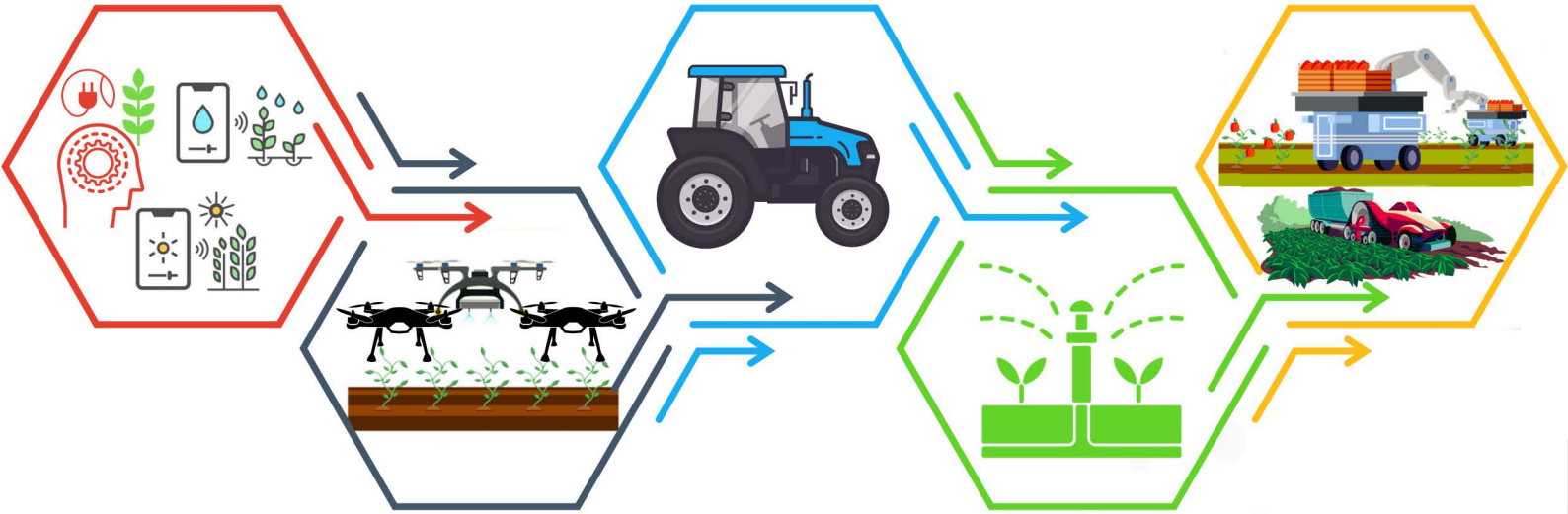
Kingdom of Cambodia

NATION | RELIGION | KING

AgriTech Roadmap



National Council of Science, Technology & Innovation

2022

Ministry of Industry, Science, Technology & Innovation

FOREWORD

The Royal Government of Cambodia, under the supreme wise leadership and long-term vision of **Samdech Akka Moha Sena Padei Techo HUN SEN, Prime Minister of the Kingdom of Cambodia**, has made great efforts on fostering all sectors to achieve the established of Cambodian visions for 2030 and 2050. By sight of Science, Technology & Innovation (STI) is an essential core sector, therefore the Ministry of Industry, Science, Technology & Innovation (MISTI) and the National Council for Science, Technology & Innovation (NCSTI) have provided strategic guidance to implementing the National Policy on STI 2020-2030 and the Cambodia's STI Roadmap 2030.

In 2021, Agricultural Technology Roadmap was identified and approved as a priority sector during the very first meeting of the NCSTI. Agriculture is a major sector of Cambodia economic system. Like all sectors, agriculture was affected by the Covid-19 pandemic. Its current decline shall be strategically addressed with STI at the core of the agricultural recovery program. This Agricultural Technology Roadmap was meant to strengthen and improve productivity in agricultural sectors by providing strategic recommendations for diversification and value addition for agriculture via the use of STI approaches.

Above all, I trust that relevant ministries, the private sector, academia, general public, and development partners will leverage this Roadmap to enable further strengthening the agricultural productivity of Cambodia.

Finally, I would also like to express my gratitude and commend preciously to the Steering Committee and the Sub-Committee, which jointly composed of various relevant institutions altogether to actively developed this Agricultural Technology Roadmap, including the leaders and officials of the General Department of STI under MISTI and the Science and Technology Policy Institute (STEPI) of the Republic of Korea, which participated in the development of this Agricultural Technology Roadmap.

Phnom Penh, 22 June 2022

Senior Minister
Minister of Industry, Science, Technology & Innovation
and Chair of National Council of Science, Technology & Innovation

***Kitti Settha Pandita* CHAM Prasidh**

ACKNOWLEDGEMENTS

The Agricultural Technology Roadmap was endorsed by the National Council of Science, Technology & Innovation (NCSTI) on July 08, 2021. This roadmap was produced by the Ministry of Industry, Science, Technology & Innovation (MISTI), under the supervision of the General Department of Science, Technology & Innovation (GDSTI) and supported by the Science and Technology Policy Institute (STEPI) of the Republic of Korea.

This roadmap has been written by working group of the General Department of STI with received inputs from a panel of sub-committee on development of Agriculture Technology Roadmap and relevant stakeholders who specialized in agriculture and technologies through a series of workshops and discussion.

The members of sub-committee and relevant stakeholders composed of:

- General Department of Agriculture, Ministry of Agriculture Forestry and Fisheries (MAFF)
- General Department of STI (GD/STI), MISTI
- General Department of SME and Handicraft, MISTI
- Royal University of Agriculture (RUA)
- Cambodia University of Technology and Science (CamTech)
- Cambodian Agriculture Research and Development Institute (CARDI)
- Department of STI promotion and Development, National Institute of STI (NISTI), MISTI
- Department of STI Cooperation, GD/STI, MISTI
- Department of Technology Transfer, GD/STI, MISTI
- Department of STI Policy, GD/STI, MISTI
- Department of STI Data Management, GD/STI, MISTI
- Khmer Fresh Milk Co., Ltd (Kirisu Farm)
- Cambodia-Australia Agricultural Value Chain Program (CAVAC).

EXECUTIVE SUMMARY

Agricultural sector is one of the sectors that play an important role in the national economy and is one of the main contributors for Cambodia to achieving its vision of becoming a high middle-income country by 2030 and high-income country by 2050, particularly contributing to poverty reduction, improving living standards and creating jobs for people with the effective utilization of technology and innovation. The agricultural sector faces a number of significant challenges, including low productivity, low quality of agricultural products, lack of technical skills, unmatched demand and supply, lack of trade facilitation mechanisms, low competitiveness of local products, insufficient research and development, climate change vulnerability, and the current impact of global pandemics. To respond to these challenges, Cambodia must embrace science, technology and innovation, which is considered as a backbone for the national economy growth by many countries, to thrive agricultural sector to be on the par with the neighbors and enable the "catch-up" to happen; and in turn to increase productivity, enhance the efficiency, and promote quality standards for exports.

The vision of the roadmap is to increase productivity of agriculture commodities and high value-added production/service for the global supply chain through technology and innovation by 2030. In order to achieve this vision, this roadmap seeks to identify drivers, opportunities and key challenges in the current agricultural context. Strategic products/services, key technologies, through consultation workshops and interviews, were then proposed to address those challenges.

The drivers in social, technological, economic, environmental and political were identified. Drivers in social aspects consist of young population, nationalism on agriculture products, lifestyle change and etc. The drivers in technology are mechanization, automation, AI, drone etc. The drivers in the environment composts of climate change, soil and water pollution, while the drivers in economics and politics are mainly center on finance facility, globalization, large enterprise, privatization, trade facilitation, and so forth.

Six prioritized strategic products/services are derived from the defined drivers including farm machinery and technology, water management and irrigation, harvest and post-harvest, computer modeling, processing, and marketing/trading. The key technologies to support these prioritized strategic products/services were then identified, based on consensus from experts and committee members, to deploy in short (~2024), medium (~2027), and long term (~2030). In the short term, Cambodia should focus on farm mechanization, water management, irrigation system, fertilizer and animal feed, E-registration, screening and breeding, preservation technology, and market information platform. For the medium term, Cambodia shall embrace key technologies

related to solar energy, logistics, and others. While in the long run, Cambodia shall encompass highly sophisticated technologies from industry 4.0 including sensor/sensor network, biotechnology, drone, robotic, GIS/remote sensing, fintech, and others. In addition, safety, standard, and branding are very crucial to bringing the highest possible value creation for agricultural commodities and to integrate into the global supply chain.

The government also play a central role in the realization of the vision by providing the right policies and regulations, incentivizing scheme, training, skill development, financial support for innovation, and entrepreneurial activities and initiatives. Moreover, to enhance the national output, the government shall invest in the national productive assets and capital including physical capital (apparatus and equipment), human capital (education, skills, health, experience), infrastructure capital (hard and soft infrastructure, internet, electricity), intellectual capital (scientific and technological capabilities), natural capital (fertile soil, clean atmosphere) and social capital (trust, nationalism). A technology transfer mechanism shall be put in place to ensure the capacity building of local firms/farms. Enhance, the government shall pursue ~~the~~ macroeconomic stability, trade facilitation, intellectual property protection, standard compliance and building the enabling ecosystem that is conducive to innovation and entrepreneurship.

The recommendation has been proposed as below:

- Science Technology Innovation (STI) shall be the driving force for present and future development in the agricultural sector and others.
- Investing in R&D in agriculture including the animal sector and fisheries is very vital for increasing sustainable productivity, competitiveness, adaptation, and resilient capabilities.
- Enhancing the quality and standards of agricultural products are key to effectively competing in the regional and global market
- The government should strategically and financially support the development of agri-food industrial parks or zones.
- Government agricultural policies should focus on the private sector, farmers, and key stakeholders along supply chains from production to markets.
- The public-private partnership on increasing accessibility of inclusive finance schemes/ programs for promoting mechanization and technology adaptation in agriculture should be supported.
- The government should initiate and support a collaborative platform between governmental bodies, academic institutions, and the private sector.
- Technology transfer mechanism shall be in place.

- Government should create an enabling framework/ platform that effectively engages to improve a critical mass of agricultural exports and the next generation of well-trained farmers.

ABBREVIATIONS LIST

ADB	:	Asian Development Bank
AI	:	Artificial Intelligence
ASEAN	:	Association of Southeast Asian Nations
ACFTA	:	ASEAN-China Free Trade Area
CARDI	:	Cambodian Agriculture Research and Development Institute
CAVAC	:	Cambodia-Australia Agricultural Value Chain Program
FAO	:	Food and Agriculture Organization
GDP	:	Gross Domestic Product
GI	:	Geographical Indication
GVA	:	Gross Value Added
ICT	:	Information and Communication Technologies
IoT	:	Internet of Things
MAFF	:	Ministry of Agriculture Forestry and Fisheries
MAP	:	Modified Atmosphere Packaging
MISTI	:	Ministry of Industry, Science, Technology & Innovation
NCSTI	:	National Council Science, Technology & Innovation
NISTI	:	National Institute of Science, Technology & Innovation
RCEP	:	Regional Comprehensive Partnership Agreement
R&D	:	Research and Development
RGC	:	Royal Government of Cambodia
RUA	:	Royal University of Agriculture
SME	:	Small and Medium-sized Enterprises
SNCE	:	Supreme National Economic Council
STEM	:	Science Technology Engineering and Mathematics
STI	:	Science, Technology & Innovation
UN	:	United Nations
USAID	:	United States Agency for International Development
WB	:	World Bank

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1. INTRODUCTION

1.1. Background

The Royal Government of Cambodia (RGC) has set out the ambitious vision to become high middle-income country by 2030 and high-income country by 2050. This vision can only be realized by exploiting country's potential to promote structural transformation and boosting economic dynamism by leveraging science, technology and innovation to increase industrial high value-added production, diversify export and strengthen local firm capacity in strategic prioritized sectors, one of which is agricultural sector. To this end, the RGC has developed a numerous strategic policy to support such transformation. In October 2019, the Ministry of Agriculture, Forestry and Fisheries (MAFF) launched 5-year strategic development plan for agricultural sector 2019-2023. This development plan aims to improve farming and agricultural sector through modernizing the agricultural practices to become more competitive, increase productivity, diversify export and commercialization (MAFF, 2019). In December 2019, the RGC approved and adopted the National Science Technology and Innovation Policy 2020-2030 (MISTI, 2020). This policy seeks to harness Science Technology and Innovation as a main source of socio-economic and sustainable development. The main objectives of this policy are to strengthen the STI foundation, improve the enabling ecosystem, develop an STI environment for sustainable development, and enhance the quality of people's lives at all levels and in all sectors. This national STI policy has set to target five main sectors include: 1) Agricultural yield increase, produce diversification and agro-processing; 2) Modern production and engineering; 3) Health and biomedical; 4) Material science and engineering and 5) Services and digital economy, including artificial intelligence and space and spatial technology. Moreover, Industrial Development Policy 2015-2025 has also been adopted by relevant ministries to promote sustainable and inclusive high economic growth in industrial sector in the country. This policy set three main targets: 1) Transforming and strengthening the industrial structure in the national economy; 2) Increasing and diversifying export products; and last but not least; 3) Strengthening and Promoting of SMEs. Most recently, the RGC has decided to establish two new institutions to oversee the STI development in Cambodia namely Ministry of Industry Science Technology & Innovation (MISTI) to serve as a main coordinating body for STI policies among key ministries, and National Council of Science Technology & Innovation (NCSTI) as a national body to set the direction of STI policy in Cambodia. Shortly after the establishment of these two institutions, the RGC developed and adopted the strategic Cambodia's Science Technology & Innovation Roadmap 2030 to harness the power of STI as a locomotive and driving force for sustainable and inclusive economic development to achieve RGC's vision 2030 and 2050. The Cambodia's STI

roadmap has taken into account the strength and weakness of the National Innovation System (NIS) in Cambodia, and targets five main pillars, namely: 1) Governance. The main objectives are to enhance the governance of the STI ecosystem to reducing the fragmentation and breaking down the silos of all relevant ministries. This pillar aims to clarify role of all relevant ministries and stakeholders as well as MISTI as a coordinating body. 2) Education. This pillar aims to build human capital in STI by promoting scientific and entrepreneurship culture, digital literacy and technological readiness of the youth starting in basic education and STEM education in higher education. 3) Research. This pillar set out to strengthen the research capacity and quality to serve in the national interest and in priority sectors of Cambodia. 4) Collaboration. This pillar aims to increase collaboration and networking between different actors as innovation comes from the exchange of ideas, across different people, organizations, and sectors, and by considering the weakness of Cambodia national innovation system. 5) Ecosystem. This pillar aims to foster an enabling ecosystem for building absorptive capacities in firms and attracting investment in STI, support technology transfer and promote domestic technologies.

1.2. Share of Agriculture sector to Cambodia's economy

Cambodia has performed an impressive economic progress, as can be seen, in Figure 1, through a significant average annual GDP growth rate of above 7% since 2011, and a substantial increase in GDP of capita from merely 785 USD in 2010 to about 1205 USD in 2018; however, this statistics is relatively low compared to the average GDP per capita of ASEAN nation, which is of about 12000 USD (World Bank, 2019). The poverty and income inequality has also experienced a significant reduction in the past decades. With the substantial investment by both public and private sector, Cambodia's economy is predicted to continue to grow robustly in the following years. The impact caused by the pandemic Covid-19 has contracted Cambodia's economy since 2020. However, it is forecasted that the robust growth will be resumed in 2021.

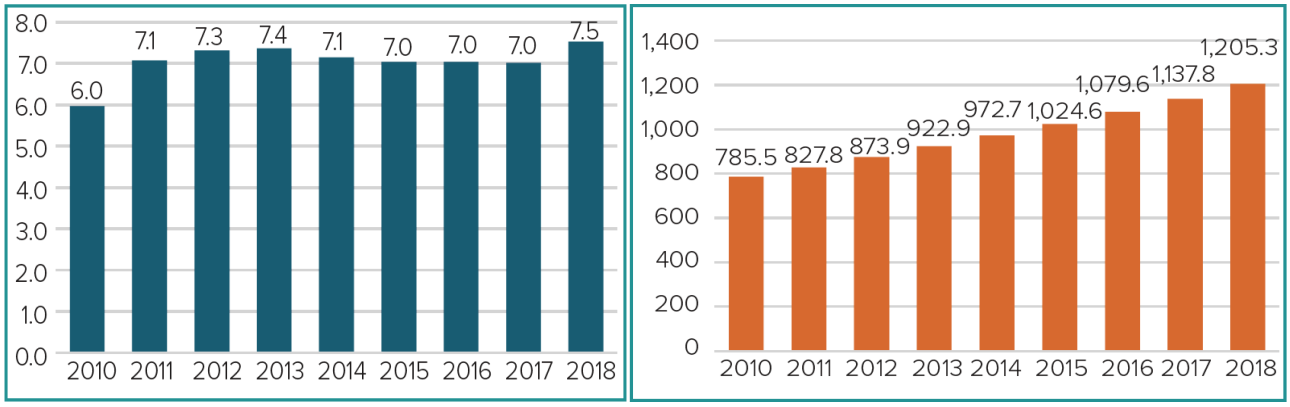


Figure 1: Cambodia's GDP-annual% (Left) and GDP per Capita-US$ (Right), 2010-2018. (UNDP, 2020)

In recent years, Cambodia has experienced the significant changes of economic structure that impact the whole economy. The share of the industrial sector in the whole GDP has seen increase in the decade. However, agricultural sector is still the primary source of production and employment. Figure 2 shows the contribution of manufacturing and agriculture share of GDP in Cambodia's economy. Agriculture accounts for 22%, estimated 5.3 billion USD of total GDP, and employed up to 30.8% of the total employment in Cambodia. However, the contribution to export of agricultural commodities is about 6.5%. As a result, there is room for improvement in this category through increasing the industrial value add in order to integrate into the global supply chain through harnessing the power of STI. In addition, industry sector contributed about 34.7% of GDP, while service sector contributed about 36.2% of GDP in 2020 (MAFF, 2021).

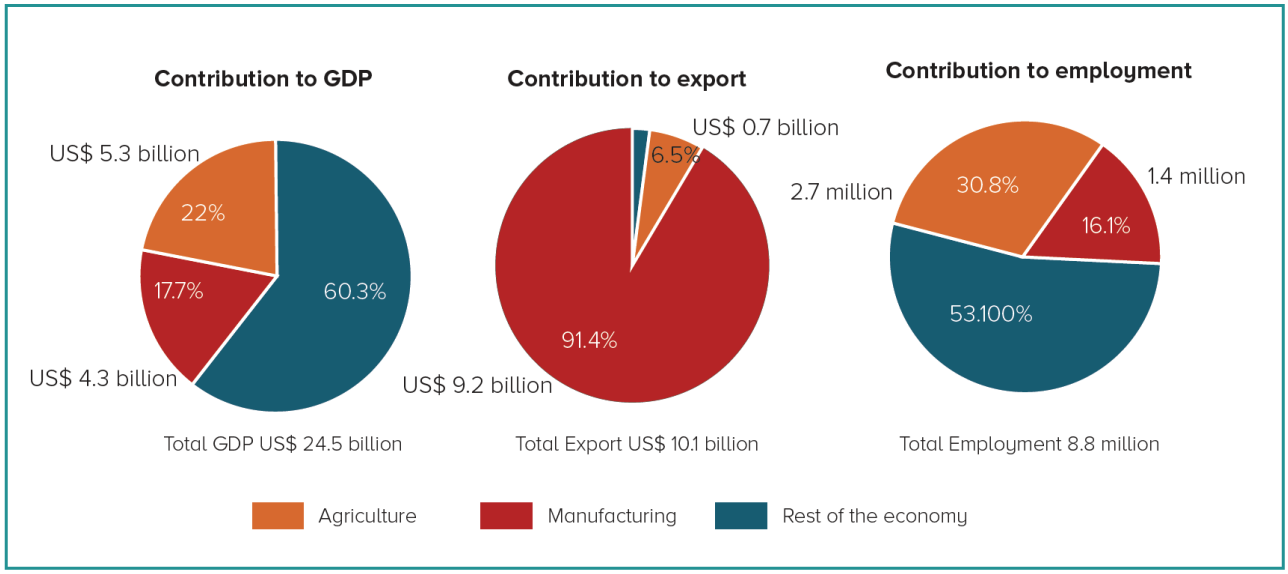


Figure 2: Contribution to GDP of Agriculture and Manufacturing. (UNDP, 2020)

1.3. Value of agricultural exports by categories

Figure 3 indicates that the total value of agricultural exports increases more than tripled since 2010. The majority of the country's agriculture exports remains in raw form and mainly dependent on crops. The major export products are rice and rubber, with some increasing share of cassava. From 2010 to 2018, the biggest reduction of export value was seen in maize (ADB, 2021).

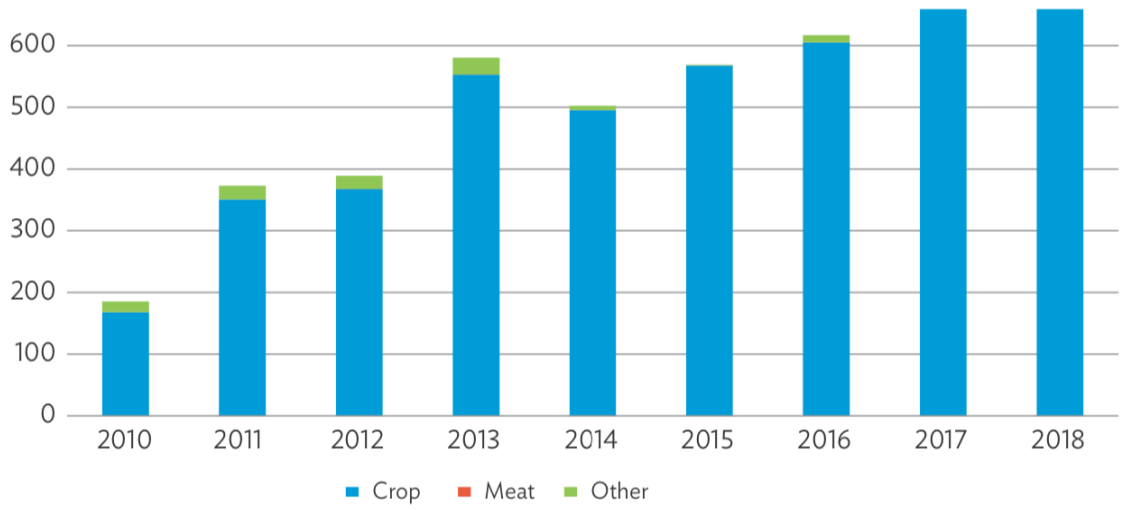


Figure 3: Value of agricultural exports 2010-2018 (million USD)

1.4. Potential agriculture commodities

Cambodia has prioritized six commodities for domestic market and export. The in-depth studies of these value chains needed to be conducted to have a better understanding of market opportunities, supply constraints, risks and threats faced by smallholder farmers, entrepreneurs and consumers, as well as of opportunities to support socio-economic development and sustainable development goals. The six prioritized commodities are mango (Keo Romeat), cashew, maize (red corn), cabbage, pig, and chicken. They are considered as strategically important for food security and nutrition, and for their potential contribution to decent employment and reduction of rural poverty (FAO, 2021). In addition, according to the 2019 final report of USAID on Cambodia Agriculture Competitiveness Opportunity assessment, about 3 million people are engaged in agriculture production, earning an average of about 1200 USD per year. Most farmer are smallholders with an average landholding of approximately 1.2 hectares. 66% of farmer own less than 1.6 hectares of land, about 20% of farmer own 1.6-3.2 hectares of land, and around 14% of farmers own bigger than 3.2 hectares of land. Majority of farmers grow only 1 crop and practice subsistence farming. 58% of farmers grow only one crop and 79% of farmers consume more than 50% of the production. Figure 4 shows potential production of provinces around Tonle Sap and Mekong Basin.

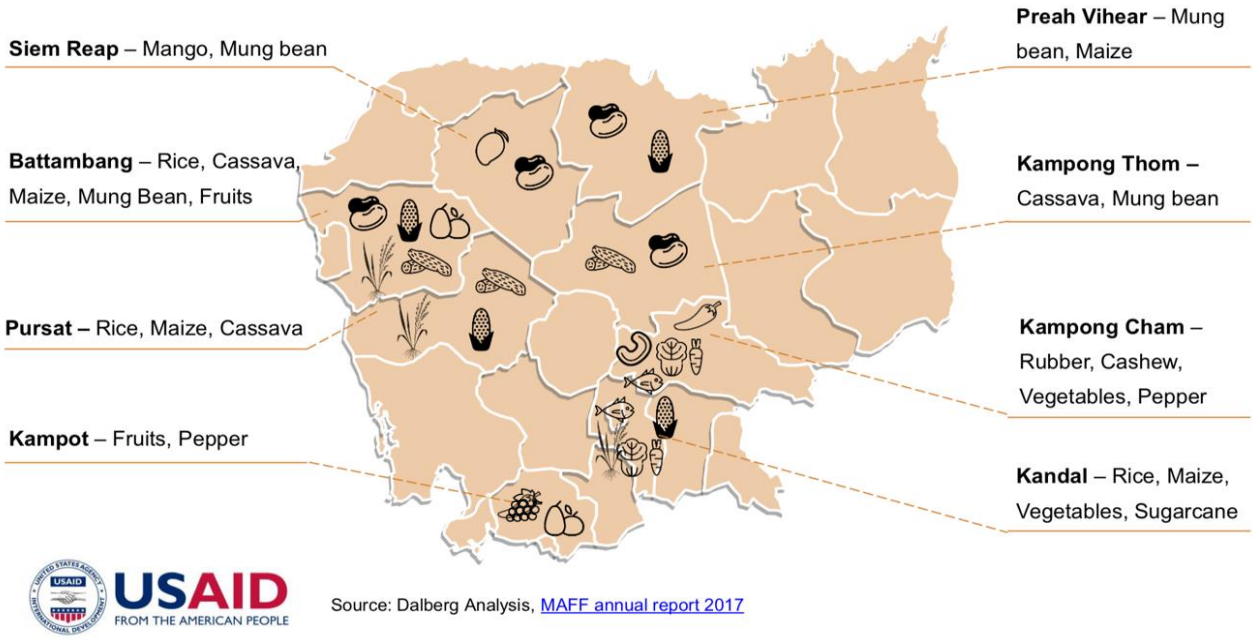
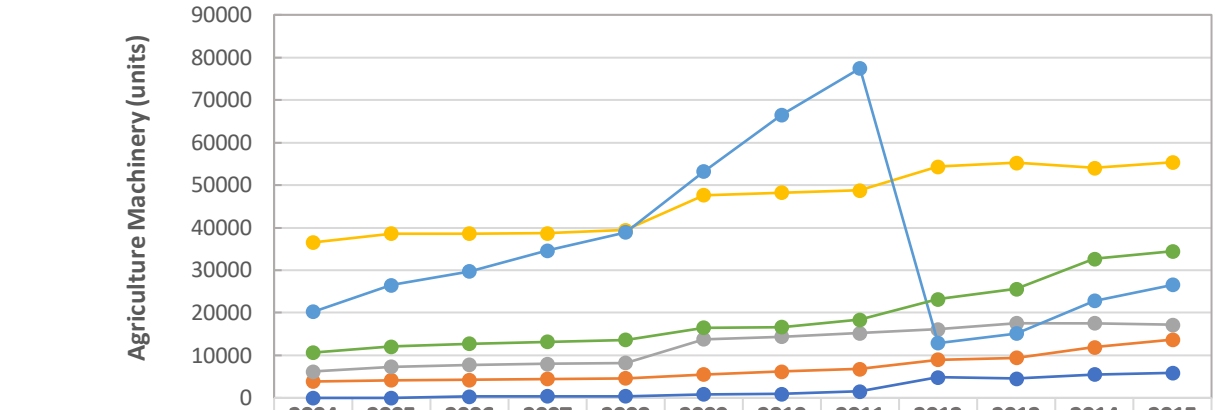


Figure 4: Province around Tonle sap and the Mekong basin account for the bulk of production. (USAID, 2019)

1.5. Current technology usage

To increase productivity and diversify crops and markets, the transformation of the agricultural sector is a new and widespread approach to develop with focusing on new technology, machinery usage, irrigation capacity, and R&D. Mechanizing will help to expand production and quality of crops and goods in the rural area and to address challenges from a declining labor force in the agriculture sector. Figure 5 shows the agricultural machinery used in Cambodia from 2004 to 2015, the number of machines used increased from year to year. The needs of machineries were not the same and varied by geographic locations, land size, and type of crops for cultivation. High Technology in the mechanical and biosciences in recent years are doing the foundation developments in agricultural, farming practices and technology. Advances in biological, mechanical, environmental and chemical sciences can improve yields of crops, soil, water, product, knowledge and income whilst also reducing the waste of land. Improving the productivity and the nutritional quality of crops or products through mechanization can improve human health and offer more income. By using more technology that can control water and soil by remote sensing, monitoring and precision farming are reducing the energy and environment footprint of modern farming.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Harvester	0	0	325	395	430	836	947	1548	4820	4580	5503	5893
Tractor	3857	4166	4247	4475	4611	5495	6200	6786	8961	9467	11940	13701
Thresher	6220	7338	7795	8036	8237	13798	14390	15210	16146	17542	17532	17169
Rice milling	36531	38606	38618	38680	39429	47620	48217	48753	54328	55270	54062	55364
Power tiller	20279	26504	29706	34639	38912	53220	66548	77421	12880	15170	22845	26600
Water engine pump	10656	12096	12761	13170	13606	16497	16663	18350	23194	25595	32683	34463

Figure 5: Usage of Main Agricultural Machinery in Units (2004-2015). (BDLink (Cambodia) Co.,Ltd 2017)

In addition to mechanization, there are other techniques that help increase the production of agricultural products, including the use of nethouses. This technique can reduce the cost of using pesticides, protect crops from large amounts of rainfall, and enable farmers to grow crops in both the dry and rainy seasons[1]. Moreover, farmers in Cambodia have utilized drone technology for use, especially for spraying pesticides, crops and land monitoring. This technology can eliminate them from the hazard of absorbing the pesticides and save time consuming compared to their traditional ways. The farmers have been looking for innovative solutions such as automating irrigation, allowing them to remotly control the irrigation system via mobile phone, which is time saving, while the water usage is manageable. In Asia Pacific, reached about 64% of smartphones compare to 45% in Sub-Saharan Africa (Simelton and McCampbell, 2021). Even though many farmers have at least one mobile phone or smartphone, a specific case of Southeast Asia is that farmers have limited use for services or applications specifically developed for the dissemination of agricultural information (Simelton and McCampbell, 2021). Apart from mechanics that can improve the flow of agriculture, now it is a retail store and mart that use applications to buy goods. The internet plays an important role in pushing products or goods to the end user. Previously farmers continued to sell their main crops or goods to traders or collectors in their village, which was slow and not effective to improve the market. MAFF just launched, recently, the CAMAgriMarket app, which is a platform to promote agri-business and also a platform where famers, buyers, sellers and relevant stakeholders can

[1] Agricultural Innovations Help Cambodian Farmers Thrive | UC Davis

connect to each other for the transportation of their products and services. However, it is not sufficient to accelerate this sector yet. Therefore, Cambodia needs more support and cooperation from all relevant stakeholders.

Agricultural sector also could be improved through R&D, notwithstanding a considerable increase in agricultural research in recent years, Cambodia invested in R&D only 0.22 percent of agricultural GDP in 2017 (Stads et al., 2020). From 2013 to 2017, CARDI released seven new crop varieties, six of which were rice and one of which was maize. Even though it is important, but no new varieties of casava, beans, and horticultural crops were in the CARDI's research agenda. The numbers of released varieties were very low compared to the other countries in Southeast Asia.

1.6. Global technology trends in food and agricultural sector

According to a UN FAO report, the world population is expected to rise to 10 billion by 2050 and boost agricultural demand by 50 percent compared to 2013, with an increase in demand for protein sources, fruits, and vegetables. Meeting global food security needs remains a challenge since the demand increases at a rate even faster than the population growth. Economically, the share of agriculture in the world GDP has gone up by 68%, but comparing it with the growing population has been a stable 4% share since 2000[2]. The development and dissemination of new technology is an important key factor determining the future of agriculture.

Technological innovations are beginning to transform every link in the food chain, from farm to fork. In developed countries, digital technologies and data based decision analytics are making farm operations more insight-driven and efficient. Technology is changing the ways that farmers manage their operations. Technological developments in machinery, software and genetics are urging farmers to have more control over how they plant and manage their crops. Agriculture 4.0 an agricultural revolution which science and technology must be put into practices. Agriculture 4.0 will need to look at both the demand side and the value chain/supply side of the food-scarcity equation, using technology not simply for the sake of innovation but to improve and address the real needs of consumers and reengineer the value chain. Agriculture 4.0 will no longer have to depend on applying water, fertilizers, and pesticides across entire fields. Instead, farmers will use the minimum quantities, or even completely remove them from the supply chain. They will be able to grow crops in arid areas and use abundant and clean resources such as the sun and seawater to grow food.

There are three general trends which technology is disputing the industry:

[2] UN FAO report, The future of food and agriculture Trends and challenges

1. Produce differently using new techniques, eg. Hydroponics is the method of growing plants without soil; this technology combines solar, desalination, and agriculture to grow vegetables anywhere in the world. Algae farmed in aquaculture can become a substitute for feedstock and fishmeal. Bioplastics which are a new technology that recycled, biodegradable or compostable any kind of packaging. Desert agriculture and seawater farming, most of the world's surface are sea and deserts.

2. Use new technologies to bring food production to consumers, increasing efficiencies in the food chain, eg. Vertical farming is process of growing plants in vertically stacked layers and able to grow year-round plants with high yields than traditional farm. Connected with urban farming, it uses soil, hydroponic, or aeroponic growing method which less using water, fertilizer, nutritional supplements, and no pesticides, while enhancing productivity. Moreover, genetic modification and cultured meats in order to address food needs in the future.

3. Incorporate cross-industry technologies and applications, eg. Drone technology is giving a high-tech makeover, drone can use for: soil and field analysis, planting, crop spraying, crop monitoring, irrigation, and health assessment. Blockchain is another example of technology which able to reduce inefficiencies, reduce waste, fight food fraud and improve food safety.

The Figure 6 is showing the summary of the three general trends of disrupting technology.

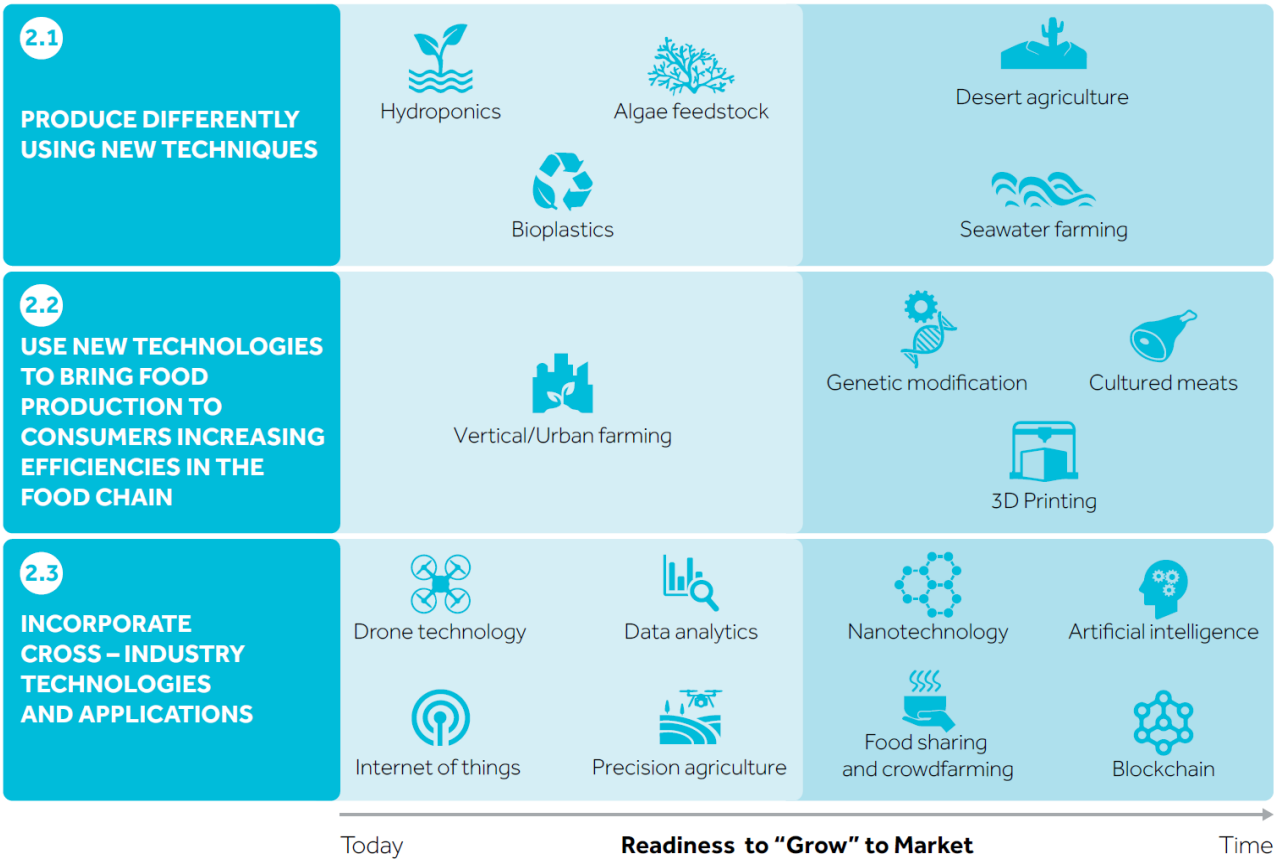


Figure 6: Map of technologies and maturity (Clercq et al., 2018)

2. DEMAND AND SUPPLY SIDES AND TREND OF SECTOR

2.1. National endeavor

Agricultural sector has traditionally been one of main contributors for Cambodia's growth domestic product. In 2019, 22.1% of the growth is from the agriculture sector, while the share was 35.7% in 2000. Overall, it remains important that the sector stands in the front line for two decades of Cambodia's economic development (WB, 2021). Globally, the sector gets hit by the rampant of the pandemic. It is noted the impact seems affected significantly on the demand side due to restriction of mobility between borders among the provinces. Quick response and cash transfer program helps significantly to vitality of the agricultural sector (ADB, 2021).

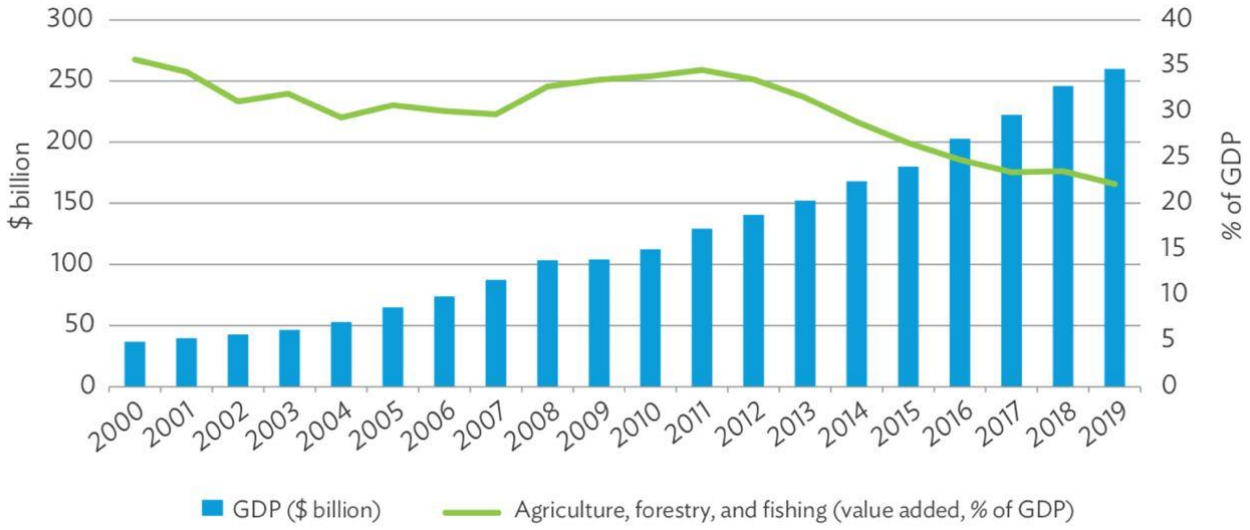


Figure 7: Share of Agricultural sector in Cambodia's GDP. (WB, 2021)

The five-year Agricultural Development Strategic Plan 2019-2023 of MAFF of the Kingdom of Cambodia has been a significant foundation of guidelines to exploit the sector for pushing socio-economic development of Cambodia. The strategy aims to enhance the socio-economic development of the country and alleviate poverty in the next five years. These continuous tools from strategy 2014-2018 address the need to modernize the sector to be more competitive and resilient to climate change with shifting from labor-intensive practices. There are two main priorities by the ministry for development of the sector, which includes 1) increasing productivity, diversification, and commercialization, and 2) efficient management and development of resources viz land, forestry, and fisheries for sustainability. The mission to provide high quality service with foundation of science and technology, legal framework, and sound policy are dimensional to achieve the vision (MAFF, 2019).

The export of the products from the sectors has shown an impressive development for overall view from 2014 to 2018. However, the slight decline of exportation in 2018 as shown in the

Figure 8 below could be one of reasons for the government to take more rigorous initiatives to have the strategic plan 2019-2023 for more resilient growth in the sectors. Despite the growth there are various challenges facing the sector, which include low productivity and competitiveness in market, insufficient infrastructure and logistic support, limited research performance on agricultural technologies, illegal activities on forestry and fisheries, and skill mismatched and gaped of labor (MAFF, 2019).

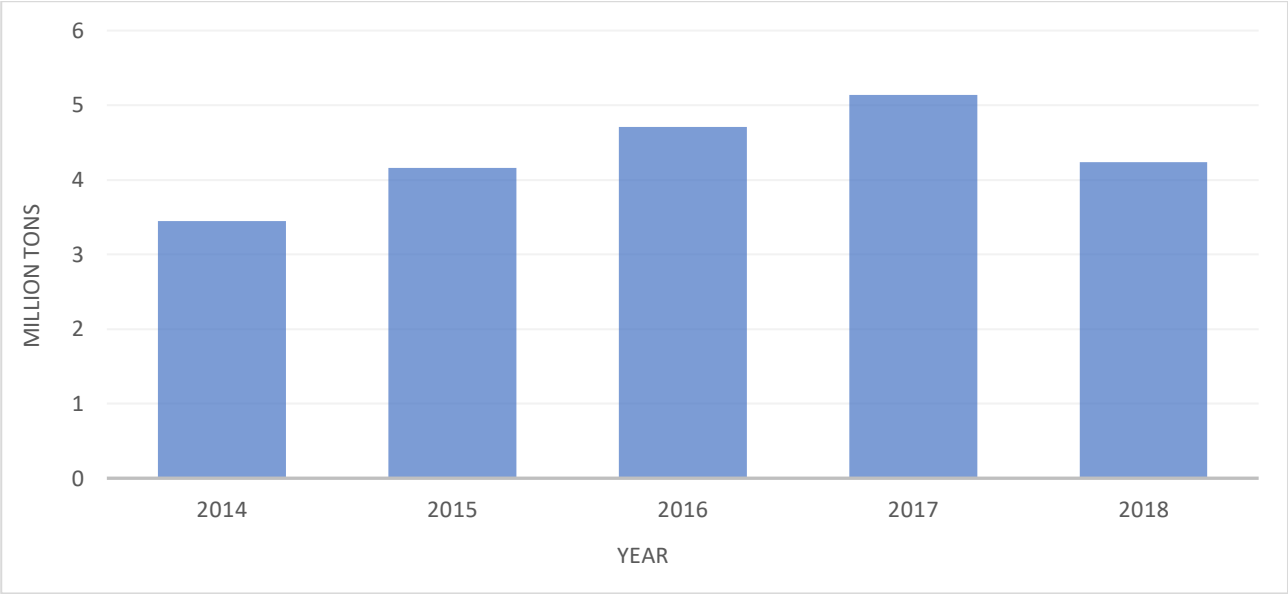


Figure 8: Exports of agricultural products 2014-2018. (MAFF, 2019)

The past decade has shown a remarkable increase of agriculture product exportation. Some subsectors get improvement in reaching global market. It is, however, seen the quantity is much farer if it is compared to neighboring countries. The efforts in production and trading are the two of the common challenges facing some sector such as rice. The data from 2010 till 2019 reveals far lower than Thailand and Vietnam. Figure below (Figure 9) gives paddy rice exportation in yearly basis. Data of milled rice and unmilled rice is not clearly differentiated and accessible. It is seen generally that the constraint for Cambodia's milled rice to reach global market could be insufficient equipment to process the paddy rice. For this reason, modernizing machine could be one of priority of the country to promote (Adapted from ADB, FAO, 2021).

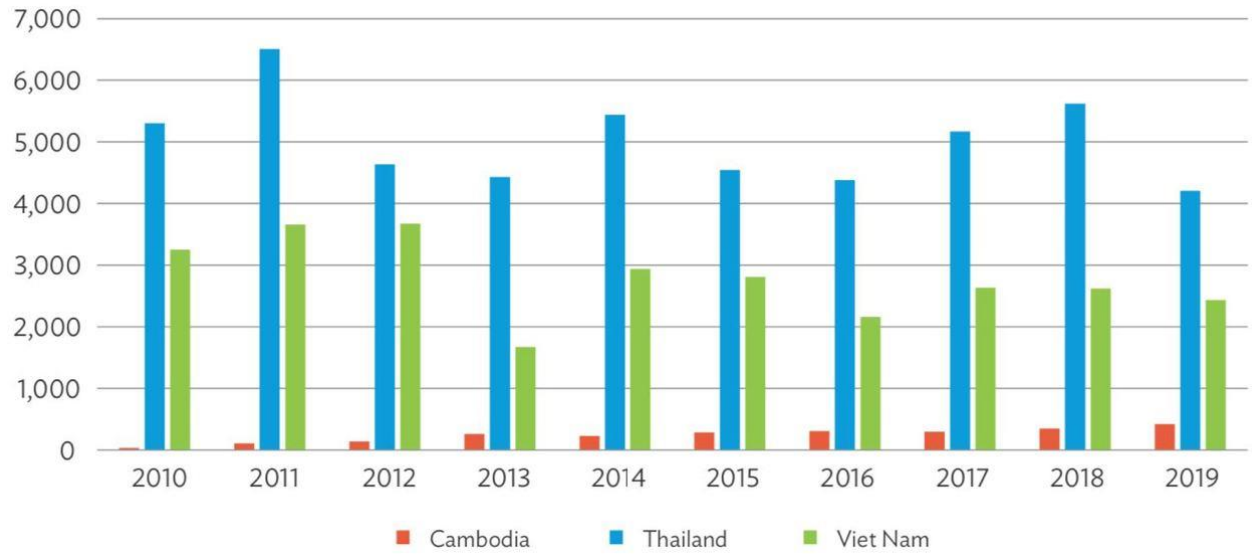


Figure 9: Rice export ($ million, rice milled equivalent). (Adapted by ADB from FAO, 2021)

Overcoming the above challenges MAFF has pointed out in new strategic plan by continuing the existing efforts in sectors and introduction of digital technologies to ensure the agricultural product is more to be in the global or regional supply by 2030 and 2050. Some others weaknesses of agricultural products could be insufficient productions and limited quality, because of high production cost, low technical capability and community management, lack of investment in R&D, climate change, limited trading environment, lack of diversification, lack of investment from government, insufficient supporting infrastructure, required improvement of governance, lack of standard, reduced labor supply, overuse of fertilizer and chemicals, and poor logistics. Also, it is found that some sub-sectors could not supply local market such as cattle, poultry, and pig.

2.2. Trends and opportunity

The agricultural sector remains to be one of Cambodia's GDP shares. However, the percentage has stayed stable around 20% in the last several years. Specifically, while sharing to the GDP from others sectors was decrease during the Covid-19 pandemic, agricultural sector triggers small percentage from 20.8% in 2019 to 22.8% in 2020. Global production of agricultural products has been increasing since 1960. Asia supplies dominantly in terms of meat according to the UN and FAO in their publication for data till 2018. Locally, data for meat production in Cambodia shows supply about a quarter of all local demand (Mony, 2021). For this reason, a call for efforts to supply animal feeds for the local market was made by Samdech Prime Minister in 2019. He urged MISTI to have appropriate support, particularly on the increasing of animal feed production by the local firm. It is expected the local farm will get benefits from these initiatives once animal feed policy is launched. Generally, the consumption of meat shows a significant trend of the demand. Fish is the

dominant meat in every meal of a Cambodian household. It is estimated 50 kg of fishes per capita per year (Sinwat, 2021).

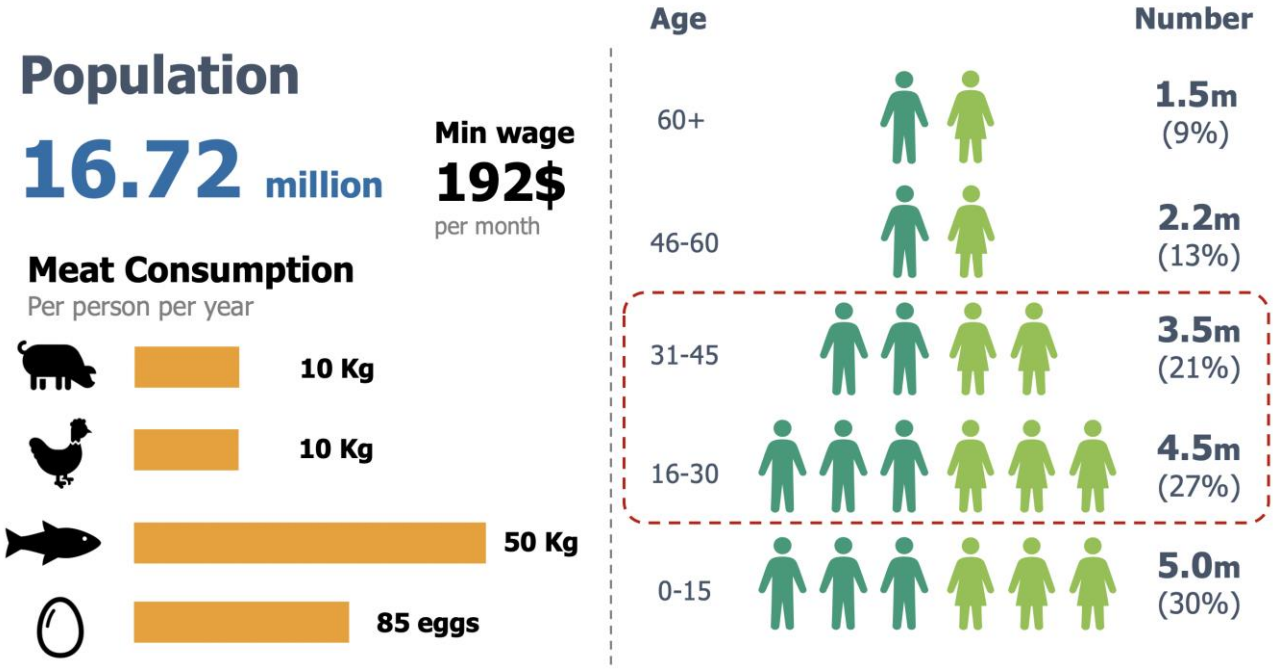


Figure 10: Meat consumption by age by type of meet per person per capita. (Siwvat, 2021)

Other agricultural products such as rice, rubber, and others seem in positive trends in terms of its production. Rubber product has increased nearly double in its productions and export between 2016 and 2020. However, the surplus of rice production in the country looks generally stable since 2016 (Mony, 2021).

Despite the constraints facing agricultural sectors, there could have number of opportunities in this sector still exist, in which some favorable conditions include:

- Potential in accessing international markets (ASEAN, China, Korea, Japan, Europe, US, and others)
- Increase of investment in the sector from ASEAN and China
- Trends in investment in agriculture, eg. One among the majority of committed investments were in the agriculture sector which accounted for 6% of total investment in the last five years, 2015-2019 (CDC, 2022).
- More favorable infrastructure supporting the development of agriculture
- Policy support of food safety and security, eg. National Research Agenda- Cambodia's food 70% for local consumption by 2030.
- Industrial zones development for agro-processing industries, e.g., some initiatives of SMEs Cluster and Agriculture Parks

- Accessing to ICT
- Access to local public service e.g., SMEs Bank, Khmer enterprise, Techo Startup Center, and Skill development fund
- Trend in Demand-driven investment.

3. SECTOR VISION, POLICY AND STRATEGY

3.1. Essential policy for self-sufficient production

Cambodia's agricultural sector master plan 2030 points outs sharply on provide high quality services with a sound scientific, technological and legislative & policy base for developing an efficient and sustainable Cambodian agriculture sector. However, most recent report by National Institute of Statistic reveals the insufficient of local supply of vegetables, meat, fishes, and poultries. The import of these products cost Cambodia to pay annually around 600 million USD. The local supply of the agricultural products for socio-economic development and security of the Kingdom of Cambodia requires an urgent synergy among stakeholders. The report on policy study on "modernizing agriculture sector: long-term vision and policy orientation" published in 2019 by the supreme national economic council (SNEC) provided a comprehensive policy intervention by RGC during the decline of agricultural share to economic development with the last five years (MAFF, 2020). The document shows the projection of agricultural trends toward 2030 to be likely influenced by:

- The economic changing in the region and the increase on the purchasing of agricultural products at regional market
- Increasing use of the agricultural high quality, safety and nutritional products
- The decline of agricultural labor force versus increase of agricultural mechanization
- The decrease of small-scale agricultural production and the increase of rural agricultural enterprise
- The expansion of modern agricultural technologies and digital agriculture system (modernization, online agri-business, ICT and remote sensor)
- The decrease of agricultural land at some urbanization zone.

If it is looked to the Timmer's theory of agricultural transformation, Cambodia seems to be in the early phase of development since the agricultural sectors have been focused substantially on the mass production rather than niche market, high value-added products, and/or strategic development for having the regional or global supply chain. The theory explains four phases in agricultural transformation, which includes i) Phase 1: Beginning, ii) Phase 2: Agricultural surplus,

iii) Phase 3: Integration, and iv) Phase 4: Industrialization (Chenery and Srinivasan, 1988). Study by ADB since 2013 shows Cambodia was in the second phase in 2010. The comparative agricultural transformation of Cambodia and other neighboring countries are given in detail in the below table. If it is used the framework and the agricultural development vision 2030, it is important that sufficient and right investment in the sectors must be done on time, while evidence shows that the sector is softening by number of constraints as given in the above section. Consideration could be investment in R&D, skill labor investment, technology transfer, mechanization, strategic subsectors having high valued added potentials, trading ecosystem, environmental sustainability, and technologies.

Table 1: Comparative development of agricultural transformation of Cambodia and others (ADB, 2013)

		Countries in 1980	Description	Countries in 2010
Beginning		Bangladesh, Cambodia, Nepal, Viet Nam	Low income country; agricultural labor productivity only $240. Agriculture's output share is 37%, and employment share is 66%	Nepal
Agricultural surplus		Bhutan, India, Indonesia, Kyrgyz Republic, Lao PDR, Pakistan, PNG, PRC, Sri Lanka, Samoa, Uzbekistan	Low income countries; agriculture output share ranges from 19% (Bangladesh) to 36% (Cambodia); employment share from 33% (Kyrgyz Republic) to 85% (Lao PDR). Agricultural labor productivity ranges from $434 (Cambodia) to $947 (Pakistan).	Bangladesh, Cambodia, Kyrgyz Republic, Lao PDR, Pakistan, PNG, Tajikistan
Integration	**Early**	Armenia, Philippines, Tajikistan, Thailand, Vanuatu	Middle income countries. Agriculture's labor share ranges from 33% (Sri Lanka) to 52% (Viet Nam); output share ranges from 10% (PRC) to 21% (Viet Nam). Agricultural labor productivity as low as $367 (Viet Nam), up to $1,100 (Philippines)	India, Indonesia, PRC, Philippines, Thailand, Sri Lanka, Viet Nam
	Middle	Georgia, Malaysia, Rep. of Korea	Middle income country. Agricultural labor productivity is $2,800; output share is 20%; employment share is 38%.	Georgia, Samoa, Uzbekistan, Vanuatu
	Late		Middle income country. Agricultural labor productivity approaching $ 7,000; employment share of agriculture is 14%; output share is 10%.	Armenia, Malaysia

Industrialized	Japan	High income countries. Agricultural labor productivity ranges $6,423-$76,830 (median of $33,450). Output share ranges 0%-3.9% (median of 1.9%); employment share ranges 1.0%-10.9% (median of 2.9%).	Rep. of Korea, Japan

Lao PDR = Lao People's Democratic Republic, PNG = Papua New Guinea, PRC = People's Republic of China

Notes:

Output per worker is measured in constant 2000 dollars; per capita income is measured in constant 2005 PPP-adjusted dollars. 2010 represents either 2010 or the final year for which data is available; 1980 represents 1980 or the earliest year for which data is available.

High income: GDP per capita above $20,000; *Middle income*: $2,500-$20,000 GDP per capita; Low income: Below Middle income. Middle income can be demarcated further as Upper middle (U), at GDP per capita above $6,125 (In 1980 no country in Asia was in the Upper middle income level) The sub-stages under the Integration stage are demarcated as follows: Middle income countries with labor productivity of $1,750 or below are in the Early integration phase; between $1,750 and $3,300 are in the Middle integration phase; and above $3,300 are in the Late integration phase.

SNEC report suggests three strategic objectives for Cambodia, particularly to MAFF to oversee seriously in order to ensure the sustainable development of the country. The three are 1) boosting economic opportunity through crops development, diversification of production, and agriculture commercialization and agrobusiness, 2) enhancing food security, and 3) promoting environmental sustainability. It is in generally concluded the necessity of policy support must be in place as soon as possible if the master plan of agriculture 2030 is to be realized. In summary, the improvement at the upstream part of agriculture supply must be done firstly at site, and the support on the downstream is made secondly together for the easy access to the market. In addition, the aspect of sustainable development is in inevitable through proper usage of land, pest, and herbicides, and other inappropriate use of chemicals and/or practices (SNEC, 2019).

3.2. Sustainable agriculture

The impact of climate change on agricultural activities is normally considered at first hand once there is disruption to usual practices among Cambodia's farmer. Cambodia is one of most vulnerable countries in the region (WB and ADB, 2021). Furthermore, sustainable agriculture for Cambodia means beyond its link to climate change. For these reasons, it is necessary important to reiterate again SNEC report emphasizes the long-term development of Cambodia must address:

- Promoting socio-economic growth, job creation, and generating income
- Building food security
- Promoting environmental sustainability (sustainable agriculture, sustainable forestry, and sustainable fisheries).

3.3. Technological trends in agricultural sectors in Cambodia

Technologies have always been linked with agricultural development since the beginning of agricultural revolution between 17th CE and 18th CE. The application of technologies is indispensable from upstream at farm to downstream at fork. For instance, the introduction of mechanized agriculture equipment in Cambodia provided the increase of land use for agricultural activities, which results in high productivity in the last several years (Chen, 2018). More demand for high quality of food products requires not only good agricultural practice, but also handling processes to the table of consumer. It is known that some drivers are being the contributors to the transformation of agricultural activities. Technology will surely play a fundamental role in the development of agricultural transformation. Some concepts of agribusiness of downstream contributes actively to the transformation. They include, but not limited to, safety and hygiene, convenience and affordability, value chain, alternative food, and sustainable agriculture development.

On the other hand, the upstream part must harness the potential of technological development viz smart farming initiatives as one of the concepts in industrial revolution 4.0. Cambodia is not different from other emerging developing nations, harnessing as soon as possible the potential of technology to acquire the endeavor to be upper-middle income countries 2030 and high income 2050 is the required stepping stone. Data gathering and systemizing is one of the first fundamental factors to be done in current context for Cambodia. Thus, building platform as big data for smart farming is an example to be considered (Wolfert et al., 2017).

4. NATIONAL AGRICULTURAL TECHNOLOGY ROADMAP DEVELOPMENT

The Agricultural Technology Roadmap (AgriTech Roadmap) is a guiding document that indicate critical technology candidates and development pathways within ten years – by 2030. Moreover, this establishment provides the prioritization and guiding principles of investment to government, private sector, and academia institutions on the technologies identified in this roadmap. Based on background information, the main objectives of AgriTech Roadmap are:

- To develop a Technology Roadmap for the implementation strategy to support the National Policy on STI 2020-2030 and other policies to promote the development of the agricultural sector.
- Provide a strategic direction to address the challenges in agricultural technology.
- For Cambodia to catch up the transformation of industry revolution 4.0

The process of developing an AgriTech Roadmap (Figure 11) is carried out in the following phases:

1- First step is the identification of a vision and goals for the agricultural sector in Cambodia over the next 10 years and the crucial technology needs to develop this sector in the region and the world, especially to contribute and accelerate the growth of the national economy.

2- Environmental analysis that consists of social, technological, economic, environmental and political drivers. Then, the opportunities and threats of the agricultural sector based on the drivers are identified.

3- Third is the identification of candidate strategic products/services. Then, the prioritized products/services are selected through scoring from the expert committees.

4- Fourth is the identification of key technologies. Then, key technologies are rated to select the prioritized key technologies by the expert committees.

5- Finally, charting of technology roadmap is set with a period from short, medium, to long term.

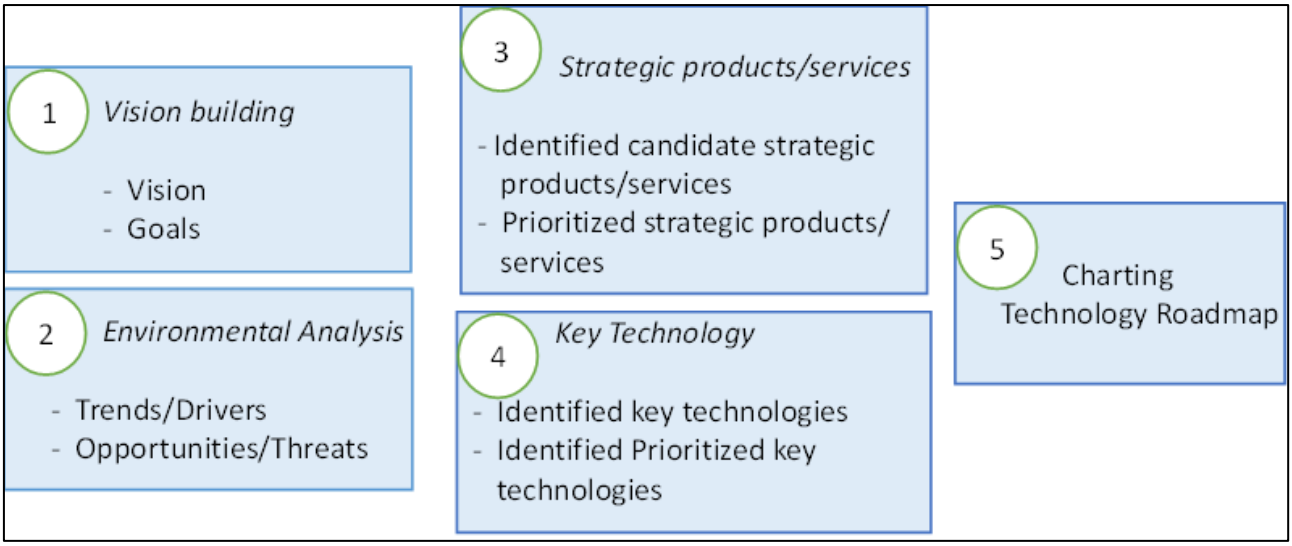


Figure 11: Process of AgriTech Roadmap Development

4.1. Building vision and goals

Vision

To increase productivity of agricultural commodities and high value-added production/services for global supply chain through technology and innovation by 2030.

Goals

To harness the power of Science Technology and Innovation in agricultural sector to:

1. Increase the agricultural productivity and quality infrastructure, food security and for export.
2. Leverage the high value-added production/service to agricultural commodities to increase the agricultural contribution in the gross value added (GVA) and export.
3. Integrate agricultural commodities into the global supply chain to expand Cambodia's agricultural businesses and reputation into international markets and networks.

4.2. STEEP analysis

In order to identify strategic products, we need to understand the market and environmental aspects. The STEEP analysis looks at external factors that influence trends, enable analysis of the past and predict the future. STEEP cover five most important factors, which is acronym for Social, Technological, Economic, Environmental, and Political. Future events of AgriTech Roadmap in Cambodia, trends and broad range of drivers are explained in STEEP analysis as shown in Table 2.

Based on drivers from STEEP analysis, the following opportunities have been generated:

One of the main drivers is globalization (ASEAN, China, USA, Europe, Japan, …) which shares a lot of benefits to Cambodia population by opening the door for exports including agricultural commodities to parts of the world. Since globalization creates potential of expanding quality product to local and international market; thus, strategic products in order to promote trading and marketing of Cambodia agricultural product should be on the focus.

Cambodia government has tried its best to increase the trade facilitation for exportation of all types of goods including agricultural products. Recently, Regional Comprehensive Partnership Agreement (RCEP) will eliminate tariffs. RCEP will give Cambodia's SMEs and consumers with increased commercial opportunities and partnerships. There will be more opportunities for local enterprises to boost exports, especially in new value chains in the region, and increase foreign investments. Free Trade Agreement (FTA) favorable to agricultural products: FTA with Korea, and FTA with China. Even though the vast majority of Cambodia's exports to China are tariff-free through

the ASEAN-China Free Trade Area (ACFTA), the China-Cambodia FTA extends tariff-free trade to over 340 products, such as seafood products, garlic, cashew nuts, and dried chili, among others (add reference). Example, the export of fresh Cambodian mango was made possible because both countries were able to finalize sanitary requirements for fresh fruit in June 2020. Cambodia also has many potentials of Geographical Indication (GI) products for export. GI protection has wider positive benefits, especially for local communities. In particular, it encourages the preservation of biodiversity, local know-how and natural resources. Three main PI products of Cambodia includes Kampong Speu palm, Kampot pepper, Koh Trong pomelo. More GI products are on the way to be recognized such as prahok Siem Reap, Phnom Srok silk, Battambang fragrant rice, etc. Thus, processing of above agricultural products and other products should be the prioritization which leads to support on the development of strategic products.

In recent years, large enterprise, larger privatization and contract farm (Cai et al., 2008) are also drivers lead to mass production which potential support to the local food security and the global supply chains. To increase the high value added on the product of current agricultural commodities, harvest and post-harvest technology is important and needs to be developed.

Young population (60% under 25) is also one of the drivers that makes Cambodia potentially at ease of technology adaption and adoption. The use of technology and innovation products to boost agricultural productivity is necessary. With the opportunity of its young population and the needs to deploy technology in agriculture, farm machinery and technology or high-tech machinery is strongly recommended as the strategic products.

Good access to ICT and internet connectivity has been one of the strengths. Based on World Bank, ITU and GSMA statistics 2020, the mobile connections in Cambodia reached 21.18 million, and mobile penetration reached more than 126%. The internet users are 8.86 million and the penetration reached 52.6% by January 2021. This data increased by 1.1 million which is +14% within just one year. Average Mobile Data of Usage (DOU) per month is more than 30 Gigabyte, which is 3 times of global average and higher than that of neighboring countries in ASEAN. Due to the climate change which is known as global drivers, there are opportunities that country should create agricultural technologies responded to climate change via ICT; example, the needs to make precisive decision in farming. Thus, strategic services such as smart farming, indoor farming, precision agriculture, or even more advanced technology such as computer modeling could be put into prioritization.

In regards to soil and water quality, Cambodia has advantage of rich fertile soil, and abundant of water sources. Though, agricultural productivity in Cambodia has been suffered by insufficient of

water management and irrigation (Sithirith, 2017). Thus, strategic product in water management and irrigation system should be developed.

Overall, there are 10 strategic products/services that are driven from opportunities generated by the current social, technology, economic, environment, and politics context. However, based on voting and consensus discussion of different stakeholders in agricultural sectors (Government, Private, University), 6 has been selected due to theirs most importance of economic impact, strategic importance, and potential for success (see annex 6.1).

Table 2: Analysis of environments and identification of strategic products

<table>
<tr><td>Vision</td><td colspan="5">Increase productivity of agricultural commodities and high value-added production/services for global supply chain through technology and innovation by 2030.</td></tr>
<tr><td>Goals</td><td colspan="5">1. Increase the agricultural productivity and quality infrastructure food security and for export.
2. Leverage the industrial high value-added production/service to agricultural commodities to increase the agricultural contribution in the gross value added (GVA) and export.
3. Integrate agricultural commodities into the global supply chain to expand Cambodia’s agricultural businesses and reputation into international markets and networks.</td></tr>
<tr><td>Drivers</td><td>Social:
Young population (Approximately 60% are under the age of 25)
Increasing consumerism of finished products.
Consumer awareness on food safety</td><td>Technological:
Drone
Digital control
Remote sensing
Automation
Mechanization
R&D for new invention
Post-harvest technology
High tech processing technology
Internet of Things</td><td>Economical:
Growing economy
Productivity increase
Globalization
Large Enterprise
Larger privatization
High production cost compares</td><td>Environmental:
Environment pollution
Soil and water quality
Climate change
Poor Pesticide application</td><td>Political:
Political stable
Encourage
Support (technical and financial) from the government
Rice policy formation
Land titling
Trade facilitation
GI policy</td></tr>
</table>

	• Safety/Security (lifestyle change) • Nationalism on agricultural products. • Decrease of workforce in agriculture sector • Consumer behaviors (Local, regional, international)	• Big data analysis • Artificial Intelligence (AI) • Immersive/ game tech • Robotics • Satellite technology • Mobile technology • Nethouses • Indoor growing • Vertical growing • Sensor technology • Waste reduction technology • Cellular	to other counties • Internationalization for investment • Local products consumption • Stable inflation • Controllable • Finance accessing facilities (Bank, SME bank, Enabling)	• Right crops selection • Biodiversity	• Food safely standard regulation • Regional comprehensive economic partnership (RCEP) • Free Trade Agreement • Agricultural technology supporting regulation • Conducive policy to attract investor
Opportunities & Threats	**<u>Opportunities</u>** • Free trade agreement favorable to agriculture products • Potentiality of expanding quality product to local and international market • Increased new technology needs in agricultural field • Access to ICT and internet connectivity		**<u>Threats</u>** • Vulnerable to climate change • Lack of trust of consumers • Financial dependency and high investment cost • Uncontrol food trade • Lack of reliable internet speed in rural		

	• Technologies responded to climate change • Potential of strategic products (GI products) • Availability of fertile soil and abundant water sources • Potentiality of technology adaption and adoption • The needs to make precise decision • Mass production	• Barriers to trade in term of condition • Bureaucracy and fragmented • High cost of transportation/energy • Lack of maintenance service • Import products from outside • Decrease workforce in agriculture sector • Global epidemic of Covid-19 • Insufficient of irrigation system • Insufficient of high-tech human resources
Products/Services	**Candidate Strategic Products/Services** - Precision agriculture - Farm machinery and technology - Marketing and trading - Water management and irrigation - High tech machinery - Smart farming - Harvest and post-harvest - Computer modelling - Indoor farming - Processing	**Prioritize Strategic Products/Services** - Farm machinery and technology - Water management and irrigation - Harvest and post-harvest - Computer modelling - Marketing and trading - Processing

4.3. Key Technology

Figure 12 illustrates the structure of AgriTech Roadmap including vision, direction, strategic product, and key technology. In order to support vision and achieve goal by 2030, three main directions are strongly oriented: increase productivity of local product, increase high value-added product, and integrate Cambodia product into global supply chain. Within these three directions, together with drivers from STEEP analysis, strategic products & service are set by committee members and 6 of them are selected as prioritization. The three directions cover 6 main strategic products and services including farm machinery/technology, water management and irrigation, harvest and post-harvest, computer modeling, processing, and market/trading. As shown in the Figure 12, each strategic product contributes to the development of many key technologies. In addition, one key technology also possible to serve the purpose of more than one strategic product/service as indicated by connection link in the figure. The thicker the line, the more importance or more frequent used of the key technology to strategic product/service.

The 48 key technologies listed in this figure are the candidate strategic product/services. To sharpen their significance, score is given to each key technology based on strategic important serving to vision, and feasibility for short term, medium term, and long term (see annex 6.2). The selected key technologies are considered to be prioritized key technology which they were added to charting in figure 13.

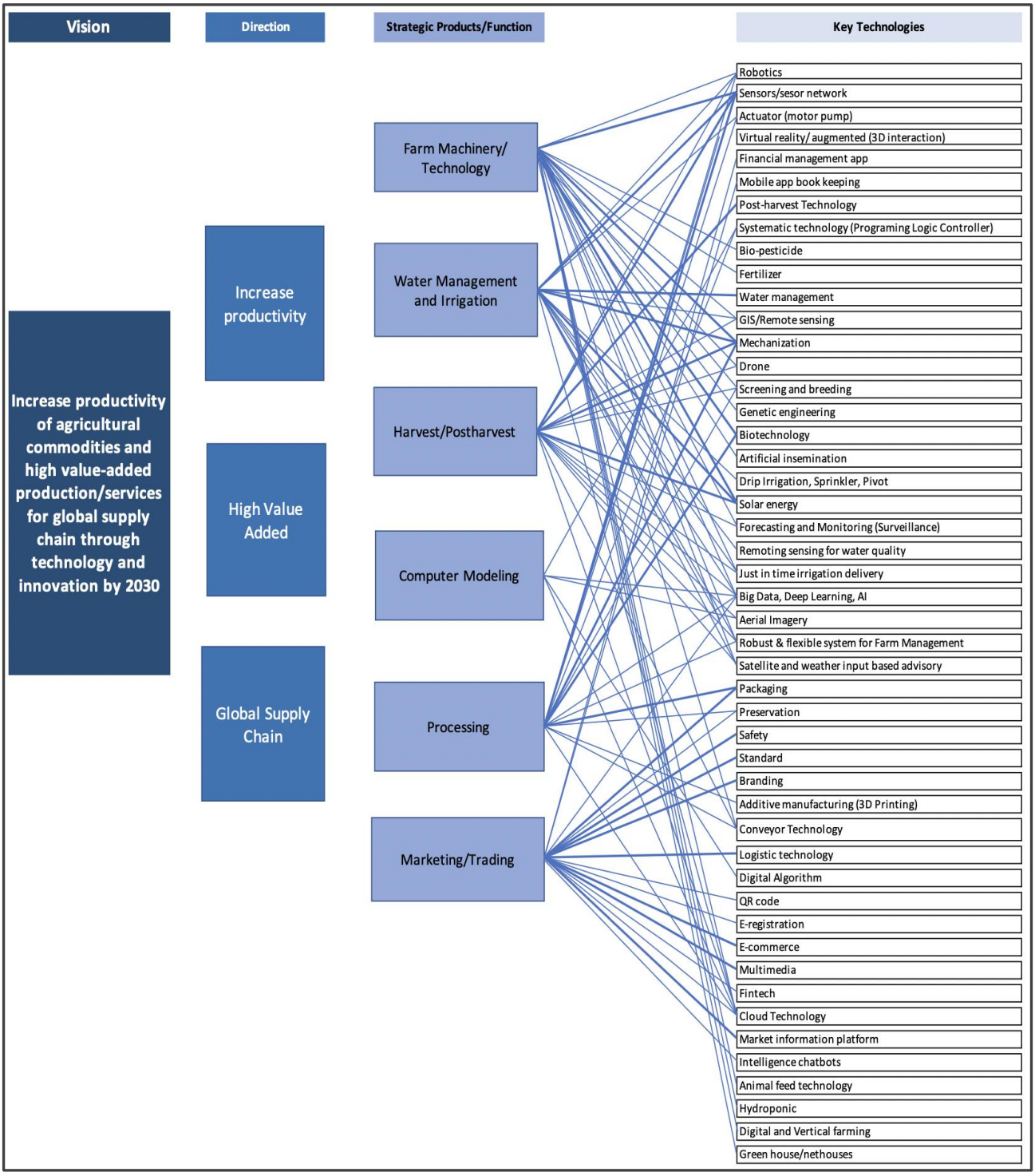


Figure 12: Key Technology

4.4. Charting Technology Roadmap

Figure 13 depicts the charting AgriTech Roadmap in response to the vision of increasing productivity of agricultural commodities and high value-added production/services for local consumption and for export and, for the ultimate goal, to integrate itself into the global supply chain by 2030. To realize this vision, efforts must be continuously put into the introduction of changes from a traditional method to modern practices by utilizing the power of science, technology and research in order to obtain the increase of productivity, improve quality, enhance efficiency and promote sustainability. Technology and innovation will be amongst the best available, if not the sole, means to achieve the above-mentioned criteria. Increased agricultural production, in turn, could offer a great deal of employment opportunities, food security, poverty reduction, income gap minimization, and economic development especially for the rural farmers.

This charting roadmap outlines the technologies, ranging from simple mechanization to advanced and sophisticated technologies, to be deployed in agricultural sector in pre-defined strategic products/function, explained in the previous section, including farm machinery/ technology, water management and irrigation, harvesting and post-harvesting, computer modelling, processing and marketing and trading, in the short (present-2024), medium (2024-2027) and long term (until 2030) for Cambodia to embraced.

For the short term, until 2024, the focus shall be placed on farm mechanization, Agricultural mechanization refers to the application of machine, equipment or tool to replace human's labor and animal force to improve the efficiency and increase the productivity. Mechanization is broadly categorized into 3 different levels from low, medium and high performance. The higher the level, the more sophisticated the mechanization will be, and the higher training the operators will be. The use of mechanization depends on the type and the scale of the agricultural farms. For example, the large-scale farms take advantage of an economic scale of the increased products and tend to equip the farm with more sophisticated modern mechanization of its production, storage and distribution process. While the relatively small-scale farms are reluctant to invest in big machinery in their production line. However, the mechanization of both the large and small agricultural farming system has become very indispensable for increasing crop and livestock yields. This is because of the reason that mechanization can be easier to supervise labor. The shortage and limited availability of labors especially in remote areas or where the job in farming is not attractive could even exacerbate the situation and force to adopt the new mechanization technology even more. Hence, in the short term, it is very crucial to focus on farm mechanization. Fertilizer and animal feed, actually, despite not receiving many scores from the committee's voting, was also considered the priority in the short

term based on the interviewing with experts and firm owners. It is reported that fertilizer and animal feed pose problematic challenges for farmers and firms to ensure that the animals as well as crops receive the nutrition they need throughout the year. That could be one of the reasons why the yield is not sufficient enough for local consumption, not to mention for commerce and export. On the other hand, fertilizer and animal feed have to be imported from the neighboring countries and abroad. As a consequence, the price tends to be relatively higher comparing to that of other countries in the region. For this reason, the technology of fertilizer and animal feed production alone would help tackle a lot of challenges faced by farmers and companies for not only increasing the yield but also its quality. Water management is another alarming concern for farmers in Cambodia. It is widely known that Cambodia is among the most vulnerable countries in the world to climate change, suffering from flooding in the rainy season while drought in the dry season caused by irregularity and unpredictability of climate change affected people's life and wellbeing (UNDP, 2013). Water stress poses a serious problem to the majority of farmers in Cambodia, and consequently allowing farmers, especially paddy rice farmer, to farm and harvest only once a year, strictly in rainy season where water is surplus. This is comparatively disadvantageous comparing to those of the neighboring countries, where water sufficiency is not a problem because of the efficient water management system enabling them to harvest twice or even three times a year. Evidently, if water scarcity alone could be addressed, the productivity will be increased significantly, not to mention with the introduction of cutting-edge technologies. Thus, an effective water management system and irrigation technologies must be placed in the priorities to be tackled in the short term. Improving the surface irrigation shall be the first step to dealing with water stress and shortage in the rural area. The more modern techniques or technologies such as drip irrigation, sprinkler and so on shall be deployed in small to medium farms. The more advanced tools, integrating with ICT, such as pivot irrigation system, irrigation scheduling, just in time water delivery, shall be introduced in large farms. The technologies for the efficient use of energy in irrigation will be effective and efficient for water management while rain harvesting techniques and storage system technologies could be effective for ensuring water sufficiency. Minimizing the evaporation loss technologies from the water reservoir and irrigation storages could be another factor that could put into account for water preserving. Screening and breeding are another technology that should be embraced in the short term. Selecting the right breed and variety is of importance to ensure the high productivity, resiliency to the different climate condition and to the climate change as well. The available techniques and technologies ranging from simple such as eyes observation to advanced tools such as biotechnology could guarantee the most optimal selection of variety for specific areas and

climate condition. Best practices on screening and breeding techniques shall be shared and made known to farmers, especially in the small-scale farms, to the last mile possible. Last but not meant least, to promote the industrial value added to the agricultural products, in the short term, it is very crucial to uptake the techniques/technology for preservation and packaging. Preservation techniques, including coating, cool chain transport, cool storage, freezing, disinfection, cold bot tech and so forth could ensure the maintaining the products' quality and expanding products' shelf-life. On the other hand, preservation techniques could boost the export of the finished products to the international market. Packaging technology including coating, modified atmosphere packaging (MAP), vacuum, aseptic, etc, if properly and effectively deployed, could promote industrial high value added significantly. Perseveration, together with packaging, technique/technologies not only could bring high value added to agricultural products, but also promote diversification and dynamism for export. Access to market information is also perceived to be important for farmers to get all the information needed regarding the price, demand, supply and others. Government shall put the effort in establishing such platform, preferably in the online form, as it does not only enable farmers to access all the information they need for their products, but also allow farmers in the remote areas to access all the information equitably, which subsequently minimize the information gap. The ease of business registration and removal of the complicated barrier is believed to be vital to take into account. The e-registration platform is considered to be the most effective way considering the current context of the covid 19 pandemic and for the future development.

In the medium term, technologies for energy generated from alternative sources such as solar, wind, hydropower and biomass shall be adopted. Agricultural productivity in the modern time largely relies on the energy. Machineries and technologies deployed in the farming production, demand of energy to operate. As the world is now committing for the greenhouse gas emission reduction and fight with climate change, in addition to the great demand for energy usage along with high prices of energy, caused the need of improving the agricultural energy efficiency and the exploring the alternative energy sources. In the consultation workshop suggested that energy is a problematic issue for all the manufacturing and industrial activities in almost all sectors in Cambodia. First and foremost, the price of the electricity and fossil fuel is much higher among other countries in the region. Frequent electricity blackout is another major concern that could exacerbate the situation even worse. As a result, the need to identify the alternative energy sources or the development of fuel-substituted energy generation technologies for agriculture and production will be the priority that should be identified for the substantial growth. Solar energy is consensually agreed to be the best possible option for Cambodia to embraced based on the suitability,

availability, contextuality and climate condition. Photovoltaic systems promise to be affective and provide the best solution for the current existing challenges faced by many farmers regarding energy. PV panels can be installed in the open field where the sunlight is penetrated easily and suffice for daily use throughout the whole use. The private off-grid systems are yet another possible option that the farmers and farming productions could make a good use of to their advantages. With the advancement and the cheaper price of the battery technologies, this system could enable the use of energy day and night and whenever deems necessary.

Another major challenge faced by the farmers is logistic issue especially in transporting and distributing their products to market and, even worse, for export to abroad. The major problem is the cost and unreliability of logistic system. Improving the efficiency of logistics could help farmers and producers to sell their agricultural commodities fast and in high prices. In addition to improving the physical infrastructure for logistics, the online platform such as e-commerce and marketplace platform is reported to be effective solution to help farmers and agricultural producers sell their products and deliver to consumer fast and effectively. Traceability is agreed, by the expert, to manage and trace the destination as well as the origin of the products sold on the market, it could subsequently gain trust from sellers and consumers alike that could result in increasing the commodity prices. Blockchain-enabled technology is voted to be the most effective tool for traceability.

In the long term, the charting agriculture technology roadmap depicts the necessities to embrace the highly sophisticated technologies such as sensor, sensor networking, GIS, drone, robotics, fintech, blockchain enabled technology and biotechnology as they could enhance efficiency and effectiveness and to get the maximum benefits from the highly connected between cyber and physical world, and it also could tackle the problems of the shortage and the unavailability of the manual labor workforce as well. Standard, safety and branding are all crucial for future prospects for agricultural sectors in order to bring the highest possible value added to the agricultural commodities. Additionally, these requisites could enhance the competitiveness of Khmer local products in regional and global market as well as to integrate itself into the global supply chain. Safety and standard shall play in the central role in value creation of products for local consumption and export. Safety and standard do not only refer to just ensuring the safety of the products to the consumers' life and health, but also the ability to meet with the international and the destination countries' standard and safety requirement. Hence, technologies shall be required to ensure the compliance of the test parameters required by the exported destination countries. Lastly, promoting the branding of local products shall play a very vital role in enhancing high value-

added products and integrate into the global supply chain. For high value creation, products required to complement the quality, safety and standard with the innovation, design, branding and marketing. Hence, the government could also help to promote national commodities through smart foreign diplomacy.

Government plays a very crucial role in order to achieve the set-out vision through various policies, regulation framework, incentivizing schemes and others. The nation's output will be depended on the national productive assets and capitals including physical capital, human capital, infrastructure capital, intellectual capital, natural capitals as well as social capital. The physical capital includes all the apparatus and equipment necessary to produce the national outputs. Human capital consists of education, training, skill, experience, health with other quality values of the citizens that be able to involve in national production outputs. Infrastructure capital refers to both physical and soft infrastructure including electricity and Internet that enable for the production and export. Intellectual capital can be the scientific and technological capabilities of all actors in the national ecosystem. Natural capital refers to the fertilized soil, clean air, potable water and other softies of the environment. Last but not least, the social capital consists of the relation, network, nationalism and trust of the citizens in the country. As a result, the government need to put an effort and also make an investment in these national asset and capital, not only in the agricultural sectors, but also in the others. Most importantly, government shall have policy and regulation financial support for the farmers and agricultural companies to adopt technologies in their production line. Moreover, it is the ensure that the farmers could utilize and harness the available machineries and technologies to their fullest. Thus, the government shall provide the skill development scheme to upskilling and reskilling to farmers and local firms in technologies and their needed skillsets. Technology transfer mechanism shall be in place to ensure that the technologies, know-how, high skillsets, best practices will be transferred from high-tech farms or firms to the lower-tech farms or firms. Hence, the government shall provide the environment that is conducive to learning among actors across the agricultural value chains. Last but also importantly, enabling ecosystem for innovation and entrepreneurship especially in the industrial high value-added sector is of equal vitality for future economic growth. Thus, the government shall pursue the policy to ensure the macroeconomic stability, trade facilitation, IP protection law and standard compliance.

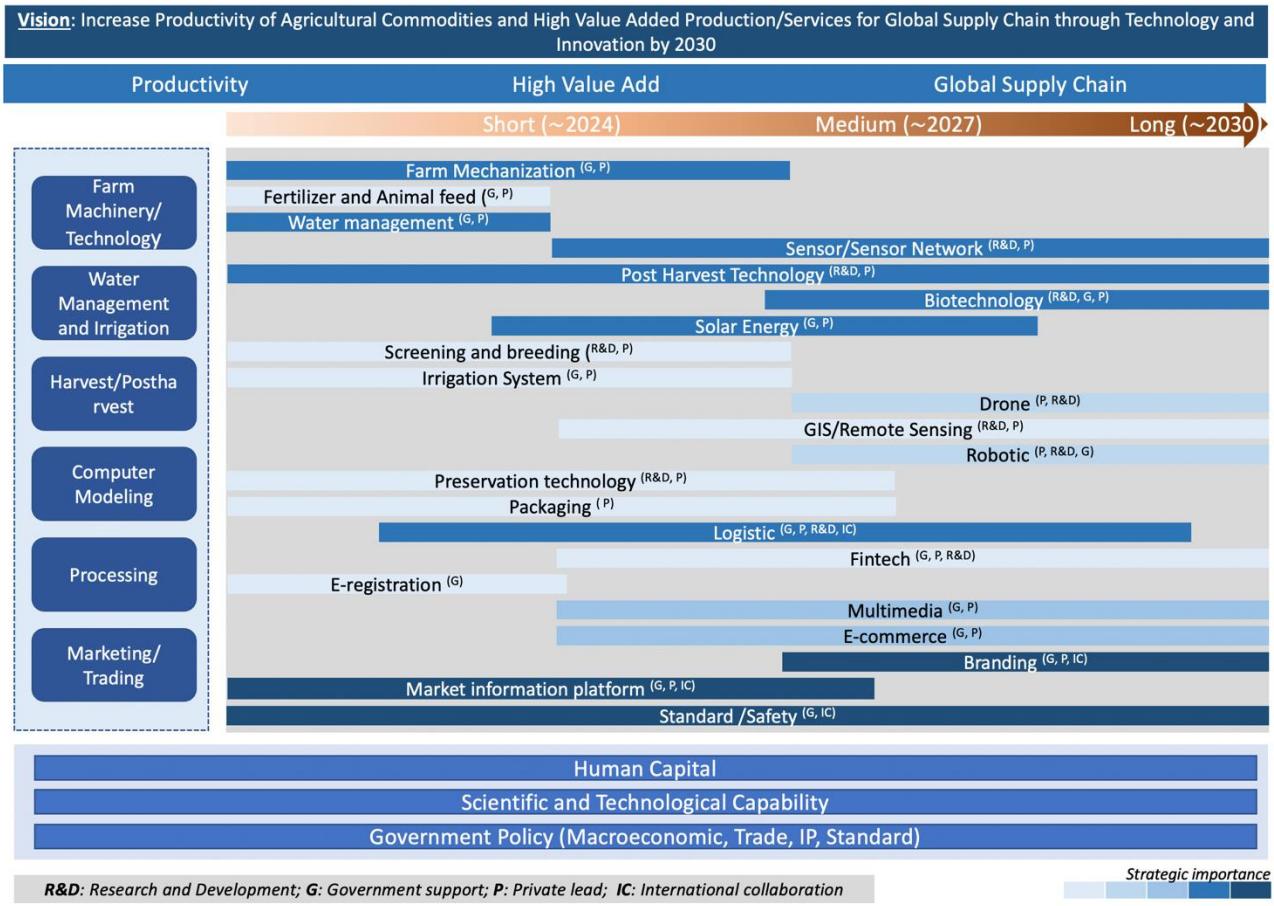


Figure 13: Charting Technology Roadmap

5. CONCLUSION AND RECOMMENDATION

Agriculture is among the main sources of income, employment, and livelihood of the populations of Cambodia. It will be remained the same in the next several decades. Agricultural production consists of all aspects of cultivation, harvesting, processing, storage and transportation and distribution, and it utterly depends on the availability of labor, water, arable land, energy, fertilizer and other resources. Agricultural mechanization and technologies have been practiced for several centuries especially in the developed world. Machinery and technology have become indispensable for modern agriculture and farm. In recent decade, it is witnessed a giant leap in agricultural machinery and technologies, especially through the development and deployment of innovative agricultural practices including automation technologies and data driven and real-time deep learning capabilities of various modern cutting edged technologies. Nonetheless, these practices have been seen in developed countries, which could be a lesson learned for developing countries to diverge traditional technologies practiced.

This AgriTech Roadmap has identified the technologies that Cambodia needs to embrace for its future development to realize the goal to increase productivity and high value added of agricultural commodities for global supply chain through technology and innovation by 2030 based on the evaluation of the current condition by STEEP analysis to identify the drivers, and in turn, determine the strategic products/function and key technologies.

Last but importantly, the overall recommendations for the adoption of technologies for agriculture sectors are provided as follow:

- Science Technology & Innovation (STI) shall be the driving forces for future development in agricultural sector and others. Harnessing the power of STI could enable productive structural transformation and in turn shall leverage high performing economies.
- Investing in R&D in agriculture including animal sub-sector and fisheries is very vital for increasing sustainable productivity, competitiveness, adaptation and resilient capabilities. Innovative enabling policies or platform from the government plays a crucial role in pulling out both public and private investment in this R&D sector.
- Enhancing quality and standards of agricultural products are key to effectively compete in the regional and global market. Having a strategic driver to strengthen the performance of quality infrastructure service providers in response to global market requirements.
- To increasing technology enhancement and adoption in agricultural sector in Cambodia, the government should strategically and financially support the development of agri-food industrial parks or zones because necessary infrastructures and special facilities are to developed for agricultural value-added productions and export.
- Government agricultural policies should focus on private sector, farmers and key stakeholders along supply chains from production to markets.
- The public-private partnership on increasing accessibility of inclusive finance schemes/ programs for promoting mechanization and technology adaptation in agriculture should be supported and available for any farm production and agricultural businesses.
- The government should initiate and support a collaborative scheme among governmental bodies, academic institutions and private sector to work together, to provide affordable, available, and accessible consultation services to farmers and local agricultural firms.
- Government should create an enabling framework/ platform that effectively engages with existing resources from academic institute, development agencies and governmental bodies to improve a critical mass of agricultural experts and a next generation of well-trained farmers.

- Government shall promote technology transfer mechanism to be in place for ensuring the transfer of technologies, knowledge, skillsets, know-how, best practices, and business models to strengthen local farm/firm capabilities.

6. ANNEXES

6.1. Scoring Strategic Products/Services

Products/Services	Code	Evaluation Criteria			Sum
		Economic Impact	Strategic Importance	Potential for Success	
Precision agriculture	P1	45	47	46	138
Farm machinery and technology	P2	54	54	49	157
Marketing and trading	P3	54	53	52	159
Water management and irrigation	P4	50	51	50	151
High tech machinery	P5	47	48	45	140
Smart farming	P6	46	48	47	141
Harvest and post-harvest	P7	51	52	49	152
Computer modelling	P8	47	49	46	142
Indoor farming	P9	36	41	37	114
Processing	P10	53	53	52	158

6.2. Scoring Key Technology

Key Technology	Strategic Important	Feasibilities		
		Short Term 2024	Medium Term 2027	Long Term 2030
Safety	48	46	47	48
Branding (GI, QR code, Radio Frequency Identification)	48	46	46	48
Market information platform (R&D and market information matching)	48	45	46	49
Sensors/ sensor network (irrigation, moisture, air flow, temperature, pressure, process sensor, motion sensor, position, ergonomic, chemical, electric, network, quality sorting and grading)	47	43	47	49
Post-harvest Technology (dehydration, air-fry, freeze dried, spray dried, silage, cold chain, air dry)	47	46	47	49
Water management (application, allocation)	47	46	48	47
Mechanization (land preparation, harvesting and post-harvesting, processing)	47	43	48	48
Biotechnology (Tissue Culture, enzyme, hormone, fermentation)	47	39	44	47
Solar energy (processing, pumping, for engine)	47	41	44	47

Packaging (Coating, modified atmosphere packaging, vacuum)	47	39	41	47
Standard	47	43	44	48
Logistic technology (Container management, delivery robot, Shipment tracking system)	47	45	46	48
E-commerce	46	42	43	47
Multimedia (advertising, access to market information)	46	45	46	47
Robotics (drone, driverless machine)	45	41	45	49
Drone (nutrient, pesticide)	45	42	45	47
GIS/Remote sensing	44	41	43	44
Screening and breeding	44	40	42	45
Drip Irrigation, Sprinkler, Pivot	44	40	42	46
Preservation (drying, fermentation, heat treatment, Cool chain/ Cool Bot technology)	44	44	44	48
E-registration	44	42	43	45
Fintech (Blockchain, E-banking)	44	38	42	46
Animal feed technology	44	38	42	46
Fertilizer	44	38	42	46
Financial management app	43	41	42	47
Artificial insemination	43	40	40	44
Robust & flexible system for Farm Management	43	40	41	45
QR code	43	42	42	43
Cloud Technology	43	37	40	44
Intelligence chatbots	43	39	42	44
Digital and Vertical farming	42	40	42	45
Genetic engineering	41	37	41	42
Remoting sensing for water quality	41	37	41	47
Just in time irrigation delivery	41	39	41	42
Big Data, Deep Learning, AI	41	38	41	44
Actuator (motor pump)	40	39	39	40
Mobile app book keeping	40	39	39	42
Aerial Imagery (for plantation, livestock, aquaculture, water quality)	40	38	41	43
Hydroponic	40	35	37	42
Systematic technology (Programing Logic Controller)	39	37	39	44
Additive manufacturing (3D Printing)	39	33	36	41
Green house/nethouses	39	36	40	42
HR capacity building (Game based learning, E-learning, training)	38	38	42	43
R&D	38	37	39	43
Satellite and weather input based advisory	38	34	36	40
Virtual reality/ augmented (3D interaction)	37	34	39	39
Bio-pesticide	37	36	38	43
Conveyor Technology	37	34	37	44
Skill and reskill	37	35	38	39
Digital Algorithm	33	32	34	35

6.3. Steering committee and Sub-committee for AgriTech Roadmap

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍
Ministry of Industry, Science, Technology & Innovation
លេខ: ២៣៩ MISTI / ២០២១

សេចក្តីសម្រេច
ស្តីពី
ការបង្កើតគណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោង អភិវឌ្ឍផែនទីបង្ហាញផ្លូវសម្រាប់បច្ចេកវិទ្យាកសិកម្ម បច្ចេកវិទ្យាសុខាភិបាល និងបច្ចេកវិទ្យាអប់រំ

ទេសរដ្ឋមន្ត្រី រដ្ឋមន្ត្រីក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍

- បានឃើញរដ្ឋធម្មនុញ្ញនៃព្រះរាជាណាចក្រកម្ពុជា
- បានឃើញព្រះរាជក្រឹត្យលេខ នស/រកត/០៩១៨/៩២៥ ចុះថ្ងៃទី០៦ ខែកញ្ញា ឆ្នាំ២០១៨ ស្តីពីការតែងតាំងរាជរដ្ឋាភិបាលនៃព្រះរាជាណាចក្រកម្ពុជា
- បានឃើញព្រះរាជក្រឹត្យលេខ នស/រកត/០៣២០/៤២១ ចុះថ្ងៃទី៣០ ខែមីនា ឆ្នាំ២០២០ ស្តីពីការតែងតាំងនិងកែសម្រួលសមាសភាពរាជរដ្ឋាភិបាល
- បានឃើញព្រះរាជក្រមលេខ នស/រកម/០៦១៨/០១២ ចុះថ្ងៃទី២៨ ខែមិថុនា ឆ្នាំ២០១៨ ដែលប្រកាសឱ្យប្រើច្បាប់ស្តីពីការរៀបចំនិងការប្រព្រឹត្តទៅនៃគណៈរដ្ឋមន្ត្រី
- បានឃើញព្រះរាជក្រមលេខ នស/រកម/០៣២០/០០៩ ចុះថ្ងៃទី២៦ ខែមីនា ឆ្នាំ២០២០ ដែលប្រកាសឱ្យប្រើច្បាប់ស្តីពីការបង្កើតក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍
- បានឃើញអនុក្រឹត្យលេខ៤៨ អនក្រ.បក ចុះថ្ងៃទី៦ ខែមេសា ឆ្នាំ២០២០ ស្តីពីការរៀបចំនិងការប្រព្រឹត្តទៅរបស់ក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍
- យោងលិខិតលេខ ១៣២៦ ឧបន ចុះថ្ងៃទី០៩ ខែកក្កដា ឆ្នាំ២០២១ ស្តីពីលទ្ធផលកិច្ចប្រជុំលើកទីមួយនៃក្រុមប្រឹក្សាជាតិវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍
- យោងលិខិតចាត់តាំងសមាសភាពឱ្យចូលរួមក្នុងគណៈកម្មការគណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោងអភិវឌ្ឍផែនទីបង្ហាញផ្លូវសម្រាប់បច្ចេកវិទ្យាកសិកម្ម បច្ចេកវិទ្យាសុខាភិបាល និងបច្ចេកវិទ្យាអប់រំ
- យោងតាមសំណូមពរការងារចាំបាច់របស់ក្រសួង

សម្រេច

ប្រការ១.-

ត្រូវបានបង្កើតគណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោងអភិវឌ្ឍផែនទីបង្ហាញផ្លូវសម្រាប់បច្ចេកវិទ្យាកសិកម្ម បច្ចេកវិទ្យាសុខាភិបាល និងបច្ចេកវិទ្យាអប់រំ ដែលមានសមាសភាព៖

១. ឯកឧត្តមបណ្ឌិត **ឆែម គាតវិថី**	រដ្ឋមន្ត្រីប្រតិភូអមនាយករដ្ឋមន្ត្រី និងជារដ្ឋលេខាធិការក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍	ប្រធាន
២. ឯកឧត្តមបណ្ឌិត **ហ៊ិល សៀងហេង**	អគ្គនាយកនៃអគ្គនាយកដ្ឋានវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍ នៃក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍	អនុប្រធាន

៣. លោកស្រីបណ្ឌិត **លី សុខនី**	ប្រធាននាយកដ្ឋានសហប្រតិបត្តិការវិស័យវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍ នៃអគ្គនាយកដ្ឋានវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍	សមាជិក

ប្រការ២.

គណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោង មានតួនាទី និងភារកិច្ចដូចតទៅ៖

- ជានានូវការសិក្សារបស់គម្រោង ត្រូវបានបន្សុី និងគិតគូរច្បាស់លាស់ជាមួយនឹងយុទ្ធសាស្ត្រពាក់ព័ន្ធនានា
- ជានានូវការសិក្សារបស់គម្រោង និងប្រើប្រាស់ធនធានបានយ៉ាងល្អនិងគ្រប់ជ្រុងជ្រោយ រាប់ទាំងមូលដ្ឋានចំណេះដឹងក្នុងប្រទេស និងក្នុងតំបន់
- ផ្តល់យុទ្ធសាស្ត្រក្នុងការអនុវត្ត និងជួយដោះស្រាយបញ្ហានិងហានិភ័យនានាក្នុងពេលអនុវត្តគម្រោង
- ពិនិត្យនូវវឌ្ឍនភាព និងសម្របសម្រួលជាមួយថ្នាក់ដឹកនាំជាន់ខ្ពស់ និងក្រសួង-ស្ថាប័នពាក់ព័ន្ធនានា
- ពិនិត្យ និងផ្តល់យោបល់លើ សេចក្តីព្រាងកម្រងសំណួរសម្រាប់ការធ្វើអង្កេតនិងលទ្ធផលដែលទទួលបាន
- ពិនិត្យ និងផ្តល់យោបល់លើវិធីសាស្ត្រនានាដែលជាកំឱ្យប្រើប្រាស់ក្នុងគម្រោង
- ណែនាំអំពីឱកាសដើម្បីទទួលបានប្រយោជន៍ និងសារៈសំខាន់ជាអតិបរិមាពីលទ្ធផលនៃការសិក្សាគម្រោង

ប្រការ៣.

ត្រូវបានបង្កើតអនុគណៈកម្មការចំនួន៣ ដើម្បីទទួលអនុវត្តគម្រោងខាងលើតាមបច្ចេកវិទ្យា ដូចមានសមាសភាពខាងក្រោម៖

ក. អនុគណៈកម្មការអភិវឌ្ឍផែនទីបង្ហាញផ្លូវសម្រាប់បច្ចេកវិទ្យាកសិកម្ម៖

១. លោក **ប្រាក់ ជាតិថូ**	អគ្គនាយករង នៃអគ្គនាយកដ្ឋានកសិកម្ម នៃក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ	ប្រធាន
២. លោក **រាម ច័ន្ទវណ្ណា**	អគ្គនាយករងនៃអគ្គនាយកដ្ឋានសហគ្រាសធុនតូច និងមធ្យម និងសិប្បកម្ម	សមាជិក
៣. លោកបណ្ឌិត **ទ្រី សុផល**	អគ្គនាយករងនៃអគ្គនាយកដ្ឋានវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍	សមាជិក
៤. លោកបណ្ឌិត **ប៉ុក សំកុល**	អនុប្រធាននាយកដ្ឋាននៃវិទ្យាស្ថានជាតិវិទ្យាសាស្ត្រ បច្ចេកវិទ្យានិងនវានុវត្តន៍	សមាជិក
៥. លោកបណ្ឌិត **ចិន សុវណ្ណ**	អនុប្រធាននាយកដ្ឋាននៃអគ្គនាយកដ្ឋាន វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍	សមាជិក
៦. លោកបណ្ឌិត **ប៉ុល ចាន់ធី**	នាយករងវិទ្យាស្ថានស្រាវជ្រាវ និងអភិវឌ្ឍន៍កសិកម្មកម្ពុជា	សមាជិក
៧. កញ្ញា **តាំង ចាន់ស្មើ**	ប្រធានការិយាល័យនៃអគ្គនាយកដ្ឋាន វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា និងនវានុវត្តន៍	សមាជិកអចិន្ត្រៃយ៍
៨. លោកបណ្ឌិត **ប៊ិនតុង ហួរាំង**	នាយកផ្នែកស្រាវជ្រាវ និងផ្សព្វផ្សាយ នៃសាកលវិទ្យាល័យភូមិន្ទកសិកម្ម	សមាជិក
៩. Prof. Alamgir Hossain	សកលវិទ្យាធិការរង នៃសាកលវិទ្យាល័យបច្ចេកវិទ្យា និងវិទ្យាសាស្ត្រកម្ពុជា	សមាជិក
១០. លោក **ឈរ រិទ្ធី**	នាយកប្រតិបត្តិកសិដ្ឋានគីរីស្វគ៌	សមាជិក
១១. លោក **លន់ យ៉េង**	អគ្គលេខាធិការសហព័ន្ធស្រូវអង្ករកម្ពុជា	សមាជិក

ប្រការ៤..

អនុគណៈកម្មការអភិវឌ្ឍផែនទីបង្ហាញផ្លូវបច្ចេកវិទ្យាទាំង៣នេះ មានតួនាទី និងការកិច្ចដូចតទៅ៖

- ទទួលអនុវត្តការងារទៅតាមទិសដៅដែលបានដាក់ចេញដោយគណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោង
- សម្របសម្រួល ប្រមូល និងផ្តល់ធាតុចូលនានាតាមក្រសួង-ស្ថាប័ន ឬអង្គភាពសាមីដែលពាក់ព័ន្ធនឹងការសិក្សារបស់គម្រោងទៅតាមរបៀបវារៈនៃការអនុវត្ត
- ធានានូវសង្គតិភាពព័ត៌មាន និងទិន្នន័យដែលទទួលបាន និងផ្តល់ជូន និងទទួលស្គាល់ដោយក្រសួង-ស្ថាប័ន ឬអង្គភាពសាមី
- សម្របសម្រួលការងារទាំងបច្ចេកទេស និងរដ្ឋបាលនៅតាមក្រសួង-ស្ថាប័ន ឬអង្គភាពសាមី
- ពង្រឹងសមត្ថភាព (សមាជិក) បន្ថែមលើវិស័យ តាមរយៈសិក្ខាសាលា និងវគ្គបណ្តុះបណ្តាលនានា ដែលរៀបចំដោយគម្រោង
- ជាមន្ត្រីបង្គោលតាមក្រសួង-ស្ថាប័ន ឬអង្គភាពសាមីសម្រាប់ការអនុវត្តសកម្មភាពនានារបស់គម្រោង
- ទទួលអនុវត្តភារកិច្ចផ្សេងទៀតដែលបានដាក់ចេញដោយគណៈកម្មការដឹកនាំ និងសម្របសម្រួលគម្រោង។

ប្រការ៥..

ពេលប្រធានគណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោង អវត្តមាន ឬមានករណីចាំបាច់ ប្រធានគណៈកម្មការដឹកនាំនិងសម្របសម្រួលដល់ការអនុវត្តគម្រោង អាចផ្តល់សិទ្ធិជូនអនុប្រធាន ដើម្បីដឹកនាំការប្រជុំតាមការប្រគល់សិទ្ធិពីប្រធាន។

ប្រការ៦..

សមាជិកគណៈកម្មការ និងអនុគណៈកម្មការនីមួយៗ ត្រូវចូលរួមប្រជុំតាមការអញ្ជើញរបស់ប្រធាន និងទទួលខុសត្រូវតាមបន្ទុកការងារដែលបានបែងចែក។ ប្រធានអនុគណៈកម្មការនីមួយៗ ត្រូវរាយការណ៍ការងារជាប្រចាំ និងតាមការចាំបាច់ ជូនប្រធានគណៈកម្មការដឹកនាំ និងសម្របសម្រួលដល់ការអនុវត្តគម្រោង។

ប្រការ៧..

នាយកខុទ្ទកាល័យ អគ្គនាយក អគ្គាធិការ ប្រធានមជ្ឈមណ្ឌល គ្រប់អង្គភាពពាក់ព័ន្ធ និងសាមីខ្លួន ត្រូវទទួលបន្ទុកអនុវត្តសេចក្តីសម្រេចនេះ ចាប់ពីថ្ងៃចុះហត្ថលេខាតទៅ។

ថ្ងៃ ៣រោច ខែ ភទ្របទ ឆ្នាំឆ្លូវ ត្រីស័ក ព.ស.២៥៦៥
ធ្វើនៅរាជធានីភ្នំពេញ ថ្ងៃទី ១០ ខែ វិច្ឆិកា ឆ្នាំ២០២១

ទេសរដ្ឋមន្ត្រី
រដ្ឋមន្ត្រីក្រសួងឧស្សាហកម្ម វិទ្យាសាស្ត្រ បច្ចេកវិទ្យា
និងនវានុវត្តន៍

កិត្តិសេដ្ឋាបណ្ឌិត **ចម ប្រសិទ្ធ**

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