

Canadian Space Agency

Deep Space Food Challenge

Applicant Guide





For full details on the NASA-managed competition webpage, visit deepspacefoodchallenge.org.

For full details on the CSA-managed competition webpage, visit impact.canada.ca.

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1. About the Challenge

As space missions increase in duration and in distance away from Earth, it becomes ever more difficult to bring all required crew consumables, such as food. Furthermore, although safe and nutritious food can be ensured for missions on the order of several months, current processing and storage degrade nutrition and acceptability to a level that will not be adequate for long duration space missions. Thus for missions beyond low-Earth orbit, such as sustainable human presence on the lunar surface and for future missions to Mars, astronauts will require novel food system solutions.

Although there are many food systems on Earth that may offer benefits to our future astronauts, the ability of these systems to meet spaceflight demands has not yet been established.

How can the development of food production systems for future space missions also be beneficial to food production on Earth?

Food security is a significant chronic challenge on Earth, particularly in extreme environments like Canada's northern and remote communities, disaster-affected areas and resource-scarce regions. Creating a food production system with the potential to further enhance local production in these areas would foster stability in food supply chains.

1.1 Challenge Statement

The Deep Space Food Challenge seeks to create novel food production technologies or systems that require minimal inputs and maximize safe, nutritious, and palatable food outputs for long-duration space missions, and which have potential to benefit people on Earth.

1.2 Challenge Objectives

The objective of the Challenge is to identify technology solutions that can:

- Help fill food gaps for a three-year round-trip mission with no resupply;
- Feed a crew of four (4);
- Improve the accessibility of food on Earth, in particular, via production directly in urban centers and in remote and harsh environments;
- Achieve the greatest amount of food output with minimal inputs and minimal waste; and
- Create a variety of palatable, nutritious, and safe foods that require little processing time for crew members.

This Challenge seeks to incentivize Applicants to develop novel technologies, systems and/or approaches for food production that need not meet the full nutritional requirements of future crews, but can contribute significantly to, and integrate with, a comprehensive food system.

1.3 Possible Opportunity Areas for New Food System Technologies

- *Macro- and micro-nutrients:* Macronutrients are the nutrients a person needs in larger amounts, namely carbohydrates, protein, and fat. These provide a person with energy, or calories. Micronutrients are the nutrients a person needs in smaller amounts, which include vitamins and minerals. The quality of stored food degrades over time; some micronutrients are unstable; adequate macro- and micro-nutritional availability throughout the length of a mission is critical to maintain crew health and performance.
- *Desirable/palatable food:* Enjoyable, desirable, familiar food is critical for crew physical and mental health.
- *Sustainable fresh food production:* Current crews on the International Space Station (ISS) frequently get limited amounts of fresh food (e.g., apples, oranges) delivered along with prepackaged shelf-stable food. Although highly desired by crew, this type of resupply is much more expensive to deliver to the Moon, and will not be available in extended exploration missions to Mars.
- *Reliable fresh food production:* Growing food crops in space is not currently reliable or predictable as a source of critical nutrients.
- *Water needs for food production:* Spacecraft do not currently support the mass, volume, and water needs of Earth-based food production. Even approaches that recycle water are too massive to supply water in the amounts typically used for terrestrial food production.
- *Power needs for food production:* Traditional controlled environment food production systems require high energy inputs that can make their application in larger scale production systems in space or on Earth impractical.
- *Resource logistics:* Food mass dominates life support logistics for extended space missions. It would be ideal to reduce all food system inputs and waste outputs in relation to nutritional output. This includes equipment, crew time, storage of ingredients, waste and waste processing, and safety or cleaning equipment (e.g., air monitors, microbiological tests, cleaning products).
- *Farm-to-table:* Current food systems use extensive repackaging of shelf stable foods, often requiring processed food to be prepared months to years in advance of the space mission. Innovative approaches to reduce the time from fresh food generation to consumption by the crew could help improve nutritional quality and palatability.
- *Optimization for health and palatability:* Nutrition, palatability, texture, and food safety are all important aspects to ensure the crew members consume enough food and that the food provides the necessary nutrients to protect health and performance.

- *Time limitations:* Crew members should not spend too much of their mission time in growing, preparing and consuming food. Though necessary, any time so spent precludes spending time on mission objectives.
- *Acceptability of food systems:* Food production and preparation processes must be acceptable to the crew; if a process requires preparing and eating foods that are not acceptable or are too laborious or time consuming, then a crew member may choose not to use the food system or to eat the end product.
- *Terrestrial Applications:* The need for efficient use of volume, water, and other inputs for producing food could enable technologies with reduced impact on the resources needed for food production here on Earth, especially in extreme environments and resource-scarce regions. In addition to plant production, there are other advanced food systems (3D printing of food, aquaculture, cellular agriculture, etc.) that warrant exploration as they can also potentially address some of the challenges of terrestrial and space-based food systems.

1.4 Challenge Structure

The Deep Space Food Challenge is a prize competition launched in parallel, in Canada by the Canadian Space Agency (CSA), and in the U.S. by the National Aeronautics and the Space Administration (NASA) Centennial Challenges Program. Interested Canadian Applicants are invited to apply through the Impact Canada website, while U.S. and international applicants are invited to apply through the U.S. website. For more information on the NASA-managed competition, please visit deepspacefoodchallenge.org.

NASA and CSA will each organize and structure parallel challenges, with their own distinct rules, their own prizes and eligibility, but will synchronize some activities (e.g., webinars) and employ a shared challenge statement, shared goals and shared assessment criteria. CSA has no responsibility in the NASA Centennial Challenges Program.

The Deep Space Food Challenge follows a stage-gated approach. At each Phase, different financial and non-financial incentives may be available to successful participants. At every Phase, solutions will be reviewed against the assessment criteria, and selected winners will be invited to move to the following Phase.

Phase 1 - Design Report

- Applicants will be required to submit an online application which provides a detailed explanation of a design for a novel food production technology. The application will need to demonstrate how the food production technology meets the Challenge goals and performance criteria.

Note: This Applicant Guide will help Applicants complete an application for Phase 1. Once selected, successful participants from Phase 1 will receive further reporting requirements and instructions for Phase 2. The following information is provided to give

Applicants an idea of what will be required for Phases 2 and 3 of the Challenge, if selected as a semi-finalist in Phase 1. The initiation of Phase 2 is contingent on the emergence of promising submissions in Phase 1 that demonstrate a viable approach to achieving the Challenge goals. Detailed information for later Phases will be provided prior to the launch of each Phase.

Phase 2 - Kitchen Demonstration

- In this Phase, participants will be required to build a food production technology prototype (equivalent to a TRL 4¹) and have the prototype take part in a Kitchen-Level demonstration at an appropriate facility. Participants would also provide samples of food outputs (e.g., tangible nutritional products) from the prototype, and may be asked to provide a vision for future potential application of the technology in a terrestrial context.

Note: New interested Applicants may be able to apply as part of Phase 2. Further details will be provided prior to the launch of Phase 2.

Phase 3 - Full System Demonstration

- Participants will be required to build a full-scale food production technology and demonstrate the technology at a designated facility. Participants may also be required to provide a plan for future application of the demonstrated technology in a terrestrial context.

1.5 Prize Amounts

Up to CAD \$1.08 million in total will be awarded in grant funding to Canadian semi-finalists, finalists and the grand prize winner of the Deep Space Food Challenge:

Phase	Number of Canadian winners per phase	Prize amount per winner
Phase 1 - Design Report	Up to 10 semi-finalists	CAD \$30,000
Phase 2 - Kitchen Demonstration	Up to 4 finalists	CAD \$100,000
Phase 3 - Full System Demonstration	1 grand prize winner	CAD \$380,000

¹ Technology Readiness Level (TRL) 4: Component and/or breadboard validation in a laboratory environment. Source: [NASA](#)

Note: The number of winners and Canadian prize amounts may vary depending on the applications received. For each phase, prize amounts will not be less than the amount per winner indicated above.

1.6 Timeline

Phase	Date/Deadline	Event
Phase 1	January 12, 2021 9:00 AM Central Time (GMT -05:00)	Challenge Launch
	January to May 2021	Webinars, promotional activities and/or other support for those who registered their interest with CSA.
	July 30, 2021 5:00 PM Central Time (GMT -05:00)	Application Deadline for Phase 1 Submissions
	August 2021	Judging & Selection of Winners for Phase 1
	September 2021	Phase 1 Semi-Finalists Announced
Phase 2	September 2021	Phase 2 Opens
	August 2022	Application Deadline for Phase 2 Submissions
	August to September 2022	Demonstration Event: Judging & Selection of Finalists for Phase 2
	October 2022	Phase 2 Finalists Announced
Phase 3	Fall 2022	Phase 3 Opens (12 to 18 months in duration)
	Before March 2024	Grand Prize Winner announced, all prizes awarded

2. Assessment Criteria, Jury and Selection Process

Assessment Criteria

The assessment of food production technologies will be based on the following overall and performance criteria. These assessment criteria will be consistent throughout the three phases of the Challenge and only their relative weighting factors will change between phases.

Each Team admitted to Phase 1 of the Challenge will generate a robust design for an innovative food production technology that fits within the set of constraints in Table 1 below.

Table 1. Constraints

Item	Constraint
Volume	<ul style="list-style-type: none">• Food production technology must:<ul style="list-style-type: none">○ Be ≤ 2 cubic meters○ Pass through a doorway that is 1.07 m wide and 1.90 m tall<ul style="list-style-type: none">▪ Fit in a room that is: 1.829 m X 2.438 m X 2.591 m (W x D x H)
Power	<ul style="list-style-type: none">• Maximum draw of 3,000 Watts• Average draw of <1,500 Watts
Water	<ul style="list-style-type: none">• Net consumption of water is not constrained, but greater net water consumption may result in a lower score on the Resource Inputs & Outputs performance requirement described in Table 3• Net consumption of water is measured by the following equation:<ul style="list-style-type: none">○ $C_{Net} = (\text{Initial water input} + \text{“new water” added over time})$• In this calculation:<ul style="list-style-type: none">○ Do not include water recycled by your system in the “new water”○ Do not subtract the water remaining in your system after the food has been collected

	<ul style="list-style-type: none"> Do not subtract water lost to the vehicle environment (e.g., water evaporated into the vehicle's air)
Mass	<ul style="list-style-type: none"> Not constrained, but greater mass may result in a lower score on the Resource Inputs & Outputs performance requirement
Data Connection	<ul style="list-style-type: none"> In Phase 1, the technology may be designed to transmit operational data and limited video to a remote location outside of the technology itself, and receive periodic operational commands. Future phases of this Challenge will require greater autonomy.
Crew Time	<ul style="list-style-type: none"> Maintenance & Operations of the system: Not constrained, although Teams should target a maximum crew time of 4 hours per week for operations of the food production technology for the entire crew of 4 individuals.
Operational Constraints	<ul style="list-style-type: none"> Earth gravity (9.81 m/s²) and ambient atmospheric conditions of 101,325 Pascals, 22 degrees Celsius, and 50 percent relative humidity.

Teams may design any food production technology that meets the goals of the Challenge within the constraints above and the performance criteria. The overall and performance criteria are described below in Table 2. Indications on targets can be found in Section 4.3. and additional information on current standards for food systems can be found in NASA-STD-3001, provided in the Reference Materials (Annex B).

Table 2. Assessment Criteria (Phase 1)

DESIGN REPORT (100 Points Maximum)			
Category	Description	Maximum Points	Percent of Score
Overall Criteria			
Adherence to Constraints	Does the food technology design adhere to the constraints described in Table 1?	Y/N	0%

Design Approach and Innovation	Does the design approach the problem of food production technology for spaceflight in a novel and innovative way?	15	15%
Scientific and Technical Merit	Does the scientific and technical approach and design of the technology demonstrate merit?	15	15%
Feasibility of Design	Is the proposed technical approach feasible? To what extent does the Team clearly understand and address any potential risks in their design submission?	15	15%
Terrestrial Potential	To what extent does the Design Report present a feasible scenario for the potential use of the technology within terrestrial food systems?	15	15%
Subtotal		60	60%
Performance Criteria			
Acceptability	Acceptability of the food production process; and Acceptability of the resulting food products	10	10%
Safety	NOTE: Designs that fail to account for pathogens will receive a "fail" score in the Safety category. Safety of the food production process, including environmental safety; and Safety of the resulting food products, including safety for human consumption.	10	10%
Resource Inputs / Outputs	Resource requirements of the food production process (inputs) and all outputs; the amount of food output in relation to the inputs and waste; and nutritional quality of the resulting food products	10	10%
Reliability/Stability	Stability of the inputs and outputs; reliability of the technology with less	10	10%

	than 10% loss of functionality or food production		
		Subtotal	40
		Total	100
DESIGN ANIMATION (15 Points Maximum)			
Category	Description	Maximum Points	Percent of Score
Accuracy	Does the Design Animation present an accurate visual representation of the food production technology described in the Design Report and its operation?	10	67%
Engages the Public	Is the Design Animation engaging for a public audience?	5	33%
		Total	15
			100%

Phase 1 Judging

Following the Phase 1 submission deadline on July 30, 2021 at 5:00 PM Central Time, the Canadian Judging Panel will review the submissions and discuss, evaluate, and rank the entries. The Judging Panel has discretion in the assessment and scoring of submissions and in recommending the winners. CSA will review the recommendations from the Judging Panel, and CSA will select final winners for awards.

The Judging Panel will evaluate Phase 1 submissions according to the above criteria.

3. Who can Apply?

Eligibility Details Eligible Applicants to the Challenge include the following:

- Businesses or other for-profit organizations in Canada;
- Not-for-profit organizations in Canada;
- Indigenous organizations and groups located in Canada;
- Post-secondary/academic institutions located in Canada; and
- Individuals or groups of individuals based in Canada.

Individuals or groups of individuals are encouraged to submit an application to the Challenge, but in order to be eligible to receive prizes, they will be required to establish a Canadian legal entity (such as a corporation or a not-for-profit organization) capable of entering into binding agreements in Canada.

Note: Interested Applicants may not apply in more than one competitor categories: U.S., Canadian or Other International applicants. If interested applicants applied to the NASA led challenge, they will automatically be deemed ineligible Applicants for the Canadian Challenge.

4. How to Apply?

4.1 Registering Interest before Submitting an Application (optional)

Independent of the actual application, interested Applicants may register their interest to apply to the Challenge and subscribe to be notified of new challenge information as it becomes available. Registration of interest benefits include notification of newly released challenge documentation/references, challenge related events, invitations to participate in learning events or webinars and potential networking opportunities. To register their interest, interested Applicants must complete the registration of interest form. Registration of interest is optional for Canadian Applicants. Applicants will not be evaluated on the content submitted as part of this process.

[Registration of Interest Form](#)

4.2 Applying to the Challenge

Only Canadian applications, submitted through the Impact Canada website via the designated challenge [Application Form](#), will be accepted. **Applications must be submitted through the online form no later than July 30, 2021 at 5:00 PM Central Time.**

Apply to the Deep Space Food Challenge by using the [online form](#).

Note: Interested U.S. and Other International applicants may refer to the deepspacefoodchallenge.org website for more information on how to register and apply to the Challenge.

In order for an application to be considered for the Challenge, applicants must complete and submit the following documents online by the closing date and time indicated above and on the Impact Canada website. A complete application package consists of the Challenge Application Form, with the following sections:

- Section 1: Applicant details
- Section 2: Proposed solution details
 - Design Abstract, Design Report, Design Animation (video) & Intellectual Property
- Section 3: Declaration
- Section 4: Survey (optional)

Incomplete applications will not be considered or assessed further.

You will have the option to print your application for your records. If applicable, we encourage that you share this copy with the Duly Authorized Representative of your legal entity.

Application Details

Challenge Application Form

Applicants must fill in the Application Form available online on the Impact Canada website. The form consists of the following four sections:

- **Section 1: Applicant details**
This section of the form requests basic information on the Applicant and primary contact applying to compete in this Challenge.
- **Section 2: Proposed solution details**
In this section, you must provide details on your proposed solution and answer questions that relate to the assessment criteria to allow for a thorough assessment of the food production technology against these criteria.

Note that this is the main section that will be used by the Judging Panel in the assessment process. Make sure this section includes all relevant information for the Judging Panel's consideration. See below for detailed step-by-step instructions on how to answer each question in the Application Form.

- **Section 3: Declaration**
In this section, you must review and accept the terms and conditions for the Deep Space Food Challenge, and review and accept the Consent for Use, Disclosure and Copyright requirements. At any point during the Challenge, CSA may request that consent be given in writing or in a form at its satisfaction.
- **Section 4: Survey (optional)**
This section collects information on your experience with this challenge, information about your organization, as well as demographic information.

Note that any data collected will be used strictly for administrative purposes to help Impact Canada understand whether and how challenges are an effective tool and improve upon their design in the future. The data collected in this survey will be aggregated and no individual answers will be published. Your answers to this survey will not be used in the assessment process and will not affect your chances of success in this challenge or any other federal funding application. This information may be shared with other government departments.

Confirmation of legal entity and/or not-for-profit status (if applicable)

This can be a copy of the status certificate, incorporation documents, patent letters, or articles of incorporation (as applicable). Note that in order for Applicants to receive a prize, it must be an Eligible Recipient as per Section 3. This requirement can be completed after submission of the application but it must be prior to receiving any

prizes. Note that the Duly Authorized Representative, if applicable, of the Canadian legal entity will be signing the grant agreement.

4.3 How to Complete Section 2: Proposed Solution Details of the Application Form

Section 2 of the Application Form is the main section that will be used by the Judging Panel in the assessment process. Below are detailed instructions to help you submit a good quality application.

Note: The form will prompt you to provide inputs for each of the criteria except for Scientific & Technical Merit and Feasibility of Design, which will be evaluated based on your overall submission.

Q1. Design Abstract

Please provide a brief summary description of your proposed food production technology within a 1,500 character limit. The abstract may answer some of the following questions: What is your proposed solution? What is novel, sustainable, and innovative about your proposed solution? What types of food does your solution create? How are you minimizing inputs and maximizing food outputs?

Q2. Design Report

The following information provided will be used by the Judging Panel to assess your technology against the Challenge criteria.

Q2.1. Description of the food production technology

Part A: Please provide a more fulsome description of your food production technology within a 3,000 character limit. Your description needs to include information about what the technology is, what it does, how it functions, and how the crew will interact with it. Be sure to also provide any descriptions of major hardware components and processes in relation to your technology.

Part B: Please provide a 1,500 character description of the basic operations concept of the food production technology. In your response, describe assumptions required of operation. You can also include, for example, details about whether a sterile/aseptic environment is needed, if special steps are required between production cycles, or if fluids or materials must be removed or added to prime/inoculate a system.

Q2.2. INNOVATION

This question seeks to establish an understanding of how your technology is different from other technologies that currently exist. Your description needs to be clear and well

defined using simple language when detailing how your food production technology is novel, innovative and sustainable. Ensure to provide examples that will portray the novelty of your technology.

Q2.3. ADHERENCE TO CONSTRAINTS

Whether in space or in a remote community on Earth, there are several constraints that your food production technology should adhere to. This question outlines key constraints on volume, power, water, mass, data connection, crew time and operational constraints that your technology will need to address. Please ensure your responses are clear and concise as there is a 300 character limit associated with each constraint that you need to address.

In Phase 1, Adherence to Constraints is not meant to determine whether the Design Report itself is complete in including all the required information. This question is meant to ensure that Teams have considered the constraints, and that the food production technology design, at a minimum, falls within those constraints. In future Phases, Teams' food production technologies will be evaluated and scored on whether or not the design stays within the constraints so that it ultimately can meet CSA's needs and deliver value.

Q2.4. PERFORMANCE CRITERIA

This question seeks to understand how the proposed food production technology addresses the performance criteria of the Challenge. Describe how the food production technology addresses the following performance criteria.

Q2.4.1. ACCEPTABILITY

- Acceptability of the food production process
 - NOTE: The process must be something crew members could be expected to accomplish in a reasonable amount of time, on a daily basis in a small kitchen-like space after a busy workday.
 - **Target: Teams should consider the current target for Astronauts is 1 hour per meal (30 minutes for preparation, 30 minutes for the meal itself).**
- Acceptability of the resulting food product
 - NOTE: This assessment should include appearance, aroma, palatability, flavor, and texture.
 - **Target: A food item measuring an overall acceptability rating of 6.0 or better on a 9-point hedonic scale for the duration of the mission is considered acceptable.**

- **ACCEPTABILITY - Process**

Within a 3,000 character limit, describe in detail the processes and procedures of using your technology. Your response should include the operational footprint

(how much space is needed for the solution and its related processes?), the steps needed for a person to follow in setting up and using the solution, the food production cycle, the handling of food, the cleaning and stowage procedures, along with the estimated time needed for the crew to operate the solution. Please also provide an assessment (using industry standards and/or existing research) that your technology processes are likely to be user friendly and acceptable to the crew.

- **ACCEPTABILITY - Food products**

Please provide an assessment (using industry standards and existing research) that the food outputs of your technology are likely to meet the acceptability target within a 3,000 character limit. Make sure to address the appearance, aroma, palatability, flavor, and texture of the food output. You should be as descriptive as possible in your response.

Rate and describe the potential acceptability of your food products on a 9 point hedonic scale.

The hedonic scale is a quantitative method that is accepted throughout the food science industry as a means to determine acceptability. Further information regarding methods for determining food acceptability can be found in references such as Meilgaard, Morten C., B. Thomas Carr, and Gail Vance Civille. Sensory evaluation techniques. CRC press, 2006.

- **Optional - Additional comments**

This additional text box with a 1,000 character limit allows you to provide any other information on acceptability and palatability you would like to submit to the Judging Panel.

Q2.4.2. SAFETY

The overall safety of the food production process and the food products are a top priority for this Challenge.

NOTE: No pathogens are permitted to exist within the food technology or its outputs. Teams must take this into account in their Phase 1 designs. Designs that fail to account for pathogens will receive a "fail" score on the Safety category.

- Safety of the food production process
 - **Targets:** Environmental & process safety:
 - Avoidance of hazardous compounds or materials used or produced (e.g., microbes, off-gassing, toxic components)
 - Avoidance of hazards associated with cleaning this technology prior to and/or after use
 - Avoidance of physical, chemical, or biological hazards associated with the hardware or the process
 - Clear mitigation strategies to address the aforementioned risks
 - Safety of the resulting food products
 - Target: Consumption safety: Resulting food product is safe for repeated human consumption as defined by NASA-STD-3001 (see Reference Materials)

SAFETY - Process

Your answer will need to describe, in 3,000 characters, the safety associated with the food production process using your technology. The food production process includes: the safety of the food handling or processing procedures and environmental safety. Please include all food safety procedures that need to be followed. Your answer must demonstrate an understanding of the risk(s), and potential mitigation.

- **SAFETY - Food products**

Your 3,000 characters answer will need to describe the safety of the resulting food products (outputs), including safety for repeated human consumption.
- **Optional - Additional comments**

This additional text box with a 1,000 character limit allows you to provide any other information on the safety associated with the food production process using your technology.

Q2.4.3. RESOURCE INPUTS & OUTPUTS

- **Inputs and Outputs associated with the technology & Quantity of nutritious food output in relation to the quantity of inputs and quantity of waste output**
 - Targets:
 - **Maximum quantity food output relative to quantity of system inputs**
 - **Maximum quantity food output relative to quantity of waste output**
 - Nutritional potential of food produced
 - Targets:
 - **Maximum macronutrients supplied, as a percentage of a crewmember's complete dietary needs**
 - **Maximum micronutrients supplied, as a percentage of a crewmember's complete dietary needs**
 - **Maximum variety of nutrients supplied**

In your response, you will need to describe the resource requirements of the food production process (inputs) and all outputs. You will need to also include the estimated quantities of each input and output, as well as the nutritional quality of the food product.

- **INPUTS to the technology**

In a 3,000 character limit response, indicate the inputs needed to run your food production technology
Inputs may include: Raw materials, energy, water, or other materials that enter the system.
- **OUTPUTS to the technology**

In a 3,000 character limit response, indicate the outputs generated from your food production technology.
Outputs may include: Food products, waste, heat (latent and sensible), and other usable or unusable products exiting the system, including liquid and gaseous process flows (e.g., water vapor, low-molecular weight organic and inorganic compounds, water, oils, etc.).
- Within a 1,500 character limit, provide a description on how the food production technology achieves the greatest amount of food output in relation to the quantity of inputs and quantity of waste output.
- Please describe in 3,000 characters the nutritional quality of the resulting food products from your technology. You will need to provide the nutritional potential of the food produced with your technology. Use values based on reasonable literature information that you can reference. For example, as defined by NASA-STD-3001 (see Reference Materials).
- **Optional - Additional comments**

This additional text box with a 1,000 character limit allows you to provide any

additional information on the resource inputs and outputs related to the use of the food production technology.

Q2.4.4. RELIABILITY / STABILITY

- Reliability of the food production technology
 - **Target: Less than 10% loss of functionality or food production throughout a three-year mission.**
- Stability of the input products used and food product outputs.
 - **Target: Longest possible shelf-life of the input and food products. They must remain safe, without any significant loss of nutritional value or quality at ambient conditions**

- **RELIABILITY - Process**

Please provide a description of the reliability of your technology within a 3,000 character limit, which may include an estimate of your technology's operational lifespan (i.e., how long is the solution designed to last?) and percentage of functionality loss over three years. Your answer should also account for an overview of the maintenance process and procedures, including the maintenance schedule, component maintenance or replacement as well as all critical spare parts that would be needed for the length of the mission.

- **STABILITY**

Provide a 1,500 character description of the stability of both the input products used and food product outputs. Your description should include a rationalization of the estimated time the inputs and outputs will be fit for use and/or consumption (i.e., shelf-life).

- **Optional - Additional comments**

This additional text box with a 1,000 character limit allows you to provide any other information on reliability and stability you would like to submit to the Judging Panel.

Q2.5. TERRESTRIAL POTENTIAL

In 3,000 characters, describe your vision of your food production technology's potential to improve food production on Earth. Provide a concrete scenario in which your technology would serve the community in which it operates.

Q2.6. Supporting Material

Q2.6.1. Include any visual representations of the food production technology, which may include models, schematics, or drawings.

You are required to submit (a) visual representation(s) of your proposed technology. You should submit these visuals in a document in PDF format, of maximum five (5) Letter Size pages (8.5" x 11").

Q.2.6.2. Optional: Include any preliminary data or calculations that support the design and operation of the food production technology.

You may submit a document in PDF format, of maximum two (2) Letter Size pages (8.5" x 11"), including preliminary data or calculations.

Q3. Design Animation

You are required to submit a 5-minute (maximum length) design animation demonstrating a simulation of your food production technology under operation. This animation should include key elements, such as: the setup, any operation from a user perspective, various inputs and outputs and the shutdown and cleaning process. It is recommended that the animation be saved on a platform that support video files (e.g., YouTube, Google Drive) and provide a link of the video in your submission.

Q4. Intellectual Property

Please provide all relevant details and explain the ownership of the intellectual property of the proposed solution. You may also demonstrate ownership of or permission to use any existing or off-the-shelf technology's intellectual property in the context of the Challenge.

5. Information for Semi-Finalists (If you are selected as a winner in Phase 1)

Prize Distribution

CSA will issue prize payments, by signing a grant agreement, to the winning Eligible Recipient within 60 calendar days after the announcement of the winner(s) as recommended by the Judging Panel and determined by CSA. All terms of payment for the prize will be set out in the grant agreement.

Because Impact Canada Challenge Prizes are funded using grants and contribution funds, the authority to release funds lies with the head of a federal department or agency or their delegate. Therefore, Judging Panels make recommendations for who should be awarded funding, and the Challenge planning team acts as a conduit to get those recommendations approved, in this case, CSA, and funding released.

Winning individuals and winning groups of individuals understand that CSA can only make Prize payments to an Eligible Recipient. If a winning Applicant is not an Eligible Recipient, it will be required to establish a Canadian legal entity (such as a corporation or a not-for-profit organization) capable of entering into binding agreements in Canada as indicated in Section 3 (Who can apply? Eligibility Details). CSA will require at a minimum from the Eligible Recipient the same information and consent submitted by the Applicant as part of the Phase 1 Application. Such information and consent must be provided upon request and to CSA's satisfaction. CSA may request additional information as the case may be.

Grant Agreement

In order to receive the prize amount at each phase, each successful semi-finalist, finalist, and winner will be required to enter into a grant agreement with CSA.

Prior to entering into the grant agreement, all selected participants will undergo a due diligence process to confirm that they meet all requirements to receive Deep Space Food Challenge grant funding. This may include the review of documentary proof of establishing that the Applicant is a Canadian legal entity capable of entering into legally binding agreements. The grant agreement will be signed by the Duly Authorized Representative of the organization.

Organizations in Quebec

An organization in Quebec whose operations are partially or fully funded by the province of Quebec may be subject to the [Act Respecting the Ministère du Conseil exécutif](#), R.S.Q., Chapter M-30.

Under Sections 3.11 and 3.12 of this Act, certain entities/organizations, as defined in the meaning of the Act, such as municipal bodies, school bodies, or public agencies, must obtain authorization from the [Secrétariat du Québec aux relations canadiennes \(SQRC\)](#), as indicated by the Act, before signing any funding agreement with the Government of Canada, its departments or agencies, or a federal public agency.

Consequently, any entity that is subject to the Act is responsible for obtaining such authorization before signing any funding agreement with the Government of Canada.

Quebec applicants will have to complete, sign and provide the M-30 Supporting Documentation form before signing the grant agreement (if applicable).

Subsequent Phases

Detailed information for Phases 2 and 3 will be shared with Semi-Finalists and Finalists respectively, prior to the launch of each new Phase.

6. General Terms & Conditions

Applicants to the Challenge agree to the following when submitting their application:

- Applicants agree to comply with all applicable laws.
- Applicants must be able to demonstrate ownership of or permission to use any intellectual property (IP) used in the Challenge and provide necessary permission to CSA for the purpose of administering this challenge.
- Applicants warrant that all information given in and with the Challenge Application Form for this solution is, to the best of their knowledge, complete, true and accurate.
- CSA has the discretion to cancel this challenge or any part thereof at any time.
- If applicable, CSA may seek translation services for applications, for the purpose of evaluation.

Privacy

Use and/or Disclosure

The personal and/or business information in, accompanying and/or submitted in support of this application is being collected under the authority of the [Canadian Space Agency Act](#) and, by applying to the Challenge, Applicants agree that such information, may be used by CSA, or disclosed to third parties including other Government Departments, members of the Jury Panel and National Aeronautics and Space Administration (NASA) and their respective authorized representatives, to:

- Assess and review the eligibility of the Applicant and the Solution under the applicable CSA program.
- Verify the accuracy of the information provided in or with the Application Form and additional documents.
- Assess the efficiency of the challenge model in furthering departmental priorities.
- Assess how well the initiative contributed to CSA program objectives.

By applying, the Applicant consents that the information may also be used for the purposes of: contacting you should additional information be required; validating your credentials; facilitating payment of the grant in the event your application is successful; program administration; and evaluation, reporting, and statistical analysis.

The information collected under the application form of the Deep Space Food Challenge will be stored and protected in the personal information bank of CSA (ASC PPU 045). Personal information will be treated and disclosed in accordance with the [Privacy Act](#). You have the right to access your personal information held by CSA and to request changes to correct personal information by contacting the CSA Access to Information and Privacy Director at asc.aiprp-atip.csa@canada.ca.

Business information will be disclosed only in accordance with the provisions of the Access to Information Act.

Information on the Privacy Act and the Access to Information Act is available at the following website: <http://laws.justice.gc.ca>. For further information about these Acts please contact the Access to Information and Privacy Director at asc.aiprp-atip.csa@canada.ca.

Copyright permission

CSA may disclose, reproduce and distribute any part of or the whole of the documentation provided in or with this Application Form, within CSA and to its authorized third parties, including other Government Departments and the National Aeronautics and Space Administration (NASA), for purposes consistent with the receipt, assessment and subsequent treatment of the Application.

Intellectual property

Notwithstanding anything to the contrary in the Applicant Guide, CSA and the Privy Council Office claim no intellectual property (IP) rights from the application.

To the extent the Applicants and Recipients own IP resulting from their participation in the Challenge, the Applicants and Recipients agree to negotiate in good faith with CSA for a grant of a nonexclusive, non-transferable, irrevocable license to practice or have practiced for or on behalf of the Government of Canada, the intellectual property throughout the world, at reasonable compensation, if CSA chooses to pursue such a license.

By applying, in addition to the consents and authorizations contained in the Application Form, Applicants:

- Agree and certify that, the Applicant owns the intellectual property rights or is authorized to use them in connection with its project and the content presented in the application; and
- Agree that CSA may, at any time, require the Applicant, Recipient, its shareholders or members, as applicable, to provide it with any original document or additional information for the purpose of verifying the application or other information submitted or representation made in the course of the Challenge.

Delay, Cancellation or Termination

Applicants acknowledge that circumstances may arise that require the Challenge to be delayed, delayed indefinitely or cancelled. Such delay or cancellation, and/or the termination of the Challenge, shall be within the full discretion of CSA. Applicants accept any and all risk of damage or loss due to such delay, cancellation, and/or termination.

Costs and Expenses

Applicants are not required to make a purchase or pay a fee to participate in or win the Challenge. Applicants are fully responsible for all and any expenses incurred in connection with their participation in the Challenge, including, but not limited to, any expenses related to the submission of their application, for the elaboration or testing of solutions, supplies and materials, such as for prototyping, intellectual property, transportation of people or material, and any insurance.

Similarly, participants will remain fully responsible for all expenses incurred and resources expended in connection with preparing their proposals, attending and participating in the testing for Phases 2 and 3, as the case may be.

Release, Liability and Compensation

Applicants agree to hold harmless and discharge CSA, the members of the Judging Panel, other federal departments or agencies from any and all liability for claims, losses, damages or expenses arising from its project and/or participation in the Challenge, as well as personal injury or death, loss or damage to property, or allegedly caused by the applicant, its shareholders, members, directors, officers, employees, contractors or volunteers, as applicable, when carrying out its project or during the course of its participation in the Challenge.

CSA, the members of the Judging Panel and other federal departments or agencies will not be liable to the applicant, its shareholders, members, directors, officers, employees, contractors or volunteers, as applicable, for any third party claims, lawsuits, demands or actions.

Applicants agree that CSA may, at any time and at its sole discretion, reject any application that fails to comply with the Applicant Guide, attempts to register for the Challenge in any manner or by any means other than those described in the Applicant Guide, attempts to disrupt the Challenge or circumvent the content of the Applicant Guide.

Applicants agree that CSA and the members of the Judging Panel cannot be held responsible for any rejected, lost, delayed, illegible, damaged or undeliverable applications or any delay or problem in the sending, processing, receiving or review of applications.

Records

It should be noted that original documents may be required by CSA at any time during the Challenge for the purpose of evaluating the application and verifying the submitted documents. Applicants are required to retain, for the duration of the Challenge, all original documents pertaining to their participation in the Challenge. Failing to provide

those original documents or send them within the given time frame will result in the application being rejected.

Communication

By applying, the Applicants and Eligible Recipients consent to CSA and Impact Canada publishing photographs, videos or captions containing their name or image or of their representatives. They agree that this may include electronic publishing via the Internet, the social media or the Intranet, as well as publishing in printed documents and videos, or presenting at public events. They also agree that they cannot charge any fees or royalties in relation to the use of their name or image or of their representatives.

Legal Entities Constituted during the Challenge

If a new legal entity is constituted during the Challenge for purposes of recipient eligibility described in Section 3 above, and unless the context suggests otherwise, Applicant(s) include Eligible Recipient(s) for purposes of this section (6. General Terms & Conditions).

CSA is not responsible for any dispute between individuals of a group of individuals who applied for the Challenge regarding the distribution among that group of the prize or parts thereof. Any failure of the Eligible Recipient to share or otherwise make payments of any kind to individuals or a group of individuals who applied is the responsibility of the Eligible Recipient and not of CSA. CSA may, at any time and at its sole discretion, reject any application or ask reimbursement of any payments should such dispute arise.

Governing Law

The Challenge, including the Applicant Guide, shall be governed in accordance with the laws of the Province of Quebec and the applicable federal laws.

7. Official Languages

English and French are the official languages of Canada. The Government of Canada is committed to supporting the vitality and development of the English and French language minorities in Canada and encouraging full recognition of the use of English and French in Canadian society. Applicants can apply and require that they be contacted and served in the official language of their choice.

8. Contact

For any questions or clarifications regarding The Deep Space Food Challenge, please contact the Canadian Space Agency team: <mailto:ASC.DefiAEL-DSFChallenge.CSA@canada.ca>. We will get back to you within five business days.

It is the responsibility of the applicants to obtain clarification of the requirements contained herein, if necessary, before submitting an application. At any point, applicants are welcome to share with CSA their comments or suggestions regarding the initiative or the process.

Updates will be provided on the Impact Canada website, including the latest Challenge news and frequently asked questions (FAQs).

Applicants are encouraged to follow us on social media for the latest developments.

Annex A: Definitions

Definition of Collaborators and Challenge Administrators

National Aeronautics and Space Administration (NASA): Is an independent agency of the U.S. Federal Government responsible for the civilian space program, as well as aeronautics and space research.

Canadian Space Agency (CSA): Is a federal agency responsible for managing all of Canada's civil space-related activities. CSA is responsible for advancing the knowledge of space through science and using its discoveries for the good of Canadians and all of humanity.

Privy Council Office (PCO): Supports the Canadian Prime Minister and Cabinet. Led by the Clerk of the Privy Council, the department helps the Canadian government in implementing its vision, goals and decisions in a timely manner.

Impact Canada: Housed within the Privy Council Office, is a Government of Canada-wide effort to help accelerate the adoption of innovative funding approaches to deliver meaningful results to Canadians. Challenge Prizes, Pay-for-Success projects and Behavioral Science are its key business lines.

Definition of Terms

Applicant(s): As defined in Section 3 of the Applicant Guide.

Application Form: Form described in Section 4.2 of the Applicant Guide.

Applicant Guide: Rules of the Challenge, including all terms and conditions contained in this present document and any new document published for Phase 2 and Phase 3 of the Challenge. Applicant Guide applies to all Applicants and Eligible Recipients.

Concept of Operations: A document describing the operations of a proposed system from a user's perspective, through a complete production cycle, including cleanup and any activities required to prepare for the following production cycle.

Eligible recipient(s): Is an Applicant eligible to receive prizes as described in Section 3 of the Applicant Guide. If at the time of Application, the Applicant is not an Eligible Recipient, the Eligible Recipient will be the legal entity described in Section 3 and as identified by the primary contact (as they appear in the Application Form) to the CSA.

Judging Panel: A panel of professionals and subject matter experts from government, academia, and industry who will evaluate and score all submissions.

Kitchen-Level: A level of technology development roughly equivalent to Technology Readiness Level (TRL) 4.

Phase: A stage of the Challenge representing a key step in the development of food production technologies for feeding crews on long duration space exploration missions. This Challenge will have up to three Phases.

Recipient: Eligible Recipient who has been awarded a prize.

Registration of interest form: Form described in Section 4.1 of the Applicant Guide.

Team: An individual or group of individuals, identified as a Team or Team Members in the submitted Application Form in Section 1.

Technology Readiness Level (TRL): A method for estimating the maturity of technologies. The use of TRLs enables consistent, uniform discussions of technical maturity across different types of technology. Please refer to Annex B for more details.

Annex B: Reference Materials

Note: A more comprehensive reference list (including translations when relevant) will be provided on the Deep Space Food Challenge Impact Canada website.

NASA Technology Readiness Level (TRL) (English only)

https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html

<https://www.nasa.gov/sites/default/files/trl.png>

NASA STD-3001: NASA Spaceflight Human-System Standard; Volume 2
Human Factors, Habitability, and Environmental Health (English only)

<https://www.nasa.gov/hhp/standards>

Food Acceptability (hedonic scale) (English only)

Meilgaard, Morten C., B. Thomas Carr, and Gail Vance Civille. *Sensory evaluation techniques*. CRC press, 2006.

Users should be aware that information offered by non-GoC sites that are not subject to the *Official Languages Act* and to which the Canadian Space Agency links, may be available only in the language(s) used by the sites in question.