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Report Highlights:

Singapore does not have any domestic commercial production of plant biotechnology. The Singapore Food Agency provides a link in its website that lists a total of 64 genetically engineered (GE) crops that have been approved for use as food for direct consumption, ingredients, and further processing into ingredients for other food in the country. GE foods sold in Singapore must undergo a rigorous safety assessment by the Genetic Modification Advisory Committee (GMAC) and Singapore Food Agency (SFA). The assessments are based on Codex principles.

EXECUTIVE SUMMARY

Plant biotechnology product development in Singapore is minimal and has been limited to just one project to date. There is no commercial production of GE plants in the country.

Singapore is a large importer of processed food products, many of which may have been derived from GE crops. In 2021, Singapore imported about $10.6 billion in consumer-oriented food and beverage products, with the top suppliers being France, Malaysia, China, Australia, the United Kingdom, and the United States (source: Trade Data Monitor). The Singapore Food Agency (SFA) provided a link in its website that listed a total of 64 genetically engineered crops that have been approved for use as food for direct consumption, ingredients, and further processing to become ingredients for other food in the country.

GE foods sold in Singapore have to undergo rigorous safety assessments by both the Genetic Modification Advisory Committee (GMAC) and SFA. The assessments are based on Codex principles. The SFA is the national body that regulates GE crop market access in Singapore. The multi-agency GMAC was established under the country's Ministry of Trade and Industry in 1999 to provide science-based advice on research, development, production, release, use, and handling of GE products in Singapore. Developers who wish to gain market access for GE products in Singapore must first submit a proposal to GMAC for a safety evaluation. SFA then considers GMAC's recommendations (and may conduct further safety evaluations) before making an official regulatory decision. GMAC recently revised its regulations on stacked events. As of August 2020, GMAC adopted the "high covers low" approach which exempts lower order combinations of stacked events from assessment if they are derived from prior GMAC-endorsed higher order combinations.

Currently, Singapore does not have any specific guidelines on the labeling of GE products. As a member of the Codex Committee on Food Labeling (CCFL), Singapore closely monitors international developments and collaborates with other CCFL members on acceptable GE food labeling guidelines.

Singapore's animal biotechnology development is limited to research activities in fish hatchery technology. There is no commercial animal biotechnology production in the country.

For additional reference on biotech, please click here for a copy of the FAIRS Country report, 2022.

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CHAPTER 1: PLANT BIOTECHNOLOGY

PART A: PRODUCTION AND TRADE

a) PRODUCT DEVELOPMENT:

Plant biotechnology product development in Singapore is minimal and has been limited to just one finished project to date. In 2015, the Singapore Agri-Food and Veterinary Authority (AVA) granted approval for a local company, JOil (S) Pte. Ltd, to conduct small scale field trials for GE Jatropha kernels with high oleic acid content for the biofuels industry.

b) COMMERCIAL PRODUCTION:

There is no commercial production of GE plants in Singapore.

c) EXPORTS:

Singapore does not export any GE crops.

d) IMPORTS:

Singapore's imports of GE agricultural products in bulk form are negligible, as the local livestock industry is insignificant. However, the country is a large importer of processed food products, many of which may have been derived from GE crops. Data on the exact percentage of imports derived from GE plant products is unavailable. In 2021, Singapore imported over $10.6 billion in consumer-oriented food and beverage products with the top suppliers being France, Malaysia, China, Australia, the United Kingdom, and the United States.

e) FOOD AID:

Singapore does not provide or receive food aid.

f) TRADE BARRIERS:

There are no special barriers for the import of GE plant products into Singapore, providing the products are already approved for commercial use by official regulators in the country of origin and by SFA in Singapore. SFA's evaluation of food products is based on Codex's "Guideline for the Conduct of Food Safety Assessment of Foods Derived from Recombinant-DNA Plants." Also, there are currently no mandatory guidelines on the labeling of foods, seeds, fibers, oils, or feeds that are derived from biotech crops.

PART B: POLICY

a) REGULATORY FRAMEWORK:

SFA has replaced AVA as the national body that officially regulates GE crop market access in Singapore. This occurred in April 2019, when AVA was restructured into two separate agencies: SFA, which now exclusively manages food security and food safety matters, and the Animal & Veterinary Service (AVS), which manages all non-food plant and animal matters.

The multi-agency GMAC was established under the country's Ministry of Trade and Industry in 1999 to provide science-based advice on the research, development, production, release, use, and handling of GE products in Singapore. GMAC's objective is to 'ensure public safety while maintaining an environment that is conducive for commercial exploitation of "GMOs" and "GMO-derived" products.' As an advisory committee, GMAC works closely with other national bodies and the regulatory agencies, particularly SFA and the Ministry of Health (MOH). GMAC published *Guidelines on the Release of Agriculture-Related "Genetically Modified Organism (GMOS)"and "Biosafety Guidelines for Research on "Genetically Modified Organisms (GMO)"* (last revised July 2020). GMAC also endorsed as a separate Annex on their website a document titled *Risk Assessment of Stacked Events* (revised in August 2020; please see Stacked or Pyramided Event Approvals Section below).

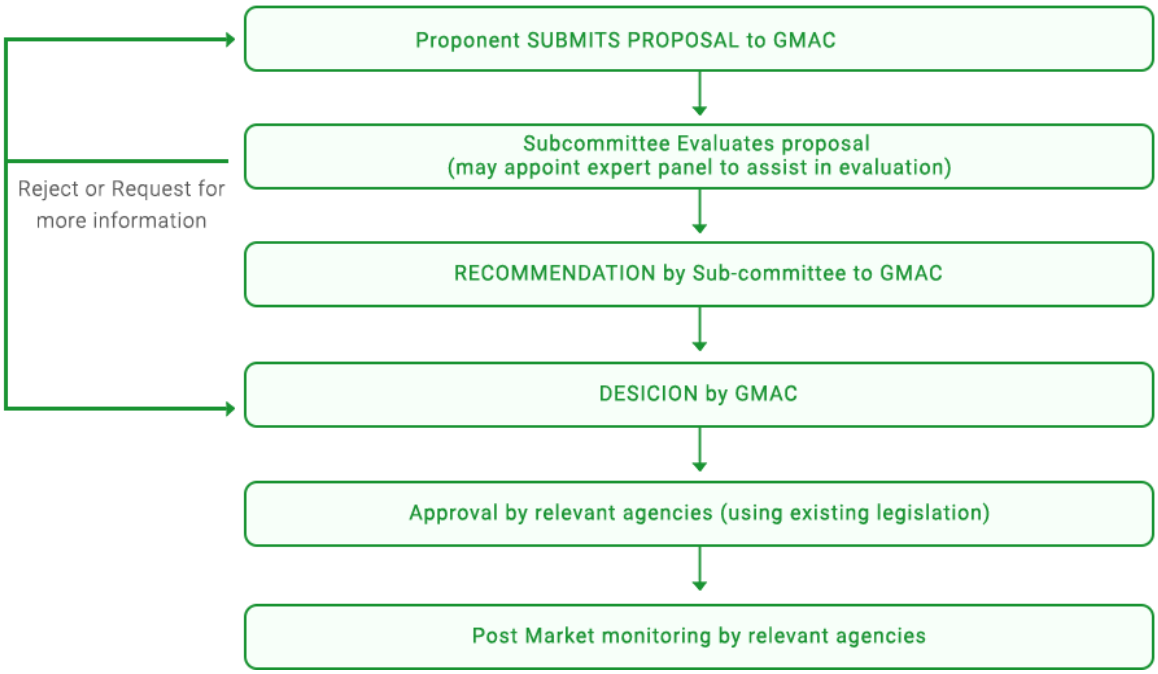
GMAC's *Guidelines on the Release of Agriculture-Related "GMOs"* provide a common framework to assess risks of agriculture-related GE products to human health and the environment, and approval mechanisms for their release in Singapore. Under the guidelines, a proposal has to be submitted to GMAC and its subcommittees (please see details below). Collectively, they will review the application, including an examination of the GE product's origin, the experimental procedures used in its development, and the methods used to prove it is safe for consumption. Following the review process, GMAC decides whether or not to endorse the application. GMAC's recommendation are then forwarded to SFA and relevant agencies, which determine final regulatory approval.

GMAC's members are from local regulatory agencies and academic institutions, and they serve on a voluntary basis. The GMAC Main Committee is currently chaired by Professor Prakash Kumar from the National University of Singapore. The other members come from 13 agencies/institutions, including SFA, MOH, the Ministry of Manpower, the National Institute of Education International, and the Nanyang Technological University. Please click here for more information on GMAC and the full list of current GMAC Main Committee members.

In addition to the Main Committee, GMAC has four Subcommittees. For details on the Subcommittees and a list of Subcommittee members, please refer to the following:

- Subcommittee for Release of Agriculture-Related "GMOs" (please click here for details)
- Subcommittee for Research on "GMOs" (please click here for details)
- Subcommittee for Labeling of "GMOs" (please click here for details)
- Subcommittee for Public Awareness (please click here for details)

Approval Process for GE Products in Singapore



Source: GMAC

Legal term (in official language)	**Legal Term (in English)**	**Laws and Regulations where term is used**	**Legal Definition (in English)**
Genome Edited (GE)	Genome Edited	Regulations pertaining to biotechnology: SFA and GMAC guidelines	Genome Edited techniques (e.g., Site-directed nucleases, Base-editing) that change the genome of a crop by inserting, deleting, or altering the genetic material at specified targeted locations in the genome, with or without the introduction of foreign DNA to the genome (Source: SFA)
Genetic Modification (GM)	Genetic Modification (GM)	Regulations pertaining to biotechnology: SFA and GMAC guidelines	Genetic Modification is a form of technology that involves direct alteration of DNA of an organism. It involves the identification, isolation and introduction of specific gene(s) from donor to recipient organisms. Genetic Modification also permits the transfer of genes between totally different organisms. Genetic modification is being applied to develop new benefits, such as creating crops with new traits (Source: GMAC)
Genetically Modified Organism (GMO)	Genetically Modified Organism (GMO)	Regulations pertaining to biotechnology: SFA and GMAC guidelines	An organism which has its DNA altered by molecular techniques is termed a genetically modified organism (GMO). DNA (Deoxyribonucleic acid) itself is the molecule within a cell nucleus that contains genetic instructions which are required for a cell to function. (Source: GMAC)

Agri-Tech (Agriculture Technology)	Agri-Tech	Grants, 30 by 30 Initiative	Use of technology to aid efforts in farming, which enable Singapore to find ingenious and highly efficient ways to grown produce. These range from high-tech indoor farms which can product up to 10 times the crops of conventional farm to multi story fish farms that rely on automation to improve/increase yield (Source: SFA)

b) APPROVALS/AUTHORIZATIONS:

A total of 64 GE plant products have been approved for use as food for direct consumption, ingredients, and further processing to become ingredients in Singapore. For an updated list of the approved products, please click here. The list was updated on August 30, 2022.

c) STACKED OR PYRAMIDED EVENT APPROVALS/AUTHORIZATIONS:

In July 2016, GMAC endorsed a document on stacked events that was prepared by the Subcommittee for Release of Agriculture-related "GMOs." The document, *Risk Assessment for Stacked Events, Annex A*, was revised in 2020 to adopt a "high covers low" approach which exempts lower order combinations of stacked events from assessment if they are derived from prior GMAC-endorsed higher order combinations. Please click here to view an updated version of the *Risk Assessment for Stacked Events, Annex A* document.

d) FIELD TESTING:

AVA (SFA's predecessor) granted approval in 2015 for a local company, JOil (S) Pte Ltd, to conduct small scale field trials on Semakau Island for Jatropha kernels with high oleic acid content for the biofuels industry. JOil has completed its trials and it has been reported that GMAC is reviewing the company's findings. No further information is available on the trial.

e) INNOVATIVE BIOTECHNOLOGIES:

Market analysts report Singapore is deliberating on regulatory and ethical issues arising from innovative biotechnologies and has yet to develop a harmonized regulatory framework on genome editing.

f) COEXISTENCE:

There are no rules on coexistence, as there are no GE crops approved for domestic commercial cultivation at this time.

g) LABELING AND TRACEABILITY:

Currently, Singapore does not have any specific guidelines on the labeling of GE products. However, generally, SFA's policy is that food products for sale in Singapore can be voluntarily labeled as "GM" or "non-GM", as long as it is factual and not misleading. GE foods, like all other food products, must meet existing food labeling requirements on product information as well as details to facilitate product

tracing and recall (e.g., ingredient listing, details of manufacturer or importer). However, according to industry observers, GE labeling is receiving increased public attention, and the GMAC Subcommittee for Labeling of "GMOs" was created to consider the issue.

Additionally, as a member of the Codex Committee on Food Labeling (CCFL), Singapore is closely monitoring international developments on acceptable GE food labeling guidelines.

h) MONITORING AND TESTING:

SFA monitors for the presence of GE products in the market. As GE foods are controlled items in the country, they are subject to special declaration, review, inspection, and testing procedures implemented by SFA's Food Control Division. This includes taking samples and testing in SFA laboratories. GE product detection methods and reference materials are required by SFA as part of the market access approval process.

i) LOW LEVEL PRESENCE (LLP) POLICY:

Singapore does not have a threshold established or specific policy on LLP. However, the country has demonstrated sensitivity to instances of inadvertent release of unapproved products. Additionally, LLP is connected to Singapore's policy on labeling, and GMAC is actively monitoring developments on the labeling of GE products internationally.

j) ADDITIONAL REGULATORY REQUIREMENTS:

None at this time.

k) INTELLECTUAL PROPERTY RIGHTS (IPR):

While Singapore does not have any commercial production of GE crops, the country does have intellectual property legislation covering patents.

Singapore has a very advanced IP regime and the Intellectual Property Office of Singapore (IPOS), a statutory board under the country's Ministry of Law, administers IP laws, promotes IP awareness, and facilitates the development of IP in Singapore.

l) CARTAGENA PROTOCOL RATIFICATION:

Singapore is not a party to the Cartagena Protocol on Biosafety.

m) INTERNATIONAL TREATIES and FORUMS:

Singapore is an active member of the Asia-Pacific Economic Cooperation (APEC) forum and Codex Alimentarius. The country is also one of the 15 signatories of the Regional Comprehensive Economic Partnership (RCEP), and one of the 11 signatories of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). Singapore is a member of the International Union for the Protection of New Varieties of Plants (UPOV), and the International Plant Protection Convention (IPPC). It is also

a member of the Association of South East Asian Nations (ASEAN) and the ASEAN "GM" Food Testing Network (AGMFTN) sub-group that caters to regulatory and scientific exchanges on issues related to GE food analysis.

n) RELATED ISSUES:

Singapore has a multi-pronged strategy to promote food security, with research and development using modern agriculture technologies playing a key role. For example, the Singapore government in February 2021 announced they allocated a budget of $45.2 million for the creation of the Agri-Food Cluster Transformation (ACT) Fund to "continue supporting technology adoption in the agri-food sector." The ACT Fund was designed to better support local food producing farms to achieve the country's "30 by 30 goal" – i.e. the plan to produce 30 percent of Singapore's nutritional needs by 2030. In 2019, the Singapore government announced the development of an 18-hectare Agri-Food Innovation Park that would bring together hi-tech farming and research and development activities, and it would be progressively developed over the next 20 to 25 years. The country's sovereign fund, Temasek, has invested close to $5 billion in the agri-food sector over the last five years in areas such as agricultural biotechnology, alternative proteins, vertical farming, and commodities.

The country is also a member of the Agricultural Innovation Mission for Climate (AIM4C).

PART C: MARKETING

a) PUBLIC/PRIVATE OPINIONS:

Market analysts report that although cautionary letters and demands for stringent labeling occasionally appear in public forums, overall opposition to GE foods is insignificant in Singapore.

Singapore's position on GE labeling is in tandem with international trends and practices. SFA's fundamental principle is that any labeling must be "practical, scientifically-driven and effectively implementable across countries." SFA and GMAC are expected to continue monitoring international developments closely.

b) MARKET ACCEPTANCE/STUDIES:

In response to a public query on the safe consumption of GE food in Singapore, AVA (SFA's predecessor) stated in a 2012 letter that it wanted to assure the public that all commercially available GE products in Singapore have undergone GMAC and AVA safety assessments based on Codex Alimentarius principles. Additionally, GMAC states on its website that its objective is to "ensure public safety while maintaining an environment that is conducive for commercial exploitation of "GMOs" and "GMO" derived products."

CHAPTER 2: ANIMAL BIOTECHNOLOGY

PART D: PRODUCTION AND TRADE

a) PRODUCT DEVELOPMENT:

Singapore's animal biotechnology development is limited to research activities at SFA's Marine Aquaculture Center (MAC) located at St. John's Island. Established in 2003, the MAC's objective is to "deepen the country's expertise in the areas of aquaculture genetics, nutrition and health." MAC has undertaken several research activities to develop large-scale hatchery technology, including upstream molecular applications, genetic selection to facilitate fish breeding, and the development of fish vaccines and diagnostic kits. Please click here for additional information on the MAC.

b) COMMERCIAL PRODUCTION:

There is no commercial production of animal biotechnology in Singapore.

c) EXPORTS:

None

d) IMPORTS:

None

e) TRADE BARRIERS:

There is no commercial production or trade in animal biotechnology. As a result, there are no applicable trade barriers.

PART E: POLICY

a) REGULATORY FRAMEWORK:

The approval process for animal biotechnology is the same as the approval process for plant biotechnology (please refer to the PLANT BIOTECHNOLOGY REGULATORY FRAMEWORK section above).

b) APPROVALS/AUTHORIZATIONS:

There are no approved animal biotechnology products for commercial use in Singapore.

c) INNOVATIVE BIOTECHNOLOGIES:

There is no specific regulatory status for innovative biotechnology in animals.

d) LABELING AND TRACEABILITY:

Currently, Singapore does not have any specific guidelines on the labeling of GE products, nor does it have specific traceability requirements beyond those required for all food products.

e) ADDITIONAL REGULATORY REQUIREMENTS:

There are no specific regulatory requirements for animal biotechnology.

f) INTELLECTUAL PROPERTY RIGHTS (IPR):

There is no current legislation that addresses IPR for animal biotechnologies.

g) INTERNATIONAL TREATIES and FORUMS:

Singapore is a member of the World Organisation for Animal Health (WOAH/OIE). Singapore regularly sends officials to Codex forums.

h) RELATED ISSUES:

In 2020, Singapore became the first country to approve sale of lab-grown meat. Eat Just currently sells its cell-based chicken product in the country, and other companies are also developing cell-based meat and seafood products. Singapore hopes to be a leader in this alternative protein industry, as well as in innovative/novel foods overall.

Before submission of a new cell-based protein for approval [please refer to "Part H, a) Regulatory Framework" for more details], companies are required to complete self-assessment checklists, including a checklist for cell-based companies. Please click here for the details.

PART F: MARKETING

a) PUBLIC/PRIVATE OPINIONS:

Few discussions of GE animals, cloned animals, or products derived from cloned animals take place in Singapore.

b) MARKET ACCEPTANCE/STUDIES:

FAS Singapore is unaware of any studies on animal biotechnology market acceptance.

CHAPTER 3: MICROBIAL BIOTECHNOLOGY

PART G: PRODUCTION AND TRADE

a) COMMERCIAL PRODUCTION:

Singaporean companies work on a variety of bacteria, yeasts, fungi, and enzymes that may have been derived from microbial biotechnology for application in food and beverage, pharmaceutical, bio-industrial, and veterinary areas. For example, the Singapore-based company Life3 Biotech currently produces microbial biotech-derived ingredients for plant-based protein production. In 2020, the

company announced that it would be setting up the country's first integrated agri-food pilot facility with support from SFA. The facility is used to produce the country's first plant-based alternative protein source, Veego.

b) EXPORTS:

Singapore exports alcoholic beverages, dairy products, and processed products, which may contain microbial biotech-derived food ingredients.

c). IMPORTS:

Singapore imports alcoholic beverages, dairy products, and processed products which may contain microbial-derived food ingredients.

d) TRADE BARRIERS:

There are no known trade restrictions related to microbial biotechnology at this stage.

PART H: POLICY

a) REGULATORY FRAMEWORK:

In 2018, SFA (then the Agri-Food & Veterinary Authority) initiated a series of public consultations for a regulatory framework on novel food and ingredients. Following this initiative, SFA implemented a new regulatory framework that requires companies to seek SFA approval (via a safety assessment) before market access for novel foods is allowed. In order to ensure that food safety assessments are rigorously conducted, SFA formed a Novel Food Safety Expert Working Group in March 2020 to provide scientific advice. Chaired by the Head of the Center for Regulatory Excellence, the working group comprises experts in toxicology, bioinformatics, nutrition, epidemiology, public health policy, food science, and food technology.

For novel food ingredients that are produced from a GE microbe, information must be provided to SFA that includes safety information of the production strain, allergenicity of the ingredients, and residual impurities (if present). SFA produces a frequently updated document entitled *Requirements for the Safety Assessment of Novel Foods and Novel Food Ingredients* to help companies better understand the requirements regarding the safety assessment and application process for novel foods. For a copy of the document (most recently revised on September 26, 2022), please click here Before submission, the companies are required to complete self-assessment checklists, including a checklist for precision/biomass fermentation process. Please click here for the details.

b) APPROVALS/AUTHORIZATIONS:

Novel food products derived from microbial biotechnology for human consumption are subject to SFA's *Requirements for the Safety Assessment of Novel Foods* (please refer to the link in the above REGULATORY FRAMEWORK section). Food additives derived from microbial biotechnology are subject to the SFA *Guidance Information Requirement for Food Additives* (revised April 1, 2019).

Singapore has given approval for multiple food ingredient and food additive products derived from microbial biotechnology, including products such as soy leghemoglobin for use in meat analogues (e.g., Impossible Foods™ products), and lutein esters for coloring.

c) LABELING AND TRACEABILITY:

Currently, Singapore does not have any specific guidelines on the labeling or traceability of GE products and, therefore, of products derived from microbial biotechnology.

d) MONITORING AND TESTING:

SFA is the agency in charge of monitoring and testing of all food ingredients derived from microbial biotechnology.

e) ADDITIONAL REGULATORY REQUIREMENTS:

None at this time.

f) INTELLECTUAL PROPERTY RIGHTS (IPR):

Singapore has a very advanced IP regime and the IPOS, a statutory board under the country's Ministry of Law, administers IP laws, promotes IP awareness, and facilitates the development of IP in Singapore.

g) RELATED ISSUES:

None

PART I: MARKETING

a) PUBLIC/PRIVATE OPINIONS:

Food industry contacts report the public has a positive view of plant-based protein due to growing environmental concerns and sustainability benefits. As a result, multiple local companies utilize microbial biotechnology and are increasingly seeking alternatives to animal/fish fats.

b) MARKET ACCEPTANCE/STUDIES:

FAS Singapore is unaware of any studies on microbial biotechnology market acceptance.

Attachments:

No Attachments