Upper Midwest Regional Agriculture

PAIN POINT REPORT

2026

5TH EDITION

FOREWORD FROM THE
Executive Director

Agriculture in the Upper Midwest is under real pressure. Growers are managing tighter margins, labor challenges, weather variability, and increasing operational complexity, all while trying to make sound decisions in a fast-changing environment. At the same time, new technologies continue to emerge faster than the problems they are meant to solve are fully understood. That creates risk, not just for growers, but for everyone working to support the future of agriculture.

At Grand Farm, we believe innovation has to start with listening. It has to begin with a clear understanding of the challenges growers face every day and the realities they are navigating across their operations. Through our work with growers, industry partners, researchers, and educators across the region, we continue to hear many of the same issues rise to the surface. Those recurring challenges are what shaped this report.

The 2026 Upper Midwest Regional Agriculture Pain Point Report (RAPPR) is intended to bring greater clarity to the issues most consistently affecting crop production across Minnesota, North Dakota, and South Dakota. Our hope is that it helps create better alignment between real need and the technologies, research, investment, and partnerships being built to address it.

Agriculture does not need innovation for its own sake. It needs solutions that are relevant, practical, and grounded in the conditions growers are actually working in. We hope this report helps move that work forward.

DR. WILLIAM ADERHOLDT
// Executive Director of Grand Farm

Background on Grand Farm

Grand Farm is a collaborative network of growers, corporations, startups, educators, researchers, government partners, and investors working together to solve agricultural challenges through technology and innovation. Headquartered in North Dakota's Red River Valley, Grand Farm connects this global ecosystem around real-world agricultural problems and helps accelerate the development, validation, and adoption of new solutions.

Through its Innovation Campus near Casselton, North Dakota, technology demonstration projects, and industry partnerships, Grand Farm provides a platform where agricultural innovation can be tested and refined in collaboration with growers and agricultural professionals. Insights gathered through these collaborations help identify the challenges that most impact production systems across the region. The Regional Agriculture Pain Point Report (RAPPR) builds on these insights to highlight the challenges most consistently identified across the Upper Midwest.

OVERVIEW

Grand Farm's Upper Midwest Regional Agriculture Pain Point Report (RAPPR) identifies the most significant challenges shaping field crop production across Minnesota, North Dakota, and South Dakota. Understanding these individual challenges is critical for innovators, researchers, and industry partners working to develop tools, research, and strategies that address the realities of modern crop production. By organizing these challenges into a focused set of regional pain points, the RAPPR provides a clearer view of the operational and agronomic constraints influencing modern agriculture in the region.

Across the rapidly evolving AgTech landscape, new technologies are emerging faster than the problems they aim to solve are clearly defined. Without a shared understanding of the challenges facing growers, innovation efforts can become fragmented or misaligned with on-farm realities. The RAPPR helps address this gap by highlighting the issues that most consistently affect crop production across the Upper Midwest, helping innovators, researchers, and industry partners focus their efforts where they can have the greatest impact.

Methodology

The RAPPR focuses on field crop production across North Dakota, South Dakota, and Minnesota. The analysis centers on the region's primary crops that represent the majority of field crop acreage and economic value in the Upper Midwest: wheat, corn, soybeans, sunflower, sugarbeet, dry edible beans, canola, and barley.

INITIAL PAIN POINT IDENTIFICATION

RAPPR pain points were identified through synthesis of research priorities published by 11 regional commodity organizations. These grower-funded groups continuously collect producer input, making their priorities a strong proxy for on-the-ground challenges.

Individual issues were grouped into shared themes, such as pest pressure, soil health, water management, labor, and data systems, to identify challenges that cut across crops, geographies, and production systems.

This process resulted in 29 mid-level pain points. These are challenges that are widely experienced across the region and specific enough to be addressed through research, technology, or innovation.

EVALUATION AND SELECTION PROCESS

Each of the 29 pain points was evaluated using a structured scoring framework based on three criteria:

1. PREVALENCE
How broadly the issue impacts crops and regions

2. AGRONOMIC SEVERITY
The impact on yield, risk, and operational complexity

3. TECHNOLOGY ADDRESSABILITY
The potential for innovation to improve outcomes

Technology Addressability					
Economic Impact					
Agronomic Severity					
Prevalence					
	Low Alignment				High Alignment

Pain points were scored on a 1 to 5 scale across each criterion and averaged to generate a composite score. Top-ranking challenges were then reviewed and refined through internal discussion. Some were combined where overlap existed to ensure the final set reflects distinct, high-impact opportunities rather than purely numerical rankings.

This process resulted in the five priority pain points featured in this 2026 Upper Midwest Regional Agriculture Pain Point Report.

SCOPE OF ANALYSIS

The report focuses on challenges that can be influenced through applied research and innovation. Policy-driven or structural issues are acknowledged but not evaluated as primary pain points.

2026

Upper Midwest Regional Agriculture Pain Points

Researched and written by Jenny Lagervall.

1. Decreased Reliability of Weed Control Due to Herbicide Resistance
2. Late Identification of Pest and Disease Pressure Limiting Effective Intervention
3. Excess Soil Moisture And Poor Drainage Limiting Access During Narrow Fieldwork Windows
4. Difficulty Matching Nutrient Applications to Variable Soil Conditions and Crop Needs
5. Skilled Labor Shortages in Increasingly Complex Production Systems

PAIN POINT 1

Decreased Reliability of Weed Control Due to Herbicide Resistance

OVERVIEW

Herbicide resistance has become a major challenge in field crop production, making weed control less reliable both globally and within the region. As resistant populations expand, they remain a recurring research priority for the tri-state region (North Dakota, South Dakota, and MinnesotaND, SD, and MN) commodity councils.

The economic stakes are substantial. If left uncontrolled, weeds in corn and soybean systems alone could result in more than 43 billion dollars in annual losses across North America[1]. Herbicide resistance reduces the effectiveness of weed control, undermining the level of control required to prevent substantial losses.

At the farm level, herbicide resistance is costly. Programs to manage resistant weeds can range from 50 to more than 100 dollars per acre for chemicals alone, two to four times higher than traditional programs[2]. Costs are not limited to inputs. Under uncontrolled conditions, yield losses in corn and soybean systems average approximately 50% and 52%, respectively[3]. This risk is greater in specialty crops, where many herbicide-based solutions are not available or suitable, limiting effective chemical control options[4]. Uncontrolled weed competition has reduced sugarbeet yields by an average of 70% to 75% across Minnesota and North Dakota, while dry edible bean yields in the region face even greater risk, with North Dakota trials documenting potential losses as high as 94%[5].

REGIONAL HIGH-IMPACT HERBICIDE RESISTANT WEEDS

While herbicide resistance is a global issue, pressure in the Northern Plains is driven by three key species consistently identified across regional research priorities.

KOCHIA

// Bassia Scoparia

Adapted to saline and drought-prone soils, Kochia competes aggressively for moisture, reducing yields in corn by an average of 68%, soybeans by 52%, and sugarbeets by over 95% under severe pressure[6]. The species is resistant to five herbicide groups globally, with four documented within the tri-state region[7]. Its tumbleweed dispersal mechanism, releasing on average 2,000–30,000 seeds per plant, rapidly spreads resistant populations across field boundaries[8].

WATERHEMP

// Amaranthus Tuberculatus

Known for emerging in repeated waves throughout the growing season, Waterhemp is resistant to 9-10 herbicide groups globally and up to 7 families regionally[9]. Waterhemp seed production varies widely depending on growing conditions, ranging from potentially fewer than 1,000 to over 1,000,000 seeds per plant when not competing with nearby crops[10]. Season-long waterhemp competition can reduce yields by up to 74% in corn and 56% in soybean, even at relatively low weed densities[11].

PALMER AMARANTH

// Amaranthus Palmeri

An aggressive weed that keeps sprouting throughout the season, Palmer Amaranth can grow 2–3 inches per day, and can reach 6–8 feet tall[12]. A single plant can produce up to 250,000 seeds, allowing it to spread quickly and outcompete crops[13]. It has developed resistance to multiple herbicides, with 9 modes of action globally and 6 reported regionally[14]. It has also been ranked the most troublesome weed in U.S. cropping systems for nearly a decade[15]. Under severe infestations, yield losses can reach up to 91% in corn and 79% in soybean[16].

CURRENT MANAGEMENT APPROACHES

To manage resistant populations, growers rely on complex herbicide programs that use multiple treatments over time to kill existing weeds and prevent new ones from emerging[17]. This complexity is driven in part by metabolic resistance, a mechanism where weeds can break down a herbicide before it can work effectively[18]. As a result, single herbicides are often no longer sufficient, requiring the use of different herbicide types in rotation and combination to maintain control and reduce resistance risk[19].

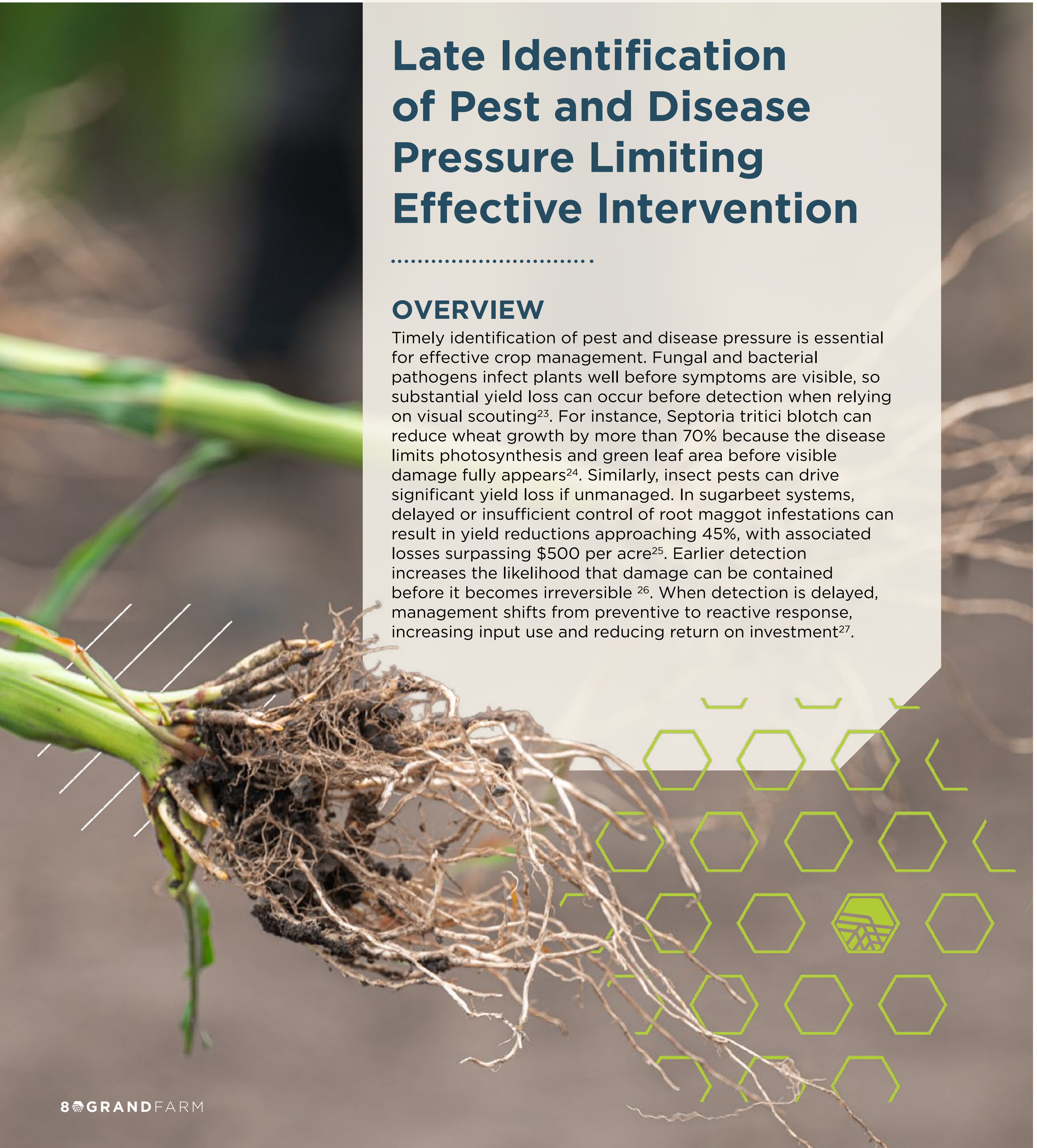
Herbicide programs are sensitive to environmental disruption. In the Northern Plains, weather often restricts application windows; wind prevents spraying, while drought can limit the activation needed to move herbicides into the root zone[20]. Missing these windows often requires unplanned extra applications that increase fuel and labor costs[21]. As a result, growers are increasingly turning to non-chemical tactics such as cover crops, narrow row spacing, and diversified rotations to reduce weed pressure before chemical control is needed[22].

SUMMARY

Herbicide resistance and operational constraints are reshaping weed management across the region, turning a once predictable input into a more complex and variable risk. As resistance spreads, maintaining effective control becomes a broader production challenge with implications for yield, cost, and competitiveness.

PAIN POINT 2

Late Identification of Pest and Disease Pressure Limiting Effective Intervention



OVERVIEW

Timely identification of pest and disease pressure is essential for effective crop management. Fungal and bacterial pathogens infect plants well before symptoms are visible, so substantial yield loss can occur before detection when relying on visual scouting[23]. For instance, Septoria tritici blotch can reduce wheat growth by more than 70% because the disease limits photosynthesis and green leaf area before visible damage fully appears[24]. Similarly, insect pests can drive significant yield loss if unmanaged. In sugarbeet systems, delayed or insufficient control of root maggot infestations can result in yield reductions approaching 45%, with associated losses surpassing $500 per acre[25]. Earlier detection increases the likelihood that damage can be contained before it becomes irreversible [26]. When detection is delayed, management shifts from preventive to reactive response, increasing input use and reducing return on investment[27].

HIGH-IMPACT REGIONAL THREATS

Several major pests and diseases common to the tri- state create persistent detection challenges across multiple crops.

WHITE MOLD

// Sclerotinia Sclerotiorum

This disease can infect hundreds of different plant species including major crops such as soybean, dry bean, canola, and sunflower[28]. Yield losses in grain legumes vary with environmental conditions, but can exceed 50 percent, with losses in soybean occasionally surpassing 60 percent[29]. Effective management depends on identifying infection risk within a narrow window, as treatments are less effective once disease is established[30].

FUSARIUM HEAD BLIGHT

// Fusarium Graminearum

This disease affects cereal crops including wheat, barley, and corn, reducing yield and contaminating grain with toxins that can render it inedible[31]. Risk is driven by warm, wet conditions rather than crop stage, requiring well-timed management ahead of favorable infection conditions[32].

SOYBEAN CYST NEMATODE

// Heterodera Glycines

This disease is the most economically damaging soybean pathogen in North America, accounting for more than 1.5 billion dollars in annual losses[33]. Because it infects roots below ground, yield reductions of 15 to 30 percent may occur before visible symptoms emerge[34]. A key challenge with SCN is its ability to form protective cysts that allow it to survive in the soil for many years and spread as soil is moved[35].

CURRENT MANAGEMENT APPROACHES

The effectiveness of any crop pest or disease intervention is dictated by the speed of detection. Most pests and diseases have predictable periods of vulnerability within their life cycles, such as insect immature stages or weed seedling stages, making early detection and timing critical for effective management[36]. Routine scouting is typically conducted weekly during the growing season[37]. However, as infestations begin to threaten yield or crop quality, or when conditions favor rapid development, monitoring should occur more frequently[38].

While manual scouting remains the primary approach to disease and pest detection, labor shortages and rising production costs are driving increased adoption of digital agriculture tools[39]. For instance, predictive disease models used in regional sugar beet management, provide foresight for pesticide application timing[40]. However, their effectiveness depends on adequate regional weather station coverage and requires local calibration to reflect real-world growing conditions[41]. Remote sensing and imaging technologies show strong research promise for identifying crop diseases, with laboratory accuracies of 95–99% reported across detection methods[42]. However, real-world deployment remains limited due to performance drops of 15–30% in field conditions, high equipment costs from $500–$50,000, and difficulty distinguishing disease symptoms from other stressors like nutrient deficiencies[43].

SUMMARY

Delayed detection of pest and disease pressure compresses already narrow intervention windows, reducing the effectiveness of management strategies. This detection gap increases input use, limits yield protection, and elevates overall production risk.

PAIN POINT 3

Excess Soil Moisture And Poor Drainage Limiting Access During Narrow Fieldwork Windows

OVERVIEW

Across the Midwest and Great Plains, the frost-free season has lengthened by as much as two weeks since the early 20th century, yet increasingly intense and variable weather, including more intense rainfall and increased flooding, is offsetting those gains and narrowing the already tight windows producers depend on[44]. Even then, how those conditions play out in the field often depends on soil type. Across the region, soils have been shaped by glacial history. Heavy clay soils dominating the Red River Valley of eastern North Dakota and western Minnesota are rich in organic matter and support high crop yields, but they tend to hold water and drain poorly[45]. Sandier soils are more common in parts of central Minnesota, where water and nutrients move through the soil quickly[46]. However, even these faster-draining soils can experience standing water and flooding during intense rainfall events[47].

Flat topography across much of the region, particularly in the Red River Valley and surrounding glacial lake plains, increases the likelihood of flooding and water accumulation by limiting natural drainage due to minimal slope[48].

NUTRIENT LOSS AND REDUCED INPUT EFFICIENCY

When fields remain saturated for several days, nutrients can be lost before the crop can take them up. In heavy clay soils, saturated conditions trigger denitrification, a process where microbes convert nitrogen into gas that escapes to the atmosphere before crops can use it[49]. In sandier soils, excess water drives leaching, where nutrients like nitrogen and sulfur are carried below the root zone and are no longer accessible to the crops[50]. Waterlogged conditions also disrupt root function, reducing the crop's ability to take up nutrients that remain, including nitrogen, phosphorus, potassium, magnesium, and zinc[51]. Phosphorus responds differently, as excess water can release it from soil particles and allow it to move with water rather than remain available to crops[52].

In fields with mixed soil types, a single rainfall event can drive losses through multiple pathways at once[53]. The yield impacts are substantial: a global meta-analysis of 115 studies found waterlogging reduced average crop yields by 33%, with wheat averaging a 25% reduction and maize losses exceeding 50% when saturation persisted beyond six days[54]. For producers who have already paid for inputs and are now watching a narrow growing window close, these are not abstract statistics but real losses on fields that may not recover within the same season.

COMPACTION RISK AND LONG-TERM CONSEQUENCES

Excess soil moisture also increases the likelihood of soil compaction, where heavy equipment compresses the soil and limits its ability to support crop growth[55]. With more intense rainfall and flooding, cropland soils are at risk of compaction throughout the growing season[56]. Compaction risk varies by soil type: clay soils hold water more readily, while sandy soils drain more quickly, but both are at risk under wet conditions[57].

The impact of compaction is both immediate and long-term. When soils are worked under wet conditions, compaction increases soil density and reduces water infiltration. This makes it harder for soils to store and supply water and nutrients, while causing water to pool at the surface and increasing runoff[58]. These effects do not resolve quickly. Crop losses of 9% to 55% have been observed in the first two years following compaction, with a median reduction of 21%[59]. In western Minnesota, corn and soybean yields dropped 16–17% for two years after a single wet season[60] . In some cases, soils may not fully recover within four growing seasons[61].

This leaves producers with a difficult choice: delay fieldwork and risk missing critical windows across the season, or operate in wet conditions and accept multi-year yield losses[62]. As a result, excess moisture becomes a long-term production risk rather than a short-term disruption.

CURRENT MANAGEMENT APPROACHES

Producers across the region draw on a range of tools to manage excess soil moisture, each with meaningful benefits and real limitations. Conventional tillage, which involves physically turning and aerating the soil, can help dry fields faster in wet conditions but degrades soil structure over time, making drainage worse in the long run[63]. No-till systems take the opposite approach, preserving soil structure and improving how water moves through the soil, though these benefits often take multiple growing seasons to develop[64] . Subsurface tile drainage uses a network of underground pipes to remove excess water from the soil profile and can allow earlier planting and improve yields on poorly drained soils, but installation is costly and can increase nitrate loss into nearby waterways[65]. While each of these approaches can be effective under the right conditions, cost, landscape, and the unpredictability of wet seasons mean excess moisture remains an ongoing challenge for many producers across the region.

SUMMARY

Across Minnesota, North Dakota, and South Dakota, increasingly intense rainfall is reducing workable field days and disrupting planting, nutrient efficiency, and soil conditions. Excess soil moisture has become a recurring structural constraint on timely operations and yield stability across major Northern Plains cropping systems.

PAIN POINT 4

Difficulty Matching Nutrient Applications to Variable Soil Conditions and Crop Needs

OVERVIEW

The landscape of the tri-state region was shaped by glaciers, leaving behind a patchwork of hills, depressions, and wetland potholes. The result is farmland where soil texture, drainage, and nutrient availability can shift over just a few hundred feet[66]. Low-lying areas tend to accumulate water, sediment, and organic matter, storing up to 76% more organic matter than nearby hilltops, while higher ground stays drier and nutrient-poor[67]. Crops respond to those differences, and yields can vary significantly from one part of a field to another, even under identical management[68].

WITHIN-FIELD SOIL VARIABILITY AND NUTRIENT MANAGEMENT CHALLENGES

High and low areas within a field don't just hold different amounts of organic matter; they create fundamentally different nutrient environments for a crop to grow in. A statewide survey of commercial farms in Minnesota found that 7 of 15 soil health indicators were influenced by hillslope position, with consistently larger nutrient pools in lower areas[69].

This pattern is evident in key nutrients such as nitrogen and phosphorus, both of which tend to be higher in lower areas[70]. Organic nitrogen also releases at different rates, with slower release in the drier soils on higher ground[71]. Sulfur follows a similar pattern, with deficiency more common on higher ground where coarser, low-organic-matter soils allow sulfate to leach from the root zone, a pattern seen in crops like canola, wheat, and corn[72]. Sulfate levels can also vary widely within a single field[73].

In practice, a single field often contains multiple nutrient environments that respond differently to the same fertilizer application. Uniform application based on a field average can lead to over-supply in some areas and under-supply in others, driving up input costs and making efficient nutrient management a persistent challenge for producers across the region[74].

MATCHING NUTRIENT TIMING TO CROP DEMAND

Beyond variable soil conditions, effective nutrient management also requires applying nutrients at the right time, a challenge made difficult by the region's climate and operational realities. Phosphorus and potassium remain relatively stable once applied, but phosphorus becomes less accessible in the cold spring soils typical of the Northern Great Plains, limiting uptake even when soil test levels are adequate[75].

Nitrogen presents a more acute challenge because it is highly mobile in the soil and vulnerable to loss through multiple pathways[76]. Preseason application is more practical than multiple in-season passes, but nitrogen applied weeks or months before crop demand does not simply remain available. For example, residue from previous crops, such as corn stalks and wheat straw, is broken down by soil microbes that temporarily lock nitrogen away from young plants, even in recently fertilized fields[77]. For cereal crops like wheat, these early-season nitrogen shortages can limit leaf area and root development during critical establishment stages, reducing yield potential even if nitrogen becomes available later[78].

Timing sensitivity extends to other crops in the region as well. For sugarbeets, nitrogen that remains available late in the growing season, whether from over-application or gradual release from decomposing organic matter, promotes leaf growth rather than sugar storage in the root, directly reducing the sucrose concentration that determines crop value[79].

Taken together, these dynamics mean that even a well-planned fertilizer application can fall short, not because of how much is applied, but when it is available to the crop.

CURRENT MANAGEMENT APPROACHES

Nutrient management in this region has evolved beyond blanket field applications toward strategies that account for within-field variability[80]. One of the primary approaches used to manage this variability is zone-based soil sampling, which divides fields into areas based on soil characteristics, terrain, and yield patterns to generate prescription maps that direct where and how much fertilizer to apply. These maps are then used by GPS-equipped applicators through variable-rate technology, which adjusts fertilizer flow as equipment moves across a field to match nutrient conditions[81]. However, this approach relies on data that can vary depending on how and when samples are collected, and because these maps represent conditions at a single point in time, they may not fully capture how nutrient availability shifts throughout the growing season in response to weather, residue decomposition, and soil temperature[82].

More recent approaches have explored the use of in-field sensors mounted on application equipment to detect soil and crop conditions in real time. These systems can feed data directly into variable-rate applications without relying on a pre-built map. However, adoption is still limited due to cost and equipment availability[83]. Even in systems where sensors are used, readings can be influenced by factors such as soil moisture, salinity, dust, and sun angle, which may affect accuracy and complicate interpretation of nutrient status[84].

Taken together, the tools available to producers in this region represent meaningful progress, but they have not yet fully closed the gap between the complexity of the landscape and what current technology can consistently capture.

SUMMARY

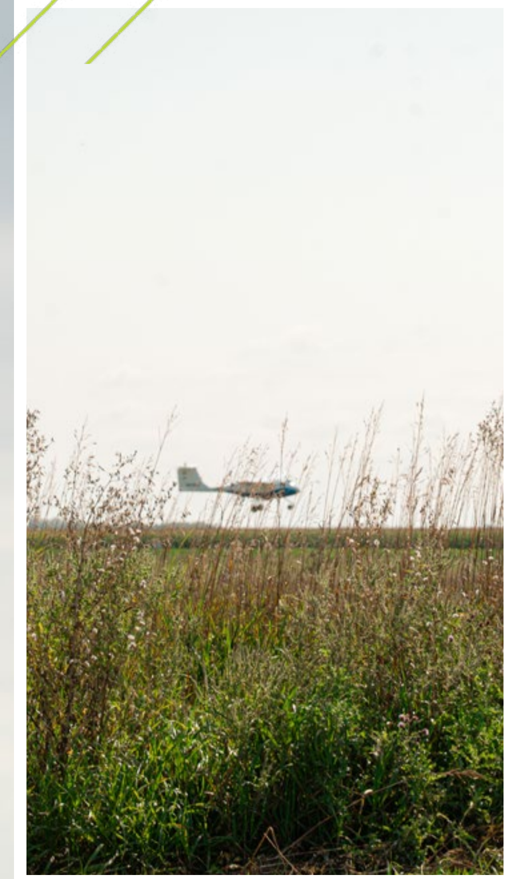
Soil variability and timing gaps make it difficult to match fertilizer applications to crop needs, even when inputs are applied correctly. Differences within and across fields, combined with shifting nutrient availability throughout the season, create persistent inefficiencies in nutrient use. While tools such as soil sampling, mapping, and sensors improve decision-making, each has limitations that prevent fully precise nutrient management.

PAIN POINT 5

Skilled Labor Shortages in Increasingly Complex Production Systems

OVERVIEW

Labor availability in agricultural regions is shaped by broader demographic trends affecting rural America. Nationally, rural areas saw a small population increase from 2023 to 2024[85]. However, farming communities have largely missed this limited growth, experiencing virtually no population change[86]. Further, migration has not been even across age groups, younger workers continue to leave, with the sharpest declines among residents aged 25 to 34[87]. Meanwhile, rural populations are aging as the Baby Boomer generation reaches retirement age[88]. Farm producers nationally and regionally average in their late 50s, with only 9 percent under age 35[89].



THE GROWING SKILLS GAP IN MODERN AGRICULTURE

As production systems shift from mechanical to digital, the nature of agricultural work is changing. North Dakota and South Dakota rank among the top five states nationally for precision agriculture adoption, with more than half of farms in each state using these practices [90]. Operations that once depended on a larger workforce performing physically demanding tasks now rely on fewer workers managing complex automated systems, monitoring performance, interpreting data, and intervening when technology fails or encounters unexpected conditions[91]. Each worker is expected to manage more, and the skills required are more specialized than in previous generations of farm work[92].

This shift has created a persistent mismatch between what the industry needs and what it can find. A national workforce survey found that applicants for precision agriculture positions were rated low or deficient in nine out of ten skill areas evaluated[93]. The challenge is not simply a shortage of technical ability, it is the difficulty of finding workers who combine digital proficiency with the hands-on understanding of crops, soil, and equipment that effective decision-making requires[94]. Filling that gap has proven difficult even at the institutional level. Research led in part through South Dakota State University found that precision agriculture innovation occurs primarily in industry, and universities have struggled to develop curricula and find instructors with the necessary expertise to keep pace[95]. Meanwhile, the informal pathway, the experiential knowledge built through years of direct engagement with field conditions, is also narrowing as operations automate and fewer workers are involved in hands-on production[96] .

CURRENT MANAGEMENT APPROACHES

Even on operations that have adopted precision agriculture technologies and have capable people running them, the volume of information generated creates its own burden. Currently, the capacity to collect data has outpaced the ability to convert it into usable information[97]. Producers collect data on soil conditions, crop health, equipment performance, and yield variability across every acre they manage, but few analytical tools exist to help translate it into actionable decisions[98]. Data-intensive technologies like variable rate application have seen limited adoption in part because they require decision-making skills that go well beyond operating the equipment itself[99].

This is not simply a skills problem. It is a capacity problem. Larger operations may have the workforce to distribute these demands across specialized roles, but many smaller and mid-sized operations do not[100] . Under seasonal conditions where timing is critical to production outcomes, this gap in capacity becomes an operational vulnerability[101]. As digital systems take over more routine work, the decisions left to the operator become less frequent but more consequential[102]. These challenges are compounded by producer concerns about how their data is collected, shared, and controlled by technology providers, which can discourage engagement with the tools designed to support them[103]. The technology ecosystem has been slow to address these gaps, with development largely oriented toward automating decisions rather than supporting the people who make them[104].

SUMMARY

Labor shortages in the Northern Plains reflect both a shrinking workforce and a widening gap between the demands of modern production systems and the capacity available to meet them. The challenge is no longer just finding enough workers. It is ensuring that the people managing these systems have the support, tools, and expertise to use them well.

3717 153rd Ave SE
Wheatland, ND 58079
grandfarm.com
info@grandfarm.com

REFERENCES

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