doi: 10.17221/78/2016-AGRICECON

Bioeconomy as a new S-curve for Thai economy

Narumon SAARDCHOM*

National Institute of Development Administration (NIDA) Business School, Bangkok, Thailand

*Corresponding author: narumon_saardchom@yahoo.com

Saardchom N. (2017): **Bioeconomy as a new S-curve for Thai economy**. Agric. Econ. – Czech, 63: 430–439.

Abstract: Thai economic growth lags behind all other ASEAN countries because its export dependence along with the political and economic vulnerabilities. With the growing bioeconomy worldwide, Thailand needs a clear bioeconomy roadmap as a new growth engine for its economy. Four potential clusters to build bioeconomy in Thailand include the bioenergy, bio-based industry, bio-food and bio-agriculture, and bio-medicine and health. There are roadmaps for only the first two clusters. The paper discusses the potential bio-based products for the bio-food and bio-agriculture as well as bio-medicine and health and proposes the use of the Pracharath strategy to build bioeconomy in Thailand with the main objective of creating the sustainable economy. Since a smart community is a key driver for the sustainable economy, five steps to smart community proposed in the paper will immune communities in the rural area of Thailand, make them self-reliant, and remove the dependency culture.

Keywords: biotechnology, sustainability, private-public partnership (PPP)

What is bioeconomy?

Bioeconomy covers all economic activities derived from the commercial application of biotechnologies to healthcare, industrial, agriculture sectors, and associated service areas that develop, produce, process, handle, or utilize any form of biological resources, such as plants, animals, and microorganisms. The bioeconomy is not a new industry. It is a combination of several primary sectors and end product markets, which span numerous subsectors, such as the forestry, fisheries, plant and animal breeding, food and beverage, paper, leather, textile, chemicals, pharmaceutics, and renewable energy sectors. Biotechnology innovations also provide growth opportunities for the existing sectors like the commodity production, IT, automotive, construction, tourism, and other service industries.

Changing consumer behaviour is a key to the bioeconomy development. Since biotechnology offers solutions for many of resource-based problems, the concern over the scarcity of non-renewable raw materials will lead to an increasing usage of the bio-based technology and products in the economy. Thus, typical features of the bioeconomy include the use of renewable, bio-based natural resources, clean technologies, and efficient recycling of materials. The application of biotechnology to the primary production, health, and industry could result in an emerging bioeconomy where the biotechnology contributes to a significant share of the economic output.

Bioeconomy benefits the society by relying on renewable natural resources to produce food, energy, products, and services. The bioeconomy will not only reduce our dependence on the fossil natural resources, but it will also create a new sustainable economic growth and jobs. The bioeconomy strategy has been used in several countries to provide strategic directions for achieving a better economic growth and employment and an increased well-being.

A smart exploitation of natural resources and high added value products and services will both secure the competitiveness of the existing industries and create new business opportunities from new products and materials. According to Van Haveren et al. (2007), the bio-based products, made from biological materials in total or in some important part derived from living organisms, have played an important role in the emerging bioeconomy in the near future. Langeveld et al. (2010) define the bio-based products to include products from a high value added fine chemicals (e.g. pharmaceuticals, cosmetics, food additives, and vaccines etc.) to high volume materials (e.g. enzymes, biopolymers, biofuels, and fibres etc.). Biotechnology is required to achieve advanced market competeiveness and strengthen the agricultural sustainability by increasing the quality, productivity and innovation while reducing costs. Meeting these objectives

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requires not only the political and social efforts, but also an intense research and innovation to create the knowledge-based competitive bioeconomy.

Although bioeconomy can create the aforementioned benefits, the opponents of the bioeconomy argue that industrial approaches to ensure the energy security by replacing the fossil energy with biomass can be dangerous for the biodiversity and ecosystem. Bioeconomy policy focusing only on increasing the sustainable production of the biomass and relying on the ecosystem services could result in large losses of the biodiversity because of the dramatic change in land use.

Furthermore, an increased demand for land and the competition with food crops may result in the socio-economic issues affecting employment, economic growth, food security, and prices of agricultural commodities and food. To minimize the potential biodiversity impact, the land demands for the agricultural food production and biomass production need to be reconciled with a sophisticated geographical analysis covering the land use, characteristics of habitat, and sensitive ecosystems.

This article studies the potential bio-based products for the bio-food and bio-agriculture as well as the biomedicine and health and the political approach to build bioeconomy in Thailand with the main objective of creating the sustainable economy.

Thai economy at risk

Thailand is an export oriented economy with manufacturing as the most important sector and accounts for 34% of GDP. The GDP annual growth rate, shown in Figure 1, reported by the Office of the National Economic and Social Development Board (NESDB) of Thailand averaged 3.61% from 1994 to 2015, with the peak of 19.10% in the fourth quarter of 2012 and a record low of –13.90% in the second quarter of 1998. As exports have been weakening throughout 2012 and 2013 due to the economic downturns in the US and European countries, the domestic and public consumption became the main source of the economic expansion. In 2014, the decline in agricultural products had further dragged the domestic consumption. In the third quarter of 2015, Thailand's GDP expanded by only 2.9% from 2014.

The economic growth of developing countries in East Asia is expected to slow down from the effects of the China's economic rebalancing and the US policy of the interest rate. The Chinese economic growth is expected to further shrink in 2016 and 2017. If the Chinese economic growth were worse than expected, the effects would impact the rest of the region through both the trade and financial volatilities. Even so; according to the World Bank, the GDP of the countries in the East Asia-Pacific region is expected to grow as much as 6.5% in 2016, while it is estimated by the World Bank to grow by only 2.5% for Thailand. The World Bank underestimated the Thai economic growth by roughly 1% less than the NESDB estimate, because the World Bank was not confident about the estimated Thai public spending on the infrastructure projects. Moreover, the World Bank asserted that the economic stimulus packages launched by the government in late 2015 were only for the short-term results. Outdated technologies are

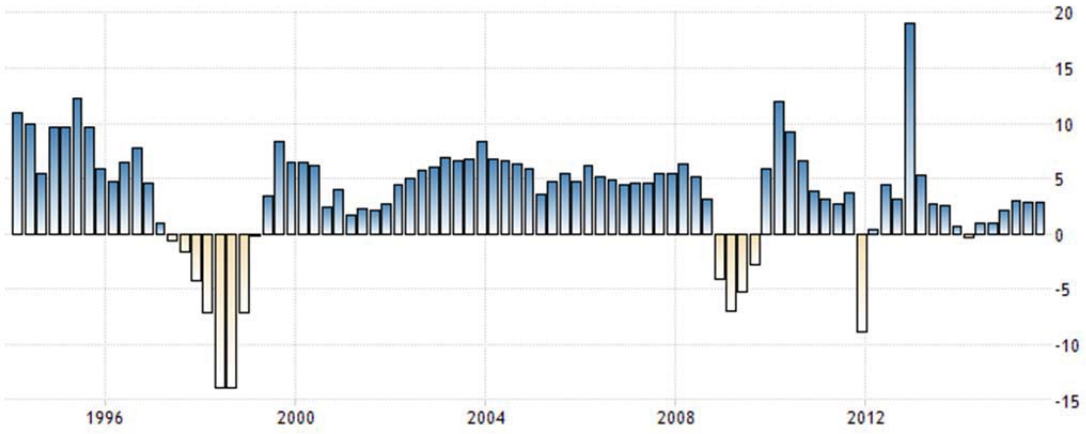

Figure 1. Thailand GDP annual growth rate

Source: NESDB, Thailand

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the main reason that caused the Thai export to lose its competitiveness in the global market.

Thai economic growth will lag behind all other ASEAN countries because its export dependence along with the political and economic vulnerabilities leaving Thailand directly exposed to the global and Chinese economic slowdowns. The Thailand's exports are being dragged down by the decline in the Chinese investment spending on the property and manufacturing capacity, which reduces the demand for industrial products and commodities. The Thai exports to the ASEAN countries also shrank due to the depreciation of their currencies as a result of the capital outflow responding to the US Federal Reserve's interest rate increase.

The new S-curve

Apart from the export deterioration, the healthy economic expansion is not possible for Thailand because it is no longer one of the top destinations for investors. To achieve a new S-curve of the economic expansion shown in Figure 2, the cabinet approved on 17 November 2014 the plan to improve five existing industrial clusters and to promote five new industrial clusters, among which there are biofuels and the biochemical cluster. The Thai government hopes that this plan will be able to boost the Thai GDP growth from its typical 3% per year to at least 5% per year.

The Thai government's effort is in line with several European countries' political and economic agenda to expand the economy via the bio-based markets. Figure 3 shows the expected new wave of the economic development as a transition from the fossil economy to the bioeconomy strategy in Finland (Finland' Ministry 2014). Bioeconomy is of an interest not only because of the increasing environmental awareness and a more stringent legislation but also because of the estimated scarcity of raw materials from the growing demand.

It is expected that, by 2030, the world will need by 50% more food, by 45% more energy, and by 30% more water than today (UN 2012). Ultimately, the demand for the bio-based products will increase. According to the European Commission report (2012), the EU 28 bioeconomy is worth over 2 trillion euro and employing 25.1 million people in the EU Bioeconomy. These figures are expected to grow dramatically with the strong EU support and international cooperation.

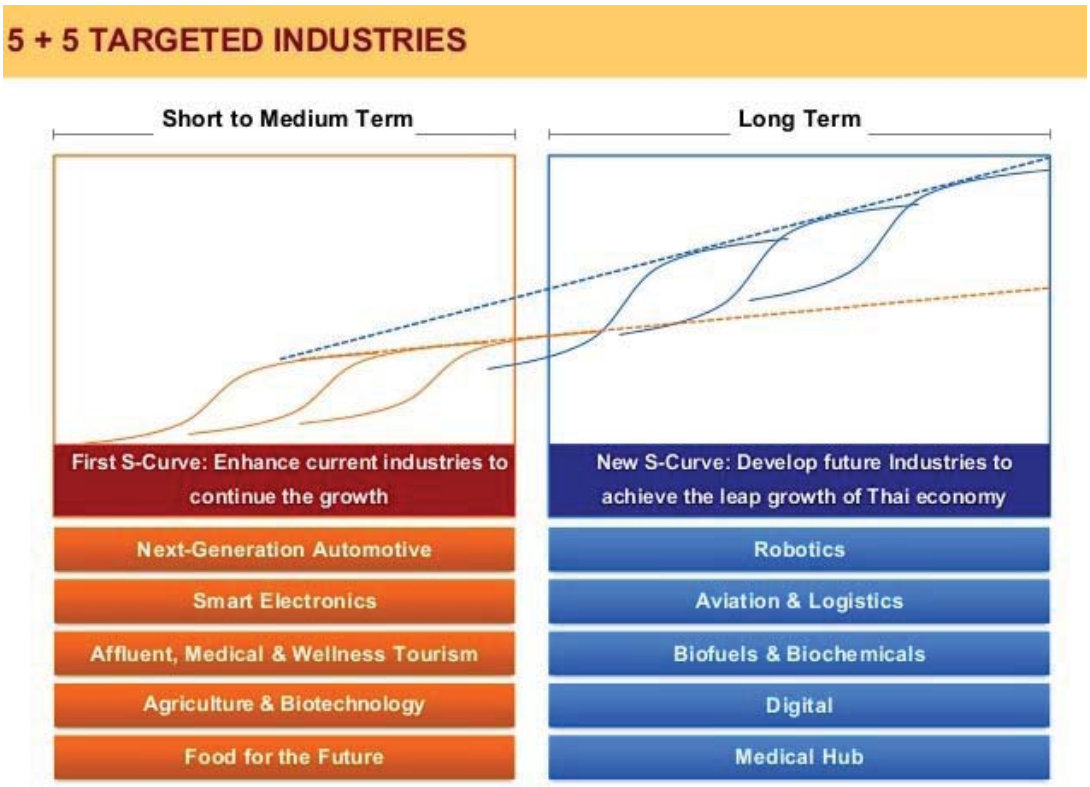

Figure 2. Thailand's new engine of economic growth

Source: Presentation by the Minister of Industry on 23 November 2015

doi: 10.17221/78/2016-AGRICECON

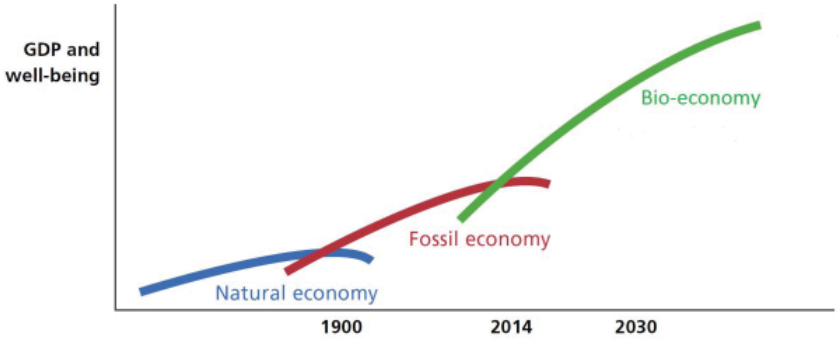

Figure 3. New wave of economic development

It is worth noting that the bioeconomy cluster has become a leading cluster in Germany.

In June 2015, the US Agriculture secretary, Tom Vilsack, announced in the USDA report (2013) that the market size for the bioeconomy in the US is approximately 369 billion USD, employing 4 million workers. The 2014 US Farm Bill created additional opportunities for the growth in the bioeconomy, supporting the Obama Administrative effort to develop a new rural economy and promoting the creation of sustainable jobs. The bioeconomy job multiplier is 2.64, meaning that for every 1 bio-based product job, 1.64 more jobs are created in the US.

Thailand has both the agricultural and industrial strengths that could gear towards the bioeconomy. The agricultural production accounted for an estimated 9% of the Thai GDP and 40% of the population works in the agriculture-related jobs (Luedi 2016). A clear bioeconomy strategy can enhance the competitiveness of the agricultural sector and promote the sustainable rural economy by creating sustainable jobs in rural areas.

Bioeconomy-related policy in Thailand

The National Centre for Genetic Engineering and Biotechnology (BIOTEC) was established in 1983 under the Ministry of Science, Technology and Energy. On 30 December 1991, the BIOTEC later became a part of the National Science and Technology Development Agency, operating outside the normal framework of civil service and state enterprises to support and transfer technology from research to industry, agriculture, natural resources, environment, and consequently the social and economic well-being of Thai people[1]. The BIOTEC research covers both the laboratory and policy research.

The first bio-related strategy in Thailand is the National Biotechnology Policy Framework for 2004 to 2011. The National Science Technology and Innovation Policy Office (STI), the National Centre for Genetic Engineering and Biotechnology Office (BIOTEC), and the National Science and Technology Development Agency (NSTDA) together work on the second version of the National Biotechnology Policy Framework for 2012 to 2021, aiming at providing the concept of biotechnology applications to the medical, agricultural, aquatic, and industrial fields. However, the terms bioeconomy or bio-based economy were not used in the framework.

Figure 4 shows the framework's expected milestones, which are more conceptual in many aspects. For example, the food supplement products from Thailand would be well received by the global markets by 2018, or the international venture capital would invest in Thai bio-business by 2019.

A Bioplastics Roadmap was proposed by the National Innovation Agency (NIA) and approved by the cabinet in 2008 to promote the bioplastics sector as a potential bio-based industry. The context of the bioenergy was addressed in the Alternative Energies Development Plan (AEDP: 2012–2021), developed by the Department of Alternative Energy Development and Efficiency (2015) in the Ministry of Energy, to support the bioenergy and biofuels based on the plentiful agricultural feedstock including by-products and residues. Based on the AEDP, biomass accounts for approximately 80% of the Thailand's renewable energy, which is about 10% of the Thailand's total energy consumption. By 2021, the renewable energy is expected to grow to 25% of the total energy consumption in Thailand.

The objective of the National Biotechnology Framework is to make Thailand a centre of biotechnology in Asia by motivating the private-sector invest-

[1]http://www.biotec.or.th/en/index.php/about-us/overview

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ment in the R&D, technology transfer and application. The Thai government has supported the innovative biotech projects by improving the R&D infrastructure and providing tax incentives. The framework targets agriculture and food, medicine and healthcare, and bioenergy. Given the concern over food security, the framework clearly emphasizes that the expansion of bioenergy and biofuel production must not be in conflict with the food production. Even so, the food security and other concerns have caused a significant change of the renewable energy policy ever since the 2014 coup, resulting in a revised AEDP for 2015 to 2036. Figure 5 shows the continuum of the Thai alternative energy development plan. In the latest version, the new target for the usage of renewable energy was increased to 30% of the total energy consumption by 2036.

Potential clusters

The National Biotechnology Policy Framework (2012–2021) identified four strategic sectors almost similar to the bio-product value pyramid shown in Figure 6. These sectors include the bioenergy, bio-based industry, food and agriculture, and medicine and health. However, the framework focuses on the potential types of biotechnology to be applied in each of these sectors rather than on the strategic plan for the commercialization with measurable outcomes.

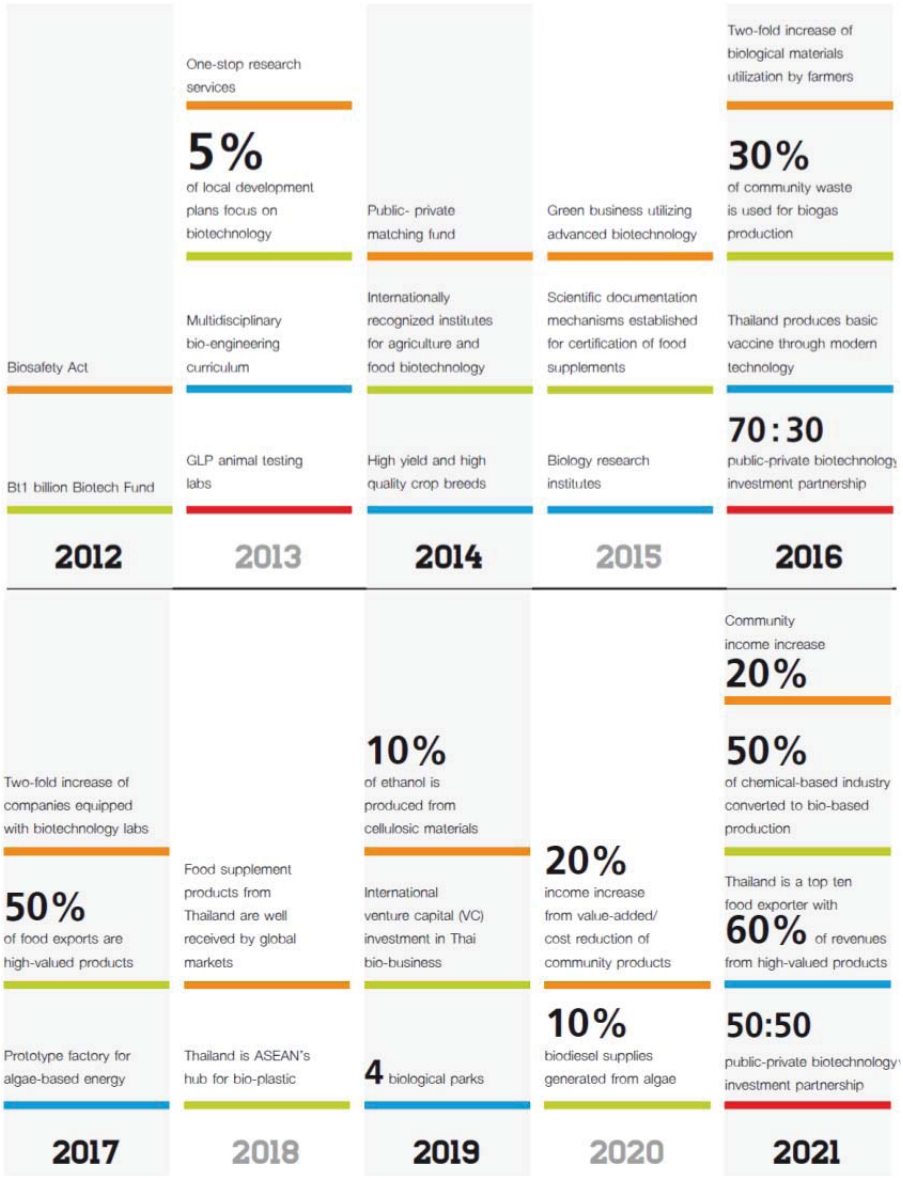

Figure 4. Milestones of the National Biotechnology Policy Framework (2012–2021)

Source: National Biotechnology Policy Framework (2012–2021)

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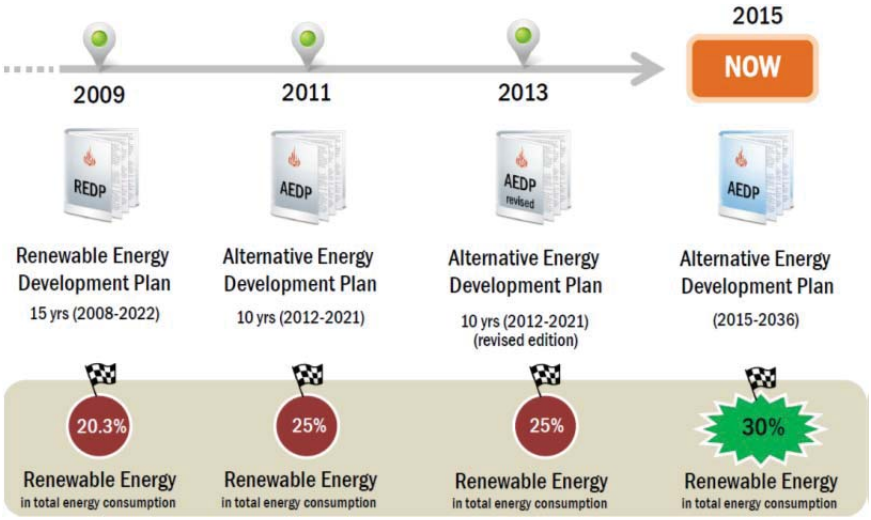

Figure 5. Continuum of the Thai Alternative Energy Development Plan (AEDP)

Source: Department of Alternative Energy Development and Efficiency, the Ministry of Energy (2015)

The AEDP (2015–2036) is the policy for bioenergy for the bottom of the pyramid, while the Bioplastics Roadmap (2008–2015) is to promote the bioplastics sector as the most potential sector in the biochemical and biomaterial industry. There is no bioeconomy-related policy for the top two layers of the pyramid that could create even a higher economic value.

Thailand has the competitive advantage in the food and agriculture cluster, but Thailand has no clear roadmap for this cluster to respond to the increase demand in the bio-based food and agricultural products. The major crops in Thailand include rice, para rubber, cassava, oil palm, sugarcane, and corn. In the first half of 2015, the agricultural sector declined by 5.3% because of a decline in the main agricultural production from the drought and a decline in agricultural product prices in the global market. According to the Office of Agricultural Economics, agricultural products accounted for only 8% of the exports in 2015, compared to 11.7% in 2011.

In addition, the NEDSB Economic Report in August 2015 shows that the Agricultural Product Index, the Agricultural Price Index, and the farm income dropped by 6.1, 6.5, and 6.1%, respectively. Without the biotechnology implementation in the agricultural and food sectors, the Thai agricultural and food products will soon lose its competitiveness in the global market. This paper proposes a potential bio-based products derived from the major crops as shown in Table 1.

At the top of the bio-based product pyramid, the pharmacy and health derived from biotechnology could generate the largest economic value. The Thai government has set an objective to make Thailand

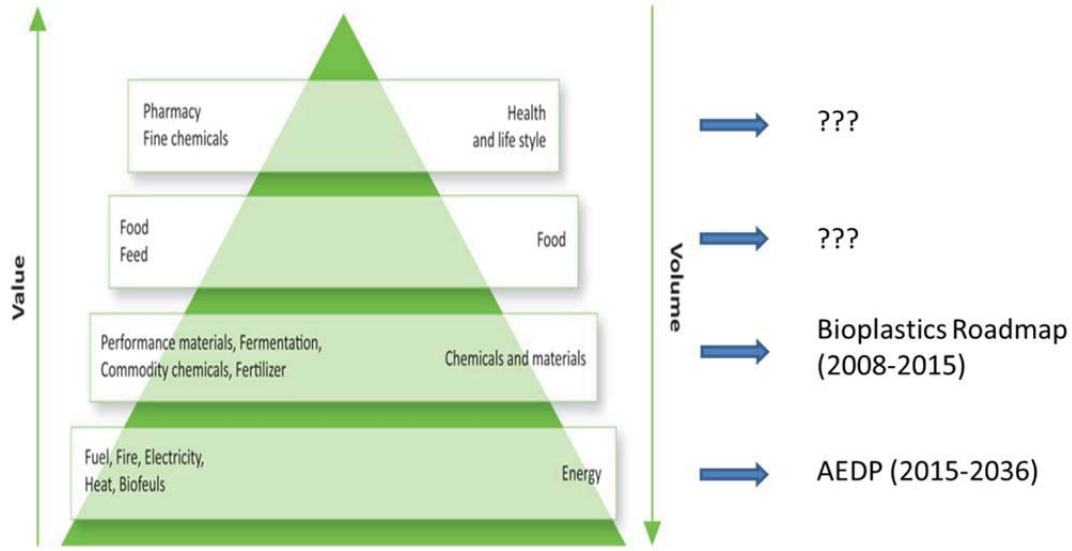

Figure 6. Bioeconomy-related policies in Thailand

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Table 1. Potential bio-based products for the food and agricultural cluster

Major crops	Production* (tons) in 2015	Bio-ingredients and Bio-food	Bio-material and Biochemical
Rice	23 009 340	Rice enzyme	Bioplastics
Para rubber	4 466 063	Para rubber seed meal	Foam rubber Para rubber seed oil
Cassava	32 357 741	Cassava starch Lactic acid	Bioplastics
Oil palm	11 015 872	Palm wax	Cellulose Phosphate
Sugarcane	116 712 776	Yeast extracts	Industrial sugar Biodegradable packaging
Corn	4 610 992	Organic acid Amino acid Feed supplements	Bioplastics

*Office of Agricultural Economics, Thailand, http://www.oae.go.th/ewt_news.php?nid=13577

the medical hub of Asia by improving the medical facilities and technologies and increasing the number of the internationally certified medical services and medical professionals. The medical hub policy focuses largely on the medical tourism to generate the economic value from patients who are at the very end of the medical supply chain. Recently, with a significant number of the internationally accredited medical facilities and a rising number of international patients, the Ministry of Public Health was confident to implement the Medical Hub Policy (2012–2016) to promote investments in the medical science research and the development of medical devices.

The Thailand Board of Investment (BOI 2014) offers incentives such as the corporate income tax exemption, and duty concessions on machinery and raw materials for a wide range of activities related to the medical sector such as the manufacture of the medical food and the manufacture of the medical equipment. Non-tax incentives include the right to own land and the facilitation regarding visas and work permits for the expatriates. In addition, the retirement homes and care centres are eligible for the exemption or reduction of the import duty on machinery provided that they achieve the standards set by the relevant government agencies. Apart from the incentives from the BOI, the Revenue Department provides 40% deduction on the depreciation of machinery and 200% deduction on training expenses.

Even with the aforementioned incentives, a major part of the medical hub policy outcome is only from the medical tourism, which generates a higher revenue for the private hospitals in Thailand, but leaves a negative impact of the higher healthcare cost for the Thai patients. The medical tourism policy successfully attracts a growing number of foreign patients from the high income countries. According to the Public Health Ministry and the Kasikorn Research Centre, 2.5 million international patients received medical treatment in Thailand in 2012, generating up to THB 140 billion in income. Since these medical tourists are willing to pay higher medical expenses than the usual medical fees in Thailand, private hospitals make a hefty profit by increasing the treatment fees. Although the rising healthcare costs have come to the government's attention, the government's effort to control the medicine prices and treatment fees ignores the effect of the medical tourism. Private hospitals could raise their medicine prices and treatment fees without caring about the Thai patients because they continue to enlarge the proportion of foreign patients from rich countries in their portfolio.

Many healthcare economists in Thailand have urged the government to reconsider the medical hub policy. Anchana Na Ranong and Viroj Na Ranong (2011) suggest the government to implement a medical tax on medical tourists to lower their purchasing power which would force the private hospitals to cut their treatment fees. They stated that without the medical tax on the medical tourists, it is unfair for the Thai taxpayers because the medical system and medical training in Thailand are mostly subsidized by the tax money. The medical tourists have taken advantage of the high standard medical treatment in Thailand without making any contribution to support the Thai medical system.

Moreover, private hospitals in Thailand can charge ridiculously high medicine prices, sometimes as high as 300% of the retail price at the pharmacy, because Thailand does not have the central price for all drugs sold at hospitals and pharmacies. Preyanan Lorsermvattana, the Thai medical activist and President of Thai Medical Error Network, suggests

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Table 2. Potential bio-based medical businesses in the medicine and health cluster

Healthcare			
Alternative medicine	Molecular screening	Bio-similars	Drug Discovery
Stem cell therapy	Early disease detection and mitigation	Cheaper medical treatment	Higher efficiency and success in drug discovery
Herbal medicine	Personalized medicine	Improved versions of original drugs	Drug discovery for tropical/ neglect disease

that the government should impose a price control system to limit the medical fees at private hospitals to a fair price and to regulate the medicine price to at most 15% more than the medicine price charged at the government hospitals.

However, the Medical Council Secretary-general Dr Samphan Komrit believes that the medical hub policy has brought a very profitable outcome for Thailand, generating more than THB 1 billion in profit for the country annually. He disagreed with the proposed price control policy claiming that it is difficult to set the price of each medicine because the hospitals have to pay not only for the cost of the medicine but also for the management and service costs[2].

Whether the medical hub policy should be revised, the policy for the medicine and health cluster should cover the whole medical supply chain from the biopharmaceutical development to the biomedical treatment, not just the medical tourism, to be competitive in the growing bioeconomy. Table 2 shows the potential bio-based medical products and services in Thailand. Many of these businesses are already on its way, but tangible government supports for these potential biomedical businesses are required.

Political approaches

The current Thai government promotes the People's State strategy referred to as the Pracharath strategy, which was largely criticized as only a rebranding of the political populism strategy. The key difference between populism and the Pracharath is that the latter policy aims to build the rural sustainable economy and to remove the dependency culture among the poor. To accomplish such objectives, the government and the private sector must work together to create a sustainable rural economy. The Pracharath strategy is, in fact, almost similar to the Private-Public Partnership (PPP) strategy implemented in the EU -Bioeconomy under the Bio-Based Industries (BBI) Joint Undertaking[3] with Euro 3.7 billion Public-Private Partnership between the EU and the Bio-based Industries Consortium operating under the Horizon 2020. A European public-private partnership is needed as a mechanism to pool resources from the public and private sectors to create a platform for the leverage of a further investment in the bio-based industries. With an addition of people in the private-public partnership, the Pracharath strategy is shown in Figure 7.

Thailand supports the development of biotechnology through establishing a public-private research matching fund for the demonstration plants and allowing 300% annual deductions for the research and technology development expenses. While research is very important for creating bioeconomy in Thailand, the nation's education plan on biotechnology should not be taken lightly because it is where the human capital for it originated. The fact that the biotechnology education has not been addressed in any bio-related policy in Thailand or under the Ministry of Education can become a big obstacle for the government to pursue its objectives in the biotechnology research and innovation.

Bioeconomy can be successful and sustainable with the Pracharath strategy by building a smart community

Figure 7. The Pracharath

[2]http://www.nationmultimedia.com/national/Overpriced-medical-care-could-bring-down-Thai-heal-30262812.html
[3]http://ec.europa.eu/research/participants/data/ref/h2020/other/legal_basis/jtis/bbi/bbi-establact_en.pdf

doi: 10.17221/78/2016-AGRICECON

in the rural area of Thailand with the education embedded in the process. The smart community will not only serve as a foundation for the Thai bioeconomy, but will also immune the community in rural area with the non-dependency culture.

This paper proposes five steps for building a smart community. The first step is for the government to support the renewable energy project for a community through the joint venture between the private sector and people in the community. The community power plant will not only bring sustainable energy supply for the community but also create jobs for farmers to grow energy crops and jobs for skilled labours working in the power plant. The second step is for the government to lay out a clear bioeconomy roadmap for Thailand and to support establishment of networks among the government, private companies, financial institutions, educational institutions, and the regulator for the knowledge and technology transfer. In the third step, the Pracharath strategy should be implemented not only for the power plant, but also to the bio-related commnuity's small and medium enterprises (SMEs) covering the whole supply chain of each major crop to maximize the total economic value generated from the biotechnology. After that, the fourth step should be to improve the living standard of the community by implementing the biotechnology and a more efficient management in the community. Finally, in the last step, the government should create the knowledge-based society by supporting the talented individuals for a higher education and providing the knowledge transfer platform within a community and among communities. The government should also emphasize its support for the venture capital for the business in the smart community to be able to enter the global market of bioeconomy.

CONCLUSIONS

The Thai government is aware of the importance of biotechnology, but the scope of the National Biotechnology Policy Framework (2012–2021) mainly covers the types of biotechnology to be implemented for each potential cluster without a detailed analysis for the potential bio-based products and how to commercialize them to create the economic value. Without a clear roadmap toward the bioeconomy, Thailand will soon lose its competitiveness in the growing bioeconomy.

Four potential clusters to build the in Thailand include the bioenergy, bio-based industry, bio-food and bio-agriculture, and bio-medicine and health. Although the current government has included a part of the last two clusters into its new 5 clusters to achieve the new economic S-curve, a more study needs to follow to identify the potential opportunities. Many other potential bio-based products and businesses are yet incorporated into the plan. There are roadmaps for only the first two clusters which are the bioenergy (AEDP: 2015–2036) and the bio-based industry (Bioplastics Roadmap: 2008–2015). This paper discusses the potential bio-based products for the bio-food and bio-agriculture as well as the biomedicine and health.

The political approach to successfully create bioeconomy in Thailand is the Pracharath strategy that the current government uses as the political agenda to build a sustainable economy in rural areas and to remove the dependency culture resulting from the former political populism agenda. The Pracharath strategy is well suited for creating a smart community.

The five steps to a smart community proposed in this paper will strengthen the communities in the rural areas of Thailand, make them self-reliant, and remove the dependency culture. These five steps comprise of (1) supporting renewable energy project and energy crop farming for a community through the joint venture between the private sector and the people in the community, (2) finalizing a clear bioeconomy roadmap for all four potential clusters and establishing networks among the government, private companies, financial institutions, educational institutions, and the regulator for the knowledge and technology transfer, (3) the Pracharath strategy is implemented to the related community's small and medium enterprises (SMEs) covering the whole supply chain of each major crops, (4) improving the living standard of the community by implementing the biotechnology and a more efficient management in the community, and (5) creating the knowledge-based society by supporting talented individuals for the higher education and provide the knowledge transfer platform within the community and among communities.

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Received March 3, 2016
Accepted August 23, 2016