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Barriers and Adoption of Precision Ag Technologies for Nitrogen Management in Nebraska

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Abstract.

A statewide survey of Nebraska farmers shows that they determine the N rate based on soil lab recommendations (82%), intuition, traditional rate, and own experience (67%). The adoption of dynamic site-specific models (23%), and sensor-based algorithms (11%) remains low. The survey identified the main barriers to adopting these N management technologies. Traditional methods like soil lab recommendations prevail, while advanced tools like crop models see limited uptake. Fear of yield loss due to underapplication of nitrogen ranks as the primary barrier to changing strategies, alongside concerns about profit reduction and weather constraints. Despite this, nearly a third of farmers are considering new approaches, prioritizing ease of implementation and tool accuracy. Recognizing their role in water quality, over 85% of farmers accept responsibility for managing nitrogen effectively.

Keywords.

Nutrient management, farmers survey,

Introduction

DA refers to integrating technology and data analytics in various aspects of agriculture to enhance productivity, sustainability, and efficiency of the agriculture value chain. DA includes the use of sensors, drones, satellite imagery, robotics, internet of things (IoT), precision agriculture, and artificial intelligence (AI), to optimize farming operations, increase yields, improve resource management, and enable data-driven decision-making (Puntel et al., 2022). Digital agriculture offers numerous benefits that can revolutionize farming practices and enhance the agricultural sector. There are DA tools that can help to optimize N management. Our goal was to conduct a survey to identify the level of adoption of different DA technologies for N management and to identify barriers to the adoption of other N management programs.

Materials and Methods

A survey encompassing both multiple-choice and open-answer questions was deployed to elucidate Nebraska (US) farmers' adoption of Nitrogen management-related Digital Agriculture technologies and barriers to adoption. The survey was deployed by the Bureau of Sociological Research (BSR) at the University of Nebraska. Farmer participants were sourced via probability-based stratified random sampling of 2,500 Nebraska farmers. The 2,500-farmer sample was drawn from counties in proportion to their respective farm densities, ensuring equitable representation (e.g., Buffalo County, containing 2% of Nebraska farms, accounted for 2% of the sample). Nebraska farmers were allowed to complete the survey via traditional paper format (mail) or digitally. All responses were anonymized and aggregated into two distinct databases to uphold confidentiality. Descriptive statistics were used to analyze survey responses.

Results

Farmers selected from 24 Digital Agriculture technologies related to N management and indicated whether they know the specific technology or use it. The top five DA technologies used by farmers are phone apps, GPS, yield monitors, soil sampling grids, and autosteer. The top five less adopted technologies were robotics, LoRa Network, blockchain, AI for decision making and big data (Fig. 1).

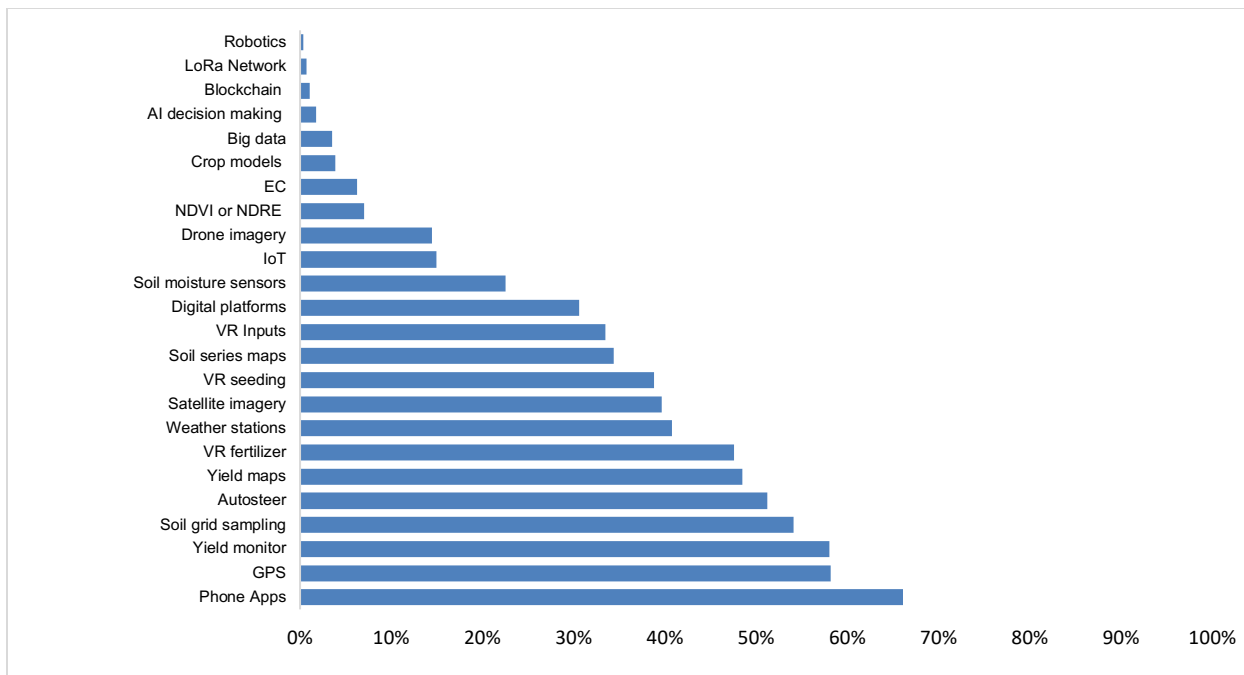


Fig 1. Digital Agriculture technology adoption by farmers in Nebraska (US) (n=322).

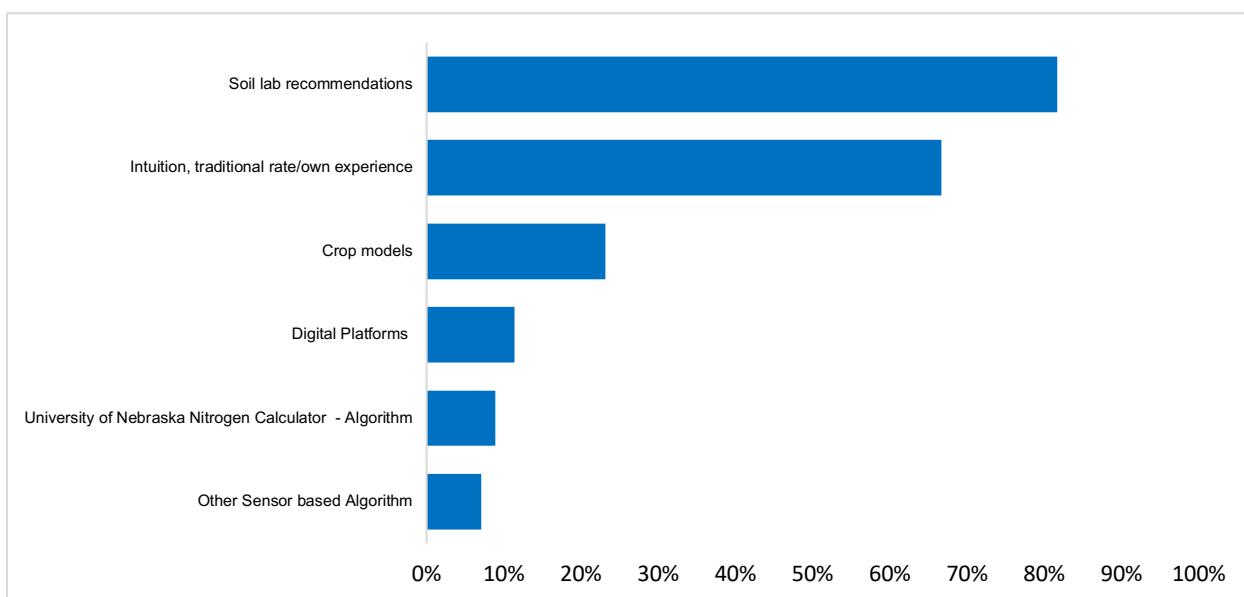


Fig 2. Methods adopted by Nebraska Farmers to determine their Nitrogen rate in corn.

Over 80% of Nebraska farmers rely on soil lab recommendations to determine their corn N rate. Surprisingly, seven out of ten farmers rely on their intuition, traditional rate/own experience (Fig. 2). Tools that can be classified as Digital Agriculture technologies have a very low rate of adoption (Crop models 23%, digital platforms 11%, UNL Algorithm 9%).

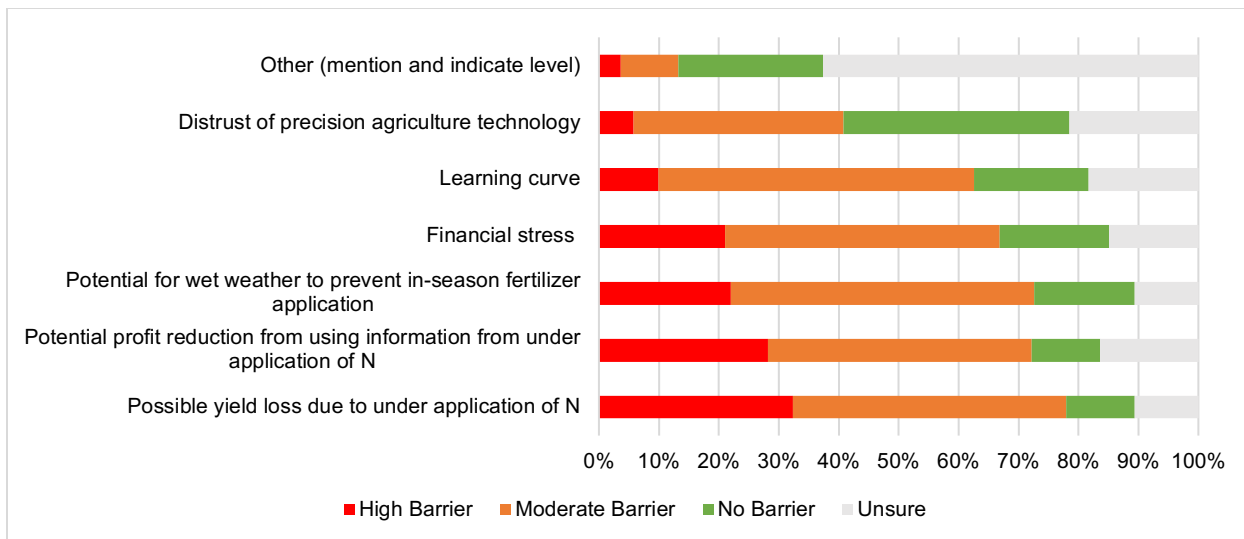


Fig 3. Nebraska Farmers Barriers to change Nitrogen management strategy.

The main barrier to changing Nebraska farmer's nitrogen management strategy was the possible yield loss due to the underapplication of N (moderate+high barrier 77%). The potential profit reduction from using information from under application of N and the potential for wet weather to prevent in-season fertilizer applications were indicated as important barriers for farmers. Barriers were followed by financial stress, learning curve and distrust of precision agriculture technologies (Fig. 2).

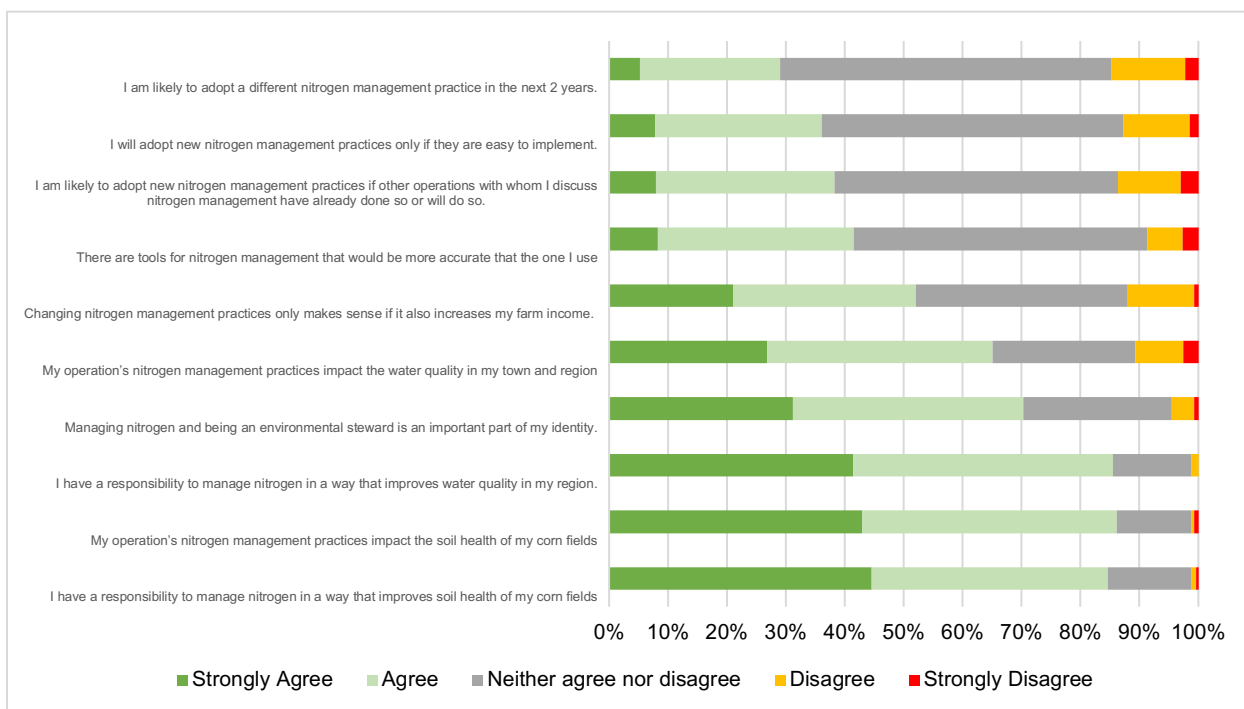


Fig 4. Perception of Nebraska farmers regarding Nitrogen management for corn and the impact in the environment and the society.

The survey indicates that 29% of Nebraska farmers are planning to adopt a different nitrogen management practice. Four out of ten farmers consider that the technology needs to be easy to implement. Four out of ten farmers also consider that there are more

accurate nitrogen management tools than the ones they use. 65% of Nebraska farmers are aware that their N management practices impact the water quality in their town and region. More than 85% of farmers know that they have the responsibility to manage N to improve water quality in the region.

Summary

A survey of Nebraska farmers highlights varied adoption of Digital Agriculture (DA) technologies for nitrogen management, with phone apps, GPS, and yield monitors among the most utilized. Traditional methods like soil lab recommendations prevail, while advanced tools like crop models see limited uptake. Fear of yield loss due to underapplication of nitrogen ranks as the primary barrier to changing strategies, alongside concerns about profit reduction and weather constraints. Despite this, nearly a third of farmers are considering new approaches, prioritizing ease of implementation and tool accuracy. Recognizing their role in water quality, over 85% of farmers accept responsibility for managing nitrogen effectively.

Acknowledgments

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