

# *Preeminent Leadership in Theory with Practice—*

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## *—Preparing to Shape the Future*

- *Excel in Innovative Teaching and Learning*
- *Advance Frontiers of Discovery and Creative Activity*
- *Improve Society with Effective Engagement*
- *Promote an Ethical Culture of Unity in Diversity*

Department of Horticulture and  
Landscape Architecture

Purdue University  
West Lafayette, Indiana

Strategic Plan 2017–2022

October 2017

## PREAMBLE

The Department of Horticulture and Landscape Architecture (HLA) is one of the stellar departments in its disciplines in the nation, with worldwide recognition. In May 2013, the department crafted a programs plan asserting its mission and vision and identifying signature program areas. This plan culminated from department-wide participation in a plant sciences realignment discussion and was included an analysis of departmental strengths, weaknesses, opportunities, and threats (SWOT), a discussion of the role of science in HLA, and trajectories of programs going forward. This programs plan has been guiding the execution of departmental initiatives and priorities until the completion of this document.

The College of Agriculture (CoA) approved its strategic plan, *People, Purpose, Impact*, in 2015. HLA enthusiastically supports the CoA strategic plan as it serves as the impetus and context for HLA to redesign its own strategic plan. Under the leadership of Dr. Hazel Wetzstein, the new department head starting in 2014, HLA has crafted its new strategic plan as introduced in this document. This plan builds on HLA's tradition of outstanding leadership and excellence in effective teaching/learning, impactful research, and pervasive engagement/Extension—all in the contemporary spirit of Purdue as Indiana's land-grant research (R1) university.

The conceptual framework utilized for this strategic plan includes descriptions of the HLA mission and vision followed by the articulation of goals, corresponding strategic initiatives, redefined signature areas, and critical metrics to assess progress. The CoA strategic plan goal areas are addressed integrated within the HLA goals and the signature area descriptions ([Appendix-A](#)). This framework complements the CoA strategic plan as the umbrella under which the HLA plan will serve its faculty, staff, and students and contribute to the College and University priorities.

The document that follows captures the department's basic mission—*Preparing to Shape the Future*, and its aspirational vision to achieve *Preeminent Leadership in Theory with Practice*. These themes will guide the department going forward during the next five year plan period—2017-2022.

In concert with the College of Agriculture strategic plan implementation, HLA is well-positioned to implement its new strategic plan with ownership by all departmental constituencies.

## MISSION

### *Preparing to Shape the Future*

***Provide students, industry members, and the public with knowledge and skills, through innovative programs in horticulture and landscape architecture, that educate them to help shape the future.***

#### **Key Characteristics**

- Teaching and learning for a wide range of students to reach their full potential, industries to advance quality of life, and an informed public.
- Discovery, including research, scholarship, and creative activity, with innovations and inventions that continually advance knowledge and skills, enrich all educational programs, and drive business and industry growth for sustainable development.
- Engagement/outreach programs that address scientific, environmental, and societal issues of mutual concern and interest.
- A collegial climate of human and intellectual diversity and inclusion, focused regionally and globally for all endeavors in learning, discovery, and engagement.

## VISION

### *Preeminent Leadership in Theory with Practice*

***Demonstrate preeminent leadership in integrative learning, discovery, and engagement that blends fundamental and translational research, with emphasis on creativity and sciences, relevant to sustainable horticulture and landscape architecture, planning, and design that promote well-being.***

#### **Key Characteristics**

- Premiere educational and engagement programs enriched by state-of-the-art research-based information in the regional, national, and international arenas.
- Recognition for successful integration of discovery, learning and engagement across all academic activities.
- Highest levels of strengths that blend fundamental and translational research seamlessly integrated in HLA signature areas—*Sustainable Horticulture, Plant-Environmental Interactions, Controlled Environment Agriculture, and Landscape Systems and Design*—promoting environmental and integrative development of the built environment.
- Model educational programs emphasizing the integration of creativity, science, technology, and collaborations that prepare students to make a difference in the global workplace and quality of life.
- Keen focus on relevancy of curricula in horticulture and landscape planning and design, as integral parts of a College of Agriculture committed to serving state, regional, national, and international interests.
- A nurturing and supportive culture, with mentoring that promotes individual as well as interdisciplinary and collaborative excellence where *all* members can succeed in reaching their career goals.

## GOALS / STRATEGIC INITIATIVES

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### *Goal-1: Excel in Innovative Teaching and Learning*

***Excel in teaching and learning at the undergraduate and graduate levels to prepare future leaders and practitioners who uniquely blend theory and practice in horticulture and landscape architecture, planning, and design.***

#### **Key Characteristics**

- Up-to-date knowledge and skills in learning content synergistically integrated with discovery, encompassing research, scholarship, and creative activity, as well as engagement at state, regional, national, and international levels.
- Innovative teaching and learning methods that ensure a comprehensive breadth and depth of learning experiences for students in their respective curricula commensurate with the HLA signature areas— *Sustainable Horticulture, Plant-Environmental Interactions, Controlled Environment Agriculture, and Landscape Systems and Design*.
- Nurturing all students at all levels to fully reach their potential with critical thinking and problem solving capacities.
- Optimizing learning delivery for on-campus as well as digital education that are appropriately developed for selected audiences.
- Dedicated student mentoring by faculty to ensure educational success and career development
- Exposing students to a wide range of experiential, extra-curricular, and co-curricular learning.

#### **Strategic Initiatives**

- Develop and implement innovative ideas in instructional methods in HLA signature areas, including experiential, collaborative, and digital learning, that build upon knowledge of how students learn so as to advance teaching and learning at all levels.
- Usher in world-class instructional and support facilities in accordance with expected quality of learning experiences for enhancing competitiveness with peer institutions.
- Renovate and improve design studio facilities in landscape architecture in accordance with the highest standards of excellence and program accreditation expectations.
- Create facilities for informal interaction among faculty, staff, and students to promote sharing of knowledge and interdisciplinary/collaborative endeavors in teaching and learning.
- Review curricula, courses, and programs so as to enhance competitiveness with peer institutions to enhance faculty recruitment and to develop and implement a graduate program in landscape planning and design/landscape architecture.
- Implement appropriate class sizes as well as student-to-faculty ratios commensurate with accreditation and/or other external agency expectations for excellence in student learning.
- Seek significant additional resources (e.g., from high-capacity donors, external foundations, and federal/state funding agencies for community engagement) to further intensify the learning experiences of students including intern programs that successfully connect to sustainability initiatives.
- Increase digital education with assurance of administrative and funding support to develop on-line courses for a broad clientele.

## *Goal-2: Advance Frontiers of Discovery and Creative Activity*

***Achieve worldwide recognition for advancing the frontiers of discovery and creative activity, with groundbreaking contributions that advance knowledge and skills internationally.***

### **Key Characteristics**

- Defining discovery, encompassing research, scholarship, and creative activity, that advances the frontiers of knowledge with regional, national, and international recognition.
- Enhancement of preeminent research in signature areas—*Sustainable Horticulture, Plant-Environmental Interactions, Controlled Environment Agriculture, and Landscape Systems and Design*—to achieve and sustain regional, national, and international leadership.
- Discovery that actively informs and integrates with undergraduate and graduate learning and drives engagement at regional, national, and international levels.
- Interdisciplinary research with collaborative approaches that address challenging frontiers.
- Significant external grant awards for premiere, long-term research endeavors.
- Visionary creative activities that draw national and international attention, interest, and recognition.

### **Strategic Initiatives**

- Enhance and sustain substantive research expertise in HLA signature areas signified by recognized high-impact scholarship, and creative activities.
- Pursue significant levels of external research funds to sustain and enhance discovery/research in signature areas, including interdisciplinary research grants, complementing and leveraging the deployment of internal resources.
- Recruit and retain talented faculty engaged in leading-edge fundamental and translational research to complement and enhance current strengths in signature areas.
- Acquire external grants to fund major research instrumentation for shared use—with attention to genetic and molecular analysis of secondary metabolism, epigenetics, and quantification of responses of gene regulatory networks during plant adaptation to the environment.
- Encourage and advance translational discovery/research and creative activity expanding applied science and technology commercialization activities of faculty, specialists, and students.
- Renovate and improve signature area research facilities, particularly focusing on *Sustainable Horticulture, Plant-Environmental Interactions, Controlled Environment Agriculture, and Landscape Systems and Design*, through internal resources as well as external grant opportunities.
- Implement a research program in landscape planning and design with concomitant faculty, staff, and facilities resources, with the intention of introducing a graduate program in landscape architecture.
- Develop faculty, staff, and student interaction space/facilities that promote sharing of knowledge and interdisciplinary/collaborative endeavors in discovery and creative activity.

### *Goal-3: Improve Society through Effective Engagement*

***Demonstrate excellence in university engagement serving academic, industry, community partners, as well as society at the state, regional, national, and international levels.***

#### **Key Characteristics**

- Demonstrated leadership in the creation of innovative and effective delivery of timely, high-quality research-based Extension programs and products, in keeping with land-grant university expectations, drawing state, regional, national, and international attention, interest, and recognition.
- Contribution to the public good through effective communication and dialogue with stakeholders that drive the foci of applied research and educational programs on priority issues.
- Mutually beneficial partnerships with industry, public, and community groups to facilitate leadership and problem-solving.
- Targeted dissemination of critical science-based information to inform public policy development.
- Synergistic integration of teaching/learning with discovery/research for scholarship of engagement that leads to informed decisions and improved quality of life.
- Promotion of departmental achievements at state, regional, national, and international levels with the intention of advancing alumni relations and private fund raising efforts.

#### **Strategic Initiatives**

- Implement new technologies to enhance effective delivery of Extension/engagement programs.
- Develop and leverage resources to increase programmatic funding, including Extension assistantships.
- Enhance scholarship of engagement, along with programs and products, based on research areas and their impact on society, with the intent to increase regional, national, and international recognition of engagement activities.
- Promote involvement of HLA graduate students in Extension programs at the discipline, department and college levels.
- Enhance academic synergies, emphasizing close connections among learning, discovery, and engagement, as a hallmark of engagement programs.
- Develop informal interaction space/facilities for faculty, staff, and students to promote sharing of knowledge and interdisciplinary/collaborative endeavors in Extension/engagement initiatives.
- Establish a departmental advisory committee of key stakeholders to interact and assist with continuing development of departmental programs.
- Enhance alumni engagement, and fundraising activities to promote departmental achievements and programmatic connectivity of alumni with faculty, staff, and students.

## *Goal-4: Promote an Ethical Culture of Unity in Diversity*

***Promote a culture of human and intellectual diversity and inclusion demonstrating collegial unity, mutual respect, and support for all members' success.***

### **Key Characteristics**

- Highest standards of ethical and moral standards, defining the core human values embraced by all members in all endeavors.
- A collective body of faculty, staff, and students marked by human and intellectual diversity that enriches learning, discovery, and engagement.
- Recognition of people as the lifeblood of the department who work in a productive climate that celebrates the contributions made by each member.
- Pervasive collegiality, trust, and trustworthiness among all members of the department demonstrating mutual respect, support, and open communication.
- An intellectual environment that values and engages the academic and professional roles of all members and how their multiple points of view create a rich educational setting defined by academic freedom.
- Constructive leadership that motivates, nurtures, and facilitates the success of all members to reach their highest potential through the quest for exceptional individual and collective achievements.

### **Strategic Initiatives**

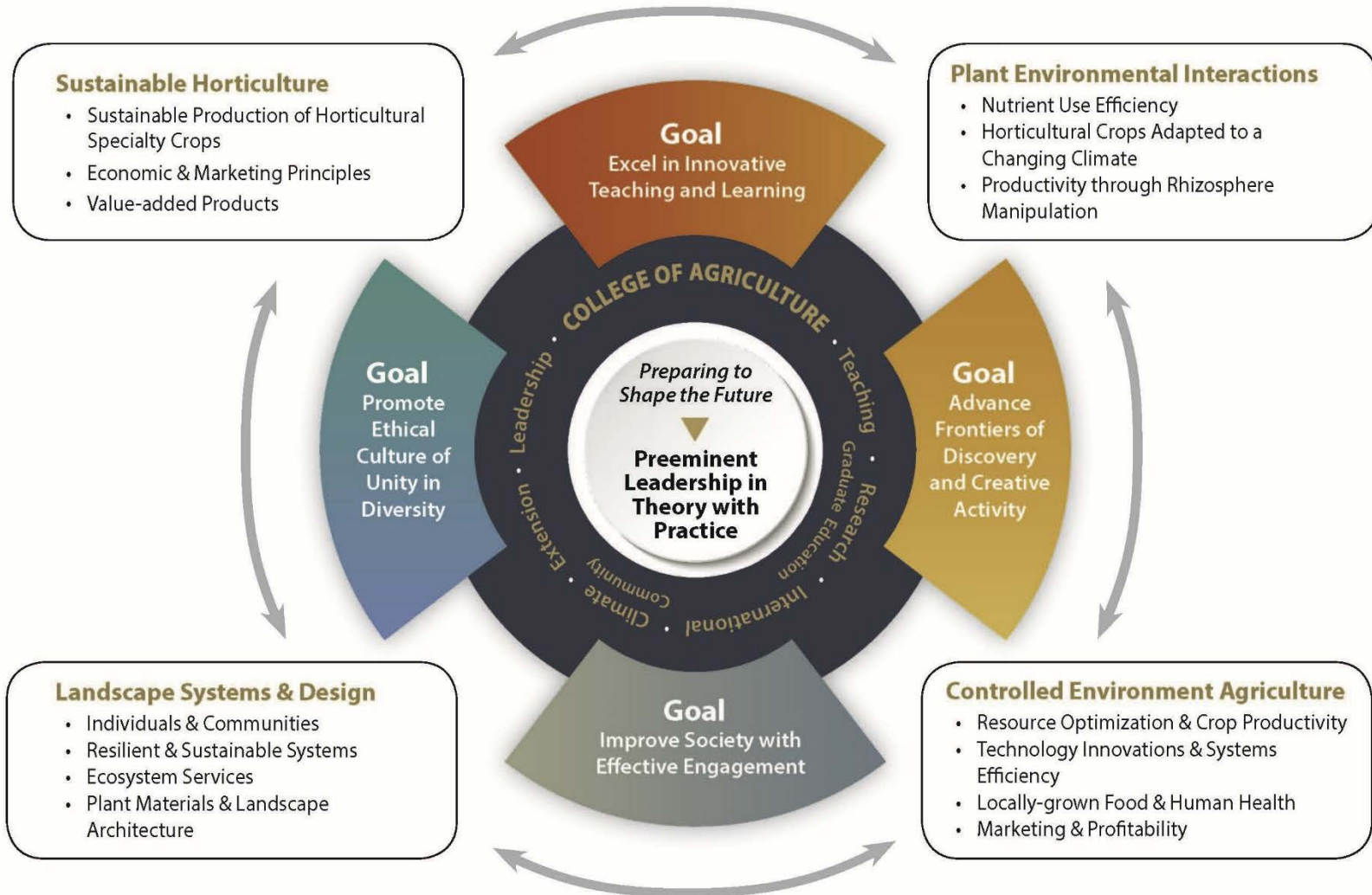
- Demonstrate uncompromised integrity in all endeavors, and fairness in all decisions involving faculty, staff, and students.
- Actively pursue human and intellectual diversity in faculty, staff, and student recruitment and retention.
- Develop mentoring programs designed to facilitate success for all members of the department.
- Enhance internal communications to promote the sharing of learning, discovery, and engagement initiatives, as well as interdisciplinary and collaborative endeavors, supported by physical facilities that catalyze interactions among faculty, staff, and students.
- Ensure diversity and inclusion in departmental initiatives, including internal and external representation.
- Promote open dialogue, and engage diverse and inclusive participation in developing and implementing policies and procedures.
- Facilitate and incentivize the quest for excellence by all members and acknowledge their achievements with awards, rewards, and other forms of recognition.
- Ensure provision of appropriate facilities commensurate with a diverse and inclusive faculty, staff, and student community (e.g., ADA compliance, gender-accommodative facilities).

# HLA Strategic Plan Concept

## Department of Horticulture and Landscape Architecture

Purdue University

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## METRICS

The overarching metrics to measure progress associated with each of the four goals are summarized below. These metrics are consistent with those of the College of Agriculture strategic plan and include specific metrics for the goals and initiatives of the HLA strategic plan.

### **Overarching Metrics (pertaining to all goals)**

- National/Global Program Rankings
- Enhancement of Signature Areas (descriptive, development)
- Faculty, Staff, Student Awards and Leadership Positions (#, %)
- Private Fund Development-Support for Students, Faculty, Staff, Instrumentation, and Facilities (\$\$)

### **Metrics for Goal-1: *Excel in Innovative Teaching and Learning***

- Undergraduate/Transfer/Graduate Enrollments (#, demography, trend)
- Undergraduate Class size and Student-to-Faculty Ratios (mean, program specific, trend)
- One- and Two-year Undergraduate Retention Rates (%), trend)
- Students Engaged in Experiential, Collaborative, Digital, International/Study-Abroad, and Professional/Cooperative Learning Experiences (#, %, trend, by category)
- Four-, Five-, and Six-year Undergraduate Graduation Rates (Five-year rate for LA, %, trend)
- Undergraduate Career and Advanced Studies Placement (#, %, trend)
- Graduate Student Time to Degree (mean, trend)
- Innovative State-of-the-Art Teaching and Learning, Facilities and Equipment (exemplars, trend)
- Programmatic Synergies with Goal-2 and Goal-3 (descriptive, exemplars)

### **Metrics for Goal-2: *Advance Frontiers of Discovery and Creative Activity***

- Faculty Recruitment, Retention, Development, Promotion (#, demography, by 'signature' areas)
- State-of-the-Art Discovery/Research/Creative Activity Facilities and Equipment (exemplars, trend)
- Total Research Awards/Expenditures (\$\$, trends)
- Number of Interdisciplinary Grant Proposals Submitted/Awarded (#, \$\$, trend)
- Peer-Reviewed Publications (# total, # high impact journals, # per faculty, trend)
- Commercialization Metrics (Discoveries #, Patent Applications/granted #, Startups #, etc.)
- Programmatic Synergies with Goal-1 and Goal-3 (descriptive, exemplars)

### **Metrics for Goal-3: *Improve Society through Effective Engagement***

- New Technologies Implemented (descriptive, impact)
- Extension Grant Awards/Expenditures, Sponsored Research with Extension Component (\$\$, trend)
- Delivery of Programs (# and types of programs, # participants, trends)
- Scholarship of Engagement/Peer-Reviewed Publications (# total, # per faculty/specialist, trend)
- Graduate Student Exposure to Extension (#, %, trend)
- Alumni Engagement (# programs, # alumni engaged, # interacting with students and faculty)
- Programmatic Synergies with Goal-1 and Goal-2 (descriptive, exemplars)

### **Metrics for Goal-4: *Promote an Ethical Culture of Unity in Diversity***

- Faculty, Staff, and Student Attitudes on HLA Climate (periodic surveys, in conjunction with CoA)
- Representation of Women, Minority, and URM, Faculty, Staff, and Students (#, %, by category)
- Recruitment, Retention, Promotion of Women, Minority, and URM Faculty and Staff (#, %, by category)
- Facilities Commensurate with a Diverse and Inclusive Community (#, descriptive)
- Internal and External Representation of HLA department by Women, Minority, URM (#, %, trend)

## KEY PRIORITIES

The key priorities will correspond with the strategic initiatives and the signature areas—*Sustainable Horticulture, Plant-Environmental Interactions, Controlled Environment Agriculture, and Landscape Systems and Design*—that are embedded in this strategic plan. HLA will articulate the specific expectations of these priorities. At the big picture level the most impactful priorities will include:

- Enhancing coordination/collaboration, and identifying/capturing synergies among discovery/research, teaching/earning, and engagement/outreach/Extension programs to further develop preeminence in the defined signature areas.
- Building robust student enrollments (undergraduate and graduate).
- Ensuring timely graduation rates for undergraduates, and time to degree for graduate students.
- Substantially increasing externally funded research.
- Enhancing scholarship, and creative activity.
- Providing state-of-the-art equipment/technology, instrumentation, and physical/space facilities.
- Increasing funding resources (general fund, grants and contracts, private philanthropic funds.)
- Ensuring a constructive collegial climate in support of diversity and inclusion.

## IMPLEMENTATION

The implementation of this strategic plan will commence upon its finalization by HLA and acceptance by the College. College/HLA administration will drive implementation processes with the participation of faculty, staff, students, and other stakeholders, as appropriate. Implementation plans for specific strategic initiatives will be developed through annual action planning. This action planning will clarify responsibility centers—leadership, stakeholder (faculty, staff, students, alumni, others) task forces and committee structures—along with a timeline for desired outcomes.

The development of the annual budgets of HLA will be synchronized with the annual action plans based on the strategic plan priorities. A key aspect of strategic plan implementation is the annual assessment of progress on strategic priorities/initiatives. This assessment will be conducted to gauge progress based on the metrics identified in this plan relative to the five-year time-line. Based on this annual progress assessment, the annual action plans will be adjusted as necessary—including course corrections and/or realignment of timelines, if any, for the strategic initiatives. During the fifth year of the strategic plan period, a comprehensive assessment will be conducted to measure the cumulative progress during the plan period. This process sets the stage for HLA to renew and/or recast its next five-year strategic plan.

This strategic plan charts the course for HLA for five years going forward (2017—2022). It is a visionary plan that HLA will implement to achieve its aspiration—*Preeminent Leadership in Theory with Practice*. The plan has been developed with the participation of all faculty at every step. Faculty ownership of this plan is intrinsic to its success. As HLA now embarks on the implementation of this plan, it does so with enthusiasm and full support of its faculty.

**Controlled Environment Agriculture Signature Area**  
**Purdue University**  
**Horticulture and Landscape Architecture**

Controlled-Environment Agriculture (CEA) is a contributing approach to feeding 9+ billion people on Earth by 2050. The Purdue Horticulture and Landscape Architecture (HLA) Department has embraced CEA as one of its signature areas for research, extension, and teaching as we move toward the end of the second decade of the 21<sup>st</sup> century.

CEA involves protected cultivation of high-value specialty crops with differing degrees of control over the required environmental factors of plant growth i.e., light, temperature, water, nutrients, and atmosphere. The environmental-control capabilities range from relatively low-tech high tunnels that permit cropping-season advancement/extension to semi-controlled greenhouses to enclosed facilities with control of the plant-growth environment including repurposed warehouses, converted shipping containers, and high-tech indoor vertical farms. The CEA umbrella includes all such crop-growth platforms. Purdue HLA faculty and staff members address needs that will help realize a productive, profitable, and sustainable CEA industry.

As the degree of CEA environmental control increases, the number of cropping cycles per year increases (crops grow and mature faster), and yield per cycle tends to increase as well, thereby greatly multiplying crop productivity as compared to open-field agriculture. CEA is particularly valuable for specialty crops, which have high economic value on a per-plant basis. This is important since the cost of growing CEA crops tends to be significantly higher than for field crops. Major drivers for CEA include consumer desire for locally grown, fresh, healthy produce, with cropping-season extension at the least, and year-round production possible with sufficient inputs. CEA also has appeal given the looming prospect of climate change that potentially threatens capability for reliable outdoor crop production.

Despite many appealing productivity advantages for CEA, it is a young field of study, with many unknown crop by growth-environment combinations needing to be tested and optimized for resource-use efficiency and resulting crop outcomes. As control of the growth environment increases, so do unknown interactions that need to be addressed by systematic research on optimized cultivation of specialty crops. For all platforms of CEA, crop and cultivar selection are needed, cultural practices need refinement as well as optimization of light, temperature, and atmosphere, and soilless-culture approaches to conserve nutrients and water. Closing loops on wastes and water is addressed by research on organic crop production, aquaponics, hydroponics, and innovations for indefinite resource recycling. Application of engineering innovations is sought for efficient delivery of sole-source or supplemental lighting from energy-efficient light sources, as well as for automated sensing and switching/dimming of light in response to crop health status or stage of development. For indoor agriculture, including vertical farming, energy sources are sought from readily available renewable sources that not only offset utility costs but also serve as a source of photosynthetic CO<sub>2</sub> and reduce the carbon footprint of CEA. By optimizing crop productivity, minimizing cultural, environmental, and energy inputs, and selecting crops appropriate for controlled environments, Purdue research and extension programs will enable all platforms of the CEA industry to be profitable to growers and CEA produce to be desirable to and affordable by consumers.

There are four key emphasis areas of the CEA signature area. Every emphasis area overlaps with other signature areas of the HLA Department, and considerable potential exists for crossover and collaboration outside of HLA.

### **Resource Optimization & Crop Productivity**

Data are lacking regarding best cropping outcomes for minimal resource inputs for protected cultivation of specialty crops, so research, extension, and teaching programs related to CEA are early in their development industry. The HLA CEA program addresses issues of ornamental as well as edible species. Purdue applied research and extension programs seek to help the young CEA industry become not only profitable but also sustainable, while HLA teaching programs are helping to generate the next generation of professionals who will help lead the future CEA industry.

### **Technology Innovations & Systems Efficiency**

CEA is a technology-intensive industry, and much of the promise of productivity, profitability, and sustainability depends upon the development of new technology that will make protected crop production more efficient in terms of resource utilization and crop yield. Purdue HLA faculty members are developing and testing innovative technologies designed to minimize inputs and optimize outputs.

### **Locally Grown Food & Human Health**

Consumer demand for year-round fresh, locally grown produce year is a strong driver for CEA. This saves on transportation costs from distant outdoor production areas, but presents challenges for CEA in northern regions to reduce energy requirements for crop production. Controlled-environment crop production has potential to improve product quality in addition to freshness for human-health applications. As such, there is potential to design environments that affect plant metabolic pathways to improve human health benefits from specialty crops.

### **Marketing & Profitability**

A strong economics and marketing research, extension, and teaching program is needed to make the CEA start-up industry become fiscally sound and well managed within a reasonable break-even time. Many issues of business and marketing are just as important as technical areas of controlled-environment crop production. Purdue HLA is well staffed to provide business as well as horticultural and technical support to the CEA industry.

**Landscape Systems and Design Signature Area**  
**Purdue University**  
**Horticulture and Landscape Architecture**

The Landscape Systems and Design (LSD) signature area arranges and manages land for function, sustainability, and beauty, vital for human health and well-being now and in the future. The signature area focuses on professional practice, management, and service in turf, design, and landscape industries. This team of faculty and staff generate industry leaders at both the graduate and undergraduate level by providing innovative education and research opportunities that support the needs of public and private practice. Faculty and staff members support practitioners through creative engagement programs that provide solutions and meet their continuing education needs. Our diverse blend of management, planning, functional systems creation and management, and aesthetic thinking strengthens and drives landscape services at both local and international levels.

The nationally ranked landscape architecture professional degree program is further reinforced with active turf research at the W.H. Daniel Turfgrass Research and Diagnostic Center, innovative campus teaching gardens, and numerous experiential hands-on labs providing field experiences for Purdue students and Indiana state extension officers. LSD signature area faculty members work together to provide a substantial mix of traditional classroom courses, community service work, and specialized distance education which is focused locally and also impacts national and international audiences.

A distinctive feature of this signature area is the student co-op and internship programs. Students study in professional offices nationally and internationally for a year prior to their senior year. Students in other Horticulture and Landscape Architecture (HLA) majors are placed in summer and semester long internships. Through these connections and experiences, Purdue HLA graduates have consistently enjoyed a high employment rate.

There are four key emphasis areas of the LSD signature area. Every emphasis area overlaps with other signature areas of the HLA Department, and considerable potential exists for crossover and collaboration outside of HLA.

**Impacting Individuals and Communities**

Faculty under the LSD umbrella are well situated to provide a mix of traditional classroom coursework and community engagement through service-learning courses, along with effective engagement efforts. Real world experience/experiential learning challenges with community partners provide students opportunities to learn in team environments and build and strengthen leadership skills. These projects achieve the learning objective of a course as well as meet the needs of local ecosystems and communities. Scholarship and learning in this form connect students to socially conscious, process driven projects that enhance real people's lives.

To capitalize and strengthen the LSD signature area, administration and the Landscape Architecture (LA) faculty are in the planning stages of developing a graduate degree program in LA to serve our students and community. The ability to offer a more in-depth study in LA plays a key role in advancing the program. The entire LSD team will be instrumental in shaping the education of future leaders in environmental-focused professions.

### **Building Resilient and Sustainable Systems**

Resilient and sustainable horticultural cropping systems can recover from stress and are maintained in a manner that allows for continual reuse. Similarly, resilient and sustainable design allows spaces to adapt to changing conditions and be transformed to meet future community needs. These efforts involve research and analysis of historic and current economies and systems, using predictive models that forecast future practices and patterns.

### **Enhancing Ecosystem Services**

Ecosystems services form the core of human survival, working towards a sustainable future. Purdue's LSD team is committed to supporting, provisioning, and disseminating information about these ecosystems. Through effective research and education in design, installation, and management of spaces the LSD team is highlighting and enhancing the health of local and regional ecosystems. Faculty members present contemporary issues in their courses, such as how to incorporate native and other horticulture plants into a design to enhance environmental health and faculty discuss environmental processes and natural systems, highlighting the importance of each link in the chain and how choices profoundly influence the environment. This focus is evident in the research being done on management practices that influence soil health in turf and urban environments. The LSD team's focus on natural and human ecologies positions them to widely disseminate sustainable environmental health and quality information and improve current management practices.

### **Integrating Plant Materials and Landscape Architecture**

Located within a diverse department of Horticulture and Landscape Architecture, the LSD signature area benefits from opportunities to collaborate in education, research, and extension. For example, integrating turf science into the study of herbaceous and woody plants provides a broader understanding of plant communities and environmental dynamics into landscape architecture coursework, along with a reciprocal use and maintenance approach to plant materials provided by design students in horticulture courses. Leveraging faculty expertise in areas of parallel undergraduate plans of study and discovery grounded in novel research generates graduates who will excel in an increasingly multi-disciplinary market.

**Plant-Environmental Interactions Signature Area**  
**Purdue University**  
**Horticulture and Landscape Architecture**

The Plant-Environmental Interactions (PEI) signature area facilitates research, teaching, and engagement to develop and encourage adoption of more resilient horticultural crops needed to mitigate the effects of a changing climate and increased pressure from pests and pathogens. The study of PEI involves understanding the genetic, epigenetic, biochemical, cellular, and developmental mechanisms plants use to mediate interactions with other organisms and to respond to abiotic stresses in their environment. Purdue Horticulture and Landscape Architecture (HLA) aims to become a world leader in this field through the synergistic activities of its faculty, staff, and students. The knowledge from the discoveries made in the PEI signature area can then be translated to conventional breeding and innovative biotechnological strategies for developing improved crop cultivars.

Traditionally, Purdue HLA has had strong, internationally recognized research programs centered around questions about how plants respond to environmental stresses and interact with their biotic partners. HLA retains robust research and teaching programs in these areas and has been strengthened with the recruitment of new faculty specializing in natural product metabolism, mineral nutrition, epigenetics, plant-microbial relationships, and computational biology. The PEI signature area faculty members are poised to use gene editing and metabolic engineering technologies to enable and enhance their respective research and for molecular breeding to develop more resilient horticultural crops.

Discovery efforts in the PEI signature area are supported by laboratories equipped for modern molecular biology, biochemistry, and cell biology. The department is also home to a Plant Growth Facility with modern computerized greenhouses and growth chambers, and temperature-controlled tissue culture growth space. Faculty members have access to on-campus Genomics Core, Bioinformatics Core, and Metabolic Profiling Facilities with state-of-the-art equipment, staffed with skilled personnel. Additional support is available through resources at Purdue's Bindley Bioscience Center.

The teaching component of the PEI signature area engages students with learning opportunities in *Plant Physiology*, *Plant Responses to the Environment*, *Plant Microbiomes*, *Metabolic Plant Physiology*, *Plant Mineral Nutrition*, and *Post-Harvest Physiology* courses. The signature area is further strengthened by engagement and extension activities, including well-established, formal outreach programs targeting the horticultural industry. Students are engaged through transformative undergraduate research experiences and innovative summer research internships. HLA faculty in the PEI signature area also host workshops for K-12 students to stimulate their interest in fundamental horticultural research.

There are three key emphasis areas of the PEI signature area. Every emphasis area overlaps with other signature areas of the HLA Department, and considerable potential exists for crossover and collaboration outside of HLA.

### **Increasing Nutrient Use Efficiency**

Depleted soil fertility and the economic and environmental costs of fertilizers create a need to improve the nutrient use efficiency of fruit, vegetable, ornamental, and turf crops. Research groups are working to understand the molecular and physiological basis of nutrient use efficiency in crops using genetic, genomic, biochemical, and physiological approaches.

### **Adapting Horticultural Crops to a Changing Climate**

With major challenges brought on by climate change and other environmental issues, horticultural crops must acclimate and adapt to adverse abiotic factors, including drought, salt, and temperature stresses. Purdue HLA is engaged in using molecular and computational approaches to identify key molecular factors that regulate plant stress response and developing or adapting novel molecular strategies such as CRISPR/Cas systems to rapidly validate the stress alleviation benefits of altering these key factors in horticultural crops.

### **Enhancing Productivity through Rhizosphere Manipulation**

Interactions that occur between plants and their biotic partners in the rhizosphere play crucial roles in helping plants acquire nutrients and withstand abiotic and biotic stress; manipulating these partnerships has great potential, but it has been underutilized. Research programs in HLA are working to develop strategies to regulate agroecosystem services through manipulation of the soil microbial community, to increase carbon sequestration in turfgrass species, and to reduce weed pressure by harnessing allelopathic plant natural products.



**Sustainable Horticulture Signature Area**  
**Purdue University**  
**Horticulture and Landscape Architecture**

The Sustainable Horticulture (SH) signature area focuses on developing integrated systems for horticultural plant production that maintains productivity, enhances environmental quality, makes efficient use of resources, and sustains the economic viability of producers. The approach encompasses scientific discovery, and the integration of theory and practice in the development of methods in plant production. The SH signature area focuses on the production of specialty crops and complements the other departmental signature areas. The Horticulture and Landscape Architecture (HLA) department has a history of research, education, and extension activities focused on meeting these goals in specialty crop production systems that include fruits, vegetables, nursery, ornamental plants, turf (sod), mint, and hop among others. The long-term goals of the SH signature area are to increase the productivity of commercial horticultural and home gardens, while being attuned to the needs of growers and markets and the environmental and social impacts of these production systems. Over the past few years, increased interest in home gardening, urban agriculture, lawn and sports turf management, sod production, local foods, small acreage farming, beginning farming, organic farming and diversified crop production systems has increased the need for additional work on these topics.

Traditionally, research in the SH signature area focuses on translational research aimed at providing immediate benefits to stakeholders such as variety trials and evaluation of new crops and products, and evaluation of new innovative production techniques with potential to increase nutrient and water use efficiency and reduce pest pressure. Recently, new faculty and specialists with expertise in economics and marketing have joined the department, providing valuable insights needed to determine whether these new practices are economically viable and allow growers to integrate these practices into production systems in practical ways. Many HLA faculty and specialists are actively engaged in transferring results of these studies to stakeholders through innovative programming conducted at conferences, hands-on workshops, farm tours, and field days, as well as through participatory research with growers and county extension educators. Some faculty and specialists are also engaged in longer-term projects aimed at developing improved germplasm using traditional and molecular plant breeding techniques and fundamental research to elucidate mechanisms regulating plant-environmental interactions that support the SH signature area. Examples include identifying mechanisms that regulate fruit size in apple, and determining how management practices alter soil microbial communities and influence plant tolerance to biotic and abiotic stress.

The Purdue Student Farm, Meigs Horticulture Research Farm, and W.H. Daniel Turfgrass Research and Diagnostic Center are hallmarks for the department as they bring together faculty and staff with students from across the university to provide students with practical hands-on experience and the opportunity to participate in field-based research. A new major, Sustainable Food and Farming Systems (SFS), supports students interested in learning about sustainability, urban agriculture, aquaculture, and other recent trends in horticulture. A number of long-standing courses, which provide instruction focusing on the sustainable production of ornamental, vegetable and fruit crops, support SFS as well as existing departmental majors. Students are also exposed to the industry via field trips and guest lectures by industry professionals, and are provided with

opportunities to attend local industry conferences. Graduate students in the SH signature area are engaged in both translational as well as fundamental research. Some graduate students participate in the traditional plant physiology focused curriculum within the department, while others obtain a degree through cross-departmental, interdisciplinary programs such as Ecological Sciences and Engineering, to obtain a more holistic understanding of crop production systems.

There are three key emphasis areas of the SH signature area. Every emphasis area overlaps with other signature areas of the HLA Department, and considerable potential exists for crossover and collaboration outside of HLA.

### **Sustainable Production**

The primary emphasis of this signature area is maximizing production with fewer inputs. Efficient use of resources is a key principle of sustainability. Reusing, recycling, and increasing capacity for and utilization of ecological services in the production environment all contribute to reduced need for inputs. For example, pesticide costs are reduced in vegetable production by grafting susceptible scions onto disease resistant rootstocks. Well-adapted cultivars, such as cold hardy grapes, are more consistently productive than marginally hardy cultivars. Turfgrass cultivars with functional and aesthetic qualities are identified through various drought and low-input research. Utilization of LED lights in controlled environments reduces energy costs in controlled environment production systems. Increasing the amount and potency of allelochemical compounds released by plant roots could make crops more competitive by suppressing weeds. Long-term efforts aimed at developing new improved crop varieties using traditional and new molecular techniques will further support these efforts.

### **Promoting Sound Economic and Marketing Principles**

Horticultural businesses face numerous risks that can make income and profit fluctuate widely from year to year. These businesses also face new realities in internet commerce and social media marketing. To address these challenges, basic information about prices received at farmers markets is being collected for the first time and will ultimately be used to inform decisions that improve the financial health of these businesses. Enterprise budgets are being developed to help growers make educated decisions and reduce risks associated with growing new crops, altering their management practices, or purchasing new equipment.

### **Value-Added Products**

If the user recognizes a greater value, an increase in effort can greatly increase income from a product. By identifying kinds, types, and varieties of crops, production systems, and marketing opportunities that add value, faculty and specialists support the economic health of the horticulture industry. For example, investigating new leafy green crops that may have high nutritional content, are well-adapted to local or marginal production systems in developing countries, and have potential for development into processed products, will increase opportunities for producers and consumers. Current work on evaluating specialty crop germplasm for use in organic systems or enhanced nutritional content will assist in the production of value added crops.