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Transition of bioeconomy as a key concept for the agriculture and agribusiness development: An extensive review on ASEAN countries

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Transition of bioeconomy plays an important role in the development of any economy. Therefore, the purpose of the current paper is to review the key concept of transition of the bioeconomy in the ASEAN economies that is considered to be an innovative collective method for observing the operation of national economies' numerous sectors that produce and process biological wealth. Based on current literature, it has been reviewed that the transition of bioeconomy is being presented with respect to the theoretical concept, and their essence and bioeconomy size, and the challenges and risks which are related to the bioeconomy transition. The various ways and the area of action along with present strategies which are supporting the development of bio economies and their relationship with the circular economies model had been presented. It was seen in the literature that ASEAN agricultures sectors had been contributing their major part in the development of value-added products and employment, except for Malaysia, Thailand, and Laos. Moreover, the analysis results had also shown that the transition of bioeconomy is considered to be an important concept in the growth of agriculture, forestry, agribusiness, and various sectors that produce and use bio-based raw materials. It was further found that for real bio-economy opportunities, it is essential that there should be a proper national and regional strategy for the bioeconomy development in place and for the development of a proper design and proper management coordination at every level of sectors, enterprises, and provincial systems.

KEYWORDS

transition, bioeconomy, strategies, sustainable improvement, strategies development, ASEAN

Introduction

According to the NORDIC Council of Ministers, bioeconomy is defined as the efficient use of renewable energy and biological resources from water and land to attain mutual benefits for human society and business (Refsgaard et al., 2021). Transformation of the typical economy to a bioeconomy employed a transition in form of fossil fuel to more efficient resources based on value addition with low energy consumption. Bioeconomy suggests that renewable resources must be converted in the form of bio plastics, biofuel, biopharmaceuticals, and foods. According to the European Commission, a bioeconomy utilizes the biological resources from the wastage of sea and land including foods using as industry inputs for efficient energy production (Patermann and Aguilar, 2018). Bioeconomy transition is considered the adoption of socio-technological processes for efficient energy production. A transition process is employed in the systematic change with respect to consumption and production accompanied by governance values and belief systems (Kern and Smith, 2008). In previous studies, academic scholars extensively discuss the bioeconomy in last decade with a number of review articles (Staffas et al., 2013; De Besi and McCormick, 2015). According to the European Commission (2012) a bioeconomy based on the strategies explains the need for partnership between civil society, government, industries, and universities. More specifically, current actors on bioeconomy transition elaborate the concept as a means to fight against global climate change and energy insecurity to minimize the global economic and financial crisis (Schmidt et al., 2012). Bioeconomy also includes food, agriculture, pharmaceuticals, aquaculture biomass, electricity production, and products of industrial biotechnology including bioplastics and enzymes (Scarlat et al., 2015; Liobikiene et al., 2019).

In the modern age, the transition of bioeconomy is now a common theme in policy documents and strategies around the world. The political concept of bioeconomy is still largely undefined (International Advisory Council on Global Bioeconomy, 2021). In other words, bioeconomy is not a fixed concept that will remain the same forever (Sanz-Hernández et al., 2019). Bioeconomy is a knowledge-based production and involves biological resources utilization and biological principles to sustainably deliver services and goods over all economic sectors (Babakus et al., 2003). It involves three parts: renewable biomass use and effective bioprocesses to gain sustainable creation converging and useable technologies, comprising biotechnology, and incorporation across the applications like agriculture, industry, and health (Babakus et al., 2003). Various countries comprise several sectors in their bioeconomy strategies based on their priorities and conditions. These various countries often endeavor to assess the contribution of bioeconomy to their overall economy by taking

into account various variables, which typically reflect their priorities. Economic growth, employment, energy security, food security, the reduction of fossil fuels, climate change adaptation and mitigation, and rural development are among the country's goals and bioeconomy objectives (Bracco and Flammini, 2018).

ASEAN region is based on the international economies which facilitate and promote co-integration and cooperation in Southeast Asian countries such as Thailand, Vietnam, Brunei, Malaysia, Laos, Myanmar, Indonesia, Colombia, Singapore, and the Philippines. According to the statistics of 2018, the combined GDP of ASIAN economies is worth about 3 trillion USD. The annual growth rate of Gross Domestic Product is about 5.3, reported from 2002 to 2018. The individual GDP growth rate of ASEAN countries are as follows: Thailand 8.4%, Singapore 0.5%, Vietnam 15.3%, Brunei 1.2%, Philippines 7.4%, Indonesia 31.7%, Columbia 25.3%, Laos 20.9%, and Myanmar 8.9% (Zelina and Rudi Purwono, 2021). The main production and export of these countries are based on livestock, plants, trees, and crops that are very critical for the security and safety of energy resources, food, and bio-based products to ensure their economic sustainability. However, the contribution of the agriculture sector to GDP is lower than the service and industrial sector contributions. This industrial sector ultimately produces harmful and toxic wastage, pollutes the land and water, and destroys natural resources because of toxic and chemical emissions. For this reason, Asian governments must focus on bio-economic development by transforming a typical economy to a bioeconomy (Masud et al., 2018).

The current study employed and incorporated the ASEAN countries because of major issues facing industrial and agriculture development. After the financial crisis of 1997 to 1998 Asian countries strengthened more than the expectations (Waters et al., 2003). Criticism against unsympathetic western reactions forced the ASEAN countries to achieve cooperative arrangements in their region. In addition, their rivalry with Japan and China for leadership directed the ASEAN countries in seeking negotiable partnerships (Egberink and Van der Putten, 2010). The ASEAN region is still facing challenges because of the rapid economic growth in India and China. Hence ASEAN has made very slow economic progress. Private business and ownership still achieve little benefits from ASEAN-oriented agreements because of unaffordable and high tariffs. Facing such issues, ASEAN countries still continue their binding commitments. Moreover, sponsorship has been unable to support sufficiently and significantly that encourage agriculture business to invest substantially to attain deeper level integration.

Issues of environment and climate change, explosion of population, sudden change in urbanization in the big cities, generation of wastage, reduction of energy resources, and high depletion of fossil fuel are creating issues associated with the economy specifically based on the fossil, which required great attention. For this reason, recently the world has gradually

transformed from a fossil oriented economy into a sustainable bio-economy. Biogenetic wastage that is produced in large quantities in ASEAN countries create high pressure to transform their industry into a bio-based economy (Lakra and Krishnani, 2022). These arguments and discussions depict a requirement for the structuring of bio-economy based on waste produced in ASEAN countries. In developed countries, wastage is now considered a valuable form of energy resource, specifically to supplement petroleum products obtained by proper utilization (Aguilar et al., 2019). Hence, it is very necessary to introduce wastage as an essential element for energy resources in future economic models for sustainable development. The review also helped to establish and structures the bio-economy based on drivers of wastage recycling in a sustainable format to achieve the futuristic needs and wants as well as create the opportunities predicted in the economic and business realms. Bio-economy based on the recycling of wastage has a significant and crucial scope that requires innovation at the industrial scale if technological and scientific knowledge is efficiently used (Lokko et al., 2018). Adoption of bio-economy, based on wastage recycling more precisely can be attained the major sustainability development goals given by United Nations.

Policies and initiatives for bioeconomy have high objectives and aims, but there is no agreed-upon mechanism for monitoring progress toward them (Bracco and Flammini, 2018). Because countries have different constraints, opportunities, and priorities, no standardized method for determining how much the bioeconomy contributes to the national economy has been devised at this point (Williamson, 2013). Lack of a consistent methodology could cause confusion when evaluating the importance of bioeconomy across countries (Sanz-Hernández et al., 2019). Along with previous countries' consequences, the previous studies had a major focus on developed economies (Asada and Stern, 2018; Jakarta, 2018; Sanz-Hernández et al., 2019) but had little attention on developing economies, especially on the Association of Southeast Asian Nations (ASEAN) economies. The current study includes the ASEAN region that promotes and facilitates cooperation among ten Southeast Asian countries namely, Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam (World Integrated Trade Solution, 2021). In 2018, the region's combined GDP was USD 3.0 trillion, with an average annual growth rate of 5.3% from 2000 to 2018. To sustain this rate of growth, ASEAN member countries recognized the importance of capitalizing on the opportunities offered by innovation and employing the concept of bioeconomy as a key to sustainability (World Integrated Trade Solution, 2021). It was further explained that ASEAN economies could be maintained as proper bioeconomies to sustain in the global world (World Integrated Trade Solution, 2021).

Along with the previous discussion, the current study has been conducted on the ASEAN countries which are currently measuring the contribution of bioeconomy to their overall

economy because the ASEAN population has nearly doubled over the last four decades, reaching 632.1 million in 2017 (Jakarta, 2018). This increase in population shows that the ASEAN is undergoing a demographic transition, as evidenced by declining fertility and mortality rates over the last few decades (Jakarta, 2018). The population has now reached 682.9 million as per the report by English (n.d.). This change in the demographic is being associated with with the decreasing fertility and mortality rates in ASEAN Member States (AMS) from the last decades. An increase in population creates the problems of deficiency in biological resources and climate instability because of high industrial production that ultimately requires a bioeconomy transition. In contrast, the 10 AMS are at different stages of demographic transition, indicating different levels of development. The population of the ASEAN countries is consistently and rapidly increasing. Keeping in mind the rising population, the agriculture sector played a significant role in gathering their requirements, as agricultural goods added a significant share of both total exports and imports of goods in some AMS. The AMS with the highest proportion of agricultural goods in their total goods exports in 2017 were Myanmar (32.3 %), Indonesia (21.7 %), and Lao PDR (28.8%). While the share in these three AMS, and to a lesser extent in the Philippines, increased between 2010 and 2017, it tended to decline in Malaysia and Vietnam during the same period. Furthermore, the agricultural share of goods exports was about 10% or less in Malaysia (10.0%), Singapore (2.8%), the Philippines (8.8%), Cambodia (5.2%), and Brunei Darussalam (0.2%). It has been shown that agricultural goods accounted for 15.1 % of total goods imports in Brunei Darussalam in 2017, followed by Myanmar (14.8 %), Philippines (12.1 %), and Indonesia (11.2 %) and Lao PDR (13.3 %). Singapore's share of the lasting AMS was only 3.7 % in 2017 (Jakarta, 2018). Along with the significance of agriculture, the share of the services sector has improved in recent years, while the shares of both the manufacturing and agriculture sectors have decreased (Jakarta, 2018). In 2017, the services sector growth accounted for almost 50.9% of the region's total GDP, increased from 46.6 % in 2005. The manufacturing sector added almost 36.8 % of the ASEAN total GDP in 2017, which decreased from 39.7 % in 2005), although the agricultural sector added only one-tenth of ASEAN of the total GDP in 2017, which decreased from 12.8 % in 2005 (Jakarta, 2018).

Along with the declining share of agriculture in the international market, ASEAN agriculture has a number of internal and external challenges in modern times. Rural areas' socio-economic and cultural growth depends on agriculture and the agriculture bioeconomy complex, and the outer procedures of globalization and worldwide integration remain crucial for both of them. The various authors also recommended in their studies that the transition of bioeconomy for agriculture and agribusiness is very important for long-term survival globally (Saardchom, 2017; São Simão, 2019). Even if globalization has a life of its own, as a newly admitted member of the

ASEAN union, does not have the ability to influence national institutions or authorities, it does have a few, but limited, options for influencing the development of the ASEAN Union (São Simão, 2019; Yean, 2019). If you want to have an impact on the form of familiar Agricultural Policy as well as additional vital Community strategies in place of agriculture and rural regions, you could do so by voting for or against candidates is explained by Von Rintelen et al. (2017) and Sanz-Hernández et al. (2019). Furthermore, this is also possible to enhance an innovative development theory, such as bioeconomy, through a variety of procedures of support as well as planned development platforms, which are made possible by these policies (Wyse, 2011; Saardchom, 2017; World Integrated Trade Solution, 2021). Bioeconomy is a concept that extends well beyond the borders of agriculture as well as agribusiness while remaining heavily reliant on these sectors. The objective of the current study is to elaborate on the development conditions, occurrence forms and bioeconomy transition outcomes development process with special attention paid to all the challenges for economic policy of the state that presents this process. The paper was written after reviewing comprehensive scientific literature, various official documents from the ASEAN countries and several other international organizations, and the own observations of the authors. The study could contribute to helping other economies know about the importance of bioeconomy transition that could help to increase the employment, value added products, and turnover. This increase could help to any economy along with social and economic perspective to decrease the poverty level and unemployment. Moreover, the study could also help researchers to know about the importance of this topic as a new area of research in the future. The findings of this study could also help all agriculturist countries where the main area of contribution to the economy is agriculture for their long-term survival.

ASEAN economies are belonging to the upper middle-income class and their GDP growth rate is not matched with developed countries and economies (Elistia and Syahzuni, 2018). These countries are still faced with social and environmental problems that create a serious threat to the well-being of the common public and economic growth. The prominent reason behind the issues is low biological development that is unable to balance the climate, higher emission of wastages, and hazardous elements produced by economic activities (Siman et al., 2021). For this purpose, the current study contributes by paying attention to these problems and issues by employing the transition in the bioeconomy concept. More specifically, the objective of the study is to explore the role of agriculture and agribusiness in the bioeconomy transition from a traditional economy. The current study intends to explain the impact of biomass, wastage, and fossil fuel transition for developing energy resources in ASEAN economies. Current study will determine developed economies where a highest portion of waste, Biomass and fossil fuel transfer into biological and

renewable energy resources are considered as the biological economy or bio-economy. Hence by the utilization of efficient technological process related to energy production unable to protect environment, enhanced climate stability and preserve the natural resources by making progress in the agriculture and agribusiness sector.

Theoretical underpinnings

Bioeconomy transition is defined as the technical shift in the social system that requires the fundamental restructuring for societal development based on specific changes in technology, society, state, and market (Ingrao et al., 2018). In the analysis of bioeconomy transition, various methods and frameworks have been employed in the literature. Most of the theoretical framework originate from the innovation field. Previous studies found that research on innovation helps us better understand the emergence of sustainable bioeconomy and consumption practices as well as the formulation of policies and regulations to shift away from unsustainable bioeconomy (Diakosavvas and Frezal, 2019). In the development of bioeconomy, transition studies extensively explained the process of innovations. For this purpose, the current study highlighted the importance of technical knowledge that is very crucial and specifically required for the protagonist of bioeconomic transition.

According to Awasthi et al. (2020), sustainability in bioeconomy demands the transformation of technology that is efficient to socio-economic development. Distinct theoretical frameworks of the bioeconomy transition required intensive discussions on the conceptual approaches. In such situations, it is necessary for contributions of study in the literature to be followed by the application of conceptual approaches to assess the strategies and identify the possible changes required for a complete system transformation simultaneously overcoming the barriers during the application of new system (Gottinger et al., 2020). Transition theory postulated a long-term transformation in the economic, social, cultural, and technical changes in society. The theory believes in an evolutionary view of innovation with respect to dynamic changes in the environment (Van den Bergh et al., 2011). The most prominent methods and approaches applied in the transition of systems include multi-level perspective, niche management, transition management, and innovation systems based on technology (Weber and Rohrer, 2012). Previous studies founded effective policy-making which demands functional and structural analysis. The process of transition management is employed for better problem-solving and coordination as well as for strategic policy-making. Scholars of transition management mostly focus on the transition process and vision of effective change. According to Loorbach and Rotmans (2010), transition management research and academic scholars take

the advantages of transition management model that is often called transition management cycle. The model includes three characteristics: problem-solving, developing an agenda on the transition, and application and evaluation of the experiments. A short discussion on transition management and various analytical approaches suggests different conceptualizations for system transformation and tackling their barriers. Summing up the above discussion found that criteria for judging a specific analytical framework based on the nature of transition problems. In the current study, our objective is to contribute to the understanding of bioeconomy transition in agriculture and agribusiness supported by the existing theoretical framework based on transition studies.

Agriculture and agribusiness structure of ASEAN economies

In the international literature, there are very few studies that conduct comprehensive bioeconomy analyses at the ASEAN level. Comparing one country (often India) to the ASEAN countries is a common theme in related articles. Between 1990 and 2007, Chandran (2011) used the trade intensity index to examine trade between India and the ASEAN region and found a comparative advantage. As per his results, most major ASEAN agriculture bioeconomy producers had a comparative advantage in the production of both agricultural and food items, including “Vietnam, Thailand, Indonesia, Malaysia, and the Philippines” in decreasing order. While most ASEAN countries showed competitiveness in fish and fish products, it was lower than India’s (Chandran and Sudarsan, 2012). It was a major factor in the fact that even with a tariff reduction, imports of marine products did not increase significantly. Reyes (2014) found high indices in the agriculture bioeconomy sector in the ASEAN-6 countries excluding Singapore and Brunei within the decade of 2007 and 2011, using the Balassa and Lafay indices as a basis. On the other hand, Indonesia has the greatest comparative advantage when it comes to prepared edible fats (such as margarine) and animal or vegetable waxes. In Malaysia and the Philippines, this product line had a significant comparative advantage.

Modern activities in the agriculture sector of the ASEAN countries are still in the developing stage due to the internal and external factors affecting the economy. External factors such as internationalization and globalization are considered the main and important factors in the development of agriculture. ASEAN countries still required industrial, social, and economic development and development in agri-food complex (Chopra et al., 2022). While globalization is an autonomous process and is unable to control and shape by National or local economic authorities. ASEAN still required huge support for industrial development and policymakers must formulate

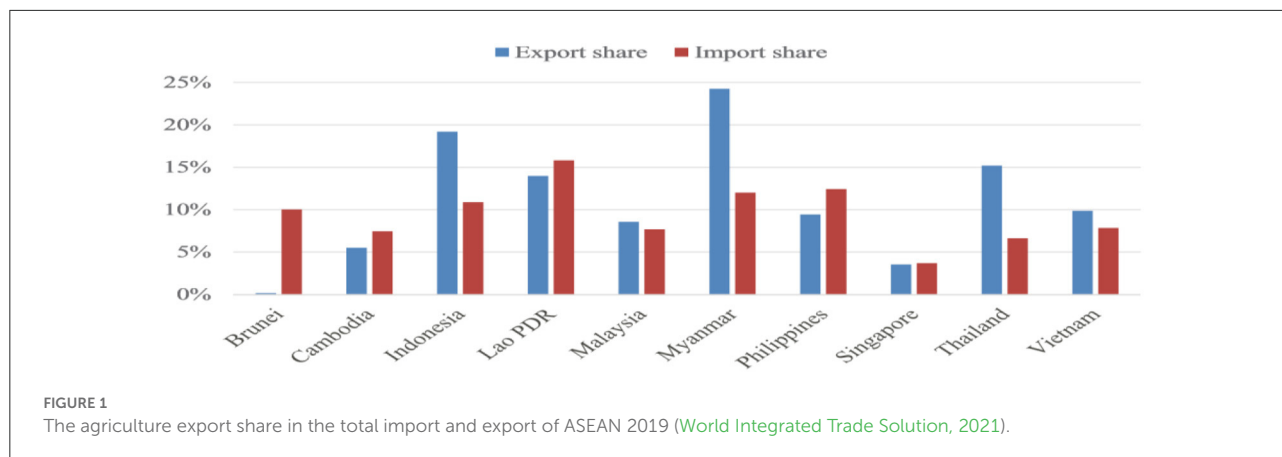
programs and regulations which are able to concepts building in bio-economy transition.

In general terms, bioeconomy can be perceived as a new analytical and cognitive concept, an emerging new complex sector of the economy, a trans-sectoral form of analysis, and a new application of previously known development concepts of agriculture and agribusiness (Adamowicz, 2020).

Other researchers, Kea et al. (2020) found that the competitiveness of Cambodian rice exports was increasing, but that these values were lower than those of the country’s major competitors, based on relative export competitiveness and relative symmetric export competitiveness. To keep this competitiveness, the authors emphasized the significance of managing domestic supply and demand. While Suntharalingam and Othman (2017) found that Malaysia had comparative advantages over some of its rivals in the selected commodities, they also found that innovative technologies were needed to tailor the products to the market’s specific needs (bananas, watermelons, papayas, pineapples, starfruits, and mango). Except for nonfrozen shrimp, the shrimp industry in the years 1999–2009 showed a comparative disadvantage (Khai et al., 2016). As Khai et al. (2016) also discovered, Thailand’s shrimp industry is highly competitive in the global market. RXA, RTA, In RXA, and RC were used by Benalywa et al. (2019) for the Malaysian broiler industry between 2009 and 2017. A number of countries were included in this study to see how these results stacked up against each other. Their findings showed that the performance of countries differed depending on which subgroup. According to Zhang et al. (2019), Myanmar has enormous agricultural potential, but realizing it will necessitate both policy changes and investments, particularly in the processing industry. The Thai tuna industry was highly competitive on the international stage from 1996 to 2006, but to be profitable, small farms must be merged (Kuldilok et al., 2013). According to Hoang et al. (2017), the RTA index for Vietnam found that in 2014, 27 agricultural sectors had a competitive advantage, such as wood chips, spice production, and rice, while 34 agricultural sectors had a competitive disadvantage. Convergence means an increase in the early competitiveness of the weakly competitive industries, while decreasing initial competitiveness. Various authors also recommended in their studies that the transition of bioeconomy has become a major part of agriculture and agribusiness in the ASEAN economies (Wyse, 2011).

Basic characteristics of asian economies

As a result of the agricultural sector’s contribution to total export and import, its importance could so be assessed (Figure 1). No general trends in export or import share could be found when looking at all-time series data together Myanmar



had the highest percentage of agricultural exports in 2019, followed by Indonesia (19.2%) and Thailand (15.2%). However, it is interesting to note that this figure was significantly lower than the global average for a major producer like Vietnam (9.9%). Agriculture and food products account for 15% of Laos' total imports, with the Philippines and Myanmar coming in second and third, respectively (12.4 and 12.0% in that order). Similar results have been proved in Malaysia (Pek and Ee, 2022).

Figure 2 shows the trade balance for the ASEAN countries studied as an indicator of agricultural performance. There is a trade surplus between Thailand and Indonesia of over 20 billion USD and nearly 14 billion USD for Vietnam, as shown in Figure 2. The other countries with a trade surplus are Malaysia, Myanmar, and Singapore. Although Singapore's agricultural sector is negligible, the country was able to achieve a value-added trade surplus. It is a sure sign that something has been done to make it more valuable. Exports outweighed imports in six of the ten countries examined overall. Overall, the trade surplus is 39.2 billion USD.

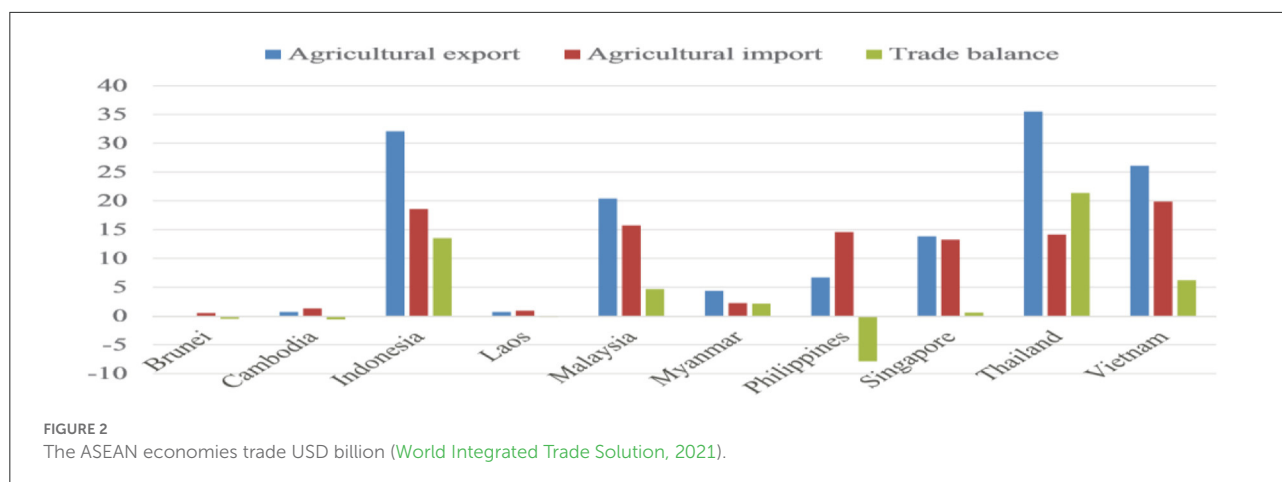
Economic resilience and evolution in the ASEAN region

Beyond establishing regional stability, ASEAN's primary goal was to integrate the economies of its member states. The adoption of the ASEAN Economic Community (AEC) Blueprint in 2007 and the formal establishment of the AEC on December 31, 2015, were important ASEAN milestones. One market and production base, competitive economic region, equitable economic development, and integration into the global economy are the four pillars of the AEC Blueprint 2015 initiative (Viswanathan and Anbumozhi, 2018). Among these interconnected pillars are the elimination of trade tariffs, free movement of goods, services, and investments as well as the development of a coherent external economic relationship and enhancing sharing in the global supply network, as well as

the establishment of a common framework, standards, and cooperation across several fields (Viswanathan and Anbumozhi, 2018). Various researchers mentioned in their studies that the revolution in the economy could be properly addressed in the ASEAN economies by addressing the proper transition in the bioeconomy (Wyse, 2011) because the transition has become a major part of the nation that could increase the social contribution both in the value-added and employment perspective (Von Rintelen et al., 2017). Therefore, the transition of bioeconomy had become a major factor across the world. The next section describes the transitions of bioeconomy from the theoretical and empirical perspective.

The essence of and new approaches for the transition of bioeconomy

Originally developed in the 1970s, the sustainable development idea is constantly being broadened and altered to meet the ever-changing conditions and demands of society. Today, sustainable development encompasses three primary categories, just as it did when it was first proposed: economic, social, and environmental considerations. According to Chcialowski et al. (2016), it is quantified in the ASEAN Union through numerous indicators drawn into 10 thematic categories. The assessment of the long-term viability of development increasingly emphasizes the issues of the reduction of fossil fuels as an energy source, as well as the necessity to move in the renewable energy foundations and the repurposing of waste materials. Biomass is a renewable energy resource that could be utilized for making fuels as well as an extensive range of other goods. It is the most widely used renewable energy source in the world. Manufacturing these items will be achievable by a variety of physio-chemical and biotechnological approaches, ranging from genetic technologies to nanotechnology as well as synthetic biology, among other approaches (Adamowicz, 2020). While looking into these concerns, particular emphasis is



placed on possible means of restraining economic development and growth. The notion of bio-economy is introduced here, which could be regarded as a subset of biological resources, for example (production based on biological resources) and therefore a subset of biological processes (utilization of the biological procedures for the creation of goods and services) (Ratajczak, 2013).

Bio-economy could be examined in place of as an innovative method of thinking about economics, a growing economic sector, a cross-sectoral approach to exploration, in addition to an innovative approach to thinking about agricultural and agribusiness growth (Adamowicz, 2020). The original concept of bioeconomy is an analytical and cognitive concept in economics, rather than a theoretical one. Scientists and practitioners could carry out research in a way that is aided by a better understanding of the scope, nature, and relationships between components. This approach highlights the expansive, changing sector of the modern economy known as the bioeconomy, which employs biological resources in the production of food, industrial goods, and medicines. These include biotechnologies as well as bioprocesses that are applied in fisheries, aquatic cultures, forestry, and agriculture.

A new sector called the bioeconomy is expected to rise to address different problems of sustainability. There is a bipolarization of the economic processes is the basic concept of bioeconomy, and it is also the most widely used term. In a sustainable manner, non-renewable resources are substituted with renewable biological resources. Bioeconomy is thus a novel systemic innovation, an alternate economic model that functions outside of the current system. The bio-economy has three aspects, including: utilizing innovative genetic knowledge as well as complicated cellular procedures; the creation of new industrial methods and goods using this information; and the use of biotechnology in a variety of sectors (Leitão, 2016). Using a third perspective, bioeconomy is seen as a set of smart measures that may be used as a part of the strategic formation

including transdisciplinary funding of research and scientific activities, as well as the utilization of intellectual resources. In addition, the main objective of the current research is to indicate bio-economy as a wide and speedily increasing sector of an economy that incorporates biological resources, like live beings, bio-technologies, bio-based goods, as well as bioprocesses, into an economic procedure for the purpose of making product or service. Bio-goods are produced in a number of sectors, including fisheries, forestry, aquaculture, agriculture, too other industries, besides they are employed for a variety of uses beyond the provision of food. The bio-economy could provide renewable resources in place of non-renewable resources. This means food, fuel, chemicals, pharmaceuticals, and other items could be made while recycling trash and capturing carbon dioxide. By doing this, a circular economy is created, where economic development is ecologically sustainable.

Theoretical foundations of transition of bioeconomy

The transition of bioeconomy could be characterized as an economy that depends on biological and renewable resources for manufacturing, chemicals, and energy (McCormick and Kautto, 2013). To create a transition in the bio-economy is a bio-based action, and biological resources are used which are used to get the necessary biological materials. All of these remain in thermos-chemical, biochemical, and mechanical manners. Moreover, other crops, bushes, plants, trees, as well as plantations are just the beginning of the resources that could be utilized: aquatic plants, algae, major waste as well as residue, after that secondary waste residue and waste, furthermore the waste and residue left over after a generation. By employing the biomass inside of economic processes, chemicals, food, bio-based items, feed, cosmetics, liquid fuels, thermal energy, and pharmaceutical goods could be produced and used.

This term was gradually established by J. Enriquez and R. Martinez, who first introduced the idea of bioeconomy in 1997, and then the ASEAN and OECD gave official interest to the idea. Following the initial interest in 2005, there were multiple new definitions created in numerous locations, from 2005 to 2009. Following this, the ASEAN Commission put forth more refined definitions in the period between 2010 and 2012.

These definitions haven't lost their usefulness, but they have been updated to include new aspects. This new development stresses the importance of the circular economy concept. Diverse scientific institutions, international organizations, and national governments all added to distributing the various definitions of bioeconomy by formulating national bio-economy development policies. According to Enriquez and Martinez, bioeconomy is defined as any Economics derived from scientific investigation and/or activity needed to understand processes and mechanisms there at the molecular genetic level, as well as their application to industry applications (Martinez, 1998). As biology and biotechnology began to make gains, we started exploring the idea. Later, the relationship between bioeconomy and the natural environment, also known as eco-development, as well as sustainable development, came to light. The ASEAN Commission's Directorate-General for Research defined bio-economy as the sustainable, environmentally efficient integration of sustainable assets toward food, energy, as well as other industrial goods in a definition published in 2005 (Cichočka et al., 2011).

In order to achieve the ASEAN bio-economy goals, the research of Von Rintelen et al. (2017) broke decreased the term bio-economy into the generic technologies that make up the three core areas: life sciences, agriculture, and industry (Table 1). On the other hand, bioeconomy remains described as the use of biological materials for the production of bioenergy or bio-chemicals, as well as new forms of land-to-sea procedures for the purpose of creating public goods. It also includes materials that were previously considered waste (Levidow et al., 2013; Gladkykh et al., 2020). The ASEAN countries' position in the formulation of policies is part of their definition of bioeconomy, which they defined in 2006. A bio-productivity definition, according to the group, is defined as the overall collection of financial activity inside a society that exploits that latent value inherent within biological goods or processes in order to obtain new growth as well as welfare advantages for individuals and groups (Kamal and Dir, 2015; Dietz et al., 2018). The study of Linser and Lier (2020) concludes that bio-economy describes a new approach to creating goods using life science knowledge. It was therefore noted that biotechnologies constitute a significant factor in the economy, and hence bioeconomy could be considered a reality. According to the Publishing (2009), the concept of bio-economy is made up of three parts: the use of advanced genetic and cellular knowledge for product and process development,

TABLE 1 ASEAN bioeconomy.

Sector	Employment in Million	Turnover USD Billion	Value added USD Billion
Aggregate	19	2,400	631
Agricultural	9.3	390	184
Forest	0.5	50	24
Food, drinks, and others	4.7	1153	234
Textiles	1.0	103	28
Chemicals, plastic, pharmaceuticals,	0.4	187	57
Electricity	0.01	13	3
Fisheries and aquaculture	0.30	12	8
Wood goods, furniture	1.60	174	48
Liquid fuels	0.03	12	4

Asian Development Bank (2021), International Advisory Council on Global Bioeconomy (2021).

effective bioprocesses through the use of renewable biomass for sustainable production, together with the incorporation of biotechnological research for the implementation of the technology in many sectors.

The Wyse (2011) findings stated that biotechnologies might fix many worldwide health issues as well as nutrition issues further it is also proposed they could assist in significantly altering the global economy over the next 30 years. Those countries with an already highly developed agricultural sector and advanced biotechnology, along with abundant natural biological resources, claim that "knowledge-based bio-economy" is in progress. on the other hand, the concept of bio-economy has come to be very popular inside the ASEAN Member States because of a conference held in 2007, during the duration of the "German Presidency of the ASEAN Union", it was announced that the bioeconomy is made up of renewable biological resources that are converted into food, feed, and pharmaceuticals, as well as other bio-based commodities and services (Presidency, 2007). The statement produced at the meeting, which envisioned the future of the ASEAN economy, made it clear that biotechnology would be a major part of it by 2030. This publication especially indicated a significant enhancement in the share as well as significance in industrial production in ASEAN of so-called white biotechnology items (medicines, cosmetics) (McCormick and Kautto, 2013; Androniceanu, 2019).

During the period of 2007, the theory of bioeconomy remained moderately different and was little communicated. However, because of the efforts of ASEAN Union organizations,

the concept gained widespread exposure from 2010 to 2013. As explained in the draft BECOTEPS in 2010 the term “bio-economy” refers to all industries that derive their goods from biomass; however, “Geoghegan-Quinn, the Director of ASEAN Commission”, defines it as the portion of the economy that produces investment and employment from development and processing, including the use of biological resources in an environmentally responsible way (Mariusz and Hofreiter, 2013; Zhao et al., 2022).

The ASEAN Commission issued a number of other documents in 2010 and 2011, each with different definitions of bioeconomy. One of the reports defines the bio-economy Biological production designs as well as natural ecosystems have been used in conjunction with natural materials to create production models that intake very little quantities of energy and generate no waste, because all waste resulting through one process has been used as a raw material in the next, and therefore is recycled back into the environment (Nebe, 2011). In 2011, the ASEAN Union used the term “bio-economy” to describe an industry that produces as well as processes renewable mass inside of a variety of goods as well as services, such as energy resources, food, industrial materials, and medical supplies. On the other hand, Mariusz and Hofreiter (2013) have produced a wide range of definitions for the bio-economy. This collection, which was later built upon, is shown in Table 1. The ASEAN Commission’s definition, which was produced in 2012 to support a strategy for utilizing renewable biological resources within diverse economic sectors, is the most detailed and most thorough. This description states that bio-economy is comprised of renewable biological resources in their use of industrial goods, feed, food goods, as well as bioenergy, which would be constructed on agronomy, ICT, biotechnology, food sciences, forestry, food, paper production, agriculture, fishing industry, cellulose, ecology, social sciences, and nanotechnology, along with aspects of the chemical, biotechnology, energy, and transport sectors (Commission, 2012). In addition, bioeconomy is now generally accepted as a key component of the human-environment system and is widely viewed as having the ability to help restore ecosystems, natural resources, green growth, faster innovation, and make development that incorporates health as well as social factors. Because of this, it is essential to examine bioeconomy as a sustainable way to employ organic renewable properties to develop the goods which fulfill the demands of the current group while leaving future generations with the potential to meet their own needs as illustrated by Wiseman et al. (2022). Bioeconomy, therefore, must be defined by sustainability, since it could have environmental protection, competitiveness, job creation, food security, and a long-term focus on human welfare as well as health. In 2018, the worldwide Bio-economy Summit showed how bio-economy contributes to sustainable economic development (Adhikari et al., 2018; Pan et al., 2021).

The scope and size of bioeconomy transition

Different countries and economic sectors have varying views on their bioeconomy transition. However, it is cross-sectoral. It doesn’t matter what industry you are in, you could think about the potential for innovation and the associated economic benefits, as well as the inherent risks that come with it. The bioeconomy necessitates the assistance of institutions set up around the world with the specific purpose of supporting it. Manufacturing in the bioeconomy transition uses biomass that is obtained from mechanically processed plant and animal resources or biochemically or thermo-chemically processed. In addition to trees, shrubs, crops, and plantations, other waste and residues like algae and aquatic plants, primary waste and residues, secondary waste, and residues, and succeeding generations of waste and residues are used. Thermal energy, liquid fuels, chemicals, bio-based goods, and pharmaceuticals could all be produced using biomass in economic processes (Abdullah and Azam, 2020).

Biological and technological advancements are critical for the future of the bioeconomy because it is built upon historical economic realities and has no clear path forward. Agriculture, processing, fisheries, and forestry the processing of biological raw materials made up the bulk of the bioeconomy’s preindustrial output. Today, the bioeconomy encompasses a broader range of activities than just resource management, including processing, industrial production, transportation, trade, and consumption, all of which are intertwined with scientific research and development. For example, to build a circular economic system, items produced from primary biomass in the bioeconomy transit through processing sectors, trading, and distribution channels, and finally reach final consumers as food or biomaterials (Gołębiewski, 2013). Creating and applying knowledge and innovation connects these three components: distribution, processing, consumption, and biomass production.

As a renewable resource, biomass is the basis for the bioeconomy’s activities, which include the production of food, feed, biofuels, and consumer goods derived from biomaterials. A wide range of technologies, such as biotechnologies, mechanical techniques, chemical processes, and physical processes, are critical in the conversion of biomass into more sophisticated and refined goods. There are three ways to look at the bioeconomy: microeconomically, mesoeconomically, and globally. Companies could specialize in a wide range of products and services associated with living organisms, both for ingesting and for use. Regions have the option of selecting bioeconomy as a top smart development specialization focus. There is great potential for innovation in the bioeconomy sectors and industries because they are built on technical knowledge, toned

TABLE 2 Agriculture shares of ASEAN economies.

Countries	Bioeconomy Sector Workers		Share in Total Number of Bioeconomy Workers in ASEAN economies	Agricultural Workers Shares in Total Bioeconomy Workers in ASEAN economies		
	2008	2017	2017	2008	2017	Change%
Malaysia	368,647.2	334,095.2	1.79	48.43	43.52	-10.14
Thailand	226,861.1	209,643.7	1.13	29.27	26.72	-8.71
Indonesia	966,586.1	847,766.5	4.55	74.18	75.73	2.09
Laos	348,809.8	216,809.8	1.16	52.99	42.62	-19.57
Myanmar	36,399.1	32,250.37	0.17	44.23	44.31	0.18
Philippines	401,444.8	386,167.3	2.07	34.50	36.03	4.43
Singapore	184,988.4	165,093.2	0.89	35.68	37.74	5.77
Vietnam	71,429.1	65,509.48	0.35	25.03	25.22	0.76

Asian Development Bank (2021). Author's Computations.

industrial technologies, and latent local knowledge. The use of resources sustainably and rationally, employment, and the production of domestic products are critical for a country's economy.

The value-added, employment, and turnover are depicted in Table 1, showing the 2019 bio economy of ASEAN. The value of the commodities' production which were being sold, linked to bioeconomy in ASEAN was being predicted at USD 2079 trillion in a year at second decade start of the twenty-first century, and it reached at USD 2400 in 2019. The Employment rate in the sector fell from 22 million in 2010 to 18 million in 2019, which accounts for 9-10% of the labor resources which are used during the economy. Agriculture accounted for almost 55% of the bioeconomy employment in 2010, along with the food industry which accounted for 20% and the forestry industry which accounted for ~14%. Therefore, it is possible that agricultural employment's unique effects on value added and also turnover are not considered to be fully accounted for in the industry's overall impact; a significant portion gets carried to other industries and becomes apparent in the food and other items production out of the agricultural sector. Rendering to the table, the agriculture segment still employs more than half of all the bioeconomy workforces, creates 28% of value added, and accounts for 16.5 % of the total turnover. In addition, food and beverage industries generate 50% of total bioeconomy turnover, 25% of total employment, and 38% of total value added. The chemical, plastics, and pharmaceutical industries employ a small percentage of the workforce and generate 8- 9% of the turnover and the value added. Within 2008 and 2019, the ASEAN bioeconomy's turnover increased by USD 141 billion, or 6.8%. The growth of food production drives the growth rate of bioeconomy's turnover, which was ~9.3%. The turnover of liquid fuels, plastics, pharmaceuticals, and

biochemicals demonstrated the faster growth rate. Singapore (18%), Vietnam (15%), and the Philippines were the most significant countries subsidizing the turnover of the ASEAN bioeconomy. Furthermore, Malaysia and Thailand were not at significant positions.

In addition, the sector's relevance for bioeconomy growth, as well as the quantity of human assets, must be assessed (Gladkykh et al., 2020). More than half of all bioeconomy workers are employed at the ASEAN level (Gladkykh et al., 2020). Agriculture's importance and potential vary depending on the size of the country. The number of agricultural workers as a percentage of all bioeconomy workers in a country reflects this variability (Waramit, 2012). In the analyzed years, the increasing share was the highest in Singapore, with a 5.07% positive change. Agriculture in each of these countries accounted for more than 60% of all workers in the bioeconomy. In the 10 member states of the ASEAN a decrease in this share could be observed (Table 2). The largest drop in employment in agriculture in 2008–2017 took place in Malaysia (10.14%), Laos (19.57%), and Thailand (8.71%). While, small number of employment in Vietnam (0.76%), Myanmar (0.18%), Indonesia (2.09), Philippines (4.43%) are increased. As a result, this mostly refers to new member states embarking on the path of development. According to Borucki et al. (2011), agricultural employment declines as the level of socioeconomic development rises. He observes that economic development first results in a decrease in the role of agriculture (as a primary sector), which is replaced by a growing role of industry (secondary sector), and then in a decrease in the role of agriculture and industry due to the growing importance of the services sector. Godlewska-Dzioboń (2020) agrees, claiming that agriculture is still an important sector of the economy. However, structural changes are characterized by high dynamics of employment,

production, and productivity in sectors that use advanced technologies, participate in the innovation network, and invest in intangible assets.

The decline in bioeconomy employment in Table 2 indicates a critical situation for the ASEAN economies. Various previous bioeconomies shares related strategies that were already developed. Prior to its 2017 revision, the ASEAN Bio-economy Strategy from 2012 advocated for maximizing the contribution made by this sector to the implementation of ASEAN's top policy priorities. Bioeconomy gives chances to meet development targets in areas such as sustainable usage of natural resources, economic efficiency, and competitiveness, as well as to ensure social stability, as was confirmed by this policy. An important part of the ASEAN economy is the bioeconomy, which employs more than 8.2% of the region's labor force and generates over USD 2.3 trillion in sales annually. In agricultural and remote areas, a large share of the new jobs predicted to be created by 2030 will be situated. There should be a strong emphasis on the creation of innovative new jobs by startups and other firms. Reduced conservatory gas tasks and a rise in the production and usage of renewable energy are both dependent on bioeconomy growth. According to current projections, bioenergy will make up 20% of the total generated energy capacity by 2020 and at least 32% of the total by 2030.

Research discoveries and innovation used to generate new and sustainable bio-based goods could help modernize and improve ASEAN's industrial base through a sustainable bio-economy (biofuels, bio-chemicals, bio-packaging). As a result, fossil fuels will be more easily replaced in a variety of industries and construction projects, and pharmaceutical, textile, food, and other businesses will have access to numerous new intermediates. Demand for industrial biotechnologies is expected to more than treble in the next decade, according to industry predictions. Creating a circular economy, where waste, leftovers, and rejections could be turned into usable products, will be a major priority. In the year 2030, 65% of municipal waste will be recycled, and 75% of packaging waste will be recycled. As a result, less waste will need to be landfilled, with the overall weight of waste reduced by 10% at most. Landfilling of segregated trash will also be restricted in the future. Reduced negative environmental impact of product life cycles will be facilitated by the growth of the circular economy. Families and small and medium-sized companies will have a significant impact on this. ASEAN governments should prioritize the protection, repair, and support of healthy ecosystems, as well as the encouragement and acceleration of the adoption of circular economic models. All tools and policies, as well as synergies with other ASEAN and national funds and instruments, comprising by way of the Common Agricultural Policy, and implementing supporting investment processes, must be made available as part of this strategy.

Different challenges and opportunities associated with transition to bioeconomy

The development of the ASEAN bio-economy concept has grown in popularity during the previous three decades. It remained a topic of discussion in the white paper which was released in the 1993 in which this issue was released. It underlined the necessity of knowledge-based investments, especially those in biotechnologies. According to the ASEAN Commission's findings in 2002, life sciences and biotechnologies provide the highest promise for attaining the 2000 Agenda's ASEAN strategic goals. New potential for bio-economy development was described by the ASEAN Commission in 2005, and the ASEAN Council outlined a 20-year bio-economy development plan in 2007 (Saardchom, 2017; Lewandowski, 2018). An ASEAN futures paper was linked between 2010 and 2012 to the sustainable bio-economy concept. Smart, sustainable, and inclusive growth is the goal of this plan in 2010. According to the 2012 report titled "Innovating for Sustainable Growth: A Bio-economy for ASEAN," sustainable strategies to utilize renewable biological sources in many economic sectors were offered. A research program published at the same time addressed the need for public monies to finance bio-economy and innovation research (Gladkykh et al., 2020). A bio-economy idea was developed between 2010 and 2012 as part of the ASEAN's overall strategy to solve today's concerns. One of the key strategic objectives is to move the economy away from its reliance on fossil fuels and toward the complete usage of the resources of renewable energy as well as materials through integrating the procedures of findings, civil societies, states, and economy (ETP, 2010).

- Accelerating fundamental knowledge, generating innovative technologies, and absorbing innovation. Stepping up efforts in research, education, and implementation will help. Enterprise growth and the building of network systems could both be critical in this situation.
- A framework for managing risks and implementing international collaboration must be developed and implemented.
- In order to ensure that progress continues, we need to lay a solid basis through developing research programs, encouraging innovation, and enhancing market efficiency.
- Getting the bio-economy concept widely accepted and socially supported for implementation and improvement throughout time.

An expert team from the "Standing Committee on Agricultural Research" (SCAR) existing a study on March 19, 2019, in which they indicated that bioeconomy has the ability to

report concerns like food safety, sustainable organization, and minimizing reliance on nonrenewable resources. Furthermore, additional bio-economy difficulties were identified, including the requirement for effective raw material control and continuous recycling from the source to the final waste treatment and disposal, as well as building hierarchies and implementing cascading principles in the biomass processing chain. Sustainability, innovation, and engagement in activities aimed at putting these ideas into action should all be emphasized in development strategies, according to all these elements. Consequently, the bioeconomy has emerged as a key topic of ongoing practical concern for several ASEAN bodies and has been associated with various national and community policies adopted by the Member States. A sustainable bio-economy for ASEAN improving the link between economy, society, and the environment was published in 2017 by the ASEAN Commission as a form of summary of the current successes and a hint of future development paths for various ASEAN bodies (ASEAN, 2018; Global Bioeconomy Summit, 2020).

The 2017 strategic review enhanced and expanded the transition to bio-economy field, which includes an October 2018 update (ASEAN, 2018). A bio-economy's new role will mainly demonstrate in the following categories: among the most essential means of attaining ASEAN developmental goals, procedure for enabling a bio-potential, economy's area for resource efficient bio-economy operation, the strategy for rapidly implementing local bio-economies inside of Member States, as well as understanding the environmental limits of bio-economy. The update to the Bio-economy Development Strategy in 2017 highlighted the significance of five initially stated goals: ensuring food security and nutrition, preserving natural resources responsibly, decreasing reliance on non-renewable resources, trying to mitigate global climate influences as well as modifying it, and enhancing ASEAN competitiveness *via* employment generation and development of new industries.

One of the initial strategic goals was achieved because agriculture, food manufacture as well as supply systems account for around 3/4 of total bioeconomy employment and about 2/3 of total turnover. As population trends, eating practices, and consumption patterns shift, a deficiency of rationale inside biomass management, as well as an increasing problem with waste and climate change, ensure that the long-term operation of these systems presents numerous challenges. Human resources must be rationalized while the transformation to sustainable and healthful eating, food production, and management systems that are low in resource consumption and circular in production is accelerated. Rural inhabitants will be able to earn more, and social exclusion will be reduced as a result of improved utilization of by-products or waste in bio-based product manufacturing. Sustainability in the use of natural resources is a top priority. Unfortunately, ecological degradation persists despite efforts to rectify it. Securing ecosystems that produce food and water is very important. They also need

to be strengthened because of climate change. The challenge of reducing gas emissions and removing carbon from the atmosphere is critical. The conservation of biodiversity and the improvement of the production of healthy ecosystems necessitate constant attention, notwithstanding the repression of some negative tendencies. For this, it is necessary to develop monitoring systems and forecasting of natural resource conditions (Abdullah and Azam, 2020).

To reach ASEAN's energy and climate commitments, it is essential to reduce reliance on nonrenewable resources, regardless of where they come from. This is generally done by utilizing biomass. Plants, plant fractions, manufacturing process leftovers, and garbage all go toward making biomass. It is possible to categorize biomass according to where it comes from (land or sea), how it is produced (forest or agricultural), what it contains (humidity, biochemical makeup), and how it will be used (energy, food, chemicals, materials). Food, industrial goods, and energy are all made with the help of agricultural raw materials, which are a primary source of biomass. Agricultural biomass output in the ASEAN region is estimated to 817 million tons of gasping substance, with major products making up 53% of that and residues making up 47%. Waste and primary products from agriculture, which is essential to the functioning of the food market, are being used to produce bioenergy, which is becoming increasingly vital. Biodiesel output has significantly expanded over the past two decades, reaching 156 billion liters in 2017. ASEAN agriculture's overall biomass production has increased marginally during the last two decades (Marcinek and Smol, 2020). The ASEAN region's energy mix is predicted to include more bioenergy sources by 2030. To achieve this, a few things will be necessary: the biotechnology sector must be strengthened, industry symbiosis must be implemented, and bioprocess innovations must be implemented in industries that are exposed to greening processes. Creating new innovative products in a range of industries should be performed as part of this circular economy to reduce trash generation generally (Abdullah and Azam, 2020).

The current generation faces major problems in justifying the influences of climate change as well as adapting to it. ASEAN also prepared significant assurances toward reducing greenhouse gas releases; this will only be achieved if a circular bioeconomy is implemented. Novel crops that improve soil carbon sequestration could be introduced to help achieve this goal. The ASEAN's competitiveness and job creation are two important policy objectives in the implementation of the bio-economy program. An important focus of this chapter is the implementation of innovations and the establishment of standards and regulations for the bio-based product market, as well as energy policy, energy prices, and carbon allowances. It is the goal of all of these initiatives to transform the ASEAN sector and make it more globally competitive. As a tool for enhancing regional policy efficacy, the bioeconomy could be used to promote the territorial cohesiveness of outlying regions

while also serving as a stimulant for the growth of local systems in rural areas. As a result, the bioeconomy is becoming an increasingly significant tool for achieving the needs indicated in the Strategic Plan for 2016.

Different action areas for sustainable transition of bioeconomy

The five objects that were engaged from the 2012 strategy, the bio-economy strategic plan was updated in 2018. The three main action areas that were added are as follows: strengthening and developing as well as scaling up sectors that use biotechnologies, fast placement of local bio-economies throughout ASEAN and trying to protect the ecosystem by a proper understanding of environmental limitations in bio-economy (Kamal and Dir, 2015). Institutional solutions and Horizon 2020 research, as well as initiatives to stimulate innovation, are the foundations for the above-mentioned proposed actions. To provide trade-offs between competitive biomass use and the effective achievement of various policy objectives, the undertaken plan covering several areas as well as policies relevant to the bioeconomy and facilitating coherence and synergies was designed on a global scale. With a budget of USD 100 million, six measures have been identified under the first area: formation of the targeted financial appliance in the procedure of bio-economy circular investment stage to implementing innovation with minimal risk; the establishment of a standard-setting system and Labe (Gladkykh et al., 2020).

Fast deployment of the local bio-economies inside of ASEAN associate countries was given top priority by the ASEAN Commission. Biomass generation and waste utilization have huge untapped potential in Malaysia and Thailand in particular (Saardchom, 2017). A lasting idea of sustainable and circular approaches for using and scaling up the bioeconomy will be provided, together with the agri-food, forestry, land, marine systems, aquaculture, and wood items sectors organized in various conditions, as well as processing industries. This will be done by the Commission through a strategic implementation program. In addition to rural and suburban settings, this production will also take place along the coast and in urban centers. It is now being prepared to launch five pilot projects, including one in a coastal area and four in agricultural areas, as well as one in 10 ASEAN cities and one in agroforests. The ASEAN transition bioeconomy policies promote the growth of a rural bioeconomy that benefits all residents. Cities will place a high priority on waste management utilizing emerging bio-economy technology. Numerous initiatives will be pushed to engross the carbon dioxide within the soils and reduce greenhouse gas emissions in the cattle industry, as well as reduce fertilizer use. "Living labs" will be developed as part of the Horizon 2020 initiative for testing and providing data for biotechnological advancements as well as information for

study. Systemic, cross-cutting bioeconomy approaches demand novel educational forms and practical expertise acquisition in numerous stages of upper education, as well as the establishment of ties between the scientific community and business practice. Ultimately, this must lead toward a greater understanding of ecological possibilities, as well as limits of bioeconomy, and also establishment of a suitable monitoring system, as well as more data collecting and analysis, and themed databases of information.

Conclusion

As an industry, agriculture is always changing due to both internal and external influences. These influences originate both locally and globally while also having an impact on community policies and global processes. In addition to agriculture's shrinking economic role, the rural economy is becoming stronger with non-agricultural sectors, as well as constant business progress and technological development. The rural economy is becoming more dependent on collaboration through other agroindustry areas besides agricultural policies to provide protection as well as financial support. The social and family aspect of agriculture must be protected, rural degradation must be prevented, the natural and cultural environment's values preserved, and international competitiveness strengthened in light of these changes. Agriculture development and rural area functioning in ASEAN countries have become canonized according to sustainable development concepts that ensure a balance among social, environmental, and economic policies. For these consequences, the transition of bioeconomy has become a major part of the survival of any economy because it has been mentioned in the literature that bioeconomy agriculture system is a very important part of the survival of any country. It has been found that ASEAN agricultures sectors had been contributing a major part in the development of value-added products and employment. Moreover, the analysis results had also shown that transition of bioeconomy is considered to be an important concept in the growth of agriculture, forestry, agribusiness, and various other sectors producing and for use of the bio-based raw materials. It was further found that for getting a real bio economy opportunity, it is very essential that there should be a proper national and regional strategy for the development of bioeconomy in place and for the development of a proper design and proper management system at every level of sectors, enterprises and provincial systems. On the other hand, it is also found that the contribution of agriculture in the employment perspective had been increasing in the various countries of ASEAN economies except for Malaysia, Thailand, and Laos while the other seven countries of ASEAN economies have had a significant role in the development of employment in the agriculture. Therefore, sustainable development could be implemented using a wide range of ideas and methodologies.

Therefore, the idea of the transition of bioeconomy holds enormous promise. The findings of this study contribute to the long term vision of the European Commission by completing the transformation of the agriculture sector into a bioeconomy. However, bioeconomy transition is limited because of the poor economic situation in ASEAN region.

In the theoretical sphere, it has been developed for over two decades and in the practical preparation and implementation for over 15 years, In addition, it has evolved into a brand new analytical and intellectual concept, as well as a multi-sector management area focused on biomass and different contemporary processing technologies, particularly biotechnologies with advanced materials and technology that makes usage awareness and collaboration with other parties (Chichaibelu et al., 2021). According to the bioeconomy, we should make the switch from a production-based economy to one that relies on renewable resources and environmental stewardship. A sustainably circular bioeconomy, focused on resource reuse, particularly of renewable resources, while avoiding waste output and negative externalities, is a particularly promising form of economics.

The growth of the transition of bioeconomy has the potential to give agriculture and other economic sectors with various environmental, social, and economic benefits. Benefits to the environment may include better use of resources, less wastage of materials and energy, and less emissions of pollutants and waste. Significant social benefits include greater employment, the activation of cross-sector cooperation, and a higher level of social need fulfillment. A reduction in non-renewable raw material usage, as well as lower input prices and energy savings, and improved production cycle management are all economic benefits. The growth of these production systems may also be plagued by problems and restrictions of a technological, organizational, social, or political nature. Competitors in building specialized production systems may face increased competition for resources (land, technology, bio-components, competencies), and new and unanticipated environmental problems may emerge. The introduction of new manufacturing systems demands the formulation of appropriate strategies, policies, and action plans, all of which must be supported by enough information. The ASEAN Bio-economy and Circular Economy Development Strategy was developed in advance and is regularly updated. National bio-economy strategies and plans have been created in dozens of countries around the world (Biber-Freudenberger et al., 2020).

Theoretical implications

The current study has numerous practical implications with a lot of contributions to the emerging literature on bioeconomy. This study explains the significance of transition in bioeconomy transformation from a typical economy with respect to economic, social, and environmental aspects in the

lens of transition theory (Kirk, 1996). This study contributes to the literature by presenting the ideas and ways of fossil fuel, biomass, and wastage transformation from a typical economy into a bioeconomy, specifically in industrial and agribusiness. This study elaborates the impact of agriculture and industrial business, forest areas, fossil fuel, and wastage on development in energy production through transition management theory (Foxon et al., 2009). Previous studies focused on the specific contribution of agriculture in bio-economic development. However, the analysis of the current study has a great impact on the agri-business and industrial sector on the development of bioeconomy transition, specifically in the ASEAN countries with new contributions in the emerging literature. Hence the current study also has an empirical significance. This study has a significant contribution to the world economies irrespective of global market and industry location. Findings also provide a guideline for issues related to population and limited sources with respect to quantity and quality that ultimately enhance economic and domestic activities. By bioeconomy transition, the ASEAN region can balance their climate and environmental stability in their concerned regions. For this purpose, the current study provides recommendations to academic scholars for future research and to help policymakers in developing strategies and regulations related to transition in bioeconomy. In addition to its current study also provide recommendations to government agencies, environmental controlling bodies, and economists in efficient policy-making for sustainable economic development. This study also provides the guidelines for bio-economy development with the assumptions of protecting the global climate, environment, and natural resources while producing wastage and fossil fuel. Moreover, the findings also explain the ways of fossil fuel recycling by transitioning to bio-economy.

Future recommendations

Based on the above findings, the study could contribute to help to other economies to know about the importance of bioeconomy transition that could help to increase employment, value added products, and turnover. This increase could help any economy along with social and economic perspectives to decrease the poverty level and unemployment. Moreover, the study could also help researchers to know about the importance of this topic as a new area of research in the future. The findings of this study could also help all agriculturist countries where the main area of contribution to the economy is agriculture for their long-term survival. Along with these contributions, the study still had some limitations. The study was limited to the ASEAN economies which means that most of the countries are developing economies, while there are various other developing economies that have agriculture as the backbone of their contribution. Therefore a future study could be done on other developing or Asian economies to know about

the importance of bioeconomy transition. Moreover, the study was limited to limited data while a future study could explore along with empirical findings results which could increase the generalizability of the study.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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