NSF SBIR/STTR AgTech Pitch Proposal

Submitted on June 18th, 2024

Invitation for Full Proposal received on June 20th, 2024

Briefly Describe the Technology Innovation:
Up to 500 words describing the technical innovation that would be the focus of a Phase I project, including a sentence discussing the origins of the innovation as well as an explanation as to why it meets the program's mandate to focus on supporting research and development (R&D) of unproven, high-impact innovations. This section should not just discuss the features and benefits of your solution, it must also clearly explain the uniqueness, innovation and/or novelty in how your product or service is designed and functions.

We propose to research and develop new geospatial technology for ecological planting design. Our innovation will enable smartphone apps to spatially estimate microclimates, ecosystem metrics, and recommended plants to grow that are naturally fit for targeted environments. To enable this vision, we propose to research and develop new ecophysiological inference models, based on new geospatial datasets. Our innovation could improve cost-efficiency, sustainability, and performance of many plantings by farmers, gardeners, and landscapers.

To the best of our knowledge today, we believe new datasets are needed to support geospatial inference of microclimates and plant habitats. We will produce these critical datasets through professional-grade site survey techniques, across many unique environments. Surveys will capture ecophysiological metrics, which are geospatially mapped, both by software and human experts. For efficient and scalable site surveying, we will develop a new mobile app synchronized with new cloud databases and API services. We will develop tools for visual, 3D spatial, and geological sensor data collection, as well as for on-site expert annotations of environmental properties. This may include spatial annotation UIs for microclimates (e.g. sunlight and drainage gradients) and soil sample locations, which will be automatically linked to lab tested soil pH and nutrients (P, K, Ca, Mg, S, B, Cu, Mn, Zn).

Our approach in Phase I also benefits from research and development based on existing datasets and models (e.g. radiance, climate, biodiversity, agricultural). Global, national, and regional ecophysiological and geospatial models will be linked to micro site surveys. Ecophysiological models may be based on metrics such as radiation, rainfall, soil properties, temperature, humidity, wind, air pressure, landscape topography, geographic coordinates, and species classifications. Automatic inferences of microclimate and planting design properties will be limited initially, but these functionalities will be iteratively introduced based on data-driven, experimentally validated R&D. We will pursue development of new probabilistic, statistical, and hierarchical deep learning models for inferring "hidden" site parameters (e.g. soil pH) from limited geospatial inputs (e.g. camera images + GPS). Our models will consider how any naturally existing plants on a site may constrain possible underlying site conditions. Models will also communicate statistical uncertainty, e.g. via confidence intervals.

Origins of this innovation stem from ongoing active R&D with research groups based at the University of Florida, including distinguished NSF-funded leaders in plant habitat modeling;

from visionary leadership of an ASLA award-winning landscape architecture firm with decades of field experience; and from technology leadership by the small business, 3co, supported by years of venture-funded R&D in 3D spatial and ecological technology.

In summary, our technology will equip smartphones to recommend plants that are naturally fit for environmental sites ("right plant, right place"), through innovation in microclimate and plant habitability inference. This could scale to drive more intelligent plantings that reduce agricultural, gardening, and landscaping costs; reduce required labor, fertilizers, pesticides, and irrigation; increase resilience to extreme weather and climate change; and deliver greater ecological benefits, including increased yield of flowers and fruits.

Briefly Describe the Technical Objectives and Challenges:
Up to 500 words describing the R&D work to be done in a Phase I project, including the highest-risk research challenges to be investigated in a Phase I effort that are specific to your innovation. This section should also include a brief description of your unique scientific approach to solving those challenges and how this would lead to a sustainable competitive advantage for the company. Please note that challenges common to an industry or market are not responsive in this section.

Groups for Field R&D and Modeling R&D will work in parallel over 18 months for Phase I:

[Field Objective 1] Months 1-6: R&D of prototype site survey technology.
(A) Design site analysis tools with professionals (e.g. architects, soil labs, site grading firms).
(B) Develop prototype site survey mobile app and cloud computing infrastructure.
(C) Test, refine, and validate utilities with expert research partners in field trials.

[Modeling Objective 1] Months 1-6: R&D of prototype ecophysiological and geospatial models.
(A) Data mine regional, national, and global environmental and plant data sources.
(B) Parameterize, optimize, and validate model synchronization with site survey data.
(C) Prove accuracy of inference systems at kilometer-scale resolution for target sites.

[Field Objective 2] Months 7-18: Improve, go-to-market, and scale applications for many users.
(A) Increase speed, ease, accuracy, precision, and applications of site survey tools.
(B) Market and scale technology to target users via key networks (e.g. ffl.ifas.ufl.edu, fngla.org).
(C) Improve ecological planting designs via ecophysiological models for many sites of users.

[Modeling Objective 2] Months 7-18: R&D in geospatial-to-ecophysiological inference models.
(A) Train, test, and validate systems for geospatial environmental analysis and planting design.
(B) Integrate fast, easy, accurate, precise, high-value ecophysiological inference APIs into apps.
(C) Fine-tune, monetize, and optimize models based on commercial needs and opportunities.

Following are unique challenges, risks, solutions, and upshots to our innovation, which would lead to sustainable competitive advantages.

Challenge 1. Training models to predict microclimates from geospatial data.
- Problem: Not enough data on complex post-industrial site properties, e.g. soils and drainage.
- Risk: Under-constrained models could be too erroneous to be trustworthy and useful.
- Solution: Invest into the scalable production of new high-resolution datasets for modeling.
- Upshot: Industrial tools will gather data with economies of scale and “network effects”.

Challenge 2. Developing spatial analysis tools for microclimates and planting habitability.
- Problem: Site properties can be spatially and physically complicated.

- Risk: Site surveys could fail to capture sufficient information for habitat modeling.
- Solution: Leverage state-of-the-art advances in geospatial and ecophysiological modeling.
- Upshot: Innovation in producing best-in-class datasets will increase barriers to competition.

Challenge 3. Scaling site surveys to statistically representative sample sizes for modeling.
- Problem: High variability across environmental sites could confound modeling.
- Risk: If site surveys are "spread too thin", data may be too sparse for accurate modeling.
- Solution: Phase I will focus on limited geographies and habitats within Florida.
- Upshot: Successful prototyping with scalable methods will inspire follow-on "growth capital".

Challenge 4. Optimizing and serving models will require large amounts of computation.
- Problem: Models based on so much data will need vast computing resources.
- Risk: Insufficient access to appropriate computing resources for modeling.
- Solution: Partner with University of Florida HiPerGator as well as NSF NAIRR.
- Upshot: Simulation precision and accuracy will unlock groundbreaking applications.

Briefly Describe the Market Opportunity:
Up to 250 words describing the customer profile and pain point(s) that will be the near-term commercial focus related to this technical project.

In Phase I, we will partner with landscaping professionals for single-family residential homes in Florida. The resulting R&D methods and software services can eventually be adapted and deployed for landscaping, gardening, and farming markets across the United States.

Our technology addresses prevalent, deep, and high-pressure pain points in planting design. Long, expensive, and exhausting labor-intensive workflows are needed to address these pain points today, or else planting performance may suffer. We will address pain points of geospatial modeling across site microclimates and ecosystems, and ecophysiological modeling of plant habitability across sites.

Environmental inference speed, accuracy, precision, and utility are key technical problems facing landscapers today. Landscapers universally struggle with complex modeling challenges -- e.g. geospatial 3D modeling of microclimate, simulated over time with influence from regional long-term climate models. Organizing global, national, and regional databases is just part of the difficulty. A greater and growing challenge facing landscapers in 2024 and beyond is in cultivating climate-resilient plantings. This includes designing plantings for flood mitigation, heat regulation, and habitat sustainability.

If landscapers could just visit a site, quickly scan it with a smartphone, and then instantly begin designing ecologically intelligent plantings, this would be a revolutionary and market-changing innovation. This technology could eventually reach millions of end users, through B2B business models that partner with leading industrial, commercial, academic, non-profit, and government service providers.

Briefly Describe the Company and Team :
Up to 250 words describing the background and current status of the submitting small business, including team members related to the technical and/or commercial efforts discussed in this Project Pitch.

The Phase I team is led by 3co, with support from R&D leaders at the University of Florida (UF) and ASLA award-winning landscape architects at Dix.Hite (dixhite.com):

1. Lance Legel, CEO of 3co, MS in Deep Learning, Physics R&D for NASA, trained by Techstars.
2. Dr. Rob Cohn, CTO of 3co, PhD in AI, Software Engineer for Google and Microsoft.
3. Dr. Pamela Soltis, UF Professor, Director of UF Biodiversity Institute, NSF-funded iDigBio.org.
4. Dr. Doug Soltis, UF Professor, Plant Evolutionary Biologist, Plant Diversity Specialist.
5. Dr. Rob Guralnick, UF Professor, Biodiversity Informatics Laboratory (gurlab.net).
6. Dr. Franta Majs, UF Director, Soil Testing Laboratory (soilslab.ifas.ufl.edu).
7. Dr. Tom Obreza, UF Professor, Soil Fertility and Nutrient Management.
8. Dr. Eban Bean, UF Assistant Professor, Agricultural and Biological Engineering.
9. Dr. Ryan Klein, UF Assistant Professor, Environmental Horticulture.
10. Dr. Jorg Peters, UF Professor, Computer Science, Geometric Modeling and Simulation.
11. Dr. Howard Beck, UF Professor Emeritus, PhD in Computer Science.
12. Dr. Gail Hansen, UF Professor, Sustainable Landscape Design.
13. Kody Smith, CEO of Dix.Hite, Landscape Architect.
14. Christina Hite, FASLA, LEED AP, Founding Partner of Dix.Hite, Landscape Architect.

Since 2018, 3co has raised over $500,000 including from Techstars and Royal FloraHolland. It launched a plant search engine in 2024 (ecodash.ai), which will soon feature millions of ecological planting parameter inferences (e.g. habitat preferences, environmental benefits, agricultural yield) for 90,000 plant species.