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An Econometric Analysis Of Food Security And Related Macroeconomic Variables In Malaysia: A Vector Autoregressive Approach (VAR)

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Abstract

Food security is a concept originated in the mid-1970s. According to the definition of the Food and Agriculture Organization (FAO), food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. At the national level, food security is a situation whereby a country is able to cover the food requirements of its population on a continuous and stable basis. Malaysia, although a middle income country, has been a net food importer in the last four decades. In fact, the country has grown to depend more on imports for most important food especially rice. With these trends lurking, understanding the determinants of food security is important because it will help the policy makers keep abreast of the main variables for food security in Malaysia. This paper thus analyse the dynamic relationship between selected macroeconomic variables (biodiesel production, exchange rate, government expenditure on rural development, Malaysia's GDP, food price index and Malaysia's population) and food security in Malaysia using VAR approach. The variance decomposition also shows that biodiesel production, exchange rate and government expenditure on rural development variables will give the highest shock to food security in year ten. Whereas exchange rate and population in year five and finally GDP in year six. This model is a useful tool and reacts as an effort to better understand how food security reacts and is affected by the integration of domestic and global markets. It could also provide a more quantitative means of assessing food security, and in particular to pinpoint specific variables that explain the highest shock to food security at the national level. It would also benefit to consumers and policy makers.

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Keywords: biodiesel production; food security; macroeconomic variables; VAR

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1. Introduction

Many studies have been carried out to explain food security and its determinants. In terms of literature we could identify the conceptual definition of food security and the determinants of food security at individual, household and national level. Food security is a concept originated in the mid-1970s. Since then, the terms of food security (FS) was introduced, evolved, developed, and diversified by the academic community and politics (Giraldo et al., 2008). Around two hundred definitions of the FS have been developed (Maxwell & Smith, 1992) considering the problem of FS from original view point. According to the definition of the Food and Agriculture Organization (FAO), food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. This involves four dimensions; i) adequacy of food supply or availability; ii) stability of supply, without seasonal fluctuations or shortages; iii) accessibility to food or affordability; and iv) utilization: quality and safety of food. Generally, food security is not simply a function of production or supply; it involves all of the above which include a broad spectrum of socio-economic issues with great influence on farmers and on the impoverished in particular. However, this study will focus on the first dimension which is food availability.

Food security and food insecurity can be examined at many levels such as national or country, household and individual level. In the national level, a country is food secure when on the continuous and stable basis, the food supply and effective demand are able to cover the foods requirements of its population. Food requirement can be met by the country either through domestic food production, through access to food beyond domestic production or through combination of both factors (Aker & Lemtouni, 1999). In close economy, food requirements can be met just by the domestic food production alone. But in open economy, the food requirements of the population depend upon the world market to meet their population's caloric needs. This indicates the country level of food security is dependent upon the interaction of domestic and global forces.

Although there are growing concern of improving food security, factors influencing food security in Malaysia is not well-documented. Identifying the determinants of food security is important as it can assist researchers and policy makers in making decisions on policies that matter for food security in Malaysia. Malaysia has been a net food importer in the last four decades. It depends more on imports for most important food for instance, rice. The domestic consumption of rice increased at an annual rate of 2% during the last decade (1998-2007), but production increased by only 1% during the period. This leads a gap between production and consumption. Consequently, rice imports increased from 594 million tones in 2000 to 799 million tones in 2007, raising Malaysia's rice import bill from RM700 million in 2000 to RM 10.1 billion in 2007 (Department of Statistics, 2008).

The purpose of this study is to analyze the dynamic relationship between selected macroeconomic variables (i.e. biodiesel production, exchange rate, government expenditure on rural development, Malaysia's GDP, food price index, Malaysia's population) and food security in Malaysia using a time series data from 1980-2012 where vector autoregressive (VAR) approach is employed. The results of this study will reveal whether all variables mentioned above have an impact on food security in Malaysia and therefore appropriate policies can be implemented by the government.

The rest of the paper is outlined as follows. Section 2 provides the literature review. Section 3 discusses empirical data used and methodology, followed by empirical results in section 4. Section 5 concludes.

2. Literature Review

In terms of literature we could identify the conceptual definition of food security and the determinants of food security both at individual, household and national level.

As been mentioned in previous studies food security has spiralled since in the 1970s where during those years "food security" was mostly concerned with national and global food supplies. However in the 1980s the focus

shifted to questions of access to food at household and individual levels. According to the International Conference on Nutrition (ICN) food security is defined as "access by all people at all times to the food needed for an active and healthy life". Many definition and conceptual models of household food security have been presented and most of them agreed that the key defining characteristics of household food security is the secure access at all time to sufficient food. The four main concepts that have been discussed are; sufficiency of food; the concept is presented in different ways by different authors i.e. according to Reutlinger and Knapp (1980) it is the "minimal level of food consumption", Siamwalla and Valdes (1980) as a "target level", or as the food "adequate to meet nutritional needs" by Barraclough and Utting (1987). Another issue is the difficulty of measurement which is an important aspect to assess whether people have access to "enough" food by asking how far they fall below the threshold. Heald and Lipton (1984) discuss about proportionate shortfalls in access to calorie. Meanwhile Maxwell et al., (1990) mentioned the idea of the "intensity" of food insecurity. Second is access to food. It is related to the question of whether individuals and nations are able to acquire sufficient food. The focus on access is a phenomenon of the 1980s, which resulting from the pioneering work of Sen (1981) on food "entitlements". An individual's entitlement is rooted in his/her endowment, then transformed via production and trade into food or commodities which can be exchange for food. Security is the third concept and it defines secure access to enough food. The notions of risk and risk avoidance have been central to definitions of food security. Linking the discussion of risk to the discussion of entitlements, it is necessary to identify the risks to food entitlements which can be originated from many sources including variability in crop production and food supply, market and price variability, risks in employment and wages. Finally, time where it shows secure access to enough food at all times. Although it is not much discussed in the literature, it has become conventional to draw a distinction between chronic and transitory food insecurity. Chronic food insecurity is a situation where a household runs a continually high risk of inability to meet the food needs of household members, while transitory food insecurity occurs when a household faces a temporary decline in the security of its entitlement and the risk of failure to meet food needs is of short duration.

There is a vast and growing literature analyzing the relationship between food security and its determinants. Among others are Aker and Lemtouni (1999); they present a framework for assessing food security (FS) at the national level in an effort to better understand how food security reacts to and is affected by the integration of domestic and global market. Six variables are used such as domestic food production, average annual rainfall, world food prices, gross domestic product, Gini coefficient of income distribution and exports of goods and services to capture the domestic and global supply and demand mechanism. Findings show that there are Inter-variables correlation between rainfall and domestic food production and income and domestic production. Cereal production used as a proxy of food production is not significant to food availability (FA). Meanwhile income (GDP) was significant and had a positive effect on FA. Cereal prices to FA and FS are ambiguous (depends on country status as exporter or importer and the market regulation in an economy) and negative impact to FA. Foreign exchange to FA and FS is ambiguous and negative impact.

Food prices are one of the factors that influence food security. Arshad and Abdel Hameed (2010) examine factors that bring to the increase of price in food commodities and the implication to food security in Malaysia. Factors that cause the food price crisis are the fundamentals that include decline in growth of agricultural production, hence supply, decline in global cereal stocks and strengthening food demand from emerging economies. As stated by the authors, second cause is the systemic factors that include underinvestment in agriculture and lopsided policy towards export crops at the expense of food. Third and fourth causes are increase in biofuel demand and technical factors respectively. As a net food importer, all these factors affected Malaysian in terms of first, higher food import bill where in 2008, Malaysia food deficit increased to RM10.9 billion compared with RM4.9 billion in year 2000.

Morrissey et al., (2013) conducted a study to estimate how local food prices influence the weight outcomes, food insecurity, and food consumption patterns of children from infancy to 5 years of age. This study found that compared to children living in areas with lower-priced fruits and vegetables, children living in areas with higher priced fruits and vegetables averaged higher measures of standardized Body Mass Index (BMI) scores. This study

also found that there are significant association between food prices and child and family weight and food security outcomes. About 30 percent of children were overweight, and about 12 percent of children reported low or very low food security are lived in households in which the adult respondent. Overweight children faced higher average annual fruit and vegetable, fast food, and soft drink prices than their peers who were not overweight, but the standardized price ratios did not differ. Households with food insecure adults faced average lower fruit and vegetable prices than those with food secure adults. This study suggests that 30 more research on the interactions between food prices and public food assistance, particularly the effects of these new initiatives, is needed.

According to United Nations Environment Programme (UNEP), low and fluctuating prices are a core problem for stable food production. Agricultural price volatility increases the uncertainty faced by farmers and affects their investment decisions, productivity and income. Lagging investments can be a constraint in meeting changing consumer demands. For willingness to invest it is the volatility of the revenue flows that matters. Instability in prices is related to factors in the agricultural domain as well as in other sectors.

3. Data and methodology

3.1 The data

The study employs observations for the period 1980 to 2012 for seven variables used. All variables are expressed in logs. The data sets were obtained from International Finance Statistics (IFS), Food and Agriculture Organization (FAO) and the Statistics Department of Malaysia websites.

The seven variables used in this paper are defined as follows:

i. Food production index (FPdI) covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.
ii. Biodiesel production (BdPd) which is produced in Malaysia using palm oil (in liters).
iii. Real gross domestic product (RGDP) is a measure of total output for the Malaysian economy. This variable is expressed in RM million.
iv. Exchange rate (ER) and this variable is in RM/USD.
v. Government expenditure on rural development (GovDevExp) in RM million.
vi. Food production index (FPI).
vii. Malaysian Population (MPop).

The choice of six macroeconomic variables is based on work by Aker and Lemtouni (1999). However, there are certain variables that has been substituted for example food security variable itself where food production index has been used replacing Guttman Scale of Food Security. Biodiesel production has been included as a determinant and it is known as one of the fundamental factors in Arshad (2009a & 2009b) and Arshad (2012). The use of RGDP is consistent with previous literature using income as one of the factor influence food security, (see Ahmed & Siddique, 1995, LeBlanc & McMurry, 1998, Arshad, 2009a & 2009b). World food prices as employed in Aker and Lemtouni (1999) are substituted with Malaysia food price index. The use of real exchange rate reflects the strength of the currency. Government expenditure in rural development shows a systemic factor as mentioned in Arshad (2009a & 2009b) and food price index reflects the inflation in food prices. Finally, Malaysian population reflects the population in a country.

3.2 Model specification

The conceptual model for food security that will be used in this study is based upon the framework by Thomson and Metz (1996). Within this framework, food security can be defined as a state in which supply and effective demand fulfill aggregate food requirement. Food availability is central to any model of food security and for a long time was the only indicator of food security for a fundamental reason. Food availability refers to the total food

available for human consumption, supplied either by production, stocks, imports, or food aid. The empirical model outlined in this paper proposes food production index which will be used as proxy for food security since food production indicate food is available for the population which is produced by a country through domestic food production alone or beyond food domestic production or both. Lack of food supplies will cause hunger and food insecurity. Based upon the literature of food security and its components presented in the previous section, food security is a function of the following variables:

FPdI = f (BdPd, GDP, ER, GovDevExp, FPI, MPop) ……(1)

where:

FPdI	= Malaysia's Food Production Index
BdPd	= Biodiesel Production (liters)
GDP	= Real Gross Domestic Product (RM million)
ER	= Real Exchange Rate
GovDevExp	= Government Expenditure on Rural Development (RM million)
FPI	= Food Price Index
MPop	= Malaysian Population (person)

The first six independent variables (BdPd, GDP, ER, GovDevExp, FPI and MPop) capture the domestic and global supply and demand mechanisms that affect the food economy, and thus serve to explain food security at the country level. Among the important variables of this model are population determinants where it is more focused on local population. ER is included as a proxy for the availability of foreign exchange, which is needed to purchase food imports. The econometric model outlined above is suggested as a means to assess food security at the national level, and in particular to measure how certain domestic and international market forces affect it.

Thus, to investigate the response of food security to selected macroeconomic variable an unrestricted Vector Autoregressive (VAR) model is explored. The VAR model could provide a multivariate framework where changes in a particular variable (biodiesel production) are related to the changes of its own lags and to changes in other variables and the lags of those variables.

4. Empirical results

This section presents the empirical results of the analysis which begins with the summary of the unit root test of the variable used for the empirical study in Table 1. Thus, both the Augmented Dickey Fuller (1979) and Phillips Perron (1988) tests are employed. The results shows that the variables expressed at level are non-stationary but when all the variables are first differenced there is evidence that all the variables are stationary. Since the variables n the model follow an I(1) process the next step is to test if there is a long run relationship exist among the variables.

Table 1: Unit root results

Variable	ADF				PP			
	Level		1st difference		Level		1st difference	
	No Trend	With Trend	No Trend	With Trend	No Trend	With Trend	No Trend	With Trend
LFPdI	-2.4351	-2.0636	-6.6760***	-7.3234***	-2.6133	-2.0636	-6.5911***	-7.3681***
LBdPd	2.0158	-1.7401	-1.8777	-2.0424	-1.7899	-0.5920	-2.9480*	-3.0463
LER	-1.7406	-1.6094	-5.9295***	-6.0407***	-1.7046	-1.6084	-5.9526***	-6.1640***
LFPI	-1.4908	-2.2591	-2.2065	-2.0216	-2.4575	-2.2005	-4.9224***	-5.0694***
LGDP	0.0254	-2.5762	-5.3705***	-5.3705***	0.3596	-2.5762	-5.3788***	-5.2872***
LGovDevExp	-2.2261	-2.5264	-2.4946	-2.0341	-2.4443	-3.2476*	-8.5224***	-7.7700***
LMPop	-1.3985	1.5879	0.9857	-0.2046	-3.5398	2.1250	-5.8890***	-6.9777***

Source: Compiled by authors from unit root test.
Note: *, **,*** represent significance at 10, 5 and 1 percent respectively.

The number of cointegrating relations from all seven variables, on the basis of trace statistics and the maximal eigenvalue statistics at 5 percent are summarized in Table 2. The result of the test statistics indicate that the hypothesis of no cointegration among the variables can be rejected for Malaysia and the result reveal that at least five cointegrating vectors exist. Considering the existence of long term equilibrium relationship among non-stationary variables in the system the analysis employs an unrestricted VAR. The optimal lag length is 1. In addition, since the variables are cointegrated the equations of the VAR also include the lagged values of the variables in levels to capture their long-run relationships.

Table 2: Cointegration test results

Hypothesized No. of CE(s)	Trace Statistic	Max-Eigen Statistic	Critical Values (5%) Trace	Max-Eigen
None	258.2965***	84.36019***	125.6154	46.23142
At Most 1	173.9363***	60.37140***	95.75366	40.07757
At Most 2	113.5649***	39.10362***	69.81889	33.87687
At Most 3	74.46128***	34.95885***	47.85613	27.58434
At Most 4	39.50243***	27.53697***	29.79707	21.13162
At Most 5	11.96547	7.231683	15.49471	14.26460
At Most 6	4.733783**	4.733783**	3.841466	3.841466

Source: Compiled by authors from cointegration results.
Note: **,*** represent significance at 5 and 1 percent respectively.

The output of the regression is given in Table 3 while the standard error and the t-statistics are in parentheses. With several lags of the same variables, each estimated coefficient might not be statistically significant due to multi-colinearity but collectively they may be significant on the basis of the F-test. The VAR result reveals the statistical and theoretical significance of the parameter estimate. Looking at the results individually, food price index (FPI) and population (MPop) were found to be statistically significant. Most of the other variables are found not to be significant. Nevertheless, the F-statistics of 1012.67 and 4115.88 are high enough and they imply the overall significance of the model. The lower value of the Akaike and Schwarz statistics suggest that the parameter estimate is significant statistically. The FPI exerts a positive impact on food security. This finding is following the *a priori* expectations. Mpop also shows a positive impact on food security. Both of these variables found to be significant. While the other variables follows the a priori expectations even though not significant.

Overall, the theoretical implications of these variables can further be evaluated from the variance decomposition result. In this study, we are interested with the importance of each variable shock in food security. This is addressed by computing the forecast error variance decomposition based on the VAR estimates. Variance decomposition

allocates each variable's forecast error variance to the individual shocks, which is a measure of the quantitative effect that the shocks have on the variables. The variance decomposition suggests that shocks to the food security which is proxied by food production index increase as evidenced in Table 4 shows that own shocks constitute the predominant source of variation for all the variables in the model. The shocks in food security ranged between 100 percent in the first year declining in effects to about 85 percent in the second year, declining further to 74, 66, 58, 48, 40, 33, 28 and 24 percent respectively from year three to ten.

Table 3: Vector Auto Regressive estimates

	LFPdI	LBdPd	LER	LFPI	LGDP	LGovDevExp	LMPop
LFPdI (-1)	0.426931	-0.390678	-0.373703	0.501341	0.257707	-2.545688	0.050041
	(0.19145)	(2.25637)	(0.43875)	(0.32261)	(0.29406)	(1.42466)	(0.03780)
	[2.22995]	[-0.17314]	[-0.85175]	[1.55402]	[0.87637]	[-1.78688]	[1.32387]
LBdPd (-1)	-0.007212	1.100871	0.039454	0.041567	-0.007454	0.385295	0.003843
	(0.02145)	(0.25277)	(0.04915)	(0.03614)	(0.03294)	(0.15959)	(0.00423)
	[-0.33628]	[4.35531]	[0.80273]	[1.15017]	[-0.22629]	[2.41421]	[0.90753]
LER(-1)	0.089718	0.258143	0.699340	-0.331358	-0.195896	-1.338030	0.023473
	(0.08880)	(1.04656)	(0.20350)	(0.14963)	(0.13639)	(0.66079)	(0.01753)
	[1.01033]	[0.24666]	[3.43654]	[-2.21446]	[-1.43626]	[-2.02490]	[1.33885]
LFPI(-1)	0.205109	-0.290808	0.149229	0.536911	-0.130302	-0.196216	-0.005610
	(0.07573)	(0.89255)	(0.17356)	(0.12761)	(0.11632)	(0.56355)	(0.01495)
	[2.70831]	[-0.32582]	[0.85984]	[4.20729]	[-1.12017]	[-0.34818]	[-0.37519]
LGDP(-1)	-0.128219	-0.542024	0.025364	-0.169809	0.675638	-0.533630	0.016814
	(0.09679)	(1.14070)	(0.22181)	(0.16309)	(0.14866)	(0.72023)	(0.01911)
	[-1.32473]	[-0.47517]	[0.11435]	[-1.04117]	[4.54476]	[-0.74091]	[0.87991]
LGovDevExp (-1)	0.019389	-0.511249	-0.103552	0.001451	-0.009065	-0.154358	0.000316
	(0.03508)	(0.41341)	(0.08039)	(0.05911)	(0.05388)	(0.26102)	(0.00693)
	[0.55275]	[-1.23666]	[-1.28817]	[0.02454]	[-0.16825]	[-0.59135]	[0.04561]
LMPop(-1)	1.268363	1.967397	0.325126	-0.078328	1.128953	5.455270	0.774483
	(0.58378)	(6.88016)	(1.33784)	(0.98370)	(0.89666)	(4.34408)	(0.11526)
	[2.17266]	[0.28595]	[0.24302]	[-0.07963]	[1.25906]	[1.25579]	[6.71958]
C	-9.704124	-7.139551	-1.886690	2.926529	-7.294239	-29.35451	1.815620
	(4.20107)	(49.5117)	(9.62746)	(7.07902)	(6.45265)	(31.2613)	(0.82943)
	[-2.30992]	[-0.14420]	[-0.19597]	[0.41341]	[-1.13043]	[-0.93900]	[2.18900]
R-squared	0.994074	0.971384	0.838091	0.959615	0.996626	0.680109	0.999168
Adj. R-squared	0.992346	0.963038	0.790868	0.947836	0.995642	0.586808	0.998925
Sum sq. resids	0.034118	4.738895	0.179178	0.096874	0.080489	1.889192	0.001330
S.E. equation	0.037704	0.444358	0.086405	0.063533	0.057911	0.280564	0.007444
F-statistic	575.1297	116.3856	17.74738	81.46776	1012.668	7.289376	4115.882
Log likelihood	64.09269	-14.84712	37.55573	47.39522	50.35986	-0.132644	116.0082
Akaike AIC	-3.505793	1.427945	-1.847233	-2.462201	-2.647491	0.508290	-6.750510
Schwarz SC	-3.139359	1.794379	-1.480799	-2.095768	-2.281057	0.874724	-6.384076
Mean dependent	4.221460	8.267834	1.101416	4.583924	12.35813	7.324655	9.960342
S.D. dependent	0.430950	2.311295	0.188941	0.278170	0.877200	0.436472	0.227031

Akaike information criterion	-17.58778
Schwarz criterion	-15.02274

Apart from its past values, biodiesel production, exchange rate, food price index, GDP, government development expenditure on rural development and population also accounted for variation in food security. Specifically, shock in biodiesel production did not contribute initially to the shocks in food security in the first year but the contribution rose to 2.62 percent in the second year but decline marginally to 2.32 percent in the third year. Also, shocks in a exchange rate did not contribute initially to the shocks in food security in the first year but the contribution rose to 1.72 percent in the second year and increased to 4 percent in the third year. GDP shocks showed a mixed trend where in the second year it shows 2.91 percent of the shock and it increased till year six but and then decreased marginally till the 10^{th} year. The government expenditure on the rural development showed a positive increase from year to year till year 10. Finally population shocks contribute an increasing trend at first from year two to five but and then declined marginally till tenth year. As a conclusion it is very clear from Table 4 that biodiesel production, exchange rate and government expenditure on rural development variables will give the highest shock to food security in year ten. Whereas exchange rate and population in year five and finally GDP in year six.

Table 4: Variance decomposition analysis

Variance Decomposition of LFPdI							
Period	LFPdI	LBdPd	LER	LFPI	LGDP	LGovDevExp	LMPop
1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	85.08907	2.619472	1.720207	6.016740	2.914270	0.010612	1.629633
3	74.23988	2.319169	2.822732	11.47288	5.425538	0.567430	3.152372
4	66.31892	3.121540	4.007353	14.14182	7.093766	1.355569	3.961025
5	57.63667	6.945510	5.851022	15.02367	7.977577	2.347262	4.218289
6	48.34943	13.00544	8.491619	14.63232	8.057546	3.438402	4.025245
7	39.78603	19.56963	11.63969	13.48016	7.517403	4.456877	3.550210
8	32.89794	25.28584	14.82764	12.06082	6.666249	5.281881	2.979632
9	27.85382	29.65421	17.70152	10.70295	5.762306	5.884528	2.440673
10	24.34744	32.76595	20.10836	9.550466	4.945198	6.294692	1.987891

5. Conclusion and policy recommendation

This paper thus analyse the dynamic relationship between selected macroeconomic variables (biodiesel production, exchange rate, government expenditure on rural development, Malaysia's GDP, food price index and Malaysia's population) and food security in Malaysia using VAR approach. The FPI exerts a positive impact on food security. This finding is following the *a priori* expectations. MPop also shows a positive impact on food security. This means the more population the more food insecure. Both of these variables found to be significant. While the other variables follows the a priori expectations even though not significant. The variance decomposition also shows that biodiesel production in Malaysia did not contribute initially to the shocks in food security in the first year but the continued to rise till year ten. The findings confirm that in the long run biodiesel production will have a negative impact on food security. This is mainly due to the competition in terms of land between food and fuel. In terms of policy implication the investment in the biodiesel industry should be under control or limited or else Malaysia has option to invest offshores in ASEAN countries such as Indonesia and Papua New Guinea.

Based on the findings, it was established and can be concluded that, while population remains as one of the important determinant, the shock showed a decreasing trend after the fifth year possibly due to the increase in

foreign workers where the demand for food is more from the foreign workers in Malaysia. The findings and conclusion of this study suggested the need for the policy makers to spend more on government expenditure and rural development. This will enhance and promote agriculture development specifically on food production. In the longer run, the impact of the foreign exchange on food security must be noted. A favourable RM/USD portion may hurt food security of Malaysia after the 5th year due to reliance on imports rather than local production of food.

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