# A BIBLIOMETRIC STUDY OF ASEAN LITERATURE ON AGRICULTURAL BIOTECHNOLOGY RESEARCH 2003-2013

**SEDIGHEH FAMIL DARDASHTI**



**FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY UNIVERSITY OF MALAYA KUALA LUMPUR**

**2018**

# A BIBLIOMETRIC STUDY OF ASEAN LITERATURE ON AGRICULTURAL BIOTECHNOLOGY RESEARCH 2003-2013

SEDIGHEH FAMIL DARDASHTI

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN LIBRARY AND INFORMATION SCIENCE

FACULTY OF COMPUTER SCIENCE
AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2018

**A BIBLIOMETRIC STUDY OF ASEAN LITEARATURE ON GRICULTURAL BIOTECHNOLOGY RESEARCH**
**2003-2013**

## ABSTRACT

ASEAN (Association of Southeast Asian Nations) is a geo-political and economic organization of ten countries which is located in Southeast Asia with an average of 6 percent per annum Growth Domestic Product (GDP) growth over the past 15 years. The agricultural industry is the mother industry to accelerate ASEAN countries' economic growth besides regional stability. Due to the importance of agriculture in sustainability of the ASEAN countries, this study applied bibliometric methods to evaluate agricultural biotechnology research situation (due to its key role in food productivity and sustainability) among ASEAN scholars, institutes, and countries. To fulfill this, the required data were extracted from the Web of Science (WoS) database for all ASEAN countries in the field of Agricultural Biotechnology during the period 2003 to 2013. In addition, the economic data including total GDP and the share of agriculture in total GDP were collected through World Bank Database for all ASEAN countries during 2003 to 2013. To analyze the data, the Statistical Product and Service Solutions (SPSS) were applied to illustrate both descriptive statistics (frequency, average) and inferential statistics (Correlation Coefficient). The 753 papers in agricultural biotechnology were calculated for all countries during 2003 to 2013. Malaysia with 37 percent of total publication in agricultural biotechnology, had the highest number of publication followed by Thailand with 33.1 percent and Singapore with 14.2 percent which indicated the highest papers were published by these countries. The results showed that the number of published papers among ASEAN countries were significantly different according to year. The results for total number of citation indicated that Malaysian papers had the highest number of citation (7012) followed by Thailand (5284). Malaysia had the highest number (35.4%) of involved institution and organization, followed by Thailand (31.6%). Among

top 92 authors who had more than 4 papers, Malaysia had the highest frequency of authors (50%) followed by Thailand (26.1%) and Singapore (17.4%). Findings for relationship between GDP and research output among ASEAN countries showed that there was a positive relationship for all countries except Cambodia and Myanmar. The highest correlation coefficient between GDP and number of publication was observed for Thailand (r=0.928) and Malaysia (r=0.911).

**Keywords:** agricultrual biotechnology, bibliometric, research productivity, ASEAN

**A BIBLIOMETRIC STUDY OF ASEAN LITEARATURE ON GRICULTURAL BIOTECHNOLOGY RESEARCH 2003-2013**

## ABSTRAK

ASEAN merupakan organisasi berlandaskan geopolitik dan ekonomi yang merangkumi 10 buah negara yang terletak di Asia Tenggara dengan kadar purata Keluaran Dalam Negara Kasar (KDNK) sebanyak 6% p.a sepanjang 15 tahun yang lalu. Industri pertanian ialah sebuah industri induk yang bertindak untuk mempercepatkan pertumbuhan ekonomi negara-negara ASEAN selain kestabilan serantau. Bagi mengekalkan kepentingan pertanian dalam negara-negara ASEAN, kaedah bibliometrik telah digunakan untuk menilai situasi penyelidikan bioteknologi pertanian (disebabkan oleh peranan utama dalam produktiviti makanan dan kelestarian) pada setiap organisasi seperti institut dan negara-negara ASEAN. Bagi memenuhi kehendak kajian ini, maklumat yang diperoleh telah dikumpulkan daripada Rangkaian Sains untuk semua negara-negara ASEAN di dalam bidang Bioteknologi Pertanian pada tahun 2003 hingga 2013. Tambahan pula, maklumat ekonomi termasuk maklumat jumlah KDNK dan jumlah perkongsian pertanian dalam KDNK telah dikumpul melalui Pengkalan Data Bank Dunia untuk negara-negara ASEAN pada tahun 2003 hingga 2013. Bagi menganalisis data ini, perisian SPSS telah digunakan untuk mengilustrasikan kedua-dua statistik iaitu statistik deskriptif (frekuensi, min) dan statistic kesimpulan (Koefisien Korelasi). Sebanyak 753 kertas kerja dalam bioteknologi pertanian telah dikira untuk semua negara ASEAN sepanjang tahun 2003 hingga 2013. Malaysia telah memperoleh jumlah penerbitan kertas kerja dalam bioteknologi pertanian yang tertinggi iaitu sebanyak 37% daripada jumlah keseluruhan dan diikuti oleh Thailand dan Singapura yang memperoleh 33.1% dan 14.2%. Keputusan tersebut telah menunjukkan bahawa bilangan kertas kerja yang diterbitkan oleh negara-negara ASEAN amat berbeza. Manakala, keputusan untuk jumlah keseluruhan

penggunaan petikaan menunjukkan bahawa akhbar Malaysia mempunyai hasil petikan paling tertinggi iaitu (7012) diikuti dengan negara Thailand sebanyak (5284) petikan. Malaysia merupakan negara yang mempunyai jumlah paling tinggi iaitu (35.4%) dalam penglibatan institusi dan organisasi diikuti dengan negara Thailand yang mempunyai jumlah penglibatan sebanyak (31.6%). Di antara 92 orang pengarang yang berada di carta teratas memiliki lebih daripada 4 kertas kajian, majoriti pengarang yang berada di carta teratas ialah Malaysia iaitu sebanyak 50%, diikuti dengan Thailand iaitu (26.1%) dan Singapura sebanyak (17.4%). Hasil penemuan mengenai hubungan diantara KDNK dengan hasil kajian penyelidik di seluruh ASEAN menunjukkan hubungan yang positif dengan seluruh negara kecuali Cambodia dan Myanmar. Koefisien Korelasi yang tertinggi di antara KDNK dan jumlah penerbitan yang dibawah pemerhatian untuk Thailand ialah (r = 0.928) dan Malaysia (r=0.911).

**Keywords:** bioteknologi pertanian, bibliometrik, produktiviti penyelidikan, ASEAN

## ACKNOWLEDGMENTS

I wish to express my deepest gratitude, in brief, to the people who have contributed, directly or indirectly, to the completion of this dissertation. First of all, to my supervisor, Professor Dr. Abrizah Binti Abdullah, I wish to sincerely thank her for her guidance, patience, motivation and encouragement that has enabled me to successfully conduct the study and complete the dissertation.

I would also like to record my special thanks to Arash Amini Tabrizi, Dr. Mahmoud Danaee, Dr. Nahid Bayat Bodaghi, and Dr. Nader Ale Ebrahim, for their academic training, professional advices and continuous guidance in the process of my research. I would not have managed to finish my MLIS program on schedule without their support.

I am also grateful to the staff of the Faculty of Computer Science and Information Technology, University Malaya for their assistance and supports throughout my study and in completing the research project.

Thanks for all your encouragement!

## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

## LIST OF ABBRIVATIONS

| | |
|---|---|
| AMAF | ASEAN Ministers on Agriculture and Forestry |
| ASEAN | Association of Southeast Asian Nations |
| COST | Committee on Science and Technology |
| CSV | Comma Separated Format |
| DNA | Deoxyribonucleic A caff caffcid |
| GDP | Gross Domestic Product |
| IAASTD | International Assessment of Agriculture Knowledge, Science and Technology for Development |
| IF | Impact Factor |
| INRA | French National Institute of Agriculture Research |
| ISI | Scientific Information/Web of Science |
| KDNK | Keluaran Dalam Negara Kasar |
| MDS | Multidimensional Scaling |
| OUAT | Orissa University of Agricultural Technology |
| R&D | Research and Development |
| SCIE | Science Citation Index Expanded |
| SJA | Sarhad Journal of Agriculture |
| SSCI | Social Science Citation Index |
| WoS | Web of Science |

## LIST OF APPENDICES

# CHAPTER 1: INTRODUCTION

## 1.1 Introduction

Researchers utilize diverse methods and indicators to measure the performance of scientific research. Bibliometric study is the quantitative analysis of research literature based on citations, and can be used to evaluate the impact on the academic community of a research paper, a research group or institution, an individual researcher or a journal. The number (quantity), type and distribution of publications are the most commonly applied bibliometric indicators of scientific output. The number of publications and citations has been used to monitor publication performance. The number of publications in a field is considered an indicator of research activity, and the number of citations is an indicator of impact. The use of number of publications can be considered a proxy of the scientific manpower available in a particular region or country (Schubert et al 1986). Different scholars adopted citation analysis to assess the publication productivity of individual authors, institutions or countries (Norhazwani & Zainab, 2007).

For extraction of these indicators, several databases offer bibliometric parameters such as number of publications (e.g. productivity) and total citations (e.g. the total impact) by each author, as well as by affiliation or key words. This group of databases includes the Clarivate Analytics (previously owned by Thomson-ReuterWeb of Science database Elsevier's Scopus, Publish or Perish and Google Scholar. Scientific productivity depends on various factors, such as age and subject specialization, laboratory history and economic indicators, such as government expenditure on civil research and development (Hammouti, 2010).

The objective of the present study is to highlight and compare the scientific productivity of agricultural biotechnology scientists and institutions for the ten ASEAN (the Association of Southeast Asian Nations) countries (Malaysia, Indonesia, Philippines,

Thailand, Brunei, Burma (Myanmar), Cambodia, Laos, Vietnam and Singapore) in the period 2003-2013 based on data from the Web of Science.

ASEAN was formed via the Bangkok Declaration on the 8th August 1967 by Indonesia, Malaysia, Philippines, Singapore and Thailand. Other countries joined in later years, namely Brunei, Burma (Myanmar), Cambodia, Laos and Vietnam. The establishment of the geo-political organization was a move towards social progress, cultural development, promotion of peace and stability in the region, and the acceleration of economic growth (ASEAN, 2006).

The main purpose of agricultural research is to improve the performance and production rate of agricultural products. Nowadays, food production is a life and death issue for human beings, and every kind of research which helps in any way is useful for every country. Nguyen and Pham (2011) highlighted that the publication share of researchers of ASEAN countries in Web of Science (WoS) indexed journals during the 20 years from 1991 to 2010 was 165,000 articles, representing 0.5% of world scientific output.

The main purpose of establishing ASEAN was "to accelerate the economic growth, social progress and cultural development in the region through joint endeavors in the spirit of equality and partnership in order to strengthen the foundation for a prosperous and peaceful community of South-East Asian nations" (ASEAN Secretariat, 1967, p. 1). Therefore, ASEAN has economical purposes and also covers agricultural issues. The combined population of the member countries is 600 million. Agriculture is an important industry in most of these countries and, as such, more research is required.

Bibliometrics is a powerful tool for studying the research situation of people, institutes and countries. Some similar bibliometric researches are performed in other countries and unions. Also, there are similar researches conducted in ASEAN countries on other

subjects, such as fuel. The results of these researches study and compare the rate of R&D in these countries. They can also reveal the strengths and weaknesses of the researches performed in various agricultural sub-categories.

## 1.2 Agricultural biotechnology

Agricultural biotechnology refers to the application of various scientific techniques (based on the content of Deoxyribonucleic A caff caffcid (DNA)) to create new solutions for increasing agricultural productivity, enhancing crop protection, improving food processing, promoting nutritional value and increasing nations' sustainability. It is defined as the area of biotechnology which applies to agriculture, improving agricultural organisms via selection and breeding (Wieczorek, 2003). In the Web of Science (WOS) categorization, agricultural biotechnology covers two subcategories of agriculture: biotechnology and applied microbiology.

## 1.3 Background of the study

Bibliometric study is the quantitative analysis of research literature based on citations, and can be used to evaluate the impact on the academic community of a research paper, a research group or institution, an individual researcher or a journal. The number (quantity), type and distribution of publications are the most commonly applied bibliometric indicators of scientific output. The number of publications and citations has been used to monitor publication performance. The number of publications in a field is considered an indicator of research activity, and the number of citations is an indicator of impact. The use of number of publications can be considered a proxy of the scientific manpower available in a particular region or country (Schubert et al 1986). Different scholars adopted citation analysis to assess the publication productivity of individual authors, institutions or countries (Norhazwani & Zainab, 2007). As another indicator, Meyer (2009) regrouped the overall h-index proposed in 2005 by Hirsch. H-index seems

to be a good indicator to quantify an individual's scientific research output (Hirsch, 2005). Although Hirsch's proposal was not the first attempt to rank scientists in an objective way, namely by number, he introduced an idea that was both convincing and controversial (Meyer, 2009). As a result of his bibliometric study of the publication patterns of scientists in South Africa between 1992 and 1996, Jacobs (2001) endeavored to establish the relationship between the scientists' situation and their productivity.

Braun et al. (2006) assessed UK scientific performance based on publication and citation counts, and similar indicators were used by Zhou (2006) in regard to China. Bibliometric research into the performance of the Nordic countries for the period 1989 to 2008 was carried out by the Nordic Network (Schneider, 2010). Performance was gauged through publication activity and citation impact at both national and field levels. In Germany, Schomch et al. (2011) studied the performance of German science systems and public non-university research institutes, based on number of publications and citation of publications. Hammouti (2010) assessed data from Scopus to determine the scientific productivity of Algeria, Morocco and Tunisia, collectively known as the Maghreb countries. Hammouti findings indicated that Tunisia had a higher output than Morocco and Algeria, despite only producing a third as many publications. At 2001, Jacobs research into scientists' publication patterns in South Africa between 1992 and 1996 revealed that papers in the fields of physics and astronomy, agricultural and biological sciences, medicine and engineering (Jacobs, 2001). In another research, Bouabid and Martin (2007) studied publication patterns in Morocco between 1997 and 2006, comparing them with the performance South Africa, Egypt, Nigeria, Algeria, Tunisia, Portugal and Greece. The research looked at publications' h-indexes and average citation rates per paper, and came to the conclusion that the h-index was a good indicator of the quality of researchers' scientific output (Hammouti, 2010).

The importance of publication is highlighted by the increased pressure to publish more. Altbach and Rapple (2012) spoke of the need to 'publish or perish', noting that scholars are 'under increasing pressure to publish more, especially in English language internationally circulated journals that are included in globally respected indices such as the ISI Citations.' Often, pressure is placed on non-English academics to publish in English language journals, as it helps to improve rankings. The increase in publication has also led to an increase in studies on publication productivity, which shows the growing interest in the subject.

### 1.4 Problem statement

Scientific publication is one of the most important outputs of every scientific research, demonstrating its results and opening a communication channel with other scholars. Publication of research results in a journal, especially an impact factor journals ranked in the Web of Science, is an accepted quality measurement of both the publication and the research.

The number and rank of the WoS papers is a measurement for analyzing and comparing productivity of scientists and the output of institutions. In large scale analysis, examining the scientific output of countries can demonstrate the overall productivity of their scientific communities in every institution, and can help to highlight the performance of their investment in research.

The researches by Mankiw and Barro showed positive and significant effects of research output on economic growth (Mankiw et al., 1992; Barro, 1991), while the study by Bils and Klenow showed a possibility of an inverse relationship between economic growth and research (Bils & Klenow, 2000). In a recent research study, Jin and Jin indicated that publication productivity in different fields has differing effects on economic growth.

Engineering and science publications, for example, have more positive influence on economic growth than output in the social sciences (Jin & Jin, 2013).

Publication productivity is a more of a priority for researchers nowadays than it was in the past, and the results provide benefits for the whole community (Zain et al, 2009). In order to help economies grow faster, education in human resources field is the key (Jin & Jin, 2013). This is borne out by the fact that the most productive research universities in the world are in highly developed countries such as the United States, Canada and the United Kingdom. Boasting average GDP growth of 6 percent per annum over a 15-year period, ASEAN is considered the 3rd pillar of growth in Asia, behind China and India. (IMF DB Research 2013). Figure 1.1 presents the general information of ASEAN counties, including GDP, GDP growth, and population.

While research performance and investment in research can be compared with the GDP of countries, bibliometric study can be useful as a measurement for assessing the output of research investments. However, there are limited bibliometric studies investigating science in ASEAN, and even fewer which focus exclusively on agricultural science.
This study applies bibliometric methods to evaluate the research situation of agricultural biotechnology, due to its key role in food productivity and sustainability, among ASEAN

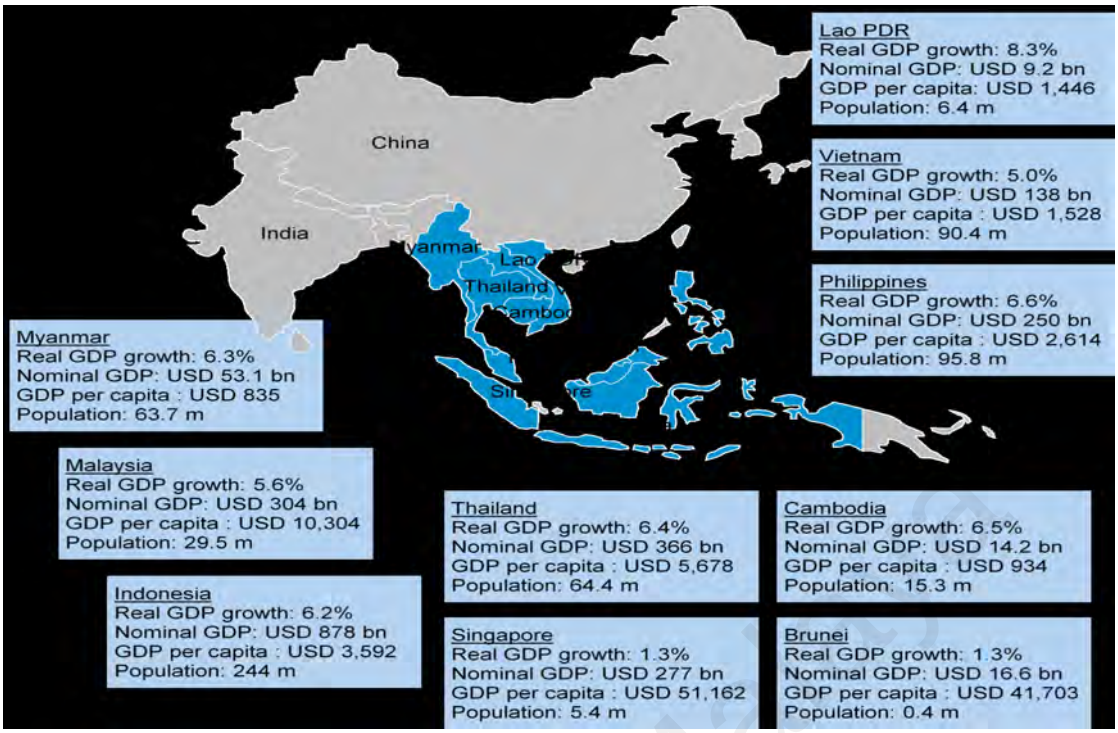


Figure 1.1: General information on ASEAN countries

authors, institutions and countries. The main intention of this study is to identify publication productivity among ASEAN in a 10-year period (2003-2013). This study also investigates the relationship between biotech-agriculture research publications and GDP in ASEAN countries.

## 1.5 Objectives of the study

The main purpose of the present study is to assess the performance of agricultural biotechnology research in ASEAN countries during the years 2003 until 2013 using descriptive statistics and bibliometric methods at the macro, meso, and micro levels. The 10-year data is harvested from the Web of Science database, which provided the necessary data to support a bibliometric study. Hence, the specific objectives of the study are as follow:

At the macro level:

1. To rank the top productive ASEAN countries, using total and average number of publications.
2. To compare the total and average citation between ASEAN countries

3. To identify the total and annual distribution of publications
4. Identify the frequency of publications according to journals
5. To identify the most cited papers and their country of publication
6. To determine the distribution of top researchers in ASEAN countries based on h-index and number of publications
7. To compare the impact of publication between countries

At the meso level:

8. To compare the performance of institutions among ASEAN countries in terms of number of publications
9. To identify the top institutions based on number of publications

At the micro level:

10. To identify the top productive ASEAN researchers using number of publications and h-index

In addition,

11. to identify the relationship between GDP of ASEAN countries and their publication productivity

## 1.6 Research questions

The research questions follow the objectives of the study:

1. What is the performance of ASEAN countries in terms of the number of publications in agricultural biotechnology research (macro)?
2. What is the performance of ASEAN countries in terms of the number of citations in agricultural biotechnology research (macro)?
3. How is the total and annual distribution of publications among ASEAN countries?
4. How is the frequency of publications of ASEAN countries in agricultural biotechnology according to the journals?
5. What are the most cited papers and what is their country of publication?

6. How is the distribution of top researchers in ASEAN countries based on h-index and number of publications?
7. What is the impact of publications for ASEAN countries?
8. What is the performance of ASEAN institutions in terms of the number of papers and citations in agricultural biotechnology research (meso)?
9. What are the top institutions based on number of publications (meso)?
10. How is the productivity of ASEAN researchers in terms of the number of publications and h-index in agricultural biotechnology research (micro)?
11. What is the relationship of the GDP of ASEAN countries and their research publication productivity?

## 1.7 Scope of the study

In this study, the research performances of Association of Southeast Asian Nations (ASEAN) countries and universities in agricultural biotechnology field were assessed using bibliometric indicators. All data was retrieved from the Science Citation Index Expanded (SCIE) of Web of Science (WoS) database for the period 2003 until 2013. Agricultural biotechnology science consists of biotechnology and applied microbiology.

## 1.8 Limitations of the Study

This study looks at the scientific performance of agricultural biotechnology scientists in ASEAN countries using bibliometric indicators and statistical parameters: number of publications, number of citations, and h-index. All data is retrieved from the Science Citation Index Expanded (SCIE) of Web of Science (WoS) database for the period 2003 until 2013. This study only investigates the 10 years of publications in ASEAN countries. In addition, it only uses the data from SCIE, and the other resources as Scopus, which cover more types of publications and a wider range of researches are not in the scope.

## 1.9 Contribution of the Study

This study is based on descriptive statistics and bibliometric analysis. The focus of descriptive statistics is to depict the quantity and pattern of publication productivity among ASEAN countries in biotech-agriculture. In addition, bibliometric analysis is applied to measure the performance, scientific productivity and trends of ASEAN countries, institutes and scholars in the field of biotech-agriculture, using publication and citation counts. The results of the study should reveal the most productive countries, institutions, and authors in ASEAN. In addition, the statistical analysis investigates the relationship between number of publications and GDP as an economical growth index for ASEAN countries.

## 1.10 Organization of the Dissertation

The content of this study divided into 5 chapters. Chapters 1 introduce the study and the outlines of the research including statement of the problem, objectives, research question and significance of the study. Chapter 2 discusses the literature in agricultural biotechnology research from world to ASEAN countries and moving on to bibliometric study. Chapter Three explains the proposed methodology and research design. Chapter 4 presents the data analysis and findings obtained from bibliometric analysis used in this study, while Chapter 5 discusses the findings from data analysis and recommends future works.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

This chapter provides a review of the relevant literature related to the topic of the dissertation. The first part of the literature presents the history of the establishment of ASEAN, its fundamental principles, and the key role of agriculture among ASEAN countries. The second part discusses biotechnology, its definitions, and depicts the nature of agricultural biotechnology. The third part of the literature focused on bibliometrics, its origins, data sources for bibliometric analysis, bibliometric indicators, and finally bibliometric studies in agricultural biotechnology. The final part of this chapter introduces the VOSviewer software and looks at various studies which used it to visualize their bibliometric data.

## 2.2 A glimpse of ASEAN

On 8$^{th}$ of August 1967, the foreign ministers of Malaysia, Indonesia, Singapore, Thailand, and the Philippines signed the Bangkok Declaration to establish ASEAN (the Association of Southeast Asian Nations), the purpose of which was to safeguard the security and economic wellbeing of the region. Later, other countries joined ASEAN; Brunei in 1984, Vietnam in 1995, Laos in 1997 and Cambodia in 1999. Figure 2.1 presents the geographic map of southeast Asia, including the ASEAN countries.

The Bangkok Declaration consisted of five simply worded articles which referred to social and cultural development, economic growth and the expansion of equality. Moreover, it emphasized the vital need to improve regional sustainability, to promote regional collaboration in all aspects (social, cultural, educational, technical and economic), to progress the utilization of agriculture and industry among member

countries, and to increase the level of cooperation with regional and international organizations. Accordingly, to achieve the

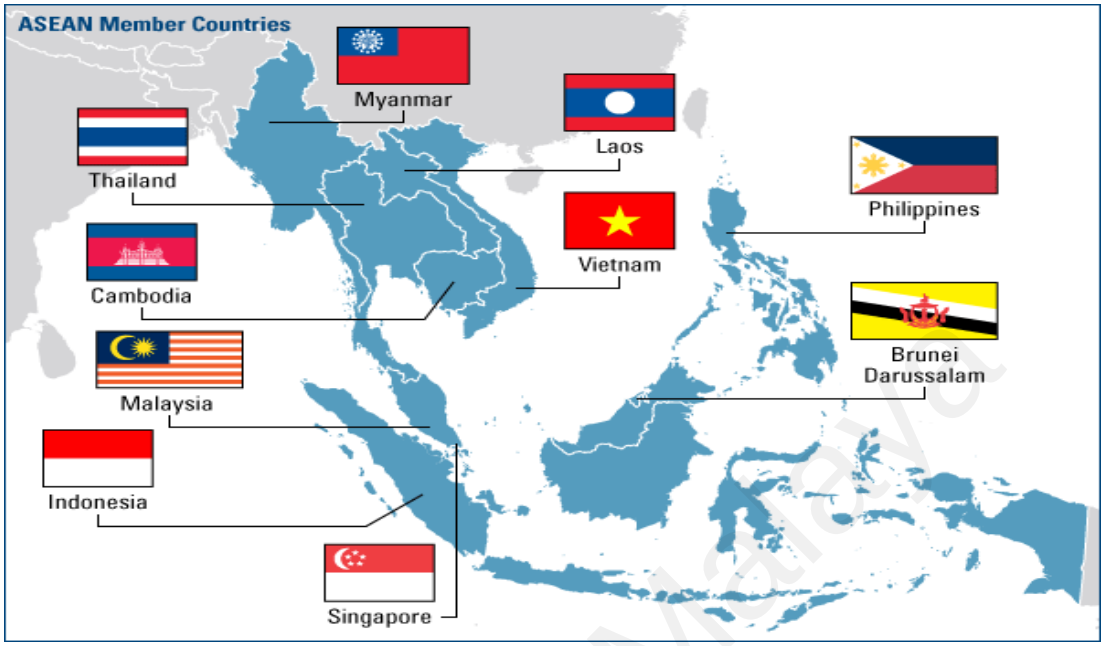


Figure 2.1: The ASEAN member countries

defined objectives, they considered some fundamental principles such as mutual respect of nations' independence and identity, ensuring leadership free of external interference, establishing effective cooperation, and settlement of disputes via a peaceful manner (http://www.asean.org/asean/about-asean/history).

In general, the ASEAN countries aimed to assure the inclusive and fair growth of all member countries, concentrating on areas such as development of infrastructure, education (high skilled human resources), health, energy and, most specifically, agriculture. To this end, the logo of ASEAN was designed in a way which reflects its key objectives. In this respect, the logo of ASEAN consists of four colors - blue (symbolizing stability and peace), white (purity), red (dynamism and courage) and yellow (prosperity) - which depict the main colors of all member countries in ASEAN. In addition, ten stalks of 'padi' in the center represent the ten member countries bound together. The logo

(Figure 2.2) attempts to illustrate the dream of ASEAN's aim for friendship, solidarity, cooperation and peace among the ten member countries.


Figure 2.2: The Logo of ASEAN

### 2.2.1 Research in Agriculture

The main purpose of agricultural research is to improve the performance and production rate of agricultural products. Nowadays, food production is a life and death issue for human beings, and every kind of research which helps in any way is useful for every country. Nguyen and Pham (2011) highlighted that the publication share of researchers of ASEAN countries in Web of Science (WOS) indexed journals during the 20 years from 1991 to 2010 was 165,000 articles, representing 0.5% of world scientific output.

### 2.2.2 Agriculture and ASEAN

A glimpse of ASEAN history indicates that two decades ago, before its establishment, agriculture in ASEAN countries reflected their long-standing traditions which, viewed through the world's eyes, was considered as laggard. Now, through applying biotechnology techniques, agricultural growth seems brighter; it has grown around 6 percent on average. Therefore, due to the key role of agriculture in the economic growth of ASEAN countries, the ASEAN bodies concerned themselves with 'biosafety' and 'biotechnology' in agriculture. In this regard, they established: the AMAF (ASEAN Ministers on Agriculture and Forestry), with the aim of promoting trade in ASEAN food

and products, facilitating ASEAN trade in agriculture, and strengthening the ASEAN position regarding regional and international affairs; COST (Committee on Science and Technology), for utilizing the technology, research development, human resource development, networking of regional technology infrastructure, and technology transfer.

### 2.2.3 Agriculture and Gross Domestic Product (GDP) in ASEAN

Gross domestic product (GDP) is a monetary measure of the market value of all final goods and services produced in a particular period, usually either quarterly or yearly. As a gauge of the health of a country's economy, GDP is one of the main indicators used. It is a representation of the total value of all goods and services produced over a specific time period; it can be thought of as the size of the economy. Usually, GDP is expressed as a comparison to the previous quarter or year. For example, an expression that GDP is up by 3 percent year-on-year is taken to mean a 3 percent growth in the economy over the course of that year (Gutierrez et. al., 2007).

Measurement of GDP is a complex procedure, but the simplest way of looking at it is to say that it can be calculated in two different ways. Firstly, by adding up how much everyone earned in a year (income approach). And secondly, by adding up how much everyone spent (expenditure method). Logically, in both instances the result should be roughly the same.

The economic production and growth which is represented by GDP has a knock-on effect for everyone within that economy. A healthy economy generally leads to low unemployment figures and increased wages, as a growing economy leads to more demand for labor from businesses which have more money to spend. The stock market can be significantly affected by a major change in GDP, whether the change is up or down. In a bad economy, companies generate lower profits, leading to lower stock prices. In a good

economy, the opposite is true. Negative GDP growth is a cause of major concern for investors, and this is one of the factors used by economists to determine when an economy enters recession.

It is possible to view GDP in three separate ways (Gutierrez et. al., 2007):

a) The production approach. This calculates the total of 'value-added' at every stage of production, where 'value-added' is taken to mean total sales minus the value of intermediate input into the production process. An example of this can be found in the bread-making process, where one intermediate input is flour; another example is architecture, where the services of the architect is an intermediate input, and the final product is the building itself.
b) The expenditure approach. This calculates the value of purchases made by consumers. For example, the amount of money spent on food, televisions and medical services by households; investment in machinery by businesses; and purchases of goods and services by the government and foreign parties.
c) The income approach. This calculates the total income generated by production. For example, remuneration for employees, and companies' operating surpluses, which roughly equates to sales less costs.

A country's GDP is normally measured by the national statistical agency, which uses several different sources to compile the data. In order to do this, most countries abide by established international standards in order to achieve the correct figures. To calculate the GDP, the international standard is found in the System of National Accounts (1993), which was compiled by the International Monetary Fund, the European Commission, the Organization for Economic Cooperation and Development, the United Nations and the World Bank.

The total land area of ASEAN is 4.4 million square kilometers, which is 3% of the total land area of Earth. The territorial waters of ASEAN cover an even greater area, which is around three times larger than the amount of land. The combined population of the member countries is roughly 625 million, which is about 8.8% of the total world population. By 2015, the combined GDP of all the countries totaled more than US$2.8 trillion, which means that if ASEAN were one country it would have the sixth largest economy in the world, behind USA, China, Japan, Germany and the UK (ACIF 2013). ASEAN's land borders are with India, China, Bangladesh, East Timor and Papua New Guinea. Meanwhile, its sea borders are with India, China, Palau and Australia. Certain ASEAN members have given their backing to East Timor and Papau New Guinea in their bids to accede to membership of the organization. Table 2.1 presents the International Monetary Fund for ASEAN counties at 2014, while the table 2.2 demonstrates the International Monetary Fund estimation for World and ASEAN Countries at 2019.

Table 2.1: International Monetary Fund for ASEAN countries 2014

| Rank | Country | Population in millions | | GDP Nominal millions of USD | | GDP Nominal per capita USD | | GDP (PPP) millions of USD | | GDP (PPP) per capita USD | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***ASEAN*** | ***633.35*** | ***100.0*** | ***2,305,542*** | ***100.0*** | ***3,745*** | ***100.0*** | ***3,605,602*** | ***100.0*** | ***5,857*** | ***100.0*** |
| **1** | Indonesia | 244.47 | *39.7* | 878,198 | *38.1* | 3,592 | *95.9* | 1,216,738 | *33.7* | 4,977 | *85.0* |
| **2** | Thailand | 75.2 | *10.5* | 365,564 | *15.9* | 5,678 | *151.6* | 651,856 | *18.1* | 10,126 | *172.9* |
| **3** | Malaysia | 30.89 | *4.8* | 303,527 | *13.2* | 10,304 | *275.1* | 498,477 | *13.8* | 16,922 | *288.9* |
| **4** | Singapore | 6.9 | *0.9* | 276,520 | *12.0* | 51,162 | *1,366.1* | 326,506 | *9.1* | 60,410 | *1,031.4* |
| **5** | Philippines | 102.8 | *15.6* | 250,436 | *10.9* | 2,614 | *69.8* | 424,355 | *11.8* | 4,430 | *75.6* |
| **6** | Vietnam | 90.39 | *14.7* | 138,071 | *6.0* | 1,528 | *40.8* | 320,677 | *8.9* | 3,548 | *60.6* |
| **7** | Myanmar | 60.67 | *10.3* | 53,140 | *2.3* | 835 | *22.3* | 89,461 | *2.5* | 1,405 | *24.0* |
| **8** | Brunei | 0.40 | *0.1* | 16,628 | *0.7* | 41,703 | *1,113.5* | 21,687 | *0.6* | 54,389 | *928.6* |
| **9** | Cambodia | 15.25 | *2.5* | 14,241 | *0.6* | 934 | *24.9* | 36,645 | *1.0* | 2,402 | *41.0* |
| **10** | Laos | 6.38 | *1.0* | 9,217 | *0.4* | 1,446 | *38.6* | 19,200 | *0.5* | 3,011 | *51.4* |

Table 2.2: International Monetary Fund 2019 Estimates

| Rank | Country | Population in millions | GDP Nominal millions of USD | GDP (Nominal) per capita USD | GDP (PPP) millions of USD | GDP (PPP) per capita USD |
|---|---|---|---|---|---|---|
| — | ***World*** | *7,450.00* | *97,598,942* | *13,100* | *119,344,057* | *16,000* |
| — | United States | 331.39 | 21,101,368 | 63,676 | 21,101,368 | 63,676 |
| — | *European Union* | *509.25* | *19,754,593* | *38,800* | *19,713,269* | *38,710* |
| — | China | 1,394.88 | 14,941,148 | 10,711 | 22,641,047 | 16,231 |
| — | India | 1,344.77 | 3,311,747 | 2,463 | 11,565,735 | 8,600 |
| — | Japan | 125.42 | 5,930,147 | 47,281 | 5,619,492 | 44,804 |
| — | ***ASEAN*** | ***670.71*** | ***3,751,171*** | ***5,593*** | ***5,612,921*** | ***8,369*** |
| — | South Korea | 51.42 | 1,729,880 | 33,644 | 2,270,913 | 44,167 |
| **1** | Indonesia | 266.15 | 1,251,875 | 4,638 | 2,033,577 | 7,533 |
| **2** | Malaysia | 32.59 | 538,028 | 16,417 | 788,912 | 24,072 |
| **3** | Philippines | 107.63 | 522,271 | 4,757 | 732,138 | 6,669 |
| **4** | Thailand | 65.94 | 491,520 | 7,023 | 959,722 | 13,712 |
| **5** | Singapore | 5.99 | 378,191 | 65,790 | 483,686 | 84,142 |
| **6** | Vietnam | 97.10 | 240,185 | 2,780 | 565,091 | 5,919 |
| **7** | Myanmar | 71.75 | 96,891 | 1,325 | 197,972 | 2,707 |
| **8** | Cambodia | 16.19 | 26,392 | 1,614 | 68,039 | 4,160 |
| **9** | Laos | 6.93 | 18,898 | 2,493 | 36,157 | 4,769 |
| **10** | Brunei | 0.44 | 18,890 | 42,313 | 31,496 | 70,549 |

## 2.3 Biotechnology

After the World War II, there was international cooperation in agricultural research and development to assist researchers all around the world in exchanging their knowledge and consequently increasing agricultural productivity in both developed and developing countries. In this respect, The IAASTD (International Assessment of Agriculture Knowledge, Science and Technology for Development) highlighted the vital need to improve the world's agricultural system with the aim of overcoming environmental crises, reducing poverty and advancing food sustainability (Pesticide Action Network North America, 2010). Therefore, making a positive impact on world hunger andsolving the global food crisis is vital for the global community. Moreover, according to a United Nations estimate, by 2050 the world population will have to increase food productivity by up to 70% in order to avoid a global food shortage (FAO, 2009). This highlights the essential need for the new scientific techniques offered by biotechnology, such as bio-fertilizing and crop genomics, in the food production process.

In fact, agricultural production is based on the exploitation of plants and animals, world biological resources which consist of different features such as regeneration, reproduction and being inexhaustible. Although agricultural production has such characteristics, the stability of achieving sustainable development and high productivity is directly linked to human civilization, and to new technologies such as biotechnology. (Vucinic & Pesic, 2001). Indeed, developing biotechnological techniques and applying them to agriculture led to the emergence of agricultural biotechnology, which enabled countries to solve their food productivity problems (Suvedi & Smalley, 1996).

Wieczorek (2003) defined biotechnology as the new scientific technology which enables animals, plants and microorganisms to achieve their potential values. Similarly, in 2005 the OECD (Organization for Economic Cooperation and Development) defined biotechnology as the application of technology to living organisms to modify living or non-living materials with the aim of producing services and goods.

Accordingly, agricultural biotechnology is defined as the area of biotechnology which applies to using techniques to improve agricultural organisms via selection and breeding (Wieczorek, 2003). In agriculture, biotechnology is defined as any new technology or technique, such as gene splicing, genomics and recombination, which is applied to modify the living organism's biological system. Indeed, the key aim of applying agricultural biotechnology is to develop a sustainable agricultural industry, improving people's livelihoods and guaranteeing global food security (Serageldin, 1999). In simple terms, agricultural biotechnology refers to applying various scientific techniques, based on the content of DNA, to create new solutions for increasing agricultural productivity, enhance crop protection, improve food processing, promote nutritional value, and finally to ensure the sustainability of nations (Wieczorek, 2003).

Over time, biotechnology revolutionized different fields of study, such as healthcare (medicine delivery systems, diagnostic tools) and energy supplies, but its most important effect has been on agriculture (Ernst & Young, 2007). In addition, with the advance of biotechnological science, various categories emerged such as biomaterials, bioengineering, crop genomics, system biology and bio-nanotechnology. Currently, all of this new scientific biotechnology is applied in agriculture, which brings lots of advantages such as environmental benefits (reducing the degree of dependency on pesticides, and preventing the production of hazardous products). Furthermore, biotechnological agriculture can assist less developed countries to improve their health conditions. For example, in their investigations, the Swiss Federal Institute of Technology aimed to improve the genes of rice in developing countries with rice-based diets, in order to produce golden rice with sufficient vitamin A (via improving the beta-carotene) to prevent the increase of blindness among children (Wieczorek, 2003). Another example is the soybean. Indeed, scientists, through applying biotechnology, have produced around 10 new versions of soybean. These new versions have lots of benefits for human health, such as improving omega fatty acid, reducing saturated fat and increasing the degree of flavone content in the soybean. More importantly, applying the biotechnological agriculture in the context of less developed countries will not only increase farmers' earnings, but will also improve their communities.

## 2.4 Bibliometric as a research field

### 2.4.1 The Origin of Bibliometric

Nowadays, Bibliometric is considered one of the most interesting interdisciplinary research fields which mostly used in the field of library and information science to explore the impact of a set of scholars, particular field or papers (Kumar et al., 2012). Indeed, the aim of bibliometric is to assist the stakeholders to achieve better understanding of

construction, dissemination and apply of scientific knowledge through assessing researchers' communication activates. For example, the UK government apply the bibliometric methods as an auxiliary instrument for their Research Excellent Framework to enable them to identify the quality of the UK universities and research institutes outputs. On the other words, the bibliometric assist them to evaluate the national research performance in compare with international research activities.

The word 'Bibliometric' is a combination of two words 'biblion' as books, paper and 'metrics' as the science of meter. In 1969, Allan Pritchard for the first time used the term bibliometric in his article under title "Statistical Bibliography or Bibliometric" which became more popular during 1980s. The key aim of Pritchard was to apply the mathematics method to measure the publication patterns of books and other communication media besides their authors (Pritchard, 1969; Potter, 1981). In this respect, Nicholas and Ritchie (1978) defined the bibliometric as the providing information regards the pattern of knowledge and the process of knowledge communication.

Recently, Sengupta defined bibliometric as the "quantitative evaluations of publication patterns … along their authorship" through statistical calculation (Sengupta, 1990, p. 256). Ma (2005) and Bellis (2009) noted the bibliometric is the quantitative analysis to illustrate the pattern of publication in a given field or technological literature. In other words, bibliometric can determine the performance of scientific community such as individual scientist productivity, departments or institutions (Katz & Hicks, 1997; Zainab, 1999). According to Glanzel (2003) currently bibliometric considered as the standard tools for research management and science policy.

### 2.4.2 Data Sources of Bibliometric Research

The units of bibliometric analysis include books, papers in serials, reports, monographs and theses. Nevertheless, scientific papers published in referred scientific journals are mostly considered to be the basic unit for bibliometric analysis. Bibliometric scholars use various data sources for collecting bibliometric analysis such as Medline, Scopus, SciVal, Chemical Abstracts, Inspect and Mathematical Review. However, the Science Citation Index Expanded (SCIE) and Social Science Citation Index (SSCI), which are published by Thomas Reuters Institute, are currently the most generally accepted databases among bibliometric scholars when it comes to collecting accurate data. The key reasons that the validity of data in SCI and SSCI is highly regarded includes: they are multidisciplinary, and all research fields are presented; their selectiveness, based on impact measurement and reinforced by expert opinion; fullness of coverage and completeness of address – all authors' addresses are shown, enabling scholars to illustrate collaboration and publication counting patterns; bibliographical references; and their availability in e-format. In addition, the availability of large ranges of search options in both SCI and SSCI, as well as different methods of literature index such as Citation Index (cited authors, cited work or patent), Source Index (author source), Corporate Index (source of organization), and Permuterm Subject Index (title words), enable bibliometric scholars to extract a holistic picture as regards their desired field of study (Glanzel, 2003).

### 2.4.3 The Bibliometric Indicators

Bibliometrics is "the use of quantitative analysis and statistics to describe patterns of publication within a given field or body of literature" (Ma, 2005). Bibliometrics includes "the study of bibliometric distribution and citation analysis." (Ma, 2005). Citation is defined as a reference to a published or unpublished material which is embedded in the body of an intellectual work to acknowledge the relevance of that work with other topics in the field, as well as making readers aware of material which supports the author's

arguments in the way they have claimed. Prior knowledge is always embedded in the literature of new scientific research by citing research activity from previous papers (Narin, 1996). Some scholars, such as Weinstock (1972), consider various advantages for citation in research study, including identifying the pioneers of the work, giving credit to related works, illustrating background reading, criticizing previous work and improving the quality of them.

Over time, different scholars have adopted citation analysis to assess the publication productivity of individual authors, institutions or countries (Norhazwani & Zainab, 2007). In fact, citation analysis is one of the most popular methods of bibliometrics, consisting of examining the frequency, structure and graphs of citations in published communication materials such as books and articles (Rubin, 2010). According to Baughman (1974), citation analysis is a systematic enquiry into the paternal properties of the desired field. Kumbar and Akhtary discussed that researchers can utilize the citation in illustrating the average number of references per article and the authorship patterns (Kumbar and Akhtary, 1998). In this respect, Beile and her colleagues (2004) demonstrate that citation is the procedure of tabulation and counting the frequency of times sources are cited in different documents to enable estimation of the productivity, strength and value of the authors' work, growth of publications, and level of institutional collaborative effort. In other words, citation analysis enables bibliometric scholars to evaluate the citation impact of a publication in relation to the number of publications (Marx et al., 2001). To sum up, the core idea of citation analysis is to determine the different links which exist between scholarly works, authors, journals, fields, and even countries. Most importantly, citation analysis enables bibliometric scholars to identify the impact of a single author or field via counting the number of times the work of a specified author has been cited by other scholars (Osareh, 1996).

In her paper, Meyer (2009) regrouped the overall h-index proposed in 2005 by Hirsch, a physicist of the University of California at San Diego. H-index seems to be a good indicator to quantify an individual's scientific research output (Hirsch, 2005). Although Hirsch's proposal was not the first attempt to rank scientists in an objective way, namely by number, he introduced an idea that was both convincing and controversial (Meyer, 2009).

As a result of his bibliometric study of the publication patterns of scientists in South Africa between 1992 and 1996, Jacobs (2001) endeavored to establish the relationship between the scientists' situation and their productivity. Braun et al. (2006) assessed UK scientific performance based on publication and citation counts, and similar indicators were used by Zhou (2006) in regard to China. Bibliometric research into the performance of the Nordic countries for year 1989 to 2008 was carried out by the Nordic Network (Schneider, 2010). Performance was gauged through publication activity and citation impact at both national and field levels. In Germany, Schomch et al. (2011) studied the performance of German science systems and public non-university research institutes. Hammouti (2010) assessed data from Scopus to determine the scientific productivity of Algeria, Morocco and Tunisia, collectively known as the Maghreb countries. The findings indicated that Tunisia had a higher output than Morocco and Algeria, despite only producing a third as many publications. Research into scientists' publication patterns in South Africa between 1992 and 1996 revealed that papers are in the fields of physics and astronomy, agricultural and biological sciences, medicine and engineering (Jacobs, 2001). In another research, Bouabid and Martin (2007) studied publication patterns in Morocco between 1997 and 2006, comparing them with the performance South Africa, Egypt, Nigeria, Algeria, Tunisia, Portugal and Greece. The research looked at publications' h-indexes and mean citation rates per paper, and came to the conclusion that

the h-index was a good indicator of the quality of researchers' scientific output (Hammouti, 2010).

The importance of publication is highlighted by the increased pressure to publish more. Altbach and Rapple (2012) spoke of the need to 'publish or perish', noting that scholars are 'under increasing pressure to publish more, especially in English language internationally circulated journals that are included in globally respected indices such as the ISI Citations.' Often, pressure is placed on non-English academics to publish in English language journals, as it helps to improve rankings. The increase in publication has also led to an increase in studies on publication productivity, which shows the growing interest in the subject.

### 2.4.4 Bibliometric Study in Agriculture

A review of published bibliometric literature on the subject of agriculture indicated that agricultural scholars examined the field mostly based on the specific subject categories of performance and productivity, on specific agricultural research institutes or on specific agricultural journals. Each of these will now be discussed in more detail.

Bartol (2002) evaluated the plant and crop science articles that were indexed in the Slovenian Agris Centre publications in the period 1994-2000 based on bibliographic elements. Bartol discovered that 60% of articles were published in Slovenian languages while only 36% of the indexed ones were published in English. He noted that among 560 authors who contributed to the publications, only 18 of them published the majority of the indexed articles. The indexed articles covered various aspects of agriculture such as crop production, physiology and production of forest trees.

In 2010, an annual bibliometric assessment was conducted by the French National Institute of Agriculture Research (INRA) based on indexed articles in Web of Science since 2005 in the field of agriculture, in order to find out the extent of co-publication

between INRA and their international partners. The findings of the study indicated that INRA had collaborated with 20 principal countries. Indeed, the findings enabled INRA to better situate themselves in collaboration with other countries via re-grouping the collaborated countries, and considering geopolitical identity.

In 2012, Krauskopf assessed the current situation of the Chilean Journal of Agricultural Research, which joined with the Institute of Scientific Information (ISI) in January 2007, based on their productivity and publishing patterns (Krauskopf, 2012). The findings of the study indicated that the majority of authors, six out of ten, were from Chile, and most contributing countries were in Latin America. In addition, The Universidad de Concepcion was indicated as the most productive research institution. Most interestingly, they reported that the journal self-citation rate was 19.3%, which highlighted it as a high ratio in comparison with the same subject categories listed in the JCR (Journal Citation Reports).

Along similar lines, Thanuskodi (2012) also examined the Indian Journal of Agricultural Research's publishing productivity and agricultural scholars' performance based on the bibliometric analysis method (authorship pattern, number of articles, subject distribution, article citation, and yearly distribution) between 2001 and 2010. The findings of the study indicated that the majority of contributors to the journal were Indian (98.67%) and the rest were from foreign countries. In addition, according to the findings the majority of articles (93.69%, which means 564 among 602) were contributed by joint authors whereas the rest of them (6.31%, which means 38) were published by a single author.

In 2011, Nguyen and Pham examined the relationship between scientific output and knowledge economy index in ASEAN countries during 1991 to 2010 with bibliometric

study of scientific articles published in international peer-reviewed journals based on the data of the Institute of Scientific Information. They demonstrated that with total number of 165,020 original articles, ASEAN counties represented ~0.5% of the world scientific publication output during the 20-year period.

The results of their investigation illustrated that Singapore with 45% of total ASEAN publication had the highest number of publication, followed by Thailand and Malaysia (Table 2.3)

Table 2.3: ASEAN peer-reviewed publication distribution during 1991-2010

(Nguyen and Pham, 2011)

| Country | Percentage of total publication |
|---|---|
| **Singapore** | 45% |
| **Thailand** | 21% |
| **Malaysia** | 16% |
| **Vietnam** | 6% |
| **Indonesia** | 5% |
| **Philippines** | 5% |

Payumo and Sutton in their bibliometric assessment of ASEAN countries publications in the field of plant biotechnology, analyzed the publication and citation data during a 10-year period between 2004 and 2013, to assess the research performance, impact, and collaboration of the countries (Payumo and Sutton, 2015). This research used the Elsevier's Scopus database of peer-reviewed literature Elsevier, with no filter on the type of publication (including all document types: "article, review, conference paper, short survey, note, editorial, letter, book chapter, book, and article in press") (Payumo and Sutton 2015). Their data collection includes 7,907 papers with 117,856 citations, related to plant biotechnology, from 13,000 researchers. The focus of the study is the research performance and collaboration (domestic, regional, and international), linked to the status of the economic development of ASEAN countries.

Table 2.4 illustrates their findings of number of publications and citations for the ASEAN countries. Thailand, Malaysia, and Singapore with 2489, 2199, and 1594 publications, were the most productive countries in planet biotechnology.

Table 2.4: Comparison of article output, citation and number of Authors

(Payumo and Sutton, 2015)

| Country | Publication | Citation count | Average citation |
|---|---|---|---|
| **Thailand** | **2,489** | 27,863 | 11.19 |
| **Malaysia** | 2,199 | 14,584 | 6.63 |
| **Singapore** | 1,594 | **49,094** | **30.80** |
| **Philippines** | 757 | 14,492 | **19.14** |
| **Indonesia** | 611 | 7,208 | 11.80 |
| **Vietnam** | 418 | 3,957 | 9.47 |
| **Brunei** | 35 | 157 | 4.49 |
| **Myanmar** | 23 | 180 | 7.83 |
| **Laos** | 10 | 186 | 18.60 |
| **Cambodia** | 6 | 135 | **22.50** |
| **Total** | 7,907 | 117,856 | 14.91 |

The findings of the study highlighted the increased research collaboration by domestic individual scholars and with international partners during the investigated time whereas the regional collaboration found to be limited. More interestingly, they discovered that there is a direct relationship between the status of economic development of ASEAN countries and their research productivity. According to the findings of the study, Payumo and Sutton suggested more investigation regarding the flow of knowledge, policy diagnosis in plant biotech and the influence of plant biotech on economic growth among ASEAN countries.

In 2013, Maharana conducted a bibliometric study to examine the research contribution and productivity of Orissa University of Agricultural Technology (OUAT) scholars. The data of this study was retrieved from Scopus, and covers the period between 2008 and

2012. The findings of the study (Maharana 2013) indicated that the most popular research journal among OUAT scholars is the *Indian Journal of Animal Research*. In addition, the degree of collaboration among scholars is around 0.96 percent based on the average annual publication of agricultural scholars, which is between 33 and 34 articles. Indeed, the findings of the study highlighted the OUAT as one of the most prolific research institutes in India.

In 2013, Ahmad and Anwar evaluated the publication performance (authorship pattern, institute productivity, collaboration pattern, yearly distribution of articles and number of citations) of *Sarhad Journal of Agriculture* (SJA) for the first time (Ahmad and Anwar, 2013). The SJA has been published by KPK Agriculture University in Peshawar, Pakistan since 1985. In respect, Ahmad examined 2761 agricultural articles which were published by SJA in the period of 1985 until 2009. The findings of the study highlighted that the majority of scholars, either individually or in collaboration, only published one article in SJA (56.87%). Also, the ratio of multi-author articles published in SJA was reported as 93.34 percent (2577 papers out of 2761). The majority of authors were from Pakistan, with the USA as the most frequent international collaborator, followed by the UK. Furthermore, the findings of the study highlighted the most contributed sub-categories of agriculture were plant breeding, genetics, fertilization and crop husbandry. Ahmad and Anwar also reported the average number of articles published yearly as 110.44 per year, and the average number of citations as 13.5 percent.

The review of the literature, highlighted that there are limited bibliometric studies investigating science in ASEAN, and even fewer which focus exclusively on agricultural science. This study applies bibliometric methods to evaluate the research situation of

agricultural biotechnology, due to its key role in food productivity and sustainability, among ASEAN

## 2.5 VOSviewer as a bibliometric tool

VOSviewer is a useful computer program which has been developed to visualize the moderately large numbers found within bibliometric data, such as journal based co-citation, co-occurrence, construction of author maps, and the examination of bibliometric maps (distance-based and graph-based maps) in full detail, through presenting them in different ways and from different perspectives. (Van Eck, Waltman, Noyons, and Buter, 2008). Table 2.5 shows the examples of distance-based and graph-based map programs. VOSviewer is a computer program which is used to visualize and examine bibliometric networks, using VOS mapping techniques developed by Van Eck and Waltman. These techniques aid in the process of constructing maps and visualizing similarities (Van Eck and Waltman, 2007).

Table 2.5: Sample of Distance-based and Graph-based map Programs

| **Distance-based map** | **VOSviewer** | **VxOrd** | **Multidimensional Scaling** |
|---|---|---|---|
| **Graph-based map** | Pajak | Pathfinder Networks | |

Van Eck and Waltman (2009) discussed that the VOSviewer, unlike other bibliometric programs which mostly focus on bibliometric mapping, also concentrates on the graphical representation of bibliometric data. In 2010, Van Eck and his colleagues (Van Eck, Waltman, Dekker, & Den Berg, 2010) conducted a bibliometric study to compare VOSviewer with MDS (Multidimensional Scaling) regarding the accuracy of constructing bibliometric maps. The findings of their studies indicated that VOSviewer, when compared with MDS, constructed more satisfactory datasets and bibliometric maps.

A review of bibliometric literature indicates that VOSviewer is applied in different fields of study. For instance, Bronmann and Haunshild (2016) applied VOSviewer in their investigation to produce base maps for Mendeley reader count data in 2012 based on the Web of Science database to depict the impact of publication.

## 2.6 Summary of Chapter Two

This chapter has outlined a review of the relevant literature related to the topic of the dissertation. The first part of the literature presented the history of the establishment of ASEAN, and the key role of agriculture among ASEAN countries. The second part discussed biotechnology, its definitions, and depicts the nature of agricultural biotechnology. The third part of the literature focused on bibliometrics, bibliometric analysis, and bibliometric indicators, and finally bibliometric studies in agricultural biotechnology. The final part of this chapter introduced the VOSviewer software and looks at various studies which used it to visualize their bibliometric data.

# CHAPTER 3: METHODOLOGY

## 3.1 Introduction

This chapter describes the methods applied to evaluate the research productivity of ASEAN countries in biotech-agriculture in three different categories (authors, institutes and countries), and to investigate the relationship between biotech-agriculture research publications and GDP in ASEAN countries.

In this respect, due to the aim of the study, both statistics and bibliometric analysis are employed. The focus of statistic analysis is to depict the quantity (using frequency, percentage and average of variables as number of publications and number of citations) and pattern (using relationship between research variables and comparison between countries, institutions, and authors) of publication productivity among ASEAN countries in biotech-agriculture. In descriptive statistics, the variables of the study are studied using statistical methods such as frequency, percentage and average. In the inferential section, the relationships between variables are investigated and compared. In addition, bibliometric analysis is applied to measure the performance, scientific productivity and trends of ASEAN countries, institutes and scholars in the field of biotech-agriculture. Therefore, citation analysis is one of the key bibliometric methods employed in this study to determine the trends of publication output in biotech-agriculture, and the most productive authors, institutes and countries among ASEAN. Accordingly, the main purpose of the present study is to assess the performance of agricultural biotechnology research in ASEAN countries during the years 2003-2013 using descriptive statistic and bibliometric methods in macro, meso and micro levels. The 10-year data is harvested from the Web of Science database, which provided the necessary data to support a bibliometric study. Hence, the specific objectives of the study to:

1. To rank the top productive ASEAN countries, using total and average number of publications (macro level).
2. To compare the total and average citation between ASEAN countries (macro level).
3. To identify the total and annual distribution of publications (macro level).
4. Identify the frequency of publications according to journals (macro level).
5. To identify the most cited papers and their country of publication (macro level).
6. To determine the distribution of top researchers in ASEAN countries based on h-index and number of publications (macro level).
7. To compare the impact of publication between countries (macro level).
8. To compare the performance of institutions among ASEAN countries in terms of number of publications (mesoo level).
9. To identify the top institutions based on number of publications (mesoo level).
10. To identify the top productive ASEAN researchers using number of publications and h-index (micro level).
11. What is the relationship of the GDP of ASEAN countries and their research publication productivity?

### 3.2 Data Collection

Based on the aim of the research, the data for this study has been retrieved from the Science Citation Index Expanded (SCIE) from the Web of Science. The researcher employed the SCIE for collection of data for two rational reasons; firstly, its holistic coverage of mainstream journals and secondly, the simplicity of the data retrieval process. In addition, in accordance with literature on the subject, other features of SCIE validated it for use by the researcher as the key database. These include the citation index which enables the researcher to determine what has been published by authors in a specific field, and the citation which is related to the published work (Haiqi & Yuhua, 1997).

To fulfil the objective of the study, and with the aim of assisting in categorizing the subject matter, the subject category of SCIE is used. Furthermore, in this study scholarly works by authors affiliated to institutions with ASEAN work addresses are included. Data on work by authors affiliated to non-ASEAN institutions is also included to examine the collaborative aspects of ASEAN institutions. To illustrate trend characteristics among ASEAN countries, the total counts, percentages and regression analysis are also included. This study covers data from 2003 to 2013. It is assumed that a period of 10 years will assist the researcher in illustrating a clear picture of the nature of research in the field of biotech-agriculture among ASEAN countries at macro (development of publishing among ASEAN countries), meso (institute productivity and collaboration) and micro level (author productivity). Furthermore, in keeping with the objective of the study to visualize bibliometric data among ASEAN countries in the field of biotech-agriculture (such as publishing, institute publishing activities, productivity, collaboration, and the author publication productivity of each country), the researcher also extracted data in comma separated format (CSV) format via SCI which was applied in VOSviewer software for analysis.

### 3.2.1 Subject Categorization Used

As mentioned in the previous paragraph, the data for this study was retrieved from the SCIE. Hence, the researcher collected the data via subject categories (SU= Agriculture) and sub-categories (SU= Biotechnology & Applied Microbiology) which were limited by country (field tag "CU") and time span (PY= Year published 2003-2013). Table 3.1 shows the list of SCI subject and sub-categories in agricultural biotechnology, whereas Table 3.2 presents the Sample of Research Areas in SCI. Table 3.3 demonstrates a sample of search history in SCI. For extracting the data, mixed query of Table 3.2 was used for all the countries, e.g. query 6 in Table 3.3 illustrate the result for Malaysia. Total results for all the ASEAN countries included the 753 papers.

Table 3.1: List of SCI subject and sub-categories in agricultural biotechnology

| Subject |
|---|
| **Agriculture** |
| **Biotechnology & Applied Microbiology** |
| **Energy & Fuels** |
| **Environmental Sciences & Ecology** |
| **Plant Sciences** |
| **Veterinary Sciences** |
| **Food Science & Technology** |

Table 3.2: Sample of Research Areas in SCI

Research Areas (Categories / Classification):

Agriculture
Biotechnology & Applied Microbiology

**SU**= Research Area Agriculture AND Biotechnology & Applied Microbiology
=> **SU**=Agriculture
=> **SU**=Biotechnology & Applied Microbiology
**CU**= Country Malaysia
=> **CU=** Malaysia
**PY**= Year Published 2003-2013
=>**PY**=2003-2013

| Set | Results | Save History / Create Alert | Open Saved History | Edit Sets | Combine Sets AND OR | Delete Sets |
|---|---|---|---|---|---|---|
| # 3 | 114,911 | CU= Malaysia *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 2 | 553,839 | SU=Biotechnology & Applied Microbiology *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 1 | 827,139 | SU=Agriculture *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All years* | | | | |

Table 3.3: Sample of Search History in SCI

| Set | Results | Save History / Create Alert | Open Saved History | Edit Sets | Combine Sets AND OR | Delete Sets |
|---|---|---|---|---|---|---|
| # 7 | 3,012 | #2 AND #3<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 6 | 279 | #1 AND #2 AND #3<br>**Refined by: PUBLICATION YEARS:** ( 2013 OR 2007 OR 2011 OR 2005 OR 2012 OR 2006 OR 2010 OR 2004 OR 2008 OR 2003 OR 2009 )<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | | Select to combine sets. | Select to delete this set. |
| # 5 | 2,714 | #1 AND #3<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 4 | 391 | #1 AND #2 AND #3<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 3 | 114,911 | CU= Malaysia<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 2 | 553,839 | SU=Biotechnology & Applied Microbiology<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |
| # 1 | 827,139 | SU=Agriculture<br>*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH*<br>*Timespan=All years* | | Edit | Select to combine sets. | Select to delete this set. |

### 3.2.2 Headings of Bibliographic Records

To prepare the data for analysis, the researcher imported the final results of the searches (a total of 753 records, which have been converted into tabbed delimited format in Microsoft Excel. The researcher separated the bibliographic records based on different fields such as publication type, authors, author's full name, group authors, sources, document type, abstracts, etc. in different worksheets. Table 3.4 shows the heading of bibliometric records in the results. Furthermore, to manage the collected data efficiently for analysis, the researcher classified the data in several Microsoft Excel files with the aim of fulfilling the objective of the study. Table 3.5 presents the Microsoft Excel files and worksheets which were created.

Table 3.4: Headings of Bibliographic Records

| WoS Export Tag | Description |
|---|---|
| **PT** | Publication type |
| **AU** | Authors |
| **AF** | Author's full name |
| **TI** | Title |
| **CA** | Group Authors |
| **SO** | Sources (journal name) |
| **DT** | Document type |
| **AB** | Abstracts |
| **CI** | Author Address |
| **RP** | Reprint Address |
| **TC** | Web of Science Times Cited Count |
| **SN** | International Standard Serial Number (ISSN) |

Table 3.5: Microsoft Excel files and worksheets name

| File Name | Worksheets content |
|---|---|
| **Main file** | All Main Data 2003 t 2013<br>Selected columns<br>Selected columns w Abbreviation |
| **ASEAN Authors** | Total Top Authors |
| **ASEAN Institutes** | Institutes |

### 3.2.3 Handling Authors' Names

To identify the productivity of authors among ASEAN countries, the researcher manually separated the authors of different countries by considering the variation of authors' names.

### 3.2.4 Bibliometric Analysis

VOSviewer (version 1.6.2) is utilized to analyze the data that was retrieved from SCI and categorized in different Microsoft Excel files and worksheets. Indeed, VOSviewer is a computer software tool which has been developed to construct and visualize bibliometric networks such as researchers, journals and research institutions based on citation, co-authorship relations and bibliographic coupling (http://www.vosviewer.com/Home).

Figure 3.1: The cluster density visualization

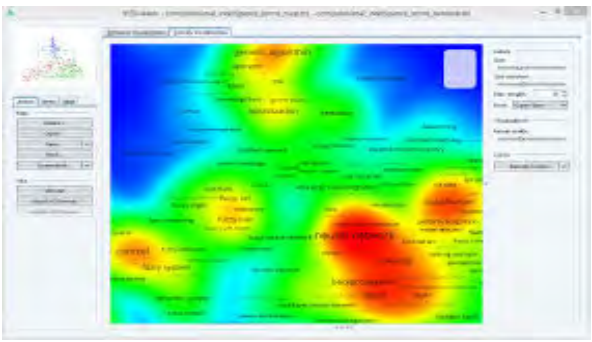

Figure 3.2: The item density visualization

The key features of VOSviewer (Figure 3.1 and 3.2) can be summarized as follows:

a) Creating maps based on network data (referring to the possibility of creating maps of authors, co-authorship, co-citation, journals and bibliographic coupling from Web of Science or Scopus)
b) Visualizing and exploring maps (such as density visualizing and network visualizing) (VOSviewer Manual, 2015).

### 3.2.5 Citation of Papers

In this study, citation is considered as the frequency of times the publications have been referred by other publications. To fulfil the objective of the study, the researcher retrieved data from SCIE bibliographic records based on the period under consideration for the study (2003-2013) for all 10 ASEAN countries.

The analysis of this data enabled the researcher to identify the most cited articles, authors and institutes, and also to determine the authorship pattern and the pattern of distribution of citation during the study period.

## 3.3 Statistcal Analysis

In addition to bibliometric analysis, this study is based on statistics analysis. The focus of statistical analysis is to depict the quantity (using frequency, percentage and average of variables as number of publications and number of citations) and pattern (using relationship between research variables and comparison between countries, institutions, and authors) of publication productivity among ASEAN countries in biotech-agriculture. In descriptive statistics, the variables of the study are studied using statistical methods such as frequency, percentage and average. In the inferential section, the relationships between variables are investigated and compared.

### 3.4 Correlation Coefficient Analysis

To Analyze the relation between research productivity and GDP of the ASEAN counties, study of correlation cefficient can be a helpful method to reveal the relationships. Gholizadeh et. al. (2014) applied Spearman's correlation coefficient to evaluate the relationship among related items of publication productivity and GDP. This finding was similar to the previous researches that found positive and significant relationship between education and economic growth (Mankiw et al., 1992; Barro, 1991; Bils & Klenow, 2000). Prior to data analysis, normality test should proof the non-normal distribiotion of the variables. Due to non-normal distribution of resutls, Spearman's correlation coefficient can be applied as a non-parametric method (Gholizadeh et. al., 2014).

The Spearman correlation coefficient is defined as the Pearson correlation coefficient between the ranked variables (Myers et. al., 2010). Spearman's correlation coefficient, ( $\rho$ , also signified by $r_s$) measures the strength and direction of association between two ranked variables:

$$(1) \qquad r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

where *n* is the number of observations of each variable (with same ordering for both variables), and d is the distance of each pair of the values for the variables (d = rank of x - rank of y) (Crawshaw and Chambers, 2001). The Spearman's Rank Correlation Coefficient is a derivation of the correlation coefficient. Therefore, the values of $r_s$ must be between -1 and +1 [$-1 < r_s < 1$]. $r_s = +1$ means that the rankings have perfect positive association, and variables rankings are exactly alike. $r_s = 0$ means that the rankings have no correlation or association. $r_s = -1$ means that the rankings have perfect negative association, and variables have exact reverse ranking to each other.

## 3.5 Data Analysis

Data analysis will be based on number of papers and paper citations at macro (countries), meso (institutions) and micro (authors) levels. The study also analyzes the growth rate of papers and citations during the 10 years (2003- 2013). The bibliometric study will target the science of agricultural biotechnology, which consists of biotechnology and applied microbiology.

Utilizing descriptive statistics, the output of the study will highlight:

At macro level:

a) Total and average number of publications in countries
b) Growth of papers in countries
c) Total and average number of citations in countries
d) Impact of publications of countries
e) Percentage of top researchers

At meso level:

a) Performance of institutions
b) Top collaborating institutions

At micro level:

a) Top researchers
b) Most cited papers

Also, the result will highlight the correlation coefficient between GDP and countries' number of publications

## 3.6 Summary of Chapter Three

This chapter has outlined the research methods that were applied based on the objectives of the study; the process of bibliometric data collection, bibliometric sources of data collection, the structure of handling the bibliometric data, and the bibliometric tools and methods applied in analyzing the data.

# CHAPTER 4: DATA ANALYSIS

## 4.1 Introduction

The objective of the present study is to highlight and compare the scientific productivity of agricultural biotechnology scientists and institutions for the ten ASEAN Countries (Malaysia, Indonesia, Philippines, Thailand, Brunei, Vietnam, Cambodia, Laos, Burma (Myanmar), and Singapore) in the period 2003-2013 based on data from the Web of Science.

The research questions of this study, following the research objectives, are as follow:

1. What is the performance of ASEAN countries in terms of the number of publications in agricultural biotechnology research (macro)?
2. What is the performance of ASEAN countries in terms of the number of citations in agricultural biotechnology research (macro)?
3. How is the total and annual distribution of publications among ASEAN countries (macro)?
4. How is the frequency of publications of ASEAN countries in agricultural biotechnology according to the journals (macro)?
5. What are the most cited papers and what is their country of publication (macro)?
6. How is the distribution of top researchers in ASEAN countries based on h-index and number of publications (macro)?
7. What is the impact of publications for ASEAN countries (macro)?
8. What is the performance of ASEAN institutions in terms of the number of papers and citations in agricultural biotechnology research (meso)?
9. What are the top institutions based on number of publications (meso)?
10. How is the productivity of ASEAN researchers in terms of the number of publications and h-index in agricultural biotechnology research (micro)?

11. What is the relationship of the GDP of ASEAN countries and their research publication productivity?

In this chapter, results of the study are presented in two different types of statistic, descriptive and inferential. In descriptive statistics, the variables of the study are studied using statistical methods such as frequency, percentage and average. In the inferential section, the relationships between variables are investigated, and countries are compared. In accordance with the main purpose of the present study to assess the performance of agricultural biotechnology science research in ASEAN during the years 2003-2013, data was collected from the Web of Science database, which provided the necessary data to support a bibliometric study. Data has been collected at August 2015.

Based on the selected criteria, which were ASEAN countries and field of publication (agricultural biotechnology), a total of 753 articles, with total of 16029 citations, published between 2003 and 2013 were extracted from the Web of Science database and were subjected to statistical analysis. The data analysis was conducted at macro, meso and micro levels.

Macro level analysis (performance of ASEAN countries), which is a comparison between countries, highlights the answer of 7 research questions (RQ 1 to RQ 7)

At the meso level, the data analysis concentrated on institutions of ASEAN countries, in order to investigate two research questions (RQ 8 and RQ 9). The micro level analysis is based on the number of publications and h-index of researchers in ASEAN countries. The results emphasize the answer of 2 research questions (RQ 9 and RQ 10).

Finally, the correlation coefficient between GDP and the scientific performance of ASEAN countries was analyzed regarding the number of publications and number of citations of the various countries (answering the RQ 11).

## 4.2 Data Analysis at Macro Level: Performance of ASEAN Countries

### 4.2.1 Number of publications

The first RQ of the current research was: "What is the performance of ASEAN countries in terms of the number of publications in agricultural biotechnology research?" The question was asked in order to evaluate the performance of ASEAN countries when it came to number of papers published. Frequency of papers in agricultural biotechnology were calculated for all countries between 2003 and 2013, and results (Table 4.1 and Figure 4.1) indicated that Malaysia, with 37.1 percent (279 papers) of total publications in agricultural biotechnology, had the highest number of publications followed by Thailand with 33.1 percent (249 papers) and Singapore with 14.2 percent (107 papers). This indicated that the highest number of papers was published by these countries. Only 6 percent (45 papers) were published by Indonesia.

Table 4.1: Number of publication per country in ASEAN

| Country | Number of Publications | Percentage |
|---|---|---|
| **Malaysia** | 279 | 37.1% |
| **Thailand** | 249 | 33.1% |
| **Singapore** | 107 | 14.2% |
| **Indonesia** | 45 | 6% |
| **Vietnam** | 33 | 4.4% |
| **Philippines** | 33 | 4.4% |
| **Cambodia** | 6 | 0.8% |
| **Myanmar** | 1 | 0.12% |
| **Laos** | 0 | 0% |
| **Brunei** | 0 | 0% |
| **TOTAL** | **753** | **100%** |

Philippines and Vietnam's contribution to the total number of published papers in agricultural biotechnologies were 4.4%, and the lowest number of papers belonged to Cambodia with 0.8 percent (6 papers) and Myanmar with 0.12 percent (1 paper). Two countries, namely Laos and Brunei, did not publish any papers in this field between 2003 and 2013.

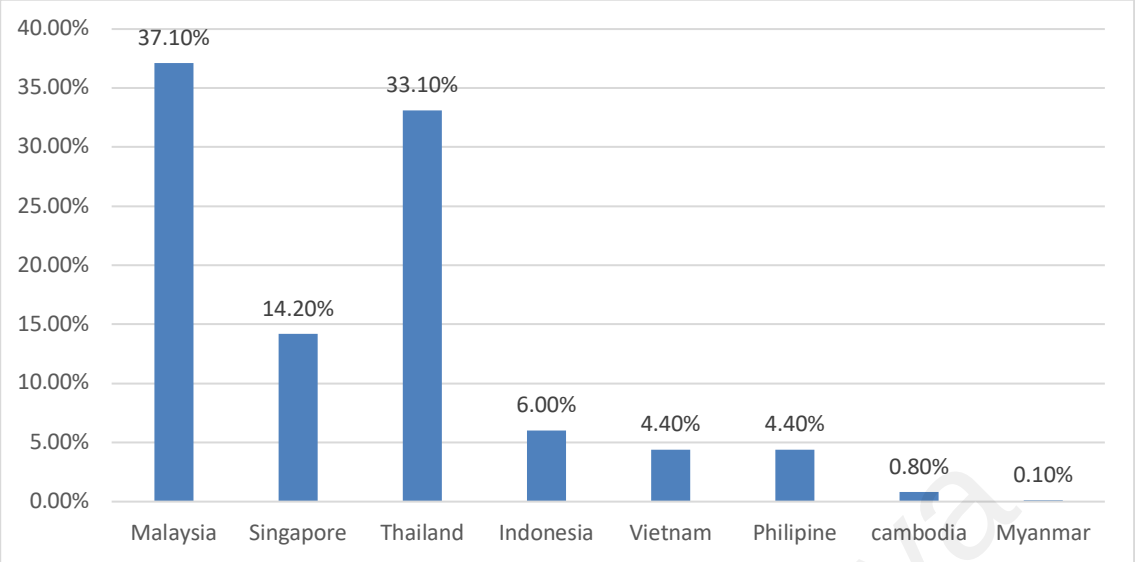


Figure 4.1: Distribution of total paper among ASEAN countries (N=753)

### 4.2.2 Number of citations

Another RQ of this research is about number of citations of publications among ASEAN countries. To evaluate the situation of number of citation, total number of citation related to all countries and also the average of citation per each paper were calculated in related to papers in agricultural biotechnology during 2003 to 2013 (Table 4.2 and Figure 4.2). Results indicated that the Malaysia's papers with 7012 citations had the highest number of citation (43.75% of total citation of all the papers), followed by Thailand with 5284 citation (32.97%), and Singapore with 1835 (11.45%). Indonesian papers were cited totally 1054 (6.57%) during 2003 to 2013. Philippine and Vietnam had 398 and 397 total number of citation respectively (both 2.48%). Figure 4.3 demonstrates the density visualization of citation for ASEAN countries. It illustrates the same result as the Table 4.3. In addition, it emphasizes the pattern of citations of the papers. Malaysia and Thailand researchers have co-citations on a group of papers, means they are in a similar cluster, while the Singapore's publications were in a separate cluster in terms of citation.

Table 4.2: Performance of ASEAN countries in terms of the number of citation

| Country | Number of Publications | Number of Citations | Percentage |
|---|---|---|---|
| **Malaysia** | **279** | **7012** | **43.75%** |
| **Thailand** | **249** | **5284** | **32.97%** |
| **Singapore** | **107** | **1835** | **11.45%** |
| **Indonesia** | 45 | 1054 | 6.58% |
| **Vietnam** | 33 | 398 | 2.48% |
| **Philippines** | 33 | 397 | 2.48% |
| **Cambodia** | 6 | 47 | 0.29% |
| **Myanmar** | 1 | 2 | 0.01% |
| **Laos** | 0 | 0 | 0% |
| **Brunei** | 0 | 0 | 0% |
| **TOTAL** | 753 | 16029 | 100% |

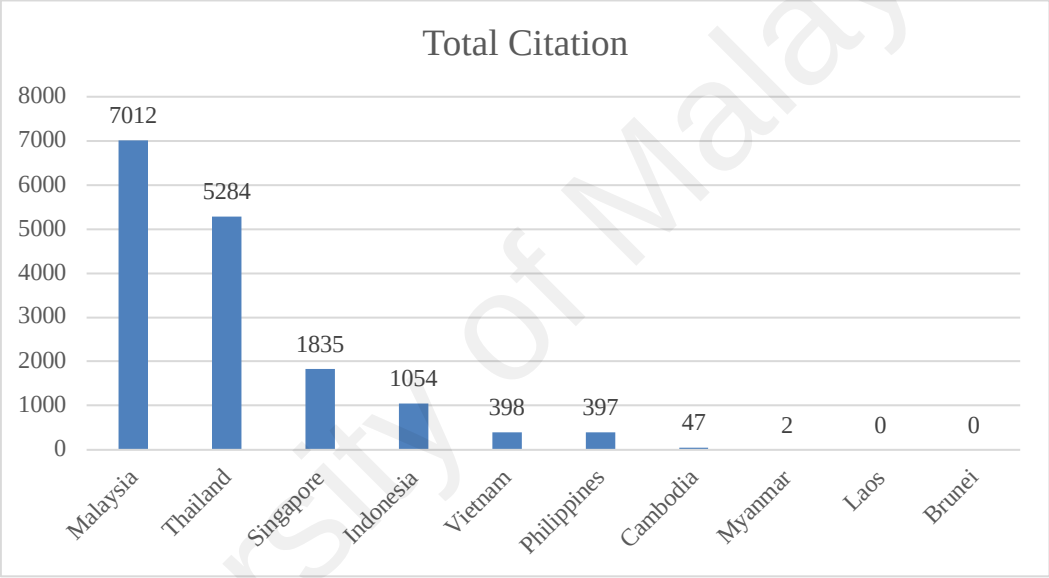


Figure 4.2: Total number of citations for ASEAN countries

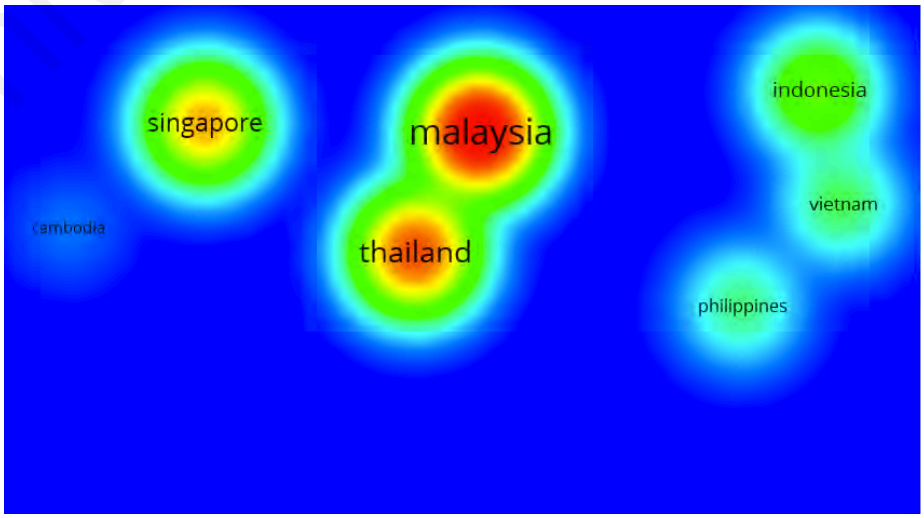


Figure 4.3: Density visualization of citations for ASEAN countries

The average number of citations for all countries was calculated by dividing total citation by number of publications (Table 4.3 and Figure 4.4). The highest average belonged to Malaysia (Ave = 25.13), which was significantly higher than other countries, followed by Indonesia (Ave = 23.42) and Thailand (Ave = 21.22) which were not significantly different. The lowest averages of citations for papers was observed for Cambodia (Ave = 7.83) and Myanmar (Ave = 2) between 2003 and 2013. These results indicate that for Malaysia with 279 publications and 7012 citations during the 10 years, each article was cited 2.5 times yearly.

Table 4.3: The average of citations for each paper among ASEAN countries

| Country | No. of publications | No. of Citation | Average of citations per paper |
|---|---|---|---|
| **Malaysia** | **279** | **7012** | **25.13** |
| **Indonesia** | 45 | 1054 | **23.42** |
| **Thailand** | **249** | **5284** | **21.22** |
| **Singapore** | **107** | **1835** | 17.15 |
| **Vietnam** | 33 | 398 | 12.06 |
| **Philippines** | 33 | 397 | 12.03 |
| **Cambodia** | 6 | 47 | 7.83 |
| **Myanmar** | 1 | 2 | 2 |

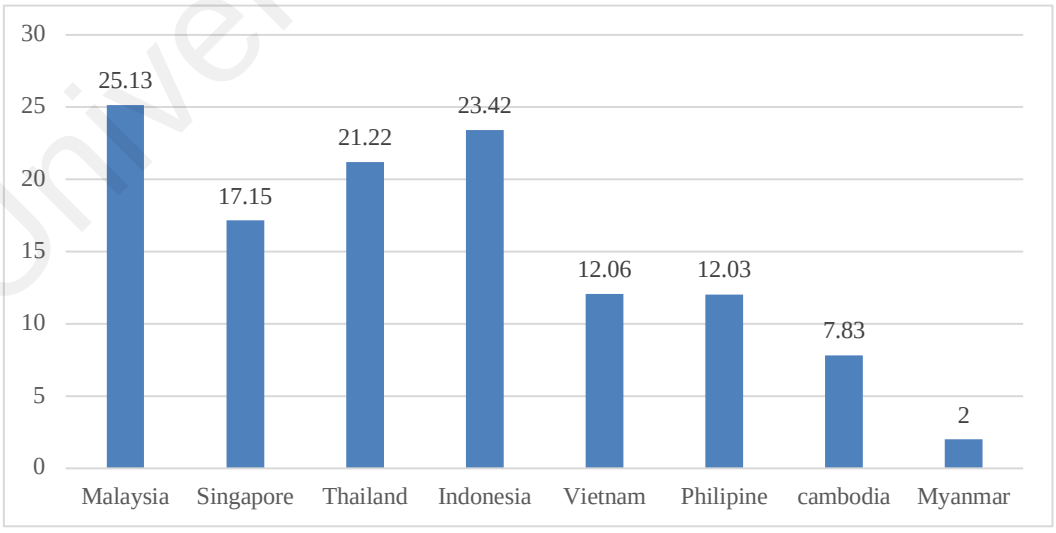


Figure 4.4: the average of citation per paper among ASEAN countries

### 4.2.3 Distribution of Publications

To study the contribution of all ASEAN countries in publications related to agricultural biotechnology (RQ 3), the proportion of papers were calculated for each year. Figure 4.5 demonstrates the annual distribution of total published papers by all ASEAN countries during 2003-2013. The percentage of papers for all countries showed that the total number of papers in the area of agricultural biotechnology increased after 2009. In addition, the growing rate of amount of publication is significant; number of publications in 2013 is 7.4 times more than 2003 (163, in comparison with 22).

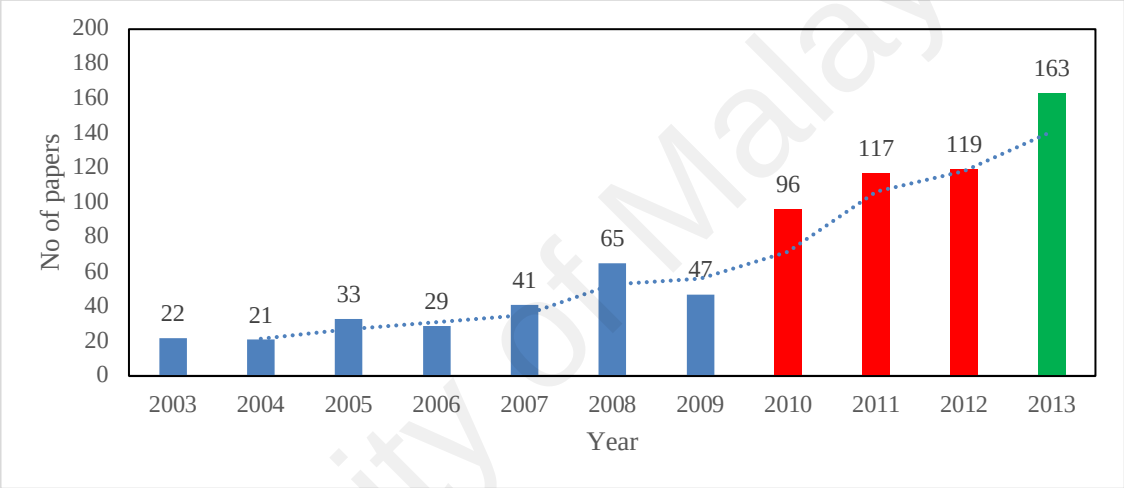


Figure 4.5: Number of published papers by all ASEAN countries (2003-2013)

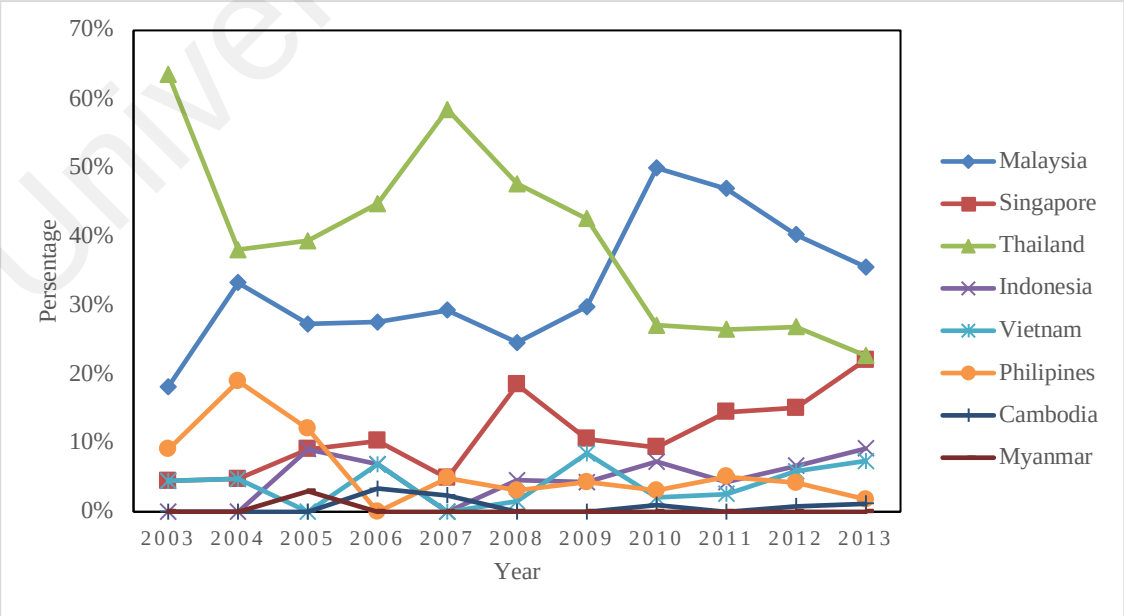


Figure 4.6: Annual comparison of percentage of number of publications by ASEAN countries

Figure 4.5 and Table 4.4 show the trend and annul number of papers for all countries between 2003 and 2013. It can be observed that the highest frequency until 2009 belonged to Thailand, with the second highest being Malaysia. These results indicate that after 2009, the percentage of papers for Thailand decreased while papers published by Malaysia in this field increased between 2008 and 2010, but decreased after 2010. Singapore and Indonesia showed a positive trend in terms of contribution to the publication of papers after 2010. Malaysia had the highest publication contribution during 2010 to 2013. The results also revealed that all other countries across this decade had a low contribution, with fewer than 10% of total papers published.

Table 4.4: Annual number of publication per country in ASEAN

| Country | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Total per country |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Malaysia** | 4 | 7 | 9 | 8 | 12 | 16 | 14 | 48 | 55 | 48 | 58 | **279** |
| **Thailand** | 14 | 8 | 13 | 13 | 24 | 31 | 20 | 26 | 31 | 32 | 37 | **249** |
| **Singapore** | 1 | 1 | 3 | 3 | 2 | 12 | 5 | 9 | 17 | 18 | 36 | **107** |
| **Indonesia** | 0 | 0 | 3 | 2 | 0 | 3 | 2 | 7 | 5 | 8 | 15 | **45** |
| **Vietnam** | 1 | 1 | 0 | 2 | 0 | 1 | 4 | 2 | 3 | 7 | 12 | **33** |
| **Philipine** | 2 | 4 | 4 | 0 | 2 | 2 | 2 | 3 | 6 | 5 | 3 | **33** |
| **cambodia** | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | **6** |
| **Myanmar** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| **Total per year** | **22** | **21** | **33** | **29** | **41** | **65** | **47** | **96** | **117** | **119** | **163** | **753** |

### 4.2.4 The frequency of Publications according to journal

To answer the RQ 4, the publications were categorized based on the journals. Table 4.5 showed that all these 753 papers were published by 18 journals, and the highest number of papers with 567 publications (75.3% of 753) in this field was published in “Bioresource Technology”, followed by “biomass & bioenergy” with 113 articles (15% of 753). Journal Citation Ranking (JCR) of both of these journals is Q1 in agriculture and biotechnology (Table 4.5). According the ranking findings, from the 753 publications, 691 papers were published in Q1, 35 in Q2, 6 in Q3, and 1 in Q4 journals.

Table 4.5: The frequency of papers according to journal

| Journal | Frequency | Percentage |
|---|---|---|
| **Bioresource technology (Q1)** | **567** | **75.3%** |
| **Biomass & bioenergy (Q1)** | **113** | **15%** |
| **Plant breeding (Q2)** | 35 | 4.6% |
| **Global change biology bioenergy (Q1)** | 11 | 1.5% |
| **Biotechnology and sustainable agriculture 2006 and beyond** | 4 | 0.5% |
| **Biological Nitrogen Fixation, Sustainable Agriculture and the Environment** | 3 | 0.4% |
| **Biotechnologie agronomie societe et environnement (Q3)** | 3 | 0.4% |
| **American journal of enology and viticulture (Q3)** | 2 | 0.3% |
| **Animal biotechnology (Q3)** | 2 | 0.3% |
| **Applications of Gene-Based Technologies for Improving Animal Production and Health in Developing Countries** | 2 | 0.3% |
| **Proceedings of the International Symposium on Biotechnology of Temperate Fruit Crops and Tropical Species** | 2 | 0.3% |
| **Symbiotic nitrogen fixation: prospects for enhanced application in tropical agriculture** | 2 | 0.3% |
| **Technologies and management for sustainable biosystems** | 2 | 0.3% |
| **Agricultural biotechnology: finding common international goals** | 1 | 0.1% |
| **Applications of gene-based technologies for improving animal production and health in developing countries** | 1 | 0.1% |
| **Biological nitrogen fixation: towards poverty alleviation through sustainable agriculture** | 1 | 0.1% |
| **Citrus and other subtropical and tropical fruit crops: issues, advances and opportunities** | 1 | 0.1% |
| **Crop breeding and applied biotechnology (Q4)** | 1 | 0.1% |
| **TOTOAL** | 753 | 100% |

### 4.2.5 Most cited papers

To answer the RQ 5, regarding the most cited papers, table 4.6 illustrates the top 13 most cited papers according to country, with number of citations >100. The results for top articles among ASEAN countries showed that the most y cited article was “Developments in industrially important thermostable enzymes: a review” which belonged to Thailand and had 414 citations. The next highest was “Removal of heavy

Table 4.6: Top 13 most cited papers according to country (Citations >100)

| Country | Title | citation |
|---|---|---|
| **Thailand** | Developments in industrially important thermostable enzymes: a review | **414** |
| **Malaysia** | Removal of heavy metal ions from wastewater by chemically modified plant wastes as adsorbents: A review | **336** |
| **Indonesia** | Biodiesel production from crude Jatropha curcas L. seed oil with a high content of free fatty acids | **320** |
| **Malaysia** | Adsorption behaviour of Fe(II) and Fe(III) ions in aqueous solution on chitosan and cross-linked chitosan beads | 189 |
| **Vietnam** | Equilibrium and kinetics of biosorption of cadmium(II) and copper(II) ions by wheat straw | 146 |
| **Thailand** | Biosorption of CU2+, Cd2+, Pb2+, and Zn2+ using dried marine green macroalga caulerpa lentillifera | 135 |
| **Malaysia** | Bio-electrochemical removal of nitrate from water and wastewater - A review | 120 |
| **Malaysia** | Ethanol fermentation in an immobilized cell reactor using Saccharomyces cerevisiae | 117 |
| **Singapore** | Evaluation of the marine algae Ulva fasciata and Sargassum sp for the biosorption of Cu(II) from aqueous solutions | 109 |
| **Indonesia** | High surface area activated carbon prepared from cassava peel by chemical activation | 109 |
| **Malaysia** | Preparation and characterization of activated carbon from palm shell by chemical activation with K2CO3 | 106 |
| **Malaysia** | Catalytic processes towards the production of biofuels in a palm oil and oil palm biomass-based biorefinery | 104 |
| **Malaysia** | Oryza sativa L. husk as heavy metal adsorbent: Optimization with lead as model solution | 102 |

metal ions from wastewater by chemically modified plant wastes as adsorbents: A review” from Malaysia with 336 citations and “Biodiesel production from crude Jatropha curcas L. seed oil with a high content of free fatty acids” from Indonesia with 320 citations. Among 13 papers with a citation level above 100, seven articles belonged to Malaysia followed by Thailand and Indonesia, both with two articles (Table 4.6). All of these top articles were published in “Bioresource technology” journal (Q1).

### 4.2.6 Distribution of top researchers of ASEAN countries

According to the RQ 6, regarding the performance of ASEAN countries, the distribution of top researchers in the field of agricultural biotechnology was analyzed. In this section, the top researchers were extracted from all collected data. A total of 92 researchers were found to have more than four papers (Figure 4.7).

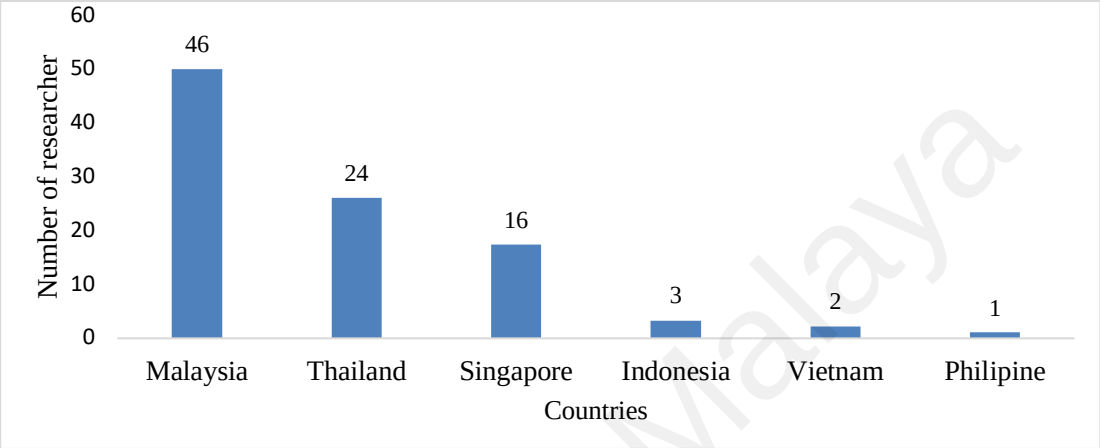


Figure 4.7: Distribution of top researchers with more than 4 papers

According to the results of the data analysis, Malaysia had the highest number of top researchers and authors among all countries with 50% of the top 92 authors, followed by Thailand with 26.1%. The frequency of Singaporean authors was 17.4%, and all other countries had fewer than 4%. These results indicated that there were no researchers from three countries, namely Cambodia, Laos and Brunei (Figure 4.8).

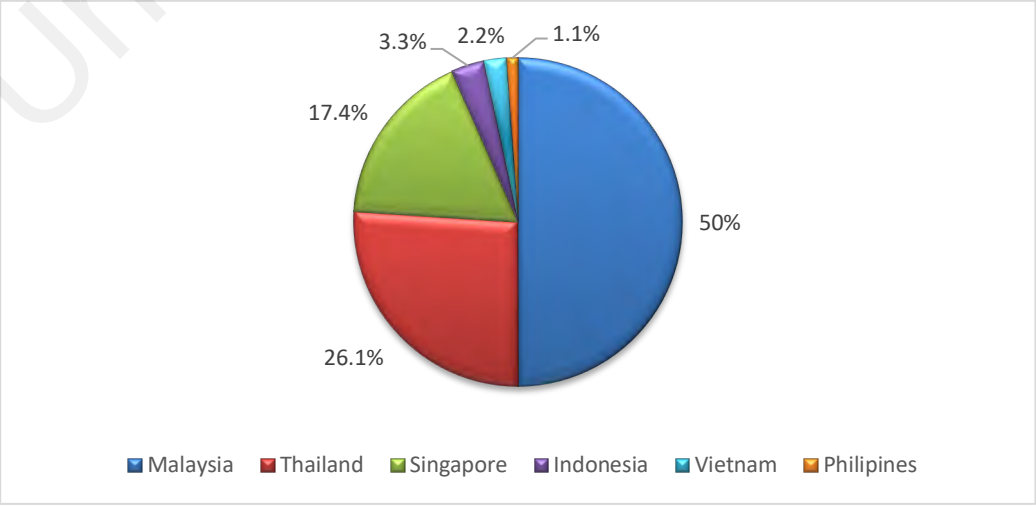


Figure 4.8: Parentage of top researchers with more than 4 papers

### 4.2.7 Impact of publications for ASEAN countries

In consideration of the RQ 7 regarding the most productive country with the highest impact, firstly the impact factors of all publications were extracted and countries were compared based on the average and total impact factor of publications. Table 4.7 shows the descriptive statistics of impact factors.

Considering the average IF for publications, the highest average belonged to Cambodia (Ave=1.97), followed by Indonesia (Ave=1.43) and Malaysia (Ave= 1.25). Based on total impact factors of publications, Malaysia had the highest total performance with 349.71, followed by Thailand with 276.87 and Singapore with 117.94. The lowest total performance belonged to Cambodia with 11.85 .

Table 4.7: Performance of publications of ASEAN countries

| Country | Number of Publications | Average Impact | Performance |
|---|---|---|---|
| **Malaysia** | 279 | 1.253451 | 349.71 |
| **Thailand** | 249 | 1.111868 | 276.87 |
| **Singapore** | 107 | 1.102226 | 117.94 |
| **Indonesia** | 45 | 1.430909 | 64.39 |
| **Vietnam** | 33 | 0.899419 | 29.68 |
| **Philippines** | 33 | 1.3075 | 43.15 |
| **Cambodia** | 6 | 1.975167 | 11.85 |

## 4.3 Data Analysis at Meso Level

### 4.3.1 Performance of institutions among ASEAN countries

One of the main RQs of the current research is about the performance of ASEAN institutions in terms of the number of papers in the field of agricultural biotechnology (RQ 8). According to collected information for related organizations and institutions, a total of 163 were involved in publishing papers, which was made up of 84 non-ASEAN institutions and 79 ASEAN institutions and organizations. Table 4.8 shows that Malaysia

had the highest number of institutions among all countries with 28, followed by Thailand with 25. All other ASEAN countries had less than 10 institutions.

To evaluate the productivity of these institutions, the average number of papers per institution was calculated and compared for all countries. Results revealed that there was a significant difference among countries when it came to the average number of publications by their institutions (table 4.9). According to the results, the highest average of published papers belonged to Singaporean institutions, with Ave=18.17 papers, which differed greatly from other countries. Next highest was Thai institutions (Ave=11.8), and then Malaysian institutes (Ave=11.11). The lowest number of papers belonged to the institutions of Vietnam (Ave=2.6) and Cambodia (Ave=2).

Table 4.8: Average number of publications of institutions among ASEAN countries

| No | country | Number of institutions | Average number of publications per institution |
|---|---|---|---|
| 1 | **Malaysia** | 28 | 11.11 |
| 2 | **Thailand** | 25 | 11.8 |
| 3 | **Indonesia** | 8 | 2.88 |
| 5 | **Philippines** | 6 | 4.67 |
| 6 | **Singapore** | 6 | 18.17 |
| 7 | **Vietnam** | 5 | 2.6 |
| 8 | **Cambodia** | 1 | 2 |

Based on the average number of publications per institution and the number of institutions, the performance for each country was calculated (average number of publications per institution * the number of institutions). Malaysia had the highest total performance with 311, followed by Thailand with 295 and Singapore with 109. The lowest total performance belonged to Cambodia with 2 (Table 4.8).

Table 4.9: Performance of institutions among ASEAN countries

| No | country | Number of institutions | Average number of publications per institution | Performance |
|---|---|---|---|---|
| 1 | **Malaysia** | 28 | 11.11 | 311 |
| 2 | **Thailand** | 25 | 11.8 | 295 |
| 6 | **Singapore** | 6 | 18.17 | 109 |
| 5 | **Philippines** | 6 | 4.67 | 28 |
| 3 | **Indonesia** | 8 | 2.88 | 23 |
| 7 | **Vietnam** | 5 | 2.6 | 13 |
| 8 | **Cambodia** | 1 | 2 | 2 |

### 4.3.2 Most productive institutions among ASEAN countries

The top 17 institutions (with more than 10 publications) were defined among 79 institutions (Table 4.10). These institutions published 75.17% of the total 753 agricultural biotechnology publications among the ASEAN countries. The results showed that from the top ten institutions, four of them belonged to Malaysia. The top institution was University Science Malaysia with 113 published papers, followed by National University of Singapore with 54.

Table 4.10: Top 17 productive institutions by number of publications

| No | Institution | Number of publications | Percentage |
|---|---|---|---|
| **1** | **UNIV SAINS MALAYSIA** | 113 | 15.01% |
| **2** | **NATL UNIV SINGAPORE** | 54 | 7.17% |
| **3** | **CHULALONGKORN UNIV** | 45 | 5.98% |
| **4** | **ASIAN INST TECHNOL** | 40 | 5.31% |
| **5** | **NANYANG TECHNOL UNIV** | 37 | 4.91% |
| **6** | **UNIV PUTRA MALAYSIA** | 35 | 4.65% |
| **7** | **KASETSART UNIV** | 35 | 4.65% |
| **8** | **UNIV MALAYA** | 32 | 4.25% |
| **9** | **UNIV TEKNOL MALAYSIA** | 30 | 3.98% |
| **10** | **KING MONGKUTS UNIV TECHNOL THONBURI** | 30 | 3.98% |
| **11** | **PRINCE SONGKLA UNIV** | 24 | 3.19% |
| **12** | **MAHIDOL UNIV** | 14 | 1.86% |
| **13** | **KING MONGKUTS UNIV TECHNOL** | 14 | 1.86% |
| **14** | **SURANAREE UNIV TECHNOL** | 13 | 1.73% |
| **15** | **UNIV TEKNOL PETRONAS** | 12 | 1.59% |
| **16** | **INT RICE RES INST** | 12 | 1.59% |
| **17** | **UNIV KEBANGSAAN MALAYSIA** | 11 | 1.46% |
| | **TOTAL** | **551** | **75.14%** |

## 4.4 Data Analysis at Micro level

The other question of the current study is related to the performance of ASEAN in terms of the number of papers and the h-index of researchers in the field of agricultural biotechnology (RQ 10).

### 4.4.1 Performance of ASEAN researchers: most productive authors

According to the results of the data analysis, the highest number of articles in this field was published by B. H. Hameed with 23, followed by K. T. Lee with 22 articles and S. Bhatia with 16. As can be seen in Table 4.11, the five top authors were Malaysian, and next four authors belonged to Thailand.

Table 4.11: Top 11 authors among ASEAN countries in number of publications (with publication ≥10)

| No | Author | Number of Publications | Country |
|---|---|---|---|
| **1** | **B. H. Hameed** | 23 | Malaysia |
| **2** | **K. T. Lee** | 22 | Malaysia |
| **3** | **S. Bhatia** | 16 | Malaysia |
| **4** | **A. R. Mohamed** | 14 | Malaysia |
| **5** | **K. Y. Foo** | 13 | Malaysia |
| **6** | **C. Visvanathan** | 12 | Thailand |
| **7** | **C. Chiemchaisri** | 12 | Thailand |
| **8** | **S. Sirianuntapiboon** | 12 | Thailand |
| **9** | **J. Yh** | 10 | Indonesia |
| **10** | **J. Obbard** | 10 | Singapore |
| **11** | **P. Pavasant** | 10 | Thailand |

### 4.4.2 Performance of ASEAN researchers: authors with highest H index

According to the results in terms of the H index, S. Bhatia has the highest with 15, followed by B. H. Hameed with 14 and K. L. Lee with 12. (Table 4.12). All three of these researchers are from Malaysia. The result showed that all the researchers with a H index ≥ 5 are from Malaysia and Thailand.

Table 4.12: Top authors among ASEAN countries in H index (H index ≥ 5)

| No | Author | H index | Country | Number of Publications |
|---|---|---|---|---|
| **1** | **S. Bhatia** | 15 | Malaysia | 16 |
| **2** | **B. H. Hameed** | 14 | Malaysia | 23 |
| **3** | **K.T. Lee** | 12 | Malaysia | 22 |
| **4** | **C. Visvanathan** | 11 | Thailand | 12 |
| **5** | **A. R. Mohamed** | 8 | Malaysia | 14 |
| **6** | **K. Y. Foo** | 7 | Malaysia | 13 |
| **7** | **C. Chiemchaisri** | 6 | Thailand | 12 |
| **8** | **S. Sirianuntapiboon** | 5 | Thailand | 12 |
| **9** | **P. Pavasant** | 5 | Thailand | 10 |

## 4.5 Relationship of GDP and publication in ASEAN countries

One of main objectives of this study was to identify the relationship between publication productivity among ASEAN and gross domestic product (current US$) between 2003 and 2013 (RQ 11). To answer this question, the average number of publications and average of citations for each country was computed for each of these years. GDP data related to the same time period was extracted from World Bank reports. Prior to data analysis, normality test was done for the obtained data. The normality test revealed that variables were not distributed normally. So, the test needed a non-parametric method. Due to non-normal distribution, Spearman's correlation coefficient was applied as a non-parametric method. Table 4.13 indicated that, except for the Philippines, Cambodia and Myanmar, there was a positive relationship between number of publications and GDP as an economical growth index, indicates the positive effect of higher GDP in increasing the number of publications. The highest and strongest relationship was observed for Thailand ($r = 0.928$) and Malaysia ($r = 0.911$), both with $p < 0.001$, each of which had a very strong relationship ($r > 0.9$, $p < 0.001$). The second group of countries included Singapore ($r = 0.870$ with $p < 0.001$), Vietnam ($r = 0.863$ with $p = 0.001$) and Indonesia ($r = 0.807$ with 0.003), all of which also showed a strong and positive relationship between number of publications in agricultural biotechnology and GDP. For Myanmar, there was a weak negative relationship which is not indicating the reverse ranking for GDP and number of citations.

Table 4.13: Spearman Correlation coefficient (r) between GDP and number of publications

| Country | Correlation coefficient (r) | p value |
|---|---|---|
| **Cambodia** | 0.545 | 0.083 |
| **Indonesia** | .807 | 0.003 |
| **Malaysia** | **.911** | <0.001 |
| **Myanmar** | -0.32 | 0.337 |
| **Philippines** | 0.388 | 0.239 |
| **Singapore** | .870 | <0.001 |
| **Thailand** | **.928** | <0.001 |
| **Vietnam** | .863 | 0.001 |

Table 4.14 presents the spearman's correlation coefficient observation of number of citations and GDP among ASEAN countries. According the results, only for Singapore (r = 0.818 with p = 0.002), Malaysia (r = 0.709 with p = 0.015), and Vietnam (r = 0.567 with p = 0.112) there is a positive relationship between number of citations in agricultural biotechnology and GDP, and only for the Singapore it is considered strong (r > 0.8 with p = 0.002). Although Cambodia and Philippine showed negative relationship, there were not strong (, and did not show a reverse ranking relationship between GDP and number of citations.

Table 4.14: Spearman's correlation coefficient (r) between GDP and number of citations

| Country | Correlation coefficient (r) | p value |
|---|---|---|
| **Cambodia** | -0.300 | 0.624 |
| **Indonesia** | -0.071 | 0.867 |
| **Malaysia** | **0.709** | 0.015 |
| **Myanmar** | N/A. | N/A. |
| **Philippine** | -0.529 | 0.116 |
| **Singapore** | **0.818** | 0.002 |
| **Thailand** | -0.064 | 0.853 |
| **Vietnam** | **0.567** | 0.112 |

Due to the main objectives of the current research, which were concentrated on agricultural biotechnology publications, data on the value added to GDP by agriculture was extracted from World Bank reports to evaluate the relationship between these two indexes which are related to the agriculture sector. The results (Table 4.15) showed that

for only two countries, Malaysia and Thailand, there is a positive and significant relationship indicates the dependency of number of publications and value added to GDP

Table 4.15: Spearman's correlation coefficient (r) between value added to GDP by agriculture and number of publications

| Country | Correlation coefficient (r) | p value |
|---|---|---|
| **Cambodia** | -0.096 | 0.779 |
| **Indonesia** | 0.162 | 0.634 |
| **Malaysia** | **.628** | 0.039 |
| **Myanmar** | N/A | N/A. |
| **Philippines** | -0.081 | 0.813 |
| **Singapore** | -.749 | 0.008 |
| **Thailand** | **.798** | 0.003 |
| **Vietnam** | -0.375 | 0.255 |

by agriculture of countries, while for the other countries the relationship is non-significant. The highest correlation coefficient belonged to Thailand ($r = 0.798$ with $p = 0.003$), followed by Malaysia ($r = 0.628$ with $p = 0.039$).

## 4.6 Summary of Chapter Four

In this chapter, results of the study were presented in descriptive and inferential statistics. In descriptive statistics, the variables of the study were studied using statistical methods such as frequency, percentage and average. In the inferential section, the relationships between variables were investigated, and countries were compared. In accordance with the main purpose of the present study to assess the performance of agricultural biotechnology science research in ASEAN during the years 2003-2013, data was collected from the Web of Science database, which provided the necessary data to support a bibliometric study. The data analysis was conducted at macro, meso and micro levels.

# CHAPTER 5: CONCLUSION

## 5.1 Introduction

The objective of the study is to highlight and compare the scientific productivity of agricultural biotechnology scientists and institutions in the ten ASEAN countries (Malaysia, Indonesia, Philippines, Thailand, Vietnam, Cambodia, Laos, Brunei, Burma (Myanmar), and Singapore) in the period 2003-2013 based on the Web of Science. GDP data related to the same time period was extracted from World Bank reports. Data analysis was conducted at macro, meso and micro levels. Macro level analysis included total and average number of publications and citations in countries, growth of papers in countries, impact of publications of countries, and distribution of top researchers in ASEAN countries. At meso level, the data analysis concentrated on institutions of ASEAN countries, to investigate the performance and productivity of institutions in ASEAN. The micro level analysis is based on the number of publications and H index of researchers in ASEAN countries. The results emphasized the top researchers and most cited papers, based on their affiliations.

Finally, the correlation coefficient between GDP and the scientific performance of ASEAN countries was analyzed regarding the number of publications and number of citations of the countries.

The results of the chapter 4 demonstrated that all of the objectives of the study have been achieved.

## 5.2 Findings and Discussions

Based on the selection criteria of ASEAN countries and field of publication (agriculture and biotechnology), a total of 753 articles, with total of 16029 citations, were extracted from the Web of science database during 2003 to 2013 and were subjected to statistical and bibliometric analysis. The results indicated that Malaysia, with 37.1% (279 papers)

of the total publications in agricultural biotechnology, had the highest number of publications, followed by Thailand with 33.1% (249 papers) and Singapore with 14.2% (107 papers), as shown in Table 4.1, P 44. Regarding the positive correlation coefficient between value added to GDP by agriculture, and number of publications for Malaysia and Thailand (0.628 and .798 respectively), it seems logical to have more publication in these countries, in comparison with Singapore which showed negative correlation coefficient (-0.749), as shown in Table 4.15, P57. Only 6% (33 papers) were published by Indonesia. The Philippines' and Vietnam's contributions to the total number of published papers in agricultural biotechnology were 4.4%, and the lowest number of papers belonged to Cambodia 0.8% (6 papers) and Myanmar 0.12% (1 paper). Two countries, namely Laos and Brunei, did not publish any papers in this field between 2003 and 2013. The highest frequency until 2009 belonged to Thailand, followed by Malaysia. After 2009, the percentage of publications for Thailand decreased, while papers published by Malaysia in this field increased between 2008 and 2010 but decreased after 2010. Singapore showed a positive trend in terms of contribution to papers published after 2010. The results also revealed that all other countries across this decade had a low contribution (less than 10%) in terms of the total papers published.

All of the 753 papers in research results were published by 18 journals, and the highest number of papers (75.3% of 753) in this field was published in "Bioresource Technology", followed by "Biomass & Bioenergy" (with 15% of 753). Having the same Quartile ranking for both of these journals, the significant difference in interest of authors for publishing in "Bioresource Technology" in comparison with "Biomass & Bioenergy" can be related to the impact factors of the journals (1.382 in comparison with 0.768 at 2003, and 5.039 in comparison with 3.411 at 2013, respectively).

The most cited publication belonged to Thailand with 417 citations, followed by Malaysia with 336 citations and then Indonesia with 326 citations. Among 13 papers with citations

above 100, 7 articles belonged to Malaysia, 2 to Thailand and 2 to Indonesia. The total number of citations is 16029, with average citation per paper of 21.29. According to Payumo and Sutton (2015), average citation per paper of ASEAN publications is 8.4. This indicated that the average citation of agricultural biotechnology articles is 2.5 times higher than the ASEAN average citation per paper. In comparison of average of citation per article between ASEAN countries, findings revealed that the highest average of citation belonged to Malaysia with Ave = 25.13 followed by Indonesia with Ave = 23.42 and Thailand with Ave = 21.22. According Payumo and Sutton (2015), the average citation per paper in planet biotechnology during 2004-2013 in ASEAN countries from Elsevier's Scopus database of peer-reviewed literature is 14.91 (117,856 citations for 7,907 papers). It revealed that the average citation of agricultural biotechnology publications in WOS at the same period, was 1.43 times higher than peer-reviewed publications in Scopus. These results showed a big difference between average citation for countries in WOS and Scopus (Table 2.4, P26).

In terms of number of citations, the results indicated that Malaysia's publications had the highest number of citations with 7012, followed by Thailand with 5284 citations and Singapore with 1835. The results showed a logical connection between number of citation and level of agricultural biotechnology research in Malaysia and Thailand, because all the top 9 authors with highest h-index and highest number of publications in ASEAN were from these two countries. Indonesian papers were cited a total of 1054 times between 2003 and 2013. The Philippines and Vietnam had 398 and 397 citations respectively.

According to information collected for related organizations and institutions, a total of 163 were involved in publishing papers, made up of 77 non-ASEAN institutions and 86 ASEAN institutions and organizations. Malaysia had the highest number of institutions

among all countries at 28, followed by Thailand with 25. All other ASEAN countries had fewer than 10. Malaysia had the highest number of involved institution and organization compare to other countries (35.4%) followed by Thailand (31.6%) while the average of publication for Singaporean institute was higher than the other countries (Ave = 18.17) followed by Thailand (Ave = 11.8) and Malaysian (Ave = 11.11). In addition, the top ten institutions were defined among all institutes, and the results showed that four of these institutes belonged to Malaysia. The top institute was University Science Malaysia with 113 published papers, followed by National University of Singapore with 54 papers.

A total of 92 researchers were found to have more than four papers. According to results of the data analysis, Malaysia had the highest number of top researchers and authors among all countries with 50%, followed by Thailand with 26.1% of the total top 92 authors. Singaporean authors' frequency was 17.4% and all other countries had less than 4%. These results indicated that there were no researchers from three countries, namely Cambodia, Laos and Brunei.

As the result of micro level analysis, the highest number of articles in this field was published by three authors from Malaysia (B. H. Hameed, K. T. Lee and, S. Bhatia with 23, 22 and 16 publication respectively). In total, the five top authors were Malaysian, followed by four authors from Thailand.

The results indicated that apart from the Philippines, Cambodia and Myanmar, there was a positive relationship between number of publications and GDP as an economical growth index. The highest and strongest relationship was observed for Thailand (r=0.928) and Malaysia (r=0.911), both of which had a very strong relationship (>0.9). The second group of countries included Singapore (r= 0.870), Vietnam (r=0.863) and Indonesia

(r=0.807), all of whom also showed a strong and positive relationship between number of publications in agricultural biotechnology and GDP. In terms of correlation between value added to GDP and number of publications, for only two countries, namely Malaysia and Thailand, was this relationship positive and significant, while for other countries it was not significant. The highest correlation coefficient belonged to Thailand (r= 0.798) followed by Malaysia (r=0.628). This pattern, revealed the strong positive relationship between GDP and number of publications and between value added to GDP by agriculture and number of publications in Malaysia and Thailand, having the highest number of publications, highest number of citations, and most productive authors and institutions.

According the results of observing the relationship between number of citations and GDP among ASEAN countries, only for Singapore (r = 0.818), Malaysia (r = 0.709), and Vietnam (r=0.567) there was a positive relationship between number of citations in agricultural biotechnology and GDP, and only for the Singapore it is considered strong (r>0.8).

To summarize the findings, Malaysia was the most productive country in agricultural biotechnology publications among the ASEAN countries at the macro level analysis:

- Highest number of publications (273 publications, 37% of the ASEAN)
- Highest total citations (7012 citations, 43.7% of the ASEAN)
- Highest average of citations per paper (25.13)
- Highest performance in macro level (342.19)
- Highest percentage of top researchers (46 researchers with more than 4 papers, 50% of ASEAN)

- Has the second most cited papers (336 citations)[1]

At the meso level, the most productive institution was Universiti Sains Malaysia, with 113 publications (15% of publications) and an 11.11 average of publications per institution, giving a total performance of 311. In second position was National University Singapore, with 54 publications (7% of Total) and an 18.17 average of publications per institution, giving a performance of 109.

At the micro level, productivity rank based on number of publications revealed that the three most productive authors of ASEAN are Hameed, Lee, and Bhatia, with 23, 22, and 16 publications respectively. All of these authors are from Universiti Sains Malaysia. These researchers were not only the most productive authors in terms of number of publications, but also had the highest H index values for researchers of ASEAN countries. Bhatia, who was in last position, had the highest H index, higher than the two other authors who were ahead of him (Bhatia 15, Hameed 14 and Lee 12).

### 5.3 Limitations of the Study

This study looked at the scientific performance of agricultural biotechnology scientists in ASEAN countries using bibliometric indicators and statistical parameters: number of publications, number of citations, and h-index. All data was retrieved from the Science Citation Index Expanded (SCIE) of Web of Science (WoS) database for the period 2003 until 2013. This study only investigated the 10 years of publications in ASEAN countries. In addition, it only used the data from SCIE, and the other resources as Scopus, which cover more types of publications and a wider range of researches were not in the scope.

[1] Thailand has the most cited papers (414 citations)

## 5.4 Significance of the Study

This study was based on descriptive statistics and bibliometric analysis. The focus of descriptive statistics was to depict the quantity and pattern of publication productivity among ASEAN countries in biotech-agriculture. In addition, bibliometric analysis was applied to measure the performance, scientific productivity and trends of ASEAN countries, institutes and scholars in the field of biotech-agriculture, using publication and citation counts. The results of the study highlighted the most productive countries, institutions, and authors in ASEAN. In addition, the statistical analysis showed a positive relationship between number of publications and GDP as an economical growth index for some of the countries.

## 5.5 Recommendations and Further Works

For further studies, there are some recommended research directions that can be defined. Among them, is a bibliometric comparison in agricultural biotechnology publication, between ASEAN countries and the other productive areas as Europe and China.

Detailed analysis of relationship between agricultural biotechnology publication productivity and investments in agriculture (instead of GDP) may be explored.

## 5.6 Conclusion

This chapter has presented the conclusions of data analysis of agricultural biotechnology research publications in ASEAN countries between 2003 and 2013 for country, institution and author levels, based on findings such as number of papers, number of citations, most cited papers, most productive institutions, distribution of top researchers, top researchers with highest publication and H index, performance at each of the levels, and relationship of GDP and the publication productivity of ASEAN countries.

## REFERENCES


Abdullah, A., & Wee, M. C. (2011). Malaysia's Computer Science research productivity based on publications in the Web of Science, 2000-2010. *Malaysian Journal of Library & Information Science, 16*(1).

Ahmad, S., & Anwar, M. A. (2013). Sarhad Journal of Agriculture: A bibliometric analysis of the articles published from 1985 to 2009. *Putaj Humanities & Social Sciences, 20*.

Altbach, P. G. (2013). Anarchy, commercialism, and "publish or perish". In *The International Imperative in Higher Education* (pp. 119-122). SensePublishers.

Barro, R.J. (1991). Economic growth in a cross section of countries. The Quarterly Journal of Economics, 106(2), 407-443

Bartol, T. (2002). Animal science, production and protection: bibliometric evaluation of bibliographic data in documents published in slovenia between 1994œ2000. *Kmetijstvo (Zootehnika)*.

Baughman, J. C. (1974). A structural analysis of the literature of sociology. The Library Quarterly, 44(4), 293-308.

Bellis, D (2009). Bibliometrics and Citation Analysis: From the Science Citation Index to Cybermetrics. U.K: Scarecrow Press.

Bils, M., & Klenow, P. J. (2000). Does schooling cause growth?. American economic review, 1160-1183.

Bouabid, H., & Martin, B. (2007). A *Scientometrics, 78*(2), 203-217.

Braun, T., Glänzel, W., & Schubert, A. (2006). A Hirsch-type index for journals. Scientometrics, 69(1), 169-173.

Bornmann, L., & Haunschild, R. (2016). Overlay maps based on Mendeley data: The use of altmetrics for readership networks. *Journal of the Association for Information Science and Technology*, *67*(12), 3064-3072.

Commission of the European Communities, & Inter-Secretariat Working Group on National Accounts. (1993). *System of national accounts 1993* (Vol. 2). International Monetary Fund.

Crawshaw, J., & Chambers, J. (2001). *A concise course in advanced level statistics: with worked examples.* Nelson Thornes.

Ernst & Young (2007). Beyond Borders: Global Biotechnology Report 2008, Ernst & Young.

Fao, U. (2009). How to Feed the World in 2050. In *Rome: High-Level Expert Forum*.

Gholizadeh, H., Salehi, H., Embi, M. A., Danaee, M., Ordi, A., Tanha, F. H., ... & Osman, N. A. A. (2014). Economic growth and internet usage impact on publication productivity among ASEAN's and world's best universities. *Modern Applied Science*, *8*(5), 169-178.

Glanzel, W. (2003). *Bibliometrics as a research field a course on theory and application of bibliometric indicators.*

Gutierrez, C. M., Glassman, C. A., Landefeld, J. S., & Marcuss, R. (2007). Measuring the economy: A primer on GDP and the national income and product accounts. *Bureau of Economic Analysis*.

Haiqi, Z., & Yuhua, Z. (1997). Scientometric study on research performance in China. *Information Processing & Management*, *33*(1), 81-89.

Hammouti, B. (2010). Comparative bibliometric study of the scientific production in Maghreb countries (Algeria, Morocco and Tunisia) in 1996-2009 using Scopus. *Journal of Materials & Environmental Science*, *1*(2), 70-77.

Hemmings, B., & Kay, R. (2010). Research self-efficacy, publication output, and early career development. *International Journal of Educational Management*, *24*(7), 562-574.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National academy of Sciences of the United States of America*, *102*(46), 16569.

Jacobs, D. (2001). A bibliometric study of the publication patterns of scientists in South Africa 1992-96, with special reference to gender difference. In *ISSI-2001: International Society for Scientometrics and Informetrics. International conference* (pp. 275-285).

Jin, J.C. and Jin, L. (2013). Research publications and economic growth: evidence from cross-country regressions. Applied Economics, 45(8): 983-990.

Katz, J., & Hicks, D. (1997). How much is a collaboration worth? A calibrated bibliometric model. *Scientometrics*, 40(3), 541-554.

Krauskopf, E. (2012). Short term impact of the Chilean Journal of Agricultural Research: a bibliometric analysis. *Chilean Journal of Agricultural Research*, *72*(1), 161.

Kumar, S., Tiwari, C., & Deepu, M. (2012). Contribution to Indian Sociology: A Bibliometric Study. Language in India, 12(5).

Kumbar, M., & Akhtary, S. (1998). Bibliometric analysis of ophthalmology literature. Library Science with a Slant to Documentation and Information Studies, 35(3), 201-207.

Ma, Z. (2005). From theoretical essentials to paradigms: The development path of electronic commerce research. *International journal of electronic business*, *3*(5), 491-507.

Maharana, Rabindra K. (2013). A bibliometric analysis of the research output of Sambalpur University's publication in ISI Web of Science during 2007-11. Library Philosophy and Practice (e-journal). Paper 926.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. The quarterly journal of economics, 107(2), 407-437. http://dx.doi.org/10.2307/2118477

Meyer, V. R. (2009). The h Index–Help or Hype?. *CHIMIA International Journal for Chemistry*, *63*(1-2), 66-68.

Myers, J. L., Well, A., & Lorch, R. F. (2010). *Research design and statistical analysis*. Routledge.

Narin, F., & Hamilton, K. (1996). Bibliometric performance measures. *Scientometrics*, *36*(3), 293-310.

Nguyen, T. V., & Pham, L. T. (2011). Scientific output and its relationship to knowledge economy: an analysis of ASEAN countries. *Scientometrics*, *89*(1), 107-117.

Nicholas, D., & Ritchie, M. (1978). *Literature and bibliometrics*. C. Bingley.

Norhazwani, Y., & Zainab, A. N. (2007). Malaysian publication contributions to the field of library and information science. / Yazit, Norhazwani, & Zainab, AN. (2007). Publication productivity of Malaysian authors and institutions in LIS. Malaysian Journal of Library and Information Science, 12.

Nunes, L.C. (2008). *Collateral Damages*. Lulu Enterprises Incorporated.

Osareh, F. (1996). Bibliometrics, citation analysis and co-citation analysis: A review of literature I. *Libri*, *46*(3), 149-158.

Payumo, J. G., & Sutton, T. C. (2015). A bibliometric assessment of ASEAN collaboration in plant biotechnology. *Scientometrics*, *103*(3), 1043-1059.

Pritchard, J. (1969). Statistical bibliography or bibliometrics?. Journal of documentation, 25(4), 348-349.

Potter W G (1981). Introduction to bibliometrics, *Library Trends,* Vol. 30, p.5.

Rubin R (2010). Foundations of library and information science 3rd edition. New York: Neal-Schuman Publishers.

Schneider, J. W. (2010). Bibliometric Research Performance Indicators for the Nordic Countries: A publication from the NORIA-net" The use of bibliometrics in research policy and evaluation activities".

Schmoch, U., Mallig, N., Michels, C., Neuhäusler, P., & Schulze, N. (2011). *Performance and structures of the German science system in an international comparison 2010 with a special analysis of public non-university research institutions* (No. 8-2011). Studien zum deutschen Innovationssystem.

Schubert, A., & Telcs, A. (1986). Publication potential—an indicator of scientific strength for cross-national comparisons. *Scientometrics*, *9*(5-6), 231-238.

Secretariat, A. S. E. A. N. (1967). The ASEAN Declaration (Bangkok Declaration).

Sengupta, I. N. (1990). Bibliometrics and the identification of core periodicals. *Herald of Library Science*, 29 (3-4), 226-245

Serageldin, I. (1999). Sustainable agriculture for a food secure third world. Social research, 105-115.

Suvedi, M. (2018). Agricultural Biotechnology for Sustainable Productivity: Micropropagtion of Tropical Crops for Commercial Planting Stock Project Evaluation.

Thanuskodi, S. (2012). Bibliometric analysis of Indian Journal of Agricultural Research..International Journal of Information Dissemination and Technology, 2(3), 170-175.

Van Eck, N. J., & Waltman, L. (2009). How to normalize co-occurrence data? An analysis of some well-known similarity measures. *Journal of the American Society for Information Science and Technology*, *60*(8), 1635–1651.

Van Eck, N. J., & Waltman, L. (2007). VOS: A new method for visualizing similarities between objects. In: H.-J. Lenz & R. Decker (Eds.), *Advances in data analysis: Proceedings of the 30th annual conference of the German classification society* (pp. 299–306). Berlin Heidelberg: Springer.

Van Eck, N. J., Waltman, L., Noyons, E. C., & Buter, R. K. (2010). Automatic term identification for bibliometric mapping. *Scientometrics*, *82*(3), 581-596.

Van Eck, N. J., Waltman, L., Noyons, E. C. M., & Buter, R. K. (2008). *Automatic term identification for bibliometric mapping*. Technical Report ERS-2008-081-LIS, Erasmus University Rotterdam, Erasmus Research Institute of Management.

Weinstock, M. J. (1972). ISI's Social Sciences Citation Index: A New Comprehensive Multidisciplinary Information Retrieval System for Social Science Literature.

Wieczorek, A. (2003). Use of Biotechnology in Agriculture--Benefits and Risks.

Zain, Z. M., Ishak, R., & Ghani, E. K. (2009). The influence of corporate culture on organisational commitment: A study on a Malaysian listed company. European Journal of Economics, Finance and Administrative Sciences, 17, 16-26

Zhou, P., & Leydesdorff, L. (2006). The emergence of China as a leading nation in science. *Research policy*, *35*(1), 83-104.