OFFICE OF SUSTAINABILITY
CAMPUS SUSTAINABILITY FUND

Fungi Blocks for Fresh Crops

Grant Type
Annual Grant

Application Type
Final Application

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Requested Funding Amount

Only enter this number after completing the budget sheet (the budget template will round up your request).
Mini Grants may request $250 up to $5,000.
Annual Grants may request $5,001 up to $100,000, and up to three years of funding.

Year 1:
$88200

Year 2:

Year 3:

Project Name
Fungi Blocks for Fresh Crops

Primary Project Category
Waste

Secondary Project Category
Food

Background and Context

Please provide relevant background about your organization/team including your mission and/or expertise. Lay out the rationale for the proposed project, focusing on the issue that your project would address. You may also share how the project is new or how it complements, builds upon, or scales existing initiatives. This section is meant to give us more information about you and the context for the project, while the questions below provide space to go into detail about your proposal's plan and specifics.

Response:

The Good: The Teaching Greenhouse (TGH) at the UA-CEAC (Controlled Environment Agriculture Center) is a one-of-a kind facility in higher education, providing hands-on learning and showcasing

sustainable food production through hydroponics and Controlled Environment Agriculture (CEA) technology. Hydroponics and CEA allow plants to be grown in a greenhouse using soilless substrate and nutrient solution, enabling year-round food production in areas where traditional farming with arable land and good climate are limited. Furthermore, hydroponics and CEA can use one-third less water, minimize fertilizer waste, and eliminate the need for restricted pesticides by using integrated pest management (IPM) practices. The TGH supports a variety of educational activities, including classes and labs for hands-on learning, student internships, public tours, annual workshops, and conferences. Each week, several hundred pounds of fresh produce are harvested from the TGH and used to strengthen food security among UA students and the local community.

The Problem: While the Teaching Greenhouse (TGH) has many benefits, it currently depends on a non-renewable and non-compostable soilless substrate called rockwool to sow seeds and grow plants. Although rockwool is the industry standard, it's mined from lava rock, requires a lot of energy to produce, and can't be reused – meaning it ends up in the landfill after each growing season. In the past, the TGH experimented with alternative substrates like coco coir (made from coconut husks) and green fiber (made from recycled wood). However, both have their drawbacks, including the need for international shipping from Sri Lanka and Denmark, respectively. In fact, last year, the TGH couldn't even obtain coco coir due to shipping delays!

The Solution: A locally sourced, renewable substrate that can be composted at the end of each season would make the TGH a truly sustainable model for food production! Therefore, the TGH under Dr. Hooks has teamed up with Bree Gomez and the Mycology Lab at the UA-CEAC to develop a sustainable substrate using mushroom mycelia! The Mycology Lab focuses on growing edible mushrooms from agricultural waste, with an emphasis on bio-circular food production. With the help and expertise from Bree Gomez and the Mycology Lab, this project aims to grow fungi blocks for fresh crops! These fungi blocks will provide a renewable, locally sourced substrate that can be produced on-site and composted afterwards, reducing the need for international shipping and waste. The TGH and the Mycology Lab are uniquely positioned at the UA-CEAC to collaborate on this project and establish a bio-circular system that minimizes waste and enhances local food production. This partnership will not only contribute to the sustainability of the University but also offer hands-on learning opportunities for students, while showcasing this groundbreaking approach to visitors, professionals, and the local community.

Project Description

Please provide a thorough description and explanation of your project. Be explicit in what your team is proposing. What will your project's outcomes be and how will you achieve them? Outcomes should be specific, measurable, achievable, realistic, and timely.

Response:

Big Picture: Our project aims to minimize waste in local food production systems by integrating mycelium-based fungi blocks as a hydroponic substrate. Specifically, we want to reduce reliance on single-use products like rockwool, by demonstrating that fungi blocks can serve as a viable, sustainable alternative. The CEA industry is actively exploring more sustainable substrate materials

and there is ongoing research in this area (see supplemental docs). We believe this strengthens our project by making it very timely and impactful. We also believe the future of sustainable and resilient food production lies in collaboration and integration of diverse fields and backgrounds—such as the Mycology Lab's expertise in mushroom production and the TGH's work with hydroponic crop production. This interdisciplinary approach also provides valuable hands-on learning opportunities for students across a wide range of majors who take classes at the UA-CEAC. Therefore, we are committed to sharing this work with our students and empowering them to become the next generation of leaders and innovators in sustainability.

Fungi Blocks: The Mycology lab will create a series of mycelium-based substrates, or fungi blocks, on-site for use in the TGH throughout the school year, including both the Fall and Spring semesters. These fungi blocks will be made from lignocellulosic waste materials—such as seed hulls, plant material from the greenhouse such as chipped tomato stems, and sawdust—all bound together by fungal mycelia, which will provide the necessary adhesion and structural rigidity. Several different shapes of fungi blocks will be made, including small, medium, and large blocks to accommodate the plants during seed sowing, transplant, and production stages. Containers will be used as molds to shape the growth of the mycelium into the desired block sizes. The two main fungal species used for this project will be Ganoderma lucidum (Reishi mushroom) and Pleurotus ostreatus (Pearl oyster mushroom).

Fresh Crops: The TGH grows fresh tomatoes, peppers, and cucumbers throughout the Fall and Spring semesters. The TGH uses hydroponics and CEA so plants can grow their best. The TGH also relies on Integrated Pest Management (IPM) to keep the plants healthy while avoiding restricted pesticides. This includes bumble bees for pollination, beneficial insects like ladybugs, and good microorganisms like Trichoderma to keep the roots healthy. The TGH is a sustainable food production system except for its rockwool substrate. We propose that half of the TGH will be dedicated to using the fungi blocks for this project. This will accommodate 288 tomato plants, 80 pepper plants, and 32 cucurbit plants. This will allow for effective demonstrations and comparisons between rockwool and the fungi blocks, which will provide great teaching opportunities with the hope of implementing the fungi blocks long-term. A schematic of the TGH set up is provided in the supplemental doc.

Timeline

Please provide a timeline breakdown for the key steps in your project. The timeline can be basic, but please include anticipated timeframes for each major step, including any key dates for when certain elements must start or be completed. The timeline can be in list format.

Response:

June: Because our project is largely student-based, our first step would be to advertise and hire the students that will be critical to the success of this project. We anticipate initiating this process as soon as possible so that students can be hired and ready to start training in July when funding begins.

July: Bree Gomez will begin training students in the Mycology lab on proper sterile techniques,

inoculation, and fungi culture procedures. Bree Gomez will also train students on the safe use of the chipper, mill, and autoclave which will be used for the preparation of organic material to be inoculated with mycelium to grow the fungi blocks. Work will also begin growing the fungi blocks on a weekly schedule. We anticipate about three weeks for each set of fungi blocks to grow and be ready to use in the TGH (see supplemental doc). Simultaneously, Dr. Hooks will begin training students in the TGH to clean and prepare the greenhouse for the new year. This includes cleaning and sanitizing the greenhouse walls, floor, gutters, irrigation lines, preparing nutrient solution, and testing and calibrating the greenhouse and hydroponic equipment. We anticipate the entire month of July to complete these tasks which is standard from previous years.

August – October: Once the first set of fungi blocks are grown and ready to use, the Mycology Lab students will continue to grow fungi blocks for all nine rows in the TGH. We anticipate this to take 3 months to complete. Likewise, TGH students will sow seeds in both the fungi blocks and rockwool on a weekly schedule to ensure a steady rhythm of work with the Mycology Lab. We anticipate 3 months for the entire greenhouse to be filled with fungi blocks, rockwool, and plants.

November – March: Mycology lab students will continue to grow more fungi blocks for the new crops in the TGH during the Spring semester (pepper and cucurbits are replaced each semester). Extra sets of fungi blocks will be grown during this time to demonstrate and give away for free during our workshops. Simultaneously, Dr. Hooks will train TGH students on plant steering techniques. This includes weekly pruning of suckers and older leaves, lowering and leaning the plants, and harvesting and grading fresh produce. Students will also learn to manage the greenhouse and hydroponic system so that the plants can grow their best.

April: Dr. Hooks, Bree Gomez, and all students in the Mycology Lab and TGH will plan, advertise, and host a hands-on workshop at the UA-CEAC demonstrating the fungi blocks and fresh crops to our community!

May: TGH students will begin clearing plants out of the TGH and closing down the greenhouse for the end of the year. Mycology lab students will use plants from the TGH as organic material to chip, mill, and autoclave and be ready for the possible continuation of this project into the next school year!

Budget Narrative

Use this section to provide supplemental justification for the items you are requesting on your budget sheet. Please break down your justifications into the budget categories: Personnel or operating budget. Do not list out each expense or repeat notes made in the budget template, but instead address why the line items are being requested and the purpose they will serve, providing elaboration when necessary.
If you are requesting funding for personnel, use this section to elaborate on the position you are creating and how the budget and timeline was established for it. If you plan to hire students, describe in what capacity. Describe relevant details thoroughly (wages, responsibilities, duration of job, extent of involvement, how you will solicit/ market these opportunities etc.).
Ensure the descriptions match the line items in the budget sheet.
If matching or supporting funds are secured for the project, identify the source and amount in this section, and detail the impact of the matching funds on your overall budget.

Response:

Personnel Budget:
Currently, the TGH and Mycology Lab operate with two paid student employees each, funded through workshop events and greenhouse produce sales. However, both facilities could support many more students but have been limited by funding. For example, unpaid student internships and volunteers are relied on to help. Historically, the TGH and Mycology Lab at the UA-CEAC involve a diverse community of students, eager and excited to learn about plants and mushrooms and gain hands-on experiential learning, and we hope to continue that spirit through this project.

Furthermore, this project will involve a new and collaborative approach to crop production, requiring an integrated understanding of growing plants in the TGH and growing mycelium fungi blocks in the Mycology Lab. To support this, we need a larger team of students, and we are requesting funding for their wages.

One Student Greenhouse Manager and three Student Greenhouse Assistants will be hired to learn and develop team skills to help manage the TGH and grow greenhouse hydroponic plants. The student manager will be responsible for organizing and communicating weekly tasks such as seed sowing, plant steering, and harvesting. Dr. Hooks will communicate with and train all the greenhouse students.

One Student Mycology Manager and two Student Mycology Assistants will be hired to learn and develop team skills related to help manage the Mycology Lab in fungal culture maintenance (transfers and media preparation), inoculation (of both spawn and substrate), and organic biomass processing. The student manager will be responsible for monitoring the growth of the mycelium and keeping a log to track progress and ensure proper procedure. Bree Gomez will communicate with and train all the Mycology Lab students.

Bree Gomez, the current Research Technician in the UA-CEAC Mycology Lab, would dedicate 10 hours/week for student training in Mycology lab tasks and helping manage the project throughout the year. Bree Gomez is essential to the success of the students in the Mycology Lab and her position would be partly funded through this project.

Operational Budget:
The operational budget ensures enough funds for day-to-day operations, including the purchase of supplies for mushroom culture maintenance, hydroponic system materials (e.g., fertilizer, seeds, and IPM supplies), and general cleaning and sanitation items. Containers, trays, and bins of various sizes will be purchased and used specifically as molds to grow the mycelium into the fungi blocks.

Capital Equipment:
A mill and pelletizer machine are requested to improve the Mycology Lab's efficiency in preparing organic material (plant biomass) to use as material for the mycelium to grow into the fungi blocks. Therefore, the mill and pelletizer are important items to the viability of this project. We've included a quote from one potential company for these within the supplemental material.

Project Feasibility and Logistics

The Campus Sustainability Fund will only fund projects that have completed the necessary work to ensure they can succeed, be completed in the grant's timeline, or have an accurate budget.

Please provide a description of the work that has been completed so far to make this project feasible. Please provide a description of the work that has been completed so far to make this project feasible. If relevant partners have been contacted/coordinated with, please identify them in your response.
For example, have you received consent or authorization to complete your project (such as from Housing and Residence Life, Facilities Management, Parking and Transportation, etc.)? If you are making modifications to campus, do you have written authorization or official quotes from Facilities Management to accurately identify the cost of labor and supplies?

Response:

The TGH and Mycology Lab at the UA-CEAC come with a uniquely complimentary blend of both expertise and infrastructure resources making this project possible and positioned for success. The UA-CEAC is an active hub for student engagement, hosting classes, labs, workshops, and tours. This educational infrastructure will be invaluable for involving students in the project and providing hands-on learning experiences. The greenhouse also regularly engages with the public and professionals, making it the perfect space to showcase the success of the fungi blocks. The combination of these resources not only makes this project feasible but also positions the TGH as an ideal location to set new standards for sustainability in hydroponic farming.

The TGH spans 5400 ft^2 and can accommodate up to 864 plants at a time, including large vine crops like tomatoes, peppers, and cucurbits. It is equipped with an automated control system and hydroponic drip fertigation that optimizes the environment and plant growth. The TGH is operational from August to May (Fall and Spring semesters) and is supported by the classes, labs, and students it serves (see supplemental doc for the full list). Therefore, the TGH offers the perfect opportunity to implement and demonstrate fungi blocks for fresh crops in a real-world setting with lots of access and visibility to students, visitors, and professionals.

The Mycology Lab, which focuses on the utilization of lignocellulosic waste material for mushroom cultivation, is equipped with the necessary tools and infrastructure to produce high-quality mycelium-based fungi blocks, using organic materials such as plant biomass. This aligns with the lab's ongoing work in areas focused on sustainable agricultural practices, including previous success with creating mycelium composites. The year-long timeline will allow for the fungi blocks to be utilized as the substrate material for half of the crops grown in the TGH for the year, ensuring this material is utilized just the same as the conventional substrate.

Specifically, the fungi blocks will be made in sets using molds of three different sizes to match conventional rockwool sizes and accommodate the plants needs in the TGH:

- 10 x 20 in. trays of 1.5 x 1.5 in. cubes for sowing seed (small fungi blocks)
- 4 x 4 x 2.5 in. cubes for boosting seedlings (medium fungi blocks)
- 4 x 6 x 36 in. slabs for transplanting in the TGH (large fungi blocks)

Bree Gomez has already successfully made several iterations of these fungi blocks and some early tests have already been done in the TGH (see supplemental doc for photos). We are very excited and confident that the fungi blocks will work well and the plants will grow just as good if not better (due to the beneficial nature of the organic/fungal material) than the rockwool!

Environmental Sustainability Outcomes

Please provide a description of how you expect your project to advance environmental sustainability on campus. A definition of environmental sustainability is provided on our Guides and Tips page.

Response:

This project sets out to make local hydroponic food systems more sustainable by teaming up with the power of fungi to produce a locally sourced, renewable, and compostable substrate made from mycelium - fungi blocks!

Hydroponic systems are widely recognized for their ability to grow food anywhere while using less water, making them ideal for urban agriculture or where water resources are limited. These systems also reduce transportation emissions by bringing food production closer to city centers. However, a significant challenge to their sustainability lies in the substrate material used for plant growth.

Traditionally, rockwool has been the go-to medium and while effective as a substrate, rockwool is a non-renewable, energy-intensive material that relies on international shipping. Once used, it cannot be composted and often ends up in landfills, contributing to long-term waste. About 200 rockwool slabs, 1200 rockwool blocks and about 12 rockwool trays are used per year in the TGH! Cutting this use by half and demonstrating the success of fungi blocks will make a huge difference to the sustainability of the TGH but also the UA and even the CEA industry! Indeed, every year at the annual workshops at the UA-CEAC, participants ask about sustainable substrates and companies are working on local products such as recycled wood and 3D-printed substrates. This project could enable us to demonstrate and share a novel and sustainable substrate to the rest of the world!

The fungi blocks for this project will be created using organic material (plant biomass) from the greenhouse itself. This material closely resembles the current mushroom substrate we use for our edible mushroom production operations. This would also showcase a bio-circular economy by turning the waste of one product into the resource for another. Currently, we either compost our spent mushroom substrate on-site as part of CEAC's larger composting efforts or share this material with an entomology lab (also co-located here at CEAC) where it is repurposed as substrate for insect production, which is then used for fish feed (MISAS project under Dr. Goggy Davidowitz). Here at the UA-CEAC, we are all about endless loops for sustainability!

This project specifically advances environmental sustainability on campus by reducing waste, expense, energy, and shipping of conventional substrate material and pioneering a locally sourced, bio-circular fungi blocks to support the production of fresh crops and safe food for our students and local community.

Social Sustainability Outcomes

Please provide a description of how you expect your project to advance social sustainability on campus. A definition of social sustainability is provided on our Guides and Tips page.

Response:

This student-driven project will offer an opportunity for hands-on learning and collaboration in innovative, sustainable practices while directly contributing to their local community. Hydroponic systems offer a promising solution to the challenges of food sovereignty and food resilience, particularly in urban centers and food deserts. By enabling local food production, hydroponics can reduce reliance on long-distance transportation, improving access to fresh, healthy food in underserved communities. However, for these systems to truly benefit social equity and community well-being, it is essential that all components be accessible and sustainable—especially given that low-income communities are disproportionately burdened by both landfills and food deserts. This project directly addresses these challenges by producing fresh, locally grown food while simultaneously reducing waste.

We are committed to creating an inclusive environment, particularly for students from Black, Indigenous, and People of Color (BIPOC) communities, who are often underrepresented in the field of sustainable agriculture. We will be proactive in this area by reaching out with flyers during the hiring process to student affairs centers such as African American Student Affairs (AASA) and Native American Student Affairs (NASA), among others. At the UA-CEAC, TGH, and Mycology Lab, we have always had a diverse student community, especially among Native American, Hispanic, and women, as indicated by our student internships and student club (see supplemental doc for links). Through this project, we hope to build and grow in our student diversity and engagement with the community regarding socially sustainable food production!

The collaboration between the Mycology Lab and the Teaching Greenhouse will create a unique opportunity for students to explore the intersection of hydroponics, mycology, waste reduction, and circular food production in a real-world setting. This interdisciplinary approach not only promotes self-fulfillment and skill-building but also fosters connections between students and the broader campus community. Additionally, through our partnership with the Campus Pantry, we will be able to donate fresh produce to those in need, further strengthening food security on campus. From Fall 2023 to Spring 2024, the TGH produced over 10,000 lbs of hydroponic fresh produce and donated approximately 3,500 lbs to the Campus Pantry, gave away about 3,500 lbs to students, staff, and faculty at the UA-CEAC, and sold ~3,500 lbs at local markets and restaurants in town, making a significant impact to our local community regarding fresh food production!

By combining sustainability, innovation, and community engagement, this project tackles food access issues and in doing so creates a more equitable food system that benefits everyone—especially those most in need.

Student Leadership & Involvement

Please provide a description of how your project will benefit students on campus regarding the creation of leadership opportunities or student engagement. What leadership opportunities exist within your proposal? If you plan to seek student involvement, include relevant details thoroughly and how you will solicit/ market these opportunities.

Response:

Students involved in the project will receive comprehensive training and in-depth knowledge of both fungi blocks and fresh crops, as this cross-functional understanding will be crucial for the project's success. Because this project involves both the TGH and the Mycology Lab, we feel our project is very much focused on both student leadership and involvement, primarily through the support of seven student employees, including two manager positions. This initiative aligns with our goal of providing experiential learning opportunities and empowering the next generation of growers and sustainability leaders!

Student employee positions will be posted University-wide through Handshake and advertised through flyers posted at the Student Union to reach as many UA students as possible. Instagram will also be used (@UA_CEAC @UA_CEASA @professor_hydroponics) to share and tag other University handles (such as @uarizonasustainability and @hauryprogram) to reach a diverse range of students with or without experience related to the project! This will not only provide support to these students but also equip them with skills and experiences to carry into their professional careers.

We have a strong sense of community at the UA-CEAC, with weekly team meetings, communication via Discord, tasks that involve teamwork, and interaction with the community through weekly donations to the Campus Pantry and weekly markets at TVF. Our student managers take on responsibilities such as planning, organizing, and delegating tasks, in addition to encouraging good communication and problem solving.

Because of this, we regularly receive student interest to volunteer or intern in the mycology lab and TGH. We also feel that this will enhance this project since there is already an enthusiastic student interest, therefore this project will provide further opportunities with funding and experiential learning to some of our students and build a collaborative foundation at the UA-CEAC that we hope will last beyond the extent of this grant.

Education, Outreach, and Behavior Change

What opportunities does this project provide for members of the campus/community to learn about sustainability? How will your project educate the campus community and/or incorporate outreach and behavior change, particularly those who are not currently engaged with sustainability or environmental work? Please provide a description of how you expect your project will communicate its impacts to the campus community.

Response:

Finally, we think this project will enhance education, outreach, and behavior change among students and the local community because of the unique position of the Mycology Lab and TGH at the UA-CEAC.

The UA-CEAC already hosts a wide range of educational activities and courses such as PLS217 Introduction to Hydroponics, AGTM497C Integrated Pest Management, and BE444 Aquaponics Engineering, which will provide excellent opportunities to share the outcomes of this project. For

example, Dr. Hooks plans to incorporate this project, specifically the demonstration of fungi blocks, into a Module on hydroponic substrates in his course, PLS 217, and in his lab (PLS217L) in the TGH where students enrolled in these classes will directly benefit from the hands-on, real-world experience provided by the project.

In addition to the regular coursework, the CEAC classroom supports workshops, conferences, and Master Gardener courses through the PIMA Co-operative Extension. This allows for continuous exposure to educational events. For example, Dr. Hooks will incorporate this project and demonstration of the fungi blocks into his annual tomato workshop at the UA-CEAC which involves amateur and professional growers both locally and throughout the US.

Regarding outreach, the UA-CEAC regularly holds tours with local high schools, community colleges, FFA, Summer Engineer Academy (SEA), and more. Dr. Hooks and Bree Gomez regularly give tours of the TGH and Mycology Lab to the public and are eager to showcase the success of the project, students involved, and of course the fungi blocks for fresh crops!

As part of this project, we will host educational tours/workshops during the second half of the spring semester to showcase the work and findings of this project. We have experience in hosting public workshops but will also involve students throughout the planning and implementation of the workshop. Our target audience will be the local Tucson community and UA students interested in sustainable food production. We plan to demonstrate the fungi blocks, show how to replicate the process, and share some of the extra material with the participants. Most likely, we will plan for a half-day workshop, free of charge, and aim for 20-30 participants each. Throughout the month of April, we should be able to advertise and host at least two of these workshops at the UA-CEAC.

Regarding behavior change, the UA-CEAC's mission for 20+ years has been to promote sustainable food production systems through CEA. We hope to make positive waves of change in the industry and showcase a piece of a bio-circular economy by reducing waste. Our hope is that other Universities, growers, and companies join this wave and potentially adopt fungi blocks for fresh crops! Therefore, we feel encouraged that we will make a positive impact and inspire people in new and alternative ways that the University of Arizona is advancing sustainability by reducing waste in local food systems!