

Agriculture, Food, and Natural Resources (AFNR) Frameworks 2021

Section 5 – Plant Systems (AS) Pathway Frameworks

Introduction

The Plant Systems (PS) pathway encompasses the study of plant life cycles, classifications, functions, structures, reproduction, media, and nutrients, as well as growth and cultural practices through the study of crops, turf grass, trees, shrubs, and ornamental plants. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of plant systems in AFNR settings.

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Recommended PS Courses and Pathway Sequence

Students concentrating on the PS pathway should complete a sequence of at least two courses within the following course offerings based their career goals and interests.

Introductory Courses	Intermediate Courses	Advanced Courses
01 Principles of Ag., Food, and Natural Resources	34 Soil Chemistry (Chemistry Credit)	13 Agricultural Education, Research, and Development
02 Advanced Principles of Ag., Food, and Natural Resources	35 Crop Production and Agronomy	44 Specialty and Emerging Plant Systems Topics
03 Principles of AFNR Biology (Science-Elective Credit)	36 Garden and Crop Operations (Simulated WBL: School Farm)	75 Food Science
04 Advanced Principles of AFNR Biology (Science-Elective Credit)	37 Pest Management, Entomology, and Plant Pathology	76 Advanced Food Science
30 Plant Science and Horticulture	38 Floriculture and Ornamental Horticulture	77 Food Chemistry (Science Credit)
31 Advanced Plant Science and Horticulture	39 Floral Design (Art Credit)	78 Advanced Food Chemistry (Science Credit)
32 Plant Biology (Science-Elective Credit)	40 Greenhouse and Nursery Operations (Simulated WBL: School Farm)	85 Animal and Plant Biotechnology
33 Advanced Plant Biology (Science-Elective Credit)	41 Turf, Landscape, and Parks Management	86 Advanced Animal and Plant Biotechnology
	42 Landscape Design (Art Credit)	87 Agricultural Biotechnology and Biology (Science-Elective Credit)
	43 Floral and Landscaping Operations (Simulated WBL: School Business)	88 Advanced Agricultural Biotechnology and Biology (Science-Elective Credit)
		93 Extended/ Summer AFNR Work-Based Learning (SAE) and Leadership (FFA)
		94 Agricultural Leadership Development
		95 Agricultural Career Seminar
		96 Advanced Agricultural Career Seminar
		97 AFNR Work Experience: Immersion SAE (Adv. Internship/Placement, Entrepreneurship, Research)

Recommended Work-Based Learning (WBL) and SAEs within PS

A Supervised Agricultural Experience (SAE) is a student-led, instructor-supervised, Work-Based Learning (WBL) experience that results in measurable outcomes within a predefined, agreed upon set of AFNR Technical Standards and Career Ready Practices aligned to a Career Plan of study. SAE teaches technical skills and knowledge within the psychomotor domain of learning. SAE includes both experiential learning (i.e., pre-WBL) and WBL (federally defined as sustained interactions with industry or community professionals in real workplace settings, to the extent practicable, or simulated environments, at an educational institution that foster in-depth, firsthand engagement with the tasks required in a given career field, that are aligned to curriculum and instruction; Sec. 3 [20 U.S.C. 2302] 55).

SAE/WBL is a required component of an AFNR program, first established in the Smith-Hughes Act (1917) and reinforced in each of the federal Perkins Career and Technical Education (CTE) Acts (1984 – I; 1990 – II; 1998 – III; 2006 – IV; 2018 – V, Public Law No. 115-224). Minnesota also requires WBL/SAE as a component of CTE Program Approval (Minn. R. 3505). Table 1 has example SAE opportunities within this pathway, as defined by the National Council for AFNR Education, Perkins V legislation, and the Minnesota Department of Education.

Table 1. Examples of WBL/SAE Curricula and Programs within PS

SAE Program Area	Examples, Non-Exhaustive
Experiential Learning (Foundational SAE; Pre-WBL)	• Career exploration • Job shadowing a local crop farmer • Assist with school/community garden project • Plant identification and management experience • Field trip to a local greenhouse
Internship (Placement SAE; Immersion WBL)	• Working for a crop services business • Working at a flower arrangement shop • Working for hay production business • Working for a seed company
Apprenticeship (Placement SAE; Immersion WBL)	• More than 450 hours in an internship, combined with coursework • Contact the Minnesota Department of Education (MDE) for support
Entrepreneurship (Entrepreneurship SAE; Immersion WBL)	• Farming grain crops • Owning a flower arrangement business • Crop services business • Fertilizer or chemical sales business
Research (Research SAE; Immersion WBL)	• Research flowering techniques by varying temperature • Vegetable production on varying light exposure • Plant pest control research
School-Based Enterprise (School-Based SAE; Simulated WBL)	• Greenhouse Management/Operations SBE WBL • Community Supported Ag/School Farm Operations SBE WBL • School or Crop Research Plot SBE WBL
FFA Work-Based Learning and SAE Proficiency Award Areas	• Agriscience Research - Plant Systems • Grain Production • Turf Grass Management

Recommended Social-Emotional Learning (SEL) and FFA Opportunities within PS

The National FFA Organization (FFA) is a student-led, instructor-supervised, Career and Technical Student Organization (CTSO) that results in measurable outcomes within a predefined, agreed upon set of AFNR Social-Emotional Standards and Career Ready Practices aligned to a Career Plan of study. FFA teaches social-emotional and leadership skills and knowledge within the affective domain of learning. FFA includes programs that provide essential employability skills such as critical thinking, consensus building, communication, teamwork, and leadership. FFA was founded in 1928 and is federally defined as intracurricular (i.e., within the curriculum; cf. extracurricular: external, co-curricular: alongside) and an integral part (i.e., necessary to form the whole) of School-Based AFNR Education (Public Law No. 116-7).

Leadership/FFA is a required component of an AFNR program, formalized in the FFA Federal Charter in 1950 (Public Law No. 116-7) and reinforced in federal Perkins CTE Acts (1984 – I; 1990 – II; 1998 – III; 2006 – IV; 2018 – V, Public Law No. 115-224). Minnesota also requires leadership/FFA as a component of CTE Program Approval (Minn. R. 3505). Table 2 has example FFA opportunities with this pathway, as defined by the National Council for AFNR Education, Perkins V legislation, Department of Education, and the Minnesota FFA Association.

Table 2. Examples of SEL/FFA Curricula and Programs within PS

FFA Program Area	Examples, Non-Exhaustive
Student Development Programs (Growing Leaders)	• Agriscience fair or SAE open house • Crop test plot • Career day/guest speakers
Community Development/Service (Building Communities)	• Community beautification projects-planting flowers/shrubs/etc. • Community education (e.g., wreath design, memorial planters) • Donate food from school garden to local food shelf • Agritourism (e.g., pumpkin patch, apple orchard)
Literacy, Advocacy, and Safety (Strengthening Agriculture)	• Crop plot research/harvest day • Agriculture in the Classroom • Activities with Master Gardeners
Conferences, Conventions, and Banquets	• InTENSE • Horizon conference • Horticulture industry events (e.g., Horticultural Society, Nursery and Landscape Association)
Career Development Events (CDE)	• Horse Evaluation • Agronomy • Floriculture • Forestry • Nursery Landscape • Soils
Leadership Development Events (LDE)	• Agricultural Issues Forum • Marketing Plan • Prepared Public Speaking • Extemporaneous Speaking

MN.PS.01: Plant Nutrition, Environmental Factors, and Reproduction

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.01.01

Determine the influence of environmental factors on plant growth.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.01.01.01.a. Identify and summarize the three measurements of light (i.e., color, intensity, and duration) that affect plant growth.	PS.01.01.01.b. Analyze and describe plant responses to light color, intensity, and duration.	PS.01.01.01.c. Analyze plant responses to varied light color, intensity and duration and recommend modifications to light for desired plant growth.
PS.01.01.02.a. Identify and summarize the effects of air and temperature on plant metabolism and growth.	PS.01.01.02.b. Determine the optimal air and temperature conditions for plant growth.	PS.01.01.02.c. Design, implement, and evaluate a plan to maintain optimal air and temperature conditions for plant growth.
PS.01.01.03.a. Identify and summarize the effects of water quality on plant growth, (e.g., pH, dissolved solids).	PS.01.01.03.b. Analyze and describe plant responses to water conditions.	PS.01.01.03.c. Analyze plant responses to water conditions and recommend modifications to water for desired plant growth.

Performance Indicator MN.PS.01.02

Prepare and manage growing media for use in plant systems.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.01.02.01.a. Identify the major components of growing media and describe how growing media support plant growth.	PS.01.02.01.b. Describe the physical and chemical characteristics of growing media and explain the influence they have on plant growth.	PS.01.02.01.c. Formulate and prepare growing media for specific plants or crops.
PS.01.02.02.a. Identify the categories of soil water.	PS.01.02.02.b. Discuss how soil drainage and water-holding capacity can be improved.	PS.01.02.02.c. Determine the hydraulic conductivity for soil and how the results influence irrigation practices.
PS.01.02.03.a. List and summarize the reasons for preparing growing media before planting.	PS.01.02.03.b. Prepare soil and growing media for planting with the addition of amendments.	PS.01.02.03.c. Analyze how mechanical planting equipment performs soil preparation and seed placement.

MN.PS.01: Plant Nutrition, Environmental Factors, and Reproduction, Continued

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.01.03

Develop and implement a fertilization plan for specific plants or crops.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.01.03.01.a. Summarize the impact of environmental factors on nutrient availability (e.g., moisture, temperature, pH).	PS.01.03.01.b. Assess and describe the impact environmental factors have on a crop.	PS.01.03.01.c. Devise a plan to meet plant nutrient needs based on environmental factors present.
PS.01.03.02.a. Discuss the influence of pH and cation exchange capacity on the availability of nutrients.	PS.01.03.02.b. Contrast pH and cation ex-change capacity between mineral soil and soilless growing media.	PS.01.03.02.c. Adjust the pH of growing media for specific plants or crops.
PS.01.03.03.a. Collect soil and plant tissue samples using generally accepted procedures and explain how incorrect sample collection will affect the results of a laboratory analysis.	PS.01.03.03.b. Interpret laboratory analyses of soil and tissue samples.	PS.01.03.03.c. Prescribe fertilizer applications based on the results of a laboratory analysis of soil and plant tissue samples.
PS.01.03.04.a. Identify fertilizer sources of essential plant nutrients; explain fertilizer formulations, including organic and inorganic; and describe different methods of fertilizer application.	PS.01.03.04.b. Calculate the amount of fertilizer to be applied based on nutrient recommendation and fertilizer analysis.	PS.01.03.04.c. Calibrate application equipment to meet plant nutrient needs.
PS.01.03.05.a. Research and summarize production methods focused on soil management (e.g., crop rotation, companion planting, cover crops, etc.).	PS.01.03.05.b. Assess and describe the short- and long-term effects production methods have on soil.	PS.01.03.05.c. Devise a plan for soil management for a selected production method.
PS.01.03.06.a. Summarize the impact of environmental factors on nutrient availability (e.g., moisture, temperature, pH, etc.).	PS.01.03.06.b. Assess and describe the impact environmental factors have on a crop.	PS.01.03.06.c. Devise a plan to meet plant nutrient needs based on environmental factors present.

MN.PS.02: Plant Anatomy and Physiology

Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

Performance Indicator MN.PS.02.01

Classify plants according to taxonomic systems.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.02.01.01.a. Identify and summarize systems used to classify plants based on specific characteristics.	PS.02.01.01.b. Compare and contrast the hierarchical classification of agricultural and ornamental plants.	PS.02.01.01.c. Classify agricultural and ornamental plants according to the hierarchical classification system.
PS.02.01.02.a. Describe the morphological characteristics used to identify agricultural and herbaceous plants (e.g., life cycles, growth habit, plant use, and as monocotyledons or di-cotyledons, woody, herbaceous).	PS.02.01.02.b. Identify and describe important plants to agricultural and ornamental plant systems by common names.	PS.02.01.02.c. Identify and describe important plants to agricultural and ornamental plant systems by scientific names.

MN.PS.02: Plant Anatomy and Physiology, Continued

Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

Performance Indicator MN.PS.02.02

Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.02.02.01.a. Identify structures in a typical plant cell and summarize the function of plant cell organelles.	PS.02.02.01.b. Compare and contrast mitosis and meiosis.	PS.02.02.01.c. Apply the knowledge of cell differentiation and the functions of the major types of cells to plant systems.
PS.02.02.02.a. Identify and summarize the components, the types, and the functions of plant roots.	PS.02.02.02.b. Analyze root tissues and explain the pathway of water and nutrients into and through root tissues.	PS.02.02.02.c. Correlate the active and passive transport of minerals into and through the root system to plant nutrition.
PS.02.02.03.a. Identify and summarize the components and the functions of plant stems.	PS.02.02.03.b. Analyze and describe the difference in arrangement of vascular tissue between monocot and dicot plant stems.	PS.02.02.03.c. Evaluate the function of the xylem, phloem and cambium tissues and the impact on plant systems.
PS.02.02.04.a. Research and summarize leaf morphology and the functions of leaves.	PS.02.02.04.b. Analyze how leaves capture light energy and summarize the exchange of gases.	PS.02.02.04.c. Devise a plan for plant management practices that takes into account leaf structure and functions.
PS.02.02.05.a. Identify and summarize the components of a flower, the functions of a flower and the functions of flower components.	PS.02.02.05.b. Apply knowledge of flower structure to differentiate between the types of flowers and flower inflorescence (e.g., complete, incomplete, perfect, imperfect).	PS.02.02.05.c. Evaluate flower structures and analyze the impact of plant structure on plant breeding, production, and use.
PS.02.02.06.a. Identify and summarize the functions and components of seeds and fruit.	PS.02.02.06.b. Analyze and categorize the major types of seeds and fruit.	PS.02.02.06.c. Evaluate the impact of different seed and fruit structures to plant culture and use.

MN.PS.02: Plant Anatomy and Physiology, Continued

Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

Performance Indicator MN.PS.02.03

Apply knowledge of plant physiology and energy conversion to plant systems.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.02.03.01.a. Summarize the importance of photosynthesis to plant life on earth and the process of photosynthesis, including the types (c3, c4, Cam), its stages (e.g., light-dependent, and light independent reactions), and its products and byproducts.	PS.02.03.01.b. Apply knowledge of photosynthesis to analyze how various environmental factors will affect the rate of photosynthesis.	PS.02.03.01.c. Evaluate the impact of photosynthesis and the factors that affect it (e.g., plant management, culture, and production problems).
PS.02.03.02.a. Summarize the stages of cellular respiration including their products and byproducts.	PS.02.03.02.b. Analyze the factors that affect cellular respiration processes and rate in a crop production setting.	PS.02.03.02.c. Evaluate the impact of plant respiration on plant growth, crop management, and post-harvest handling decisions.
PS.02.03.03.a. Summarize primary growth and the role of the apical meristem.	PS.02.03.03.b. Analyze plant growth and assess the process of secondary plant growth.	PS.02.03.03.c. Use the principals of primary and secondary plant growth to achieve desired characteristics of plant products.
PS.02.03.04.a. Identify and categorize the five groups of naturally occurring plant hormones and synthetic plant growth regulators.	PS.02.03.04.b. Analyze and identify the plant responses to plant growth regulators and different forms of tropism.	PS.02.03.04.c. Select and defend the use of specific plant growth regulators to produce desired responses from plants.
PS.02.03.05.a. Compare and contrast the effects of transpiration, translocation, and assimilation on plants.	PS.02.03.05.b. Identify and analyze the factors affecting transpiration, translocation, and assimilation rate and products.	PS.02.03.05.c. Devise plans for plant management that applies knowledge of transpiration, translocation, and assimilation on plant growth.
PS.02.03.06.a. Compare and contrast the different types of grafting and their purpose	PS.02.03.06.b. Describe the correct procedure for grafting plant parts.	PS.02.03.06.c. Demonstrate how to perform different types of grafts and use them as a part of a plant production plan.

MN.PS.03: Plant Health and Environmental Conservation within PS

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.03.01

Demonstrate plant propagation techniques in plant system activities.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.03.01.01.a. Identify examples of and summarize pollination, cross-pollination, and self-pollination of flowering plants.	PS.03.01.01.b. Examine and apply the process of plant pollination and fertilization.	PS.03.01.01.c. Select and defend the use of pollination methods and practices used to maximize crop pollination.
PS.03.01.02.a. Demonstrate sowing techniques for providing favorable conditions to meet the factors of seed germination.	PS.03.01.02.b. Prepare seed in order to overcome seed dormancy mechanisms and to maintain seed viability and vigor.	PS.03.01.02.c. Conduct tests associated with seed germination rates, viability, and vigor.
PS.03.01.03.a. Summarize optimal conditions for asexual propagation and demonstrate techniques used to propagate plants by cuttings, division, separation, layering, budding, and grafting.	PS.03.01.03.b. Manage the plant environment to support asexual reproduction.	PS.03.01.03.c. Evaluate asexual propagation practices based on productivity and efficiency.
PS.03.01.04.a. Define micropropagation and discuss advantages and disadvantages associated with the practice.	PS.03.01.04.b. Summarize the main stages of the micropropagation process.	PS.03.01.04.c. Demonstrate aseptic micropropagation techniques.
PS.03.01.05.a. Define Genetically Modified Organisms (GMO) and discuss advantages and disadvantages associated with the practice.	PS.03.01.05.b. Summarize the steps used to modify the genetic code for a plant and the applications of the various processes.	PS.03.01.05.c. Evaluate the applications of GMO technology in AFNR.

MN.PS.03: Plant Health and Environmental Conservation with PS, Continued

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.03.02

Develop and implement a management plan for plant production.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.03.02.01.a. Determine seeding rate need for specified plant population or desired quantity of finished plants.	PS.03.02.01.b. Apply pre-plant treatments required of seeds and plants and evaluate the results.	PS.03.02.01.c. Adjust and calibrate mechanized seeding and/or planting equipment for desired seed application rate.
PS.03.02.02.a. Observe and record environmental conditions during the germination, growth, and development of a crop.	PS.03.02.02.b. Monitor the progress of plantings and determine the need to adjust environmental conditions.	PS.03.02.02.c. Prepare and implement a plant production schedule based on predicted environmental conditions and desired market target (e.g., having plants ready to market on a specific day such as Mother's Day, organic production, low maintenance landscape plants).
PS.03.02.03.a. Summarize the stages of plant growth and the reasons for controlling plant growth.	PS.03.02.03.b. Demonstrate proper techniques to control and manage plant growth through mechanical, cultural, or chemical means.	PS.03.02.03.c. Prepare plant production schedules utilizing plant growth knowledge to get plants to their optimal growth stage at a given time.
PS.03.02.04.a. Identify and categorize structures and technologies used for controlled atmosphere production of plants.	PS.03.02.04.b. Compare and contrast the types of technologies used for controlled atmosphere production.	PS.03.02.04.c. Research, select, and utilize technology for use in controlled atmosphere production.
PS.03.02.05.a. Summarize the use of hydroponic and aquaponic systems for plant production.	PS.03.02.05.b. Compare and contrast the types of systems used in hydroponic and aquaponic plant production.	PS.03.02.05.c. Research, select, and create and manage a hydroponic or aquaponic plant system.
PS.03.02.06.a. Identify and categorize structures and technologies used for controlled atmosphere production of plants.	PS.03.02.06.b. Compare and contrast the types of technologies used for controlled atmosphere production.	PS.03.02.06.c. Research, select and defend technology for use in controlled atmosphere production.
PS.03.02.07.a. Summarize the use of hydroponic and aquaponic systems for plant production.	PS.03.02.07.b. Compare and contrast the types of systems used in hydroponic and aquaponic plant production.	PS.03.02.07.c. Research, select and defend the use of a hydroponic or aquaponic plant system.

MN.PS.03: Plant Health and Environmental Conservation with PS, Continued

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.03.03

Develop and implement a plan for integrated pest management for plant production.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.03.03.01.a. Identify and categorize plant pests, diseases, and disorders.	PS.03.03.01.b. Identify and analyze major local weeds, insect pests and infectious and noninfectious plant diseases.	PS.03.03.01.c. Devise solutions for plant pests, diseases, and disorders.
PS.03.03.02.a. Diagram the life cycle of major plant pests and diseases.	PS.03.03.02.b. Predict pest and disease problems based on environmental conditions and life cycles.	PS.03.03.02.c. Design and implement a crop scouting program.
PS.03.03.03.a. Identify and summarize pest control strategies associated with integrated pest management and the importance of determining economic threshold.	PS.03.03.03.b. Demonstrate pesticide formulations including organic and synthetic active ingredients and selection of pesticide to control specific pest.	PS.03.03.03.c. Employ pest management strategies to manage pest populations, assess the effectiveness of the plan, and adjust the plan as needed.
PS.03.03.04.a. Distinguish between risks and benefits associated with the materials and methods used in plant pest management.	PS.03.03.04.b. Evaluate environmental and consumer concerns regarding pest management strategies.	PS.03.03.04.c. Examine and apply procedures for the safe handling, use and storage of pesticides including personal protective equipment, and reentry interval.

MN.PS.03: Plant Health and Environmental Conservation with PS, Continued

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.03.04

Apply principles and practices of sustainable agriculture to plant production.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.03.04.01.a. Research and summarize production methods focused on soil management (e.g., crop rotation, companion planting, cover crops).	PS.03.04.01.b. Assess and describe the short and long-term effects production methods have on soil.	PS.03.04.01.c. Devise a plan for soil management for a selected production method.
PS.03.04.02.a. Compare, and contrast, the alignment of different production systems (conventional and organic) with USDA sustainable practices criteria.	PS.03.04.02.b. Analyze the alignment of modern technologies used in production systems (e.g., precision agriculture, GE crops) with USDA sustainable practices criteria.	PS.03.04.02.c. Research, prepare, and defend plans for a plant systems enterprise that aligns with USDA sustainable practices criteria.
PS.03.04.03.a. Compare, and contrast, organic and conventional production practices.	PS.03.04.03.b. Describe how organic and conventional practices impact global food security.	PS.03.04.03.c. Compare, and contrast, a U.S. and a foreign production system and their impact on global food security and the environment.
PS.03.04.04.a. Evaluate the water needs of different plants.	PS.03.04.04.b. Describe production practices used to minimize water inputs.	PS.03.04.04.c. Analyze a production system and develop a plan to decrease its water input.

MN.PS.03: Plant Health and Environmental Conservation with PS, Continued

Develop and implement a plant management plan for a given production goal based on current industry standards.

Performance Indicator MN.PS.03.05

Harvest, handle, and store crops according to current industry standards.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.03.05.01.a. Identify and summarize harvesting methods and equipment.	PS.03.05.01.b. Analyze the processes used by mechanical harvesting equipment.	PS.03.05.01.c. Assess the stage of growth to determine crop maturity or marketability and demonstrate proper harvesting techniques.
PS.03.05.02.a. Research and summarize reasons for calculating crop loss and or damage.	PS.03.05.02.b. Evaluate crop yield and loss data.	PS.03.05.02.c. Make recommendations to reduce crop loss.
PS.03.05.03.a. Research and summarize how safety is ensured at each stage of the following processes: harvesting, processing, and storing.	PS.03.05.03.b. Research and analyze practices used to maintain a safe product through harvest, processing, storage, and shipment (e.g., Food Safety Modernization Act, Good Agricultural Practices).	PS.03.05.03.c. Research laws and apply regulations to ensure the production of plants and plant products that are safe for distribution and use
PS.03.05.04.a. Identify and categorize plant preparation methods for storing and shipping plants and plant products.	PS.03.05.04.b. Analyze the proper conditions required to maintain the quality of plants and plant products held in storage and during shipping.	PS.03.05.04.c. Monitor and evaluate environmental conditions in storage facilities for plants and plant products.
PS.03.05.05.a. Summarize the reasons for preparing plants and plant products for distribution.	PS.03.05.05.b. Demonstrate techniques for grading, handling, and packaging plants and plant products for distribution.	PS.03.05.05.c. Evaluate techniques for grading, handling, and packaging plants and plant products.

MN.PS.04: Plant Design and Art

Apply principles of design in plant systems to enhance an environment (e.g., floral, forest, landscape, farm).

Performance Indicator MN.PS.04.01

Evaluating, identifying, and preparing plants to enhance an environment.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.04.01.01.a. Identify and categorize plants by their purpose (e.g., floral plants, landscape plants, house plants).	PS.04.01.01.b. Demonstrate proper use of plants in their environment (e.g., focal and filler plants in floriculture, heat tolerant and shade plants in a landscape design).	PS.04.01.01.c. Prepare and install plant materials according to a design plan that uses the proper plants based on the situation and environment.
PS.04.01.02.a. Summarize the applications of design in agriculture and ornamental plant systems.	PS.04.01.02.b. Create a design utilizing plants in their proper environments.	PS.04.01.02.c. Evaluate a design and provide feedback and suggestions for improvement (e.g., a floral arrangement, a landscape, or a landscape plan).
PS.04.01.03.a. List and describe industry standard plant preparation techniques.	PS.04.01.03.b. Create a series of plant care steps from purchase to final installation.	PS.04.01.03.c. Prepare plant materials following industry standard techniques.

Performance Indicator MN.PS.04.02

Create designs using plants.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PS.04.02.01.a. Research and summarize the principles and elements of design for use in plant systems.	PS.04.02.01.b. Apply principles and elements of design that form the basis of artistic impression.	PS.04.02.01.c. Analyze designs to identify use of design principles and elements.
PS.04.02.02.a. Identify and categorize tools used for design (e.g., computer landscape software, drawing tools, florist tools).	PS.04.02.02.b. Demonstrate the use of tools used for creating designs.	PS.04.02.02.c. Choose and properly use appropriate tools to create a desired design.
PS.04.02.03.a. Identify characteristics of a landscape that are analyzed during a site evaluation.	PS.04.02.03.b. Analyze a landscape site using proper site evaluation methods.	PS.04.02.03.c. Make recommendations based on a site evaluation.

Secondary/Multidisciplinary AFNR Pathways that Align with PS

Section 8: Agribusiness Systems (ABS).....135

A secondary or multidisciplinary AFNR pathway, often integrating standards or cumulating from coursework from the AFNR animal, plant, natural resources, and power systems pathways—encompassing the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), business planning, and sales and marketing. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the planning, development, application, and management of agribusiness systems in AFNR settings.

Section 9: Food Products and Processing Systems (FPP).....151

A secondary or multidisciplinary AFNR pathway—often integrating standards or cumulating from coursework from the AFNR animal and plant systems pathways—encompassing the study of food safety and sanitation; nutrition, biology, microbiology, chemistry, and human behavior in local and global food systems; food selection and processing for storage, distribution, and consumption; and the historical and current development of the food industry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of food products and processing systems in AFNR settings.

Section 10: Biotechnology Systems (BS).....174

A secondary or multidisciplinary AFNR pathway—often integrating standards or cumulating from coursework from the AFNR animal, plant, and natural resources pathways—encompassing the study of using data and scientific techniques to solve problems concerning living organisms with an emphasis on applications to agriculture, food, and natural resource systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of biotechnology systems in AFNR settings.