1. Introduction

1.1. Problem Statement

With the global population projected to reach 9.7 billion by 2050, the demand for food will require a 60%-110% increase in production. Improved pesticide use will be necessary to improve crop yields and achieve this goal. However, increasing efficiency of pesticide application requires new techniques to spread pesticide more precisely and minimize waste.

Our project focuses on the creation of a wireless mesh network using ESP32 microcontrollers to measure pesticide spray distribution of a corn crop. Interdigitated electrodes (IDEs), developed by the Claussen Labs research group, will be positioned at three levels of the canopy to gather resistance readings. These readings will provide a numerical value for the amount of pesticide reaching these different levels. Data collected from the network will be transmitted to a central node, for example a Raspberry Pi, allowing users to analyze pesticide spray efficiency and optimize future pesticide application practices

1.2. Intended Users

Several key user groups will interact with or benefit from the product, including researchers, graduate students, and farmers. Each of these has distinct needs related to the project, and the product will provide them with valuable data to help optimize pesticide usage and improve agricultural productivity.

Nathan Jared, a researcher and PhD student at Iowa State University working with Claussen Labs, has a background in Mechanical Engineering and experience in Chemical Engineering research. His role involves developing sensors to measure pesticide distribution. Nathan needs accurate data from the IDEs (interdigitated electrodes) placed throughout the cornfield to evaluate the efficacy of his designs. By obtaining precise resistance readings from the sensors, Nathan can identify inefficiencies in the current design and adjust the sensors accordingly to enhance their performance. The wireless mesh network we are developing will allow Nathan to receive data from many nodes at once, minimizing the need for manual data collection and reducing the time needed for troubleshooting. This data will ultimately help him refine the sensor design, improving pesticide measurement accuracy, and contributing to more efficient crop management practices.

Griffin Ellis, a graduate student also working at Claussen Labs, collaborates closely with Nathan Jared and the Senior Design Project team. As a Mechanical Engineering student, Griffin focuses on the technical aspects of the project, such as system calibration and programming. His main goal is to ensure the sensors function correctly and that their data can be used to refine his calibration algorithms. Griffin needs access to data from the IDEs to fine-tune the software

responsible for analyzing pesticide distribution. The wireless mesh network we are building will provide Griffin with the data necessary for calibration, making his process more efficient by providing consistent and reliable feedback from the sensors. This will help him better understand the real-world performance of his program and optimize the system for precise pesticide application.

Farmers can majorly benefit from the technology of our project. Farmers rely on efficient farming practices to maintain the health and productivity of their crops. Their primary need is to ensure that their fields are evenly coated with pesticides, preventing both under-application, which could lead to pest issues, and over-application, which would waste resources and harm the environment. The product we are developing offers a significant benefit to farmers by providing real-time data on pesticide distribution. This information will help them adjust their pesticide application methods, ensuring that their fields receive the proper coverage and reducing the risk of crop damage or pesticide runoff. Ultimately, this will lead to improved crop yields, reduced costs, and more sustainable farming practices—goals that align with the overarching problem of increasing food production efficiency to meet global demand.

Appendix

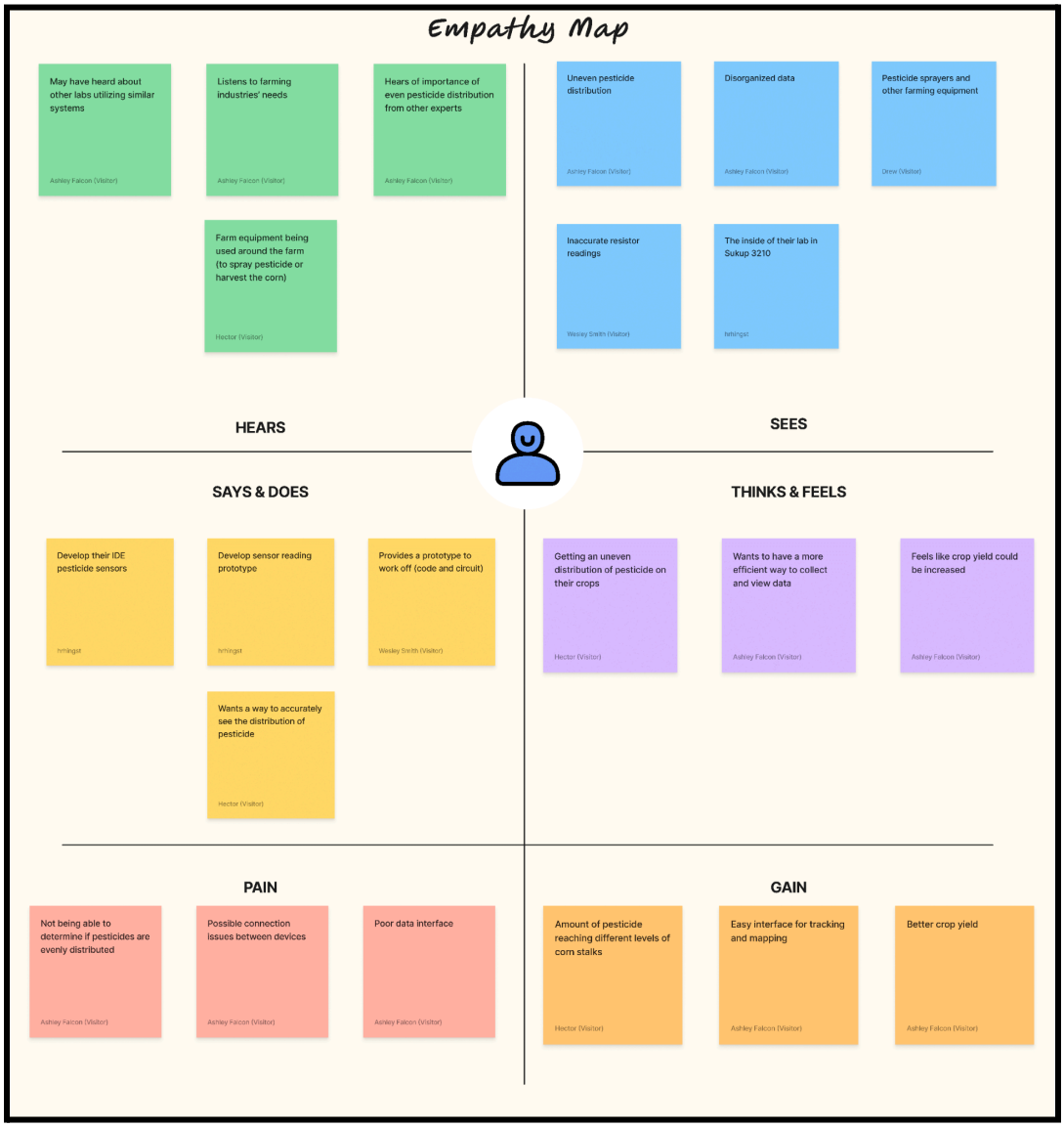

Figure 1: Empathy map of user base for this project