

SYSTEMATIC STRATEGIES FOR INCREASING YIELD IN THE WHEAT SOYBEAN DOUBLE-CROP ROTATION

INCLUDING RECOMMENDATIONS FROM INDUSTRY EXPERTS



WHAT'S INSIDE

Director Comments	2	Economics of Double-Crop Soybean Production	26
Introduction	3	Benefits	28
Wheat Management	4	Resources	29
Soybean Management	15	Advisory Panel	30
Relay Cropping	24	Footnotes	31



Double-cropping soybeans after wheat is a way to maximize returns on assets and is agronomically feasible in Southern Illinois. Long-term studies published by the University of Illinois show that this rotation is usually more profitable than planting corn or soybeans alone. However, both wheat and soybean crops face challenges that can limit yield and profitability. This new double-crop production guide includes the most up-to-date best management practices that can improve productivity and sustainability of this rotation. We encourage you to review it and adopt those practices that fit into your operation.

DAN RUBIN

President, Illinois Wheat Association



At the Illinois Soybean Association, we are dedicated to helping Illinois soybean growers be as profitable as possible. Subject matter experts across the soybean and wheat industries collaborated to create this Double-Crop guide, and we hope it will serve as your go-to resource for growing wheat and double-crop soybeans. Be sure to visit ILSoyAdvisor.com to find numerous soybean production resources: in-season management blogs, podcasts, webinars and more. And engage with ILSoyAdvisor on Twitter, @ILSoyAdvisor. While you're visiting ILSoyAdvisor, be sure to sign up for the ILSoyAdvisor weekly e-newsletter to get the latest soybean agronomy advice delivered right to your inbox.

ROBERTA SIMPSON-DOLBEARE

Nebo, Illinois, farmer and Illinois Soybean Association Board Member



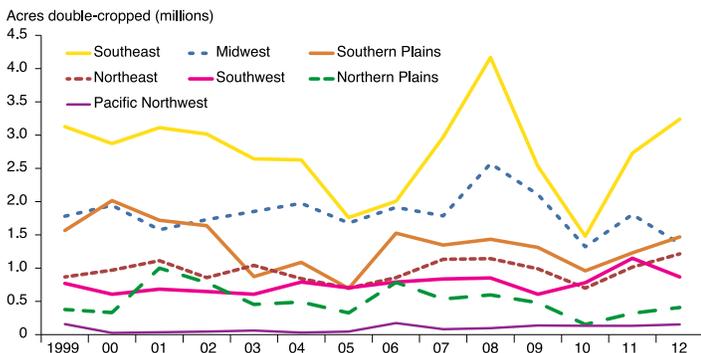
Double-cropping soybeans after wheat is a common rotation in Southern Illinois, along the Ohio River, down the Mississippi Delta and along the Atlantic Coast. Double-cropping soybeans after wheat has been limited to south of the 39th parallel (Latitude of Litchfield, Ill.) with relay cropping soybeans into wheat suggested for north of the parallel.

The practice of planting soybeans immediately after wheat harvest enables growers to harvest three crops in two seasons. In a typical double-crop system, corn harvest is followed by planting winter wheat. The wheat is harvested the next spring followed by planting soybeans. Harvesting three crops across two seasons can generate more revenue than two crops alone.

Advances in breeding have introduced earlier maturing wheat lines, and better grain drying technologies now allow for wheat harvest to occur at higher moistures, enabling growers to plant soybeans more quickly. This practice also moved double-crop soybeans farther north to 40°N, which is the latitude of Bloomington-Normal.

FIGURE 1. DOUBLE-CROPPED ACREAGE VARIES BY REGION, 1999 - 2012.

Source: USDA, Economic Research Service calculations of double-cropping acreage based on NASS, June Area Survey data.



Note: Estimates are weighted with USDA, National Agricultural Statistics Service (NASS)-supplied survey weights. Regions are derived from U.S. Geological Survey hydrologic unit code boundaries.



The wheat/soybean double-crop system is a popular rotation (Figure 1) in the Midwest. The highest adoption of this system is in the Southeast with about one-third of total U.S. double-cropped acreage, and the Midwest had almost one-fifth (with an average of 1.8 million acres).

While this double-crop rotation is well established, it has faced challenges in recent history due to the high yield and seemingly greater profitability of corn and low yield and price of wheat, discounts to wheat at the elevator and low double-crop soybean yields.

However, recent changes in technology have made the wheat/soybean double-crop rotation more economically viable and sustainably valuable.

Why might a grower adopt this rotation?

- Wheat in the rotation is good for soil conservation and soil health.
- Wheat acts like a cover crop in fall, winter and spring, protecting the soil and scavenging nutrients.
- Wheat can be grazed in the spring.
- Wheat straw can reduce SCN egg count when soybeans are no tilled into residue.¹
- Soybeans after wheat act like a cover crop in the summer and fall by scavenging nitrogen, suppressing weeds and stimulating soil biology.
- Soybean planted after wheat benefits soybean yields.

USING THIS GUIDE

The purpose of this guide is to help growers make the best management decisions, increasing yields of both crops in the rotation while increasing profitability of the enterprise.

Winter wheat is a popular grain crop in the U.S. with different market classes grown depending on the flour product needed for the specific consumer product. Across the double-crop region, soft red winter wheat (SRW) is the most common class grown with low-to-medium protein and soft endosperm. SRW is used for cake flour, pastry flour, flatbread flour and mixed with hard wheats for all-purpose flour.

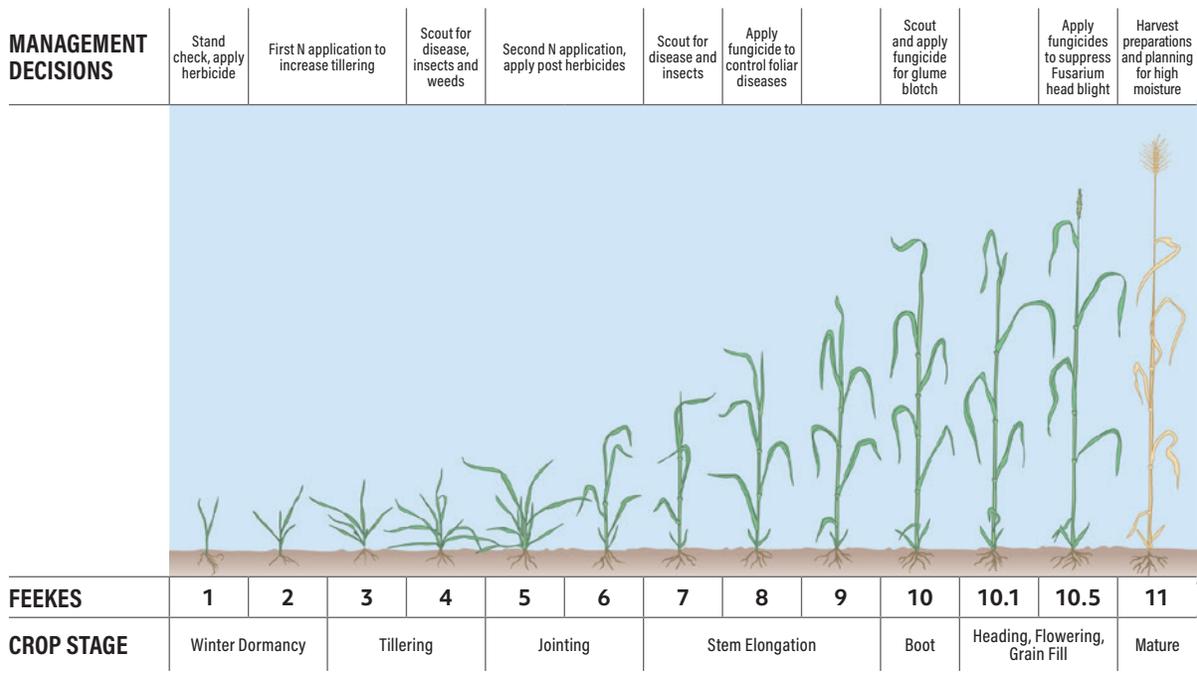
DEVELOPMENT STAGES AND ACTIONS

Growth stages in wheat are described using the Feekes scale. Most management decisions are implemented at specific growth stages

and calendar timing during the season. Base your management decisions on the stage of the crop (Figure 2).

FIGURE 2. GROWTH STAGES OF WHEAT AND MANAGEMENT DECISIONS WINDOW.

Adapted from Illinois Agronomy Handbook, Page 38.



VARIETY

Many growers know the basics about producing winter wheat. However, to maximize yield, growers must start with the highest genetic yield potential.

Select superior yielding winter wheat varieties for the respective maturity ranges that you need. Evaluate and determine which of these varieties have a solid agronomic package including good standability, test weight and resistance to the major wheat diseases.

Eric West, Soybean and Wheat Product Manager, Growmark, Inc.

Yield data is the most important in determining genetic yield potential, but height, agronomic characteristics and test weight data are useful. Below are a few tips for selecting successful wheat varieties:

1. Choose a wheat variety with high yield potential AND a good head scab rating. Review independent yield results at <http://vt.cropsci.illinois.edu/wheat.html>.
2. Select “ultra-early” wheat varieties that allow for planting of double-crop soybeans.
3. Planting a range of maturities spreads out the harvest workload and reduces disease risk. More importantly, because early varieties are more susceptible to freeze injury, planting medium and late varieties, in addition to early, will reduce your risk of freeze injury.
4. If straw yield is important, select a tall variety but manage for lodging. However, high yield wheat will also produce ample amounts of straw.

Early wheat varieties that remain dormant late into the spring are desired. They are waiting for the correct day length of sunlight before breaking dormancy to start growing. This characteristic is most important to give protection from early spring freeze damage. Avoid a variety that is stimulated to start growing by heat units which can start growing too soon, exposing the plants to freeze damage.

Ken McClintock, Regional Sales Manager Eastern US, Limagrain Cereal Seeds.



TREATING WHEAT SEED AT THE FARM. Courtesy Bayer.

SEED TREATMENTS

Treating seeds with the proper fungicide and insecticide protects seed quality, ensures good emergence and is the first step toward reaching the optimal harvest population. Select seed treatments that work and know what you are buying.

1. Fungicidal seed treatments reduce losses caused by seed-transmitted and soilborne fungal diseases.
 - a. Mefanoxam (metalaxyl) – *Pythium*
 - b. Tebuconazole – *Fusarium* root and crown rot
 - c. Prothioconazole, tebuconazole, and metalaxyl combinations – common root rot and *Fusarium* root and crown rot
2. Insecticidal seed treatments protect wheat from Hessian flies and aphids for 2 to 4 weeks after planting.
3. Today there are additional biological seed treatments available. Know what you are buying and make sure there is a return on investment.

ROTATION

Wheat is a good rotation crop. It can be planted in the fall after either corn or soybeans, depending on which is harvested first.

University of Illinois research at Monmouth shows that adding wheat into the corn-soybean rotation increases corn yields by 9–10 bu/A and soybean yields by 3 to 4 bu/A.²

PLANTING DATE

The best time to plant wheat is one that allows the crop to emerge for several weeks before low temperature brings on dormancy.

1. Plant wheat as early as possible but after the Hessian fly-free date (Figure 3).
2. Wheat planted immediately after the Hessian fly-free date should have 3 to 5 leaves and 2–3 tillers per plant, larger crowns able to overwinter and have more rapid development next spring.³
3. Don't push and plant too early as excess fall growth can increase the chances of winter kill and stand losses.
4. Timely seeding has a direct relationship with yield, as fall-developed tillers produce more yield and overall larger kernels than spring-developed tillers.

FIGURE 3. RANGE OF HESSIAN FLY-FREE DATES IN ILLINOIS.

Illinois Agronomy Handbook, Page 39.



Don't rush putting the wheat in the ground just because you are busy with corn and soybean harvest. Early establishment ideally leads to higher yield potential but remember prime stand establishment comes from the result of agronomically sound seed bed conditions coupled with proper equipment calibration and assessment of performance for maximum yield potential.

Jonathan Perkins, PFR Agronomist and Location Lead, Beck's Hybrids.



TABLE 1. CONVERSION FACTORS RELATED TO SEED RATES FOR WHEAT.

Illinois Agronomy Handbook. Page 40.

SEEDS/SQ FT	SEEDS/A (MILLIONS)	SEEDS/FT OF 7.5-IN ROW	POUNDS OF SEED NEEDED PER ACRE				
			10,000 SEEDS/LB	12,000 SEED/ LB	14,000 SEEDS/LB	16,000 SEEDS/LB	18,000 SEEDS/LB
20	0.87	13	87	73	62	54	48
25	1.09	16	109	91	78	68	61
30	1.31	19	131	109	93	82	73
35	1.52	22	152	127	109	95	85
40	1.74	25	174	146	124	109	97
45	1.96	28	196	163	140	123	109

SEEDING EQUIPMENT AND RATE

Wheat is planted in 7.5 to 10-inch rows using a box drill or air-seeder. However, some growers seed with a 15-inch planter.

1. Wheat should not be planted deeper than 1 to 1-1/2 inches. Shallow planting can result in more winter injury.
2. Plant in rows 7 to 8 inches apart. Yield is reduced by wider rows: 1 to 2 bushels in 10-inch rows and 5 to 8 bushels in 15-inch rows.
3. Use a well-maintained drill calibrated for "seeds per acre," not lbs. per acre, as seeds per pound will vary.
4. Target 30 to 40 seeds per sq. ft. or 1.3 to 1.7 million seeds/A. Higher seed counts require more management.
5. Add 10 percent more seed for each week planted later than the fly-free date.
6. Remember to calculate seed size into seeding rate (Table 1). A seed size of 15,000 seeds/lb. has 1.5 million seeds in 100 lbs.

Taking a stand count is an important part of managing wheat. For example, tiller density per square foot can be utilized to decide if a split application of spring nitrogen will be necessary. Calculate the density of tillers per square foot by laying a yard stick (3 feet long) beside tillers in 5 locations across your field, multiply the number of tillers by 4 and divide by row width.

Megan Miller, Ag Innovation and Tech Transfer Manager, Illinois Soybean Association.



SEEDING WHEAT WITH AN AIR SEEDER.
Courtesy of Steve Joehl, NAWG.

The common practice is to seed wheat in narrow rows. However, we have seen yields hold consistently even when wheat is planted in 15-inch rows. Our multi-year data shows that a 1.5 million seeds/A population on average provides yield advantage of over 3.3 bu/A in 15 in. wheat (compared to drilled wheat).

Jonathan Perkins, PFR Agronomist and Location Lead, Beck's Hybrids.

The most responsive micronutrients in wheat are copper, zinc and boron. And manganese is often applied with zinc. We are seeing more copper deficiencies in soybeans and it will carry over into the wheat crop planted afterwards. We recommend at planting, if using a starter, to add chelated copper and zinc if soil tests are low. At spring green-up (tillering) or at herbicide application at the end of tillering and into jointing copper, zinc and manganese can be applied with UAN, other nitrogen solutions or herbicide spray solutions. At boot to flowering stage, boron and zinc can be applied with either a fungicide or insecticide. At this late stage, it is too late to apply copper to be effective.

Brian Haschemeyer, Director of Discovery and Innovation, Brandt Consolidated, Inc.

FERTILITY AND APPLICATION STRATEGIES

Base fall phosphorus and potassium fertility on soil test levels. Nitrogen can be applied by two passes in the spring—one at green-up to support tillering and the other at jointing to support the canopy. Make sure there is enough nitrogen to finish.

1. Apply phosphorus and potassium in the fall for both wheat and double-crop soybeans based on soil tests.
2. As with any crop, soil pH should also be monitored and corrected to ensure maximum returns to fertilizer inputs.
3. A starting point for nitrogen would be 100–110 lbs./A for Central and Northern Illinois or 130–140 lbs./A for Southern Illinois. This regional difference is due to greater nitrogen mineralization from the prairie soils.⁴
4. Apply 30 lbs. of nitrogen pre-plant.
5. When splitting the nitrogen applications, base the rates and timings on the health of the crop and the number of tillers.⁵
 - a. If the wheat is planted early and the wheat has 4–5 tillers per plant, then apply 30–40 lbs./A at green-up and the balance around jointing.
 - b. If the wheat is planted later and only has one main stem and no tillers, apply 60–70 lbs./A around green-up and the balance at early stem elongation.
6. Nitrogen can be broadcast as dry urea or streamed as UAN (urea ammonium nitrate).
 - a. Spring-applied nitrogen can be broadcast as dry urea, ideally with an air-truck. Spinning disc spreaders can be used if they are pattern tested. Avoid using wide-spread widths or spreading urea in windy conditions as lighter density products often streak fields and reduce yields.
 - b. Streaming liquid N with stream bars is preferred, as the application method is uniform and accurate, plus many new sprayers are now equipped with section control to eliminate overlaps.
7. Consider adding 20 lbs./A of sulfur to your fertility program.
8. Base micronutrients applications on soil or tissue test results or deficiency symptoms.

The higher the yield goal the more important the nitrogen management becomes. You must know the tiller/head count to estimate the yield goal. In many cases, timing is as important as the amount of nitrogen applied.

Stephen Joehl, Director of Research & Technology, National Association of Wheat Growers.

Streaming nozzles will minimize wheat injury from UAN applications. However, they are unsuitable for herbicide applications, which require a smaller droplet spectrum. Although several wheat herbicides can be applied with UAN as a carrier, consider separating fertilizer and herbicide applications.

Nick Harre, PhD, District 17 Director, Illinois Soybean Association.



STREAMING NITROGEN.

Courtesy of Phil Needham, Needham Ag Technologies.

EFFECTIVE WEED CONTROL STRATEGIES

Have a herbicide program that addresses weed control needs and herbicide resistant weeds.

Weed management in double-crop beans begins in the wheat crop. You are not just managing garlic when you spray a herbicide on your wheat.

G. Kelly Robertson, Consulting Agronomist, Precision Crop Services LLC.

Managing weeds in wheat is much like managing weeds in corn and soybeans; know your target weed species, recognize which are herbicide resistant and have a plan to manage resistant weeds across all crops in your rotation.

1. Broad-leaved weeds and grass weeds should be controlled in the fall for best results. Waiting till spring to spray may result in lower yields, as the weeds have competed with the crop.
2. Select a herbicide program that provides broad-spectrum control of grass and broadleaf weed species.
3. Apply herbicides when weeds are small for best control.
4. Spray actively growing weeds when it is

warm for effective control.

5. Check labels and apply at the right growth stage (i.e., before joint or boot stage).

If wheat is being terminated because of a poor stand and replanted to corn or soybeans in the spring, terminate surviving wheat plants prior to planting. Be sure to check herbicide labels for applicable crop rotational intervals before replanting.

A dense wheat stand is the best defense against weeds. If wheat emergence is thin (< 25 plants/square feet), consider a herbicide application in the fall to reduce weed interference and allow more room for wheat tillering and growth.

Nick Harre, PhD, District 17 Director, Illinois Soybean Association.

When controlling weeds, wild garlic and wild onion can be a serious problem if grain delivered to the elevator is contaminated. Grain contaminated with these seeds will be docked, which can be quite severe if not controlled.

Don Guinnip, Former District 14 Director, Illinois Soybean Association.

SULFUR RECOMMENDATION FOR WHEAT

Maria Mercedes Gearhart, Senior Agronomist, AdvanSix Inc.

Whether wheat follows corn or soybeans, two crops that take up a lot of sulfur, it is important to watch for this nutrient on the following wheat crop, particularly on low organic matter soils.

Fall sulfur availability is important since tillers formed in late fall and over the winter are responsible for the bulk of wheat grain yield. Yet, not all of sulfur should go on in the fall since sulfate, the only form roots take up, is

vulnerable to leaching, mainly on coarse soils.

Sulfur deficiency symptoms are often observed in early spring when, regardless of soil test levels, wheat's root system isn't yet deep enough to reach it. Early spring applications of sulfur should be based on tiller counts, targeting 70–80 heads per square foot.

Later sulfur applications at onset of stem elongation should be based on tissue

nutrient content, making sure the N:S ratio in tissue is not higher than 15:1 (meaning N:S ratios in your fertilizer blend should not be higher than 8-10:1).

If you don't count tillers or do tissue tests, then a good rule of thumb would be to apply sulfur rates of 15 to 20 lbs./A at green up for fertile, fine textured soils, and rates of 20 to 25 lbs./A split-applied between fall and spring for low fertility or coarse textured soils.

LODGING MANAGEMENT

There are several reasons for lodging, but the most frequent is excessive canopy development between stem elongation and heading stages.

Dense canopies are caused by excessive early nitrogen rates or soils with high amounts of residual nitrogen, such as from animal manure. If heavy rains are coupled with high winds later in the season, wheat with dense canopies can't support themselves, and plants fall flat.

Nitrogen is a major factor in wheat production. Enough is needed to produce yield and protein, but too much can induce lodging.

1. Learn to optimize nitrogen rates for tiller set and yield expectations.
2. Credit for nitrate-nitrogen present in the soil profile and amount of nitrogen that can be mineralized from organic matter.⁶
3. To help avoid lodging, count tillers early in the spring to determine if fields are too thick and at risk of lodging.



LODGED WHEAT.

Courtesy of Phil Needham, Needham Ag Technologies.

According to the Palisade EC label, timing of application is from Feekes stage 5 (fully tillered) to stage 8 (flag leaf visible). Use as a risk management tool where there is a high yield potential, the variety is prone to lodging and a high fertilizer nitrogen or manure rate was used.

Daniel Davidson, PhD, Illinois Soybean Association.

- a. If there are more than 750 tillers per square yard at mid-tillering stage, a split application of nitrogen will reduce head counts at harvest.
 - b. If greater than 1,000 tillers per square yard, delay spring nitrogen until around jointing.
4. Consider applying a Plant Growth Regulator (PGR) like Palisade® EC to reduce height, thicken stems and reduce lodging.

INSECT MANAGEMENT

Few insects cause recurring economic damage to wheat in Illinois. However, there are three that can cause economic loss including Hessian Fly, aphids and army worms.

Hessian fly can be managed by planting after the Hessian Fly Free Date and was covered in the planting date section.

Four different species of aphids occur in wheat fields in Illinois—bird cherry-oat aphid, corn leaf aphid, English grain aphid and greenbug.⁷ The concern with aphids is their ability to transmit viruses that cause Barley Yellow Dwarf diseases. Seed treatments can provide some systemic control. Thresholds⁷ for foliar applications, up to the boot stage, include:

- Greenbugs: 25 aphids per stem
- Corn leaf aphid: 30 aphids per stem
- Bird cherry-oat aphid: 30 aphids per stem
- English grain aphid: 50 aphids per stem

Few armyworms overwinter in Illinois, and moths that migrate from southern states add to the native population. Moths lay their eggs on the lower leaves of wheat. Larvae will feed on plants beginning with leaves followed by stems. Management of armyworms includes⁸:

- Scouting for the presence of larvae in the spring
- Examining three feet of row in five or more spots in a field. Shake the plants vigorously and then look for armyworms on the ground and under debris
- Spraying an insecticide when there are 6 or more non-parasitized larvae ($\frac{3}{4}$ to 1 $\frac{1}{4}$ inches long) per foot of row

DISEASE MANAGEMENT

Learn to scout for diseases including stripe rust, powdery mildew and *Fusarium* head scab. *Fusarium* head scab is the most economically important wheat disease in Illinois, as it can lead to the production of the vomitoxin deoxynivalenol (DON). High levels of DON in wheat can affect human and animal health.

Even if you think head scab may not be an issue, triazole fungicide applications made at the Feekes 10.5.1 timeframe result in not only helping to reduce the potential for head scab if applied at the correct timing, but also help reduce the potential for DON. DON is the culprit for vomitoxin, which in high enough quantities can get your grain rejected at the elevator.

Jonathan Perkins, PFR Agronomist and Location Lead, Beck's Hybrids.

In years with favorable weather (frequent rains, moderate temperatures and cloudy weather) this disease has a significant impact on yield, test weight and risk of vomitoxin that contaminates grain and results in dockage or rejection. If a planned foliar fungicide/insecticide application isn't made, scout regularly and treat as needed if a risk arises.



HEAD SCAB IN WHEAT.

Courtesy of Carl Bradley, University of Kentucky.

Research has shown that regular application of a foliar fungicide will increase wheat yield even when scouting doesn't show symptoms of a disease. The fungicide application will increase yield and at least pay for its cost. Fungicide is the best insurance investment against unforeseen disease yield robbers.

Ken McClintock, Regional Sales Manager Eastern US, Limagrain Cereal Seeds.

Scab is best managed by integrating resistant varieties, cultural practices and timely fungicide applications.

1. Select a fungicide in the triazole (FRAC Code 7) or SDHI[®] (FRAC Code 7) chemical families that is effective when applied from early flowering (Feekes 10.5.1) through five days after the start of flowering.¹⁰
2. Fungicides in the strobilurin group (QoI FRAC Code 11) shouldn't be used at early flowering, as they can increase DON levels compared to triazole fungicides.

Monitor the Fusarium Head Blight Prediction Center to predict the risk of infection in your area and determine an action plan. (<http://www.wheatscab.psu.edu/>).



Harvesting at higher moisture is greatly aided with a stripper head, which takes mostly grain and chaff into the combine, leaving the damp straw standing as evenly as it was planted. The uniformity of standing wheat residue greatly aids the soybean planting process, in addition to helping reduce wind speeds at the soil surface, which in turn helps reduce evaporation of moisture from the soil.

Phil Needham, Needham Ag Technologies.

HARVEST

Harvest wheat fast and early and avoid total field dry-down.

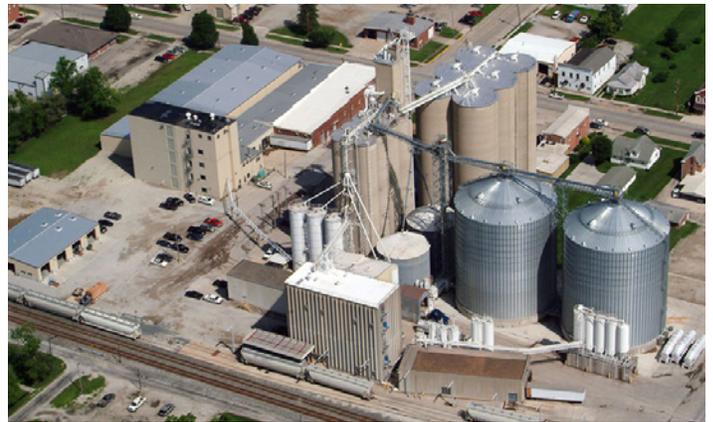
1. Even and complete spreading of straw and chaff across the header width is essential for no-tilling soybean seed into stubble and achieving good soil-to-seed contact.
2. Having the ability to dry wheat can preserve wheat quality.
3. Dry wheat at a lower plenum temperature than corn.
4. The maximum air temperature for drying milling wheat is 150° F for 16 percent moisture content and 130° F for 20 percent moisture content.

Residue management out the back of the combine during wheat harvest is a must to ensure uniform planting depth of the double-crop soybeans.

G. Kelly Robertson, Consulting Agronomist, Precision Crop Services LLC.

Higher static pressure of wheat stored in a grain bin impedes air movement. Know the capabilities of the aeration system with wheat in the bin and recognize it is different than corn or soybeans. Increasing fan size or limiting grain depth can ensure adequate air movement.

John Pike, Researcher, Pike Ag LLC.



WHEAT MILLING FACILITY IN TEUTOPOLIS, ILLINOIS.
Courtesy of Siemer Milling Co.



EARLY WHEAT HARVEST SYSTEM

Early wheat harvest optimizes the double-crop rotation in many ways. Today you can choose ultra-early wheat varieties that have comparable yields. Harvesting early maturing wheat varieties at 18 to 20 percent moisture enables growers to plant double-crop soybeans 7 to 10 days earlier.

- Earlier wheat harvest means better quality wheat grain, and earlier soybean planting means higher bean yields.
- Planting an ultra-early wheat variety results in 3 to 5 days gain on soybean planting.
- Harvesting at 18–20 percent moisture and drying grain results in an additional 3 to 5 days gain on soybean planting.

Harvesting wheat at 18 to 20% moisture produces better quality grain and improves profitability. High moisture harvesting results in higher test weights, lower incidence of DON vomitoxin and less risk of price dockage.

Carl Schwinke, Vice President Grain Supply, Siemer Milling Company.

Weather leading into harvest can impact how fast wheat matures. Hot weather in spring 2018 narrowed the advantages of early maturity over conventional medium maturities. Seasons that are cool through May and into June will extend the early planting advantages even more.

John Pike, Pike Ag LLC.

TO HELP ENSURE GOOD YIELDS WHEN THE WEATHER IS FAVORABLE, FOLLOW THESE STEPS:

1. Choose several top varieties.
2. Apply some nitrogen and phosphorus fertilizer before planting: 18-46-0 provides both nutrients.
3. Drill the seed on or near the fly-free date, using 35 to 40 good-quality seeds per square foot.
4. Make a fall herbicide application, especially in no-till where weeds emerge soon after planting.
5. Topdress additional nitrogen in late winter or early spring, at rates that bring the total applied nitrogen rate to 130 to 150 lbs./A for soils with organic matter less than 2 percent, and to 100 to 120 lbs./A for soils with 2 to 4 percent OM.
6. Manage nitrogen. Apply at the time the crop breaks dormancy and begins to green up. Application to frozen soil can result in loss if rains occur soon after application and should be avoided if possible. Urea is commonly used to topdress wheat, but UAN applied with streamer bars can be more uniformly spread.
7. In light-textured or low-OM soils, add 15 or 20 lbs./A of sulfur as ammonium sulfate (dry) or ammonium thiosulfate (solution) with nitrogen to help maintain yields.
8. Scout for weeds, insects and diseases beginning in early spring; treat for control only if necessary. Become informed about disease and insects so that control method is appropriate.
9. Have a plan to control *Fusarium* head scab and stick to it to preserve yield and quality.
10. You can't control the weather, but too much water has a negative impact on the wheat crop. Do what you can to get standing water off fields, and hope for dry weather during the spring, especially during the time of heading and into grain-filling.

Courtesy of Emerson Nafziger, Professor Emeritus, University of Illinois.

OBSTACLES TO WHEAT PROFITABILITY

As with any of the commodity grains, producer margins are slim. Management intensity will determine yield and, ultimately, profitability with corn, soybeans and certainly wheat.

Wheat, being a food grain, must achieve quality standards to maximize price at point of delivery. In addition to quality, wheat faces several obstacles that affect its profitability:

- Management practices not keeping up with new, higher yielding genetics
- Difficult to achieve optimum head population for profitable yield
- Disease management challenges such as head scab
- Russian wheat aphid, Hessian fly
- Low test weight and quality (symptoms of management practices)
- Lack of adoption of improved production practices
- Periods of low market price or high discounts

Producing both high-yield and high-quality wheat requires adopting the right system of practices and implementing at the right time. Seek out the best management information available from the experts at universities and companies and from the local CCA agronomists that serve you.

Mike Doherty, Executive Director, Illinois Wheat Association.



Soybeans are commonly grown in Illinois and across the Corn Belt. Annual corn, full-season soybean and double-crop wheat/soybean acreage in the United States are shown in Figure 4. Corn and soybean acreages have been trending up while wheat acreage has been trending down.

Double-crop soybean rotations are well adapted to the area south of the 39th parallel. However, today there is an opportunity to move the rotation north of the 39th parallel by adopting an earlier wheat harvest and shortening soybean maturity or relay cropping soybeans into wheat.

Full-season soybean yields in Illinois have been trending up the past decade as growers began adopting early planting and better management practices. At the same time double-crop soybean yields have also been increasing. Full-season and double-crop soybean yields averaged 54 and 46 bu/A, respectively, between 2003 and 2018 (Figure 5).

FIGURE 4. CORN, SOYBEAN AND WHEAT ACREAGE IN THE UNITED STATES.

Courtesy of Dr. Gary Schnitkey, University of Illinois.

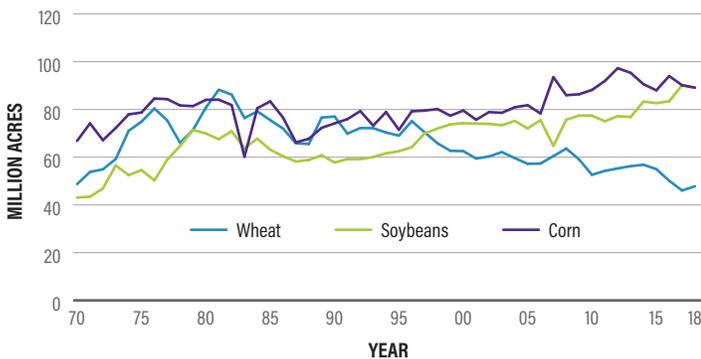
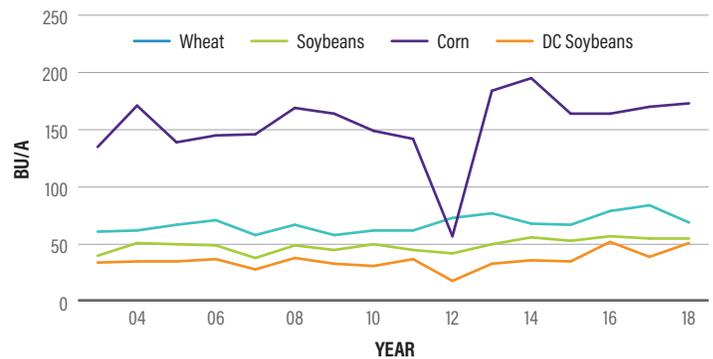


FIGURE 5. CORN, SOYBEANS AND WHEAT YIELDS TRENDS IN SOUTHERN ILLINOIS FROM 2003 TO 2018.

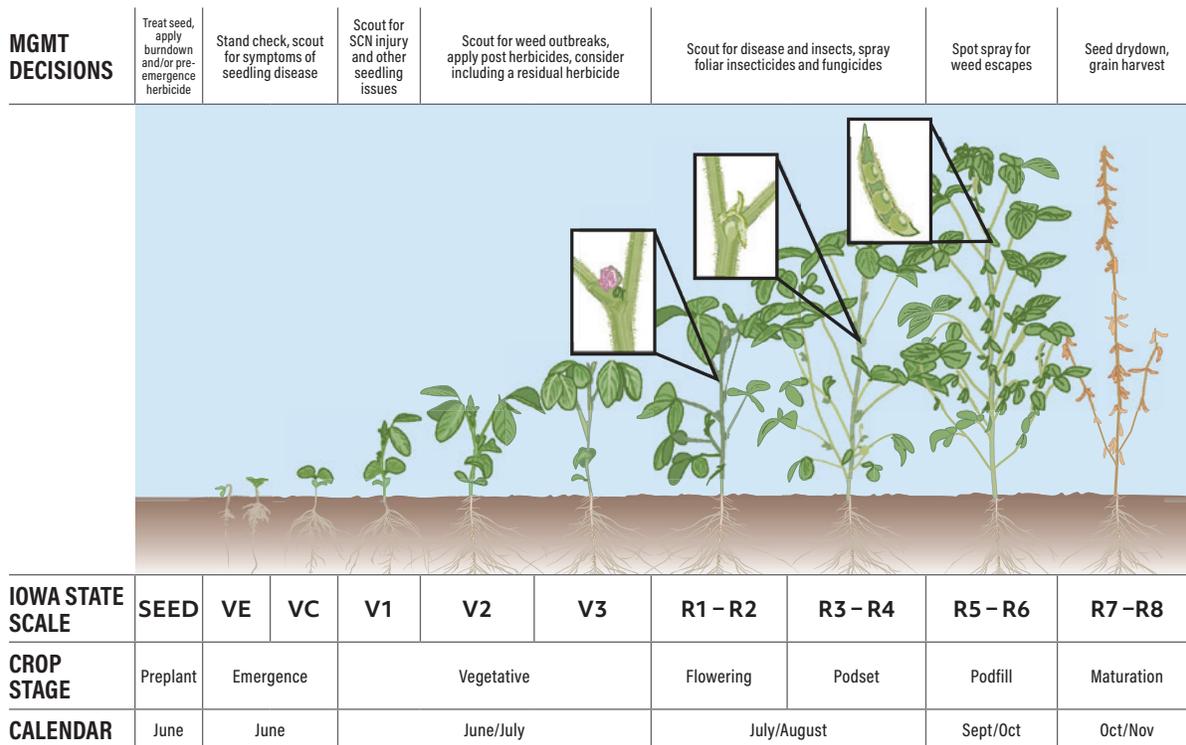
Courtesy of Dr. Gary Schnitkey, University of Illinois and FBFM.



Dr. Robert Hoelt,¹¹ Professor Emeritus, University of Illinois, wrote in 1975, “The success of double-cropping wheat followed by soybeans is enhanced by: an excellent stand of well-fertilized wheat to control weeds until the wheat is harvested; early removal of the wheat to increase chances for maturity of soybeans; equipment capable of establishing soybean stands in wheat stubble without tillage; soybean herbicides that will control the problem weeds; narrow-row spacing and high soybean plant population; soybean variety of the proper maturity; sufficient moisture; and adequate fertility.” That statement regarding best management practices made 45 years ago remains true today.

FIGURE 6. GROWTH STAGES OF SOYBEAN AND MANAGEMENT DECISIONS WINDOW.

Adapted from Pocket Guide to Crop Development, University of Illinois Extension Publication C1389, Urbana, Illinois.



DEVELOPMENT STAGES AND ACTIONS

Growth stages in soybeans follow Iowa State University’s “How a Soybean Plant Develops.” Base your management decisions for implementation at specific growth stages, calendar timing or based on crop scouting during the season (Figure 6).

Managing double-crop soybeans is the same as managing full season soybean and adopting the same best management practices. As a reference, check out the [“Illinois Soybean Production Guide: Systematic Strategies to Increasing Yields”](#) sponsored by the Illinois Soybean Association.

Daniel Davidson, PhD, Agronomist/Consultant, Illinois Soybean Association.

STARTS WITH WHEAT

A successful double-crop soybean system begins with planting wheat early while effectively managing straw.

Plant ultra-early wheat varieties and plant early to hit the sweet spot for high yielding double-crop soybeans. It’s important to choose shorter wheat varieties to reduce amount of straw and then plant immediately after the wheat is harvested. No-till soybeans need a planter that can manage residue. Strive for good seed-to-soil contact, increase planting populations and narrow up rows to produce a uniform stand.

Ken McClintock, Regional Sales Manager Eastern US, Limagrain Cereal Seeds.

VARIETY

Growers know the basics about producing soybeans. However, if they want to maximize yield in the double-crop rotation, they must start with the highest genetic yield potential and a variety adapted to that double-crop environment.

- Choose a soybean variety that performs in double-cropping environments.
- Consider taller soybean varieties that bush out to compensate for late planting.
- Look for the same disease package as full-season soybeans.
- Select a tall, bushy variety with a high *Phytophthora* rating, excellent emergence score and that yields well at high populations.
- Select the right maturity group (MG) ensuring that maturity will be reached before the first hard frost:
 - Double-crop soybeans require 90 days to reach maturity.
 - Southern Illinois – same MG as for full-season beans. If planting is delayed, consider an earlier variety to avoid frost.
 - Northern Illinois – reduce by half MG unit.
- Do not purchase the cheapest seed available.

SEED TREATMENTS

Treating seeds with the proper fungicide and insecticide package protects seed quality, ensures good emergence and is the first step towards reaching the optimal harvest population.

When planting double-crop soybeans, seed is planted in a warmer and harsher environment. Seed treatments protect the seed if it is in a dry environment for an extended period, help with emergence and prevent seedling diseases in a wet environment. Use the same seed treatment decision process as you did for your full-season soybeans.

1. Fungicidal seed treatments reduce losses caused by soilborne fungal diseases.
2. Insecticidal seed treatments protect against bean leaf beetle and aphids for two to three weeks after planting.
3. Consider inoculating seeds with nitrogen-fixing bacteria since you are planting into a hotter soil environment.

When double-cropping soybeans, select the best variety adapted for your growing area. Opt for a maturity that will ripen before the season ends to allow harvest before a typical killing frost. Don't plant seed just because of a discounted price and in-season availability.

Kelli Bassett, Agronomist, Bassett Farm & Pioneer Seed Sales.



PLANTING DATE

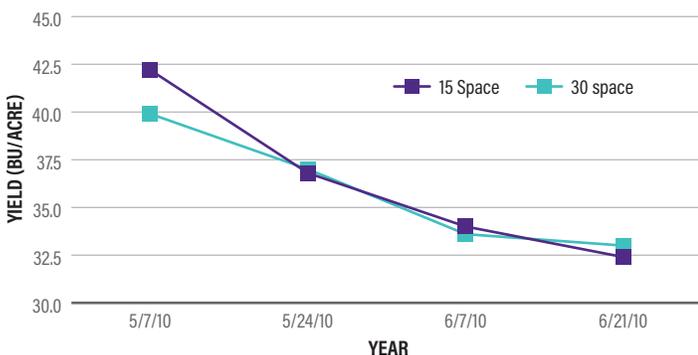
Double-crop soybeans should be planted as early as possible (Figure 7). Delays in planting after June 1 cost a potential loss of one bushel per day for each day planting is delayed.

- Adopt an early wheat harvest approach: plant an ultra-early variety and harvest at 18–20% moisture.
- Plant soybeans immediately behind the combine.

Do not use the calendar date as your sole source of when to plant double-crop. Remember the basics of good seed bed conditions and proper equipment setting to establish prime seed-to-soil contact for best stand establishment and highest yield potential.

Jonathan Perkins, PFR Agronomist and Location Lead, Beck's Hybrids.

FIGURE 7. IMPACT OF PLANTING DATE ON SOYBEAN YIELD TRENDS IN SOUTHERN ILLINOIS. Vince Davis and Steve Ebelhar, 2010. University of Illinois.



Planting date is an important determinant of double-crop soybean yield; in fact we have often seen 1-2 bu/A yield reductions for each day soybean planting was delayed after wheat harvest. Every effort should be made to plant the double-crop soybean as early as possible; this ideally includes harvesting the wheat at higher moisture. Harvesting at higher moisture and drying the wheat (often from 20–22% moisture) can move the soybean planting date 3–6 days earlier, compared to waiting till the wheat is dry. We have often seen this increase the soybean yield by 3–12 bu/A.

Phil Needham, Needham Ag Technologies.

ROW SPACE, POPULATION AND DEPTH

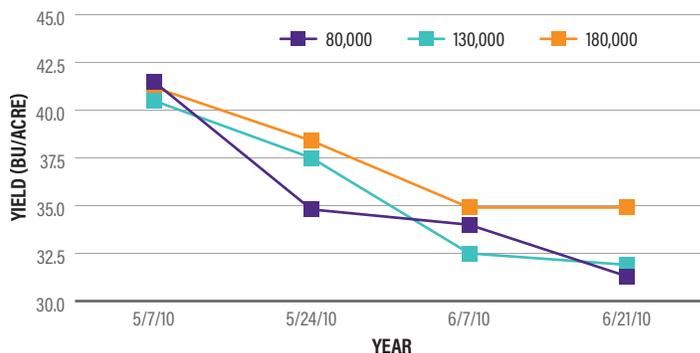
Soybeans should be planted in narrower rows.

- 15-inch row crop planter.
- 7.5–10-inch rows box drill or air-seeder.

Increase population 15–25% over full-season rate (Figure 8). Plants are shorter so higher populations will canopy sooner, aiding weed control, water conservation and aid in harvest.

- Planter: 160,000 to 180,000 seeds/A.
- Drill: 180,000 to 200,000 seeds/A.
- If planting gets pushed to the end of June or into July, push the population to the high end.

FIGURE 8. IMPACT OF PLANTING POPULATION ON YIELD AS PLANTING DATE IS DELAYED. Vince Davis and Steve Ebelhar, 2010. University of Illinois.



Soybeans should be planted at a depth of 1.5–2 inches to reach ideal moisture and a more stable soil temperature. Shallow planting at 1 inch means hotter, drier soil, which can impact germination and emergence.



PLANTING SOYBEANS INTO WHEAT STRAW WITH A SPLIT ROW PLANTER. Courtesy of John Bailey, JCB Ag Research.



WHEAT STRAW AND CHAFF SHOULD BE EQUALLY SPREAD ACROSS THE WIDTH OF THE COMBINE PLATFORM.
Courtesy of *No-Till Farmer Magazine*.



POOR RESIDUE DISTRIBUTION CAN RESULT IN STREAKING AND A POOR SOYBEAN STAND.
Courtesy of Phil Needham, Needham Ag Technologies.

RESIDUE MANAGEMENT

Seedling establishment begins with proper seed placement, good seed-to-soil contact and quick germination. This begins with managing residue from the previous wheat crop.

Residue management begins with optimizing wheat residue distribution:

- Configure combine to chop straw and spread chaff the width of the cutter head
- If removing straw as bales, keep in mind this delays soybean planting
- Harvest with a stripper head to leave stems standing
- Use a planter that can cut or move residue, open a seed slot, close the trench and firm the soil around the seed while preventing hair pinning residue around the seed
- Plant at an angle (at least 10°) to improve stand establishment

Make sure your planter is in good shape and capable of planting through the straw and residue. Disc openers must be sharp and within specifications. Be sure to plant into soil, not straw. Check down pressure and closing wheels to make sure you can close the seed slot once opened.

Plant double-crop soybeans when the soil is right not because wheat harvest is over. The combine only makes the field available for planting. It's not the signal to plant.

G. Kelly Robertson, Consulting Agronomist, Precision Crop Services LLC.

HOW TO MANAGE RESIDUE DISTRIBUTION

Phil Needham, Needham Ag Technologies.

Residue distribution is critical at wheat harvest for top double-crop soybean yields. Spreading the wheat straw (and chaff) as evenly as possible across the header width and down the combine passes are both critical for consistent double-crop soybean stands, uniform emergence and high yields. The two most important factors in this process include selecting the correct header width and chopper/spreader adjustments.

Headers should not be wider than the combines' ability to spread residue over. For example, if a well-adjusted combine chopper/spreader spreads wheat residue about 30 feet, putting

a 40' platform on the front is a bad idea and it will leave streaks about 10 feet wide (with no residue between the passes) and 30 feet each pass with about 25% more residue than what entered the combine. These differences (or more) are very common and often have a major impact on soybean yields.

When it comes to adjustments, be prepared to stop the combine a few times to adjust the spreader/chopper. Some manufacturers detail the recommended adjustments in the operator's manual; if not, be sure and ask your dealer or have them come out to assist.

FERTILITY STRATEGIES

The fertility needs of double-crop soybeans should receive the same consideration as full-season soybeans.

- Base fertility on the soil test and yield goals for wheat and soybeans
- Make sure soil pH is 6.2–6.4
- Consider soybean fertility needs when planning wheat fertility and apply at the same time

NUTRIENT pH RECOMMENDATIONS

*Terry Wyciskalla, Owner,
Wyciskalla Consulting, LLC.*

Pay attention to the nutrient requirements of wheat and double-crop soybean. Both crops, high-yielding wheat followed by double-crop soybean, need to have their fertility requirements met in order to maximize productivity and bottom-line profits.

Too many times when farm economies are lean, the first item cut is soil fertility. As yields move further up the yield curve, so should your fertility program and keep an eye on soil test levels. Try to maintain a pH in the 6.2–6.8 range, Bray P1 values in the 45–65 lbs./A range, and K values in the 200–260 lbs./A range. And sulfur is also becoming more important.

Sulfur deficiencies are becoming prevalent in all agricultural crops and hay/pastures in recent years. Therefore, factor sulfur fertilization into your crop production programs as well. Plan your fertility program on proven, realistic yield values. A 15-year moving average proven yield scenario is effective, but remember to remove extreme values (+/- 25% of the average).

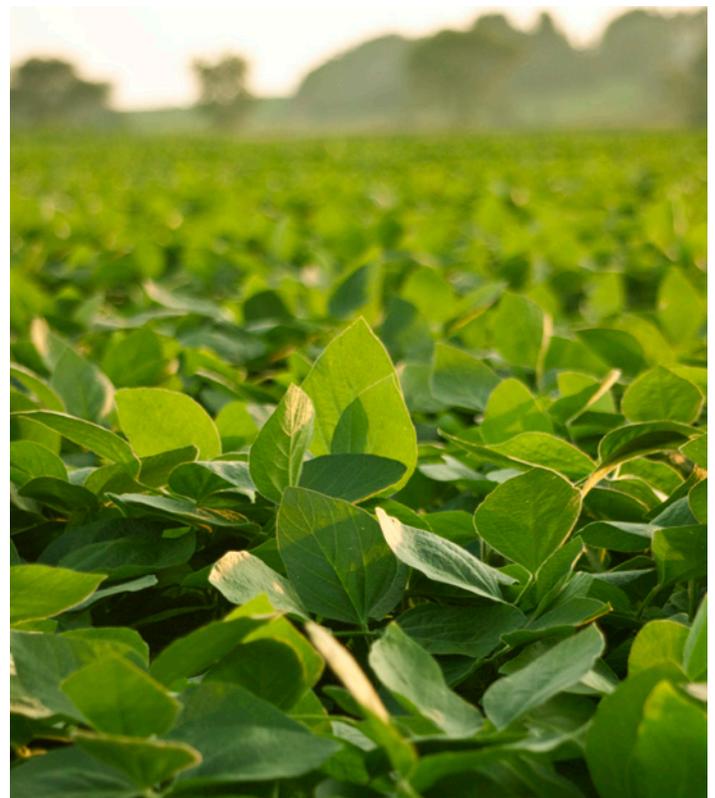
EFFECTIVE WEED CONTROL STRATEGIES

The critical period of weed control tends to be longer in double-crop soybeans compared to full-season soybeans. It is critical to start clean and stay clean by using a burndown plus soil-residual ahead of planting.

- Adopt a herbicide program that addresses weed control needs and herbicide-resistant weeds
- Keep the competition down. Ensure beans have every chance for available water and nutrients
- Don't wait and see if you have a crop before deciding to spray
- Don't rely on glyphosate alone

For herbicide applications before planting, take advantage of herbicides that offer both burndown and soil-residual properties (e.g., saflufenacil, cloransulam, metribuzin). And pay extra attention to sprayer tracks in wheat stubble. Weeds are often more prevalent here and can become especially problematic in double-crop soybean if not managed ahead of planting.

*Nick Harre, PhD, District 17 Director,
Illinois Soybean Association.*



In the double-crop rotation, a producer is planting wheat after corn. Frogeye leaf spot (FLS) can overwinter on soybean residue, but the combination of being a year out of soybean plus the physical barrier provided by the wheat cover crop residue would reduce the amount of local FLS inoculum. However, spores can still blow in from surrounding fields and infect soybeans. Growers planting no-till into continuous soybeans will be at the greatest risk, provided they have a history of the disease and weather is conducive.

Nathan Kleczewski, extension plant pathologist, University of Illinois.

DISEASE MANAGEMENT

Assess your risk for foliar disease pressure.

- Monitor for disease pressure:
 - *Pythium* and *Phytophthora* if June is wet
 - Late planting reduces risk of SDS and SCN
 - Late planting, narrow rows and higher population can increase the risk of white mold
 - Frogeye leaf spot risk is less in double-cropped than full-season soybeans
- Select a variety with good disease resistance ratings
- Monitor for risk based on temperature, humidity and disease outbreaks in full-season soybeans
- Apply a fungicide based on disease risk and opportunity for an economic return
- Select a fungicide that contains both a triazole and strobilurin

Scout double-crop soybeans often and manage like full-season soybeans. Insect and disease pressure can be an issue for developing soybeans that provide susceptible tissue and tender growth.

Kelli Bassett, Agronomist, Bassett Farm & Pioneer Seed Sales.



STINK BUG FEEDING ON SOYBEAN POD.
Courtesy of Nick Seiter, University of Illinois.

INSECT MANAGEMENT

Double-crop soybeans develop later than their full-season counterparts and offer a fresh source of foliage for pests to feed on. Be on the lookout for:

- Stink bugs, whose populations are increasing in Illinois
- Bean leaf beetles, Japanese beetles and aphids are attracted to the freshest soybeans around the end of summer
- Soybean looper is an occasional pest in Southern Illinois
- Base your decision to apply an insecticide on the presence of the pest and whether it has reached economic threshold levels

Scout for insect pressure. One of the biggest keys to high yields is preserving the factories we work hard to establish with good stands. Don't let insects destroy your photosynthesis factory; otherwise your yields will decrease.

Jonathan Perkins, PFR Agronomist and Location Lead, Beck's Hybrids.



FROGEYE LEAF SPOT.
Courtesy of Carl Bradley, University of Kentucky.

HARVESTING DOUBLE-CROP SOYBEANS

Harvesting double-crop soybeans is the same as for full-season soybeans.

- Harvest when seed moisture drops below 16%, but preferably 13 to 14%
- Don't harvest during the heat of the afternoon when moisture can drop to 9 to 10%

If soybeans experienced a hard frost prior to maturity and have higher than normal moisture, combine settings must be adjusted to minimize harvest losses.

- Reduce the concave clearance
- Increase rotor speed to increase aggressiveness for threshing of wet, tough soybeans
- Check behind the combine and readjust settings as necessary

BEST MANAGEMENT PRACTICES:

1. Think about the soybean variety, one that performs when planted later as a double-crop.
2. Use treated seed.
3. Plant beans ASAP, preferably within 24 hours after wheat harvest.
4. Planting within 24 hours can reduce hair-pinning of straw in seed furrow.
5. High population and narrow row spacing are important.
6. Since weed control is important, have a plan for resistant weeds.
7. Always scout for insect and disease pressure.
8. Treat double-crop soybeans like your full-season beans.

*David Droste, Soybean Producer,
former Director, Illinois Soybean
Association, Washington County, Ill.*



OBSTACLES TO DOUBLE-CROP SOYBEANS

Double-crop soybeans face obstacles that reduce yield and profitability¹²:

- Management is directed more towards wheat
 - Prospect of smaller soybean yields compared to full-season beans
 - Reluctance to apply the same management practices to double-crop soybeans as full season soybeans
 - Plant the cheapest seed available
 - Lack of knowledge on varieties that perform better when double-cropped
 - Weather events that delay wheat harvest and planting soybeans
 - Handling wheat residue
 - Inability to get a good soybean stand
- Belief that seed treatments, fungicides and insecticides won't pay
 - Late summer heat and dry weather reduces yield potential
 - Cost to move to narrow row planting
 - Lack of up-to-date best management practices
 - Potential for early frost cutting yield potential

Manage double-crop soybeans like full-season beans. If you treat double-crop beans like a second crop, then they will yield like a second crop. Treat your double-crop beans like first crop beans and they will have the potential to yield like first crop beans.

**G. Kelly Robertson, Consulting Agronomist,
Precision Crop Services LLC.**



Relay intercropping is a technique in which different crops are planted at different times in the same field, and both crops spend part of the season growing together in the field. An example would be dropping cover-crop seed into a soybean crop before it is mature.¹³

Planting soybeans into wheat stubble works well for growers who farm in Southern Illinois. However, for those who farm in Northern Illinois or north of Interstates 74 and 80, relay cropping may be a more viable alternative.

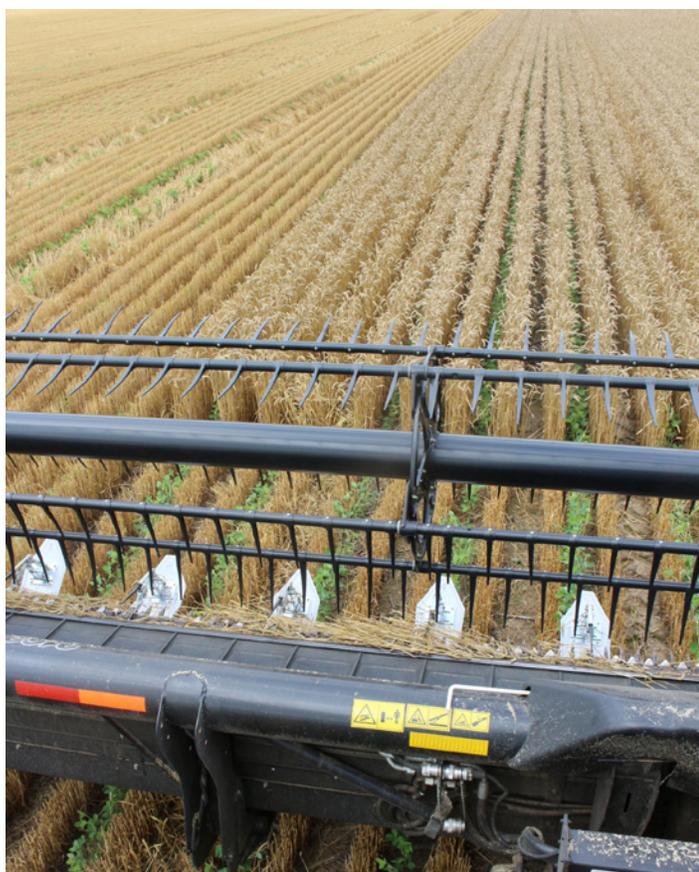
Producers who choose this system can plant soybeans into wheat fields before wheat harvest, rather than waiting until after as in true double-cropping. This allows increased solar radiation and heat available to each crop.

Relay cropping has the same advantages as a traditional double-crop system.

- Potential to reduce nitrate leaching (wheat acts as a scavenger crop)
- Increased carbon sequestration
- Increased income for producers

Unfortunately, a relay system is not without risk.

- Soybean planting can stress an actively growing wheat crop and reduce yield from what would be expected of an undisturbed crop
- Wheat harvest may stress or even damage the growing soybean crop
- Wheat straw can't be baled off and sold
- However, the income from two crops will be greater than either crop alone



HARVESTING STANDING WHEAT OVER RELAY CROPPED SOYBEANS. Courtesy of Flexfingher QD Industries, Inc.



RELAY CROPPED SOYBEANS GROWING THROUGH MATURING WHEAT. Courtesy of Eric Richer, The Ohio State University Extension, Fulton County.

MANAGEMENT TIPS

- Wheat can be planted in 15-inch rows or drilled (7.5 inches), closing every other seed meter, at 18 to 24 seeds per foot
 - Select a wheat variety that is vigorous and manage so it doesn't lodge to allow higher cutting heights
 - When planting soybeans, tire spacing and tire width should match the space available between wheat rows
 - When harvesting wheat, employ a pusher to gently lay bean plants over so they aren't clipped off
 - Spread straw and chaff evenly across head width
- Plant soybeans in late May or early June and at the same rate as full-season beans
 - Plant the same maturity as full-season soybeans
 - Apply the same best management practices as you would to full-season soybeans or single wheat crop

Relay cropping requires a greater level of management. Wheat must be planted during the soybean and corn harvest season in the fall—just after the Hessian Fly Free date—competing with other harvest and fall activities.



Over time, wheat followed by double-crop soybeans has been more profitable than corn or full-season soybeans, particularly since the decrease in commodity prices since 2012. From 2013 to 2019, the combination of wheat and double-crop soybean profitability has averaged higher than corn or full-season soybeans in all but two of the years.

Figure 9 shows per acre returns for Southern Illinois according to records from Illinois Farm Business Farm Management. From 2017 through 2019, wheat and double-crop soybeans averaged \$180 in operator and land return, compared to \$48 per acre for corn, and \$151 per acre for full-season soybeans.

In a study of profitable Southern Illinois farms, the following stood out about double-crop soybeans:

- Most of the more profitable farms have wheat in their rotations combined with double-crop soybeans.
- Most of the more profitable farms grew modest amounts of wheat, generally totaling around 10% of total acres.
- Available management time in spring limits wheat acres managed.
- Maintaining high wheat yields is key to making wheat and double-crop soybeans a profitable combination.

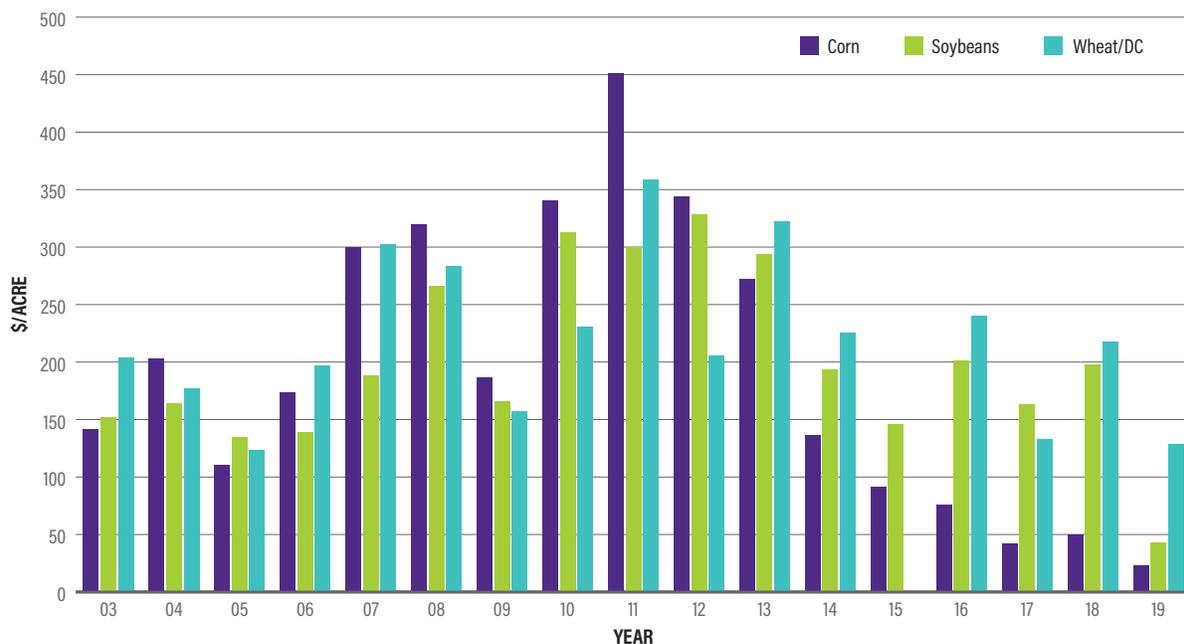
- Double-crop soybean yields have been exceptional in the last several years. Full-season soybeans averaged 55 bu/A from 2016 to 2018, compared to 46 bushels for double-crop soybeans. Very good yields for soybeans aided in making wheat and double-crop soybeans a profitable combination.

The following are recommendations for double-crop soybeans:

- Generally, stand-alone wheat will not be as profitable as corn or soybeans. If wheat is going to be grown, it needs to be grown along with double-crop soybeans.
- Wheat should be managed for both high yields and high returns.
- Early harvest of wheat facilitates early planting of soybeans, increasing double-crop soybean yields.
- Soybeans should be managed for high yields and high returns the same as wheat and full-season soybeans.

FIGURE 9. PROFITABILITY OF CORN, SOYBEANS, WHEAT/DOUBLE-CROP SOYBEANS IN SOUTHERN ILLINOIS.

Illinois Farm Business Farm Management.



A survey conducted in 2015 and funded by the Illinois Soybean Association indicated that 57% of the respondents said wheat gets the major investment, 12% said soybeans get more investment and 31% said there is equal investment. However, proper management is needed for both wheat and soybean crops for the enterprises to be profitable.

Not only does the double-cropping rotation produce higher grain production per acre, there are other inherent cost and labor savings that help make it more profitable.

- Opportunity to sell off wheat straw and increase net income.
- Land and certain inputs (e.g., lime) costs can be allocated across two crops.
- More rapid equipment depreciation.
- Better distribution of capital (income and expenses) due to additional harvests and field operations being more evenly spread throughout the year.
- Opportunity to spread labor requirements out over the year.
- Better distributed cash flow throughout the year



The wheat soybean double-crop enterprise can be more profitable when farmers adopt the latest tools and technologies. When properly managed, double-crop enterprises can provide a positive economic return while improving soil health and protecting water quality.

Double-cropping is popular because it provides many advantages, including more cash flow, improved soil quality, less soil erosion, more intensive use of land, equipment, labor and capital, and greater overall production of food and feed.

The United Soybean Board

ECONOMIC

In most years, the economic return from planting three crops is greater than planting two crops. And often the wheat-soybean double-crop provides a greater return than corn, wheat or soybeans alone.

Harvesting wheat at higher moisture produces better quality grain. Test weight is higher, incidence of DON vomitoxin is reduced and the risk of price dockage is much lower, improving profitability.

Planting soybeans earlier also increases yield potential by as much as one bu/A for each day sooner that they are planted, improving yields and profitability.



WINTER WHEAT CROP HEADING OUT IN THE SPRING AFTER PROTECTING THE SOIL OVER THE WINTER. Courtesy of the Illinois Wheat Association.

ENVIRONMENTAL

Planting three crops over two years improves crop diversity, which benefits the soil and improves water quality.

Winter wheat acts as a cash cover crop protecting the soil, suppressing winter annual weeds and scavenging nutrients in the soil, resulting in overall improved soil health.

Wheat residue will suppress and reduce soybean cyst nematode¹ populations in the following soybean crop when beans are no tilled into wheat stubble that is left in the field.

Soybeans planted after wheat act as a summer cover crop suppressing weeds, scavenging nutrients, protecting the soil and improving soil health.



WHEAT SOYBEAN DOUBLE-CROP PROTECTS THE SOIL, SCAVENGES NUTRIENTS AND PROTECTS WATER QUALITY. Courtesy of Illinois Soybean Association.

Wheat followed by double-crop soybeans will build soil tilth and provide a 12-month growing cover crop reducing soil erosion. It will also weaken weed reproduction and enhances herbicide control.

Ken McClintock, Regional Sales Manager Eastern US, Limagrain Cereal Seeds.

A Review of Soybean Yield when Double-Cropped after Wheat. Hansel DSS, Schwalbert RA, Shoup DE, Holshouser DL, Parvej R, Prasad PVV, Ciampitti IA. *Agronomy Journal* 2019;111(2):677-685. <https://dl.sciencesocieties.org/publications/aj/articles/111/2/677?highlight=&search-result=1>

Double Crop Soybean Production Guidelines. Lindsey L. 2018. The Ohio State University. <https://stepupsoy.osu.edu/soybean-production/double-crop-soybean-production-guidelines>

Double Cropping in Illinois. Hoelt RG, Wedberg J, Shurtlef MC, Harms AG, Hinton RA, Nelson R, Scott WO, McKibben GE, Hirning HJ, Thorne MD, Millis DE, Cate HA, Siemens JC, Sims FM. 1975. Circular 1106. College of Agriculture, University of Illinois. <https://www.ilsoyadvisor.com/documents/double-cropping-illinois#overlay-context=on-farm/ilsoyadvisor/webinar-soil-biology-builds-resilience-and-enhances-soil-quality>

Double Cropping Soybeans in Virginia. Holshouser DL. 2014. Virginia Tech – Tidewater Agricultural Research & Extension Center, Suffolk, Va. https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/CSES/CSES-102/CSES-102-pdf.pdf

Double Crop Soybean Planting Decisions. Shaun Casteel S. 2013. Purdue University. https://www.agry.purdue.edu/ext/soybean/News/2013/DC_Soy_Plant_Decisions_20130709.pdf

Illinois Agronomy Handbook. Chapter 3. Nafziger E. University of Illinois. 2009. <http://extension.cropsciences.illinois.edu/handbook/>

Illinois Grower's Guide to Superior Soybean Production. Pepper GE, Hoelt RG, McGlamery MD, Pope RA, Scott WO, Thorne MD, Fall DC, Nickell CD, Drablos CJW, Siemens JC, Nave RW, Hummel JW, Jacobsen BJ, Shurtleff MC, Steffey KL. University of Illinois College of Agriculture, Cooperative Extension. 1982. Circular 1200. https://www.ilsoyadvisor.com/sites/default/files/documents/17_Illinois%20Growers%20Production%20Guide%201982.pdf

Illinois Soybean Production Guide: Systematic Strategies to Increasing Yield. 2012. Illinois Soybean Association. https://review.charlestonorwig.com/isa/_2018/2516/IL%20Soybean%20Production%20Guide.pdf

Market and Production Assessment for Double Cropping – Soybeans and Wheat for the Illinois Soybean Association/Illinois Soybean Program Operating Board. 2013. Jeremy Ross, Melanie Fuhrman, Amy Carroll and Bob Stark. University of Arkansas Division of Agriculture. Funded by the Illinois Soybean Association. <https://www.ilsoyadvisor.com/documents/market-and-production-assessment-double-cropping-soybeans-report>

Modern Corn and Soybean Production. Hoelt RG, Nafziger E, Johnson R, Aldrich S. 2000. University of Illinois. MCSP Publications, Champaign, Illinois. Available online through numerous book resellers.

Multi-Cropping Practices: Recent Trends in Double Cropping. 2014. Borchers A, Truex-Powell E, Wallander S, Nickerson C. USDA/ERS Bulletin 125. https://www.ers.usda.gov/webdocs/publications/43862/46871_eib125.pdf?v=41787.

Wheat-Soybean Double-Crop Management in Missouri. Minor HC, Wiebold WJ. 1998. University of Missouri. <https://extensiondata.missouri.edu/pub/pdf/agguides/crops/g04953.pdf?ga=2.14297911.168719126.1561296713-1823361133.1559322899>.

CARL SCHWINKE

Vice President Grain Supply,
Siemer Milling Company

DANIEL DAVIDSON

PhD, Agronomist/Consultant,
Illinois Soybean Association

DON GUINNIP

Former District 14 Director,
Illinois Soybean Association

G. KELLY ROBERTSON

Consulting Agronomist,
Precision Crop Services LLC

JOHN PIKE

Agronomist/Contract Researcher,
Pike Ag LLC

JONATHAN PERKINS

PFR Agronomist and Location Lead,
Beck's Hybrids.

KELLI BASSETT

Agronomist,
Bassett Farm and Pioneer Seed Sales

KEN MCCLINTOCK

Regional Sales Manager Eastern US,
Limagrain Cereal Seeds

MEGAN MILLER

Ag Innovation and Tech Transfer Manager,
Illinois Soybean Association

MICHAEL DOHERTY

Executive Director,
Illinois Wheat Association

NICK HARRE, PHD

District 17 Director,
Illinois Soybean Association

PHIL KRIEG

Agronomic Service Representative,
Syngenta

PHIL NEEDHAM

Owner,
Needham Ag Technologies

STEPHEN JOEHL

Director Research and Technology,
National Association of Wheat Growers

TERRY D. WYCISKALLA

Owner,
Wyciskalla Consulting, LLC

TRACY HEUERMAN

Sr. Field Sales Agronomist,
Growmark

1. Research funded by Illinois Soybean Association. Bond J, Southern Illinois University-Carbondale.
2. Personal Communications, Emerson Nafziger, Professor Emeritus, University of Illinois.
3. Personal Communication, John Pike, Pike Ag LLC.
4. Personal Communications, John Pike, Pike Ag LLC.
5. Personal Communication, Phil Needham, Needham Ag Technologies.
6. Through the process of mineralization, about 1 to 3% of the organic N in the topsoil is converted annually into plant-available N. This would mean that a soil with 4% organic matter might be able to provide 40 to 120 pounds of N per acre per year, depending on weather conditions. Illinois Agronomy Handbook. Page 118.
7. Managing Insect Pests, Illinois Agronomy Handbook. Page 195.
8. Armyworm, <http://extension.cropsciences.illinois.edu/fieldcrops/insects/armyworm/>
9. Succinate Dehydrogenase Inhibitor (SDHI).
10. Miravis® Ace fungicide label allows for application as early as 50% head emergence.
11. Double Cropping in Illinois. Hoeft RG, Wedberg J, Shurtlef MC, Harms AG, Hinton RA, Nelson R, Scott WO, McKibben GE, Hirning HJ, Thorne MD, Millis DE, Cate HA, Siemens JC, Sims FM. 1975. Circular 1106. College of Agriculture, University of Illinois.
12. Results of a survey conducted by Illinois State University of funded by the Illinois Soybean Association.
13. Emerson Nafziger, Illinois Agronomy Handbook, p.50.