OFFICE OF SUSTAINABILITY
CAMPUS SUSTAINABILITY FUND

UA Database for Metal Contaminants in Produce

Grant Type:
Mini Grant

Application Type:
Final Application

Project Manager 1 Name:
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Project Manager 1 Status:
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Project Manager 2 Name:
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Project Manager 2 Department:
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Project Manager 2 Role:
Co-lead

Project Advisor Name:

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Project Advisor Department:

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Fiscal Officer Department Name:
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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:
$4800

Year 2:

Year 3:

Official Project Name:
UA Database for Metal Contaminants in Produce

Primary Project Category:
Food

Secondary Project Category:
Campus Life (Health & Wellbeing, Behavior Change

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. 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:

One of the areas of interest within the Plant-Soil Environment lab is the translocation of contaminants (particularly heavy metals) from the environment into plant tissue. Thus far, our research has focused on plants native to Arizona and their possible use in environmental clean-up operations or remediation. Our lab is uniquely equipped to perform such screenings, through our use of a portable X-ray fluorescence (pXRF) device and our connection to the Arizona Laboratory for Emerging Contaminants (ALEC). However, we have started to recognize that the methodologies we use could easily be applied to plants that are of direct critical importance to our community

members, namely fruits and vegetables.

Along those lines, we intend to develop a student-run initiative to start testing produce grown around Tucson and compiling all this information into an online, interactive dashboard. Alongside that, this dashboard would also be used to issue recommendations regarding things like plant species to avoid due to increased metal uptake, best practices for avoiding potentially hazardous contamination, and the creation of soil amendments or hydroponic solutions. The funding from this mini-grant would be used to mentor a team of students to perform sampling at university facilities, establish a workflow for said sampling, translate gathered data into information that is understandable and useful for the public, and the initial development of the online dashboard.

Here we propose a screening of the elemental composition of produce cultivated in hydroponics at Biosphere 2 as well as traditionally cultivated produce from The University of Arizona community garden, specifically from plots managed by the community garden itself and by Compost Cats.

Project Description:

Please provide a thorough description and explanation of your project. Be explicit in what your team is proposing. What are the goals of your project? What will your project's outcomes be? Outcomes should be SMART—specific, measurable, achievable, realistic, and timely. Describe how each objective will be achieved with the anticipated timeframes for each, including any key dates for when certain elements must start or be completed.

Response:

Some heavy metals such as Cu, Zn, and Ni, are essential micronutrients for the growth of human beings when present in trace amounts. However, at excessive levels, they become toxic and have long-term detrimental impacts on human health. Consumption of heavy metals through the food chain has been thoroughly documented worldwide. Vegetables with elevated concentrations of such elements are the most frequent route of heavy metal exposure. Hence, it is important to quantify metal(loid) concentration in frequently consumed vegetables. Our project will generate a database of elemental concentrations (essential nutrients and heavy metal(loid) elements) of multiple replicates of plant species grown in Biosphere 2's hydroponics facility and The University of Arizona community garden.

This would involve collecting 5 grams of tissue from 5 individuals of each plant species from each site. These samples would then be processed and scanned using a portable X-ray fluorescence (pXRF) analyzer. The pXRF has proven reliable in the systematic screening of various plant families when conducting plant surveys, facilitating the discovery of metal-accumulating and metal-tolerant plant species. The protocol to analyze elemental composition of plant tissues is well established in our lab, we have all routine lab equipment in place. Following pXRF analysis, lighter elements will also be validated with another elemental analysis technique, ICP-MS, at the Arizona Laboratory for Emerging Contaminants (ALEC). The information would be processed and translated into an online, interactive dashboard as well as graphics that can be distributed to students, displayed alongside the produce, and used in professional research presentations. If this project does identify potentially hazardous concentrations of elements in the produce from either source, that information can be used to make recommendations to treat or work around that contamination. These would be posted to the dashboard for public access. We will raise awareness of this initiative by using departmental

social media, speaking at clubs, communicating with the campus cultural and resource centers, participating in events such as Earth Week and Mines for Limitless Minds, and more. During Earth Week, we would like to give the campus community the opportunity to engage with this project by bringing samples of their own food to be scanned and analyzed. The results would be posted to the project's website and emailed to the people who provided the samples, free of charge.

After the creation of the online dashboard, we intend to expand its scope by rehiring the students who first developed it or by opening a position for a master's student. In either scenario, we intend to draw on other sources of funding at our disposal (see In-Kind funding) while also using the dashboard itself to apply for new grants and solicit funding from key stakeholders within the community whose goals align with the scope of this project.

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 ($ 2693):
We would like to establish two undergraduate student worker positions to perform the research and outreach tasks in this project. The initial 6 weeks of the project would be dedicated to sample collection, prep, and assistance with pXRF scanning, followed by 10 weeks of data analysis, research communication, and website creation. The positions associated with this project would be limited to one semester and the following break, with the opportunity to remain in our lab to work on other ongoing projects or to continue work on the expansion of this project following the acquisition of additional funding. The wages for these student workers will be $16.50 per hour. A job posting for both positions would be posted to Handshake. We would advertise this posting by sending it to academic advisors to distribute to their students, professors to mention it in their classes, and student organizations such as the University of Arizona's Cultural and Resource Centers and clubs.

Operations ($ 1715):
The operating budget of this project includes single-use consumables required to ensure the best quality of the pXRF measurements as per the specified protocol ($540), the cost of analyses of targeted nutrients in plant tissues using ICP-MS ($1175), and travel from the University of Arizona to Biosphere 2 ($260). The single-use materials consist of X-ray film, resealable bags, paper bags, and parchment paper which are all used to separate samples. All other materials involved in sample preparation and data collection are reusable and already owned by our lab.

Travel ($ 260)

The Travel budget accounts for four round trips to Biosphere 2 of roughly 104 miles each at $0.625 per mile.

In-Kind Funding ($4588)
To cover expenses that may fall outside of this budget, we have included In-Kind funding from other funding sources that our lab currently has access to. These include the Department of Energy FARMS Project, an SMMR Seed Grant, and our Center for Environmentally Sustainable Mining (CESM) Industry Membership. This additional funding is intended to primarily account for working hours for our students, increasing our students' available work time from 5 hours a week to 10 hours a week with the opportunity to increase them even further if the project calls for it. This funding would allow us to be flexible if additional, unforeseen costs arise. We will also draw on these funding sources to expand the project after its initial development through the mini-grant if necessary.

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. Have all relevant partners been contacted/coordinated with? Have you received consent or authorization to complete your project (such as from Housing and Residence Life, Facilities Management, Parking and Transportation, etc.)? Please identify them in your response.
If you are making modifications to campus, do you have authorization or official quotes from Facilities Management to accurately identify the cost of labor and supplies?

Response:

The facilities that we would like to sample from are operated or funded in part by the Office of Sustainability (see the respective letters of support in section 29: Supporting Documentation). The Deputy Director of Biosphere 2, John Adams, has agreed to allow us access to Biosphere 2's hydroponics facility and sample the plants grown within. We have also secured permission from Compost Specialist, Nat Schwark with the University of Arizona community garden and Compost Cats to sample from their plots within the community garden. We have also already developed a robust procedure for elemental analysis using a pXRF device, avoiding the time and money that would normally be dedicated to purchasing new equipment and developing/troubleshooting a new methodology.

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:

Toxic concentrations of trace metal(loid) elements are a pervasive but invisible issue. This project will develop a tool that can be used on campus and in the greater Tucson community. Should we identify high concentrations of hazardous elements, we will be able to identify the next steps to

remediate the issue and make our environment safer for us and the organisms that we share it with. The health of the environment is linked to the health of the organisms populating it, including humans. These contaminants can permanently accumulate in the bones and organs of the people who inadvertently ingest them. Metals can also be returned to the environment if they are contained in food waste that is used as compost, contaminating the next crop of plants to be grown with it.

By creating a public website to communicate both the findings of this research and recommendations informed by those findings, this project will help to demystify environmental science and create an avenue for delivering recommendations directly to the people who actually need them. We also hope that, through student leadership, we can reach a broad range of students who are part of various communities and groups. This will be achieved through social media, public events (Mines for Limitless Mind, Earth Week, etc.), and direct engagement with student clubs and organizations. Following this project, this approach would be scaled up to the city level to engage communities from around Tucson, giving them the same benefits that we hope to give the UA students.

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:

We recognize that issues of the environment often disproportionately impact minority communities. Whether they are BIPOC, members of the LGBTQIA+ community, low-income, or another group, through exclusion, discrimination, and social inequity the brunt of the consequences of things like climate change, habitat destruction, and pollution. Due to similar factors, these communities have historically been taken advantage of by researchers or completely excluded from the scientific process.

This project will address two aspects of these issues.
First, the findings of this project would be accessible to anyone and everyone at no cost. Given that the produce from Biosphere 2 and the University of Arizona community garden is distributed through programs like the Campus Pantry, it is of the utmost importance the information that we collect be made available to lower-income students and not just those with an interest in environmental science or research in general.
Second, community involvement will be baked into this project from the beginning. Involving historically excluded communities will ensure that there is not a blind spot in the research and thus a blind spot in the tool and recommendations developed as a result.

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:

The project managers, Stokes and Babst-Kostecka will collaboratively mentor and advise the undergraduate students. They will hold weekly project meetings with the students to discuss progress, explore research findings, and set professional goals. In addition, our students would be encouraged to participate in weekly lab meetings to gain exposure to the types of discussions that go into participating in research week to week. Our weekly lab meeting would also present an opportunity to deliver progress report presentations internally to our lab group, preparing our students to ultimately present their findings to a departmental colloquium with our support. These students will have an opportunity to directly participate in and guide a scientific research project. Not only would they be exposed to and trained in techniques and procedures utilized in the field of Environmental Science, but they would also be able to participate in the applied aspect of research that follows the collection of data.
Throughout this project, we would encourage our students to solicit input from their peers. This could be done through their existing social circles and through the connections that we used to distribute the original job posting. Reaching out to different communities of students through student organizations and the cultural resource centers will be strongly encouraged as it would give our students insight into the potential impact of the tools that we are developing. It would also give a voice to communities that are often underrepresented in research despite being disproportionately impacted by things like environmental contamination. These perspectives will be crucial in the expansion of the scope of the dashboard following the completion of the project outlined here.

As this project wraps up, we would also encourage our students to write a follow-up proposal based on the training they receive and what they learn from their data. If interested, we would assist them in developing and submitting such a proposal to the call for mini-grant proposals, becoming the designers of their own follow-up project. As project managers and mentors, we would provide guidance on the development of a budget, study design, and timeline. We have gained extensive experience mentoring both high school students and undergraduates through university programs such as KEYS as well as through independent internships, shadowing, and student employment. We feel that fostering the next generation of scientists is one of the core duties of being a researcher and member of the campus community. We look forward to mentoring the next environmentalist who will lead us to a brighter future.

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 beyond the "sustainability choir?"
Please provide a description of how you expect your project will communicate its impacts to the campus community.

Response:

The ultimate intent of this project would be to deliver information on the potential hazards of metal contamination despite it often being invisible. The origin of one's food is often a consideration when it comes to carbon emissions and preservatives, but the environment that produce comes from may

not be thought about as often. Fostering this awareness is critical if we want to create an equitable future where everyone has access to clean, sustainably sourced food.
The website/dashboard created for this project will be made available for anyone to view and will be advertised through a variety of means. Dr. Babst-Kostecka would share the findings with students enrolled in her classes (ENVS 225, ENVS 435/535) as with her faculty peers who also teach. The students involved in this project would deliver a presentation on their findings/recommendations to their department's colloquium, to student research symposiums, and general campus events such as Earth Week. Our lab also has standalone means of distributing information such as our lab website, the Department of Environmental Science's social media, and the Critical Zone newsletter. Information can also be posted at the Biosphere 2 and the community garden with QR codes and links to the website allowing people to watch the research progress or access it after the project has already been completed.

We hope that this project not only draws attention to sustainably grown produce, but also increases the awareness of students, staff, and faculty beyond just the nutritional content of their food. It is well known that the environment that plants are grown in affects their elemental composition. They can absorb certain elements from their growing medium, building them up in higher concentrations in their foliage. Whether or not a type of food is considered broadly healthy, if it was cultivated in an environment with trace elements (metals are a particularly important issue in Arizona), those elements can be taken up at toxic concentrations into the plant's tissue and eventually accumulated into people's bodies.

A recent example of this type of contamination being brought to the public's attention is the Consumer Report entitled "Lead and Cadmium Could Be in Your Dark Chocolate" written in December of 2022. In this report, author Kevin Loria states that researchers found that cocoa plants take up cadmium from their soil and accumulate it in their beans. This type of hazard is avoidable when the correct precautions are taken; however, the hazard needs to be identified for it to be addressed.