Upgrading along Value Chains: Strategies for Thailand's Functional Milk Industry

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Abstract

This paper is "Practical Experience Analysis" which aims to analyze critical obstacles hampering the growth of the functional milk industry and suggest recommendations to overcome those obstacles. The Sectoral Innovation System (SIS) along value is crucially analytical tool which can be used as a framework of interaction linkages among stakeholders along value chain in functional milk industry. This can be found that restriction in regulation of milk disinfection process, difficulty of dairy entrepreneurs for health claim approval of functional food & beverage and lack of intermediary between entrepreneurs and certified units for certification of functional foods and milk are major causes that needed to be resolved. Consequently, policy recommendations are proposed to tackle the problems occurring throughout the value chain. For the upstream, a collaborative platform using the quadruple helix model is proposed in a pattern of effective dairy cooperatives. For the midstream, regulation issue of new process, extended shelf life (ESL) milk or prolonged milk are necessary which can be extended the global market opportunity. For the downstream, mechanism of intermediary between entrepreneurs and certified units can be assisted in certified process of functional milk, especially a process of "Health claim" approval.

Key Words: Thailand; functional foods; functional milk; supply chain; Quadruple helix; Extended shelf-life (ESL) Milk; intermediary

Introduction

Food industry is considered one of the crucial industries for high economic growth in Thailand. It accounts for 22.22% of the country's GDP in 2018. Thailand is also one of the largest leaders of food exports in the world. At the present, Thailand is the 2nd ranked of Asia for food exporters of US$ 16.7 billion[1]. The significant reasons are included with a lot of natural resources from 50% of country's area for agricultural sector, high-skilled labor forces with low costs. Furthermore, approximately 9,000 companies for food processing are settled in Thailand which

[1] Thailand Board of Investment: BOI. (2017). *Thailand: Food Industry* [Online] Available at: http://www.boi.go.th (Accessed 5 May 2019)

could produce food products with competitive prices. Obviously, the world is disruptively changed, people have rapidly adapted themselves for survival with better life qualities. The role of food has also been not more than only nutrition, but also affected to health benefits to bodies. Recent trends of food are focused on healthy challenges, ageing community and obsessive-compulsive disorder (OCD)'s prevention. This type of food is well-known as "Functional Food". The global market of functional food was initially approximately US$ 43.27 billion in 2013 and is projected to reach US$ 275.77 billion by 2025 according to a new report by Grand View Research, Inc[2]. because of nutritional ingredient food. Milk is one kind of beverage that contain many nutrients with useful human health, for examples, casein, bioactive composition, etc. The production of functional milk can be created by natural husbandry or dairy ingredient enrichment. Moreover, the global shared market in 2018 could be demonstrated that the most proportion of functional food and beverage are "Functional dairy products" about 30% of total US$ 161.49 billion. Global consumers have more interests taking care and improving their health by intaking specific food products. Therefore, this situation has led to the development and creation of many new types of functional dairy products. In a case of Thailand, functional food has a potential growth in Thai food industry owing to more population in eldering society, lifestyle of working people and desires of disease prevention. Referring to Euromonitor report in 2018, functional food market in Thailand is about US$ 2,250 million and expect to gradually grow 4% a year in 2018 – 2022[3]. As a mention of National Food Institute (NFI) of Thailand, in 2017, the most portion of market shares for healthy food and beverage was "Milk and dairy products". This is corresponding to Food Focus Thailand's report, in 2018, milk and products were the most exported commodities. Therefore, trends of functional food have become significantly influenced to dairy industry. They have the powerful effect through the dairy value chain. When the cost of processed milk has been risen, the revenues of dairy entrepreneurs and cattle farmers have been also increased. Enhancement for farmers' quality of life and higher incomes from agricultural sectors could be occurred. Moreover, Thailand has a great opportunity because of a lot of researchers, developers and entrepreneurs which can implement advance technologies for the best quality of food for

[2] Grand View Research (2019) *Functional Foods Market Size, Share & Trends Analysis Report by Ingredient (Carotenoids, Prebiotics & Probiotics, Fatty Acids, Dietary Fibers), By Product, By Application, And Segment Forecasts, 2019 – 2025* [Online]. Available at: https://www.grandviewresearch.com (Accessed: 10 October 2019)
[3] Krungthai Macro Research (2019) *Functional Foods,* [Online]. Available at: https://www.ktb.co.th (Accessed: 5 May 2019)

worldwide market. This could be led to the leading production of premium food products such as more functionality of food and drink for human beings.

In consequence, this paper is aimed to study actual situation of functional milk and dairy industry in Thailand based on "Sectoral Innovation System: SIS" along the value chain. The analysis of happening gaps, players' demands, obstacle is led to a policy recommendation to enhance the competitive capacity of Thai functional milk and dairy products in global markets.

Methodological Approach

This paper is studied, implemented, and divided into 3 parts, following to:

Part 1: Literature review of food industry and trend, future food, functional food, functional milk, and dairy product industry

This paper is initial to study and review food industry and trend, future food focusing on functional foods in global market. Then, selected one type of functional food is milk and dairy product, due to one products of top market shares in Thailand. Actual situations and players along functional milk value chain are investigated and analyzed.

Part 2: "Analytical Framework" setting - up by using concept of Sectoral Innovation System (SIS) approach via gathering practical data and analyzing relevant information

The author has studied a concept of Sectoral Innovation System (SIS) and use to analyze along value chain of functional milk and dairy products. Information from real cases is by interview all relevant stakeholders in this industry.

Part 3: Policy recommendation designing and recommendation

Finally, the analysis results can reach to the appropriate policy recommendation. Enhancement of "Quadruple Helix" is one of proposed recommendations of enhancement for functional dairy industry in Thailand. Other necessary considerations are also suggested into this paper.

Part 1: Literature review of food industry and trend, future food, functional food, functional milk, and dairy product industry

Functional Food and functional milk in global market

Over the past decades until now, a role of food has been changed, not only satisfy humankinds to be fulfilled, but also provide nutrition directly into human bodies. The food has been concerned to be more and better functionality. In a history, a functional food was firstly known and announce in the Nature news magazine of Japan in 1993 which was defined as eatable substances between food and medicine. Notwithstanding, terms of functional food have been various in each institute and country. In general, the functional food could be defined as "food has specific functions which can be targeted to health benefits: better well-beings and disease prevention. When considering the markets, global market of functional food is US$ 153,600 million in 2018 is expected to reach US$ 275.77 billion by the end of 2025, growing at a Compound Annual Growth Rate (CAGR) of 6.8% during 2019-2025 according to a report of functional food market 2019. A comparison of generated revenue by functional food market worldwide in 2017 and 2022 can be shown. Global revenue in 2017 was about US$ 299.32 billion, meanwhile, the expected revenue in 2022 is estimated to US$ 441.56, about 47.5% of increase[4]. Favorite functional foods in worldwide market are a plenty of types, for instance, bread & bakery, dairy products, cereal and infant foods, meat, fish & egg, fat & oil and soy products. Furthermore, milk and dairy products is one of the most types for top global market share in a segmentation of functional food.

[4] Shahbandeh, M. (2019) *Revenue generated by the functional food market worldwide from 2019 to 2025* [Online]. Available at: https://www.statista.com (Accessed: 1 December 2019)

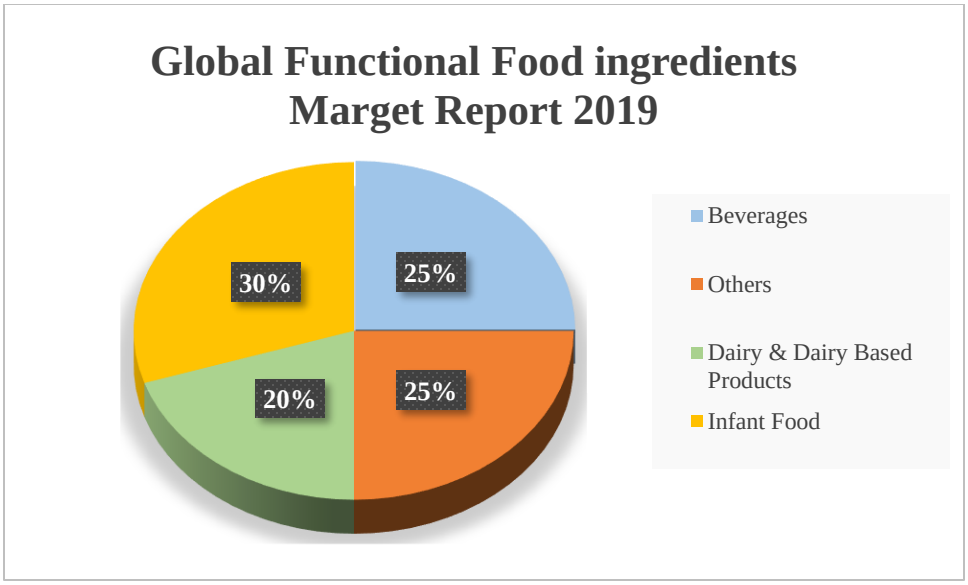

Figure 1: **Global Functional Food Ingredients Market Report 2019**[5]

People have consumed milk and dairy products because of health benefits for long times ago. The constituent of milk can be contributed biological active such as probiotic bacteria, vitamin, protein, peptides, oligosaccharides, and other organic acids.

In Thailand, "Functional food" is accountable for newcomer of healthy food innovation and has gradually grown in Thai food industry. People have behaviors to be more interested in health, less spending time to exercise. Hence, the market value of Thai market of healthy foods can be demonstrated a trend as below. The Compound Annual Growth Rate (CAGR) is calculated a 6.7% in 2011 – 2016. The tendency is gradually increasing.

[5] Market Intellica (2019) *Global Functional Food Ingredients Market Report 2019* [Online]. Available at: https://www.marketintellica.com (Accessed: 24 November 2019)

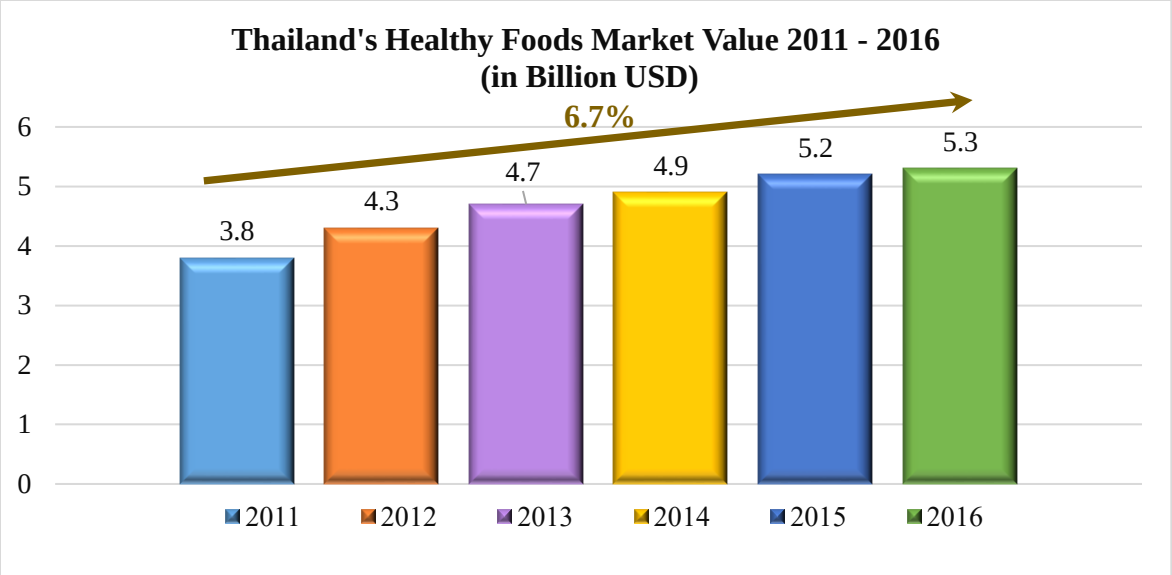

Figure 2 Thailand's Healthy Foods Market Value 2011 - 2016 (in $ billion)[6]

Thai markets of functional beverages are rather large with the market value of $1.6 billion in 2016. Example of favorable of functional drinks is a drink with supplement of collagen and hyaluronic acid, which can improve skin's smoothness and protection from any aging wrinkles. As a result of Food Focus Thailand in 2018, healthy and ready meals are the most export value is milk and dairy products that have the growth rate 10%. The survey report by National Food Institute, Thailand is stated that, in 2018, 81% of Thai people in a capital city usually consume functional foods and drinks at least once a week, especially brain nourishment food. Classifications of most favorite functional foods in Thailand are consisted of 1) Energizing food 2) Weight controlling food and 3) Self - Immunizing food. Moreover, business of functional food is one of strategic industrial sector (S-Curve Industry) which are supported and relied on Thailand's government policy. The government targets to push GDP for food industry with $44,000 million in 2026. Additionally, consumers' interest in functional milk products are likely to increase because dairy milk and dairy products are convenient to consume and have various nutrition e.g. protein and calcium.

Milk Production Industry in world markets and Thailand market

In 2014 – 2018, numbers of cows' production in top countries have been gradually increased in a proportion 0.95% annually. Particularly, in 2018, total dairy cows in the global were

[6] Thailand Board of Investment: BOI. (2017). *Thailand: Food Industry* [Online] Available at: http://www.boi.go.th (Accessed 5 May 2019)

141.45 million cows, increased from former by 1.34%. The most country of dairy cows' husbandry is India with 58.50 million cows. These values have affected on raw milk production in world market with raising up 1.39% annually. The most country of milk production is Europe region. Meanwhiles, the production of milk and dairy production has been grown up corresponding to the customer demands in the world market. The most countries of milk consumption are India (66.8 million tons), Europe (33.5 million tons) and USA (26.2 million tons), respectively.[7]

Global trends of milk production are slightly rising due to leading countries e.g. EU, USA are steady to produce. Pricing tend in global market has been gradually reduced. Unfortunately, epidemic diseases e.g. Mycoplasma bovis virus have been spread in New Zealand where is mainly milk and dairy production.

In the past of 50 years ago, Thailand dairy industry was not been flourished due to climates and traditional use of cows as draft animals and sources of meat. Then, there has short history and has been developed since 1960 when the King of Denmark gave some dairy cows to the King of Thailand as the royal tributes. In 1983, Thailand has imported cows from Australia and New Zealand. The Dairy Farming Production Organization of Thailand (DPO) and Livestock Department was initiated. The purpose is to promote the growth of milk production industry. The main role is to form milk cooperatives by granting long term startup loans to dairy farmers. Additionally, DPO also began the school feeding program which teaches the advantages of milk and dairy products to increase consumption of milk in sustainable manners for children. This is one strategy of enhancement for milk consumption in this country.

Significant reason is Thai Government's policy is to support the development of milk quality, especially milk production process. The notable policy is emphasized in improvement of forages which should be directly affected to milk quality. Moreover, there is also the control or pricing mechanism in higher level for farmers. Thailand Government has driven incentives for dairy farmers in good quality of farm management with standardized and highly effective and has eliminated low-quality and unhealthy cows from the farms. The below table is indicated numbers of cows and amount of produced milk in Thailand in 2014 – 2019.

[7] Phi. D. X. (2017) *Dairy Production and Trade in Thailand*. Kasetsart University.

***Table 1 Numbers of dairy cows and raw milk production in 2014 - 2019*[8]**

Numbers	2014	2015	2016	2017	2018	Incremental Ratio (%)	2019 (forecasted)
Total Dairy cows (cows)	591,700	608,094	626,171	645,261	660,155	2.82	670,950
Milking cows (cows)	256,585	267,182	279,456	267,932	276,321	1.52	281,621
Raw milk (tons)	1,143,798	1,179,338	1,193,737	1,191,143	1,233,483	1.62	1,332,180
Cow's Feeding rate (kg/cow/day)	12.21	12.09	11.67	12.18	12.23	0.11	12.96
Milk Consumption (tons)	1,143,798	1,179,338	1,193,737	1,191,143	1,233,483	1.62	1,332,180

In addition, the export values of milk and dairy products are mostly in a pattern of processing from imported raw milk into various products e.g. yogurt, Ultra-high temperature processing (UHT) milk, butter and condensed milk. The trade countries are Cambodia, Myanmar, Singapore and the Philippines. Hence, Thailand has imported milk and dairy products in higher values, particularly skimmed milk powder because of variety of dairy products.

Situation of dairy industry in Thailand changes for the better. Dairy farmers could earn the fair incomes due to improvement of raw milk's quality. Additionally, Thailand government's policy is to support to the development of standardized and high-quality raw milk. Meanwhile, Thai consumers have continually increased via many campaigns for milk consumption. Milk and dairy products' entrepreneurs have been more in markets. Collaboration of public and private sectors could drive domestic market through ASEAN markets.

Furthermore, Thai farmers and entrepreneurs should adapt themselves due to investment costs are higher. Unfortunately, there are still epidemic diseases, for instances, Mastitis and Foot Mouth Syndrome (FMD) which are affected to lower quality of raw milk, dairy farmers cannot sell and loss their incomes. Agricultural occupation has been less considered by young generation because this career is to spend most times in field, tough and no relaxing times. Thus, this is necessary that Thailand government should urgently assist all farmers and enhance career path of the valuable occupation.

[8] Office of Agricultural Economics: OAE (2019) *Dairy cows Situation in the world and Thailand 2019*. Ministry of Agriculture, Thailand

Functional Milk and dairy products in global and Thailand's markets

Milk is one food which has complex nutrition of particularly bioactive proteins, lipids, saccharide, and many biologically active components, therefore, milk has been just developed to be functional food. Consumers have interests to personal health. Functional milk and dairy products could be response to this desire. Nutritional benefits of functional milk play importantly in the control of chronic diseases which can be treated by functional milk, weight losing and other protection. Referring to a report of "Global Functional food ingredients Markets" in 2018, the market share of functional milk and dairy products is approximately US$ 52,080 million.

Considering a market in Thailand, a trend of functional milk is also raised because Thai people concern to own health through nutrients intaking inside food and more exercises. Types of functional milk on shelf are diversified. Thai dairy entrepreneurs can produce this milk in many processed formats, for examples, specific nutrient enriched milk, milk from special cow husbandry management, etc.

The report[9] is mentioned that functional food and functional milk can enhance the trade opportunities for Small and Medium enterprises (SME) who are the most amounts of business entrepreneurs in Thailand. Owing to functional food and functional milk can add more value in food, resulting to rise in revenues for dairy farmers and entrepreneurs. The report can also state that the more profits of functional food is 3 multiples (3X) from basic food. Thai dairy entrepreneurs are potentially to produce variety types of functional milk which are led to competitive prices. The comparison of price for each type of commercial milk in actual market can be demonstrated below.

[9] Krungthai Macro Research (2019) *Functional Foods,* [Online]. Available at: https://www.ktb.co.th (Accessed: 5 May 2019)

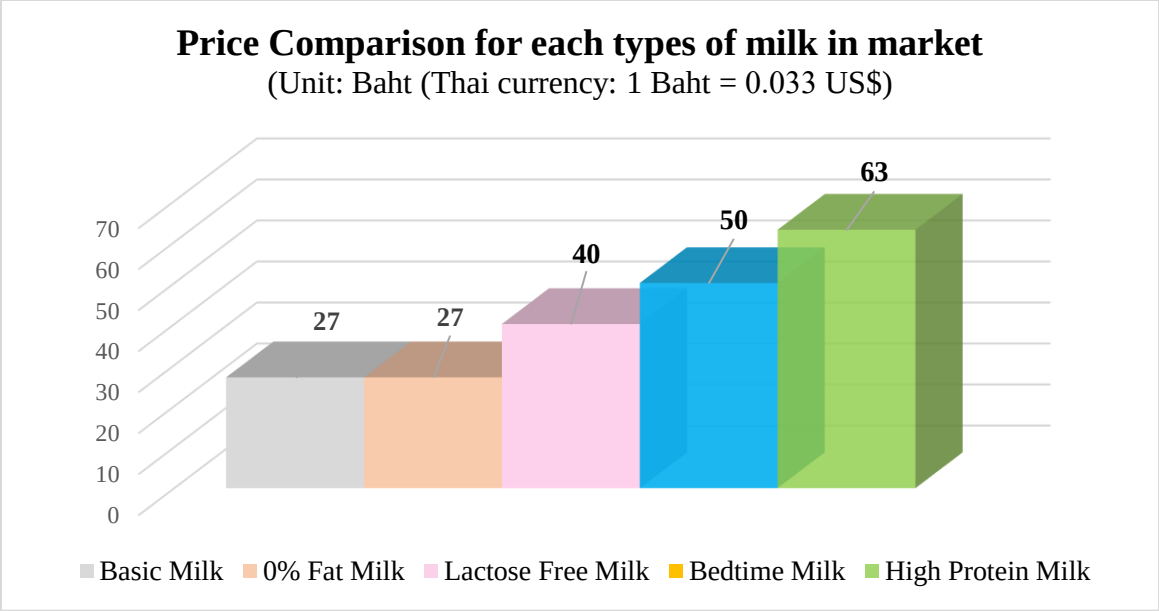

Figure 3 Price Comparison for each types of milk in market[10]
(applied from a report of Krungthai Macro Research 2019)

Referring to above figure, the prices of basic milk and functional milk are notably different in same volume of milk container. Consumers have changed in their minds to willingly pay more for more healthy food and beverage. Hence, there are adequate requirements from consumers to successfully develop new functional milk and products. However, Thai industry of functional milk and dairy products has been begun recently. Hence, production, market and other economic information cannot be found, studied, and analyzed as expected.

[10] Krungthai Macro Research (2019) *Functional Foods*, [Online]. Available at: https://www.ktb.co.th (Accessed: 5 May 2019)

Value Chain of Dairy Production

Dairy Production Value Chain could be considered and divided into 3 parts: upstream, midstream, and downstream.

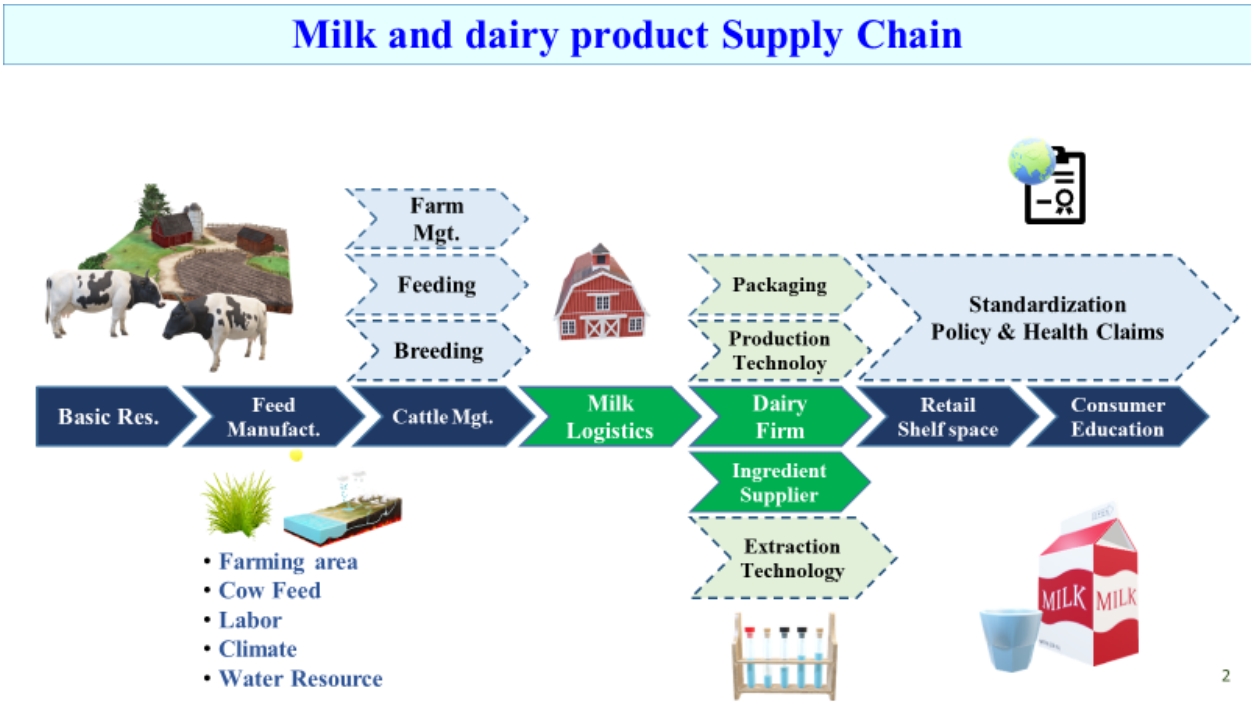

Figure 4 Milk and dairy product supply chain

An **upstream** of dairy industry is focused on genes, Deoxyribonucleic acid (DNA) and process of breeding to get specific cow species. High effective breeding technology is essential to get high – qualified pedigree of dairy cows. Hence "Breeding Service" from academic research institutes should be provided publicly to aid dairy entrepreneurs and farmers. After that, cow feeding, quality of grass and housing are also significant. Promotion of quality improvement for forages (grass) in a farm is one significant issue. However, the quality advancement of forages in market bringing into rising in fodder prices. This is necessary to develop domestic feeding production. Hence, the government should provide high qualified graze to local famers. Additionally, animal health care should be broadly deployed which is also included paper animal health diagnosis and treatment service and enough drug for dairy industry.

Midstream of dairy industry is stated since milk transportation from farm to milk collection shell which should be treated quality of milk before milk processing system. The "Dairy Cooperatives" has magnificent role as "*Intermediary*" among farmer and entrepreneurs or milk

producers. This mechanism is crucially to promote rural diary industry by facilitation which can be affected for upgrading rural economies and standard living of poor farmers. Milk processing is likewise attributed main part in midstream. Raw milk is conveyed into milk processing plants to be converted to ready milk and dairy products such as cheese, yogurt, ice cream, etc. The treatment of milk quality is processed by reducing bacteria in milk with high temperature at different time periods. This is led to classify a milk type and packaging.

Eventually, **downstream** of value chain is relevant with product standardization and distribution on shelf to markets and customers. Functional Milk is obviously involved with health claim for functional effects in human. The documents for health claim in functional food are required following strictly controlled animal studies with appropriate animal model, identification of probable biochemical mechanism via using a result of animal investigation, validation in at least one human clinical trial with outstanding statistic outcomes and metadata based on several independent studies before regarding to functional characteristics. However, in fact, a functional efficacy in functional claim has not been already proved in actual business. They have not or not enough proven cause and effect, especially in human bodies, not only in animal models. The proved health claim in functional food and drink is substantial in a case of commercialization and consumers' expectation and acceptance.

In this paper, functional milk production companies have produce and commerce in different 3 products:

1) Beta-casein A2 Milk (Absence of A1 variant milk): this milk is based on selection of only A2A2 genotype selection
2) High Melatonin – enriched milk: this milk is known as "Bedtime milk" or "Night-time milk", which produce by collecting milk in period of highest melatonin level. This kind of milk can be proven to help well sleepiness in people.
3) Nutrient extraction – enriched milk: the milk is directly fulfilled with necessary nutrition.

Part 2: "Analytical Framework" setting - up by using concept of Sectoral Innovation System (SIS) approach via gathering practical data and analyzing relevant information

Analytical Framework Approach

This paper is to apply a tool of "Sectoral Innovation System: SIS"[11] to be analyzed the linked system for innovation interactions for various industrial sectors. The terminology of SIS can be defined as "an integrated structure made up of interactions among agents/ actors in market and non-market who are inclined to develop products into a market.

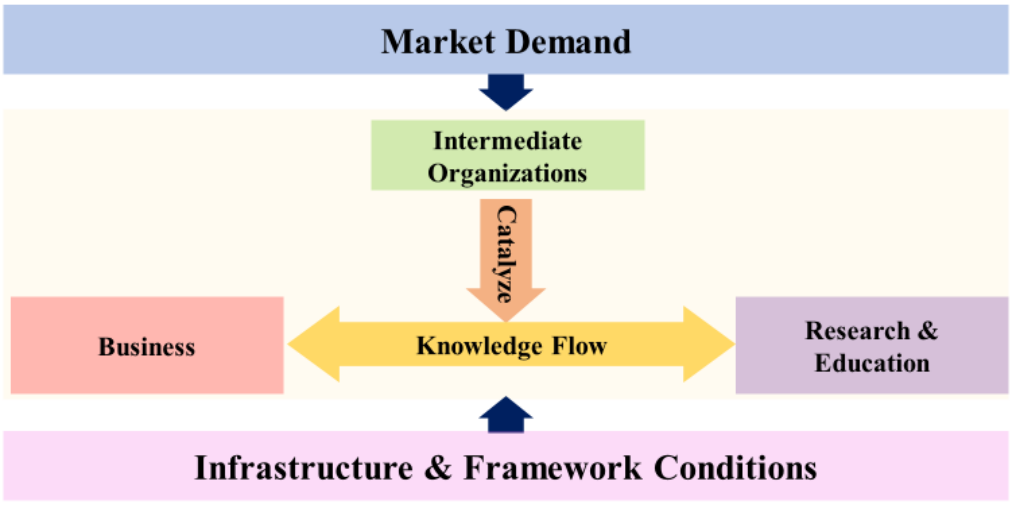

Figure 5 Theoretical framework for Sectoral Innovation System (SIS)[12]

Theorical framework for Sectoral Innovation System (SIS) is consisted of:

1) **Market Demands**: final demands from customers and intermediate demand from other players in the value chains
2) **Business**: Companies, firms that apply and process knowledge and make tacit knowledge
3) **Research and Education**: Sources of professionals, knowledge and basic technology that can be flowed, transferred, and distributed via learning processes and innovation activities
4) **Intermediate Organizations**: agency could stimulate knowledge and basic technology transfer and application

[11] Malerba F. (2002) 'Sectoral systems of innovation and production', Research Policy 31, pp.247–264.
[12] Zhen Liu, Maarten A. Jongsma, Caicheng Huang, J.J.M. (Hans) Dons, S.W.F (Onno) Omta, 'The Sectoral Innovation System of the Dutch Vegetable Breeding Industry', NJAS – Wageningen Journal of Life Sciences, pp. 27 – 30, 2015

5) **Infrastructure and Framework Conditions**: more general aspects can innovation development/ institutions such as finance, taxation, standards, regulations, and high-skilled labors

The analytical tool of SIS is used to diagnose the actual situation a value chain for dairy industry, particularly functional milk in a case of Thailand.

Analytical Framework of Thailand's fact findings along value chain

Initially, components of Sectoral Innovation System (SIS) through value chain of functional milk could be sorted into below table.

Sectoral Innovation System (SIS)	Upstream	Midstream	Downstream	Fact Findings
Market Demands	• Farm Management (Feeding: organic grass, livestock, and corral cleaning)	• Longer Shelf Life for processed milk	• Customer's needs for healthy foods and ready & nutrient meals	• Lack of new qualified milk treatment: a present process cannot be kept pasteurized milk more than 10 days on shelves. The dairy products could not be exported in so far countries
Business	• A relation in "Quadruple Helix" among dairy farmers, milk company, university, and government agency (Department of Livestock Development, Ministry of Agriculture and	• Comprehensive process of food quality certification between dairy manufactures and government authority (Food and Drug Administration). This procedure would be mutually	• Business – to – Business (B2B) in a dairy process and Business – to-Customer (B2C)	• Weak cooperation of dairy cooperatives that could be affected to the process: collection of raw milk, a method of transportation to a factory and milk treatment. The significantly negative effect is low/poor quality led to lack of qualified milk to produce other

Sectoral Innovation System (SIS)	Upstream	Midstream	Downstream	Fact Findings
	Cooperatives) through a mechanism of "Diary Cooperatives"	understood and collaborated between entrepreneurs and the authority, stimulating dairy products bought into market shelves.		dairy products and ready-to-drink milk.
Research and Education	• Educational and research institutions are major roles of functional milk's research and development (R&D) such as nutrition extraction, farming management for higher nutrients enrichment in functional milk	• New methods of milk treatment in a process to prolong milk shelf life. This new technology is known as "Extended Shelf Life (ESL)", which is novel pasteurization process to treat and preserve longer period.	• Knowledge and technology transfer to dairy entrepreneurs by experts in research and educational institutes and offices from Ministry of Agriculture and Cooperatives	• A few numbers of research for functional milk in Thailand owing to small numbers of researchers and experts • Lack of Announcement of new treatment methods for prolonged milk • Weak techniques for knowledge and technology transfer to farmers, entrepreneurs, and business
Intermediate Organizations	• University – Industry – Linkages (UIL), especially in technology for cow breeding and farm management	• Government organization which is supervised about standardization and regulations	• Logistics and transportation system to markets (local, domestic, and abroad markets)	• Weak dairy cooperatives in upstream could be affected to a quality of processed milk: shelf-life, nutrition quality and quantity

Sectoral Innovation System (SIS)	Upstream	Midstream	Downstream	Fact Findings
	• Dairy Cooperatives between farmers and entrepreneurs in farming and primary process	in **dairy process and packaging**		• Lack of new allowance and announcement of milk treatment process: innovative pasteurization, known as "Extended Shelf-Life (ESL)"
Infrastructure and Framework Conditions	• High-skilled labors in dairy industry • Experts and researchers in R&D and educational institutes • R&D infrastructures, especially in industrial places	• Standardization and regulation which is authorized by government agency, e.g. Food and Drug Administration (FDA)	• Healthy food certification and functional food verification and guarantee, that could be affected to better opportunity in international markets for functional milk and dairy products	• No approval of functional milk as "Functional food" or "Novel food", which could be verified and approved for Health claims in human beings because of deficiency in dairy entrepreneurs

Therefore, more explanation of "***Limitations***" along the value chain can be demonstrated as below

Upstream: Weak dairy cooperatives are affected to the quantity of milk which has been transmitted to milk processing factories. Poor quality of milk collection system and milk treatment facility to convert in primary process. The results are not enough number of ready-to-eat milk for consumers in a country.

Mid-Stream: Lack of new allowance and announcement of new milk quality treatment in a process. Most kinds of functional milk are treated by "Pasteurization" process which is treated milk with high temperature in appropriate period. At the present, there is new method of milk

quality treatment, known as "Extended Shelf Life (ESL)" which is treat milk with 120 – 135^{o}C for 1 - 4 seconds[13]. New milk process could be extended the milk shelf life, particularly, functional milk from 10 days to 30 days and over). This is to enhance the great opportunities of product export in more countries. Nevertheless, this method has not been yet approved and announced by the authority of Thailand.

Downstream: Nowadays, functional milk produced by Thai entrepreneurs is not approved in a case of "Functional food" or "Novel food" by Food and Drug Administration (FDA). A procedure is to comply with "Health claim requirement" in human beings. The main reasons are Thai entrepreneurs cannot declare and express any documentation to prove any efficacy based on controlled animal studies, as well as no validation especially in one human clinical trial with suitable design and statistical accepted outcomes. Hence, there are no products which are produced by Thai manufacturers, are approved in Health claim as "Functional foods".

[13] Kapadiya D. B., Prajapati J.P., Pinto S.V. (2017) 'Extended Shelf Life Milk' Technical Articles, pp.143-146.

Part 3: Policy recommendation designing and recommendation

Policy Recommendations and Conclusion

This paper is to study and review the value chain of milk and dairy products in Thailand, focused on functional milk which is one special kind of milk that has characteristics usefully affected to healthy conditions in human beings. The sectoral innovation system (SIS) of milk and dairy product industry has been recognized, focuses on "functional milk" which is one type of high value-added product and well-performance in Thailand. Therefore, recommendation for upgrading along value chain for functional milk in Thailand can be concluded as below:

- Extending high quality's cows to dairy farmers and strengthening the roles of **Dairy Cooperatives** to be "Effective and Practical ***Quadruple Helix***"

New breeding for better pedigrees of dairy cows can be developed in educational and R&D institutions. The development and commercialization of new cow pedigrees is a majority role of knowledge and technology organizations. Next step, new fully qualified cow pedigree should be distributed and extended to dairy farmers. Agricultural officers/ experts could transfer knowledge and techniques to dairy farmers to achieve fully-grow cows. This is one approach to extend the production of high nutrition in functional milk.

In another side, the main role of cooperative is to increase members involvement and promote rural development, effecting to the development of rural and local economies, also upgrading the standard of living for rural people. The power of collective members is to overcome by acting in the product markets. The need of cooperatives is to ensure in actual secure markets. The successful dairy producers' cooperatives are in Japan, the Republic of Korea, and New Zealand[14]. Complete functions of dairy cooperatives should be exactly implemented, for instances, knowledge sharing and management, financing assistance, trade negotiation empowering, higher qualified operation/ manufacturing. Their governments are also progressively to support development through technical assistance, financial schemes and standard and regulations. Perfectly strong linkage of all players along value chain since dairy farmers, dairy cooperatives, entrepreneurs/ milk manufactures, researchers in universities and research institutes until to actual

[14] Uotila M., Dhanapala S.B. *Dairy development through cooperative structure*, [Online] Available at: http://www.fao.org (Accessed: 20 November 2019)

markets as "***Quadruple Helix Linkage***" is the excellent mechanism to drive Thailand functional milk industry to be the leader in global market

- **Improving and developing regulations and institutions**

Thailand government should be adopted new knowledge and disruption which can be suddenly changed. The flexible and modern institutions such as Standardization System, Incentives for investment and financing management. Thai entrepreneurs mostly require the announcement of Ministry of Health about new milk quality process. The government should issue and support both infrastructure and expertise as useful tools to enhance the production efficiency of local milk manufacturers. The benefits of standardization facility can enhance the opportunity to export milk and dairy products, especially, functional products to the world market.

Additionally, national stamp for "Healthy food", "Functional food" from government organization can be convinced and guaranteed "Quality" of Thai products. Thus, the government should impose the food quality symbol or logo which is approved in both national and international levels and inspired Thai food and drink manufactures to achieve them. This could be one successful incentive to stimulate Thai producers to produce high value/high-end/ premium food products to the world markets and worldwide customers.

Figure 6 Example of "Healthy Food" stamp/ logo

- **Forming "Intermediary" who can facilitate the reaching procedure to be approve Thai branded food and beverage to be "Functional food" or "Novel food".**

Complicated and new procedures could be crucially obstacles to Thai entrepreneurs to develop and produce new products and services can be commercial in both local and international markets. The role of intermediary is "Practical assistant" who helps and supports in each method

and coordinate with experts such as researchers in universities and research institutes, included with relative government agencies such as standard certification units: Food and Drug Administration (FDA), Ministry of Health, etc. The result of this method can create magnificent opportunity to extend Thai functional foods and drinks' manufactures which is important part for healthy diets responding to new trend of worldwide customers.

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