Integrating wheat and other small grains into the corn–soybean rotation

Opportunities and challenges for the U.S. Midwest region

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Winter rye crop in a no-till corn field in Iowa in the spring. Photo by Tom Kasper (USDA-ARS).

> Winter wheat, barley, oats, rye, and other small grains provide opportunities not only for additional farm revenues, but also for covering the soil during winter, improving soil health by providing living roots in the soil, diversifying rotations, and improving weed and disease management. Yet, small grains do not receive the focus in most of the Midwest due to barriers such as infrastructure, market availability, crop insurance, and farm schedules favoring corn and soybean. Increasing environmental concerns, declining crop diversity, pesticide resistance, nutrient losses, soil degradation, and climate variability have renewed the interest in integrating winter wheat and other small grains into Midwestern production systems.

Across the U.S. Midwest, soybean was initially promoted as high-protein animal feed and human food in the 1920s and since then corn–soybean rotation has dominated the cropping system for more than seven decades due to advances in corn and soybean genotypes, strong export markets, better industrial infrastructure, ethanol production, and overall high grain demand in the region (Li et al., 2025).

The predominance of corn–soybean rotations creates recurring management windows for summer annual weeds such as waterhemp, while repeated reliance on herbicides can intensify selection pressure for resistant populations (Yadav et al., 2023). Moreover, the effectiveness of the corn–soybean rotation for pest suppression has also been challenged by pest adaptation. Corn rootworm (CRW) and soybean cyst nematode (*Heterodera glycines*, SCN) have adapted to the corn–soybean rotation through different mechanisms. Northern CRW populations can exhibit extended diapause, while SCN populations often maintain higher egg densities in one- to two-year rotations than in three-year rotations that include a small grain such as wheat (Yin et al., 2024). Northern CRW (*Diabrotica barberi*) populations in parts of the Midwest have evolved extended diapause, allowing eggs to remain dormant and hatch when corn returns following soybean. Extended diapause has re-emerged as an important management concern in Minnesota, with northern CRW injury observed in first-year corn following soybean in 2025 (Yang & Wang, 2025). Rocha et al. (2021) observed that frequent soybean production can maintain substantial SCN populations in infested fields, whereas introducing nonhost crops can help interrupt nematode reproduction. In Illinois field experiments, winter wheat preceding double-crop soybean reduced SCN egg densities by approximately 32% compared with winter fallow.

Recent findings on nitrate-nitrogen loss, water quality, soil degradation, and sustainable climate-resilient cropping strategies have renewed the topic of diversifying current cropping systems with winter wheat emerging as one of the potential options (Gentry et al., 2025). Small-grain crops such as wheat, oats, barley, triticale, and rye with relatively small kernels bring several benefits to the soil and agroecosystem through diversifying the rotation and improving soil health. Nevertheless, few buyers, low revenue, high grain-quality risk, and additional crop management requirements pose disadvantages.

Current status of wheat and small-grain production

Wheat is the third-largest field crop in the USA after corn and soybean with a harvested area of approximately 37.2 million acres in 2025 (USDA, 2026). In the Midwest, most wheat production acreage consists of soft red winter wheat and is concentrated primarily in Ohio (12th in USA in 2025), Indiana (18th), Illinois (10th), Michigan (8th), Missouri (16th), and Kentucky (16th) where straw has value as livestock bedding, garden mulch, or compostable food packaging.

In the Midwest, most wheat production acreage consists of soft red winter wheat. Photo courtesy of Adobe Stock/ROMAN DZIUBALO.

Nevertheless, planted wheat acreage has consistently declined over the past four decades due to lower economic returns and stronger international competition from major wheat-exporting countries in Europe, namely Russia, France, and Ukraine. Similar trends have been observed in other small grains as well. The decline of small grains is particularly striking in the Upper Midwest—Iowa, Illinois, Minnesota, and Wisconsin—where wheat, oats, barley, and rye altogether account for only about 0.7% of field crop acreage, and oat acreage declined by approximately 97% between 1929 and 2022 (Asprooth et al., 2023).

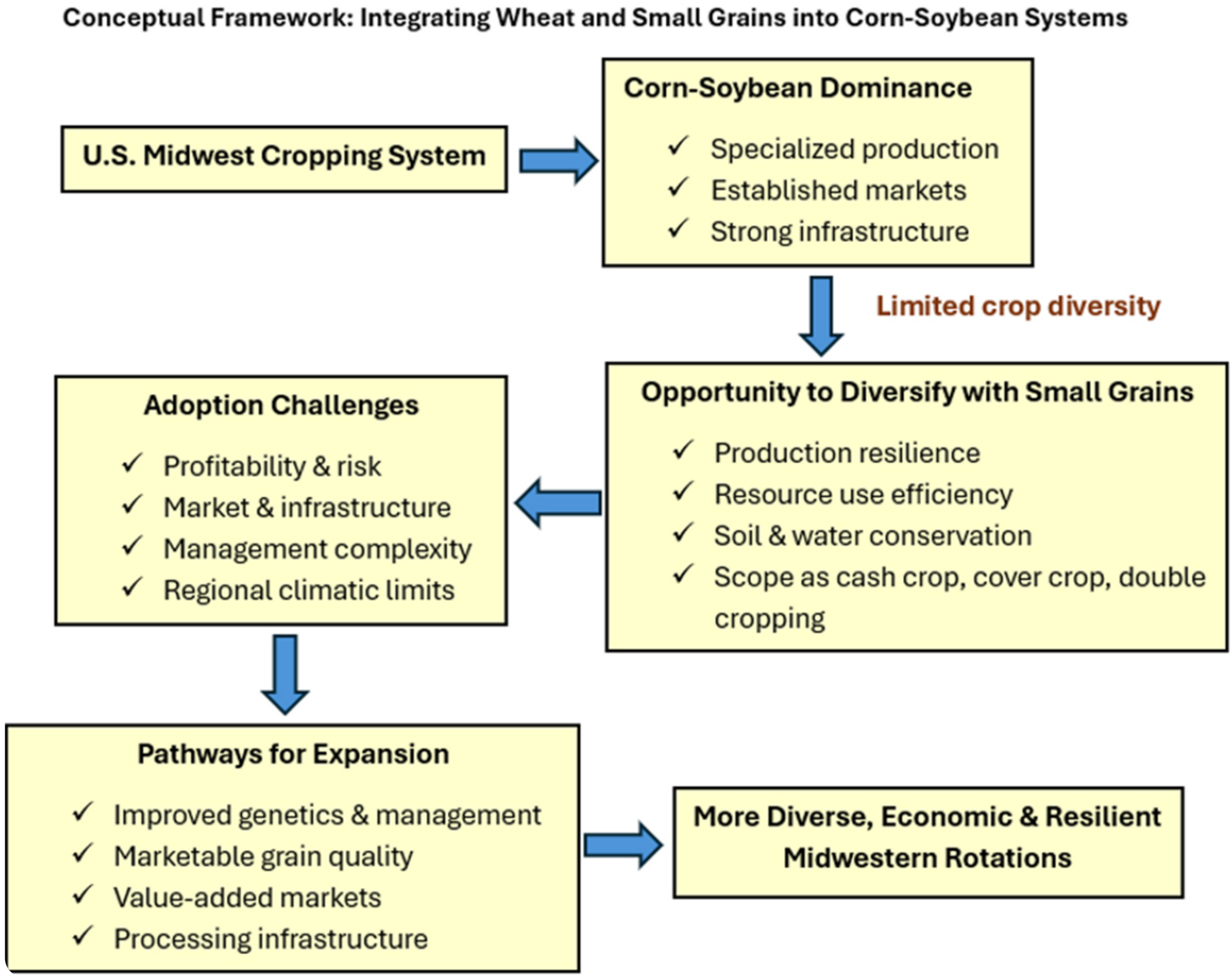
The same long-term pattern is evident farther south. Missouri Extension reports that oat acreage declined from more than 2 million acres in the 1940s to approximately 30,000 acres, commercial barley production has drastically declined, and rye has transitioned from a grain crop to a cover crop, although winter wheat remains an important component of the state's agricultural economy. These trends indicate a structural transformation of Midwestern agriculture, which is the outcome of decades of specialization in corn and soybean, accompanied by contraction of small-grain markets, processing infrastructure, research investment, and other components of supply chain.

Dominating corn–soybean rotation

Corn–soybean rotations dominate much of the U.S. Corn Belt; recent assessments indicate that they account for more than 80% of cropland in major Corn Belt states, including, approximately 93% in Illinois, 92% in Indiana, and 82% in Ohio (Robertson et al., 2024). USDA Cropland Data Layer records from 2008–2021 confirm the same cropping pattern (Wu et al., 2025). Long-term Midwestern research demonstrates that rotating corn and soybean consistently provides substantial yield advantages over continuous production. In a 28-year Nebraska experiment, corn following soybean outyielded continuous corn in 19 of 28 years, while soybean following corn outyielded continuous soybean in two-thirds of the study years, with crop rotation showing greater impact on productivity than tillage (Sindelar et al., 2015).

Both corn and soybean are planted in late spring (April–May), grow during summer, and are harvested in fall (October to early November) with no or very little soil cover between harvest and planting. A large quantity of nitrogen is supplied to narrow-leaf corn, and the pathogen cycle is disrupted by the rotation with soybean. On the other hand, broadleaf soybean in general requires less fertilizer.

In recent years, diversification of Midwest agriculture has been part of scientific discussion due to increased pest resistance, negative impact on the environment from pesticide usage, and socioeconomic issues related to input expenses. The challenge for diversification, therefore, is not simply to demonstrate that wheat and other small grains can do well in the Corn Belt, but to establish that a cool-season crop can provide sufficient agronomic and economic value to compete within an existing corn–soybean production system. Winter wheat has the most potential in Midwest as the third crop; however, oats, barley, cereal rye, spring wheat, and other small grains may also be grown depending on the farm type, and local markets. These crops can spread the risk, extend the soil coverage, disrupt the pest cycle, and create opportunities for livestock forage. But from the practical standpoint, the central question is whether wheat or another small grain can significantly affect the whole-farm performance.



Opportunities and constraints for integrating wheat and other small grains into corn-soybean rotations in the U.S. Midwest.

Wheat in corn–soybean system

Wheat has the value not specifically for grain revenue; rather, the combined effect of wheat through grain, straw, forage, cover crop establishment, rotational effects on following crops, and integrated crop management creates a highly productive and sustainable three-year (corn–soybean–wheat) or four-year (corn–soybean–wheat/double-crop soybean) cycle. A 36-ear experiment showed that the benefits of diversification became more prominent over time; during the last 16 years, wheat rotation increased corn yield by 4.2–11.8%, and a four-year wheat rotation generated 10% higher net returns than the corn–soybean rotation at one site despite wheat itself providing lower direct returns (Janovicek et al., 2021). However, this benefit is not consistent across regions. Some studies have shown that corn–soybean rotations provide significant advantages over continuous cropping but that adding wheat confers little additional short-term yield benefit (Mourtzinis et al., 2017). In short, wheat should not be evaluated primarily by its yield or for cash-flow advantage in the year it is grown; its value in corn–soybean agrosystem is to be assessed through the productivity, input-use efficiency, and economic performance of the entire rotation over time.

Winter wheat as cash crop and cover crop

Winter wheat is planted in the fall. Photo courtesy of Adobe Stock/Stockphotoman.

Winter wheat is planted in the fall, goes dormant in winter, and is harvested in summer. It can bridge the roles of cover crop and cash crop. A grower may establish wheat to maintain winter cover and, where the stand, market conditions, field and growing seasons are favorable, potentially manage it toward grain harvest rather than terminating in the spring (April to early May). This crop, because it is winter hardy and tolerates relatively low soil fertility, can also be integrated into corn–soybean systems as a cover crop rather than being carried to grain harvest. In Ohio, the wheat planting window averages from approximately the last week of September to first week of November. Less aggressive development of winter wheat than cereal rye in spring offers advantage of managing cover crop biomass. Ohio State recommends terminating winter wheat at least 14 days before corn planting to reduce potential negative effects associated with N immobilization and allelopathy. USDA-NRCS recommendations include early wheat termination under dry conditions where N tie-up or a pest habitat is a concern. Winter wheat is thus not a substitute for cereal rye or any such cover crop, but a multipurpose winter cereal whose role can be tailored to the agronomic and economic objectives of the rotation.

Benefits of small grains in agroecosystem

The benefits of integrating wheat and other small grains into corn–soybean rotations extend beyond grain production. By increasing crop diversity, small grains improve soil function, enhance resource use efficiency, and contribute to more resilient agricultural systems.

Improving soil health

Small grains maintain living roots during the fall, winter, and early spring while producing extensive fibrous root systems that improve soil structure. Their residues also remain on the soil surface longer than soybean residue because of their higher carbon-to-nitrogen ratio, helping protect the soil from erosion while contributing organic carbon that supports microbial activity and nutrient cycling.

Small grains maintain living roots during the fall, winter, and early spring while producing extensive fibrous root systems that improve soil structure. Photo by USDA NRCS South Dakota.

Long-term studies have documented measurable improvements in soil properties following the inclusion of cereal cover crops and other small grains. Blanco-Canqui et al. (2015) reported increases in soil organic carbon ranging from 0.1 to 1.0 Mg C ha^{-1} yr^{-1}, runoff reductions of up to 80%, and sediment loss reductions ranging from 40 to 96%.

In a subsequent review of 98 peer-reviewed studies, Blanco-Canqui & Ruis (2020) found that cover crops reduced soil compaction by an average of 5%, increased aggregate stability by an average of 16%, and improved water infiltration by an average of 43%, although responses varied with soil type, climate, and management.

Improving resource use efficiency

Including wheat extends the period during which sunlight, water, and nutrients are captured by the cropping system. Simão et al. (2024), in a review of nearly 300 peer-reviewed studies, concluded that adding wheat to simple crop rotations can improve nitrogen and water use efficiency while reducing nitrogen fertilizer requirements, nitrogen losses, greenhouse gas emissions, soil acidification, and production costs.

This synthesis is supported by recent field research from central Illinois. In a nine-year comparison of a conventional corn–soybean rotation and a diversified corn–soybean–winter wheat/double-crop soybean rotation with cereal rye, Gentry et al. (2025) reported approximately a 50% reduction in tile nitrate loss while maintaining corn and soybean productivity, demonstrating that greater crop diversity can improve nitrogen retention without sacrificing productivity.

Weed suppression and pest management

Small grains provide additional opportunities to manage weeds by changing the timing of field operations and increasing residue cover after harvest. Wheat residue forms a physical mulch that reduces light reaching the soil surface, suppresses weed emergence, conserves soil moisture, and delays early-season weed growth. Simão et al. (2024) also summarized evidence that wheat residue contains allelopathic compounds capable of suppressing the germination and growth of several weed species, providing an additional mechanism for weed control.

Adding wheat also interrupts pest and disease cycles by introducing a crop with different planting and harvest dates than corn and soybean. The review by Simão et al. (2024) identified wheat as an effective break crop that can interrupt pest populations, reduce disease pressure, and support greater faunal diversity within agricultural systems.

Increasing management flexibility

Winter wheat is harvested several weeks before corn or soybean, creating additional opportunities for field operations during the summer. This management window allows producers to establish cover crops earlier, apply manure or lime under favorable conditions, complete conservation practices, or prepare fields for the following crop while distributing labor and machinery use more evenly throughout the growing season.

Winter wheat is harvested several weeks before corn or soybean, creating additional opportunities for field operations during the summer. Photo by Tao Wang.

Improving long-term system resilience

Diversified rotations distribute production risk across crops with different growing seasons and management requirements. Simão et al. (2024) concluded that incorporating wheat into crop rotations improves the resilience of agroecosystems to both biotic and abiotic stresses while reducing variability in economic returns.

Major challenges in the Midwest

Despite these agronomic and environmental benefits, wheat and other small grains occupy only a small share of Midwestern cropland. Their adoption is limited by a combination of economic, logistical, and management challenges.

Limited market infrastructure

Compared with corn and soybean, marketing opportunities for small grains remain more limited throughout much of the Midwest. Simão et al. (2024) noted that declining wheat acreage in North America has been driven in part by the expansion of more profitable crops, such as corn and soybean, together with changes in production technologies and market conditions.

Grain quality requirements

Unlike corn, wheat value depends not only on grain yield, but also on quality characteristics such as protein concentration, test weight, falling number, and disease damage. Environmental conditions during grain filling and harvest can substantially affect these quality traits, increasing marketing risk.

Additional management requirements

Integrating a third crop requires additional management decisions throughout the growing season, including variety selection, planting dates, fertility management, disease control, harvest timing, and grain storage. These additional management requirements can increase labor demands and complicate scheduling within existing corn–soybean operations.

Limited research and technical support

Although interest in diversified cropping systems continues to grow, most breeding efforts, Extension programs, and decision-support tools in the Midwest remain focused on corn and soybean. Consequently, producers often have fewer locally adapted recommendations and less technical support available for successful small-grain production.

Economic considerations

Annual crop selection is often driven by short-term profitability. Simão et al. (2024) highlighted that many producers recognize the agronomic benefits of diversifying corn–soybean rotations, but identifying alternative crops with comparable economic returns remains a major barrier to adoption.

Improving wheat and small grains profitability in the U.S. Midwest remains challenging. Capturing additional income from double-crop soybean is one possibility. Photo courtesy of the United Soybean Board.

What can be done to improve profitability?

Improving wheat and small grains profitability in the U.S. Midwest remains challenging because wheat must compete for land with high-yielding corn and soybean while the markets and infrastructure facilities largely are developed around those two crops. Increasing yield alone may therefore be insufficient to make the crop competitive. A more practical approach would be to improve the value of small-grain cropping systems by reducing unnecessary production costs, protecting yield and grain quality, capturing additional income from double-crop soybean or straw, and improving market access.

Capture value beyond grains

In areas with adequate growing season, winter wheat with double-crop soybean can materially improve the economics of the wheat phase. The key to the opportunities should represent real farm value. Straw has value where there is buyer. Grazing has value if there is livestock arrangement. Hence each alternative should therefore be evaluated using farm-specific prices, yields, machinery, transportation, and labor costs.

Manage for economic return, not maximum yield

The most profitable crop is not necessarily the one receiving the greatest quantity of external inputs. So, seed, fertilizer, pesticides, tillage, and similar other inputs need to be assessed according to their probability of generating an economic return. Michigan State University Extension recommendations include reducing extra variable costs such as tillage where appropriate, matching nitrogen rates to realistic yield potential, applying phosphorus and potassium as per soil test recommendations, applying micronutrients and insecticide only when there is need, and selecting high-yielding, disease-resistant varieties.

Protect yield potential through timely plant establishment

Some management decisions have relatively low costs but greater potential for profitability. Planting date is one of such decisions. Late planting of winter wheat has less scope for healthy fall establishment and tillering before the winter sets in and thereby, negative impact on final yield. Huang et al. (2025) found that delayed planting shortened winter wheat's growing period by about 16 days and reduced grain yield by 9.77%. In their study, the largest yield-component response was a 9.33% reduction in spike number, while thousand-grain weight declined by 1.17%.

Grow double-crop soybean where growing season supports

The economic scope of winter wheat changes considerably where soybean can be successfully double-cropped after wheat harvest. The system exists in parts of the southern Midwest, particularly southern Illinois, where the wheat–double-crop soybean phase can be among the most profitable phases of a corn–soybean–wheat rotation (Gentry et al., 2025; Parvej & Holshouser, 2025). Management options such as selecting early maturing wheat cultivars with better yield potential may advance soybean planting by approximately 7–10 days.

Protect marketable yield and grain quality

Quality management begins with regionally adapted varieties that combine yield potential with disease resistance to avoid factors than can reduce the value of wheat such as Fusarium head blight shown here. Photo by Guihua Bai (USDA-ARS).

Fusarium head blight (FHB), DON contamination, low test weight, lodging, preharvest sprouting, and discoloration can reduce the value of wheat. Quality management begins with regionally adapted varieties that combine yield potential with disease resistance, stress tolerance, and appropriate end-use characteristics, while breeding for nutritional quality and biotic and abiotic stress tolerance continues (Saha et al., 2025). For wheat, processing quality is strongly affected by grain protein concentration and composition—specifically glutenins and gliadins, reflecting interactions among crop genetics, environment, nitrogen and sulfur nutrition, and water availability (Peng et al., 2022). The Ohio State University Extension recommendations include prioritizing FHB through combine airflow at harvest to remove lightweight Fusarium-damaged kernels and harvesting heavily affected fields at approximately 18–20% moisture when conditions permit, followed by prompt drying for safe storage.

Conclusion

Whether wheat and other small grains can provide value at the farm level in Midwestern corn–soybean systems depends on economic returns, global competition, farm policy, and technological advances. Their limited presence in the Corn Belt does not necessarily indicate a lack of agronomic value. Rather, it reflects an agricultural system in which corn and soybean generally benefit from stronger markets, infrastructure, genetic improvement, and economic incentives. Despite recognizing the benefits of diversified rotations, a survey of Iowa farmers identified lack of markets, high land rents, limited access to improved small-grain genetics, and equipment requirements as major barriers to incorporating small grains (Weisberger et al., 2021). In this survey, 82% of farmers identified the lack of robust small-grain markets as an important barrier, while only 28% agreed that extended rotations could be as profitable as conventional corn-based rotations and 41% remained uncertain about their long-term profitability.

On the other hand, research shows that adding small grains can address the gaps in a two-crop rotation. In Ohio, adding winter wheat to a corn–soybean rotation increased soil organic matter in some site-years and increased soybean yield in two site years; however, corn yield was reduced in five of eight site years, averaging 17% lower under the corn–soybean–wheat rotation (Huo et al., 2021). A nine-year study in Illinois comparing a diversified three-year corn–soybean–winter wheat/double-crop soybean rotation, with cereal rye following corn, against a conventional two-year corn–soybean rotation found that overall tile nitrate loss was approximately 50% lower in the diversified system (Gentry et al., 2025). However, the trade-offs were high cereal rye biomass reduced soybean yield, and an early freeze can significantly reduce double-crop soybean performance; hence, benefits of diversification depend on management and weather as well.

Winter wheat can function as cash crop followed by double-crop soybean, allowing two crops to be harvested from the same land in one year. It can also provide winter cover, capture nutrients, protect soil from erosion, and a provide a longer period of living roots. Small grains, including oats, barley, rye, and triticale, can further create opportunities for forage, livestock integration, and cover crop seed markets. Expanding small grains in the Midwest will require perspectives beyond the yield of small grain itself. Profitability should be evaluated across the whole rotation, including grain and straw revenue, double-crop soybean, forage or livestock value, effects on subsequent crops, changes in weed and nutrient management, machinery and labor costs, and possible conservation incentives. With stronger markets, appropriate incentives, improved genetics, and effective management strategies, wheat and other small grains could become strategic components of more diverse, resilient, and economically sustainable corn–soybean systems across the U.S. Midwest.

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