LAND IRRIGATION AND FOOD INSECURITY IN SELECTED ASEAN COUNTRIES

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ABSTRACT

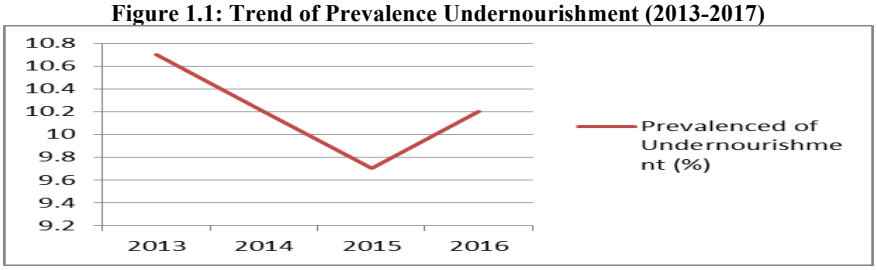
Food insecurity occurs when people do not have adequate physical, social or economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. These situations can cause undernourishment when caloric intake is below the Minimum Dietary Energy Requirements (MDER). The MDERs define the amount of energy needed to maintain a minimum acceptable weight for one's attained height. Generally, there are two types of food insecurity. The first is chronic food insecurity, which is a long-term or persistent situation that occurs when people are incapable of meeting their minimum food requirements at all times. Chronic food insecurity is caused by a long-term poverty problem, lack of assets, and insufficient access to productive and financial resources. This problem can be overcome with long-term development such as improving education and increasing access to productive resources, in order to raise the ability to meet minimum food requirements and reduce poverty. The second type of food insecurity is transitory food insecurity and is a short-term, temporary situation. The availability of food is reduced because of short-term shocks and fluctuations in domestic food production which is caused by land irrigation, food prices, and household income. To achieve food security, affected countries must strive to reduce poverty, increase cognitive and physical development, raise productivity, and promote economic growth. Improving on food insecurity problem is very important to increased economic growth, reduced malnutrition, and increased labor productivity. In addition, reduced in food insecurity problem can help certain countries grow their own food and meet their own needs, increase their domestic food production, reduce their dependency on food imports and food aid. There is four types dimension of food security known as food availability, food accessibility, utilization and food stability. Food security is a critical issue that has received serious attention in terms of the prevention of malnutrition, hunger, and famine, especially in ASEAN countries. The food insecurity problem is caused by transitory food deficit, which occurs when there is a sudden drop in the ability to produce or access enough food to maintain a good nutritional status. The objective of this paper is to examine the impact of land irrigation system on food insecurity problem in selected ASEAN countries. This research has used Random Effect Model (REM) as methodology. The finding has shown that improving land irrigation will help to reduce food insecurity problem in Selected ASEAN countries. This research can help policy maker and government in ASEAN improve land irrigation system in these ASEAN countries because improving land irrigation system will help to increase food production, less depending on food import and help to reduce food insecurity problem in selected ASEAN countries.

Keywords: Food Insecurity, Land Irrigation, Food Production

INTRODUCTION

Food insecurity occurs when people do not have adequate physical, social or economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2010). Population and food security need to increase parallel to avoid undernourished problem that can cause food insecurity occurs. Figures 1.1 illustrate the trend of prevalence undernourishment problem in ASEAN countries from year 2013 until 2017.

Figure 1.1: Trend of Prevalence Undernourishment (2013-2017)



Source: FAOSTAT

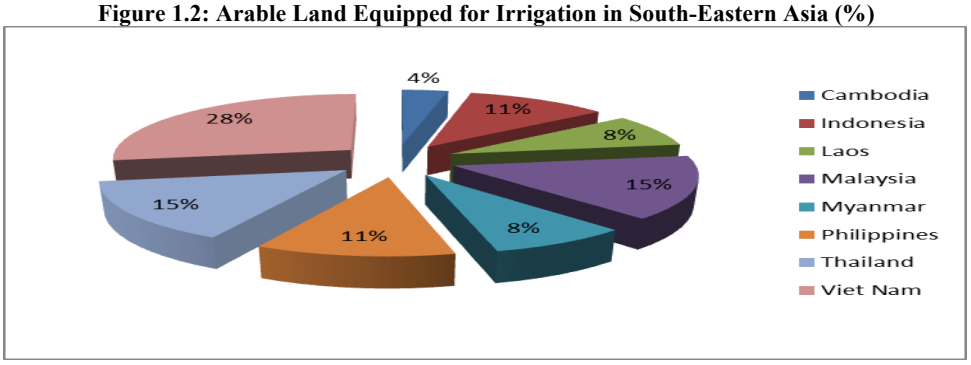
Based on Figure 1.1, its shows the trend of prevalence undernourishment decrease dramatically from year 2013 which is 10.3 percent until 2015 where the percentage of prevalence undernourishment is 9.7 percent. However, this trend has increase drastically in 2016 where the percentage of prevalence is 10.2 percent. The rising in prevalence undernourishment in 2016 is cause by several factors. First is because most of ASEAN countries have faced El Nino Phenomenon and climate-related shocks. Secondly, various conflict around the world give an impact to the ASEAN countries especially on food production and food

availability. Lastly, some ASEAN countries is heavily relying on commodity export, however because of unstable world political situation it cause decreasing in export commodities activities and reduce fiscal revenues. This situation has affected food availability through reduction in food import capacity and also rising in domestic food price. These entire situations will cause food insecurity problem in ASEAN countries.

Generally, there are two types of food insecurity. The first is chronic food insecurity, which is a long-term or persistent situation that occurs when people are incapable of meeting their minimum food requirements at all times. Chronic food insecurity is caused by a long-term poverty problem, lack of assets, and insufficient access to productive and financial resources. This problem can be overcome with long-term development such as improving education and increasing access to productive resources, in order to raise the ability to meet minimum food requirements and reduce poverty. The second type of food insecurity is transitory food insecurity and is a short-term, temporary situation. The availability of food is reduced because of short-term shocks and fluctuations in domestic food production, lack of efficiency in land irrigation, fluctuation in food prices, and household income. To achieve food security, affected countries must strive to reduce poverty, increase cognitive and physical development, raise productivity, and promote economic growth. This paper will focus on transitory food insecurity which is caused by inefficiency in land irrigation system.

Irrigated land is a major contributor to the higher crop production, especially in the agriculture sector, where more than 90% of the Asian global rice supply are obtained from irrigated land (IWMI, 2009). Figure 1.2 below shows that arable land equipped for irrigation in South-Eastern Asia, where Vietnam is a larger compare to others countries. Vietnam has the largest arable land that equipped for irrigation because this country has change policy from self-supporting production to highly intensified cropland system which is totally invested by Vietnam's government. Cambodia has the smallest arable land equipped for irrigation in 2014.

Figure 1.2: Arable Land Equipped for Irrigation in South-Eastern Asia (%)



Data Source: FAOSTAT

There have been many challenges in the irrigation sector, including a lack of adequate water maintenance and a decrease in technical support (Carruthers et al., 1997). Although certain selected ASEAN countries have many river basins and irrigation canals, this has not increased the availability of water for irrigation, especially in the agriculture sector. In addition, more countries are facing severe water shortages because of higher costs of agriculture irrigation systems, which raises the food price index accordingly (Nhundu & Mushunje, 2010). This situation is critical for success in the near future. Better and improved water management is the only way to improve food production; otherwise, the prospects of increasing food security are remote.

Proper maintenance of irrigation systems helps to increase the yields of most crops. Irrigation undoubtedly provides greater contribution to global food security in ASEAN. Based on the World Bank/UNDP estimates, improved irrigation could be extended over an additional 110 million ha in developing countries, producing enough grain for 1500-2000 million people. More than half of future increases in crop production are expected to come from irrigated land.

There are two types of known irrigation systems—large-scale and small-scale irrigation. Most of the ASEAN countries are engaging small-scale irrigation systems, as they are more affordable as compared to those of the large-scale technique, but still capable of increasing the food production. Water harvesting is one of the small-scale techniques of collecting runoff rain water for irrigation purposes and has significantly improved both the yield and reliability of agricultural production. Additionally, the usage of low-lift pumps and treadle pumps also provides other linkages of water distribution from domestic use to irrigation.
Thus, sustainable water management for irrigation is the major key to improving food production and reducing undernourished, hunger and famine. All of these problems could be alleviated in ASEAN countries as they achieve food security. Some expansion of irrigation areas and improvement in the efficiency of water supply usage will help these countries to achieve food security. Failure to achieve efficiency and sustain irrigation areas could have a negative impact on land resources and accelerate the process of environmental degradation. Irrigation and water development strategies have not been given special attention by previous studies because of the lack of understanding of the link among water scarcity, food production, food security and environmental sustainability (Carruthers et al. 1997).

Food insecurity is a critical issue that has received serious attention in terms of the prevention of malnutrition, hunger, and famine, especially in ASEAN countries. This food insecurity problem is caused by transitory food deficit, which occurs when there is a sudden drop in the ability to produce or access enough food to maintain a good nutritional status. Transitory food

deficit is a short-term shock in which there is a fluctuation in food availability caused by an insufficiency of food production and a food price crisis. Generally, domestic food production depends on the adequacy of irrigated land. Adequacy of irrigated land will benefit all farmers by helping them increase their food production. Dabour (2002) highlighted the importance of irrigated areas for sustained increases in food production. However, ASEAN countries have faced several chalanges in land irrigation system where ASEAN countries have lack of adequate water maintenance and a decrease in technical support. Besides that this ASEAN countries are facing severe water shortages because of higher cost of agriculture irrigation system which can raises the food price index accordingly. Insufficiency in food production, inefficiency in land irrigation system and increase in food price which cause by challenges in land irrigation cost have resulted in malnourishment, malnutrition, hunger, and food insecurity problem in ASEAN countries. The objective of this paper is to examine the impact of land irrigation to food insecurity in selected ASEAN countries.

The significance of this paper is in showing that efficiency in land irrigation system is very important for improving food insecurity problem. Improvement in food insecurity can help ASEAN countries grow their own food and meet their own needs, increase their domestic food production, reduce their dependency on food imports and food aid, reduce poverty and malnourishment, and increase economic growth. There has been a lack of research empirically measuring the food insecurity problem at the macro level, compared to the micro level. Improved food insecurity problem at the national level is very important for all countries, especially ASEAN countries.

LITERATURE REVIEW

The achievement of food security at the national level mainly in ASEAN countries presents a huge challenge because these countries face inefficiency in land irrigation system that caused insufficiency in food production and caused food insecurity problem. Almost all ASEAN countries still depend on irrigation systems to increase their food production. People in irrigated areas can derive direct benefits from increased crop intensities, improved yields, new technologies, and increased land values because of access to irrigation. In addition, people in irrigated areas can also enjoy indirect benefits of farm income increases, food price reduction, better nutrition, and increased clean water use for domestic purposes to ensure better health.

Food production can improve food security through land irrigation. Based on a previous study about irrigation and food security in the 21st century, this study has found that irrigation plays an important role in increasing and improving food production (Carruthers et al., 1997). Some changes must be made in terms of expansion of irrigation areas and water supplies, with continuous improvement in the efficiency of existing water supplies usage. However, if improvements in irrigated areas cannot be achieved, land resources will be under increased pressure and the process of environmental degradation will be hastened. Irrigation and water development strategies cannot be achieved due to a lack of knowledge about the relationship among water scarcity, food production, food security, and environmental sustainability. Moreover, Hassan et al. (2000) carried out a study on the trade-off between economic efficiency and food self-sufficiency using Sudan's irrigated land resources. Sudan has changed its food production strategy to be more dependent on the irrigation sector to improve the food supply, due to food shortages that occurred during the 1980s, which were caused by drought and reduced availability of food. However, this food shortage changed in 1989, when crop yields under irrigated systems increased significantly. This paper has carried out a domestic resource cost analysis to examine whether expansion in irrigation wheat production is more efficient than Sudan's irrigated land resources usage for cotton. The study results show that expenditure on irrigated wheat production in Gezira to ensure food self-sufficiency reduced employment opportunities and impacted economic efficiency. Irrigation systems are important for countries that face drought and erratic rainfall patterns.

Generally, domestic food production depends on adequate irrigated land and water. The efficiency of irrigated land will benefit all farmers and increase their food production and hence food supply, reduce hunger, and achieve food security (Dabour, 2002). Moreover, Dowgert et al. (2006) have listed several benefits of irrigation systems in domestic food production, stating that an efficient irrigation system will minimize drought-induced crop failure and famine, which have an indirect positive impact on the environment. In addition, this system will increase nitrogen fertilizer utilization, reduce nitrous oxide emission, increase the value of agricultural land, increase domestic production, and result in crop yield stabilization. Efficient irrigation technology is very important to increase food production, achieve food sufficiency, prevent hunger, and stimulate economic growth (Oriola, 2009). Besides that, climate change has a significant impact on the availability of water and irrigation (Mu & Khan, 2009). These authors have stated that if China were to address the climate change problem in terms of irrigation, it would increase its total grain production from 400 million tons in 2000 to 521 million tons in 2030. Making China's irrigation systems more efficient would directly increase food production and food security in that country.

METHODOLOGY

Generally, panel data, which are also known as longitudinal or cross-sectional time series data, is the dataset in terms of the behavior of entities such as countries, regions, companies, and firms observed over time. There are benefits to using panel data estimation because panel data can control all variables that cannot be observed, such as cultural factors; furthermore, this method will control variables that change over time but not across countries or regions. However, panel data estimation has several disadvantages, such as data collection issues in terms of sampling design, non-response in micro panels, or cross-country dependency in terms of correlation between countries in the case of macro panels. This paper will employ a panel data specification test to estimate the objectives by using a fixed-effects and random effects model because this model is suitable if unobserved individual characteristics are assumed to be correlated with the error term.

Fixed-Effects and Random-Effects Models

Fixed-effects (FE) models are used to analyze the impact of fluctuating variables over time. Besides that, fixed-effects models are used to determine the relationship between predictor and outcome variables within a country. Each country has its own characteristics that may or may not influence predictor variables. The basic model to estimate this method is shown below

$$y_{it} = \beta_1 x_{it} + a_i + u_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where, $a_i \left(i = 1 \ldots . n\right)$ is the intercept for each country, y_{it} is a dependent variable, x_{it} is an independent variable, β_1 is a coefficient of the independent variable, u_{it} is an error term, i is a country, and t is a time. The fixed-effects model, using binary variables, is shown below:

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + \ldots\ldots\ldots + \beta_k x_{k,it} + \gamma_2 E_2 + \ldots\ldots + \gamma_n E_n + u_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where E_n is a country n. By using binary models, which are dummy variables, countries with $\left(n-1\right)$ need to be added to this model, γ_n is the coefficient for the binary regressors. Besides that, this method can also add time effects to the country-effects model to have a time- and country-effects regression model, which is shown as follows:

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + \ldots\ldots\ldots + \beta_k x_{k,it} + \gamma_2 E_2 + \ldots\ldots + \gamma_n E_n + \sigma_2 T_2 + \ldots.. + \sigma_t T_t + u_{it} \quad \ldots\ldots \quad (3)$$

Where T_t is a binary variable (dummy), which is $\left(t-1\right)$ time periods, and σ_t is the coefficient for the binary time regressors. Moreover, based on equation (3.77) above, the average of the equation over time for each unit of I will apply as shown below:

$$\overline{y}_{it} = \beta_1 \overline{x}_{it} + \overline{a}_i + \overline{u}_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Next, subtracting the equation as follows:

$$y_{it} - \overline{y}_{it} = \beta_1 \left(x_{it} - \overline{x}_{it}\right) + \left(u_{it} - \overline{u}_{it}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

This equation shows that variables x and y as observations of each panel with their mean per individual have been removed. This equation is also known as the within transformation, and the estimation is known as the within estimator. The within estimator will be unbiased and consistent if all the explanatory variables are strictly exogenous. The within transformation applies the Least Square Dummy Variable (LSDV) model because the regression from LSDV will produce the same result as the model estimated from the original data and a set of $\left(N-1\right)$ indicator variables for all but one unit of the panel data. Based on LSDV, the effects of x_1 are based on the differences across countries. When the dummy variable for each country is added, it will show the pure impact from x_1, while controlling unobserved heterogeneity. Additionally, the degrees of freedom for the fixed-effects estimator would be $\left(N\left(T-1\right)-k\right)$. A constant term is included and an F-test is required for the null hypothesis test where all the coefficients $a_i^{'}$ are zero, where $a_i^{'}$ are deviations from the mean values $\overline{a}_i$. In a fixed- effects model, time invariance cannot be included because the values will be equal to zero for all time periods. Based on a fixed-effects assumption, all time-invariant characteristics are unique to all countries and cannot be correlated with others countries' characteristics. This fixed-effects model controls all time-invariant differences between countries and will cause the estimated coefficients of the fixed-effects models not to be biased because these models have omitted time-invariant characteristics. If the full set $\left(T-1\right)$ of time dummies is added, any explanatory variables that have a constant difference over time for each country cannot be included because it relates to time-constant effects.

An alternative way to substitute a fixed-effects model, is by using a random effects model. The difference between fixed effects and random effects is whether the unobserved individual effect represents the elements that have correlated with the regressors in the model, and it does not matter whether either of these effects are stochastic or not. The random effects model is the most suitable model if the error term or the differences across countries are linked with the dependent variable. Time-invariant variables can be included in this random effects model. The random effects model is:

$$y_{it} = \beta_1 x_{it} + a_i + u_{it} + \varepsilon_{it} \qquad (6)$$

Where u_{it} is a between-countries error and ε_{it} is a within-countries error.

Lastly, to identify whether the fixed-effects model or random-effects model is more suitable for this study, we needed to run a Hausmen test, where the null hypothesis represents the random effects model and the alternative hypothesis is a fixed-effects model.

MODEL SPECIFICATION

The Food and Agriculture Organization (FAO) has identified four dimensions of food security known as availability, accessibility and utilization and added food stability in term of world food price land irrigation areas on the determinant of food security. These model also can used for measuring food insecurity. The model is shown as follows:

$$\ln fis_{it} = \alpha_0 + \beta_1 \ln fm_{it} + \beta_2 \ln fp_{it} + \beta_3 \ln pr_{it} + \beta_4 \ln rd_{it} + \beta_5 \ln ppp_{it} + \beta_6 \ln sf_{it}$$
$$+\beta_7 \ln wi +_{it} \beta_8 \ln wfpi_{it} + \beta_9 li + \beta_{10} \ln al_{it} + \beta_{11} \ln gdpcc_{it} + \mu_r + \tau_t + \varepsilon_{it} \qquad (7)$$

Where the dependent variable is food insecurity (fis), which is proxied by Food Deficit (FD), and the independent variables consist of Food Import (fm), Food Production (fp), Road Density (rd), Purchasing Power Parity (ppp), Sanitation Facilities (sf), Improvement in Drinking Water (wi), World Food Price Index (wfpi), Land Irrigation (li), Arable Land (al), and Gross Domestic Product per capita (gdpcc), country unobserved fixed effects (μ_r), time-specific unobserved fixed effect (τ_t), and error term (ε_{it}). This model specification focuses on land irrigation and food production. The model is shown as follows:

$$\ln fis_{it} = \alpha_0 + \beta_1 \ln fm_{it} + \beta_2 \ln fp_{it} + \beta_3 \ln pr_{it} + \beta_4 \ln rd_{it} + \beta_5 \ln ppp_{it} + \beta_6 \ln sf_{it}$$
$$+\beta_7 \ln wi_{it} + \beta_8 \ln wfpi_{it} + \beta_9 \left(\ln li_{it} \times \ln fp_{it}\right)_{it} + \beta_{10} li_{it} + \beta_{11} \ln al_{it} + \beta_{12} \ln gdpcc_{it} \qquad (8)$$
$$+\mu_r + \tau_t + \varepsilon_{it}$$

Irrigation plays an important role in increasing food production and improving food security. In a speech titled "Feeding the World in 2050: Irrigation and Crop Management" by Dowgert (2006) at the 2010 Water Technology Conference in Clovis, he mentioned that efficient use of irrigated land will increase food production, feed populations in decades to come, and reduce hunger issues. The measurement of the impact of land irrigation on food insecurity depends on the condition of food production. The proxy for land irrigation is the total area equipped for irrigation. The Food and Agriculture Organization has classified the total area equipped for irrigation as an area equipped to provide irrigation water to crops. These two variables can be interpreted as the amount of change in the slope of food security on food production when land irrigation changes by one unit. Sanitation services need to be included in this model specification based on sanitary and phytosanitary measures, which state that sanitation services are important for achieving food safety and food security (WTO, 1998). Besides that, food production, land irrigation, and arable land are highly correlated with food production. However, this will not cause any problems in estimation because improvements in land irrigation and arable land will increase food production, increase farmers' incomes, and increase food security. Improvement in land irrigation and arable land will increase crop yields and production and benefit all farmers by increasing farmers' income and improving their diet, nutrition intake, and health. This situation will reduce food insecurity problem (FAO, 2000). These issues are supported by Shakya (2014), who found that improvement in irrigation areas will increase food security through food production. This situation occurs when improved irrigation areas increase food production, hike crop yields, increase farmers' income, and achieve food security.

DATA DESCRIPTION

The dataset in this paper is a panel of observation for selected ASEAN countries. This section will describe data and provides the econometric results from regression that has been done. The regression analysis conducted by compiled all balanced panel dataset which is consist 9 ASEAN countries namely Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand and Vietnam from period 2001 until 2016. These dataset are compiling from World Bank database and the Food and Agriculture Organization (FAO). This empirical analysis has used food deficit (FD) as dependent variable. This dependent variable is on the log-transformed. Moreover, the estimated coefficients on the log-transform for independent variables contain Food Import Index, Food Production Index, Purchasing Power Parity, Road Density, Sanitation Services, Water Improvements. World food price index, land irrigation, GDP per capita and arable land. This log transform are represent the elasticity of independent variables.

ANALYSIS AND DISCUSSION

The main results of the analysis are presented in Table 1.1 below. The result shows the analysis based on FAO models in selected ASEAN countries.

Table 1.1: The Impact of Land Irrigation on Food Insecurity in Selected ASEAN Countries

Dependent / Independent Variable	Food Deficit (FD)
Log Food Import Index (lfm)	2.5566***
Log Food Production Index (lfp)	-16.1289***
Log Purchasing Power Parity (lppp)	-0.9933***
Log Road Density (lrd)	-0.0359
Log Sanitation Facilities (lsf)	-7.4980***
Log Water Improvement (lwi)	-25.5904***
Log Land Irrigation (lli)	-22.1370***
Log world Food Price Index (lwfpi)	2.1197***
Log Interaction $(lwfpi \times lfm)$	0.4316***
Log Interaction $(lli \times lfp)$	-4.5986***
Log gross Domestic Product per capita (lgdpc)	0.0241
Log arable land (lal)	0.3454***
Intercept	159.9942***
Observation	40
Countries	9
R-Square	0.9939
Hausman Fixed	1.99

The table above shows result of the Impact of land irrigation on food insecurity in selected ASEAN Countries. Generally, food availability consists of food production, food import, and food aid. However, this paper eliminate food aid variable because of data constraint. Based on result estimation it shows that increasing in food production 1 percent will reduce food insecurity 16.13 percent. However, food import shows difference sign where increase 1 percent in food import will increase food insecurity at 2.56 percent. Increases in food production has reduced the proportion of hunger in the world and increases food security (Godfray et al., 2010). In addition, China has improved it food security through food production (Zhang, 2011), which is in parallel to this study's finding. Food security is not highly dependent on food production, but it also relies on food import. Food import contributes to the availability of food. Food production and food import should play their roles simultaneously to overcome the food shortage that occurs ASEAN countries. But depending highly in food import will increase food insecurity problem due to the higher cost of import bill.

The next dimension of food security is accessibility. Accessibility of food is very important to ensure the availability of food is sufficient at a national level. Food access is divided into two types: physical access and economic access. Physical access consists of facilities of infrastructure, such as transportation, roads, railways, and communication. The second type of food accessibility is economics access, such as price, income, and purchasing power. Table above shows the analysis of food accessibility in terms of physical access through the use of road density as a proxy to measure physical access. Road density is defined by the World Bank as the ratio of the length of the country's total road network to the country's land area. There are several types of road networks, such as motorways, highways, main or national roads, secondary or regional roads, and urban or rural roads. The analysis has shown that road density are not significant give an impact on the food insecurity in Selected ASEAN Countries. In addition, the second type of food accessibility is economic access. This analysis has adopted Purchasing Power Parity (PPP) as proxies to measure the economic access. This analysis has found that purchasing power parity has negative significant impact food insecurity where increase in purchasing power parity will reduce food insecurity problem in Selected ASEAN Countries. This situation occurs because purchasing power is a very important indicator of whether countries

have full economic access to sustain and improve food security. Furthermore, the increase in farmers' income has increased their expenditure on food, which increases their purchasing power (Fengying et al., 2010).

Moreover, utilization also play important role to reduce food insecurity problem. In other words, better utilization of food and food security can be achieved through sufficiency of diet, clean drinking water, better sanitation facilities, and good health care. This research has used the percentage of population with access to sanitation facilities and the percentage of population with access to improve drinking water sources as indicators to measure utilization. This analysis has identified that the percentage of the population with access to sanitation facilities negatively significant at the 1 per cent level, where a 1 per cent increase on sanitation facilities would reduce food insecurity problem by 7.49 per cent. Sanitation facilities have a negative relationship with food insecurity, which is similar with the World Trade Organization (WTO) condition under which food security can be achieved by better sanitation facilities (WTO, 1998). Moreover, the indicator of human health is related to food security, which, in term of better sanitation facilities, will increase food security as a whole (Pinstrup Andersen, 2009).

Commonly, water is a very important indicator to reduce food insecurity problem. More than 886 million people have limited access to clean water, and this has a bad impact on households' health, especially that of children. This situation shows that there is a strong negatively relationship between food insecurity and drinking water improvement. This research has adopted a variable percentage of the population with access to drinking water as a second proxy to measure food utilization. Water is essential to improve food security through agriculture production, food processing, food preparation, cooking food, and drinking water, where improvement in drinking water is very important to adequate nutrition and acquired good health (FAO, 2014). The World Health Organization (WHO)/United Nations International Children's Emergency Fund (UNICEF) Joint Monitoring Programmed for Water Supply and Sanitation (JMP) defines safe drinking water as water that is used for domestic purposes, drinking, cooking, and personal hygiene. Safe drinking water contains microbial, chemical, and physical characteristics that meet the WHO guidelines for drinking water quality.

The analysis shows that improvement of drinking water has a highly give negative effect on food insecurity. Improvement in drinking water will reduce food insecurity problem in Selected ASEAN countries, where 1 percent increase in improvement drinking water will reduce by 25.59 percent of food insecurity problem. This result is similar to the findings of Rosegrant & Cline (2003), who said that policy and investment in water resources are very important for achieving food security. Positive progress and higher investment in water resources will have a huge positive impact on food security and agriculture production. Also, this positive impact can reduce malnutrition and alleviate poverty. In addition, improvement in drinking water is very important to improve food security, because a lack of access to drinking water will have a bad impact on human health; almost two million people annually, including a huge number of children under five, are dying from diarrhea (USAID, 2013). Improvement in drinking water access is crucial for human health, where better access to drinking water will increase the level of school achievement, improved economic productivity, and food security (UNICEF, 2014).

Additionally, the FAO has added one more dimension to evaluate food security known as food stability, which is proxied by land irrigation and the food price index. The analysis shows that food price positively significant at 1 percent level where increase 1 percent of world food price will increase food insecurity by 2.12 percent. Improvement in land irrigation give negatively significant impact on food insecurity where 1 percent increase in land irrigation system will reduce food insecurity problem by 22.14 percent. This research also has added two more estimations: the first is the measure of the impact of food price on food insecurity through food import channels, and the results illustrate that a 1 percent increase in food price will increase food insecurity by 0.43 percent. This theory is in parallel with the theory stating that the increase in food price will reduce food import due to the increasing in food import bill and increase food insecurity. This result is supported by Ahmad (1988), who posited that higher food prices will increase poverty and undernourishment, reduce food import and food security. Higher prices for foods will increase undernourishment problems, because the rise in food price will impact income, it will reduce the purchasing power to acquire the minimum amount of quality food, with better nutrients and protein to fulfill their basic nutrition needs. When poor households, get less nutritious foods, countries experience the worst food security (Myers, 2006). The increase in food price is generally caused by several factors, such as slower growth in food production especially in developing countries, rapid increase in food demand, and the rise of global demand for biofuels, whether through shocks and an increase in agriculture production costs in terms of irrigation pumps, machinery, transportation, and fertilizer costs (FAO, 2011). Next is measurement the impact of land irrigation on food security through food production channels and the results illustrate that a 1 percent increase in land irrigation will reduce food insecurity by 4.59 percent. The conclusion that can be made on the analysis illustrated above, food availability, accessibility, utilization and stability have a significant impact to reduced food insecurity in selected ASEAN Countries.

CONCLUSION AND POLICY IMPLICATION

Food is very important for social development with sufficient nutrition to produce energy and to protect human bodies from infection and disease. Recently, food security has been recognized as one of the most important global issues. The achievement of food security is based on four dimensions of food security, according to FAO: food availability, accessibility, utilization and stability. In addition, the department of Sanitary and Phytosanitary Measures from the World Trade Organization (WTO) agrees that sanitation services are crucial to achieving food safety and food security. There is lack of research that measures the impact of these four variables in food insecurity especially in ASEAN countries.

Mainly, the objective of this paper is examine the impact of land irrigation to food insecurity in Selected ASEAN countries. Generally, this paper has used data from 9 ASEAN countries between 2001 until 2016. This paper has estimated the objective with static panel data analysis by using the random effects model.

The major finding for this research is the identification of factors that determined food insecurity FAO policy. According to USAID, food security is constructed by three important dimensions—food availability, food accessibility, and food utilization—and FAO has listed four important dimensions, the first three of which match those of the USAID policy, and FAO added food stability as the fourth food dimension that influences food security achievement. According to the analysis it shows that land irrigation negatively significant give an impact on food insecurity in Selected ASEAN Countries. Increasing in land irrigation sytem will reduce food insecurity problem by increasing food production in selected ASEAN countries.

In accordance with the objective of this paper, several policy implications emerged where the government in Selected ASEAN Countries needs to apply the twin-track approaches developed by the Food and Agriculture Organization (FAO). This twin-track approach policy has divided the policy based on two important categories. First is food availability, and based on this approach, the government needs to enhance food supply to the most vulnerable, improving rural food production, especially among small-scale farmers; increasing subsidies for importing food; and investing in production input such as irrigation tools and technology. The next category is food access and utilization, under which the government needs to reestablish rural institutions, enhance access to assets, ensure access to land, revive rural financial systems, and strengthen the labor market so that all rural farmers, especially those in ASEAN countries, can increase their income and purchasing power to buy quality food and to enhance food security. In addition, the government also needs to improve sanitation facilities and provide safe drinking water by increasing the investment in , which is the main aim to ensure that all households in can have safe food (FAO, 2006)

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