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ENHANCING SUSTAINABILITY ACROSS DIVERSE AGRICULTURAL SYSTEMS

NON-TECHNICAL SUMMARY: In the past two centuries, agriculture has put increasingly severe strain on global land resources as a result of soil degradation, water quality impairment, aquifer depletion, loss of biodiversity, air pollution, and toxin build-up. These issues are of state, national, and global importance for "sustaining" agricultural production into the future. Higher production per unit of land has generally been accompanied by higher levels of non-renewable resource use for inputs such as synthetic fertilizer, fuel for machinery, and pesticides, which increase the environmental footprint of agriculture, contribute to greenhouse gases, and leave food production more exposed to the effects of resource shortages. All of these trends and challenges have led to the emergence of the concept of "sustainable agriculture" as an important organizing principle for the future. There is need for continual development of new knowledge and practices, adoption by farmers, and evaluation of the impacts in order to "sustain" agriculture in light of ever-changing conditions (e.g., new pests, climate change, new market demands, etc.).Washington State is an important producer of a number of food products in the U.S. and worldwide. Washington is among the top three producing states in the country for apples, pears, sweet cherries, Concord grapes, blueberries, potatoes, onions, several processed vegetables, and lentils, along with extensive areas of wheat and barley production. This diversity calls for a broad portfolio of work in the agrifood sector to meet the multitude of needs. The team associated with this Hatch project represents a diversity of disciplinary skills and experience across a range of crops and geographic areas in the state and Pacific Northwest region. This interdisciplinary team will provide core leadership in the state on sustainable agriculture, while many others make additional contributions within their specific discipline or crop.Research on enhancing sustainability across diverse agricultural systems is essential to meeting the current and future needs of agriculture in Washington State, the nation, and the world. Farmers and consumers are at the forefront of demanding this systems-level type of research, and the research efforts will result in more options for farmers. Experience gained from this kind of research will contribute to improvements in the production practices of organic (and other alternative) growers and in the ability of conventional growers to adopt more sustainable management approaches. This research will expand economic opportunities for farmers and reduce reliance on agrochemicals. Farmers will gain economically,

and society will reap rewards because of attention to environmental and social sustainability. In addition, experiences gained from this Hatch project will make valuable contributions to agricultural and food systems education at Washington State University.The researchers associated with this collaborative Hatch project have extensive experience in the following areas: development and evaluation of farming practices, alternative agricultural systems, coupled human-environmental systems, ecosystem services, IPM, biodiversity conservation, pollinator health and conservation, diffusion and adoption of agricultural innovations, environmental and social impact assessment, sustainability metrics, research methods (natural, social, and economic sciences), and effective education and outreach strategies. However, the researchers share a common goal: to enhance the production, environmental, economic, and social sustainability of different types of agricultural production systems (including conventional and organic agriculture). This Hatch project will bring together multiple research programs under one umbrella in an exciting new way to focus efforts to solve agriculture's "wicked problems."

OBJECTIVES: The overall goal of this collaborative Hatch project is to enhance the production, environmental, economic, and social sustainability of different types of agricultural production systems, including conventional and organic agriculture. The specific objectives of the project are: (1) Develop scientific knowledge and production practices that enhance more sustainable farm management by both conventional and organic growers. (2) Work with the agricultural community to further the adoption and implementation of farming practices that maintain/enhance productivity and profitability, while contributing to broader environmental and social sustainability goals. (3) Monitor, measure, and compare how different types of agricultural systems contribute to production, environmental, economic, and social sustainability goals; and improve the effectivenessof tools and techniques used for these assessments.

APPROACH: Cropping system management (agronomy, horticulture, breeding, pollination)Replicated small plots on experiment station (Collins, du Toit, Murphy)Replicated large plots on farms (Collins, du Toit, Granatstein)Early, intermediate, and advanced generation breeding trails of multiple cereal and seed crops on farms and research stations across mega-environments (Murphy)Breeding and distribution of honey bee genetic stocks adapted for diverse climatic regions (Sheppard)Evaluating alternative equipment for specific management functions (Collins)Measurement of crop health via tissue sampling, growth, yield, chlorophyll concentrations, plant sap analysis (Carpenter-Boggs, du Toit, Granatstein, Murphy)Measurement of pollinator health via tissue analysis (lipid/protein), viral titers and disease occurance (Crowder, Sheppard)Evaluation of crop quality and nutrition using industry standard tests (Granatstein, Murphy)Crop protection (entomology, plant pathology, weed science)Replicated small plots on experiment station (Crowder, du Toit)Replicated large plots on farms (Crowder, du Toit, Granatstein, Sheppard, Snyder)Farms as replicates (Crowder, Snyder)Pathology: field sampling of soil, roots, whole plants or parts of plants; field trials of fungicides and biocontrol agents; greenhouse assays; DNA extraction and sequencing; pathogen isolations; microscopy; collating relevant pathogen epidemiology and management information. Necessary facilities are available at the WSU Mount Vernon NWREC. (Crowder, du Toit)Soil / water / environmentReplicated small plots on experiment station (Collins, Crowder, du Toit)Replicated large plots on farms (Collins, Granatstein, Reganold)Farms as replicates (Crowder, Reganold, Snyder)Field sampling of soil and roots; laboratory, greenhouse and field assessment of crop nutrient availability, microbial activities, and plant growth.(Carpenter-Boggs, Collins, du Toit, Reganold, Snyder)Quantification, isolation, identification, and activity testing of plant symbiotic microorganisms. (Carpenter-Boggs, du Toit)Analysis of soil physical, nutrient and chemical, and biological parameters. (Carpenter-Boggs, Collins, du Toit, Reganold, Snyder)Soil health/quality analysis using commercially available services (Collins, Granatstein, Snyder)Life Cycle Assessment, including the OFOOT tool and CROPSYST (Carpenter-Boggs)Socioeconomic research (economics, rural sociology)Surveys of

farmers, intermediaries, consumers, and other stakeholders (Dillman, Goldberger, McCracken, Ostrom)Focus groups with key stakeholders (Goldberger, McCracken, Ostrom)Evaluation and case studies of participatory sustainable farming research and education methods (Carpenter-Boggs, Collins, Goldberger, Ostrom)In-depth interviews with key stakeholders (Goldberger, McCracken, Ostrom)Econometric analysis of farm-level data on entry, exit, and growth of certified organic farms. For example, survival regression analysis will be used to analyze factors correlated with exit from organic including farm size, crop mix, gross revenue per acre, and urban proximity. (Brady, Granatstein, McCracken)

KEYWORDS: Sustainable Agriculture; Sustainability; Organic Agriculture; Agricultural Systems; Ecosystem Services; Integrated Pest Management; Biodiversity; Survey Research; Coupled Human-Environment Systems; Participatory Research Methods; Food Systems; Environmental Stewardship; Social Sustainability; Economic Sustainability; Washington State; Pacific Northwest; Crop Diversification; Transdisciplinarity; Pollinator Health; Diffusion of Innovations; Farming Systems Research; Agroecology; Agroecosystems; Cropping Systems Management; Corp Protection; Diversity; Soil Health; Marketing