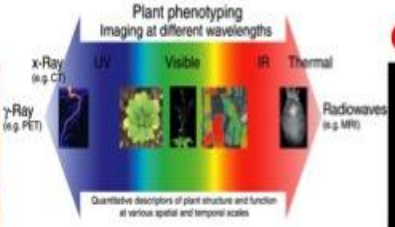
Consortium for Integrated Translational Biology

Creating a transdisciplinary environment to bridge the genotype to phenotype gap

Plant Genetic Variation



Capturing Phenotype

Consortium for Integrated Translational Biology (CITB)

Motivation for establishment of consortium infrastructure

Initiatives and subsequent developed Centers serve as drivers for research and economic development by fostering collaboration among faculty across departments and colleges. This is exemplified in the activities within the Center for Plant Science Innovation (PSI). Wherein the faculty within the Center have participated in grantsmanship resulting in millions of dollars in funding which has been translated to high impact scholarly outputs and technology development. In regards to the latter the PSI has placed a strong emphasis on lab-to-field translational research activities with real world applications towards sustainable and improved agriculture production that impact farmers and consumers in Nebraska and globally. However, for UNL to fully capitalize on its investments in Centers, Initiatives and Departments it is imperative that synergies among these entities be identified and mechanisms put in place to foster and incentivize transdisciplinary research across these units. A prime example of transdisciplinary research potential lies in a strength within PSI, enhancing oil content and quality of oilseed crops. This area of emphasis has opportunities for research interactions with the GUT Function Initiative, the Nebraska Gateway for Nutrigenomics, and UNMC to investigate impact of these novel lipids on a range of aspects of human and animal health. Moreover, these lipid modifications have value in feed and industrial applications wherein collaborative opportunities exist with the Food Processing Center, Red Meat Initiative, Industrial Agriculture Products Center and Tractor Engine Testing Laboratory. Another area of strength within PSI is stress tolerance. Recent investments in faculty hires and throughput phenotyping capacity will clearly add to this area of expertise, but to fully capitalize on these investments will require strong linkages with CALMIT, Computational Biology Initiative, faculty within SNR, BSE among others. The ability to create these linkages offers potential for development of predictive algorithms to aid in plant germplasm selection efficiency. These examples illustrate how a coordinated interactive unification structure that fosters linkages among Centers, Initiatives and Departments will build synergistic research activities in the life sciences across campus. This in turn will build upon UNL's national and international stature. However, for this vision to become reality strategic investments in research infrastructure and incentives to promote collaborative research programs will be required.

Background

Introduction of genetic variation in plants through conventional breeding methods alone or complemented by mutational or biotechnology tools is the foundation for genetic gains in yield, protection of yield and quality traits realized across plants species used for food, feed, industrial applications, and landscape resources. Genomics technologies have greatly facilitated our ability to characterize the molecular state of plant species. However, our ability to comprehensively connect genotype to phenotype is severely lagging, thus the exploitation potential of the vast repository of datasets obtained from "omics" technologies is greatly reduced. The University of Nebraska is positioned well to close

this gap in phenotype data acquisition technologies, which in turn holds great promise for the development of superior predictive models for linking genotype to phenotype in plants. To this end we are proposing the establishment of a Consortium for Integrated Translational Biology (CITB). We envision the CITB to evolve into a dynamic hub that provides an environment conducive for transdisciplinary research activities merging UNL's expertise in the areas of plant breeding, genetics, metabolic engineering, physiology, stress biology, computational modeling, along with optical and hyperspectral imagery capture and analyses. Importantly, the establishment of the CITB will be critical in strengthening our ability to translate technologies from the laboratory to the field. This in turn will aid our technology and marketing arm of the University, NU Tech Ventures, for field-level demonstration of an innovation significantly enhances the attractiveness of the technology by allowing it enter the product pipeline in a later phase of market development.

CIBT mission statement

Create a transdisciplinary environment to address the genotype to phenotype gap through the development of integrative predictive models for the selection of valuable traits that address yield, protection of yield, and quality traits across plant species used for food, feed, industrial applications and landscape resources. While facilitating translation of innovations to the field.

CIBT modular design

The CIBT will have a modular design to address three levels of phenotype data collection, plant, field and end use scale phenotyping. Research teams can address hypotheses within or across modules depending on the scope of the project.

Plant Phenotyping Module

The plant phenotyping module is designed for data capture on an individual scale. Key infrastructure elements include updated greenhouse and growth chamber capacity, along with the installation and operational oversight of the Scanalyzer HTS and Scanalyzer 3D imaging systems. The Scanalyzer imaging systems will be complemented by coordination of hand-held devises for data capture on carbon/water flux, photosynthetic capacity, leaf area and soil parameters. Key to success of this module is that these infrastructure elements be coupled with computational and modeling expertise to facilitate bridging the genotype to phenotype gap at the plant level.

Field Phenotyping Module

A unique element that distinguishes UNL from other public and private sector institutions investing in phenotyping platforms is our stellar history of canopy level image capture and analyses. UNL's School of Natural Resources and its aligned Centers, including the Center for Advanced Land Management Information Technologies (CALMIT), National Drought Mitigation Center (NDMC) and High Plains Climate Center (HRRCC),

collectively offer a suite of expertise that will greatly aid in addressing the CIBT's mission. The Field phenotyping module is merely an alternative means of describing Nebraska with UNL's research centers as living laboratories. Indeed our plant breeding programs have exploited elements of this infrastructure over the past 30 years to develop novel germplasm that is being mined for novel traits by both public and private entities across the world. The Field phenotyping module will help facilitate integration of genomic selection and genome wide association strategies being utilized by our breeding programs for trait predictions in collaboration with SNR areas of expertise. Thereby bringing together researchers with field-based genomic selection, canopy level imaging and modeling expertise to aid in developing phenotype prediction technologies that translate to the field.

End-use Phenotype module

Genomic selection for output traits including oil, protein or starch deposition, functionality and nutritional quality improvements require field phenotyping to ensure agronomic performance is not compromised. However, infrastructure to end-use phenotype for such traits is critical to ensure the accuracy of the genotype to phenotype prediction model. To this end, the C-ITB would strive to create a coordinated umbrella encompassing expertise within the Food Processing Center, Industrial Agricultural Products Center, the Tractor Testing Laboratory, Gut initiative and Redox biology center. Thereby building a network of expertise to address traits targeted for food, feed (for both farm animals and companion pets), and industrial applications.

Management structure of CIBT

A six member oversight committee composed of faculty with expertise in genetics, physiology, computation, modeling and canopy imaging will provide leadership of the proposed CIBT. All members of the oversight committee will have leadership responsibility in at least one of the CIBT modules. The leadership role of the respective modules will primarily be to help facilitate current organizational operations representing the established infrastructure. In cases wherein management structural changes are require to facilitate coordination of one of the respective modules, the module leadership team will take the lead on drafting recommendations. For example, the Field Phenotyping module leadership team will work with and help coordinate dialog across the extension and SNR associated Centers, along with the Lincoln centric farm operation committees to ensure adequate infrastructure/equipment needs are in place, and if deficiencies are identified the Field phenotyping leadership in consultation with the respective established Committee structure will draft strategic plans to secure the resources to address the identified deficiencies.

Support structure for CIBT

The overarching goal of the CIBT is to create an environment conducive for transdisciplinary research through incentivized inter- Departmental/Center collaborative research endeavors. As a mechanism to incentivize collaboration The Oversight

Committee will take the lead on drafting RFPs on programs that will target exploitation of modular infrastructure of the CIBT. Support funding for the RFPs will be solicited from ORED, ARD and the respective Center/Department from which the PIs from the selected proposals reside. Submitted proposals must include letters of support from the corresponding Unit/Center directors committing 33% of the budget for the project. All projects will be up to 3 years in duration. A criterion for funding will be submission of a competitive grant by the selected team within two years of completion of the CIBT awarded proposal, in which total budget for the competitive grant submission must be 5X the funding support of the CIBT proposal. The ORED will agree to set-up CIBT F&A partition such that 33% is retuned to ORED, 33% to ARD, and the remaining 33% is split among the Units/Centers who provided seed funding, in a manner mirroring the initial allocation of the CIBT contribution.

Critical Investments within the next 3 years for C-IBT

A set of investments will be necessary to lay the foundation for a successful path forward for the CIBT. These will include targeted funding for all three modules.

Plant Phenotyping Module:

• A faculty lead will need to be assigned for operational oversight of the Scanalyzers. We suggest a minimum of 0.3 FTE. Moreover, this faculty line appointment will need to come with two Research Technologists who will be responsible for the day-to-day operation, and logistical functioning of the Scanalyzers.

• A second faculty lead will need to be appropriated for the computational oversight of the datasets collected by the Scanalyzers. We suggest a minimum of 0.3 FTE. This faculty line will need to come with one post doctorate researcher and one Ph.D. GRA.

• Infrastructure improvements to campus greenhouses to include installation of 6 additional growth chambers at east campus complex, and replace costs for four outdated growth chambers in the Beadle greenhouse complex. Importantly, the majority of the greenhouse complex on east campus is not operational throughout the year due to poor conditions of many of the bay space. A prioritization plan must be put in place to modernize the bays to be at minimum equivalent to the operational systems of that in the Beadle Center. Monies must be invested on annual basis to target updating of 2,000 sq feet of greenhouse space per year over the next 3 years.

• The management of the east campus greenhouse complex is currently partitioned by Departmental sectors. This management style is not ideal for the proposed CIBT model. To this end, we strongly suggest that an umbrella management be established to oversee the operation of both Beadle and the east campus greenhouse complex. With fee structure, bulk purchasing of materials, lighting, pesticides, equipment centralized. Greenhouse usage is an economy of scale endeavor, with year-round space functional rental, and user-friendly services key to a successful and sustainable operation.

Field Phenotyping Module:

• The Lincoln-based nurseries and Agronomy Farm operation require substantial irrigation upgrades. The Agronomy Farm Committee working with the leadership of C-IBT will draft cost estimates to bring the irrigation system upto modern day farming operation.

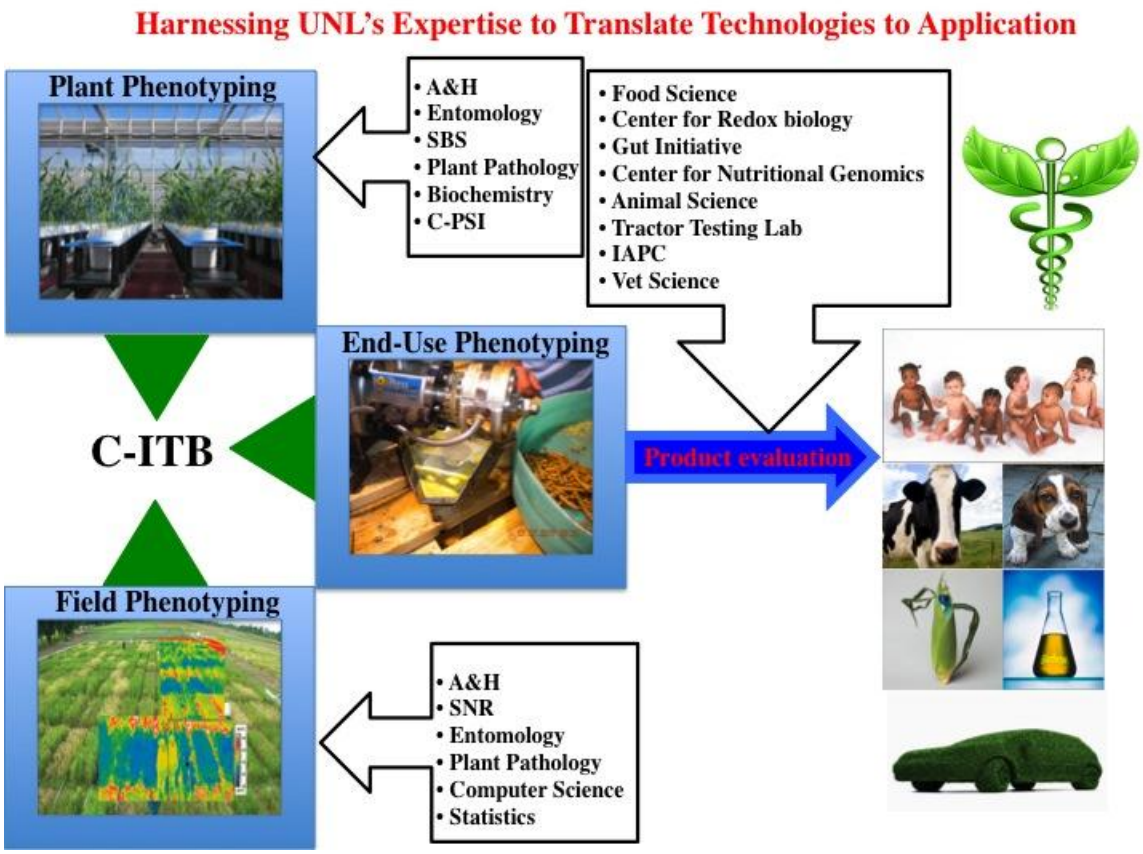
• The SNR and CALMIT will need funds to help defray the cost of additional imaging equipment to complement the Plant Phenotyping capacity and ongoing canopy data collection capabilities..

• A Faculty FTE appointment will need to be made to coordinate the modelers and computational expertise of the CIBT. This appointment will be key in meeting the target goal of bridging the genotype to phenotype gap.

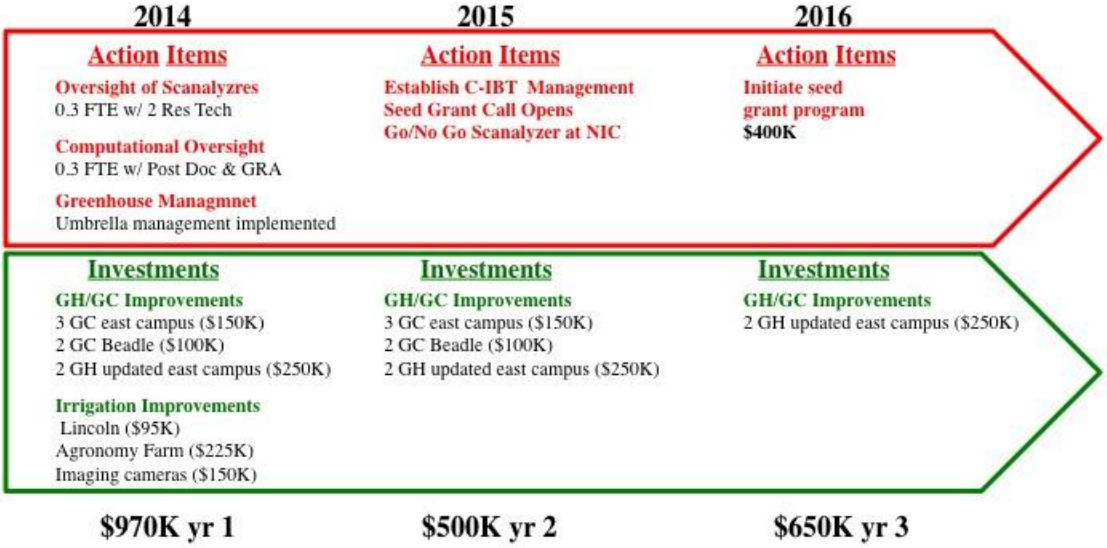
End-Use Phenotyping:

The capabilities of our seed quality laboratory need to be improved. Instrumentation to monitor lipid parameters such as cold flow, oxidative stability, and melting points is needed, along with the capacity to produce small scale biodiesel from feedstock targets.

• A faculty FTE appointment needs to be put in place to coordinate end-use testing of plant products and by-products in animal models for food, and feed testing for both farm animal and companion pets.


Harnessing UNL's Expertise to Translate Technologies to Application
Plant Phenotyping
• A&H
• Entomology
• SBS
• Plant Pathology
• Biochemistry
• C-PSI
• Food Science
• Center for Redox biology
• Gut Initiative
• Center for Nutritional Genomics
• Animal Science
• Tractor Testing Lab
• IAPC
• Vet Science
End-Use Phenotyping
C-ITB
Product evaluation
Field Phenotyping
• A&H
• SNR
• Entomology
• Plant Pathology
• Computer Science
• Statistics

C-IBT Timeline



3 year total appropriation: $2,120,000