

# Gaps List KSC Space Crop Production Project Scientist: Interview Evaluation

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## Abbreviations

AES = Advanced Exploration Systems  
BPS = Biological and Physical Science  
CIF = Center Innovation Fund  
HRP = Human Research Program

IR&TD = Independent Research & Technology Development  
ISS = International Space Station  
KSC = Kennedy Space Center  
OSTEM = Office of STEM Engagement  
SCP = Space Crop Production

## Introduction

Space Crop Production (SCP) at NASA's Kennedy Space Center (KSC) is aimed at achieving nutrient supplementation and moving towards caloric independence from Earth by growing crop plants. Currently, the program is faced with challenges of growing crops on the ISS in microgravity. These challenges are complex and need to be solved systematically. SCP research is funded by various NASA sources that focus on supporting research appropriate to their discipline. Using the Gaps List to understand where these funding sources fit into the SCP research may be important for highlighting areas where new investments can be made. The goal of this evaluation was to show alignment and identify disconnects between current SCP research and the Gaps List.



Image 1 Displays a road map of the SCP Program goals. Challenges associated with these goals are expressed in the gaps list.

## The Gaps List

The Gaps List is a dynamic system of missing knowledge that is organized hierarchically. The gaps on the list are the most attainable research topics needed to be understood such that space crop production can be realized. More complex issues are documented and are added when they become attainable. That is why the Gaps List is considered dynamic. Gaps close and open as new discoveries are made, and as new technologies are developed. The gaps are organized by an I.D. phrase that has five characters separated by periods. The first character represents the Gap Section. There are three sections (1) Hardware, (2) Crops, and (3) Ecosystem. Within these sections there is separation by Gap Category and Sub-Gap. Each gap has its own I.D., key word, and description.

Gap ID	Section	Category	Sub-gap	Keyword	Description
1.B.1.0.1	Hardware	Environmental Control	µg Water/ Nutrient Delivery	Water Delivery	Lack ability to effectively provide adequate and uniform delivery of water and nutrients to root zones in relevant space environments

Table 1 shows an example of a singular gap that is one of many on the gaps list.

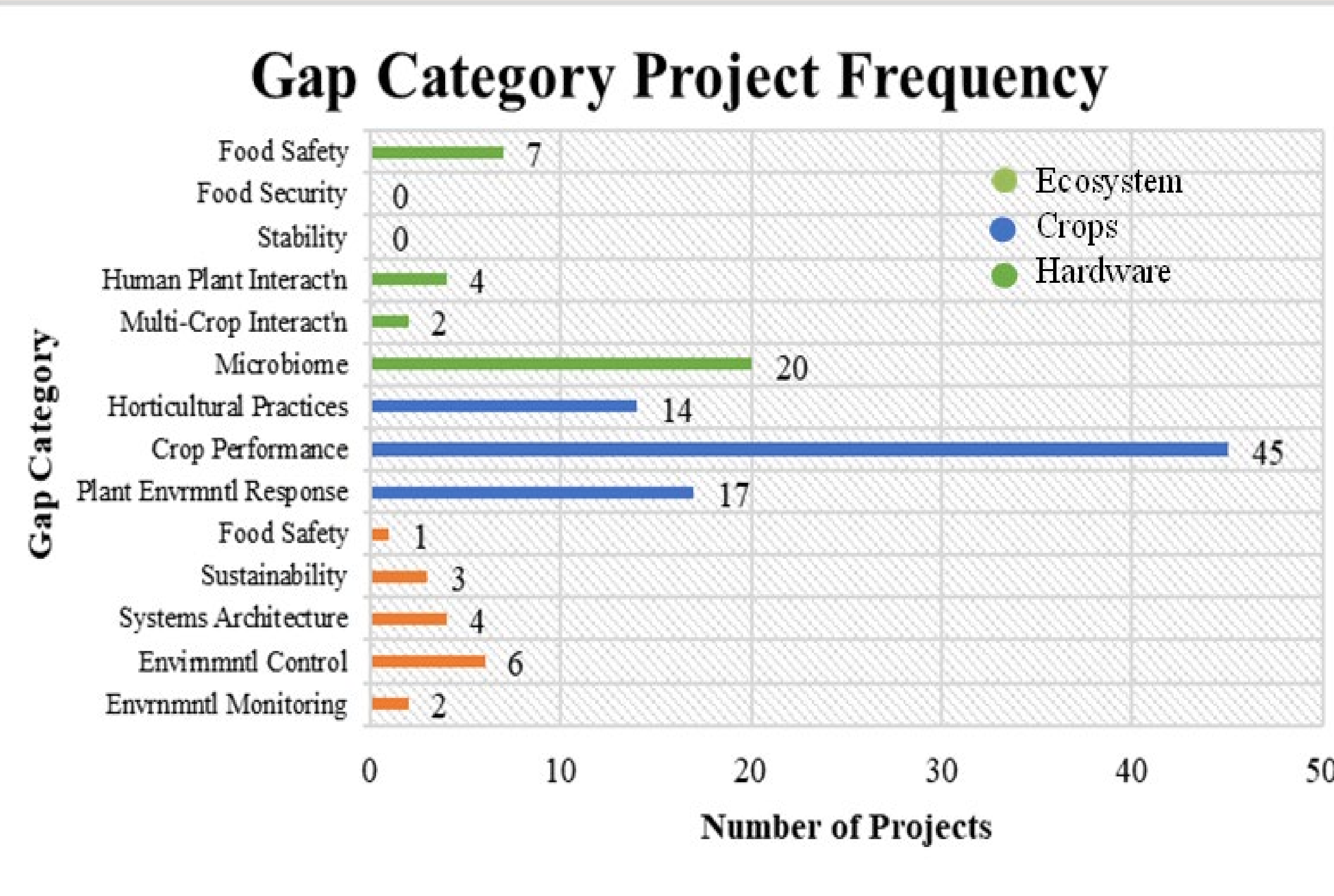


Figure 1 Gap Category Project Frequency

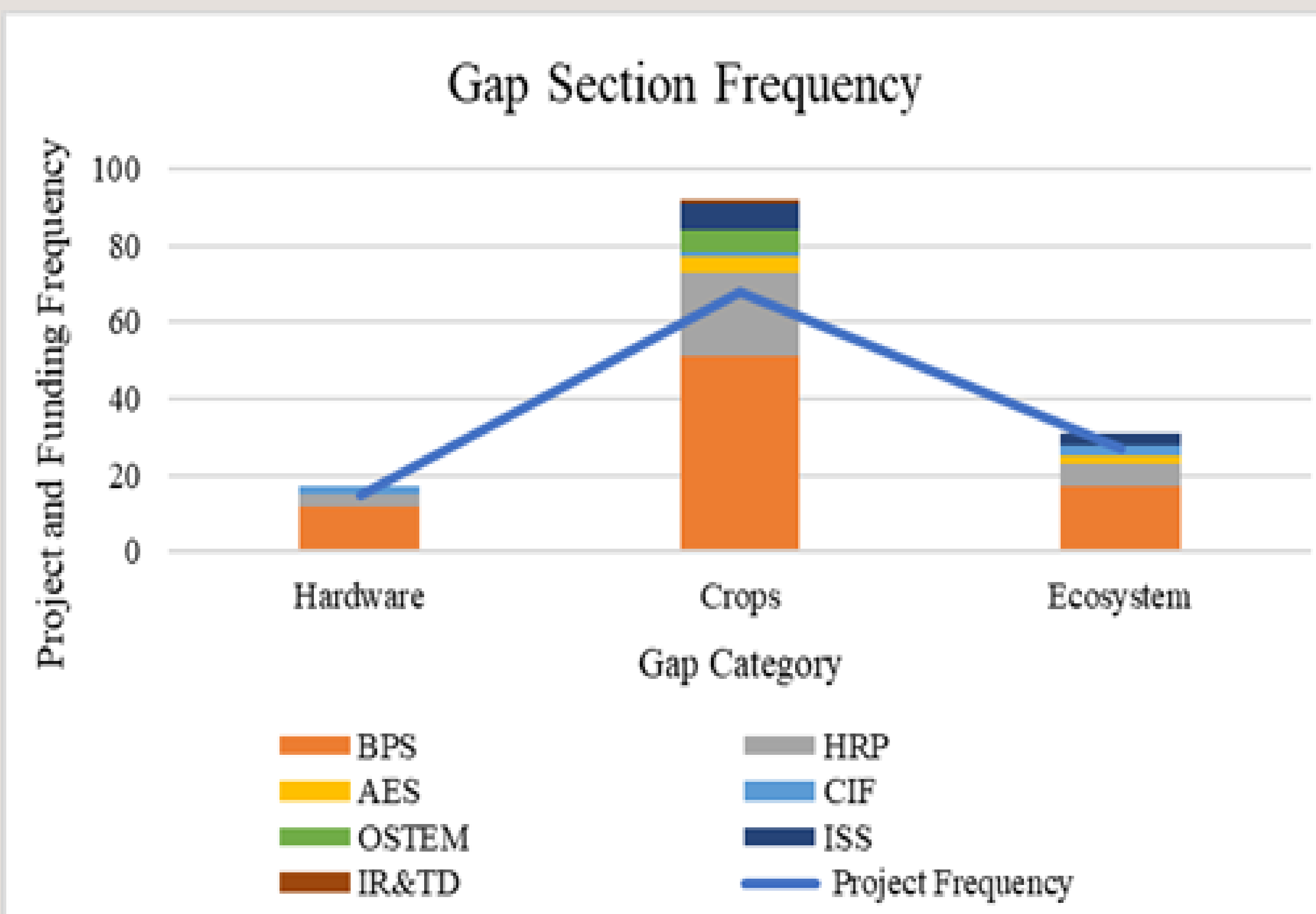


Figure 1 Gap Section Project and Funding Frequency



## Gaps List Evaluations

1. To emphasize the importance of gaps in areas such as hardware, it may be helpful to have a measure of priority.

The lowest frequency of research alignment lies in the Hardware Section seen in Figure 1. This likely has adverse effects because hardware capabilities are needed to make progress in the steps toward research for producing crops at a larger scale in space environments. Historically, BPS has been the main funding source for the SCP Project due to its focus in fundamental biology and applied crop science. Today, SCP is shifting towards production. To support this shift, the SCP Program will need more engineering and physics support from other funding sources that focus on hardware and capabilities. Making a new list may be helpful to reorganize the gaps into a taxonomy measuring priority.

2. It may be beneficial to create a roadmap of dependencies or gaps that rely on others to be complete before they can then be completed.

An intermediate frequency was found in the Ecosystem Section, represented in the center of Figure 1. The low frequency in this section is not unexpected considering these gaps are related to system sustainability over time and multi factor interactions. These aspects are hard to study and require considerable funding and time. Some of the gaps in this category depend on knowledge or technologies that are not yet available. Gaps in other categories may contribute to the completion of the gaps in this section.

3. It may be important to portray the scope or breadth in which a gap encompasses within the gap description, taxonomy or in another list.

The section of the Gaps List most emphasized in current research is the Crops Section on the right in Figure 1. In Figure 2, it is evident that Crop Performance is the most frequently researched category in the Crops Section. The density of this category is most likely due to the large scope of Crop Performance and support from the funding sources BPS and HRP. This is expected considering BPS focuses on fundamental science and it is the main contributor to the SCP Program. Many of the gaps in Crop Performance require extended effort versus other gaps that may be more straight forward. Rewording gap descriptions such that they portray their scope, may be necessary.

4. For the Gaps List to remain effective, it needs to be evaluated at regular intervals to ensure all gaps are included, the proper gaps are closed, and future gaps are added.

The dynamic nature of the Gaps List was utilized, and several future and current gaps were added to accommodate all current KSC research questions.

## SCP Project Evaluation

To address less frequent gaps such as Hardware and Microbiome, support from funding sources that focus on these disciplines may be necessary. An efficient rate of progress will likely be achieved if adequate support is given to all sections of the Gaps List.



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