Agricultural Mechanization in Indonesia and Comparison to Southeast Asia Countries

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Abstract

Agricultural mechanization refers to the use of modern technologies to mechanize agricultural activities, greatly increasing the efficiency of agricultural workers. In this age, modern technologies have replaced many agricultural activities that were previously carried out by human or draft animal workers. Indonesia is a country with the largest area in Southeast Asia, so it has the potential to optimize its agricultural sector. In 2019, Indonesia's agricultural land area reached more than 15 million. This research wants to compare the status of mechanization level, government policies, economic conditions of Indonesia with other countries in Southeast Asia. Data collection was gathered by conducting literature reviews such as journals, references, and supporting libraries, and institutions. Mechanization Level is the ratio between the amount of power (hp) of agriculture machinery with the area of agriculture. The mechanization level from Indonesia grew from 1968 which was only 1.173 HP/ha to 1.68 in 2018. Indonesia's mechanization level is indeed higher when compared to Vietnam, Cambodia, and the Philippines. However, the mechanization level of Indonesia is still below Thailand and Malaysia, so there needs to be a strategy to improve it. Through the procurement policy of 1 million agriculture machinery carried out by the Indonesian government, it is expected to improve the quality of production in the agricultural sector. In addition, Indonesia needs to improve management, improving the quality of the workforce and regulations related to agriculture.

Keywords
Level Mechanization, Agriculture, Mechanization Strategy, Indonesia, Southeast Asia

1. Introduction
Agricultural mechanization plays a role not only in increasing arable agriculture and crop intensity, but also in increasing agricultural productivity and efficiency, increasing yield losses, and increasing the quality of crops. agricultural products: and the expansion of employment opportunities in rural areas through the creation of an integrated agricultural system that will stimulate rural economic growth (Djamhari, 2009). Agricultural mechanization can support production in such a way as to increase labor efficiency, planting intensity, plant quality and quantity, efficiency, diversification, and product value (Handaka and Prabowo, 2013). It measures the performance and profitability of all stakeholders who are involved in crop production. For most of them, the modernization of agriculture involves various contributions, such as design and manufacture, correct choice, distribution, use, attachment, maintenance of mechanical devices and scaffolding in agricultural activities and their monitoring on the farm with seeds, fertilizers, irrigation, work, and season. The objectives of agricultural machinery in food culture are to increase the seeding rate, shorten the sowing time and reduce labor costs. Mechanization also provides an alternative solution to the labor shortage. In the end, it will increase the productivity and welfare of farmers. With this strategic role and strength in mind, the government intervenes in the development of agricultural machinery. Indonesia is known as the most populous country of the SEA countries and is one of the most important policy to increase the productivity of agricultural production**.** Indonesia is also a country in SEA which has the largest area. Therefore, Indonesia has the potential to become a leader in agriculture in SEA. To achieve superior agriculture and wealthy farmers, it is necessary to have economic and key actors trained, trustworthy, in leadership, and entrepreneurs. These skills and abilities can be enhanced through counseling and group approaches (Alihamsyah, 2007). The group focus on consulting aims to improve the effectiveness and efficiency of the expansion organizations.

Modern farming or agriculture industrial culture (multiple terms used today) is agriculture which managed according to industry rules. That is market-oriented agriculture. all efficient and effective in the use of every means (input) of production (seeds, fertilizers, equipment, etc.) to achieve productivity, quality, and the maximum profit. Even when agricultural mechanization had been considered a necessity as a means to realize modern agriculture, however It should be realized that the successful implementation of mechanization requires accuracy technology and management, in addition to various other supporting factors. So that mechanization can achieve the desired aspired to and not the other way around, that is, it adds to the problem and burden production costs for farmers. This study tries to see the differences in the mechanization level of Indonesia with other countries in SEA.

1.1 Objectives

This study aims to identify the mechanization status of the Indonesian government compared to other countries in SEA

2. Literature Review

2.1 Agricultural Mechanization

Agricultural mechanization is often used as a synonym for tractorization. This misunderstanding is necessary corrected, due to agricultural mechanization in relation to agricultural engineering, includes technology applications and management of the use of different types of tools agricultural resins, from processing soil, planting, water supply, fertilization, plant care, harvest for ready to market products. Agricultural mechanization refers to the use of modern technologies to mechanize agricultural activities, greatly increasing the efficiency of agricultural workers. In this age, modern technologies have replaced many agricultural activities that were previously carried out by human or draft animal workers. The main purpose of optimization in industry is to increase efficiency in production (Nurcahyo, 2016). There are many examples of the use of simple equipment such as excavators, shovels, plows, etc. in previous agricultural activities. However, the continuous combination of machines since the industrial revolution has made it possible to cultivate them using much less labor anywhere in the world. Mechanization is an important factor in increasing the production of agricultural crops. Providing energy to agriculture means that more tasks can be done at the right time and a larger area can be planted to produce greater amounts of mineral resources over time. The application of new environmentally friendly technologies enables farmers to grow crops more efficiently with less energy. The mechanization of sustainable agriculture can also make a significant contribution to the development of value chains and food systems, as it can make post-harvest, processing and marketing activities and functions more efficient and environmentally friendly (FAO ,2014). Farming modernization is the procedure by which different machineries and associated implements are used to increase labor productivity as well as boost up agricultural and food production. It is an imperative contribution for seeding, transplanting, safeguarding, reaping, handling, and including values which have been generally disregarded in developing country (Hossen, 2020).

2.2 Indonesian Agriculture

Indonesia is a country with the largest area in Southeast Asia and has a lot of agricultural lands. Moreover, the agricultural sector in Indonesia has great potential to improve the Indonesian economy. The agricultural sector has so far been a major contributor to GDP, but its role is decreasing due to growth in the non-agricultural sector which is relatively faster than the growth in the agricultural sector. In 2014 the contribution of the agricultural sector to GDP was around 13.38% (equal to the contribution of the wholesale and retail trade, car repair, and motorcycle sectors) (BPS, 2015). The agricultural sector is also the dominant sector in the absorption of labor in Indonesia, although its role also tends to decline. In 2004 the role of the agricultural sector in absorbing labor was around 45%, decreased to 34% in 2014 (BPS, 2015). In Indonesia, the development of small agricultural mechanization systems begins with the transfer of material in 1950, followed by the transfer of design in 1970 and the transfer of capacity from 1980 (Handaka, 2003). The objectives of mechanization in Indonesia are to increase productivity through intensification, reduce post-harvest losses, increase value added and maintain the quality of agricultural products. In addition to of these multiple goals, the ultimate goal is to increase the well-being of farm households and create employment opportunities in rural areas (Handaka, 2005).

Agriculture in Indonesia is dominated by small and medium-scale agriculture (Quince, 2015). Most of the Indonesian farmers are cultivated individually using traditional methods (Maat, 2016). Indonesia is having difficulty meeting its domestic food needs. It has been shown that Indonesia will continue to import agricultural products from other countries until 2018. The Indonesian government is trying to increase productivity in the agricultural sector, one of which is by increasing the use of agricultural machinery. Reliability, availability, and maintainability are the

system characteristics that have an essential impact on the sustainability of the system (Nuryanto et al, 2020). The price of agricultural machinery is the main problem faced using agricultural machinery. Therefore, farmers tend to rent rather than buy (Lintje, 2012). One form of government intervention was agricultural machinery development through the agricultural machinery service business (UPJA), so that farmers are able to access and use agricultural machine without buying or owning machinery which are unaffordable. The UPJA has function to provide agricultural machinery services to farmers such as soil cultivation and other mechanization processes (Amalia et al, 2020).

2.3 Southeast Asia (SEA) Agriculture

ASEAN is the Association of Southeast Asian Nations which is a geo-political and economic organization of countries in the Southeast Asian region (Keling 2011). Another opinion says that the meaning of ASEAN is an organization formed by countries in the Southeast Asian (SEA) region of which Indonesia is a member. This Southeast Asian region covers a land area of 4.46 million square kilometres and a sea area of 13.4 million square kilometres. The total population of Southeast Asia in 2019 reached 600 million people, equivalent to 8.8% of the world's total population. 45% of the people of SEA still depend on the agricultural sector. One of the reasons is that the availability of sufficient and stable food can increase economic, social, and political stability.

Table 1 The average of Production and Consumption of the Agricultural Sector in SEA

Country	Average Production (million ton)	Average Consumption (million ton)	Average Production Growth (%)	Average Consumption Growth (%)
Indonesia	190,08	200,57	3,2	3,46
Cambodia	14,97	14,78	10,41	10,15
Laos	13,28	13,36	1,09	1,61
Malaysia	13,9	24,43	2,52	3,92
Myanmar	56,8	53,94	0,46	1,07
Philippines	99,56	103,03	0,23	0,44
Thailand	163,9	135,44	4,78	4,02
Vietnam	93,32	80,7	4,12	4,32

Source: FAOSTAT, 2019

From Table 1 it can be seen that the average production of the agricultural sector in Indonesia has the highest rank, followed by Thailand and the Philippines. However, when compared to other countries in Indonesia, the value of consumption in the agricultural sector is greater than its production. The average consumption growth in SEA tends to be higher than the average production. So that countries in SEA must make strategies and policies in agriculture that are more effective and efficient to meet their consumption needs in the future. Constraints that cause the slow growth of the agricultural sector include mastery of modern technology, land area, and labour (Singh, 2006). The agricultural productivity of most of the Asian countries is still low compared to the countries in North America and Europe. A very major reason is the non-availability of the appropriate agricultural machines at the right time. This phenomenon is very typical in the sowing and harvesting season (Tahir et al., 2003).

One of the Southeast Asian countries that is embracing modern agriculture is Thailand, where land cultivation is rapidly increasing the change from agricultural land cultivation to an agricultural agribusiness model in 46.6% of the absolute land area distribution allocated to agricultural practices (OAE, 2015). The mechanization of agriculture in Thailand began in 1891 when the government imported steam tractors and rotary hoes. Since then, the country has experienced several milestones in the development of mechanization. Today's mechanized agribusiness combines the use of modern tillage equipment, combine harvesters, myriad types of agricultural equipment, as well as airplanes and helicopters (for the application of aerial pesticides at the research level) and various modes of transport (Hossen, 2020). Vietnam is notable in more modest farm product exports like coffee, paddy, yarn, peanuts, sugarcane and tea. It ranks second for paddy in terms of trade, with 19.6% paddy area and 69% artificial flooded land. A minimum 30% of trading crops is cultivated all around the year (Apipattanavis et al, 2008). Although

Vietnam produces innumerable crops, the quality is not enough. The more crops that are grown, the lower their prices, and Vietnam cannot escape this endless cycle. This never-ending cycle requires performance farmers and most of them do not have sufficient capabilities. Another strategy called "Inspiration" was developed to help farmers and strategic authorities take advantage of economic globalization and delve into market needs. This can help solve the cycles that arise and develop agricultural activities (Talukdar,2020).

3. Methods

This research begins with determining the object, data collection, and analyzing data. This research wants to compare the status of mechanization level, government policies, economic conditions of Indonesia with other countries in SEA. Data collection was gathered by conducting literature reviews such as journals, reference, and supporting libraries, and institution.

4. Data Collection

The data collected is in the form of conditions and policies of countries in Southeast Asia related to agricultural mechanization. Data were collected from journals, libraries, and authorized institution. Other related data are obtained through discussions with relevant agencies that are directly involved in the procurement of agricultural mechanization mechanization.

5. Results and Discussion

5.1 Indonesia agriculture condition

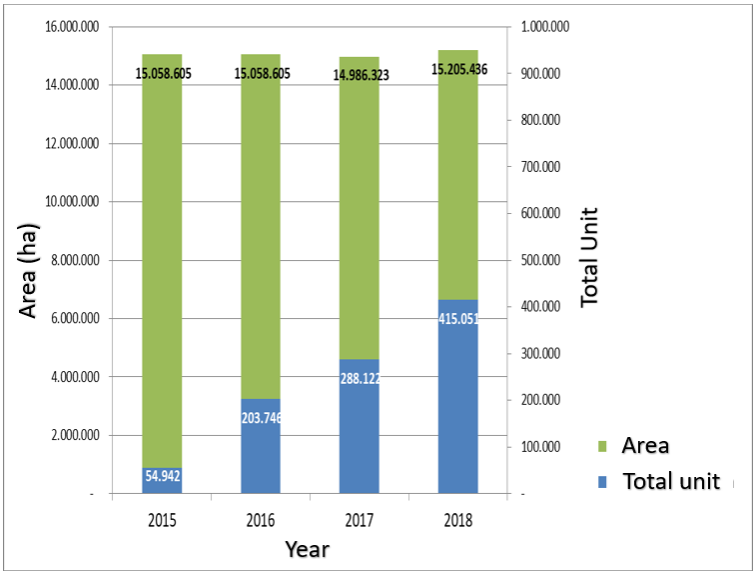
Table 2 GDP per Capita of Southeast Asia

Country	Year	
	1990	2019
Indonesia	$ 585,08	$ 4.135,20
Malaysia	$ 2.441,74	$ 11.414,20
Singapore	11861,756	65640,7079
Philippines	715,91361	3485,34084
Cambodia	-	1643,12139
Myanmar	-	1477,35537
Thailand	1508,9425	7817,01152
Laos	203,25602	2544,95255
Brunei Darussalam	13607,89	31085,9619
Vietnam	95,18826	2715,27598

Source: Worldbank

Table 2 shows Indonesia's GDP per capita compared to other countries in Southeast Asia. It shows that the GDP per capita of countries in Southeast Asia is growing. The value of Indonesia's GDP per Capita in 2019 was $4,135.20 and ranks 5th compared to other countries. Singapore ranks first with a GDP per capita of $65,640.7 followed by Brunei Darussalam, Malaysia, and Thailand. When compared with Indonesia, Singapore's GDP value is far above Indonesia's. If you look at the relationship between GDP per capita and the mechanization level, it can be seen that countries that have a high GDP per capita value tend to have a high mechanization value as well.

Table 3 Total Area dan Agricultural Machinery Unit of Indonesia



Source: BB Mektan

Based on the results of the United Nations Convention on the Law of the Sea (UNCLOS, 1982) in Montego Bay, Jamaica, Indonesia's marine area reaches 3,257,357 km², with a maritime/territorial boundary from the continental baseline as far as 12 miles measured. from the baseline, while its land area reaches 1,919,443 km². Overall, the area of sea and land reaches 5,176,800. Table 3 shows the area of agricultural land owned by Indonesia. In 2019, Indonesia's agricultural land area reached more than 15 million. Although it decreased in 2017, Indonesia managed to increase it Back in 2018. Thus, cultivating agricultural land requires a lot of labor and also agriculture mechanization. The data also shows the total number of agricultural machineries that continues to grow from year to year. Total agriculutral machineries in 2015 were 54.942 increased significantly ini 2018 to 415.051 This is necessary to increase production output from the agricultural sector.

5.2 Comparative mechanization level of Indonesia to other countries of Southeast Asia

Table 4 Comparative Mechanization Level of Southeast Asia Country

Country	Mechanization Level (hp/ha)			source
	1968	1990	Recent Year	
Indonesia	1,173	0.4	1.68 (2018)	BB Mektan, 2019
Thailand	0,348	0.89	2.5 (2015)	
Vietnam		0.61	1.5 (2015)	
Malaysia		0.24	2.4 (2015)	
Cambodia			1,32 (2013)	Singh, 2015
Philippines	0,198	0.52	1,23 (2011)	Bautista, et al 2017

Table 4 shows a comparison of the mechanization level of Indonesia with several countries in Southeast Asia such as Thailand, Vietnam, Philippines, and Cambodia. Mechanization Level is the ratio between the amount of power (hp) of agriculture machinery with the area of agriculture. The data shows that the mechanization level of these countries continues to grow over time. Mechanization level from Indonesia growth from 1968 which was only 1.173 HP/ha to 1.68 in 2018. When compared to Vietnam, Cambodia, and the Philippines, Indonesia's Mechanization level

is indeed higher. However, when compared to Thailand and Malaysia, Indonesia is still lagging. Thailand has the highest mechanization level in Southeast Asia, followed by Malaysia. When compared to developed countries such as the United States (US) and Japan, Southeast Asia are still far behind. Mechanization level from the US in 2015 was 17 hp/ha, while Japan's was 16 hp/ha (BB Mektan 2019). These results show that countries in Southeast Asia need to improve strategies to increase the mechanization level. Indonesia is trying to increase its Mechanization level. This can be seen in the assistance program for the procurement of 1 million agriculture machinery. Based on the decision of the Minister of Agriculture Number 06/Kpts/RC.210/B/02/2019 regarding the procurement and distribution of assistance for Agricultural Tools and Machinery. Assistance for the procurement of agriculture machinery by the Indonesian government, including 2-wheel tractors, 4-wheel tractors, air pumps, cultivators, excavators, and others (Ditjen PSP, 2019). This is intended to increase the amount of production from the agricultural sector and to increase the potential of Indonesia. Even so, the assistance for the procurement of agricultural machinery is still not sufficient to improve the quality of the agricultural sector. Management, improving the quality of the workforce, and regulations related to agriculture are needed to achieve this (Herlina, 2018).

6. Conclusion

Mechanization has a huge impact on the development of agriculture and farmers' livelihoods in Asia. In different regions of Asia, as well as in the different regions of the same country, there is a gap in agricultural mechanization due to the lack of transfer of technology and testing standards. The development of mechanization in Asia is necessary for the development of agriculture and the growing demand for food in the region. Indonesia is a country with the largest area in Southeast Asia, so it has the potential to optimize its agricultural sector. Mechanization level Indonesia is still below Thailand and Malaysia, so there needs to be a strategy to improve it. Through the procurement policy of 1 million agriculture machinery carried out by the Indonesian government, it is expected to improve the quality of production in the agricultural sector. In addition, there is also a need to improve management, improving the quality of workforce and regulations related to agriculture.

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Biography

Adhyka Wijaya received a S.T.P degree in Agriculture Engineering at Gadjah Mada University in 2018. He is is currently pursuing a Master of Engineering degree at the Industrial Engineering program majoring in Industrial Management from the University of Indonesia.

Rahmat Nurcahyo is a Professor in Management System, Industrial Engineering Department, Universitas Indonesia. He earned Bachelor in Universitas Indonesia, and Masters in University of New South Wales, Australia, then Doctoral degree in Universitas Indonesia. He has published journals and conference papers. His research interests include management systems, strategic management, maintenance management and business management.