supply-side analysis: agricultural and economic growth) have been conducted by [35] for North Cyprus and [36] for Tunisia. Observations during the COVID-19 pandemic use dummy variables with a value of one, i.e., the first quarter of 2020 to the third quarter of 2022, while data before 2020 is zero. Quarterly data on GDP, agricultural output (Agri), and food and beverage manufacturing output (FnB) are available in *"Statistik Ekonomi Keuangan Indonesia"* (Indonesian Economic and Financial Statistics) published monthly by Bank Indonesia (Central Bank of Indonesia). All data are in billions of Rupiah (IDR) at constant

prices (2010=100) and transformed into logarithm form. The analysis covers eight years (2015 - 2022) with 31 quarters.

The cointegration and error correction model is superior to the traditional regression method to determine the effect of one variable on another. The reasons include [37]: (i) cointegration techniques test the long-run theoretical relationship between variables and Granger causality between variables, while traditional regression techniques only make assumptions about the theoretical relationship between variables, (ii) financial variables are mostly non-stationary. Thus, ordinary regression operations on such variables will yield spurious results, given that statistical tests such as t-ratio and F-statistics are statistically not valid when applied to non-stationary variables. Performing regression operations in the differential form of these variables would solve one problem, but regressing the variables in their differential form would effectively eliminate the long-term trend. Thus, differential regression variables only capture short-term, cyclical, or seasonal effects. Regression in differential form does not test for long-run or theoretical relationships, (iii) the data empirically prove causality in cointegration, whereas in traditional regression, causality is only a presumption.

This study employs the autoregressive distributed lag (ARDL) bound test to cointegration. The ARDL approach is an OLS-based dynamic econometric model. This model is considered superior for small samples and does not require stationary variables to be of the same order as long as they are in I(0) and I(1) ([38]; [39]). The ARDL model can generate a dynamic error correction (ECM) model that integrates short-run dynamics and long-run equilibrium through a simple transformation. This advantage has made the ARDL bound test to cointegration increasingly popular and widely used recently, including [40], [41], [42], [43], and [44]. According to [39], the ARDL bound test approach gives efficient and reliable results once a single equation cointegration relationship exists between variables. The Granger procedure also tests the direction of causality in vector error correction (VECM) models. If a set of variables is cointegrated, they are guaranteed to have an error correction term (ECT). The advantage of VECM is the reintroduction of information lost due to difference time series. This step is crucial for investigating short-run dynamics and long-run equilibrium.

Equation (1) presents the long-run relationship between economic growth and the food and agriculture sector:

$$GDP_t = \beta_0 + \beta_1\, Agri_t + \beta_2\, FnB_t + DUM + \varepsilon_t \quad (1)$$

The ARDL bound test to cointegration model, which is an unrestricted ECM (error correction model) for equation (1), is formulated in equation (2).

$$\Delta\, GDPt = \beta_0 + \beta_1\, Agri_{t-1} + \beta_2\, FnB_{t-1} + \sum_{i=1}^{p} \alpha i\, \Delta GDP_{t-i} + \sum_{j=1}^{q} \alpha j\, \Delta Agri_{t-j} + \sum_{k=1}^{r} \alpha k\, \Delta FnB_{t-k} + DUM + \varepsilon_t \quad (2)$$

p, *q,* and *r* are the optimal lags with their respective variables and ε_t is the error term. The bound testing procedure tests the joint F-statistic of the null hypothesis of no cointegration relationship:

Ho: $\beta_1 = \beta_2 = 0$, against the alternative $H_1: \beta_1 \neq \beta_2 \neq 0$

We can see the cointegration test results from the F-statistics obtained using the ARDL bound test. If the F-statistic is greater than the upper critical bound (UCB), there is cointegration but if the value obtained is smaller than the low critical bound (LCB), it means no cointegration among the variables ([39]; [44]). The long-run relationships are inconclusive if LCB<F-statistic<UCB [45]. In case there is evidence of a long-run relationship (cointegration) between the variables, equation (3) displays the steps to estimate the long-run and the short-run models.

$$\Delta \text{GDP}_t = \beta_0 + \sum_{i=1}^{p} \alpha i\, \Delta \text{GDP}_{t\text{-}i} + \sum_{j=1}^{q} \alpha j\, \Delta \text{Agri}_{t\text{-}j} + \sum_{k=1}^{r} \alpha k\, \Delta \text{FnB}_{t\text{-}k} + \text{DUM} + \psi\, \text{ECT}_{t\text{-}1} + \varepsilon_t \quad (3)$$

where ψ is the coefficient of error correction term (ECT), representing the variable's adjustment speed to long-run equilibrium after a shock.

The long-run and short-run causality between agricultural output, food and beverage manufacturing output, and economic growth is investigated using Granger causality with vector error correction. Granger causality is expressed in matrix form which is formulated in the model in equation (4).

$$(1-\text{L}) \begin{bmatrix} \text{GDP}_t \\ \text{Agr}_t \\ \text{FnB}_t \end{bmatrix} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix} + \sum_{i=1}^{p} (1-\text{L}) \begin{bmatrix} \alpha_{11}\, \alpha_{12} \alpha_{13} \\ \beta_{21}\, \beta_{22} \beta_{23} \\ \gamma_{31}\, \gamma_{32} \gamma_{33} \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \end{bmatrix} \begin{bmatrix} \text{GDP}_{t-1} \\ \text{Agr}_{t-1} \\ \text{FnB}_{t-1} \end{bmatrix} \text{ECT}_{t\text{-}1} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \quad (4)$$

where (1-L) is the difference operator. Long-run causality is determined by the significance of the lagged error coefficient while short-run causality is determined by the significance of the F-statistic using the Wald test.

Results and Discussion. This section first describes the spread of COVID-19 in Indonesia, followed by the condition of the food and agriculture sectors during the pandemic. Next is the presentation of the linkage analysis between the agricultural sector, food and beverage manufacturing, and economic growth using the ARDL approach. The ARDL approach performs the following steps: unit root test, cointegration test, and causality analysis.

COVID-19 Spread in Indonesia. Various efforts have been made to prevent the entry of COVID-19, especially at cross-country entry points such as ports and airports, but Indonesia could not isolate itself from the COVID-19 pandemic. The

first case was confirmed on 2 March 2020, and the first case of death occurred on 11 March 2020, coinciding with WHO declaring COVID-19 a global pandemic. In just one month, all 34 provinces in Indonesia reported the spread of this virus. Up to Q3 2022, Indonesia went through three different major infection waves which are closely related to virus mutations with different variants, namely: Q1 2021 (the Alpha Wave) reached the peak in the fourth week of January, Q3 2021 (the Delta Wave) second week of July, and Q1 2022 (the Omicron Wave) the second week of March [46].

The Indonesian government declared COVID-19 as a non-natural disaster on 14 April 2020 through Presidential Decree No. 12. On that day, the total number of cases reached 4,839, with 400 deaths and daily deaths at 60. In addition to mitigation measures through mobility restrictions and health campaigns such as wearing masks, washing hands with soap, and keeping a distance/avoiding crowds, the government also launched a program called national economic recovery with components of basic food assistance, wage subsidies, pre-employment cards, etc., including subsidized online shopping delivery fees, which aim to drive the economy and maintain food security for the less fortunate, incredibly informal sector workers who have practically stopped their activities. In 2020 there were 56.64% of the workforce working in the informal sector.

As a result of the pandemic, between 2020 and 2022, labor statistics show that the formal sector contracted by 6%. The informal sector experienced an increase of 15.6%, indicating that the various economic recovery programs launched by the government have played a more significant role in boosting economic activity in the informal sector, including opening up opportunities for those laid off in the formal sector to start businesses in the informal sector.

Vaccination, a permanent solution to the COVID-19 pandemic, had only begun to be implemented in Indonesia on 13 January 2021, with the target that each resident will receive four vaccine doses. When the vaccination started, the number of infected cases had reached more than 850,000, with a death toll of 25,000 people. Until the end of 2022, 87.5% of the population have received one vaccine dose, and 73.5% have been fully vaccinated (two doses). 160 thousand people died, and 6.65 million were infected [47].

Indonesia's Food and Agriculture Sector During the COVID-19 Pandemic. Overall, Indonesia's economy went into recession in Q2 2020 when there was little understanding of COVID-19, so information on mitigation measures needs greater consistency. For example, the health ministry stated that healthy people do not need to wear medical masks. Only sick people and health workers should wear masks. In the face of this misunderstanding, various local governments took measures, some even implementing lockdowns by closing inter-regional roads and main urban roads up to curfew. This step paralyzed economic activity, while on the other hand, the government's economic recovery policies are still formulating, especially related to the target group and its distribution mechanism. Year-on-year, in Q2 2020, Indonesia's GDP contracted by 5.32%. GDP continues to recover, but until Q3 2022, GDP growth is below the pre-pandemic trend, as shown in figure 1.

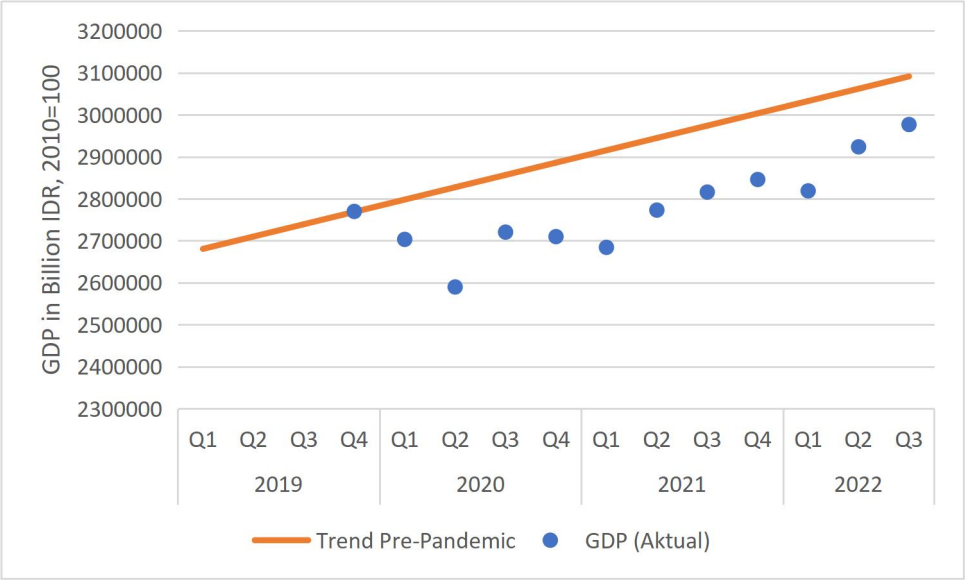

Figure 1. Indonesian Economic Growth During COVID-19 Pandemic Compared to Its Pre-Pandemic Trend (in Billion IDR, 2010=100)

Source: Author's calculation.

The agricultural output shows a seasonal oscillatory pattern. In the second quarter of each year, production peaks, then decline and reach the lowest point in the fourth quarter to increase the following quarter again. This pattern applies pre-pandemic and does not change during the pandemic. This seasonality applies to the five main agricultural sub-sectors: food, horticulture, plantation, livestock, and fisheries. Table 1 presents the growth of agricultural output per subsector per year (y-o-y) and quarter on quarter (q-o-q).

Table 1

Agricultural Output Growth per Subsector, Indonesia 2019 – 2022 (in %)

Year	Quarter	Food		Horticulture		Plantation		Livestock		Fisheries	
		y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q
2019	Q1	-6.02	73.49	6.18	7.06	3.36	-0.03	7.87	8.84	5.66	1.88
	Q2	5.05	10.70	6.06	23.79	4.50	28.14	7.70	4.22	5.59	-0.26
	Q3	-4.73	-11.27	12.38	6.96	4.96	10.41	7.69	0.49	5.68	1.90
	Q4	-1.08	-41.95	4.92	-25.99	5.23	-25.60	7.86	-5.38	5.50	1.88
2020	Q1	-10.25	57.40	2.61	4.70	3.97	-1.22	2.68	3.62	3.52	-0.03
	Q2	9.24	34.74	0.94	21.78	0.18	23.46	-1.90	-0.43	-0.63	-4.26
	Q3	7.24	-12.89	-1.23	4.66	0.68	10.97	-0.24	2.19	-1.03	1.50
	Q4	26.06	-31.76	7.85	-19.18	1.14	-25.26	-1.88	-6.93	1.06	4.03
2021	Q1	12.24	40.14	3.27	0.26	2.17	-0.22	2.12	7.84	-1.31	-2.37
	Q2	-7.97	10.48	1.85	20.10	0.32	21.23	6.74	4.08	9.69	6.41
	Q3	-5.66	-10.71	-5.22	-2.60	8.33	19.83	-2.47	-6.63	4.55	-3.25
	Q4	-13.96	-37.77	3.80	-11.50	2.28	-29.44	-5.24	-9.58	8.99	8.44
2022	Q1	-0.08	62.74	3.31	-0.20	-0.24	-2.68	6.92	21.69	-0.51	-10.89

	Q2	1.11	11.81	1.23	17.67	0.68	22.35	3.56	0.81	2.73	9.87
	Q3	-7.97	-18.73	5.56	1.57	2.74	22.28	7.40	-3.17	6.38	0.19

Source: Author calculation.

Table 1 indicates that Indonesian agricultural production has not been affected by the COVID-19 pandemic as experienced by Asian agriculture in general ([22]; [24]). Overall, GDP growth in the agricultural sector follows the pre-pandemic trend. Every second and third quarter is above the trend, and the fourth and first quarters are below the pre-pandemic trend, as shown in Fig. 2.

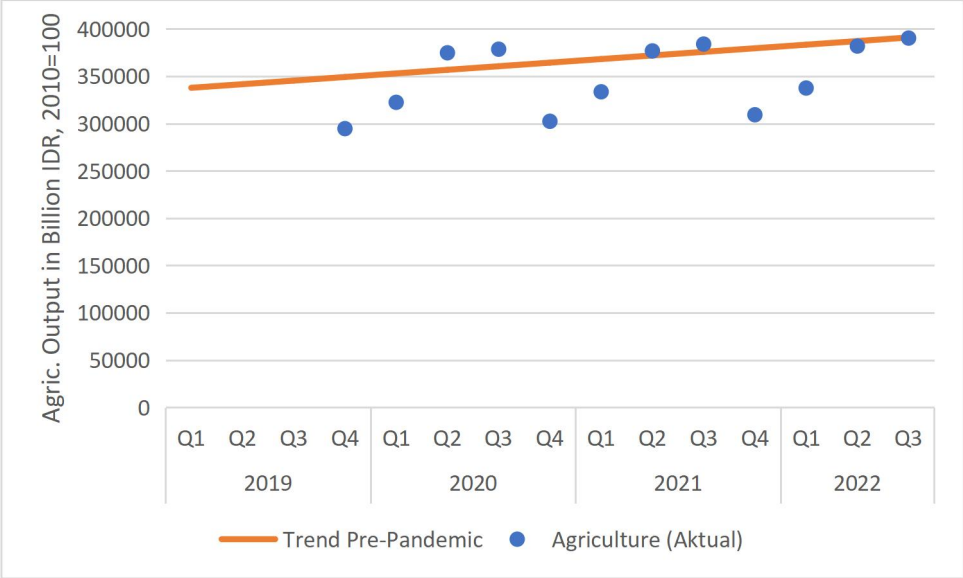

Figure 2. Indonesian Agricultural Output Growth During Pandemic COVID-19 Compared to Its Pre-Pandemic Trend

Source: Author calculation.

As reported by various studies e.g. [6], restrictive measures to contain the COVID-19 spread have disrupted economic activity in the service and manufacturing sectors which are close-contact-related. Food and beverage manufacture at a certain level also belongs in this category. Likewise, during a pandemic, this sector has always recorded positive growth (year-on-year), which has continued since Q1 2014. Meanwhile, quarter-on-quarter growth tends to follow the seasonal pattern of the agricultural sector as a supplier of raw materials, which posted negative growth in the 4th quarter of each year. Food and agriculture exports experienced positive growth (year-on-year) during the pandemic after experiencing pressure throughout 2018-2019 due to the USA-China trade war. Likewise, quarter-on-quarter growth contracted in six of the 11 quarters observed. Thus, trade barriers such as closing borders and quarantining for two weeks at ports also impact Indonesia's exports even though they mainly non-perishable goods such as CPO (crude palm oil) and crumb rubber. Quarter 3 2022 Indonesian food and agricultural exports posted growth of

34.81% (quarter-on-quarter) and 12.36% (year-on-year). Indonesia's GDP growth, along with its selected components, including agricultural output, food and beverage manufacturing, and food and agricultural exports, is presented in table 2.

Table 2

Indonesia's GDP Growth and Selected Sectors, 2018-2022 (in %)

Year	Quarter	GDP		Agriculture		Food and Beverage		Food and Agric. Export	
		y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q
2018	Q1	5.06	-0.41	3.34	16.41	12.77	-0.77	-9.54	-10.39
	Q2	5.27	4.21	4.74	10.02	8.39	4.46	-4.59	-8.28
	Q3	5.17	3.09	3.67	3.21	8.10	3.45	-0.35	14.03
	Q4	5.18	-1.69	3.92	-21.39	2.74	-4.20	-10.01	-4.00
2019	Q1	5.07	-0.52	1.86	14.10	6.77	3.13	-13.65	-14.01
	Q2	5.05	4.20	5.33	13.77	7.99	5.65	-13.22	-7.81
	Q3	5.01	3.05	3.06	0.99	8.33	3.78	-13.49	13.68
	Q4	4.96	-1.74	4.24	-20.48	7.95	-4.54	3.70	15.08
2020	Q1	2.97	-2.41	-0.02	9.43	3.94	-0.70	9.96	-8.82
	Q2	-5.32	-4.19	2.15	16.24	0.22	1.87	7.85	-9.59
	Q3	-3.48	5.05	2.17	1.01	0.66	4.23	11.40	17.42
	Q4	-2.17	-0.40	2.63	-20.13	1.66	-3.59	26.30	30.47
2021	Q1	-0.70	-0.94	3.45	10.31	2.45	0.07	38.42	-0.07
	Q2	7.07	3.31	0.53	12.95	2.95	2.37	59.19	3.98
	Q3	3.51	1.55	1.43	1.92	3.49	4.78	74.86	28.98
	Q4	5.02	1.06	2.28	-19.46	1.23	-5.69	27.53	-4.85
2022	Q1	5.01	-0.95	1.19	9.14	3.75	2.56	15.53	-9.47
	Q2	5.44	3.72	1.37	13.15	3.68	2.30	7.50	-3.24
	Q3	5.72	1.82	1.65	2.20	3.57	4.67	12.36	34.81

Source: Author Calculation.

The Nexus of Agriculture, Food and Beverage Manufacture and Economic Growth. The ARDL bound test will be employed to estimate the effect of agricultural output, the output of food and beverage manufacture on economic growth, and their causal relationship. Applying the ARDL bound test to the cointegration approach, it is necessary first to perform the unit root test. This test ascertains that no variables are stationary in order two [I(2)], or more. This study uses two different test tools, namely ADF (augmented Dicky-Fuller) and PP (Phillips-Perron), with and without trend. The ADF is the most prevalent unit root test tool and the PP unit root test is more robust in the error term process ([48]; [49]). Table 3 displays the test results. All variables are stationary at I(0) or I(1). According to Phillips-Perron, all variable (GDP, agriculture output and output of food and beverage manufacture) stationary at 1% level of significance at the first difference intercept as well as intercept and trend. The unit root results make the ARDL technique valid in estimating the effect of the food and agriculture sector on Indonesia's economic growth.

Table 3

Unit Root Test Result

Variable		ADF		PP	
		Intercept	Trend and Intercept	Intercept	Trend and Intercept
Level	GDP	-0.9729	-3.1037	-1.5009	-3.0738
	Agri	-2.9544*	0.2921	-4.3143***	-8.0966***
	FnB	-2.3351	-1.2824	-2.3121	-3.1994
First difference	Δ GDP	-7.4852***	-7.3663***	-7.4959***	-7.5695***
	Δ Agri	-0.7670	-69.8297***	10.6932***	-10.4437***
	Δ FnB	-1.6672	-2.6433	-8.1541***	-8.9162***

Source: Author's computation using EViews 10.
Note: *, ** and *** significant level $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively.

Table 4 displays the results of the ARDL bound test as formulated in equation (3). We can see that all three equations produce F-statistic bound test values greater than the upper critical bound at 1% confidence level. Thus we conclude that there is a long-run relationship among the variables.

Table 4

Results of ARDL Cointegration test

Estimated models	Optimal lag length	F-bound test	Decision
GDP | Agri, FnB, DUM	(1,0,1,0)	13.7166	Cointegration
Agri | GDP, FnB, DUM	(1,1,1,0)	18.8684	Cointegration
FnB | GDP, Agri, DUM	(1,0,0,0)	18.4200	Cointegration
	Significant (finite sample, n = 30)		
		Lower bound, I(0)	Upper bound, I(1)
	10%	2.676	3.586
	5%	3.272	4.306
	1%	4.614	5.966

Source: Author's computation using EViews 10.

The confirmation of the long-run cointegration relationship is a condition for using ARDL to estimate the long-run model. As a result, there is a tendency for the variables to move together towards the long-run equilibrium. Table 5 presents the results of coefficients estimated using the ARDL model and the results of the error correction model (ECM), respectively. In the long run, agriculture and food and beverage manufacturing output positively and significantly impact economic growth. However, in the short run, only agriculture has a causal relationship with economic growth. The system will return to long-run equilibrium in the event of a short-run shock, with an adjustment speed of 48.60% per quarter.

Table 5

Results of Coefficient Estimation of Long- and Short-run Economic Growth Equation

ARDL Regression Dependent variable: GDP, ARDL (1,0,1,0)			ECM Regression Dependent variable: Δ GDP		
Independent variable	Coefficient	t-statistic	Independent variable	Coefficient	t-statistic
GDP_{t-1}	0.5140	3.6549***	Δ Agri	0.1022	5.8433***
Agri	0.1022	2.2085**	ECT	-0.4860	-8.9450***
$Agri_{t-1}$	0.0634	2.0717**			
FnB	0.2320	2.0549**			
DUM	-0.0124	-1.6012			
R2 = 0.9731 F-stat = 173.9342 *** Residual diagnostic: there is no heteroskedasticity, serial correlation, autocorrelation, or partial correlation.					

Source: Author's computation using EViews 10.
Note: ***, **, and * are significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

The stability test of the economic growth model, as presented in table 5, exhibits that the model is stable according to CUSUM (the cumulative sum of recursive residuals) and CUSUMSQ (the cumulative sum of squares of recursive residuals). Figure 3 presents the test result.

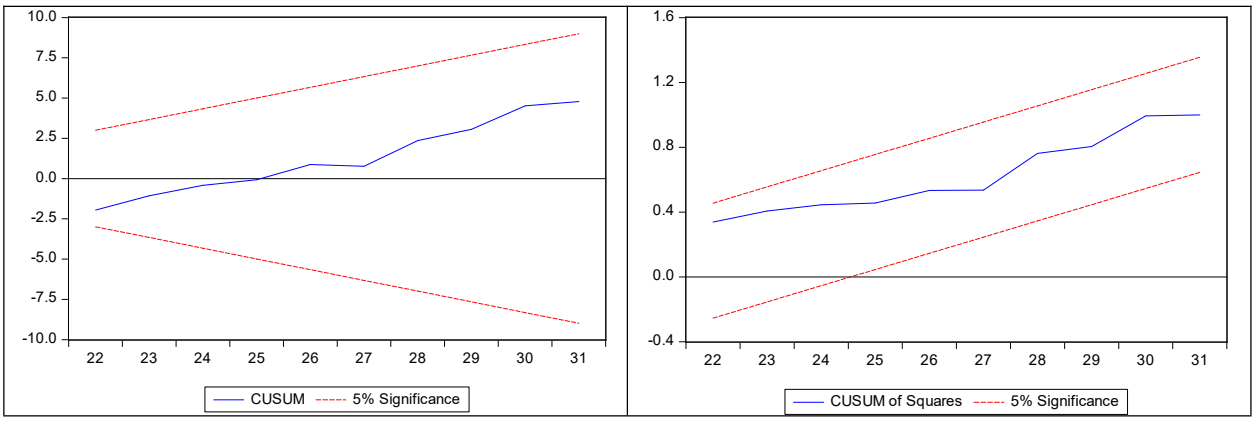

Figure 3. Stability test of Economic Growth Model
Source: Author computation, EViews 10.

The presence of cointegration in a model indicates that at least one independent variable has a causal relationship with the dependent variable. The analysis continued by operating the ARDL-Granger test. Table 6 exhibits the results. The three variables have a long-run causal relationship, and the causality between them is a bi-directional (dynamic relationship). In all three equations, there is no significant impact of COVID-19, as the coefficient of DUM (dummy variable represented the situation

during the COVID-19 pandemic) is not significant. However, in the short run, only agriculture has a causal relationship to economic growth (GDP). Meanwhile, economic growth and food and beverage manufacture have a causal relationship to agriculture in the short- and long run. In contrast, the causal relationship between agriculture and economic growth to food and beverage manufacture only appears in the long run.

Table 6

ARDL-Granger Causality Analysis

Dependent variable	ARDL optimal lag	Short run causality (-stat of Wald-test)				ECT
		Δ GDP	Δ Agri	Δ FnB	DUM	
Δ GDP	(1,0,1,0)	-	0.1022**	0.2320	-0.0124	-0.4860***
Δ Agri	(1,1,1,0)	1.5431**	-	1.5321***	0.0323	-1.1971***
Δ FnB	(1,0,0,0)	0.5631	0.2037.	-	0.0063	-0.4976***

Source: Author's computation using EViews 10.
Note: ***, **, and * are significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

Notably, the ECT of the agricultural equation is above one, which reflects the seasonal pattern of production in Indonesia's agriculture sector to produce an adjustment pattern to an oscillatory shock. According to [50 p. 339], "the error correction term with a coefficient of -1 to -2 means that it does not converge monotonically to the equilibrium path directly, but rather the error correction process fluctuates around the long-run value in a dampening manner. Once this process is complete, convergence to the equilibrium path is quick". According to [44], the deviation from the long-run equilibrium level of agriculture output in the current period is corrected by 119.71 percent in the next period to restore the equilibrium when there is a shock to the steady state relationship, but an ECT higher than 100 percent means it has an oscillating type of convergence to the long-run equilibrium and takes less than one quarter to return to its long-run. To highlight the short-run causal relationships between variables, one can present the information in table 6 in the form of a drawing as in figure 5.

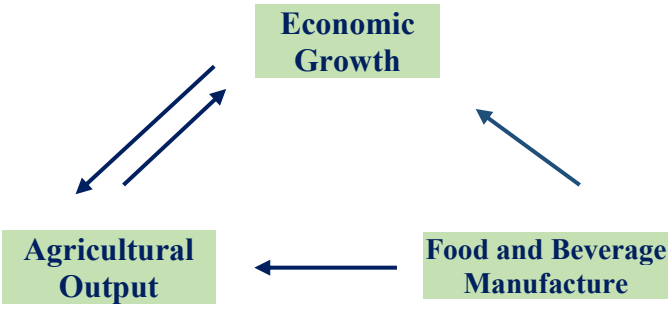

Figure 5. ARDL-Granger Causality of Agricultural Output, Output of Food and Beverage Manufacture and Economic Growth

Analysis suggests that the COVID-19 pandemic did not disrupt the role of the food and agriculture sector in Indonesia's economic growth. Agriculture and economic growth have bi-directional causality in the short and long run. Meanwhile, in the short-run, the food and beverage industry has uni-direction causality to agriculture and economic growth. In contrast, in the long run, the three variables have a dynamic relationship (bi-direction causality). This highlights the findings of [51] that agricultural production and trade are resilient, but related industries such as food service and especially food away from home are affected. Thus, the pressure on the agricultural sector is induced by the demand side, where income loss from contraction in various sectors due to restrictions to prevent the spread of the COVID-19 virus, has resulted in a decrease in demand for agricultural products both directly and through related industries. Thus, the main problem lies in the supply-chain bottleneck. Therefore, the food and beverage industry exhibits different behavior from other manufacturing sectors. According to [20], it must take a double hit in the form of disruptions to the supply of raw materials and capital goods, and logistics shortages.

Furthermore, [20] also pointed out that in Asia, the pandemic hit less agriculture in China, Indonesia, and Lao PDR. In comparison, the Asian financial crisis in 1997/1998 took about 20 quarters for the Indonesian economy to return to pre-crisis levels, while the COVID-19 crisis took only six quarters to reach pre-pandemic levels. Thus, facing the COVID-19 pandemic, the Indonesian economy not only did not fall too profoundly (Indonesia's Q2 2020 GDP contracted by 4.4%, far below the economies of Thailand, Singapore, Malaysia, and the Philippines, which contracted by 9.2, 9.6, 9.9, and 14.3% respectively), but also recovered quickly.

Several factors have supported the Indonesian economy not falling too deeply in the face of the crisis, which is categorized by many as the worst crisis of all time after the great depression of the 1920s e.g. [52]). One of the contributing factors is the character of Indonesia's agricultural sector, which has been the driving force of the economy in times of crisis, as it was in previous financial crises, namely in 1998 and 2008. One of its functions is to become a rescue anchor in a crisis. During times of crisis, most laborers, especially low-skill laborers, will shift to the agricultural sector [53]. The economic recovery is also inseparable from rapid progress in the health sector, including global cooperation in developing vaccines, cheaper tracing techniques with rapid results so that the treatment of infected people can be faster, either by self-isolation or isolation in hospitals, and the application of better therapies [6]. This, coupled with the results of intensive campaigns such as using masks in public places, social distancing, and hand washing, has successfully controlled COVID-19 in two years.

In addition to positive developments for the benefit of public health, the Government of Indonesia has also implemented various policies that balance health and the economy. These include choosing large-scale social restrictions over lockdown and sorting out different levels of social restrictions depending on the development of COVID-19 across Indonesia [20]. The budget disbursed for COVID-

19 management also reflects a balance between public health and the economy, covering (i) health, (ii) social protection by providing living assistance to poor and near-poor families, and (iii) protecting businesses from mass bankruptcy, especially MSMEs (Micro, Small and Medium Enterprises). These three aspects were handled simultaneously at the national level and by local governments whose funds came from the central government. All these measures cost IDR 1,645.45 trillion from 2020 to 2022 [54], which has increased government debt by 52% between 2019 and July 2022 from IDR 4,779.26 trillion to IDR 7,733.99 trillion ([55]; [56]). However, the steps taken by the government are in line with the domestic demand-led-growth nature of the Indonesian economy ([57]; [58]), so the most effective policy for this is to stimulate domestic consumption growth as the driving force of the economy rather than pumping exports, especially in conditions of disruption of global supply chains due to obstacles to the mobility of goods and people.

The strategy for developing agriculture-based industries to meet domestic needs and fill foreign demand (exports) has shown more resilient results (at least experienced a faster recovery) even though, in normal times, it has not shown spectacular growth. Thus, building a solid agro-industry system for sustainable contribution to the economy as one engine of growth is one of the mitigation steps to face a crisis that will surely come.

Conclusion. The COVID-19 pandemic has not disrupted the role of the food and agriculture sector in Indonesia's economic growth, which in the long run shows a dynamic causality (bi-direction causality) between the agricultural sector and economic growth, between the food and beverage manufacture and economic growth and between the agricultural sector and the food and beverage manufacture. In the short run, there is bi-direction causality between the agricultural sector and economic growth and uni-direction causality from the food and beverage manufacture to the agriculture sector and economic growth. Indonesia's agriculture sector, heavily influenced by seasonality, shows an oscillating pre-pandemic output pattern. This pattern has also not been disrupted by the COVID-19 pandemic so the quarterly down and up cycles are still visible during the pandemic as they were before the pandemic. Indonesia's economy has recovered faster than other ASEAN countries due to the rapid progress in the global health sector and the effectiveness of the Indonesian government's policies in maintaining a balance between health and economy in handling COVID-19, also helped by the role of the agricultural sector which is the driving force in times of crisis as happened in the 1998 and 2008 crises. During these two crises, the agricultural sector absorbed labor, especially unskilled labor who lost their livelihoods due to the crisis.

This study has limitations since it uses aggregate agricultural data by assuming that agricultural output is homogeneous which is basically very diverse between food crops and horticulture which are dominantly managed by rural smallholders with the aim of local market production for fresh products versus plantations whose output is dominated by large companies with the aim of exporting after processing it into intermediate or final/consumption good and fisheries which are a combination of the

two previous product groups. In the future, it is necessary to further explore whether the resilience of the agricultural sector to the crisis (in this case originating from the COVID-19 pandemic) is more equal in all sub-sectors or whether there is only one subsector that has strong resilience with a very large contribution to agricultural GDP so that in total it covers the deteriorate of other sub-sectors. Furthermore, it is necessary to examine the role of the government's safety net program in providing basic food assistance and subsidizing delivery costs for online shopping in encouraging demand-side growth that transmits signals to producer farmers to continue producing to serve demand through contactless marketing. In this case, the government implements a "bailout" policy as is generally implemented when facing a crisis in the industrial manufacturing sector.

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V. REVIEW RESULTS (REVISION REQUIRED)

May 27, 2023

Review results

From: Agricultural and Resource Economics E-Journal (editor.are.journal@gmail.com)

To: jtampubolon@yahoo.com

Date: Saturday, May 27, 2023 at 03:41 AM GMT+7

Dear author(s),

Warm greetings!

We have the reviews for your article. Please correct the errors.

Review 1

1. Some Indonesia terminology must be changed into English (e.g. GDP Aktual).
2. There are inconsistency in name the literature (As reported by various studies e.g. [6]) it was written various studies. The literature only one. Need more literature.
3. Throughout 2018-2019 due to the USA-China trade war (page 9). Need explanation about USA-China trade war. Is there a War?
4. In the conclusions, it is desirable to add a description of the empirical results of the study with certain numerical data.
5. The title of the article could be shortened.

Review 2

1. This article have novelty in relation agricultural sector and economic growth in post covid-19. But author must be carefully in employing granger causality and ECM. Please, focus on what aspect of the material: relation between variables or impact covid-19 to the economic growth in agricultural sectors.
2. In the method of analysis, please author complete with the stationarity test (ADF or PP) because you develop time series data.
3. According to the results of the analysis of the publications, you should identify the gaps that your article is aimed at filling (before formulating the purpose of the research).
4. It should be noted which hypothesis(es) of the study or which research question(s) are addressed in the article. In the future, it is necessary to confirm or refute the hypothesis (or provide answers to research questions).

5. The discussion should be improved. When discussing the results of their own research, the author/s must make also apparent the originality (novelty) of their work. What does it add to the subject area compared with other published material?

6. At the end of the article (before the conclusions) a policy implication is needed. Policy implication should be effective and practical.

7. The manuscript needs English editing, there are errors and poor construction in some sentences. Therefore, I will suggest proofreading by a professional.

Any revisions should be clearly highlighted in a certain color.

Please provide answers to all reviewers' comments in the Table

Reviewer Comments	Response to Reviewer Comments
Reviewer 1	
1.	
2.	
…	
Reviewer 2	
1.	
2.	
…	

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Yours sincerely,
Prof. Kucher

Best regards,
Editorial Board of Agricultural and Resource Economics
https://are-journal.com

VI. SUBMISSION OF REVISED MANUSCRIPT (RESPONSE TO REVIEWER)

June 8, 2023

Re: Review results

From: Dr. Jongkers Tampubolon (jtampubolon@yahoo.com)

To: editor.are.journal@gmail.com

Date: Thursday, June 8, 2023 at 01:43 PM GMT+7

To: Prof. Anatolii Kucher
Editor-in Chief
Agricultural and Resource Economics: International Scientific E-Journal

Dear Prof. Kucher.

Greeting from Medan, Indonesia.

We would like to thank you for the review of our article entitled "Food and Agricultural Sector in Indonesia's Economic Growth During COVID-19 Pandemic". In line with the comments and suggestions from both reviewers, we have revised the article. Changes (revisions) to the article sections are highlighted in yellow.
Along with the revised article, we also attach our responses to the reviewers' comments in a separate file.

We are very grateful for your kind co-operation.

With best regards

Reviewer Comments	Response to Reviewer Comment
Reviewer 1	
1. Some Indonesia terminology must be changed into English (e.g. GDP Aktual)	1. In accordance with reviewer 2's suggestion, the manuscript has been proofread by a professional.
2. There are inconsistencies in the name of the literature (As reported by various studies e.g. [6] it was written various studies. The literature is only one. Need more literature.	2. Inconsistencies have been corrected by adding literature on the topic.
3. Throughout 2018-2019 due to the USA-China trade war (page 9). Need explanation about USA-China trade war. Is there a war?	3. Information has been added along with supporting literature that describes the retaliation between the US and China in the imposition of import tariffs that escalated into a US-China trade war, its impact on the agricultural sector globally, and its spillover effects on Indonesian exports.
4. In the conclusions, it is desirable to add a description of the empirical results of the study with certain numerical data.	4. This suggestion is accepted in a limited way so that the conclusion does not repeat too much of the results and discussion.
5. The title of the article could be shortened	5. Attempts have been made to shorten the title of the article from 18 words to 14 words while maintaining the suitability of the title and content of the article and

	maintaining the econometric model used in the analysis. By maintaining the sub-title (An ARDL Approach), the use of time series data which is the novelty of the research remains visible.
Reviewer 2	
1. This article have novelty in relation agricultural sector and economic growth in post covid-19. But author must be carefully in employing granger causality and ECM. Please focus on what aspect of material: relation between variables or impact covid-19 to the economic growth in agricultural sector	1. In response to this excellent suggestion, the discussion section has been substantially rewritten and reorganized with more emphasis on the discussion of the effect of the covid-19 pandemic on the economic growth equation, the agricultural output equation, and the output of the food industry equation. This is also in line with reviewer comment no. 5
2. In the method of analysis, please author complete with stationary test (ADF or PP) because you develop time series data.	2. In the methodology, the unit root test has been added by presenting the formal use of ADF, while the PP is only described narratively without presenting the equations used for the calculation so that the mathematical equations only add one to the article.
3. According to the results of the analysis of the publications, you should identify the gaps that your article is aimed at filling (before formulating the purpose of the research).	3. Prior to "the purpose of the research", a sentence has been added that describes the advantages of ARDL econometric models (which use time series data) compared to econometric models that use cross-section data with limited predictive ability.
4. It should be noted which hypothesis(es) of the study or which research question(s) are addressed in the article. In the future, it is necessary to confirm or refute the hypothesis (or provide answers to research questions)	4. The subsection "the purpose of the article" has been reformulated and the section "discussion" has undergone substantial changes.
5. The discussion should be improve	5. Already responded in the comment no. 1
6. At the end of the article (before the conclusion) a policy implication is needed. Policy implication should be effective and practical.	6. The policy implication is already revised
7. The manuscript needs English editing, there are errors and poor construction in some sentences (suggestion: proofreading by a professional)	7. This revised article has been proofread by a professional
Note: Sections that are being revised in this article are highlighted in yellow.	

==========

Dr. Jongkers Tampubolon
Nommensen University
Jalan Sutomo 4A
Medan 20234 - INDONESIA
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REVISED MANUSCRIPT (2ND ROUND/FINAL VERSION)
June 8, 2023

JEL: Q13; C32; 047

Jongkers Tampubolon

University of HKBP Nommensen
Indonesia

FOOD AND AGRICULTURAL SECTOR IN INDONESIA'S ECONOMIC GROWTH DURING COVID-19 PANDEMIC: AN ARDL APPROACH

***Purpose*:** Global-scale financial crises, either originating from the financial sector itself or from other fields such as zoonotic disasters, in the form of the spread of viruses resulting in deaths and significant economic contraction, occur more frequently and are expected to keep occurring in the future. This study aims to assess the crisis's impacts, in this case, COVID-19 pandemic, on the food and agriculture sector's role in Indonesia's economic growth.

***Methodology/Approach*:** This study used ARDL bound test to cointegration approach to analyze whether COVID-19 pandemic had a negative impact on Indonesia's economic growth with regard to the food and agricultural sector. The relation pattern of particular interests includes (i) the relation between agriculture and economic growth, (ii) the relation between food and beverage industry and economic growth, and (iii) the causal relation between agriculture, food and beverage industry, and economic growth.

***Results*:** In the long run, economic growth, agricultural output, and food and beverage industry's output have a dynamic causal relation (bi-directional causality). Partially, COVID-19 pandemic influences economic growth negatively but insignificantly. However, the effect is simultaneously significant, but the regression coefficient is very small, and not strong enough to disrupt the positive effect of agricultural output and food and beverage industry's output. COVID-19 does not negatively influence agricultural production and food and beverage industry as the regression coefficients are positive, insignificant, and very small.

***Originality/Scientific Novelty*:** This research is the first (particularly in Indonesia) to analyze COVID-19's impacts on economic growth with regard to food and agriculture sector using an econometric operation with time series statistical data, covering data during the pandemic. Therefore, the parameter test results have higher predictability.

***Practical Value/Implication*:** This study presents evidence that COVID-19 pandemic influences economic growth not through disruption of production in the agriculture and food and beverage sectors, but induction by demand. Therefore, the most appropriate policy to deal with the crisis is to simultaneously handle health aspect as the source of crisis and maintain demand for agricultural and food products directly through fiscal stimulus in the form of social safety net for poor and near-poor households and indirectly through supporting micro, small and medium enterprises (MSMEs) from bankruptcy in the prevention of mass unemployment. In the future, however, there will be a need to further study agricultural resilience by subsector and investigate food and beverage industry's role in an open economic model. In addition, it is quite advisable to further study the impacts of the government's safety net program in the form of basic food aid and delivery cost subsidy for online shopping to encourage growth from the demand part that may keep farmers producing and serving demand through contactless marketing.

***Key Words*:** food and agricultural sector; agriculture, food, and economic growth; financial

crisis; COVID-19 pandemic and agriculture; Indonesia's economy.

Introduction and Literature Review. Globalization, which makes countries interdependent, contributes to global economic prosperity through trade liberalization and capital transfer ([1]; [2]; [3]). On the other hand, however, globalization also poses the risk of vulnerability to economic shocks. Close economic linkages result in immediate contagious effect, where a financial/economic crisis/shock in one country has harmful transmission in various countries without distinguishing between those with developing or advanced economies ([4]; [5]). As a consequence of such negative impacts, some criticize globalization [6]. Financial crises have occurred more frequently and at shorter intervals [7]. There were 11 financial crises from 1901-1990 (in 90 years), but in the last 30 years (1991-2019), the world had suffered 18 financial crises, 11 of which occurred in the 21st century (2001-2019). As [8] has mentioned, the next financial crisis is imminent – we do not know where it is coming from.

Financial crises no longer only originate from the financial sector, but also from external factors such as zoonotic disasters like viral spread resulting in death and significant economic contraction ([9]; [10]). The world has witnessed Flu development since Spanish Flu in 1918, followed by Asian Flu (1957), Hong Kong Flu (1986), Avian Flu (H5N1 and H7N7) since 1997, SARS (2002), Mexican Flu (H1N1) in 2009 and Corona (COVID-19) in 2020 and 2021. Biological disasters, in this case, the spread of various types of Flu, show a high frequency and fast emergence of new types of viruses. On this basis, [11, p. 15] warns that "the flu pandemic is at our doorstep." Thus, a zoonotic disaster such as the COVID-19 outbreak is not accurately called a black swan event [12], and therefore measures need to be prepared to deal with their future reoccurrence ([13]; [14]).

The COVID-19 pandemic is a disaster in almost all fields, including ([15]; [16]; [17]; [18]): health, environment, social, and global economy. Likewise, the pandemic has had an uneven impact on industries and businesses, affecting the workforce and individual economy ([12]; [19]). Close-contact industry and service are the areas affected the most, e.g. [6]. To restrain the viral spread through personal contact, almost all governments throughout the world implemented quarantine measures covering [20]: school closure, workplace closure, cancellation of public events, restriction of public gatherings, restriction of internal movements, and international travel control. The lockdown and mobility restrictions created economic stress, resulting in a pandemic-induced recession and mass job losses and, subsequently, a shortfall in income ([21]; [19]; [17]).

Various sectors have implemented work-from-home recommendations in order to hold down the spread of Covid-19. However, working from home is impractical for the food and agriculture sector since its various stages of operations require workers' presence on site regularly. Thus, the pandemic will shock the supply and demand parts of the market through disruption in at least one of the five phases of the food supply chain [15], including agricultural production, postharvest handling, processing, distribution/retail/services, and consumption. In the production phase,

farmers in developed countries face situations that contrast with those in developing countries, especially in Asia. In European countries, Canada, and the United States, farmers are generally unable to do their activities due to lack of seasonal workers for non-food crop cultivation such as fruits and vegetables that rely on hired labors for planting and harvesting [16]. In Asian countries such as India, which are dominated by small farms, the pandemic's impact on agricultural production is minimal as labors available from family members are plentiful. Lockdowns have forced migrant workers, as well as small-scale shopkeepers, to close their businesses and return home in reverse migration [22]. This phenomenon is more popularly known as de-urbanization in Pacific Island Countries [23]. Furthermore, most small farmers run their farms like usual, continuing to grow the same crops with nothing changing in input use [24].

Disruptions in the distribution phases occur in all countries for two reasons, domestically due to travel restrictions and internationally many countries close their borders in the prevention of viral spread. In a looser form, there is mandatory two-week quarantine for people from abroad. This reduces exports, especially perishable agricultural products such as fruits and vegetables. Disruptions in the procurement of agricultural products for raw materials in the food processing industry have hampered food production, disrupting the global food system [25]. This way, [17] believes that distribution disruption–especially agri-food products - can potentially be as damaging as the pandemic itself. Various studies conclude that COVID-19 negatively affects agriculture across all four pillars of food security - availability, access, utilization, and stability/reliability ([26]; [19]; [27]). The reason is that the pandemic has threatened people's food security worldwide and may potentially magnify the acute hunger caused by war-induced conflict and climate change [22]. Thus, COVID-19 pandemic has widely exposed the global agri-food system's vulnerability to shocks and stresses [16] which before covid-19 pandemic was already facing serious threats in the context of global food and nutritional security [19]; in other words, COVID-19 pandemic has put the global food supply system under the most robust test [22].

Indonesia is not exempted from COVID-19's impact. Its proximity to China and the close relation between governments, businesses, and personal ASEAN fellows have resulted in very high mobility of capital, goods, and persons across ASEAN countries. Even in case of slow discovery of virus transmission and the spread is concentrated in Java and some big cities outside Java, this is more due to Indonesia's geographical condition as an archipelago. The Indonesian Government has also implemented various restrictions to halt the virus transmission internally and externally from abroad. This step will shock the economy, including the food and agriculture sector.

The food and agriculture sector is one key sector of Indonesia's economy. This sector contributed about 20% to the 2019 GDP (prior to the COVID-19 pandemic), where the agricultural sector decreased while the food and beverage manufacturing sector increased to offset the decline agricultural sector. Nevertheless, agriculture's overall contribution to GDP is more significant since the food industry relies on

agricultural inputs to contribute added value to the economy. Apart from food and beverage manufacturing, sectors related to agriculture include food services and eating and drinking places. In USA's experience, agricultural food, and related industries contributed about ten times the output of America's farms to GDP [28]. Apart from that, for most Indonesian households, farming, and plantations remain the vital income generators. In 2022 the agricultural sector provided jobs to approximately 40.6 million Indonesians, representing 30% of the country's total labor force. Thus, agriculture is still the sector contributing the most to employment, followed by the wholesale and retail, industry, and eating and drinking sectors, 19%, 14%, and 7%, respectively.

Given the strategic position of Indonesia's food and agriculture sector, it is essential to understand COVID-19 pandemic's impact on this sector. The research results are a provision to address the possibility of external turmoil due to financial crises and zoonotic disasters that shocked the world economy recently and are likely to recur.

The agricultural sector plays a key role in Indonesia's economy due to its positive impact on economic growth and other sectors' growth [29]. Thus, agriculture can be categorized as an engine of growth, and in Indonesia, the agriculture-led growth hypothesis applies [30]. Whether the impact of agriculture (raw material production) and processed goods (food and beverage industry) on Indonesia's economic growth is disrupted by COVID-19 pandemic is this study's main question.

So far, many studies on the impact of COVID-19 on agriculture are mostly in the form of literature reviews both at global level such as ([15], [27], [31]) and [32] and more specifically at national level such as [33] for the United States, [34] for Turkey, and [35] for India. Research employing econometric analysis is still greatly limited to cross-section data collected from primary data, which cannot provide long-term predictions such as [16] comparing the impact and response of adaptation in the US, Norway, and China; [25] examining agricultural resilience in California with special attention to agricultural marketing aspects; [22] in India; and [36] in Nigeria. This study is the first (at least for Indonesia) to use time-series data, covering 11 observations on a quarterly basis during COVID-19 pandemic, the first quarter of 2020 to the third quarter of 2022 (Q1 2020 to Q3 2022) using a dummy variable to cover include more than 30 observations. Hence, it is feasible to carry out econometric operations properly.

The article's objective. This study aims to assess the impact of COVID-19 on the food and agriculture sector's role in Indonesia's economic growth with a specific formulation: to find out the causal relation between agricultural sector's output, food and beverage manufacturing's output, and Indonesia's economic growth during COVID-19 pandemic.

Method. To analyze food and agriculture sector's role in economic growth, we broke food and agriculture sector down into agricultural output (Agri), and food and beverage manufacturing output (FnB); Gross Domestic Product (GDP) represented economic growth. Studies have been conducted to uncover the causal relationship

between GDP and constituent variables (pseudo-supply-side analysis: agricultural and economic growth) by [37] for North Cyprus and [38] for Tunisia. Observations during the COVID-19 pandemic used dummy variables with the value one, i.e., from Q1 of 2020 to Q3 of 2022, while data before 2020 were zero. Quarterly data on GDP, agricultural output (Agri), and food and beverage manufacturing output (FnB) are available in "*Statistik Ekonomi Keuangan Indonesia*" (Indonesian Economic and Financial Statistics) published monthly by Bank Indonesia (Indonesia's Central Bank). The whole data are in billions of Rupiah (IDR) at constant prices (2010=100) and transformed into a logarithm. The analysis covers 31 quarters for eight years (2015 - 2022).

The cointegration and error correction model is superior to the traditional regression method in determining the effect of one variable on another, since [39]: (i) cointegration techniques test the long run theoretical relation between variables and Granger causality between variables, while traditional regression techniques only make assumptions of the theoretical relationship between variables, (ii) financial variables are mostly non-stationary, thus, ordinary regression operations on such variables will have invalid results, given that statistical tests such as t-ratio and F-statistics are statistically invalid when applied to non-stationary variables. Regression operations in the differential form of these variables will solve one problem, while regression operations in the variables in their differential form will effectively eliminate the long-run trend. Thus, differential regression variables only capture short-term, cyclical, or seasonal effects. Regression in differential form does not test long-run or theoretical relations, (iii) the data empirically prove causality in cointegration, whereas in traditional regression, causality is only a presumption.

This study employed the autoregressive distributed lag (ARDL) bound test to cointegration. The ARDL approach was an OLS-based dynamic econometric model. This model is considered superior for small samples and does not require stationary variables to be of the same order as long as they are in I(0) and I(1) ([40]; [41]).

Unit root test was used to check whether variables were stationary. If the variable were not stationary [42]: (i) the behavior studied was only limited to the period under observation. Thus, each variable was a particular episode that was unlikely to be generalized for other time periods, thus it had little practical value for forecasting purposes, (ii) the analysis carried out would produce an invalid or nonsensical regression. The most prevalent unit root test is the augmented Dickey-Fuller (ADF) test. In brief, [43] formulates the order p ADF regression as follows:

$$\Delta Y_t = \alpha + \mu (1- Ø)_t - (1- Ø) Y_{t-1} + \sum_{i=1}^{p} \psi_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

which is a combination of three Dickey-Fuller tests, including random walk, model without drift, and model with drift [42]. In equation (1), Y is the time series variable, ε_t is the white noise error term and p is chosen that the residuals of the equation, ε_t, are not serially correlated. In practice, model selection criteria such as Akaike

information criterion (AIC), or Schwarz Bayesian Criterion (SBC), are used to select *p*. The unit root hypothesis is

$$H_0: Ø = 1 \text{ against } H_1: |Ø| < 1$$

According to [44], Phillips-Perron (PP) unit root test is more robust in an error term process. The PP unit root test is an extension of Dicky-Fuller test. The PP test corrects serial correlation and heteroscedasticity in the error term of the test regression equation (1). The PP unit root test operation steps, models with intercept and with and without trend can be observed in [43].

The ARDL model can generate a dynamic error correction (ECM) model that integrates short-run dynamics and long-run equilibrium through a simple transformation. This advantage makes ARDL bound test to cointegration increasingly popular and widely used recently ([44], [45], [46], [47], and [48]). According to [39], ARDL bound test approach gives efficient and reliable results once a single equation cointegration relation exists among the variables. The Granger procedure also tests the direction of causality in the vector error correction (VECM) models. If a set of variables is cointegrated, they are guaranteed to have an error correction term (ECT). The advantage of VECM is the reintroduction of information lost due to difference in time series. This step is crucial for investigating short-run dynamics and long-run equilibrium.

Equation (2) presents the long-run relationship between economic growth and food and agriculture sector:

$$GDP_t = \beta_0 + \beta_1 Agri_t + \beta_2 FnB_t + DUM + \varepsilon_t \quad (2)$$

The ARDL bound test to cointegration model, which is an unrestricted ECM (error correction model) for equation (2), is formulated in equation (3).

$$\Delta GDPt = \beta_0 + \beta_1 Agri_{t-1} + \beta_2 FnB_{t-1} + \sum_{i=1}^{p} \alpha i \, \Delta GDP_{t-i} + \sum_{j=1}^{q} \alpha j \, \Delta Agri_{t-j} + \sum_{k=1}^{r} \alpha k \, \Delta FnB_{t-k} + DUM + \varepsilon_t \quad (3)$$

p, q, and *r* are the optimal lags with their respective variables and ε_t is the error term. The bound testing procedure tests the joint F-statistic of the null hypothesis of no cointegration relation:

$$H_0: \beta_1 = \beta_2 = 0, \quad \text{against the alternative} \quad H_1: \beta_1 \neq \beta_2 \neq 0$$

The cointegration test results from the F-statistics obtained using the ARDL bound test are found. If the F-statistic is higher than the upper critical bound (UCB), there is cointegration, but if it is lower than the low critical bound (LCB), there is no cointegration among the variables ([41]; [48]). The long-run relations are

inconclusive if LCB<F-statistic<UCB [49]. In case of evidence of a long-run relation (cointegration) between the variables, the steps to estimate the long-run and the short-run models are presented in equation (4).

$$\Delta \text{GDPt} = \beta_0 + \sum_{i=1}^{p} \alpha i \, \Delta \text{GDP}_{t\text{-}i} + \sum_{j=1}^{q} \alpha j \, \Delta \text{Agri}_{t\text{-}j} + \sum_{k=1}^{r} \alpha k \, \Delta \text{FnB}_{t\text{-}k} + \text{DUM} + \psi \, \text{ECT}_{t\text{-}1} + \varepsilon_t \quad (4)$$

where ψ is the coefficient of error correction term (ECT), representing the variable's adjustment speed to long-run equilibrium after a shock.

The long-run and short-run causality between agricultural output, food and beverage manufacturing output, and economic growth is investigated using Granger causality with vector error correction. Granger causality is expressed in matrix form, as formulated in the model in equation (5).

$$(1-\text{L}) \begin{bmatrix} \text{GDP}_t \\ \text{Agr}_t \\ \text{FnB}_t \end{bmatrix} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix} + \sum_{i=1}^{p} (1-\text{L}) \begin{bmatrix} \alpha_{11}\alpha_{12}\alpha_{13} \\ \beta_{21}\beta_{22}\beta_{23} \\ \gamma_{31}\gamma_{32}\gamma_{33} \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \end{bmatrix} \begin{bmatrix} \text{GDP}_{t-1} \\ \text{Agr}_{t-1} \\ \text{FnB}_{t-1} \end{bmatrix} \text{ECT}_{t\text{-}1} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \quad (5)$$

where (1-L) is the difference in operator. Long-run causality is determined by the significance of the lagged error coefficient, while short-run causality is determined by the significance of the F-statistic using the Wald test.

Results and Discussion. First of all, this section describes the spread of COVID-19 in Indonesia, along with the food and agriculture sector's condition during the pandemic. This is followed by the analysis on the correlation between the agricultural sector, food and beverage manufacturing, and economic growth using ARDL approach. The ARDL approach was performed in the following steps: unit root test, cointegration test, and causality analysis.

COVID-19 Spread in Indonesia. Various efforts had been conducted to prevent COVID-19 entry into Indonesia, especially at cross-country entry points such as seaports and airports, but Indonesia could not isolate itself from the COVID-19 pandemic. The first case was confirmed on 2 March 2020, and the first death case was confirmed on 11 March 2020, coinciding with WHO's declaration of COVID-19 as a global pandemic. In just one month, the whole 34 Indonesian provinces reported the viral spread. Until Q3 2022, Indonesia went through three different major infection waves which are closely related to viral mutations with different variants, including: Q1 2021 (Alpha Wave) reaching peak in the fourth week of January, Q3 2021 (Delta Wave) in the second week of July, and Q1 2022 (Omicron Wave) in the second week of March [50].

The Indonesian Government declared COVID-19 a non-natural disaster on 14 April 2020 under Presidential Decree No. 12. On that day, the total cases reached 4,839, with 400 total deaths and 60 daily deaths. Besides the mitigation measures through mobility restrictions and health campaigns such as wearing masks, washing hands with soap, and social distancing/avoiding crowds, the government also launched a program called the national economic recovery with components covering

basic food aid, wage subsidies, pre-employment cards, etc., including online shopping fee subsidies, aiming to drive the economy and maintain food security for those affected, countless informal sector workers who practically ceased their activities. In 2020 there were 56.64% workforce in the informal sector.

As the consequence of the pandemic, from 2020 to 2022, labor statistics show the formal sector contracted by 6%. The informal sector increased by 15.6%, indicating that the government's various economic recovery programs played a more significant role in boosting the economic activities in the informal sector, including opening up opportunities for those laid off from the formal sector to start businesses in the informal sector.

Vaccination, a permanent solution to the COVID-19 pandemic, had only been implemented in Indonesia from 13 January 2021, targeting four vaccine doses for every person. As the vaccination started, the cases had reached over 850,000, with death toll up to 25,000 people. Until the end of 2022, 87.5% of the population had been vaccinated with one dose, and 73.5% had been fully vaccinated (two doses). 160 thousand people died, and 6.65 million were infected [51].

Indonesia's Food and Agriculture Sector during COVID-19 Pandemic. Overall, Indonesia's economy went into recession in Q2 2020 when there was little understanding of COVID-19, so information on mitigation measures needed greater consistency. For example, the health ministry stated that those healthy did not need to wear medical masks. Only those sick and health workers were to wear masks. In the face of this misunderstanding, many local governments took measures, some even applied lockdowns by closing cross-regional roads and curfew to main urban roads. This step paralyzed the economic activities, while on the other hand, the government's economic recovery policies were still formulated, especially related to the target groups and distribution mechanism. Indonesia's GDP contracted 5.32% year-on-year by Q2 2020. GDP continued to recover, but until Q3 2022, the GDP growth was below the pre-pandemic trend, as shown in figure 1.

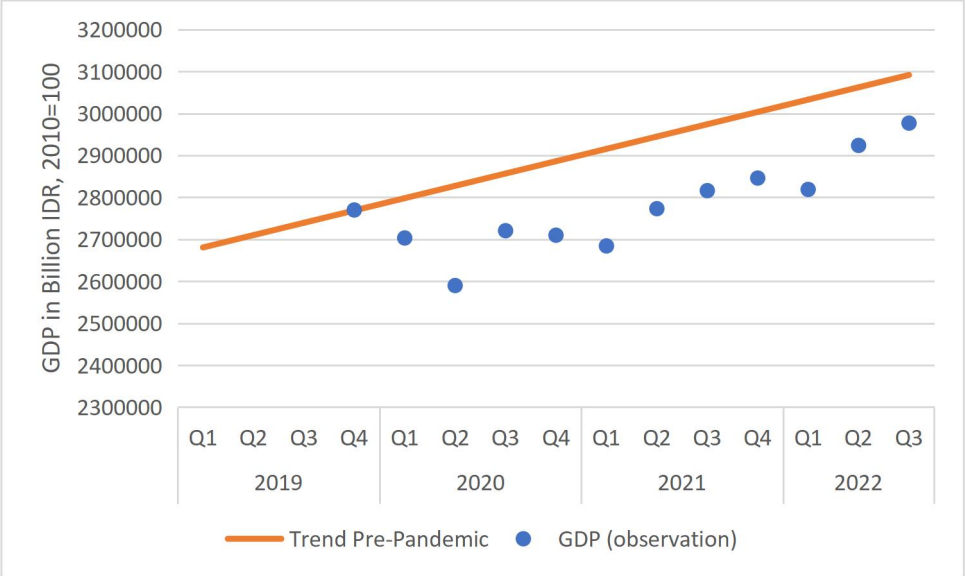

Figure 1. Indonesia's Economic Growth during COVID-19 Pandemic Compared to Pre-Pandemic Trend (in Billion IDR, 2010=100)

Source: Author's estimation.

The agricultural output shows a seasonal oscillatory pattern. Production peaks in the second quarter each year, then declines and reaches the lowest point in the fourth quarter to increase again in the next quarter. This pattern applied to pre-pandemic and did not change during the pandemic. This seasonality applies to the five main agricultural sub-sectors: food, horticulture, plantation, livestock, and fisheries. Table 1 presents the growth of agricultural output per subsector year-on-year (y-o-y) and quarter-on-quarter (q-o-q).

Table 1

Indonesia's Agricultural Output Growth per Subsector 2019 – 2022 (in %)

Year	Quarter	Food		Horticulture		Plantation		Livestock		Fisheries	
		y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q
2019	Q1	-6.02	73.49	6.18	7.06	3.36	-0.03	7.87	8.84	5.66	1.88
	Q2	5.05	10.70	6.06	23.79	4.50	28.14	7.70	4.22	5.59	-0.26
	Q3	-4.73	-11.27	12.38	6.96	4.96	10.41	7.69	0.49	5.68	1.90
	Q4	-1.08	-41.95	4.92	-25.99	5.23	-25.60	7.86	-5.38	5.50	1.88
2020	Q1	-10.25	57.40	2.61	4.70	3.97	-1.22	2.68	3.62	3.52	-0.03
	Q2	9.24	34.74	0.94	21.78	0.18	23.46	-1.90	-0.43	-0.63	-4.26
	Q3	7.24	-12.89	-1.23	4.66	0.68	10.97	-0.24	2.19	-1.03	1.50
	Q4	26.06	-31.76	7.85	-19.18	1.14	-25.26	-1.88	-6.93	1.06	4.03
2021	Q1	12.24	40.14	3.27	0.26	2.17	-0.22	2.12	7.84	-1.31	-2.37
	Q2	-7.97	10.48	1.85	20.10	0.32	21.23	6.74	4.08	9.69	6.41
	Q3	-5.66	-10.71	-5.22	-2.60	8.33	19.83	-2.47	-6.63	4.55	-3.25
	Q4	-13.96	-37.77	3.80	-11.50	2.28	-29.44	-5.24	-9.58	8.99	8.44
2022	Q1	-0.08	62.74	3.31	-0.20	-0.24	-2.68	6.92	21.69	-0.51	-10.89
	Q2	1.11	11.81	1.23	17.67	0.68	22.35	3.56	0.81	2.73	9.87
	Q3	-7.97	-18.73	5.56	1.57	2.74	22.28	7.40	-3.17	6.38	0.19

Source: Author's calculation.

Table 1 shows Indonesia's agricultural production is not affected by COVID-19 pandemic as generally occurring in Asia ([22]; [24]). Overall, the agricultural sector's GDP growth follows the pre-pandemic trend. Every second and third quarters are above the trend, and the fourth and first quarters are below the pre-pandemic trend, as shown in Figure 2.

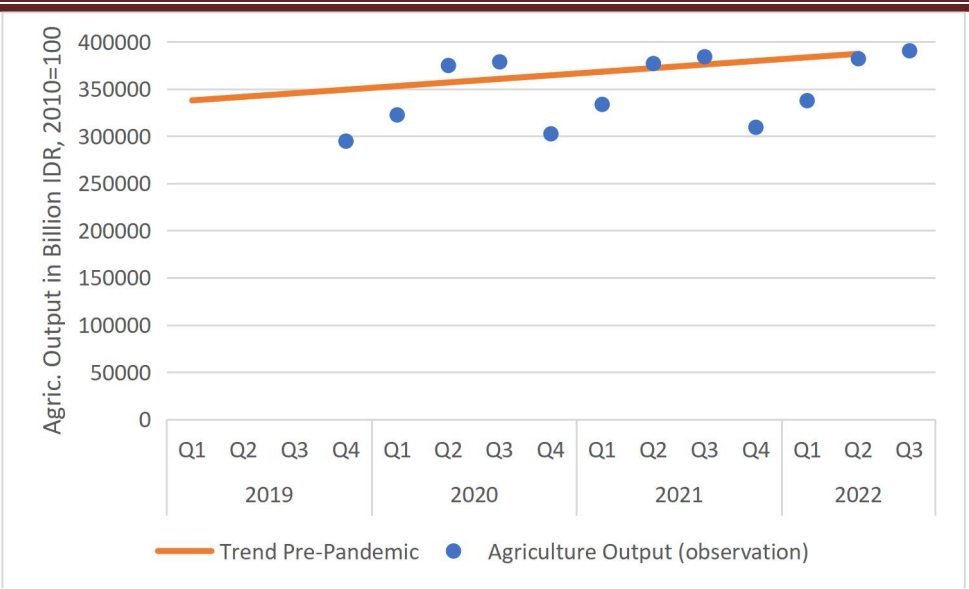

Figure 2. Indonesia's Agricultural Output Growth during Pandemic COVID-19 Compared to Pre-Pandemic Trend

Source: Author's calculation.

As numerous studies have reported e.g. ([6]; [21]; [52]; [26]; [19]), the restrictive measures to deal with the spread of COVID-19 had disrupted the economic activities in service and manufacturing sectors which were close-contact-related. The food and beverage manufacture also belongs in this category at a certain level. Likewise, during a pandemic, this sector always recorded positive growth (year-on-year) that continued since Q1 2014. Meanwhile, the quarter-on-quarter growth tends to follow the agricultural sector's seasonal pattern as the supplier of raw materials, which posts negative growth in the 4th quarter each year. The food and agriculture exports had positive growth (year-on-year) during the pandemic after having pressure from 2018-2019 due to the USA-China trade war (in 2018, the US and China imposed high import tariffs on each other, and these retaliatory actions evolved into a US-China trade war [53]. Bilateral trade disputes have far-reaching consequences beyond the countries involved in the dispute and beyond the commodities restricted [54]. The negative spillover impacts of this trade war on Indonesian exports are as described by [55]). Likewise, the quarter-on-quarter growth contracted in six out of the 11 quarters observed. Thus, trade barriers such as closing borders and quarantining ports for two weeks also affect Indonesia's exports even on practically non-perishable goods such as CPO (crude palm oil) and crumb rubber. Indonesia's food and agricultural exports grew 34.81% (quarter-on-quarter) and 12.36% (year-on-year) in quarter 3 of 2022. Indonesia's GDP growth, along with selected components including agricultural output, food and beverage manufacturing, and food and agricultural exports, is presented in table 2.

Table 2

Indonesia's GDP Growth and Selected Sectors, 2018-2022 (in %)

Year	Quarter	GDP		Agriculture		Food and Beverage		Food and Agric. Export	
		y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q	y-o-y	q-o-q
2018	Q1	5.06	-0.41	3.34	16.41	12.77	-0.77	-9.54	-10.39
	Q2	5.27	4.21	4.74	10.02	8.39	4.46	-4.59	-8.28
	Q3	5.17	3.09	3.67	3.21	8.10	3.45	-0.35	14.03
	Q4	5.18	-1.69	3.92	-21.39	2.74	-4.20	-10.01	-4.00
2019	Q1	5.07	-0.52	1.86	14.10	6.77	3.13	-13.65	-14.01
	Q2	5.05	4.20	5.33	13.77	7.99	5.65	-13.22	-7.81
	Q3	5.01	3.05	3.06	0.99	8.33	3.78	-13.49	13.68
	Q4	4.96	-1.74	4.24	-20.48	7.95	-4.54	3.70	15.08
2020	Q1	2.97	-2.41	-0.02	9.43	3.94	-0.70	9.96	-8.82
	Q2	-5.32	-4.19	2.15	16.24	0.22	1.87	7.85	-9.59
	Q3	-3.48	5.05	2.17	1.01	0.66	4.23	11.40	17.42
	Q4	-2.17	-0.40	2.63	-20.13	1.66	-3.59	26.30	30.47
2021	Q1	-0.70	-0.94	3.45	10.31	2.45	0.07	38.42	-0.07
	Q2	7.07	3.31	0.53	12.95	2.95	2.37	59.19	3.98
	Q3	3.51	1.55	1.43	1.92	3.49	4.78	74.86	28.98
	Q4	5.02	1.06	2.28	-19.46	1.23	-5.69	27.53	-4.85
2022	Q1	5.01	-0.95	1.19	9.14	3.75	2.56	15.53	-9.47
	Q2	5.44	3.72	1.37	13.15	3.68	2.30	7.50	-3.24
	Q3	5.72	1.82	1.65	2.20	3.57	4.67	12.36	34.81

Source: Author's Calculation.

The Nexus between Agriculture, Food and Beverage Manufacture and Economic Growth. An ARDL bound test was employed to estimate the effect of agriculture's output and the output of food and beverage manufacture on economic growth and their causal relation. The unit root test was conducted to ascertain that there were no variables stationary in order two [I(2)], or more. This study used two different test tools, ADF (augmented Dicky-Fuller) and PP (Phillips-Perron), with and without trend. Table 3 displays the test results. All variables are stationary at I(0) or I(1). According to Phillips-Perron, all variables (GDP, agriculture's output and food and beverage manufacture's output) are stationary at 1% level of significance at the first different intercept and intercept and trend. The unit root results render the ARDL technique valid in estimating food and agriculture sector's influence on Indonesia's economic growth.

Table 3

Unit Root Test Result

Variable		ADF		PP	
		Intercept	Trend and Intercept	Intercept	Trend and Intercept
Level	GDP	-0.9729	-3.1037	-1.5009	-3.0738
	Agri	-2.9544*	0.2921	-4.3143***	-8.0966***
	FnB	-2.3351	-1.2824	-2.3121	-3.1994
First difference	Δ GDP	-7.4852***	-7.3663***	-7.4959***	-7.5695***
	Δ Agri	-0.7670	-69.8297***	10.6932***	-10.4437***
	Δ FnB	-1.6672	-2.6433	-8.1541***	-8.9162***

Source: Author's computation using EViews 10.
Note: *, ** and *** are significant at $p < 0.1$, $p < 0.05$, and $p < 0.01$, respectively.

Table 4 displays the ARDL bound test results as formulated in equation (3). It is obvious that all of the three equations produce F-statistic bound test values higher than the upper critical bound at 1% confidence level. Thus, we may conclude there is a long-run relation among the variables.

Table 4

ARDL Cointegration Test Results

Estimated models	Optimal lag length	F-bound test	Decision
GDP | Agri, FnB, DUM	(1,0,1,0)	13.7166	Cointegration
Agri | GDP, FnB, DUM	(1,1,1,0)	18.8684	Cointegration
FnB | GDP, Agri, DUM	(1,0,0,0)	18.4200	Cointegration
	Significant (finite sample, n = 30)		
		Lower bound, I(0)	Upper bound, I(1)
	10%	2.676	3.586
	5%	3.272	4.306
	1%	4.614	5.966

Source: Author's computation using EViews 10.

Confirmation of the long-run cointegration relation is a condition for using ARDL to estimate the long-run model. As a result, there is a tendency for the variables to move together toward the long-run equilibrium. Table 5 presents the results of coefficients estimated using the ARDL model and the results of the error correction model (ECM), respectively. In the long run, agriculture and food and beverage manufacture positively and significantly influence economic growth. The food and beverage industry's influence is greater on economic growth than agricultural output, where 1% growth of the food industry will lead to 0.23% economic growth, while an increase in agricultural output will only contribute 0.10% respectively. COVID-19 pandemic negative influences economic growth, but this impact is insignificant. However, the simultaneous effect of COVID-19 pandemic and agriculture and food and beverage manufacture is significant on Indonesia's

economic growth. In the short run, only agriculture has a causal relation with economic growth. The system will return to long-run equilibrium in case of short-run shock, at adjustment speed of 48.60% per quarter.

Table 5

Results of Coefficient Estimation of Long- and Short-run Economic Growth Equation

ARDL Regression Dependent variable: GDP, ARDL (1,0,1,0)			ECM Regression Dependent variable: Δ GDP		
Independent variable	Coefficient	t-statistic	Independent variable	Coefficient	t-statistic
GDP_{t-1}	0.5140	3.6549***	Δ Agri	0.1022	5.8433***
Agri	0.1022	2.2085**	ECT	-0.4860	-8.9450***
$Agri_{t-1}$	0.0634	2.0717**			
FnB	0.2320	2.0549**			
DUM	-0.0124	-1.6012			
R2 = 0.9731 F-stat = 173.9342 *** Residual diagnostic: there is no heteroscedasticity, serial correlation, autocorrelation, or partial correlation.					

Source: Author's computation using EViews 10.
Note: ***, **, and * are significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

The stability test on the economic growth model, as presented in table 5, is stable according to CUSUM (the cumulative sum of recursive residuals) and CUSUMSQ (the cumulative sum of squares of recursive residuals). Figure 3 presents the test results.

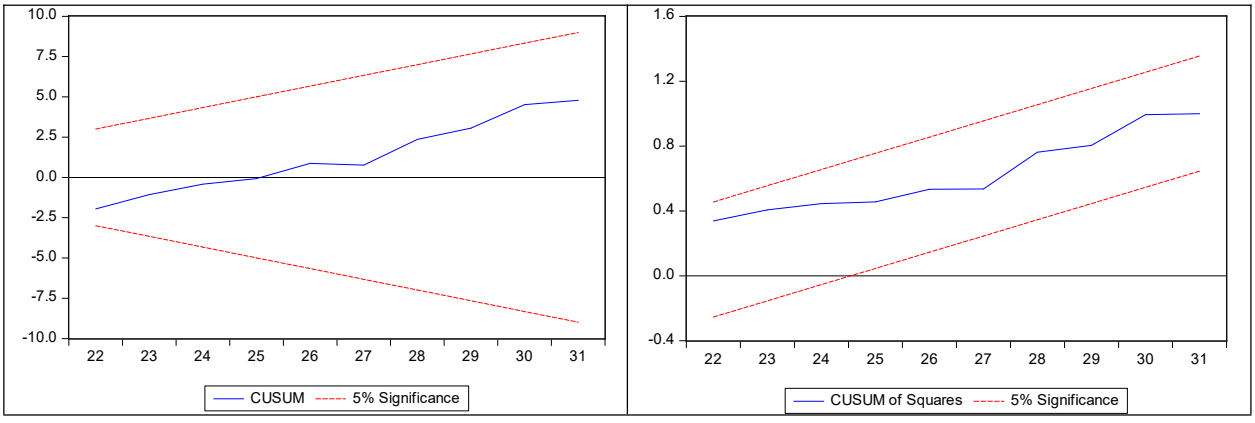

Figure 3. Stability test of Economic Growth Model

Source: Author computation, EViews 10.

Cointegration in a model indicates that at least one independent variable has a causal relation with the dependent variable. The analysis continued with the ARDL-Granger test, of which results are shown in table 6. The three variables have a long-

run causal relation, and their causality is bi-directional (dynamic relation). There is no significant impact of COVID-19 in all of the three equations, as the DUM's (dummy variable represented the situation during COVID-19 pandemic) coefficient is insignificant. However, in the short run, only agriculture has a causal relation with economic growth (GDP). Meanwhile, economic growth has a causal relationship with agriculture in the short- and long-run. In contrast, the causal relation between economic growth and food and beverage manufacture only appears in the long run.

Table 6

ARDL-Granger Causality Analysis

Dependent variable	ARDL optimal lag	Short run causality (F-stat of Wald-test)				ECT
		Δ GDP	Δ Agri	Δ FnB	DUM	
Δ GDP	(1,0,1,0)	-	0.1022**	0.2320	-0.0124	-0.4860***
Δ Agri	(1,1,1,0)	1.5431**	-	1.5321***	0.0323	-1.1971***
Δ FnB	(1,0,0,0)	0.5631	0.2037	-	0.0063	-0.4976***

Source: Author's computation using EViews 10.
Note: ***, **, and * are significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.

The three variables have a long-run causal relation, and their causality is bi-directional (dynamic relation). Highlighting the short-run causal relations between these variables, the information in table 6 is presented in the form of drawing as in figure 4.

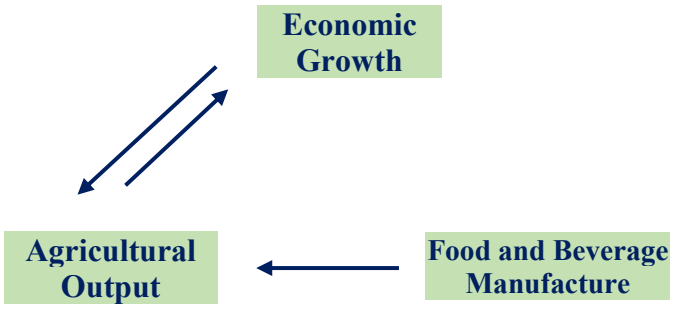

Figure 4. Short-run ARDL-Granger Causality of Agricultural Output, Food and Beverage Manufacture's Output and Economic Growth

The economic growth model in equation (2), of which regression estimation results are as shown in Table 5, indicates a dummy variable representing covid-19 pandemic does not change the agriculture and food industry sectors' role in Indonesia's economic growth, as the results of studies by [30] and [29]. Both agriculture and food and beverage manufacturing positively and significantly influence Indonesia's GDP with food processing industry sector's greater contribution. A 1% increase in food and beverage manufacturing output and agricultural output will have GDP increased by 0.23% and 0.10%, respectively. The dummy variable's

regression coefficient is negative, indicating that COVID-19 pandemic negatively influences Indonesia's economic growth despite its partial insignificance. Nevertheless, COVID-19 pandemic's negative effect cannot be disregarded completely considering that simultaneously, along with agricultural production and food industry, COVID-19 pandemic has a significant effect as indicated by the F-test of regression estimation which is significant at 1%. Likewise, with a regression coefficient of - 0.01, COVID-19 pandemic is not strong enough to disrupt the influence of agriculture and food processing industry on Indonesia's economic growth. In the short run, COVID-19 pandemic's effect does not appear at all.

The economic growth with regard to the food processing industry sector's production partially and simultaneously shows a positive and significant impact on the growth of Indonesia's agricultural sector. Although the agricultural sector's contribution to GDP decreases continuously, agriculture still serves a crucial role as food provider to satisfy household's needs for private consumption, which is the main component of Indonesia's GDP from the demand part, and as supplier of raw materials for food industry. A 1% increase in GDP will encourage the agricultural sector to stimulate an increase in production by 1.54% while food and beverage manufacturing's output growth will encourage an increase in agricultural output by 1.53%. COVID-19 pandemic has no negative impact on agricultural production as indicated by the dummy variable's positive but insignificant regression coefficient. This confirms the estimate of [20] that the pandemic hit less agriculture in China, Indonesia, and Lao PDR.

In analyzing the pandemic conditions, in the short run the estimated regression coefficients on the agricultural output equation can also be interpreted in reverse, i.e. if Indonesia's economy contracts by 1%, the agricultural production will decrease by 1.54%. Likewise, if food and beverage manufacturing output decreased by 1%, the agricultural output will also decrease by 1.53%. This study's results can thus generalize previous study results that use cross-section data and conclude that changes in the agricultural output are mostly induced by demand part e.g. [53] through the following mechanism: unemployment due to lockdown measures and mobility restrictions have resulted in a shortfall in income ([21]; [19]; [17]), thus the demand for agricultural products both directly and through related industries decreases. Therefore, COVID-19 pandemic is more of a supply-chain bottleneck problem ([52]; [26]; [32]) rather than a production problem. The economic growth model indicates a dummy variable representing covid-19 pandemic does not change agriculture and food industry sectors' role in Indonesia's economic growth, as the results of studies by [30] and [29].

It is also to note that the agricultural equation's ECT is higher than one (table 6), reflecting the seasonal pattern of production in Indonesia's agricultural sector resulting in an oscillating pattern of adjustment to shocks. This conforms to Figure 2 illustrating that during COVID-19 pandemic, the agricultural production pattern has not changed. According to [56 p. 339], the error correction term with a coefficient -1 to -2 means that it does not converge monotonically to the equilibrium path directly,

but rather the error correction process fluctuates around the long-run value in a dampening manner. Once this process is complete, the convergence to the equilibrium path is rapid. According to [48], the deviation from the long-run equilibrium level of agricultural output in the current period is corrected by 119.71 percent in the next period to restore equilibrium when there is a shock to the steady-state relation, but an ECT higher than 100 percent means it has a type of convergence that oscillates to the long-run equilibrium and takes less than a quarter of the time to return to the long-run.

In the short run, there is no noticeable effect of economic growth or agricultural production on the food industry. The relation between these three variables is only noticeable in the long run with a dynamic causality pattern. In the long run, GDP and agricultural output both partially and simultaneously have a positive and significant effect on food and beverage manufacturing, where GDP's influence is greater than agriculture's effect. A 1% increase in GDP and agricultural output will increase food and beverage processing industry's output by 0.56% and 0.20%, respectively. COVID-19 pandemic does not negatively affect Indonesia's food industry since the regression coefficient results are positive and insignificant. Although the simultaneous effect of COVID-19 and the other two variables is significant, this effect is very small with a regression coefficient 0.0063. Thus, the opinion of [20] that COVID-19 pandemic negatively influences manufacturing industry, taking double blows of disruptions to the supply of raw materials and capital goods and logistics shortages, cannot be generalized for Indonesia's food and beverage industry.

According to [20] Indonesia's economy recovered faster and [57], argued that in that recovery, the agricultural sector played a very important role. In comparison, the Asian financial crisis in 1997/1998 took about 20 quarters for Indonesia's economy to recover to the pre-crisis levels, while the COVID-19 crisis took only six quarters to reach the pre-pandemic levels. Thus, in the face of COVID-19 pandemic, Indonesia's economy not only did not fall too deeply (Q2-2020 GDP contracted by 4.4%, below that of Thailand, Singapore, Malaysia, and the Philippines, which contracted by 9.2%; 9.6%; 9.9%; and 14.3% respectively), but it also recovered quickly. This was predicted by [58] that if the pandemic could be controlled, the country's economy would recover.

Several factors supported Indonesia's economy not falling too deeply in the face of crisis, categorized as the worst crisis of all time after the great depression of the 1920s [59]. One contributing factor was the character of Indonesia's agricultural sector, as the economy's driving force in times of crisis, as it was in the previous financial crises in 1998 and 2008. During times of crisis, most laborers, especially low-skilled laborers, will shift to the agricultural sector [60]. The economic recovery is also an integral part of the rapid progress in the health sector, including global collaboration in developing vaccines, cheaper tracing techniques with rapid results for faster treatment of infected people, either by self-isolation or isolation at hospitals, and the application of better therapies [6]. This, coupled with the results of intensive

campaigns such as wearing masks in public spaces, social distancing, and hand washing, had successfully controlled COVID-19 within two years.

All countries in the world undertook fiscal interventions to halt the economic downturn caused by crises. In developed countries, the measures taken were corporate fiscal bailouts and bailouts for banks and financial institutions [61]. The Indonesian Government implemented fiscal policy instruments in the form of fiscal stimulus, which was an increase in government consumption as conceptually found in [62], namely, the budget disbursed for dealing with COVID-19 reflecting a balance between public health and the economy, including (i) health, (ii) social protection of life support aid for poor and near-poor families, and (iii) protecting businesses from mass bankruptcy, especially MSMEs (Micro, Small and Medium Enterprises). These three aspects were handled simultaneously at the national and local levels, of which fund was from the central government. All of these measures expended IDR 1,645.45 trillion from 2020 to 2022, increasing government debt by 52% from 2019 and July 2022 from IDR 4,779.26 trillion to IDR 7,733.99 trillion ([63]; [64]). However, the government's measures were in line with the nature of Indonesia's economy, that is domestic demand-driven growth ([65]; [66]).

Given the dynamic causal relation between economic growth, agricultural output, and food and beverage processing industry's output, and the fact that the economic shocks caused by COVID-19 were induced by the demand, instead of disruptions in production, the most effective policy was to stimulate domestic consumption growth as the economy's driving force through fiscal stimulus aimed at maintaining household demand for food and agricultural products and protecting industries from bankruptcy in order to prevent mass unemployment. Fiscal policy was implemented in parallel with the measures to deal with the pandemic, which was the source of economic shock.

Compared to the other ASEAN (Association of Southeast Asian Nations) countries, Indonesia recovered faster and fell into a more superficial recession, reminding us that the strategy to develop agriculture-based industries first to satisfy domestic needs and later satisfy foreign demand (exports) is an important choice, given that this strategy has shown more resilient results (strong enough to withstand the crisis's impacts leading to quicker economic recovery) even if under normal conditions it has not shown spectacular growth. Thus, building a strong agro-industrial system to develop a sustainable contribution to the economy as an engine of growth is one mitigation measure in the face of crisis, which is an inevitability.

Conclusion. Indonesia's food and agriculture sector and economic growth show a dynamic causality (bi-directional causality) between agricultural sector and economic growth, food and beverage processing industry and economic growth, and agricultural sector and food and beverage manufacturing. In the short run, bi-directional causality occurs between agricultural sector and economic growth and unidirectional causality from food and beverage processing industry to agriculture. COVID-19 pandemic partially had an insignificantly negative effect on economic

growth, but at the same time, this negative effect was also significant, despite the quite low regression coefficient of -0.01 that this effect was not strong enough to disrupt agricultural sector and food and beverage processing industry's positive effect. With the insignificantly positive regression coefficient, COVID-19 pandemic did not negatively affect agricultural production and food and beverage industry. Indonesia's agricultural sector, which was heavily influenced by seasonality, showed an oscillating production pattern before the pandemic. This pattern had also not been disrupted by COVID-19 pandemic that the quarterly down and up cycles were still visible during the pandemic just like previously before the pandemic. Indonesia's economy recovered faster than other ASEAN countries thanks to the global health sector's rapid progress and the Indonesian government's policies effectively maintaining balance between health and economy in dealing with COVID-19. In line with the health measures such as healthy lifestyle campaigns and international collaboration in vaccine development, the Indonesian Government launched a fiscal stimulus of social safety net in support of the poor and near-poor households and protecting MSMEs (micro, small, and medium enterprises) from bankruptcy and possible massive unemployment.

This study's limitation is that it uses aggregate agricultural data assuming that the agricultural output is homogeneous, which is essentially quite diverse between food crops and horticulture which are predominantly managed by small farmers in rural areas aiming at local market production for fresh products versus plantations of which output is dominated by large companies aiming at export after processing into semi-finished or finished/consumable goods, and fisheries, as a combination of the two previous product groups. It is necessary to further explore whether agricultural sector's resilience to the crisis (in this case originating from COVID-19 pandemic) is more evenly distributed across all subsectors or whether only one subsector is strongly resilient with a very large contribution to agricultural GDP so that it can totally cover the other subsectors' downturn. In addition, due to quarterly data limitations, this study uses a closed economy model that does not include international trade and its associated macroeconomic variables in the analysis. Further exploration will be needed in the future with an open economy model. Furthermore, there is a need to examine the role of the government's safety net program in providing basic food aid and delivery cost subsidy for online shopping in encouraging demand's growth that may send signals to producing farmers to continue producing in order to serve demand through contactless marketing.

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VII. ACCEPTANCE OF THE MANUSCRIPT

June 16, 2023

From: Agricultural and Resource Economics E-Journal (editor.are.journal@gmail.com)

To: jtampubolon@yahoo.com

Date: Friday, June 16, 2023 at 02:54 AM GMT+7

Dear author,

Congratulations! Your revised paper may be published in «Agricultural and Resource Economics: International Scientific E-Journal».

However, your article still requires additional design, professional English proofreading, editing and design of the reference in accordance with the requirements of the journal. The cost of this additional service is 70 Euro.
To cover the cost for providing our publishing service and free access for readers, authors pay a one-time article processing charge (APC) for manuscripts accepted after peer-review. The Journal charges 300 Euro of Article processing charge (APC) to cover the costs induced by publishing and hosting process, etc.
Therefore, the total cost of the publication is 370 euros.
Nov we can only accept payments in dollars. At the official exchange rate of our bank, 370 euros equals $ 400. **Therefore, the final amount to be paid is 400 $**. You can make a payment according to the details:

(1) Recipient's name: Lesia Kucher
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Yours sincerely,
Prof. Kucher

Best regards,
Editorial Board of Agricultural and Resource Economics
https://are-journal.com

VIII. PROOFREADING PRIOR TO PUBLICATION

June 23, 2023

Final Proofreading Before Publication

From: Agricultural and Resource Economics E-Journal (editor.are.journal@gmail.com)

To: jtampubolon@yahoo.com

Date: Friday, June 23, 2023 at 01:17 AM GMT+7

Dear author,

We send you the final version of the article for approval.

Please carefully check for any copyediting or typesetting errors in the final version of your paper.

Authors should also make sure that any renumbered tables, figures, or references match text citations and that figure legends correspond with text citations and actual figures. Proofs must be returned within 48 hours of receipt of the email.

Thanks in advance!

--
Yours sincerely,
Prof. Kucher

Best regards,
Editorial Board of Agricultural and Resource Economics
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IX. RESPONSE TO PROOFREADING TO CHECKS

June 23, 2023

Re: Final Proofreading Before Publication

From: Dr. Jongkers Tampubolon (jtampubolon@yahoo.com)

To: editor.are.journal@gmail.com

Date: Friday, June 23, 2023 at 06:16 AM GMT+7

Dear Prof Anatolii Kucher
Editor-in-Chief
Agricultural and Resource Economics: International E-Journal

Greetings from Medan, Indonesia.

Thank you for the final version of my article. I have double-checked the manuscript and found only the following minor annoyance:

(1) In the abstract section, page 223, it says "this study used ARDL bound test for cointegration", it should be "this study used ARDL bound test to cointegration" (bound test to cointegration is the standard terminology, although grammatically seems incorrect).

(2) Subsection "Methodology" on page 226 should be in bold.

(3) Table 6 on page 234 needs to add a bottom border.

For your kind co-operation I am very grateful

With best regards

==========
Dr. Jongkers Tampubolon
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Tel: 061-4522922; Fax: 061-4571426 Mobile: 0062 (0) 811615544

X. FINAL REVIEW OF UPDATED VERSION OF THE MANUSCRIPT

June 24, 2023

Re: Final Proofreading Before Publication

From: Agricultural and Resource Economics E-Journal (editor.are.journal@gmail.com)

To: jtampubolon@yahoo.com

Date: Saturday, June 24, 2023 at 12:56 AM GMT+7

Dear author,

We are sending an updated version.

As for the methodology, here italics meet the requirements of the journal.

Please review and confirm that everything is correct.

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Yours sincerely,
Prof. Kucher

Best regards,
Editorial Board of Agricultural and Resource Economics
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XI. RESPONSE/ CONFIRMATION FOR PUBLICATION

June 24, 2023

Re: Final Proofreading Before Publication

From: Dr. Jongkers Tampubolon (jtampubolon@yahoo.com)

To: editor.are.journal@gmail.com

Date: Saturday, June 24, 2023 at 05:16 AM GMT+7

Prof Anatolii Kucher
Editor-in-Chief
Agricultural and Resource Economics: International E-Journal

Dear Prof. Kucher.

I would like to inform you that I have reviewed the article's final version and confirm that everything is correct.

Thank you very much.

With best regards.

==========
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