# The DAIRY DRAGON: a particulate matter creation and distribution system for wildfire smoke exposure trials in dairy cows

Sponsor: UI Amy Skibiel and assistance from UI CoS Alistair Smith & Doug Hardman

Would you like the opportunity to help determine some of the effects of wildfire on Idaho's dairy production? Wildfires have long been a part of the Northwest's ecosystem and cows on our dairy farms get exposed to it every year. Cattle exposed to natural occurring wildfire smoke have reduced milk production and evidence of inflammation, which comes at an economic cost to dairy operations. Developing testing chambers will allow us to experimentally manipulate smoke exposure and aid in further determining how smoke inhalation impacts animal performance and health. Please see the attached flow diagram.

**Project Goal**: The goal of this project is to design and create equipment needed to supply fine particulate matter for up to eight separate testing chambers for eight continuous hours of fine particulate matter exposure at a particular concentration.

**Funding**: Amy Skibiel will provide up to $3,000.00 in funding for this project.

**Key Objectives**: To adequately demonstrate concepts and test animal response to controlled fine particulate matter exposure, a system with the characteristics below is needed for creating and distributing particulates from a burn source. These characteristics are subject to modification if the engineering team determines a more appropriate dimension or component improves the final product and an Animal, Veterinary and Food Sciences representative approves. As always, safety is paramount.

1. [Critical] Develop shut down, emergency shut down, and fire suppression procedures and mechanisms.
2. [Critical] Develop and create a mechanism to immediately stop the produced smoke from exiting the distribution system and entering the test chambers. Work with user during design to determine if this can be manual or needs to be automated.
3. [Critical] The system must be completely sealed to prevent smoke leakage. The sealing materials must be viable for 2 years.
4. [Critical] Provide hardwired CO and hazardous gas detector with audible and visual alarms. Work with the user on placement.
5. Work with the user to determine what fuel or fuels will be used for the burn chamber.
6. Work with the user to decide on range of particulate matter production required and design a fuel feed control system to meet that requirement.
7. Design and construct a burn chamber assembly and fuel feeding mechanism with controls. It is likely the feed rate will need be to be adjustable. If propane is used, a hard-wired propane detector is required.
8. Create a method to remotely initiate combustion in the burn chamber. Examples include Universal Hot Surface Ignition (HSI) or Direct Spark Ignition (DSI) systems. These are generally

available off-the-shelf available and just need to be adapted. Safeties need to be added to shut down fuel if combustion stops (also possible with off-the-shelf components).

9. Design the system to prevent fire from backing into the fuel supply.
10. Monitor the smoke generation device for safety parameters (e.g., temperature) and provide a shut down mechanism if the safety parameters are exceeded.
11. Smoke distribution will be selectable to able to feed from 1 to 8 chambers simultaneously.
12. Design for and provide temperature, CO, and CO2 gauges for each testing chamber. Work with the user on a digital feedback mechanism for each chamber's damper
13. The length from the burn chamber to each test chamber is expected to be 7 meters or less.
14. The team will work with the user to determine the needed CFM supplied from the burn chamber to the distribution system. During basic testing the user varied the CFM to rebalance the system, so a fan with multiple speeds or a continuously variable drive will likely be required.
15. The user will provide the control system to allow the smoke to enter the test chambers. Work with the user to ensure the distribution legs connect to and interface, as needed, with the users control mechanism.
16. The system shall be vibration resistant to allow transportation in the bed of a truck or in a trailer.
17. Design for 120 VAC and try to keep amperage at or below 15 amps. If this is not possible, provide alternatives (e.g., 240 VAC or two separate electrical feeds at or below 15 amps).
18. Considerations must be made for maintenance of the equipment and replacement of consumables (if any).

**Project Rationale**: As devastating wildfires become more prevalent, particularly in the western US, which supplies roughly 40% of the nation's milk, it is important to understand how wildfire smoke exposure impacts dairy cow health and production. This project will allow researchers to better characterize the physiological responses of dairy cows to inhalation of wildfire-particulates that lead to milk yield losses and cow disease and mortality.

Points of Contact:

The points of contact for these efforts will be Amy Skibiel, askibiel@uidaho.edu, 208-885-1161; Dr Alistair Smith, alistair@uidaho.edu 208-885-1009; and Douglas Hardman (PhD candidate), hard6997@vandals.uidaho.edu, 208-416-1652.

*Figure 1. Prototype Testing Chamber*

*Figure 2. Prototype Smoke Supply Input*