# A Bibliometric Assessment of ASEAN's Output, Influence and Collaboration in Plant Biotechnology

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## Abstract

This research uses 10-year (2004-2013) publication and citation data related to plant biotechnology to assess the research performance, impact, and collaboration of member states of the ASEAN in plant biotechnology. Findings indicate increased scientific output of ASEAN countries in plant biotechnology as well as increased research collaborations by individual member states and with international partners throughout the 10-year period. The nature of collaboration by ASEAN is linked with the status of economic development of each country. Domestic and international collaborations are strong and are increasing through the years, regional collaboration on the other hand is found to be limited. This limited regional partnership can be a concern for the region's goal of economic integration. Further studies using bibliometric data analysis is suggested for policy diagnosis in plant biotechnology cooperation, knowledge flows, and effect of plant biotechnology research in economic development between ASEAN countries.

## Conference Topic

Bibliometrics and research evaluation

## Introduction

The Association of Southeast Asean Nations (ASEAN) has declared biotechnology as the main area of cooperation in science and technology. ASEAN, a regional association composed of 10 countries namely: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar (Burma), Philippines, Singapore, Thailand, and Vietnam, considers plant biotechnology as the next pillar of regional economic growth (Hautea & Escaler, 2004; Erbisch & Maredia, 1998) and the answer to their food security needs. If ASEAN will continue to invest in plant biotechnology in the next years, it will be beneficial to have information on the current state of research and collaboration for strategic direction setting. This research drawing on bibliometric data, hence, will add to understanding the level and nature of collaboration, including research performance of ASEAN countries in plant biotechnology. This is relevant for ASEAN policy makers in charge of setting direction and designing strategies for research cooperation, and planning research investments, especially on biotechnology, at the country and regional levels.

## Methodology

This research is based on 2004-2013 publications in plant biotechnology authored and co-authored by 10 member states of ASEAN. The data were extracted from Elsevier's Scopus database, the world's largest abstract and citation database of peer-reviewed literature (Elsevier B.V., 2014). Different keyword combinations were used to locate plant biotechnology-related publications guided by the glossary of biotech terms by the U.S. National Institute for Food and Agriculture (NIFA, 2014) and the National Agricultural Library Agricultural Thesaurus (National Agricultural Library, 2014). Additional filter was then set according to affiliation country to include only the publications published by the 10

ASEAN countries. No filter was set for the type of publication; all document type, namely: article, review, conference paper, short survey, note, editorial, letter, book chapter, book, and article in press were included. This research also highlights the use of a home-grown open-source 'publication parser' tool (Sutton, 2013); this tool was useful in parsing extracted files from Scopus for analysis of various indicators of interest at the country, institutional, and individual levels. The methodology, including interpretation of the different indicators, builds on best practices on indicators research that have been developed throughout the years (Moed, Glänzel, & Schmoch, 2004).

## Results and Discussion

*Publication output and citation impact*

During the 10-year period (2004-2013), ASEAN researchers produced an overall total of 7,907 papers related to plant biotechnology; this output has increased 15% per year. These publications were written by more than 13,000 unique authors. The number of researchers producing knowledge for the region has increased steadily throughout the years with numbers reaching close to 8,000 authors in 2013 compared to less than 2,000 authors in 2004. Interestingly, ASEAN's plant biotechnology publications have mostly been published in open source journals such as Plos One. ASEAN's plant biotechnology publications have been cited more than 117,000 times with the highest citation count observed in 2007. The average citation per publication for plant biotechnology publications of ASEAN (19.81) is more than twice higher than the average CPP of all ASEAN publications (8.4) indicating higher influence of plant biotechnology publications than publications in other research areas.

*Country output and ASEAN research investments*

We then classified the 10 ASEAN countries into three groups based on expenditures on research and development (R&D) (UNESCO Institute for Statistics, 2015): (1) high income countries (HIC) with R&D spending more than 1% of gross domestic product (GDP); (2) middle income countries (MIC) with R&D spending of 0.1 to 0.9% of GDP; and (2) lower middle-income countries (LMIC) with R&D spending of 0.0 to 0.09% of GDP. A significant difference on the publication output in plant biotechnology of HICs with larger R&D investments was noted compared with that of LMICs with less research investments (Table 1). Thailand produced the most number of publications (n = 2489). Malaysia and Singapore are the other top three ASEAN producers with more than 150 PPY and CAGR of 29% and 9%, respectively. Philippines with a CAGR of 8% and Vietnam with a CAGR of 19% produced an average of 75 and 41 PPY, respectively. LMICs, namely Brunei Darussalam, Cambodia, Laos, and Myanmar experienced no growth during the ten-year period and have only produced an average of 1-2 papers per year. Interestingly, Indonesia despite its low R&D investments, hence, classified as a LMIC here, was able to produce 61 PPY and is growing at 12% CAGR. The number of authors contributing to ASEAN publications except the LMICs namely: Brunei Darussalam, Cambodia, and Laos, is growing. An increase in the number of contributing authors was especially noted for Malaysia; the country's number of authors from 2004 to 2013 has increased almost 15 fold.

HICs with higher number of publications received more total citations than lower income countries. Singapore is the most highly cited in plant biotechnology followed by Thailand, Malaysia, and Philippines. With the exception of Indonesia, other LMICs received the least amount of citations for their plant biotechnology publications during the last two decades.

**Table 1. Comparison of 2004 and 2013 article output, CAGR, and citation count for ASEAN.**

| Country | Country classification | Publication output | 2004 | 2013 | CAGR | No. of authors | Citation count |
|---|---|---|---|---|---|---|---|
| Malaysia | MIC | 2,199 | 39 | 510 | 29% | 10,511 | 14,584 |
| Vietnam | MIC | 418 | 14 | 83 | 19% | 2,474 | 3,957 |
| Thailand | MIC | 2,489 | 108 | 377 | 13% | 12,688 | 27,863 |
| Indonesia | LMIC | 611 | 33 | 104 | 12% | 3,421 | 7,208 |
| Myanmar | LMIC | 23 | 1 | 3 | 12% | 100 | 180 |
| Singapore | HIC | 1,594 | 101 | 234 | 9% | 10,953 | 49,094 |
| Philippines | MIC | 757 | 46 | 104 | 8% | 4,444 | 14,492 |
| Cambodia | LMIC | 6 | 1 | 0 | -100% | 64 | 135 |
| Brunei | LMIC | 35 | 0 | 0 | | 30 | 157 |
| Laos | LMIC | 10 | 0 | 3 | | 136 | 186 |
| Total | | 7,907 | | | | | 117,856 |

Note: CAGR of Cambodia and Brunei resulted in undefined values and left blank in this table. Source: Scopus

The topmost institution publishing plant biotechnology-related articles in the region are mostly local public research universities (e.g. University Brunei (Brunei), Bogor Agricultural University (Indonesia), National University of Laos (Laos), University of Malaya (Malaysia), Yezin Agricultural University (Myanmar), National University of Singapore (Singapore), and Mahidol University (Thailand). For Cambodia, Vietnam and Philippines, the top producers of publications on plant biotechnology were research institutions and include Cambodian Agricultural Research and Development Institute, Institute of Biotechnology, and International Rice Research Institute (IRRI). The two former institutions are national leading research institutions in bioscience and plant biotechnology while IRRI is an international research organization.

## Collaboration

Guided by a decision tree adapted from Lan (2014), we distinguished four types of research collaboration: (1) domestic - in which all authors are in the same country; (2) regional – in which one ASEAN author co-authored with another ASEAN country; and (3) international – in which authors in the ASEAN countries published together with at least one author from another country besides the ASEAN countries. Single authorship and publications that involved intra-institutional co-authorship are not classified as collaboration in this research.

Single author publications and publications that involved intra-institutional co-authorship for ASEAN is very limited; they only constitute 15% of ASEAN's total publications in plant biotechnology. Eighty five percent of ASEAN's total publications in plant biotechnology, on the other hand, involved research collaboration, growing at a CAGR of 15%. Interestingly, the most active institutions that engaged in collaborations in ASEAN are the public universities and institutions of higher education; these institutions have also been noted earlier to be publishing most and the active generators of knowledge for ASEAN. These results confirm observation that plant biotechnology research in ASEAN countries is increasingly conducted now by a group of collaborating researchers rather than by a single researcher (Katz & Martin, 1997; Glänzel, 2001).

The region's co-authored publications that involved domestic partnership are growing at a CAGR of 15%. Six ASEAN members were engaged in domestic collaborations with

Malaysia, Thailand, and Singapore having the highest % shares of domestic collaborations at 42%, 37%, and 20%, respectively. Brunei Darussalam, Cambodia, Laos, and Myanmar have no record of domestic collaborations.

ASEAN publications that involved regional collaboration are very limited with less than 1% of the total collaborations of ASEAN. The highest number of publications that involved regional collaborations was recorded in 2013 (n = 21); there was no regional collaboration noted for 2007 and 2008. Ironically, 2007-2008 were the early years of the adoption of ASEAN's Economic Blueprint, which serve as the guide for the establishment of the ASEAN Economic Community. All the higher income countries have co-authored with another ASEAN country although numbers are quite limited (Figure 1). Philippines and Thailand have collaborated mostly with all of the ASEAN countries except Brunei Darussalam. Laos and Myanmar are two of the most active in regional collaborations despite their late membership to the regional association. Both countries have strong regional collaborations with Thailand, their closest ASEAN neighbor; Laos and Thailand used to belong to one country (Siam) and have basically the same language. Brunei has no record of collaborations with any of the ASEAN members.

The region has a very high rate of international collaboration in plant biotechnology research during 2004-2013 at 65% and the rate of collaboration is growing at a CAGR of 11 %. Similar with domestic and regional collaborations, the highest number of publications that involved international collaborations was recorded in 2013 (n = 227) while the least was recorded in 2004 (n = 717). ASEAN has partnered with 115 countries that are in varying stages of economic development. U.S. remains to be the main international research partner of choice among ASEAN countries. ASEAN is also tapping into the research expertise and resources of other Asian nations like Japan, China, South Korea, and India and advanced countries like United Kingdom, France, Germany, Canada, and The Netherlands. Arunachalam and Doss (2000) had the same observation and stated that Asian countries are fast increasing their share of worldwide international collaboration in science and expanding its collaboration beyond the traditional collaboration with advanced nations such as the United States.

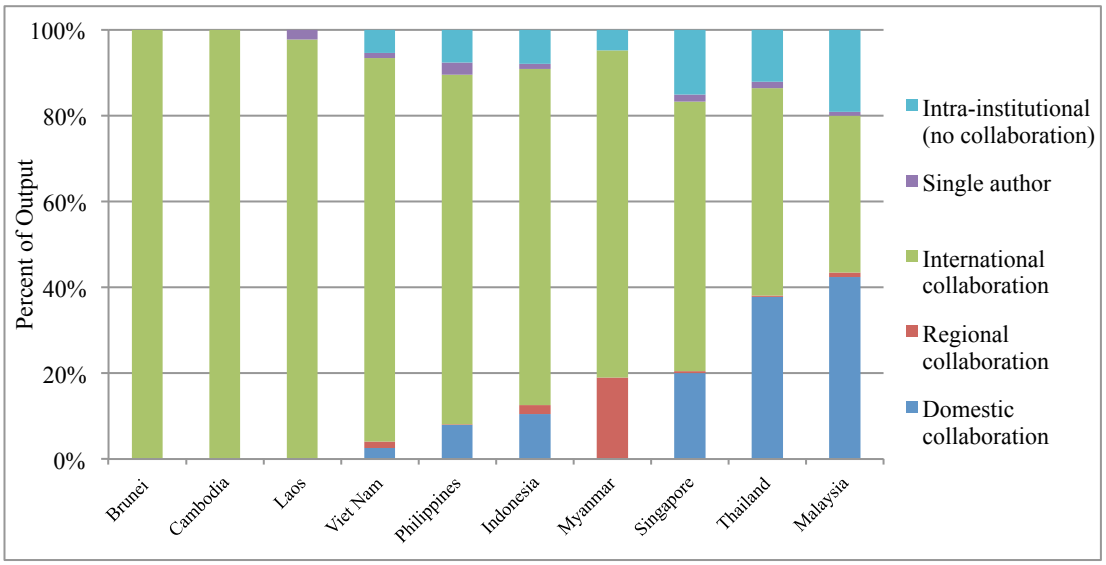


**Figure 1. Percentage of different types of collaboration for individual ASEAN countries in plant biotechnology, 2004-2013. Source: Scopus**

Brunei Darussalam, Cambodia and Laos are particularly noted for very high international collaboration. There are many justifications for this high collaboration rate and may include

the need for complementary and synergistic research expertise, greater visibility in the international plant biotechnology arena, and greater research output despite limited research investments. Interestingly, the higher income countries and the top ASEAN producers, namely Malaysia, Thailand, and Singapore have lower scientific output with the international community compared with other ASEAN countries, which validates observation that these countries have now higher domestic research capability, hence, would not need as much international collaboration as lower income countries. As expected, ASEAN publications that involved international partnerships received the highest citation count (n = 86,423) supporting earlier research while publications that involved regional collaborations received the least citation count (n = 547). It is interesting to note that despite the regional collaborations involving more authors and one or more ASEAN countries, the citation count was lower compared to single authored publications. This can indicate the less quality and influence of publications resulting from regional partnerships.

## Conclusion and Recommendations

Using bibliometric data for the period 2004-2013 sourced from the research abstract database, Scopus, and deconstructed through a non-commercial home-grown publication parser tool, this paper investigates ASEAN's research output, influence and research collaboration in the area of plant biotechnology. Analysis of the 10-year period indicated an increase in ASEAN plant biotechnology-related scientific output. The publication activity obviously varies from country to country but evident that it is linked with R&D investments: higher income countries such as Singapore produced more publication than lower middle-income countries such as Brunei Darussalam. Most of the knowledge producers of ASEAN were from local research institutions, which are a good indication of improvements in domestic research capability and increase knowledge generation activity among this group. The relatively stable trend of publication generation and increasing R&D investments in countries such as Singapore, Thailand and Malaysia, likewise, provides a good indication that more research output can be expected from these countries. The growth of the publication records especially of Indonesia and Vietnam supports the increasing commitment of these countries and their researchers to contribute in advancing the plant biotechnology field. Philippines need to push and incentivize its local research and academic institutions to produce more and increase their scientific output and not rely on international institution to boost the country's scientific productivity. Brunei Darussalam, Cambodia, Laos, and Myanmar need to improve their research infrastructure and level up their research investments to catch up with other ASEAN countries.

The increasing number of collaborative research teams and number of contributing authors based on co-authorship data in ASEAN publications over the course of the 10-year period, however, is an encouraging result. It represents an increase in the pool of researchers and a change in the balance of research focused more on collaborative research teams among ASEAN researchers and their partners and not on lone scientist.

All the 10 ASEAN countries are actively engaged in research collaboration in plant biotechnology although in varying degrees. The publication output by countries in terms of the collaboration types: domestic, regional and international, differ and is also noted to be linked with status of economic development. Domestic collaborations are very strong for higher income countries with higher R&D investments while lower income countries with lower research investments tend to publish more with their international counterparts. There is more preference for collaboration with more advanced nations but at least the region has expanded its collaboration beyond the United States.

Regional partnerships are, however, very limited, and can be a concern for ASEAN's goal of integration. ASEAN regional collaboration still lag behind in terms of productivity and

quality research in plant biotechnology, which is very evident from the region's low research output and citation count for publications co-authored among ASEAN researchers. Higher regional collaboration rate is only observed to countries that are in close proximity to each other, with common language, and with historical links. Kumar, Rohani, & Ratnavelu (2014) found the same scenario after doing bibliometric work in the field of economics. The low regional collaboration was also mentioned in one of the latest reports by the Asian Development Bank, Regional Cooperation and Cross-Border Collaboration in Higher Education in Asia: Ensuring that Everyone Wins (Asian Development Bank, 2012). Hence, it remains to be seen whether regional collaboration will serve as an important platform for continuing to modernize plant science in ASEAN and sharing knowledge in plant biotechnology. More investments in research cooperation, funding mechanisms for regional plant biotechnology research, and other regional incentives need to be setup so ASEAN can realize the goal of its regionalization agenda. Regular quantitative monitoring of inputs and outcomes of research in ASEAN is likewise encouraged to monitor research performance and help in developing research management and science policies, particularly in economic development. Additional research focused on mapping of research collaboration network among ASEAN researchers and their global partners, and a brain circulation study can be done to understand the mobility of ASEAN researchers and whether such movement helps in increasing regional productivity and collaborations and whether such benefits flow back to ASEAN. Furthermore, a qualitative study that would determine other factors that influence an ASEAN researcher to collaborate with another ASEAN researcher or a global partner is suggested.

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