AGRICULTURAL COMPETITIVENESS + RESILIENCE

Committee members: John Antle, Serkan Ates, Sheri Cole, Ryan Contreras, Christina Hagerty, Chad Higgins, Clive Kaiser, Richard Roseberg, Ramesh Sagili, & Brett Tyler. **Facilitator:** Joyce Loper

SITUATION SUMMARY

Over the next 80 years, world population is expected to increase to 10.9 billion. By 2050, the US population is expected to increase from 328 million to 430 million. Numerous circumstances will influence our ability to feed and support this growing population, including the impacts of global climate change. To meet this challenge, agriculture in Oregon, the U.S., and globally must become more sustainable. Sustainability means delivering adequate food, fiber and feed while also preserving the environment and improving human well-being across economic, environmental and social dimensions. Sustainable agricultural production systems support the livelihoods of farm businesses, families and workers, maintain and improve ecosystem services, and are competitive in regional, national and global markets. Sustainable agricultural systems also must be resilient to environmental and economic challenges, while embracing emerging technologies and economic opportunities.

Oregon agriculture is characterized by its diversity. With an emphasis on specialty crops, more than 220 commodities are represented, including nursery and greenhouse crops, hay, cattle and calves, milk, grass seed, wheat, and a variety of fruits, nuts and vegetables. The state's rich and varied geographic regions, growing demand for specialty crops by domestic and global consumers, and proximity to Western U.S. and Asian markets are key enablers to the success of Oregon agriculture. Contributing to the diversity of Oregon's agriculture are the forms of ownership and scale. About 97% of Oregon's farms and ranches are family owned and operated, according to the USDA National Agricultural Statistics Service. Oregon has more than 1200 "century" farms and ranches, which have been operated by the same family for at least 100 years. With increased urbanization, Oregon also has an increasing need for food production systems in urban settings (such as green roofs, vertical farms, aquaponics) as well as at the urban-rural interface. As the College of Agricultural Sciences (CAS) positions its research, teaching and outreach programs for the future, it must consider the tremendous diversity of Oregon agriculture.

A. Key challenges

Challenges to agricultural competitiveness and resilience are many, but key among them are:

- Need for agricultural workers and, increasingly, for a workforce skilled in the use of data-driven and technology-enabled agricultural systems.
- Need to provide safe, fair and just working conditions for all agricultural workers.
- Diminishing quantity and quality of water.
- Diminishing arable land due to environmental, financial, and societal pressures such as urbanization.
- Abiotic stresses, including those driven by climate change, such as temperature and precipitation variability and extremes, as well as soil degradation, salinity and smoke.
- Biotic stresses such as diseases, pests, and weeds.
- Increased regulation of water, crop production, livestock management, and food safety.
- Consumer expectations about how their food is produced.
- Market issues including price uncertainty, international competition and trade policy. Because of the importance of global markets, geopolitical factors such as trade policies influencing prices (such as tariffs), export promotion coordination, and transport issues (such as export capacity of ports) are key.
- Limited influence on national policy due to diversity and scale of Oregon's agriculture.

B. Scope

Our goal is to strengthen the resilience and competitiveness of Oregon agriculture while attending to our responsibilities to national and global agriculture. We do this primarily through basic and applied research, extension and education that build the knowledge base and skilled people needed to address the key challenges to agriculture in Oregon, the nation and globally.

C. Our values influence our approach

Our approach to strengthening agriculture is informed by these key values: 1) equitable access to nutritious, high quality, affordable and safe food; 2) respect for all dimensions of sustainability - economic, environmental and social; 3) collaboration with colleagues and stakeholders, locally and internationally; 4) equitable access to economic opportunities in agriculture; 5) building trust in science and data-driven decision making.

D. How we work – a collaborative, multidisciplinary approach

Oregon agriculture encompasses numerous interlocking systems that are linked to the global economy. These include diverse crop and livestock production systems, supply, processing, transportation and marketing systems, and natural and managed terrestrial and aquatic ecosystems. Thus, we must apply systems thinking and collaboration across diverse disciplines to achieve our goals. Active engagement with our external stakeholders, including producers and consumers, is important to ensure our work remains targeted and relevant. Aligned with the goal of optimizing the resilience of agriculture in a changing world, CAS faculty must anticipate changes influencing agriculture, and continually reevaluate the priorities of research, outreach, and education programs to optimize impact. In keeping with our land grant mission, CAS must give precedence to the next generation of Oregonians and future members of the agricultural community, providing equitable access to education, training, and economic opportunities that will allow them to become skilled contributors to society and the agricultural enterprise.

STRATEGIC OPPORTUNITIES

Sustainable agriculture will require the integration of fundamental knowledge and robust tools into agricultural management systems by a skilled workforce. Within this theme, the committee recognizes the need to develop fundamental knowledge, create new innovative approaches and tools, and build capacity through educational programs. New knowledge, tools and capacity then need to be incorporated into sustainable management practices to ensure the profitability, safety, and environmental stewardship of agriculture in the years to come.

These include:

Development of fundamental knowledge, tools, and capacity

- Plant breeding and genomics
- Integrative AgroTechnology
- Data Management and Building Capacity for Technology-driven Solutions

Sustainable Agricultural Management and Environmental Stewardship

- Sustainable Agricultural Management Systems
- Environmental Stewardship

DEVELOPMENT OF FUNDAMENTAL KNOWLEDGE, TOOLS, AND CAPACITY

Agricultural systems are exceedingly complex, comprising the plants and animals being produced, the physical and chemical environment, the biome (microbes, fungi, insects, and other organisms), management by humans, and the interactions of all of these variables. Agricultural science therefore spans many scientific disciplines, is highly collaborative, embraces both reductionist and integrative thinking, and encompasses discovery-driven, hypothesis-driven, synthesis-driven, and technology-driven investigation. Basic research across scales ranging from molecular to global levels will be essential to provide fundamental information needed to position agriculture for the future. CAS has world-renowned fundamental research programs in plant, animal, insect and microbial biology, soil health, environmental chemistry, and ecology, to name a few. The integration of data across temporal and spatial scales builds our ability to predict future scenarios across landscapes, including inter-organismal interactions (e.g., food web networks; interspecies competition, microbial associations, both beneficial and harmful to animals and plants; microbiomes, soil health), resource availability, adaptation and population shifts, and the success of invasive species. In an era of climate change, it will be increasingly important to understand agricultural ecosystems at many levels so we can better predict and guard against the most detrimental consequences of a changing climate on agriculture. This understanding will require the efforts of international scientists in a global effort to understand the complex interactions influencing agriculture in a changing climate. CAS faculty are well positioned to engage fully in this global effort, as many are internationally recognized leaders in their fields with extensive networks of collaborators worldwide. The committee fully supports CAS' initiative to strengthen further the international research, outreach and education programs of the College.

Innovation will be essential in positioning agriculture for the future, and is a key attribute of College research. Below, we highlight three opportunity areas where innovations can provide new knowledge, technology and tools that can then be integrated into agricultural systems. We also provide examples of how targeted investments into these opportunity areas are likely to result in innovations that will have high impact on agriculture in Oregon and beyond. These opportunity areas have distinct features but also overlap with one another, highlighting areas of synergy and integration within the larger theme.

1. Plant breeding and genomics

Genetic improvement of crops is crucial to agricultural sustainability and CAS has a long history of plant breeding that provides the principal varieties of many crops grown in Oregon and throughout the Pacific Northwest. Varieties released from CAS' breeding programs have improved quality or yield; in some cases, the varieties have saved industries through their resistance to catastrophic diseases. Crops bred at OSU are highly diverse, grown for fresh and processed markets, consumed locally or regionally, or exported nationally and worldwide. CAS plant breeding programs are composed of interdisciplinary teams, with plant breeders working closely with researchers in genomics, bioinformatics, pathology, physiology, food science, marketing, statistics, and other disciplines to develop new varieties. These programs are marked by their seamless relationships with growers, who are involved from the onset to identify breeding targets. Field agronomists or horticulturists as well as extension faculty are also essential members of the team, testing new varieties under the full spectrum of environments where the crop is grown and integrating new varieties into cropping systems that can be adopted by the industry. In the future, the committee envisions that the multidisciplinary teams breeding for sustainability, competitiveness and resilience will employ a systems-based approach that incorporates foresight analysis and multi-disciplinary computational methods and data to anticipate the economic, environmental and social consequences of new varieties under future bio-physical, economic and policy environments.

The application of gene-editing technologies (such as CRISPR-Cas) to plants can accelerate the development of new plant varieties by incorporating genomic information and precision breeding methods into conventional breeding and selection programs. Identification of agriculturally-desirable traits can be facilitated by high-throughput phenotyping, which links plant characteristics to genomic resources. CAS is well positioned to take advantage of the new opportunities posed by these technologies due to its network of highly-productive plant breeding programs and their strong relationships with agricultural producers, the exceptional capacity of the Center for Genome Research and Biocomputing in genomics and data sciences, as well as strong expertise in data and statistical sciences in CAS and other colleges at OSU. The committee advocates for an increased investment of CAS in this area, which has the potential to meet many of the challenges currently faced by agriculture in Oregon and beyond. Below are specific examples of current, future and ongoing needs and challenges to be addressed primarily by classical plant breeding, increasingly complemented by genetics and genomics technologies. This list is not complete but illustrates the goal of our programs to use fundamental and applied research to solve growers' problems and make them more competitive, resilient, and sustainable.

- Compatibility with new or alternative production systems including organic, mechanical harvesting, and high-density plantings

- Resistance to biotic stresses. OSU breeding programs focus on reducing incidence and severity of biotic stress on Oregon crops through breeding.

- Abiotic stresses. Examples include drought and urban tolerant landscape plants and agronomic crops adapted to ever-changing climate
- Consumer preferences such as flavor of berries, aroma of hops, and improved aesthetics (foliage quality, flowering) of landscape plants.

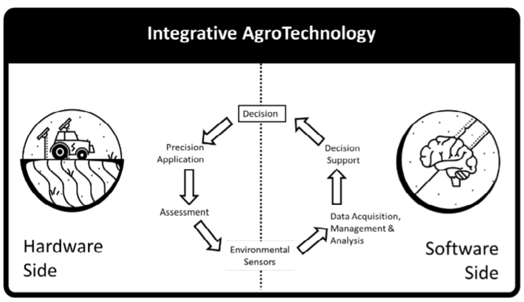
2. Integrative AgroTechnology

Technology is a cornerstone of sustainable agriculture because it allows producers to customize agricultural production practices in ways that maximize profitability, minimize environmental impacts, and provide safe and accessible conditions for agricultural workers. To optimize its value, technology must be integrated into an agricultural management system that includes environmental sensors; systems for data acquisition, management and analysis; decision support systems; precision application methods; and assessment. The committee envisions that technology utilized as part of an integrated system (Integrative AgroTechnology) will be an essential component of agricultural production in the future. Precision agricultural technology was first developed for large-acreage commodity crops, but is now being integrated into diverse cropping systems, including some of Oregon's 220+ commodities. The committee urges CAS to provide critical support to the future of Oregon agriculture, first by focusing on needs identified by Oregon growers as well as future challenges (see background), then conducting research needed to integrate AgroTechnology into diverse agricultural systems, educating the future agricultural workforce, and exchanging information and knowledge with agricultural communities throughout the process.

Examples of CAS programs in this area include:

- A "smart sprayer" that can sense the presence of various insect pests and pathogens and deliver the proper amount of pesticide with no overspray or spraying of non-infected plants. Originally developed for greenhouses and nurseries, the smart sprayers now are used more broadly on a range of specialty crops.
- Highly regarded and widely used weather and climate driven models that are available on online to support growers in making decisions about IPM, crop development, climate suitability and other issues.
- Use of methane sensors to test the influence of feed formulations on cattle methane emissions.
- AgroVoltaics (the placement of photovoltaic electric production systems on agricultural land in a manner compatible with agricultural production) has tremendous promise to help meet urban and rural energy demands of the future.

CAS is well positioned to become a global leader in integrative AgroTechnology to improve profitability, increase resource use efficiency, mitigate climate change, and bolster rural communities. Currently, CAS faculty are leaders in sensor development and decision support systems. Many faculty within the college have knowledge of agricultural production industries, an understanding of the challenges those industries face, and the necessary collaborations established to integrate AgroTechnology into Oregon agriculture. Along with faculty expertise within CAS, the College of Engineering's highly ranked robotic program provides exceptional expertise. A new CoE faculty member with expertise in agricultural robotics is already collaborating with CAS to develop robotic pruning and harvesting methods for tree fruits. CAS' statewide presence, through CAS's 11 branch experiment stations, and the strong linkage of research and extension faculty across the state will be invaluable in engaging stakeholders, as needed to maximize the impact of integrative AgroTechnology. The committee recommends that CAS take advantage of this opportunity through investments that lead to a critical mass of faculty in this area, upgraded and expanded facilities that foster innovation, and educational programs for learners at all levels. Due to the rapid development of new technology, future workers will need to be nimble, which will require strong conceptual understanding of agricultural systems, capacity for critical thinking, and problem-solving skills. OSU has an important role to play in this workforce development, building upon existing partnerships with community colleges to educate students who can operate next generation technologies and integrate them effectively into agricultural systems.



3. Data Management and Building Capacity for Technology-driven Solutions

Rapidly advancing technologies are dramatically expanding the types and volumes of data available to address the challenges faced by agriculture. Some of these data include: genome-scale data to accelerate plant breeding and to characterize and monitor pest and pathogen populations; high resolution remote sensing data from satellites and drones to monitor crop health and invasive species; real-time data from field sensors (soil moisture, heat, humidity, wind); weather and climate data and predictions at high resolution; high resolution maps of soil and geography; and real-time information on production costs and market prices. Advanced analytics including statistical and mathematical modeling, machine learning and artificial intelligence are also rapidly growing in their capabilities.

Solutions to agricultural problems that could be provided by big data and advanced analytics include:

- Water management from the landscape to the field, including modeling and forecasting of water availability and precise control of irrigation over time and space, in compliance wtih water regulations
- Planting decisions for perennial crops based on high-resolution geographic data (including land and water availability, soil depth and quality) and climate modeling
- High resolution forecasting in time and space for management of frost, freeze and heat stress; pest and disease risk prediction; pollinator health
- GPS-guided management of inputs (water, fertilizers, pesticides, herbicides), and predictions of yield and profitability over many seasons
- Inventory management, yield prediction, market analysis
- Blockchain tracking of crops from field to table to meet regulatory requirements and consumer demand for provenance information

The college has historical and continuing strengths in the applications of molecular genetics, genomics and bioinformatics to better understand crops, livestock (including fish), and the pests and pathogens that challenge them, and in turning that understanding into real-world improvements through breeding and management. Through its strong culture of collaboration, the college has benefited from complementary strengths in the life, earth and data sciences in the Colleges of Science, Engineering, Veterinary Medicine, Forestry, and Earth, Ocean, and Atmospheric Sciences. It has also benefited greatly through support from the Center for Genome Research and Biocomputing. Strengthening the data sciences will require new infrastructure and educational programs that train students to work with large data sets to develop meaningful information needed to advance agriculture.

To address the specific needs and challenges of Oregon agriculture, big data and advanced analytics must be customized to the needs of specific crops and livestock in specific locations. Furthermore, they must be integrated into decision-support systems that enable farmers and ranchers to make actionable decisions in conjunction with their own years of on-farm experience and expertise. Oregon producers need greater awareness and familiarity with the capabilities of big data and advanced analytics in order to be effective in identifying which capabilities may benefit them, how to be effective stewards of their data, and how to communicate with researchers and vendors who may be able to help them. They also need a skilled workforce with the training to implement data-driven solutions.

SUSTAINABLE AGRICULTURAL MANAGEMENT AND ENVIRONMENTAL STEWARDSHIP

Looking to the future, the economic, environmental, and social sustainability of agriculture will require the integration of knowledge, tools, and innovations, such as those described above, into production systems. Due to the complexity of agricultural systems, our capacity to meet the challenges facing the agriculture requires interdisciplinary teams to design and carry out the research. Economics must be a primary consideration while setting research priorities aiming to improve the sustainability, competitiveness, and resilience of agriculture. The impact of research is optimized when stakeholders and the scientific community come together early to assess a problem and, using foresight analysis, define trajectories and target efforts to the highest priority areas. The committee advocates for this approach, exemplified through the description of high opportunity areas where investments can address some of the primary challenges faced by agriculture today. These include issues associated with labor, including the use of technology to mechanize some tasks while fostering a trained agricultural workforce. Research coupled with outreach and educational programs is society's best option for optimizing the efficiency of agricultural land use and inputs, such as water, nutrients, chemicals (e.g., water, nutrients, chemicals), which are significant factors influencing profits. Over the last half century, Oregon agriculture has significantly increased the efficiency of land use and inputs, due to the value of these research and outreach programs. The committee advocates for a forward-looking approach with broad involvement from stakeholders throughout the process, to guide the College in making investments to enhance agricultural resilience and competitiveness.

Below, we highlight two opportunity areas aligned with this approach: the development of sustainable agricultural management systems and environmental stewardship, including the enhancement of ecosystem services provided by agriculture. As stated above, these opportunity areas have distinct emphases but also overlap with one another, highlighting areas of synergy and integration within the larger focus on agricultural management and stewardship.

1. Sustainable Agricultural Management Systems

CAS has a highly successful record of research developing sustainable production practices for Oregon agriculture, and there will be an increasing need for this research to meet future challenges, such as those described in the Background section of this document. CAS' success in developing sustainable agricultural practices has been achieved, in large part, by interdisciplinary teams. The College has world-class faculty representing diverse scientific disciplines who have a culture of collaboration and commitment to stakeholder needs. Research objectives are based from the onset on assessments of stakeholder needs. A strong OSU Extension Service provides a bridging role, transferring the knowledge and information to producers. Because Oregon growers are knowledgeable, ready adopters of new technologies and approaches, and often willing to test CAS research in commercial settings, they play a key role in taking discoveries to application.

Below are a few examples of CAS' many successes in developing sustainable agriculture practices.

- The multidisciplinary OSU Wheat Team has developed new varieties with traits needed by the wheat industry, as well as practices that incorporate these new varieties into sustainable production systems.
- OSU's internationally recognized Plant Clinic serves agriculture directly by providing plant disease diagnosis and monitoring, and also functions as a nucleus for multidisciplinary collaboration of specialists in genomics, plant pathology, population genetics, natural product chemistry and economics to develop new diagnostics, knowledge of how diseases spread, and methods for disease management.
- A coordinated, multi-institutional program involving breeding and horticulture has resulted in blueberry and caneberry production systems, now used throughout the Pacific Northwest, that minimize inputs and optimize yield and profitability.
- A CAS research team identified key steps in the nursery production pipeline where infection by plant pathogens is most likely to occur, and targeted those steps for disease management, greatly reducing pesticide use.
- The cattle and rangeland wildlife management program of Eastern Oregon Agricultural Research Center integrates many disciplines (animal and rangeland science, wildlife biology, watershed and forest management). The program provides environmentally compatible livestock systems, forage crops, and alternative livestock systems in the sagebrush-steppe of the Great Basin and inland coniferous forests of the Pacific Northwest.
- OSU's pasture-based livestock research is employing a systems approach to improve animal production and health while reducing methane emissions and nitrogen leaching problems.

The committee recommends greater emphasis on integrated, multidisciplinary approaches to provide holistic solutions for complex problems, such as improving soil health, developing integrated crop-livestock farming systems, and strategies to manage economic and policy risk. Our goal is to work closely with producers and stakeholders to identify upcoming challenges as well as opportunities, such as pathogen race shifts, pesticide resistance, and changes in domestic regulatory and international trade policies. Proactive action and rigorous research are needed such that opportunities are not missed, and challenges do not result in loss of profitability.

2. Environmental Stewardship

The College has an opportunity to more effectively measure, document and communicate the role of agriculture in enhancing ecosystem services, including the intrinsic economic and aesthetic value of those services, in balance with information about agriculture's negative environmental impacts. Agriculture often involves intense management of soil, water, plants, animals, energy, capital, chemical and biological inputs, and information. In practice, it alters the environment, and can produce negative environmental effects such as depleted soil health, soil erosion, surface and groundwater pollution/depletion, loss of beneficial insect populations, introduction of invasive species, all while using high energy inputs. Public perceptions of these negative effects can constrain, through direct action or public policies, farmer's operational choices and the availability of land for agricultural production. However, the public is not always aware of the environmental and societal benefits provided by sustainable agricultural systems, beyond the production of food or other agricultural products.

Examples of how sustainable agricultural practices improve resource management or provide valuable ecosystem services include:

- Management of water resources to improve water quality and seasonal quantity for environmental uses (in addition to agricultural uses).
- Quantify soil carbon sequestration of different agricultural management systems, and develop methods to enhance carbon capture and enhance soil health. These aims are of increasing importance to resilience and competitiveness during this time of climate change.
- Providing a diverse and resilient landscape mix of species (plant and animals) and land uses. Examples include practices such as cover cropping and green manures in agricultural fields and active management of field borders and non-crop areas to serve as refuges for beneficial insects and wildlife.
- Providing solutions for societal problems: For example, AgroVoltaics (the placement of photovoltaic electric production systems on agricultural land in a manner compatible with agricultural production) has tremendous promise to help meet urban and rural energy demands of the future.

By strengthening research and extension programs focused on sustainable resource management, CAS can both promote sustainable agricultural production and mitigate landscape-scale environmental impacts through agricultural innovations and supportive public policies that recognize the value of implementing such innovations.

CAS's strong research and outreach programs in water resource management, soil science, integrated pest management, cropping systems, and small farms will provide a solid foundation for this focus area. Faculty expertise in the design and evaluation of agricultural and environmental policy at state, regional and global scales will also be essential to this work. In the future, the committee envisions that multidisciplinary teams will employ a systems-based approach that incorporates foresight analysis to develop sustainable production practices that provide ecosystem services. Once developed, the economic, environmental and social consequences of new sustainable production practices can be communicated in a balanced way to stakeholders and the public.

CAPACITY AND STRENGTHS

We are uniquely equipped to meet these needs with proven capacity and strengths:

A. CAS has world-renowned research programs that can serve as foci for investment.

- Long-term programs that have supported agricultural productivity for generations in Oregon and beyond. Examples include a coordinated network of research and outreach programs providing invaluable resources for integrated pest management for numerous industries and the public; and a research-outreach-educational program in water management that continues to address the state's water quality and availability issues.
- CAS' centers enhance capacity and provide synergy and support for research and outreach. These include the Plant Clinic, Global Hemp Innovation Center, the Center for Small Farms and Community Food systems, the Oregon IPM Center, and the Oregon Wine Research Institute.

- Record of Innovation and responsiveness: For example, CAS faculty quickly developed methods and provided testing of wine grapes for smoke taint following the wildfires of 2020. Within OSU's research office, OSU Advantage provides valuable resources to support innovation that are highly valued by CAS faculty.

B. CAS has a strong culture of collaboration, which will be key to the college's future success in solving complex agricultural production issues in a changing world and climate.

- Many of CAS' internationally known basic research programs are closely linked to translational programs that provide science-based solutions to a variety of agricultural production problems. These established collaborations can serve as models and nuclei for building the teams needed to address the complex issues identified in the focus areas of this theme.

- CAS programs have always benefited from complementary strengths in life, earth and data sciences available throughout OSU. Likewise, expertise throughout OSU will be key to the advancement of the focus areas within this theme. Notable examples include the top ranked robotics and artificial intelligence programs (College of Engineering), highly ranking data sciences programs (CoE; College of Science; Center for Genome Research and Biocomputing), strong expertise in global positioning systems (College of Earth, Ocean, and Atmospheric Sciences), animal health (College of Veterinary Sciences), and climate science (many colleges).

C. Sustainability and stewardship, which are fundamental to Agricultural Competitiveness and Resilience, are integral to the College culture and programs. The CAS Sustainability double degree is a highly successful undergraduate program, which attracts students committed to sustainability, provides concepts and knowledge to underpin that commitment and, through its students, ultimately transforms the state and society.

D. CAS has strong and long-lasting relationships and connections across the state

- CAS's 11 branch experiment stations, with facilities in 14 locations representing the state's diverse agricultural production regions, foster strong relationships between CAS and agricultural producers statewide. The branch experiment stations provide exceptional opportunities to faculty to learn from the immense knowledge base provided by stakeholders, identify top problems constraining agricultural production throughout the state, and establish research trials in a variety of locations representative of the conditions of commercial production.

- CAS's network of excellent extension faculty, located on campus and statewide, is a two-way conduit, bringing awareness of key issues faced by agricultural and urban communities to research faculty and transferring science-based solutions to industries and farmers for use in practice. This network is strengthened by the integration of extension faculty in departments, which provide assigned academic homes, and positive connections of extension faculty with communities and county governments throughout the state.

- CAS benefits from strong ties with state and federal agencies, industry, and NGOs. Courtesy faculty, many employed by federal agencies located on the Corvallis campus or at branch experiment stations, contribute tremendously to College programs. Agricultural commodity groups are essential partners in setting research and outreach priorities, funding these programs, and providing access for research in agricultural settings.

- CAS faculty are trusted to provide an informed and impartial voice on a range of key issues in Oregon, providing testimonies to the legislature and assisting in setting public policies.

- CAS maintains strong relationships with alumni, who are among the College's most generous supporters and serve as ambassadors for CAS throughout the state and beyond.

E. Ecampus is nationally recognized for its quality, and provides an effective mechanism to reach students and stakeholders nationally and globally.

F. CAS Economists have exceptional capacity to identify key issues constraining profitability of agriculture and assessing governmental policies to address them. College faculty have extensive experience working with state and federal decision makers to design agricultural and environmental policies.

GOALS

A. Provide science-based solutions to the complex problems affecting agricultural production in the future. Advancing agricultural production in Oregon and beyond will require systems-oriented approaches involving multidisciplinary teams of faculty from CAS, throughout OSU, and in academic, governmental, and industrial settings around the world.

B. Further strengthen collaborative relationships among faculty and between faculty and stakeholders across the state, as these are critical to successful programs advancing agricultural sustainability, competitiveness, and resilience.

- Strong collaborations between research and extension faculty have been essential to CAS' many successes in advancing agricultural production. Break down the administrative barriers between AES and extension that threaten collaborations between and productivity of research and extension faculty.
- The involvement of stakeholders in the prioritization of problems for study has been a hallmark of successful research and outreach programs throughout CAS' history, and should continue as a central component of CAS' culture.
- CAS programs must address the needs of all stakeholders, balancing the needs of large and small, established and emergent growers of Oregon as priority research topics are selected. Research must reduce barriers to success for all agricultural producers and workers.

C. Provide valuable educational opportunities for all learners.

- Provide a foundation for the next generation. CAS' students, domestic and international, will disseminate a message of sustainability and stewardship in societies around the world; as alumni, they will represent CAS and become our future stakeholders. Some will become scientists solving the agricultural and societal problems of the future.
- Build capacity in rural communities. The committee recognized the current project "Data Science for the Public Good" as a model for outreach to rural communities that are currently underserved.
- Educate the public, building trust in science and experience in data-driven decision making. International students and faculty provide a connection to people around the world.

ADDITIONAL RESOURCES + STRATEGIES

A. Invest in infrastructure.

- Improved facilities are needed to advance research, extension, and teaching programs. In many cases, inadequate facilities limit advancement of CAS' programs within this theme area.
- Core facilities lack key equipment and staff needed to advance research in this theme area.

B. Fill critical gaps in faculty expertise (See Appendix 1).

- A gap analysis is needed to identify expertise required to advance college programs in each opportunity area. This process should complement the existing process for priority staffing of the College.

C. Cultivate and support the multi-investigator, interdisciplinary, global teams needed to address complex scientific and societal problems.

- Foster development of mid-career faculty to lead teams and attract federal funding.
- Provide service to CAS faculty to enhance their success in grantsmanship. Ideas include engaging a small professional grant writing team and sharing best practices used in successful grants in the past.
- Identify and employ strategies that build productive, long-lasting research and outreach teams, including cluster hires and practices that reward contributions to team achievements.
- Recognizing the increasingly global nature of scientific inquiry, develop an international research agenda for CAS, including a system to recognize and reward faculty for international scholarship.
- Increase graduate student support (tuition, scholarships, fellowships, travel funds etc.)
- Enhance the support of innovation in the College by strengthening partnerships with OSU Advantage.

D. Extend the expertise and capacity of Ecampus to public outreach. Ecampus is a tremendous resource that has the potential to transform delivery of CAS research to stakeholders and the public, but barriers currently exist that prevent the realization of this vision. The committee encourages CAS to engage in university discussions exploring ways to expand Ecampus to enhance outreach.

Appendix 1. Faculty expertise needed to advance the programs in five opportunity areas within the Theme: Sustainability, Competitiveness and Resilience of Agricultural Production*

Faculty expertise needed	**Plant Breeding and Genomics**	**Integrative AgroTechnology**	**Data management and building capacity for technology-driven solutions**	**Sustainable Agricultural Practices**	**Sustainable resource management**
Extension specialist in economics/policy	x	x	x	x	x
Economist with expertise in production economics	x	x	x	x	x
Bioinformatician	x		x		
Quantitative geneticist	x		x		
Systems biologist (for understanding and applying crop/animal/soil/microbe interactions)	x		x	x	
Artificial intelligence expert for decision support systems		x	x		
Artificial intelligence expert for agricultural robotics, smart dairies		x	x	x	
Crop systems modeling for yield prediction and input management	x	x	x	x	x
Extension specialist in agricultural systems and data science		x	x		
Extension specialist in agricultural technology		x	x	x	x
Agricultural technology instructor		x			
Animal physiology (systems approach)		x	x	x	x
Whole plant physiology (systems approach)	x	x	x	x	x

*This list is provided to capture the discussions between members of the committee developing the white paper on this theme. The committee recognizes that only a subset of College disciplines and perspectives were represented in compiling this but offer this list as a starting point for future discussions on investments in the themes identified by CAS leaders and faculty. The expertise could be provided by new hires or by existing faculty who currently work in these areas or could expand their existing programs in these directions.