GRAND FARM

GROWER
PAIN POINT REPORT
2023

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INTRODUCTION AND BACKGROUND

Grand Farm brings together a network of growers, technologists, corporations, startups, educators, policymakers, and investors to form a global ecosystem to work together to solve problems in agriculture with applied technology.

A key segment of this ecosystem are growers, who are often the recipients and end-users of agriculture technology (AgTech). To better understand the grower perspective on technology needs and adoption, Grand Farm produces the Grower Pain Point Report. The first edition of Grand Farm's Grower Pain Point Report was published in 2020. This report was disseminated throughout Grand Farm's ecosystem.

Boson Motors is a tangible outcome of Grand Farm's 2020 Grower Pain Point Report. Boson Motors, based out of California, is led by an ex-Google employee who utilized the report to build a utility truck that is affordable, electric, and can drive autonomously. This truck specifically aims to solve some of the grower pain points that were identified in 2020.

Following the outcomes of the 2020 report, Grand Farm has developed this edition because we have learned that irrespective of the industry and technology applied, challenges never end, they just evolve. Therefore, to be more strategic in our approach, Grand Farm aligned the identified pain points with Grand Farm's ecosystem. Grand Farm seeks to be intentional about how different challenges identified in this report can be addressed, and hopefully, solved by leaders throughout the global AgTech ecosystem.

Objective

Grand Farm intends to bridge the gap between growers (farmers and ranchers) and technology creators and supporters. This report identifies the challenges of a grower that are to be shared with the global AgTech ecosystem, including: growers and organizations that represent them; startups; corporations; educators and researchers; investors; and, government agencies and policymakers. Seeking solutions to problems drives innovation, and it's what drives Grand Farm. By documenting the challenges faced by growers, feedback loops form within the AgTech ecosystem to create solutions that may help growers be more productive, profitable and, ultimately, solve their challenges.

Disclaimer

Grand Farm's role in this report is to identify, document, and share these challenges with the AgTech community. Grand Farm does this from a neutral perspective and does not take positions or criticize any information. This report is provided for educational purposes only and does not constitute professional or legal advice. The information contained in this report is based on sources believed to be reliable and accurate.

METHODOLOGY

To collect this information we conducted personal interviews, surveys, and attended and participated in agriculture-related conferences. Participants included approximately 100 independent growers and ranchers, leaders representing grower councils and associations, and Grand Farm's Grower Advisory Board. These groups represent North Dakota, the Red River Valley, and parts of Western Minnesota. Leaders from the following organizations also participated:

Photo by Grand Farm

→ North Dakota Corn Growers Association
→ North Dakota Farm Bureau
→ North Dakota Farmers Union
→ North Dakota Grain Growers Association
→ North Dakota Soybean Council
→ Red River Valley Sugarbeet Growers Association
→ Northharvest Bean Growers Association

CREATION PROCESS

→ Conducted individual interviews with growers.
→ Hosted listening sessions on participants' farms and in rural communities.
→ Toured growers' operations to learn and understand the challenges firsthand.
→ Collected feedback through surveys.
→ Attended and participated in conferences hosted by different commodity groups.

IDENTIFYING GROWER PAIN POINTS

We've grouped our findings into five categories: Startups, Corporations, Policymakers, Educators, and Researchers, illustrating what these categories can do to address these challenges.

By categorizing these challenges into specific ecosystem segments, Grand Farm hopes to promote industry collaboration around these challenges.

Photo by Grand Farm

GRAND FARM ECOSYSTEM
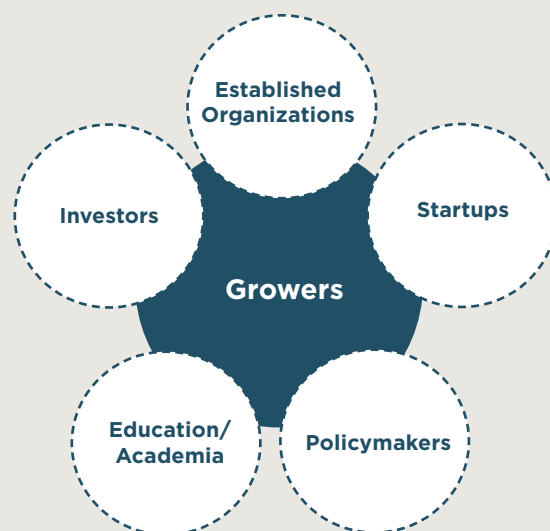
Established Organizations
Investors
Startups
Growers
Education/ Academia
Policymakers

LACK OF ACCESS TO THE LATEST TECHNOLOGY
Growers may not have the resources to access the latest technological advances in agriculture, such as precision agriculture tools, drones, and robotics. In addition, with so many technology products in the market, it can be difficult to use them even if they help solve a challenge. The upfront capital required to adopt many technologies often exceeds the perceived ROI by the grower.

UNFAMILIARITY WITH TECHNOLOGY
Technology is always changing and evolving. Growers may lack familiarity to maximize specific, newer technology. User interfaces are often overly complicated, not providing clear insights the grower can use for immediate decision making. Displayed results should empower a grower with efficient and optimal decision making.

HIGH ADOPTION COST AND UNCLEAR ROI
Agricultural technology can be expensive, making it difficult for growers to keep up with the advancements. Making new technologies affordable and accessible is important to growers. Additionally, highlighting a clear operational ROI is essential. Grower operations and fields are all unique, a one-size-fits-all approach does not address this.

DATA PRIVACY AND SECURITY
Growers are conscious about their data privacy, ownership, usage, and security. Oftentimes, it is unclear who owns the farmer data.

NETWORK CONNECTIVITY
AgTech innovations which require connectivity to function properly should consider the available last-acre and last-mile connectivity solutions of the growers they are targeting for adoption.

LIMITED ACCESS TO CAPITAL
Many growers have difficulty accessing capital to invest in new technologies and equipment. This can be a particular challenge for small and mid-size operations that may not have the resources to obtain financing.

LIMITED ACCESS TO TECHNICAL SUPPORT
Many growers have difficulty obtaining technical support for the agriculture technology they are using. Distributors similarly may not be familiar with the technology enough to assist the growers in adoption and usage. Access to support in the implementation and usage of new technologies is important.

RELIABILITY OF TECHNOLOGY
Growers prefer older, familiar equipment because they want reliability. They don't want equipment to break down at important times of the year. The window of operations at key times (planting, harvesting, etc.) is so tight due to weather, market conditions, etc. that they need the technology to work on their schedule.

LACK OF INCENTIVIZATION
There is a lot of time, labor and cost that goes into the trial of a new product/technology. There is already so much a grower has to deal with in their daily operations. Technology needs to efficiently reduce, rather than overload, a grower's repetitive tasks.

LACK OF ACCURATE VALUE PROPOSITION

The description of what products accomplish, and how they are used should be clear. An example that was raised several times was "autonomy" is overused and miscommunicated – leading to false expectations.

NEED FOR AUTHENTIC RELATIONSHIP BUILDING

Agriculture is very human-centric and hence, growers appreciate and prefer human interactions and not to be treated like just a customer. Growers need to be involved from the inception of the product rather than towards the end of the innovation and commercialization process. By involving growers, there could be a better/more creative/more applicable input added by real users. Give growers time to learn and process your product/service, express genuine interest and take the time to be on their farm. Trust is the key to get their honest feedback and have a long-term customer. Acknowledging and addressing a grower's frustration with your technology can help you win their trust.

MAKE TESTS/TRIALS CONVENIENT

Keep a grower's job easy and convenient while empowering them with resources because if it is too complicated or they lose interest due to the amount of work required, it can lead to less follow-through by the grower.

"McKinsey & Company's 2022 report on AgTech funding over the past decade revealed that a majority of deals occur during the Seed and Series A funding rounds. However, a much smaller number of start-ups are receiving funding in later stages or going public, indicating that AgTech start-ups are having difficulty establishing a sufficient customer base to progress to these funding rounds."

RE-INVENTING THE WHEEL IN THE NAME OF INNOVATION

Growers don't want to test a technology (e.g., bin-sensor) that has already existed for decades and now requires another person to monitor, and it cannot be repaired by the grower if that technology doesn't work. It's viewed as a loss of growers' time, money, and labor.

GROWERS ARE DATA-EDUCATED

Growers will buy your technology if it is backed by data and shows a clear ROI. Growers are concerned about their data. They know it's valuable but it isn't always clear how the data is being used, hence they don't trust a lot of the technologies as growers are becoming more aware of data privacy/ownership issues.

SUBSCRIPTION MODEL IS UNDESIRABLE

Growers appreciate upfront costs for their implements. Current patterns of adding subscription costs to any additional feature can turn off some growers, especially growers with smaller operations. In addition, with numerous technologies and subscriptions existing in the AgTech industry, it can be extremely exhausting to keep a track of numerous expenses.

Photo by Grand Farm

UNDERSTAND A REGION'S AGRICULTURAL DIVERSITY BEFORE PITCHING TECHNOLOGY

Characteristics of a farm, crops, ranch and livestock varies significantly in different regions within a state. It's never a one size fits all philosophy that can be applied. Hence growers expect customized solutions for their challenges. It is difficult for growers to believe a new technology just by seeing or hearing a pitch. Also learning that something worked in Iowa for example makes the growers suspicious whether it would work in North Dakota considering the soil characteristics.

MORE TECHNOLOGY NEEDED IN NON-COMMODITY CROPS

Adding smart technologies to harvester combines for crops such as edible beans (non-commodity crop), and crops grown indoors. It will further help in expanding the value-added crop market as well. These crops have smaller markets but great profits and desperately demand more technological advancement with agriculture implements.

"As stated in the State of the Farm [2021] Report by Bushel, 78% of farmers (with a sample size of 651) view agriculture as an industry that relies heavily on building and maintaining relationships."

WATER MANAGEMENT TECHNOLOGY

Water on and off the field in undesirable situations and diverse land characteristics (wetland, good/bad yield area, moisture level, etc.) affect the operations tremendously, often having a financial impact. Hence, empowering farmers with the ability to control the water on their fields could be a game changer in regions struggling with water issues (Red River Valley region included). In addition, ranchers can also apply this technology to better take care of their livestock.

MAKE PRECISION AND MONITORING TECHNOLOGY DIVERSE

Exploring precision and monitoring products for fertilizer and diverse crops while making them accessible and affordable will be a valuable product for growers. Targeting indoor agriculture operations with such capabilities can be another revenue generating avenue.

GREENWASHING

Unnecessary usage of words like 'organic' and 'sustainable' for marketing purposes is undesirable. It doesn't align with the definition of what is being projected in the name of healthy food and healthy practices. Growers suggest AgTech marketing teams simplify their agriculture vocabulary.

Photo by Grand Farm

CORPORATIONS

HIGH COSTS
Economy of scale related to the price and value of an AgTech innovation often excludes small and mid-sized growers who are already burdened by increasing costs associated with operational necessities.

LACK OF CONTROL
Growers may feel like their data is being used without their consent or that they have limited control over decisions about their operations. Privacy conditions added by organizations can be lengthy and difficult to comprehend. Growers may have limited control over the AgTech products and services they are using and may be frustrated by the lack of customization options.

"In May 2022, McKinsey conducted a survey of over 1,300 farmers specializing in row and specialty crops in the United States. The results showed that the top three areas where farmers are facing increased costs are fertilizers (71% increase in cost), crop protection (30% increase in cost), and labor (17% increase in cost). Furthermore, in the US, 80% of farmers ranked the escalating input costs as the most significant risk to their profitability."

DATA PRIVACY AND SECURITY CONCERNS
Growers are concerned about the privacy of their data, particularly if they are required to share it with AgTech corporations in order to use their products and services. AgTech corporations may not be transparent about their data collection, algorithms, and decision-making processes. In addition, growers are concerned about the security of their data and the potential for it to be misused or cause their operations to become vulnerable to cybersecurity threats.

REPAIR AND MAINTENANCE CONCERNS
Growers may experience slow response times or inadequate customer service from AgTech corporations. Growers, particularly those in rural areas, may not have access to high speed or reliable internet and other technologies that are necessary to take full advantage of AgTech products and services.

"The Federal Communications Commission estimated 14.5 million people in the U.S. lived in areas without access to broadband at the end of 2019, while the data aggregation company BroadbandNow estimated that number to be 42 million. The White House says 30 million."

TECHNOLOGY NOT WORKING
Current technologies are highly appreciated by growers, but as one grower pointed out, "when sensors go down and force the growers to not use the equipment for a few hours or even days, it's crippling as a farmer." Everything is a computer now, and requires dealers to come out, plug in and fix it. Growers want to be able to fix or maintain their equipment as soon as possible.

SUBSCRIPTION MODELS ARE STILL UNDESIRABLE BY GROWERS
Growers are aware that startups bring in new technology and ideas that eventually are bought by larger companies. These technologies may be offered to growers in a way that makes them feel boxed (i.e., subscriptions) and obligates them to pay high prices.

MAKE IT EASY FOR NON-GROWERS

The labor shortage in agriculture can be targeted by making ag-implements usable by people coming from non-agriculture families or with little or no experience. Having integrated systems along with the tools to help diagnose and provide solutions can help the agriculture community target the labor shortage while attracting and retaining more people in agriculture.

"McKinsey US Farmer Insights 2022–23 reported that over the past five years, the level of brand loyalty among operators of larger farms (>5000 acres) has declined, with approximately 30% of them indicating a decrease in brand loyalty (n=1,315)."

POLICYMAKERS

INADEQUATE ACCESS TO INFORMATION

Growers often lack access to up-to-date, relevant information about agricultural policies and programs, or access to the technical advice needed to understand and take advantage of them.

LIMITED ENGAGEMENT

Growers may lack the resources or familiarity with processes to effectively engage with policymakers on issues that affect them.

DISCREPANCIES IN VALUE SYSTEMS

Growers and policymakers can have different values and priorities, making it difficult to bridge the gap between the two.

LACK OF KNOWLEDGE OF INCENTIVES

Growers may not be aware of the incentives available to them through policy initiatives or may not have the resources to take advantage of them.

DISCONNECT BETWEEN POLICY AND PRACTICE

Policies and programs may not be implemented in a way that reflects the needs of growers or may be too complex to be easily understood.

IMPROVEMENT OF RURAL INFRASTRUCTURE

Township level roads have very little gravel, which makes many roads not drivable after it rains. In addition, bridges are too small or can't carry the weight or are entirely closed. (For example, there are 400 bridges in Trail County, North Dakota, only 200 are open.) Agriculture equipment continues to get bigger, and rural infrastructure is not keeping up.

REGULATIONS APPLIED IN EUROPE MAY NOT APPLY TO U.S. GROWERS

Farming in the US is very different from farming in the EU. Therefore, these two geographies may not be comparable, and regulations applied in the EU cannot be expected to be adapted in the US in exactly the same manner in the name of sustainable practices.

SEEKING CLEAR GOVERNMENT POLICIES

Growers appreciate new endeavors around AgTech, however, having clear governmental policies would make more sense from a decision-making perspective. This can include things like carbon credits or trading, autonomous vehicle accidents, policies on ag terrorism attacks, etc.

MAKE IT EASIER FOR GROWERS TO SELL THEIR FARMS

The ability to sell their farm has been a stress for some growers considering the expense of buying and maintaining their operations.

"Around 40% of farmers reported their participation in government-sponsored programs, which serve as the primary driving force behind the adoption of sustainability programs (McKinsey US Farmer Insights 2022–23)."

MY WAY OR THE HIGHWAY PHILOSOPHY NEEDS TO CHANGE

Growers feel having less policy and regulation is best. A sentiment expressed by one grower includes: "We want to produce the best and safest product, as we are the ones eating it as well, so why wouldn't we want it to be safe? By putting in more regulations, it makes it hard to do our job because we are always having to make sure we are doing what the government thinks is best, instead of doing what we KNOW is best." Policymakers need to keep up with the science and technology in agriculture and keep the path to technology adoption open

POLICY ISSUES ON THE HORIZON:

- The inability of local growers to compete with outside investors purchasing local land at much higher capital is a large stress factor and affects family farm culture.

- Growers expressed the need for more environmental regulations on oil and gas exploration due to too many spills affecting the land and not being taken care of properly.

- Need for incentivizing policies around gathering data from growers to eventually regulate their practices or operations.

- Many banks are skeptical of the feasibility and profitability of indoor farming so there is a large reluctance to fund these operations. Plus, the barrier to get into indoor farming is very high, which is causing immediate problems in growing the industry. Growers hope policies around indoor agriculture will get some attention in the coming years.

PRICING TRANSPARENCY

In agriculture, many pricing structures can be very complex and hidden. This is further compounded by the fact that certain item pricing (e.g., seeds) is transparent while with other item pricing (e.g., chemicals) growers must contact different sales representatives in order to find prices. Even co-ops and checkoff organizations felt like they couldn't easily get access to pricing structures. It is very difficult to plan when growers don't have a clear understanding of their expenses. Hence, accessing prices upfront will be a huge asset, especially if policies are supportive of this demand.

"Apart from the worry about the loss of biodiversity and water pollution as a result of excessive use of chemical fertilizers, farming worldwide is facing a critical challenge, which is the intersection of rising global temperatures and the depletion of both visible and underground freshwater resources. As a result, there is an increasing need for water management, with more significant attention likely to be focused on it due to mounting societal and regulatory pressures (McKinsey US Farmer Insights 2022–23)."

RESEARCHERS

LACK OF TRUST
Researchers may focus on theoretical or lab-based studies that are not directly applicable to the practical needs of farmers and ranchers. Growers sometimes feel that researchers do not understand their needs and lose trust in their ability to solve their specific problems. Growers may be skeptical of new technologies or practices proposed by researchers and may feel hesitant to invest resources in untested methods.

POOR COMMUNICATION
Issues of communication between researchers and growers can lead to frustration and a lack of understanding. Researchers and growers may have different communication styles, which can make it difficult to effectively share information and collaborate.

LACK OF RESOURCES
Growers may not have the resources needed to properly implement the research findings or technologies, or research funding may be directed towards certain livestock or crops that do not align with the specific needs or interests of those growers.

DATA SECURITY CONCERNS
Growers may be worried about the security of their data and how it is used.

TIME CONSTRAINTS
Growers may not have the time to make use of research or understand its implications. Depending on the scope, research projects can sometimes take a long time to complete and may not align with the seasonal needs of growers.

COST
Growers may find that the cost of implementing research or technology is too high.

The section below does not highlight the pain points of growers but rather is a compilation of some of the research topics that growers foresee research around. Grand Farm's ecosystem includes researchers and educators who could potentially employ these topics for both research and educational purposes. Grand Farm intends to include the 'areas of research' section to potentially:

- Identify challenges that growers might be experiencing specifically in these areas.

- Help provide solutions by exploring new techniques and technologies through research and development.

- Support decision-making by providing growers with information about emerging trends and best practices to help them make informed decisions about their operations through various collaborative events, including, but not limited to, educational workshops hosted by Grand Farm.

Based on the diversity of growers we interviewed, this subsection is divided into traditional farming, vertical farming, and ranching. Growers seek research in the above mentioned areas for a variety of reasons, including but not limited to, improving efficiency, enhancing sustainability, addressing climate change, meeting consumer demands, and exploring new frontiers (such as vertical farming, which has the potential to revolutionize food production by enabling year-round cultivation in urban environments). By staying at the forefront of new developments in agriculture, farmers and ranchers can ensure the long-term success of their businesses.

The research topics shared below are intended for the broader interdisciplinary research community, including students and educators exploring areas of research in the agriculture industry. Some of the major areas of research shared by the interviewed growers included:

TRADITIONAL FARMING

Sustainable Farming Practices: to help farmers increase crop yields while minimizing their environmental impact. This could include research on soil health, crop rotation, and water conservation.

Plant Breeding: to help develop crops that are more resistant to pests and disease, and that can thrive in different environments. This could include research on genetic modification, hybridization, and genome editing.

Precision Agriculture: to help farmers optimize their use of resources, such as fertilizer, pesticides, and water, by using data and technology to target their application more effectively. This could include research on sensors, drones, and machine learning algorithms.

Agroforestry: to help farmers integrate trees and shrubs into their farming systems, which can provide multiple benefits such as soil conservation, carbon sequestration, and diversification of income streams.

Food Safety: to help farmers reduce the risk of contamination and ensure that their products are safe for consumption. This could include research on foodborne pathogens, sanitation practices, and traceability systems.

Agricultural Economics: to help farmers understand the economic factors that affect their businesses, such as supply and demand, market trends, and government policies. This could include research on pricing strategies, risk management, and farm subsidies.

Photo by Grand Farm

VERTICAL FARMING

Crop Growth and Yield Optimization: explore different lighting, nutrient, and environmental conditions that can promote plant growth and increase crop yields in vertical farming systems. This includes investigating the effects of different LED lighting spectra, temperature, humidity, and carbon dioxide levels on plant growth and development.

Nutrient Management: efficient nutrient management is essential for maximizing crop yield and minimizing environmental impact. E.g. investigating different nutrient delivery systems, including hydroponics and aeroponics, to optimize nutrient uptake and reduce waste.

Automation and Robotics: vertical farming systems require a high degree of automation to achieve efficient and cost-effective production. Identify ways to use robotics and artificial intelligence to optimize plant growth, harvesting, and maintenance processes.

Energy Efficiency: vertical farms require significant amounts of energy to power lighting, heating, and cooling systems. Explore ways to reduce energy consumption by using renewable energy sources, such as solar and wind power, and improving the efficiency of lighting and HVAC systems.

Plant-microbe Interactions: plants interact with a variety of microorganisms, including beneficial bacteria and fungi, which can enhance plant growth and protect against pathogens. Investigate ways to optimize these interactions in vertical farming systems to improve crop yield and reduce the need for pesticides.

Crop Selection: not all crops are suitable for vertical farming. Researchers should investigate the performance of different crops in vertical farming systems, including but not limited to, leafy greens, herbs, and small fruits, to identify the most promising candidates for commercial production.

Economic Viability: vertical farming is a relatively new technology, and its economic viability is still being evaluated. Researchers should explore different business models, production systems, and market opportunities to determine the most efficient and profitable approaches to vertical farming.

Photo by Grand Farm

RANCHING

ANIMAL GENETICS: developing and improving breeding techniques to produce livestock with desirable traits such as improved meat quality, disease resistance, and higher milk production.

ANIMAL NUTRITION: to improve feed quality and efficiency, as well as to understand the nutritional needs of different livestock species and how to meet those needs in a cost-effective manner.

ANIMAL HEALTH: preventing and treating diseases and parasites that affect livestock, as well as improving vaccination and biosecurity practices to protect animal health and prevent the spread of disease.

RANGE MANAGEMENT: maintaining healthy rangelands and preventing overgrazing by implementing sustainable grazing practices that balance the needs of livestock with the needs of the ecosystem.

Meat Science: improving meat quality, safety, and processing techniques, as well as developing new products and markets for livestock products.

Agricultural Economics: factors that affect ranching, such as commodity prices, trade policies, and environmental regulations, and seeks to identify strategies for improving profitability and sustainability in the industry.

Forage and Nutrition: improving the productivity of rangelands through grazing management, improving the quality of forage and understanding how nutrition affects animal performance.

Land and Water Management: effects of grazing on soil and water resources, developing best management practices for sustainable ranching, and understanding the impacts of climate change on ranching.

Economics and Marketing: farm and ranch financial management, marketing opportunities for agricultural products, and value-added production.

Wildlife Management: understanding the effects of ranching on wildlife, developing management strategies to reduce conflicts between wildlife and livestock, and enhancing wildlife habitat on ranches.

"The adoption of biological products (biostimulants/biofertilizers/biocontrol) is projected to increase in the next two years for all types of farms, regardless of size (McKinsey US Farmer Insights 2022–23)."

EDUCATORS

SIMPLIFYING COMPLEX TECHNOLOGY CONCEPTS FOR GROWERS
The technology industry is constantly shifting and evolving, requiring a baseline understanding of often very complex systems. Getting to the core knowledge required to be effective with technology is important to the time and attention of growers

TRANSFER OF TANGIBLE KNOWLEDGE
Research and field trial reports need to be distilled and translated for quick and easy insights respecting the time and attention of growers.

ONE STOP INFORMATION ACCESS
Growers need one neutral spot to be able to ask their questions and find unbiased and real time answers for which they usually have to wait for long durations and depend on different people/organizations to find the right answers. For example, soil erosion is a very complex topic and varies from field to field. There is confusion on how growers can properly gain correct information on their field. While there are a number of systems and software that growers can use, the challenge often comes in making sense of the data.

> "Farmers in 2020 considered "less fuel cost," "less topsoil loss," and "less labor" as the primary benefits of using no-till methods. However, in 2021, a greater number of respondents cited "better weed management" as a benefit (State of the Farm Report, 2021, Bushel).

CONTINUE TO IMPROVE UNDERSTANDING OF AGRICULTURE TO ATTRACT AND RETAIN
The image of a grower needs to be updated with the new era.
New skills include technology, social media, etc. There are now occupations using technology across the industry, including with dealerships, seed and fertilizer companies, AgTech companies, etc.

KEEPING GROWERS UPDATED WITH NEW TECHNOLOGIES
Considering how different farms and ranches operate, exposing and educating growers about upcoming technologies and showcasing how they can be employed by them is much needed. Examples of this include the use of drones and precision sprayers for combating infestation in a specific area of the field, applying fertilizer in a specific area due to better yield in that specific area, tracking devices for livestock that showcase multiple parameters besides their exact location, applying chemicals where it is needed and not randomly everywhere – saving cost and enhancing sustainable practices.

MENTAL HEALTH IS IMPORTANT
Mental health for growers is extremely important, especially considering how unexpected and uncontrollable incidents (e.g., weather, covid outbreak, etc.) can affect their livelihood, especially with the rise in inflation. Because of this, it is important to establish platforms where growers can communicate confidentially, feeling secure to learn about how others are coping with the situation presently or in the past. It is easy to lose hope at times (leading to unforeseen actions such as alcoholism, suicide, critical health issues, etc.) and hence it is important we have a strong support system for the feeders of this nation.

FEMALE GROWER REPRESENTATION MATTERS

Highlighting the importance of women as farmers and ranchers and not just a grower's wife, daughter, or sister, is important to highlight representation in agriculture. The education system and society as a whole needs relabeling of roles to support equality and, above all, credit female growers for the work they are doing and have been doing.

TECHNOLOGY IS NOT A REPLACEMENT FOR HUMAN RELATIONSHIPS

A sentiment felt by growers is that: "Whether farming or ranching, relationships work hand in hand – if you need to introduce new technology or vendors (besides equipment dealers like John Deere and RDO who are very well integrated with the farmers), relationship building is a key to that." It is important for educators to highlight that technology and autonomy is here to make agriculture operations efficient while producing higher yields and not a replacement for humans

KNOWLEDGE TRANSFER ACROSS GENERATIONS

According to the U.S. Census of Agriculture, almost 70 percent of growers are over the age of 45 and almost 30 percent are over the age of 65. Over the next 10 years, there's going to be a great transfer of knowledge that needs to take place in order for the next generation of growers to succeed. This challenge is heightened by the fact that in previous generations, growers were more apt to share best practices.

LACK OF ROBUSTNESS AROUND RISK ASSESSMENT

The variables that go into risk assessment are complex and most easily understood by domain experts who have been involved in farming for years. This means that it's difficult for growers who want to invest in new opportunities as there are so many unknowns. When looking at risk assessment, it boils down to impact and profitability so the question is: how do you create simpler risk assessment so growers can properly plan and take on new risk?

ADOPTION OF NEW CROPS

Planting new crops is a risky undertaking for growers. Utilizing hemp as an example, when it was legalized in North Dakota, growers didn't understand what tools were available to plant, harvest and work the new crop. Most growers either planted hemp and lost money or didn't go into it because they didn't have full clarity on the process. As new crops emerge, it's important for that information to be transparent. (e.g., where contracts come from? Who's going to buy hemp seed and oil? How do you know you're going to make money on that crop?). Education around regulation is helpful for growers.

UPGRADE (MIDDLE & HIGH) SCHOOL CURRICULUM

Most of the growers interviewed felt that with technology becoming so prevalent on farms and ranches it is important that new generations get exposed to agriculture-related courses early on along with coding languages and skills that teach students to operate basic technology products used by growers. Also, many advocate for supporting student organizations such as Future Farmers of America (FFA) via organized and paid internships, creating connections with the industry, creating platforms for these students to continue their learnings and experiences.

> "The implementation of precision-ag hardware, which plays a crucial role in promoting sustainable and low-emission farming practices, is most prevalent in North America at 28%, followed by South America at 27% and Europe at 21%. Among these, yield mapping and monitoring software, variable rate fertilizer-application technology, and automatic sprayer-section shutoffs are the solutions that are experiencing the highest levels of adoption at 69%, 67%, and 67%, respectively. In contrast, Asia is lagging behind, with only a 4% adoption rate of sustainability-related technology categories overall (McKinsey US Farmer Insights 2022–23)."

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