**EXECUTIVE SUMMARY**

Include a summary of 250 words or less, suitable for dissemination to the public. This summary should include a concise outline of the project’s purpose; activities to be performed, including subawards (when applicable); deliverables and expected outcomes; intended beneficiaries; and any other pertinent information.

Response: Late and early blight of potato, caused by *Phytophthora infestans* and *Alternaria solani,* have caused socioeconomic damages worldwide since the 1840s. Management of both diseases depends on fungicides. These fungicides are costly, toxic, and select for fungicide-resistant pathogens. Alternative management strategies are needed to mitigate crop losses and reduce fungicide applications. The goal of this research is to develop and deploy site-specific late and early blight forecasting models for producers in PNW region. We propose to develop forecasts and recommendations with spore dispersal data, incidence data from producers, severity data from satellite imagery, phenology data, and weather data. To accomplish this goal, *P. infestans* and *A. solani* spore concentrations and disease intensity will be quantified. Spore concentrations and disease intensity data will then be modeled as a function of satellite imagery, phenology, and weather data with machine learning models. Models that generate accurate predictions will be used for future forecasts. Expected outcomes of this research include (i) site-specific forecasts that integrate data on blight intensity, phenology, and weather, (ii) daily management recommendations during the growing season, and (iii) control of late and early blight with fewer fungicide applications. The effectiveness of the outcomes will be measured with surveys. Site-specific forecasts will be distributed to producers and researchers via listservs, field days, conferences, extension bulletins, and peer-reviewed journal articles. Blight forecasts and digital outreach will help minimize fungicide applications without compromising yields by providing weekly site-specific disease management recommendations. Thus, this project will directly contribute to the sustainability of potato production and natural resource conservation in the Pacific Northwest. Ultimately, accurate disease forecasting systems will enable producers to apply less fungicides without increasing the risk of crop failure.

**ALIGNMENT AND INTENT**

**Project Purpose**

Clearly state the purpose of the project and the Project Type: food safety, plant pests and disease, research, crop-specific projects addressing common issues, and marketing and promotion. Describe the specific issue, problem, or need that the project will address. Include data and/or estimates that describe the extent of the issue, problem, or need.

Response: The three states in Pacific Northwest region (PNW), Washington, Idaho and Oregon combined, produced nearly 63% of the total US potato production in 2020. This amounts to a total value of nearly $1.82 Billion in 2020 (NASS 2021).

Unfortunately, the potato industry is often threatened by two major foliar diseases, late blight, and early blight of potato. Late bight is caused by fungus-like organism, *Phytophthora infestans* and early blight by the fungus, *Alternaria solani*. Growers spray fungicides to control these pathogens. Management cost associated with late blight alone can exceed 10% of the total production cost of potato in the United States (Guentherner et al 2001). In 1998, the cost of potato losses, fungicide applications, and other management activities in Washington alone was $22.3 million (Johnson et al. 2000). These losses translate to $35.3 million in 2020. Similarly, early blight management costs $21.4 to $44.8 million annually in North America (Stevenson et al 2007). Successful management of late and early blight is therefore of paramount importance to enable sustainable and profitable potato production.

Management of late and early blight typically includes sanitation, cultural practices, and fungicides. Sanitation and cultural practices are used to minimize disease pressure and maximize fungicide efficacy. Fungicides can provide acceptable control when applied at the appropriate time and in the absence of fungicide-resistant strains of the causal organisms. Unfortunately, optimization of fungicide applications is limited by the availability of accurate and site-specific disease forecasts. Without these forecasts, producers are forced to either apply potentially excessive amounts of fungicides or risk severe crop loss and disdain from community members for enabling disease spread. Site-specific forecasts need to be developed to satisfy the needs of producers, minimize needless fungicide applications, and maximize profits for long-term and sustainable potato production.

The goal of this project is to develop and deploy site-specific late and early blight forecasts and outreach for the PNW region. The current forecasting system for late blight in Washington was created in the late 1990s (Johnson et al. 1998) and is maintained by the PI. These forecasts, however, rely on human detection of late blight and sparse weather data from a few weather stations. The former limitation introduces bias because most humans can not accurately scout hundreds or thousands of acres of potatoes. The latter limitation also introduces bias because weather conditions are variable on local scales and not all farms are proximal to weather stations. Whereas, for early blight, there is no comprehensive forecasting system in operation for this region. Generally, growers follow routine application of fungicide if needed.

To generate site-specific late and early blight forecasts, we propose to integrate local weather forecasts with satellite imagery, phenological, disease intensity, and spore concentration data. Forecasts will be developed and validated with machine learning models. Forecasts will then be deployed with recommendations via listservs, field days, social media, conferences, extension bulletins, and peer-reviewed journal articles. Thus, the expected outcomes of this research include (i) site-specific forecasts (ii) weekly management recommendations, and (iii) promotion of fungicide stewardship. These outcomes will be measured with surveys before and after forecasts are deployed.

The outcomes of this research are aligned with the goals of Washington State Department of Agriculture’s (WSDA) Specialty Crop Multi-State Program (SCMP). Ultimately, this research will help (i) sustain and conserve natural resources by promoting fungicide stewardship and thereby minimize off-target exposures, (ii) improve profitability of producers by reducing losses due to late blight and fungicide applications, and (iii) enhance the quality of life for producers, community members, and consumers by stabilizing the food supply without excessive use of fungicides.

**Objectives**

List the objectives of the project and their relation to the issues, problems, or needs.

Response:

* Develop site-specific late and early blight forecasts for potato producers in PNW region.
* Issue weekly late and early blight disease management recommendations to potato producers in PNW region.
* Control late and early blight with fewer fungicide applications than used without the forecasts.

**Project Beneficiaries**

Provide the number of affected producers and processors as well as a description of the benefits you intend to achieve as a result of the project.

Response:

This project will benefit the collective efforts of approximately 300 producers, 36,000 employees and a $7.4 billion industry for Washington alone (Capital Press, 2016).

* Ken and James: can you please add beneficiaries for OR and ID here?

**TECHNICAL MERIT**

**Work Plan**

Complete the below narrative and table for each objective of the project listed in the Alignment and Intent section.

**Objective 1:** Identify the objective that will be accomplished. This should match the objective identified in the Project Narrative Alignment and Intent.

**Timeline:** Start Date: Enter the overall objective start date using the format MM/YYYY. End Date: Enter the overall objective end date using the format MM/YYYY.

**How/Where:** Describe how and where this objective will take place.

**Resources:** Describe the required resources for this objective.

**Milestone(s):** Describe the milestones for assessing progress and success for this objective.

**Training & Technical Assistance (if applicable):** Describe how participants will be recruited and how the project will guide program development and delivery.

| **Objective 1 Activities** | **Performed by** | **Timeline** |
| --- | --- | --- |
| Describe the activity that will help to accomplish this objective. | Enter the Person(s) responsible (including collaborators and contractors) to accomplish this activity. | Enter the timeline associated with this activity using the format: MM/YYYY – MM/YYYY |
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*Insert rows if needed for additional activities.*

**Objective 2:** Identify the objective that will be accomplished. This should match the objective identified in the Project Narrative Alignment and Intent.

**Timeline:** Start Date: Enter the overall objective start date using the format MM/YYYY. End Date: Enter the overall objective end date using the format MM/YYYY.

**How/Where:** Describe how and where this objective will take place.

**Resources:** Describe the required resources for this objective.

**Milestone(s):** Describe the milestones for assessing progress and success for this objective.

**Training & Technical Assistance (if applicable):** Describe how participants will be recruited and how the project will guide program development and delivery.

| **Objective 2 Activities** | **Performed by** | **Timeline** |
| --- | --- | --- |
| Describe the activity that will help to accomplish this objective. | Enter the Person(s) responsible (including collaborators and contractors) to accomplish this activity. | Enter the timeline associated with this activity using the format: MM/YYYY – MM/YYYY |
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*Insert rows if needed for additional activities.*

Copy tables as needed for each project objective.

**Support from Other Federal or State Grant Programs**

If the proposed project has been or will be submitted to another federal or state program for funding, provide the grant program name. If not, please state “This project has not and will not be submitted to another federal or state program for funding.”

Response: This project has not and will not be submitted to another federal or state program for funding.

**How the SCMP Project Differs or Supplements the Other Grant Program’s Efforts**

If the proposed project builds on work previously funded by a federal or state grant program, including AMS grant programs, provide the year and grant program name and describe how the proposed project, if funded, would not duplicate work previously funded by the federal or state government. If not, please state “This project does not build upon a project previously funded by a federal or state program.”

Response: This project does not build upon a project previously funded by a federal or state program.

**ACHIEVABILITY**

**Expected Measurable Outcomes**

Please refer to Form 1.7.2. Outcome Measures. Applicants must select at least one Outcome and one Indicator (sub-indicator, if applicable). Copy and paste the selected Outcome(s) and Indicator(s) here, along with the description of how the numbers were derived, how they will be measured, etc.

Response:

|  |
| --- |
| **Outcome 4:** Enhance the competitiveness of specialty crops through greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources. |
| **Indicator 1:** Enter number plant/seed releases (i.e., cultivars, drought‐tolerant plants, organic, enhanced nutritional composition, etc.). |
| **Indicator 2:** Adoption of best practices and technologies resulting in increased yields, reduced inputs, increased efficiency, increased economic return, and conservation of resources.  a. Enter number growers/producers indicating adoption of recommended practices.  b. Enter number growers/producers reporting reduction in pesticides, fertilizer, water used/acre.  c. Enter number producers reporting increased dollar returns per acre or reduced costs per acre.  d. Enter number acres in conservation tillage or other best management practice. |
| **Indicator 3:** Enter number habitat acres established and maintained for the primary benefit of pollinators and specialty crops. |
| **Description of data collection methods and activities to report on outcomes:** Click here to enter text. Describe how the numbers above were derived, how each outcome and indicator will be measured and achieved, any potential challenges to achieving the estimated targets and action steps for addressing them. |

|  |
| --- |
| **Outcome 5:** Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems. |
| **Indicator 1:** Enter number new or improved innovations models (biological, economic, business, management, etc.), technologies, networks, products, processes, etc. developed for specialty crop entities including producers, processors, distributors, etc. |
| **Indicator 2:** Enter number innovations adopted. |
| **Indicator 3:** Enter number specialty crop growers/producers (and other members of the specialty crop supply chain) that have increased revenue expressed in dollars. |
| **Indicator 4:** Enter number new diagnostic systems analyzing specialty crop pests and diseases. (Diagnostic systems refer to, among other things: labs, networks, procedures, access points.) |
| **Indicator 5:** Enter number new diagnostic technologies available for detecting plant pests and diseases. (The intent here is not to count individual pieces of equipment or devices, but to enumerate technologies that add to the diagnostic capacity.) |
| **Indicator 6:** Enter number first responders trained in early detection and rapid response to combat plant pests and diseases. |
| **Indicator 7:** Enter number viable technologies/processes developed or modified that will increase specialty crop distribution and/or production. |
| **Indicator 8:** Enter number growers/producers that gained knowledge about science-based tools through outreach and education programs. |
| **Description of data collection methods and activities to report on outcomes:** Click here to enter text. Describe how the numbers above were derived, how each outcome and indicator will be measured and achieved, any potential challenges to achieving the estimated targets and action steps for addressing them. |

**Project Dissemination**

Provide a clear description of the plan to disseminate the project results (positive and negative) to similar organizations, stakeholders, and others that may be interested in the project results or in implementing a similar project.

Response:

Site-specific forecasts and outreach will be deployed via listservs, field days, conferences, extension bulletins, and peer-reviewed journal articles. More specifically, the site-specific forecasts will be shared with producers with the *WSU Potato Pest Alerts* listserv, maintained by Dr. Carrie Wohleb at WSU. Field days will be used to share information about the forecasts with producers and other stakeholders. During field days, extension bulletins will be provided to remind producers of the services provided by the site-specific forecasts. Conferences and peer-reviewed journal articles will be used to share the scientific contribution of the research.

**Risk Management Plan**

Provide a detailed and clear risk management plan.

Response: Enter text here.

**EXPERTISE AND PARTNERS**

**Key Personnel**

List key staff, including personnel and external project partners and collaborators that comprise the Project Team, their roles, and their relevant experience and past successes in developing and operating projects similar to this project. Ensure that you have included Letters of Commitment from Multi-State partner and collaborator organizations to support the information. Disclose of any potential concerns of conflicts of interest. For example, if you recruit your spouse, relatives, and/or business partner, provide solid evidence and clear explanation of your decisions, including a detailed monitoring and risk management plan.

Response: Enter text here.

**Management Plan, Data Sharing, and Public Access**

Describe your management plan for coordinating, communicating, and sharing data and reports among members of the Project Team and stakeholder groups, both internally to personnel and externally to partners and collaborators.

Response: Enter text here.

**Project Sustainability**

Describe how the project, and its partnerships and collaborations, will be sustained beyond the project’s period of performance (without grant funds).

Response: Enter text here.