THE UNIVERSITY OF ARIZONA
Research, Innovation & Impact

NEW INSTITUTE/CENTER – APPLICATION REQUEST

Instructions

Prior to applying for Institute/Center:

- Institute/Center applicants should build consensus/support from all relevant units and collaborators prior to the formal request submission process through letters of support and commitments (funds, course buyouts, space, etc.)

- New Institute/Center proposal should be routed/approved through the Cognizant Academic Unit Administrator (CAUA) (the College Dean, Department Head or for UAHS the Senior VP for Health Sciences) prior to submission to RII.

- Upon approval, if new space is required, please submit a formal space request to Space Management upon approval of the Institute/Center: http://www.pdc.arizona.edu/space/spacerequest.html

- Suggested Schedule:

    - Proposal development, including letters of support and commitments (funds, course buyouts, space, etc.) from relevant units and collaborators.
    - Upon approval, proposal sheet submitted along with application and budget template.
    - RII review (30 days from submission)
    - Revisions (if necessary)
    - RII routing through affiliated colleges for review/approval (15 days).

APPLICATION

A. Identify the mission statement & vision of the Institute/Center.

The vision of the ARID Center is:
"To advance environmentally sustainable agriculture practices through the understanding of the complex physical and biological interactions between arid land agroecosystems and humanity."

The mission statement of the ARID Center:
"ARID will provide evidenced-based knowledge and solutions to challenges facing arid land agroecosystems to support and inform a diverse group of stakeholders thereby promoting more sustainable agricultural practices."

To accomplish this mission, ARID will focus on the following objectives:
Build: Foster new collaborations among researchers to enhance and create opportunities to pursue transdisciplinary research that spans multiple domains. Strengthen research capacity by sharing and aligning resource needs to maximize output and impact.
Develop: Develop and deploy new technologies to enhance agricultural sustainability and reduce environmental impacts. Work with existing and new companies to promote ag-tech solutions that benefit Arizona, US, and international agricultural producers.
Educate: Create novel learning and educational opportunities for students to become broadly trained in biological and physical science research. To train the next generation of researchers in data science literacy and emerging analytical methods for data analysis including artificial intelligence and machine learning.
Communicate: Use multiple platforms and methods to translate research findings and results to the larger community to inform management decisions, educate others about arid environment agriculture, and receive feedback on the direction of science being completed by the ARID Center.
Demonstrate: Show that ARID's integrated approach to agroecosystem research can deliver solutions to challenges facing agricultural production in arid environments. This would include production under heat and water stress, marginal soil types, salinity, and other environmental constraints that are expected to increase in frequency and severity due to climate change.
Evolve: Grow ARID's activities by engaging more of the world-class expertise located at UArizona to expand and promote ARID as a leader in arid land agroecosystem research. Continual self-assessment of the mission and objectives in light of the evolution of ARID will help ensure that the needs of stakeholders are being met.

B. Describe what need(s)/gap(s) will the Institute/Center address that are not already by the University of Arizona and how the Institute/Center aligns with the University strategic plan?

Climate change has been recognized as a force that is dramatically reshaping the world we live in. Significant attention is paid to the shifts and reductions in precipitation patterns. However, within climate science a new focus has begun to emerge that is centered on the increased aridity predicted in future climate scenarios. Aridification resulting from decreased precipitation and increased air temperatures combine to have significant effects on all terrestrial ecosystems. These effects include

more extreme temperatures, more severe droughts, drier soil conditions, and hydrological stress on surface water, natural ecosystems, and agricultural systems. The combined effects of these climate-related conditions are leading to drastic changes that are occurring faster than anticipated, and certainly faster than nature can naturally respond to. With climate driven changes impacting much of the Western US and other arid regions around the world in a multitude of ways, the costs to human and natural ecosystems will only increase as it continues to get hotter and drier.

Arizona, and specifically Arizona agriculture, is at the forefront of confronting the challenges posed by these rapidly changing environmental conditions. Presently, producers across agricultural sectors are facing the combined challenges of an ongoing megadrought, reductions in agricultural water resources as allocations from the Central Arizona Project are reduced, and record-breaking costs for crop inputs. This has immediate and direct consequences on agricultural output and economics as well as on Arizona's unique agroecosystem. Although these are trying times, they also present unique opportunities to leverage these circumstances to begin learning how to mitigate and adapt to the effects of climate change on agriculture productivity – something that will affect the entire US agricultural sector as climate change continues to reshape our terrestrial environment. The University of Arizona is well-positioned to be a leader in addressing challenges of arid land agricultural and creating solutions to the sustainable production of calories while conserving our natural resources.

Agroecosystems are subsets of natural ecosystems that center around the human activity of agriculture. They represent species assemblages and energy flows across all scales not only at the site of agricultural activity, but also across the entire region impacted by this activity. Given the complexity and breadth of agroecosystems, it is abundantly clear that creating solutions to the problems impacting various parts of the systems require transdisciplinary approaches and thinking that spans multiple academic units within the College of Agriculture and Life Sciences. Creation of ARID will bring together diverse skill sets to address challenges at various points within arid land agroecosystems due to aridification and other climate-related issues. Specifically, ARID will leverage UArizona's strengths in research, technology, and data science to deliver solutions to the state's agricultural sector – solutions that will also be transferrable to national and international agricultural sectors (Figure 1). This will be accomplished by aligning research questions and hypothesis with available resources across academic departments such as: School of Plant Sciences; Agricultural and Resource Economics; Agricultural Education, Technology, and Innovation; Animal and Comparative Biomedical Sciences; Biosystems Engineering; Entomology; Environmental Sciences; Family and Consumer Science; Natural Resources and the Environment; and Nutritional Sciences. By bringing together diverse skill sets represented by faculty within each unit, ARID will be able to address complex, intertwined problems related to the subcomponents of arid land agroecosystems. This holistic approach will help to deliver solutions that have real impact in production agricultural systems versus incremental solutions that generally shift the problem to another area in the agroecosystem. ARID will not only capitalize on the expertise within CALS but will also draw on resources such as the Data Science Institute, Bio5, STEM Learning Center, the Ecosystems Genomics Initiative, and the Arizona Institute for Resilient Environment and Societies.

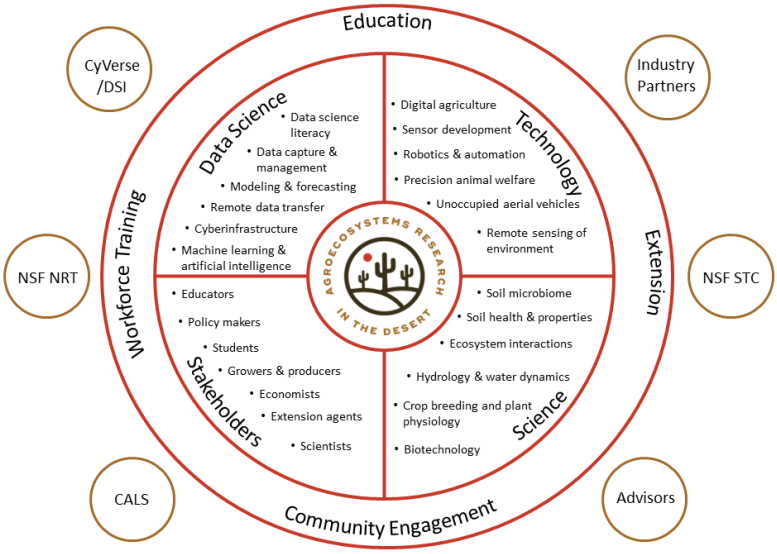


Figure 1. Overview of ARID, The Center for Agroecosystems Research in the Desert, demonstrating the four major components of ARID and the areas of expertise encompassed within each and how ARID will serve the greater community.

ARID aligns with several Pillars of the University's Strategic Plan. Specifically, the integrated research and education housed within ARID will align in the following ways:

Wildcat Journey: ARID will provide unparalleled opportunities for students to receive broad training across multiple disciplines to create students with T-shaped education and skills. This diversity will strengthen the careers of graduates as they enter the dynamic landscape of employment where having a transdisciplinary education is highly valued. ARID will help prepare students with fundamental knowledge in data literacy, biological and physical sciences, technology including hardware and software, and soft skills. The combination of these skills will prepare students for the 4th Industrial Revolution making UArizona graduates leaders in the field.

Grand Challenges: ARID is clearly focused on solving the grand challenge of sustainable agriculture in arid environments and will position itself to be a leader in understanding how humans interact with and impact managed and natural environments. Through gaining critical insights, ARID can provide key information and knowledge about the myriad of complex processes that play out in an agroecosystem. In turn, we will be better equipped to address challenges faced by agricultural producers in Arizona, the US, and globally, with data-informed solutions to sustainable agricultural production.

Arizona Advantage: ARID will leverage UArizona's Cooperative Extension Program to gain insight into the unique challenges that stakeholders are facing with arid land agriculture. Through this mechanism, ARID can be responsive to stakeholder needs to quickly identify challenges and assemble research teams and projects to address them. Additionally, the communication enabled through Cooperative Extension will ensure that the goals and objectives of ARID are aligned with constituents, which will in turn help drive societal and economic impact within our state.

Arizona Global: The challenges that ARID are addressing are not unique to Arizona – they are occurring globally and having a significant impact on all of humanity. Because of these needs, ARID will work to establish online learning materials and modules to bring the knowledge and information gained from

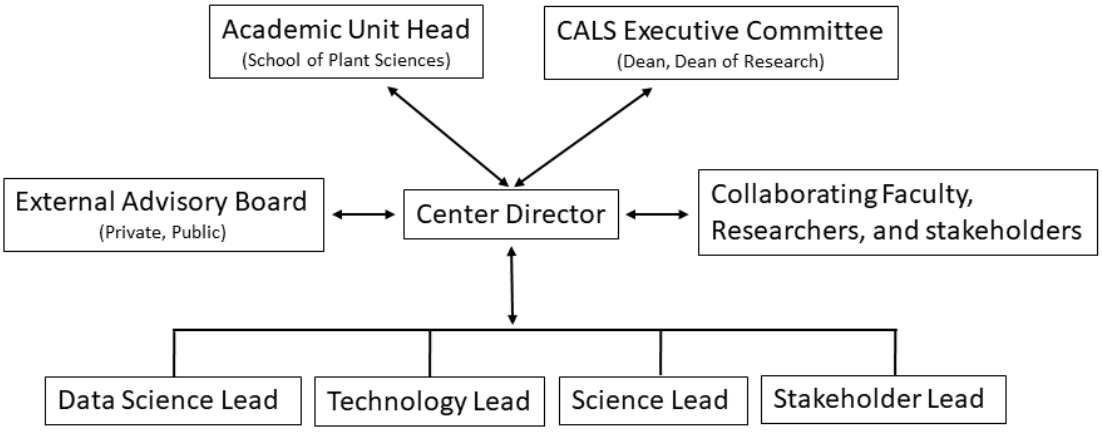
ARID to those in need across the globe. This will help increase the outreach and impact of the work conducted through ARID. As appropriate, we will also connect with international colleagues through institutional or Center level relationships to establish collaborative projects and initiatives.

In summary, ARID will create knowledge and information about arid land agroecosystems to drive solutions that are desperately needed to combat the problems brought about by climate change. UArizona will leverage our unique environment, "the climate of tomorrow, today," to be leaders in this area and help create the sustainable change that will be needed by all to address future challenges.

C. Provide a description of the administrative/organizational structure that is critical to the sustainability of the Institute/Center including:
   a. An organization chart
   b. The Institute/Center leadership

To what unit will the new Institute/Center will report

The following organizational chart shows the anticipated structure of the ARID Center. It is proposed that ARID Center will report to the School of Plant Sciences as the Center will be housed in that unit with collaboration occurring across units and potentially colleges.



D. Describe growing interdisciplinary UA research capacity and potential external funding targets.

The University of Arizona has several strategic goals and plans centered on creating sustainable interactions between humans and the environment. These span from the very basic side of research with respect to biological and physical processes to applied considerations like urban planning and building construction. Given the broad scale of research and interests at UArizona, there are a multitude of potential collaborations and expansion of research efforts focused on addressing sustainable agricultural production within an arid environment. Specifically, ARID will use the expertise within CALS to create collaborations that span academic units as well as leverage resources and knowledge that can address significant problems related to arid environment agriculture. Presently, organic collaborations have formed in this area of research (spanning SPLS, ENVS, SWES, and BE) demonstrating the capacity to align researchers with the questions – ARID will help build and strengthen these types of interactions within CALS and across the University.

The formation of ARID comes at an advantageous time as numerous funding agencies are focusing on

the impacts of climate change on agriculture. Potential funding mechanisms include the USDA-NIFA (Coordinated Agricultural Programs), Foundation for Food and Agriculture, Soil Health Institute, and the National Science Foundation. Critically, there are numerous funding calls through NSF that support centers such as the following: Biology Integration Institutes, Center for Advancement and Synthesis of Open Environmental Data and Sciences, National Artificial Intelligence Research Institutes, and others. Two calls that would be immediately targeted are the Biology Integration Institutes and Biodiversity on a Changing Planet. Both funding calls require interdisciplinary teams that span across scales including molecular, cellular, whole organism, and ecosystems. In addition to these larger center proposals, for which ARID would be well positioned, there are smaller, more traditional funding sources that could utilize the resources of ARID to strengthen their proposals and demonstrate capacity. A combination of both funding sources will help ensure the operation of ARID.

In addition to public funding, there are also opportunities to partner with private sector to develop and sustain partnerships focused on arid land agriculture and associated agrotechnology. Presently, Malcolm Green, Director of Development at the Maricopa Agricultural Center (MAC), is fostering numerous relationships with large agricultural technology companies including Case-IH, AGCO, Kubota, Raven Technologies, and Precision AI who are actively looking to invest and establish themselves at MAC. This would present numerous opportunities to leverage UArizona's strength in data science, machine learning, and artificial intelligence for the development of novel technologies to assist in arid land agriculture. Through partnerships like these, UArizona would not only establish itself within the fast-growing agtech marketplace but could also use these relationships to place recent graduates into the field, further supporting Pilar I of UArizona's Strategic Plan ("Wildcat Journey").

In summary, by using the framework and community provided by ARID, UArizona will be successful in capitalizing on our unique environment and world-class research capacity to foster and build exciting new collaborations, both internal and external to the organization. This will directly enable ARID members to pursue large collaborative projects that have the potential to generate major paradigm shifts with respect to conventional agriculture. As America begins to reinvest in agriculture, having an established Center to develop solutions to challenges will be a strategic necessity.

E. Provide a strategy for involving external stakeholders and describe important UA partnerships with departments, units, and offices not formally part of the proposed Institute/Center, and how the Institute/Center will be accessible to them.

Given that the primary focus of ARID is to develop solutions that transcend specific research disciplines, it is inherent that numerous and diverse faculty from across units and Colleges will be engaged; this also includes external stakeholders from private organizations and grower groups from across the state. To engage groups that are not formally part of ARID, numerous strategies will be employed including the following:

- Seminars and Workshops: Training and educating graduate and undergraduate students in areas related to arid land agroecosystems provides an organic approach to getting other UArizona faculty and researchers involved in ARID that otherwise may not. By providing knowledge and training in areas of research covered by ARID, students will be keen to use these skills in their own research by encouraging their advisors and mentors to seek out experiences and opportunities with ARID. This will create natural interest and a first point of engagement for external researchers with ARID from which collaborations can build. Along these lines, by providing training and education to individuals from private industries,

companies will get exposure to ARID and its research thereby generating additional interest and potential for developing collaborations. What is paramount is the that ARID serve as a conduit to train and educate others interested in this area; accomplishing this goal will ensure that all interested parties have access to the information embodied by the ARID Center.

- Sponsored Research Activities: Because research focused on arid land agriculture is the primary objective of ARID, it provides the best mechanism for members to engage with and create collaborations with others outside ARID. Through these collaborations, non-ARID members and entities will be able to access the resources of the Center in a meaningful manner. These interactions will serve to connect researchers within UArizona from various departments and colleges, helping to enhance the ARID's research capacity. This will also help foster relationships with private sector partners who are already engaged in projects with UArizona faculty and staff. These types of projects will help the create connections with other departments such as Engineering (hardware development), Optics (optical sensor design), Computer Science (algorithms to process and analyze data generated by novel sensors) , School of Information as well as the Department of Math (data analysis), Department of Geosciences (climate and earth processes), School of Earth and Environmental Sciences (human-environment interactions), Department of Hydrology and Atmospheric Sciences (climate and water relations), and the Department of Ecology and Evolution (ecological interactions in arid landscapes). With these varied interactions within UArizona, new opportunities to partner with private companies will arise that are focused on the agroecosystem space such as Case IH, Raven Technologies, Precision AI, and others. The private-public relationships present additional opportunities for ARID to expand its research portfolio and provide its services to nonmembers.
- Community Engagement and Outreach: Research activities and products will be promoted at scientific conferences, Arizona State Experiment Station Field Days, research symposiums, UArizona hosted events, and other internal and external events. These types of outreach and community engagement events will help to promote the ARID Center, generating interest that can lead to and foster further partnerships. These types of interactions are vital with respect to getting stakeholder feedback.

In summary, ARID's strategy will be to openly communicate the research and objectives of the Center with diverse stakeholders and collaborators to foster an open dialogue. Through these types of interactions, the ARID Center will be able to enhance its capacity and welcome additional partners and participants.

F. What collaborative/synergistic activities could the proposed center pursue with any of the current RII centers?

Given the ever-evolving nature of challenges associated with an arid land agroecosystem, ARID will develop a close relationship with RII to seek guidance in identifying funding opportunities, grant proposal development, and overall, being responsive to opportunities that further the mission of the ARID Center and its constituents. Along these lines, ARID will capitalize on the existing investments in current RII Centers to meet stakeholder needs and to enhance and expand capacity. Specifically, it is envisioned that ARID can develop close partnerships with the following RII Centers:

Arizona Institute for Resilient Environments and Societies (AIRES): It is anticipated that given the overlap between the AIRES Center and the proposed ARID Center that there will be numerous synergistic activities that can be pursued through partnership. Ideally, it is envisioned that through

partnering, ARID will be able to address specific components related to agriculture in arid environments to expand the research portfolio of AIRES. Additionally, AIRES will be able to provide more directed guidance and opportunities for critical feedback to ARID for continued improvement with respect to ARID's mission and objectives.

BIO5 Institute: The ARID Center will interact with Bio5 with numerous facets as several proposed faculty are currently part of Bio5. Through this collaboration, synergistic activities will likely emerge as the Bio5 core areas include agriculture, science, and engineering which directly overlap with the ARID's research portfolio. It is envisioned that projects related to nutritional quality could be accomplished through partnership with Bio5 faculty and members as well as areas related to crop genomics and biotechnology. Another critical relationship that would be further developed is that with CyVerse, a premier cyberinfrastructure system supported by NSF, that is uniquely positioned to provide computational support for the next generation of multimodal data and data analytics.

Biosphere 2: Biosphere 2 represents a unique experimental system from which translational research about ecosystem evolution and development can be leveraged for insight into that of agroecosystems. Specifically, the ongoing research being conducted as part of the Landscape Evolution Observatory (LEO) could be transferred to what is being observed in natural ecosystems. Conversely, naturally occurring phenomenon in agroecosystems could be subjected to a reductionist approach using the resources of Biosphere 2. This would allow simplification of the complexity of natural systems making the experimental approaches more targeted. This could provide fundamental knowledge and information that would be translated to native systems.

Data Science Institute: As with all of science and engineering, the generation of data is becoming cheaper and easier. This has led to an explosion of data volumes that have quickly surpassed current processing and analytical approaches necessitating new computational and statistical methods. Chief among these is the application of machine learning and artificial intelligence, areas of research that UArizona is already heavily invested. As an example, the UA Field Scanner, the world's largest outdoor agricultural robot (please see story in the Wall Street Journal: https://youtu.be/da2gKRdMeXY) generates approximately 1.5 TBs of data per day, with the ability to generate 10 TB/day. These data volumes have surpassed what is presently possible with human-led analytics. To address this problem, faculty in the Data Science Institute have used novel and emerging algorithms to process and analyze data making them more accessible to researchers on a time scale not previously possible. Through continued partnership with DSI, ARID is well positioned to become leaders in agricultural data processing and analytics – a key area with rapid private investment occurring. This will open numerous opportunities for corporate partnerships as well as student training and workforce development.

STEM Learning Center: To enhance educational experience and further promote workforce development (as part of the University's 4th Industrial Revolution), ARID will seek partnership with the STEM Learning Center. Faculty that are envisioned as part of the ARID Center have a track record of success with regards to promoting educational experiences in STEM and especially promoting those opportunities for underrepresented groups. Through the STEM Learning Center, ARID will be able to use the STEM Learning Center's expertise in recruiting and retaining students, increasing participation in ARID workshops and short courses, broadening the educational impacts of ARID, evaluating education and research progress, creating an inclusive and diverse learning environment, and enhancing inter- and intra-institution collaboration. A fruitful partnership with the STEM Learning Center will help to bolster ARID's goal of increased knowledge and education regarding arid land agroecosystems. This will help prepare UArizona graduates to lead our society

as we face pressing challenges related to climate change and its impact on our terrestrial ecosystem.