Chapter 16

Production Systems and Economics

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Arkansas soybean producers use several different irrigated and non-irrigated production systems including full-season (FSSPS), doublecrop (DCSPS) and early soybean production (ESPS). In addition, these production systems are implemented in differing tillage regimes ranging from conventional to no-till.

Yield potential, production cost, time of harvest, available equipment, etc., should be considered when determining which soybean production system to use. Some of the pertinent advantages and disadvantages of each of the major production systems are covered in this chapter.

Regardless of the production systems, there are several factors that warrant discussion when attempting to maximize yield and/or net returns. Certainly the implementation of many of the factors discussed will require an economic investment with the expectation that the returns will exceed the investment.

Factors Associated With All Soybean Production Systems

Soil Fertility – Production of high-yielding soybeans requires soil fertility levels that do not limit yield. Proper soil sampling, soil testing and fertilization according to soil test recommendations assure adequate plant nutrition. Both the soil sampling and testing represent relatively low-cost investments that can result in tremendous returns (**see Chapter 5**).

Soil pH – Optimum soybean production is achieved in soil pH ranges of 6.5 to 7.0. Although liming is only recommended when soil pH values fall below 5.8, the lack of available molybdenum results in reduced yields in the soil pH range of 5.8 to 6.9. If soil pH is less than 7.0, treat seed with molybdenum to minimize potential yield loss (**see Chapter 5**).

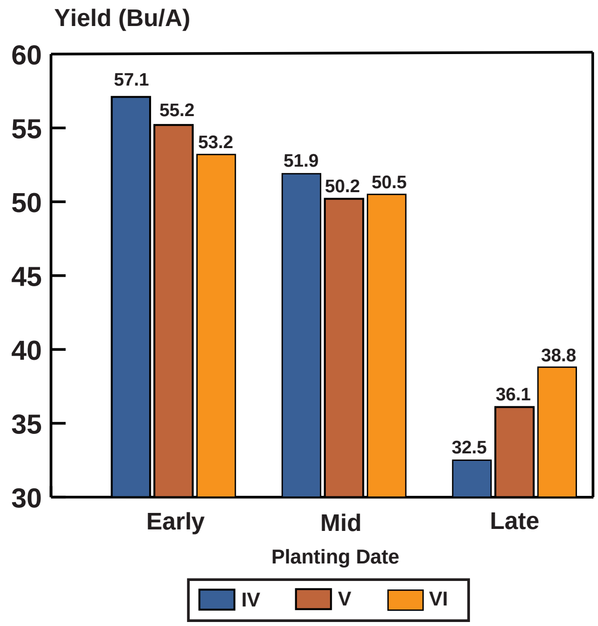
Drainage – Adequate drainage is essential for consistent production. Standing water in the field can reduce plant stand, promote seedling diseases, stunt plant growth and may even result in crop failure. The lack of adequate surface drainage is often the most serious detriment to profitable soybean production, and it should be improved at every opportunity (**see Chapter 6**).

Rotation – Research consistently shows that rotating soybeans with rice, grain sorghum, corn or cotton increases soybean yield potential (5 bu/A is common). Gains in yield potential probably arise from breaking cycles of diseases, weeds and insects, and by a general increase in soil productivity.

Figure 16.1. Crop rotation generally increases soybean yields.

Variety Selection and Planting Date – High yields cannot be obtained unless the variety being grown has a high yield potential within the cropping environment. Variety selection should represent a planned program giving consideration to diseases, soil texture, planting date, maturity, yield, etc. The data in Figure 16.2 (Ashlock, et al.) illustrate the importance of planting date on varietal grain yield by maturity group in Arkansas. From an overall farm perspective, the use of high-yielding varieties from differing maturity groups offers many advantages to Arkansas growers, including a more stabilized grain yield from year to year, especially with dryland or non-irrigated systems (**see Chapters 3 and 9**).

Figure 16.2. Effect of Planting Date on Irrigated Soybean Yield by Maturity Group (Pine Tree Experiment Station – 1995-1998)



Early – comprises planting dates between April 25 and May 6.
Mid – comprises planting dates between May 25 and June 5.
Late – comprises planting dates between July 1 and July 10.

Tillage – In all production systems, growers should look for ways to minimize tillage trips. The use of "stale seedbed" or "no-till" can be advantageous to growers for both time and labor savings, increasing the potential for higher net returns. In addition, sub-soiling has resulted in increased yields in certain situations, which will be addressed toward the end of this chapter (**see Chapter 6**).

Row Spacings – Research has demonstrated that row spacings of 30 inches or less may (but not always) result in increased yields. These yield increases occur more consistently in April and July plantings where row spacings of 20 inches or less are preferred (**see Chapter 7**).

Pest Control – Different production systems may be prone to different pest problems. For example, stink bug can be a serious problem in the ESPS but is not as likely to be of economic significance in doublecrop plantings. Regardless of the pest and/or production system, when economic thresholds are reached, control measures are warranted and should be implemented **(see Chapters 9, 10, 11 and 12**).

Early Soybean Production System (ESPS)

This production system is often profitable for many soybean producers in Arkansas. The system generally consists of planting indeterminate MG III and IV varieties in April. This system can be very effective in years when moisture is adequate until mid- to late July. Research findings indicate many MG V and VI varieties also perform well when planted during the last week in April, although plant height of most determinate varieties, regardless of MG, is reduced. Several details will now be examined that are unique to this production system.

Planting Date – The recommended planting dates for ESPS are listed in Table 16.1 for southern and northern Arkansas. **Specific varieties planted in the ESPS environment are available at the county Extension office and at Extension's website *http://www.uaex.uada.edu* in the form of a newsletter entitled *Soybean Update* and Extension's computerized soybean variety selection program, *SOYVA*.**

Table 16.1. Suggested Planting Dates for the Early Soybean Planting System (ESPS) in Arkansas

Maturity Group	South Arkansas		North Arkansas	
	Dryland	Irrigated	Dryland	Irrigated
MG IV*	4/1-4/25	4/1-4/30	4/7-4/30	4/7-5/7

* Planting indeterminate MG III and IV varieties early (April) especially in narrow row spacings (20 inches or less) allows for adequate plant growth before flowering.

Row Spacings – Research findings suggest that row spacings of 20 inches and less are often superior to 30-inch rows in the ESPS. In addition to increased grain yield, narrow row spacings help assure early canopy closure, reduce weed problems at maturity and generally result in increased profits.

Diseases – The ESPS encompasses a different seedling environment than experienced during the conventional planting dates of FSSPS (May-June). When planting in cool, wet soils, there is increased concern for serious seeding disease problems. Growers are urged to treat seed with a systemic fungicide (such as Apron, Allegiance or Apron XL) to minimize Pythium and seedling stage of Phytophthora root rot. Growers are also encouraged to include products such as Vitavax 200, Vitavax M, Maxim, etc., which will minimize damage due to Rhizoctonia organisms. Since the potential for stem canker also exists with the ESPS, growers should exercise caution when planting varieties susceptible to this disease.

Insects – Certain insect pests, especially stink bugs, may increase in the ESPS system while others decrease. Due to the limited ESPS acreage, these fields often serve to attract foliage-feeding bean leaf beetles early in the growing season, while later in the growing season stink bugs can greatly impact grain quality as they feed on developing seed. Generally, the foliage-feeding worm complex (corn earworm and loopers) are not serious problems in the ESPS. Insects should be monitored closely and economic thresholds used to determine when treatment is warranted (**see Chapter 12**).

Weed Control – Early season weed control strategies associated with the ESPS are not unlike those encountered in FSSPS. Varieties used in the ESPS typically mature in late August or early September, resulting in the opening of the plant canopy. This scenario coupled with row spacings greater than 20 inches can easily contribute to late weed emergence, which can be a problem at harvest. Fortunately, fields in narrow row spacings (20 inches or less) coupled with good early season weed control generally do not require desiccation (**see Chapter 9**).

Seed Quality – In most years, ESPS plantings mature seed in an environment of high temperature and high humidity. These environmental conditions typically result in seed that are unacceptable for planting purposes. Generally, only slight (if any) deductions for grain quality are experienced at the elevator except in seasons of extreme drought and/or stink bug damage.

MG IV seed production plantings should not be attempted without irrigation and should be confined to June plantings (**see Chapter 4**). Furthermore, seed yield (and perhaps quality) may be further enhanced if the MG IV plantings are confined to the northern portion of the state. Following these guidelines should enable Arkansas seed growers to produce MG IV seed of acceptable germination and vigor while obtaining acceptable seed yield.

Full-Season Soybean Production System (FSSPS)

Most soybeans produced in Arkansas are produced in a FSSPS and consist of both dryland (non-irrigated) and irrigated production systems. FSSPS irrigated fields planted to MG V and VI varieties in late April and May have very good yield potential (50+ bu/A) statewide but may not always be the most profitable due to increased irrigation and pest problems (weed and foliar diseases). Also, FSSPS dryland fields can be profitable, but success with this system is dependent upon receiving timely rainfall and the inherent productivity of the soil; therefore, yearly fluctuations in grain yield and profitability are often quite variable for this production system.

Planting Date – The most effective time to plant the FSSPS is between April 25 and June 15, depending on the variety (maturity group) and geographic region of the state as depicted in Table 16.2. Later plantings up to July 15 can be accomplished if soil moisture is adequate, but research has shown that yield potential is reduced as much as 2 percent per day after June 15 (**see Chapter 7**).

Table 16.2. Suggested Planting Dates for the Full-Season Soybean Production System (FSSPS) in Arkansas[1]

Maturity Group	South Arkansas		North Arkansas	
	Dryland	Irrigated	Dryland	Irrigated
MG IV	NR*	5/1-5/15	5/1-5/15	5/1-6/15
MG V	4/25-6/15	4/25-6/15	4/25-6/15	4/25-6/15
MG VI	4/25-6/15	4/25-6/15	4/25-6/15	4/25-6/15
MG VII	4/25-6/15	4/25-6/15	NR	NR

*NR – Not recommended [1]See Management Tips on next page.

Maturity – Varieties of differing MGs produce grain yields that vary considerably due to planting date, geographic location within the state and when adequate soil moisture becomes available (due to irrigation and/or timely rainfall), especially during the reproductive stages of plant development [i.e., from pod set (R3) through seed fill (R6)]. Since yields vary so much from year to year between varieties of

Management Tips

Suggestions for Improving Planting Seed Quality (Germination and Vigor) in Arkansas Plantings

- MG IV varieties may be planted for seed production with irrigation after June 15 especially in northern Arkansas.
- MG V varieties may be planted for seed production after June 1 in southern Arkansas and May 25 in northern Arkansas.
- MG VI varieties may be planted for seed production after May 25 in southern Arkansas and after May 15 in northern Arkansas.

Specific varieties planted in FSSPS environment are available at the county Extension office and at Extension's website *http://www.uaex.uada.edu* in the form of a newsletter entitled *Soybean Update* and Extension's computerized soybean variety selection program, *SOYVA*.

differing maturity groups (especially true for dryland production systems), growers are encouraged to plant three or four high-yielding varieties from more than a single MG.

Pest Management – Weeds, insects and diseases (including stem canker and frogeye leaf spot) can reach or exceed threshold levels with the FSSPS. Proper variety selection can be a great aid in minimizing the impact of many of the disease problems.

Row Spacings – Row spacing should be a width that works well in the overall farm operation (i.e., other crops in rotation), but again, preference should be given to row widths of 30 inches or less for the FSSPS. The key is for the determinate varieties to lap (obtain canopy closure) by the time the plants start to flower (R2). For indeterminate varieties, plants should be at least close to lapping or canopy closure when they are at the R2 growth stage. If lapping is occurring consistently by R2 growth stage, row spacing or width should not significantly impact yield.

Doublecrop Production System (DCSPS)

Generally, one-third of the state's soybean acreage is planted doublecrop behind wheat. This production system allows growers to harvest two crops in a single season. With **irrigation**, DCSPS yields of **50+ bu/A** are possible with proper management if planted by June 15. Research has shown that this system often results in the greatest net returns when both crops (wheat and soybean) are considered.

The dryland DCSPS is often at higher risk for stand establishment due to inadequate soil moisture in mid- to late June. If moisture is not available for germination and emergence, stand establishment is delayed and yield potential is greatly reduced. Also, the shortened season associated with a late planting date intensifies the effect of any stress on the crop. These stresses often result in reduced plant development and increased insect feeding.

Planting Date – Doublecrop soybeans should be planted as soon after wheat harvest as practical. Keep in mind that grain yield potential decreases every day after June 15 that soybeans are not planted or where dry conditions exist that prevent seed from germinating. A 40 bu/A yield potential does exist for soybean plantings that have emerged by July 1. The planting date guidelines depicted in Table 16.3 include the latest research findings regarding the performance of leading commercial varieties of differing maturity groups to late planting dates that are common with the DCPS.

Variety Selection – Recent research findings continue to support Extension recommendations for selecting varieties that are of late MG V (> 5.6) through MG VI for the doublecrop system. **Specific varieties planted in DCSPS environment (i.e., late planting dates) are available at the county Extension office and on Extension's website at http://www.uaex.uada.edu in the form of newsletter entitled *Soybean Update* and Extension's computerized soybean variety selection program, *SOYVA*.**

Row Spacing – DCSPS planting should be in rows less than 20 inches wide. For dryland production, this is an especially good practice for clay soils and when planting after July 1. With proper management, irrigated doublecrop production will often lap on 20-inch rows unless planted after July 1.

Pest Management – Soybean production within the DCSPS is generally characterized with somewhat reduced weed presence, reduced incidence of plant diseases, but often experiences accelerated insect problems (both foliage and pod feeders).

Maturity Group	South Arkansas		North Arkansas	
	Dryland	Irrigated	Dryland	Irrigated
MG IV[1]	NR*	6/1-7/15	NR	6/1-7/15
MG V[2]	6/1-7/15	6/1-7/15	6/1-7/15	6/1-7/15
MG VI[3]	6/1-7/15	6/1-7/15	6/1-7/15	6/1-7/15
MG VII	6/1-7/1	6/1-7/1	NR	NR

Table 16.3. Suggested Planting Dates for the Doublecrop Soybean Production System (DCSPS) in Arkansas

*NR-not recommended
1 MG IV varieties normally mature prior to an early frost, but reduced yield potential suggests that these and the early MG V varieties can only be warranted if planted for seed production.
2 Limit MG V dryland plantings to varieties that are of a 5.7 or later maturity.
3 MG VI varieties perform best in DCSPS, but refrain from planting late MG VI (> 6.5) varieties in northern Arkansas after July 7 due to potential frost damage.

Conservation Tillage – The practice of reduced tillage and/or no-till soybean production in a doublecrop system is growing in popularity. This management tool may result in an earlier planting, in cooler soils, with less labor, and the conservation of moisture for the doublecrop planting. Recent research by Keisling, et al., suggests that improved soybean yields have resulted, indicating that some shallow or slight tillage of the crusting soils prior to planting resulted in improved yields. This yield increase probably relates to improved water infiltration and/or conservation. Caution should also be taken in variety selection. Select varieties that have moderate to high levels of resistance to lodging, because plants that emerge through the wheat straw often become spindly or etiolated. The use of a seed treatment is recommended for all no-till planting, and treatment products discussed earlier with the ESPS also perform well in no-till doublecrop systems.

Additional Considerations

Non-Irrigated or Dryland Soybean Production

Dryland soybean production can have positive net returns, but there is no way to guarantee this outcome. Therefore, growers should weigh the risk of crop failure against input costs. There are several aspects of dryland production that should be considered to maximize yield while holding input costs down.

Weather Considerations – In dryland production, long-term weather patterns must be considered. Growers should look at ways to avoid late summer drought. One possibility is to divert at least 20 percent of the acreage to the ESPS system. In many years, the ESPS system allows seed to fill before major drought conditions occur. Another alternative is to plant a late-maturing group V or early VI variety in late May or early June to use late summer rains. The risk of poor growing conditions in any part of the season can be minimized by coupling well-adapted varieties of differing maturity groups to the different production systems.

Controlling Input Costs – Growers must continue to control input costs in all production systems, but it is imperative to control cost in all dryland or non-irrigated production systems. Reducing tillage trips by using “stale seedbed,” “minimum tillage” and/or “no-till” as well as properly timed reduced-rate herbicide technology offers the most obvious way to minimize input costs.

Conserving and Improving Moisture Utilization – Attempts should be made to optimize plant extractable soil moisture. Reduce tillage trips and consider using no-till when possible and/or appropriate. Avoid using tillage implements that promote drying the soil such as a chisel plow or disk. If these implements are used, follow immediately with a finishing tool. Additionally, recent research and Extension demonstration work document that some soil types respond significantly with improved soybean yields if **sub-soiled** in the fall when the soil is very dry. Generally, the most consistent response has been with alluvial soils that have severe root-restricting layers or plow pans within the top 6 to 8 inches and are characterized with fine sandy loam or are silty clay topsoils. Since sub-soiling is a relative expensive project and results have not been consistently positive, growers may wish to consult with their county Extension agent or the Natural Resources Conservation Service (NRCS) prior to implementing this practice.

Seeding Rates – Refer to **Chapter 7** for the current seeding rate recommendations for the production system and row spacing. Considerable research is ongoing to further refine these recommendations. Recent research findings (Vories, Keisling, et al.) suggest that increased seeding rates which contribute to higher plant populations than those listed in **Chapter 7** resulted in increased yields under certain field conditions. Fields in which increased seeding rates may be warranted are characterized with reduced development (reduced

Management Keys for Dryland Systems

1. Restrict dryland wheat-soybean doublecropped system to alluvial or highly productive soils.
2. Use recommended varieties of IV, V and VI with appropriate pest control genetics (at least moderate resistance to Frogeye Leaf Spot).
3. Utilize the ESPS system on at least 20 percent of acreage. This system would be especially useful on deep alluvial soils that have deep rooting and lots of stored water (i.e., Red River Valley, Arkansas River Valley, Mississippi, White and St. Francis). This system is not as effective in shallow soils.
4. Use molybdenum seed treatment on acid soils (soil pH less than 7.0).
5. Apply fertilizer according to soil test recommendations, especially ensure adequate soil pH (>5.7) and potassium (K).
6. Consider narrow row spacings and increased plant population on the more marginal soils.
7. When cost effective, utilize crop rotation with at least a one-year rotation between two year successive soybean crops for all but clay soils to reduce nematodes and soil insect problems.

height and canopy width). Further work is ongoing in this area, but suffice it to say that the seeding rates listed in **Chapter 7** are sufficient for many situations.

Irrigated Soybean Production

In irrigated production systems the major cause of crop failure (drought) is removed and therefore risk is diminished. However, there is the added expense associated with irrigation. With lower risk and increased expense, irrigated production systems should, with proper management, result in improved yields and greater net returns.

Level of Management

A higher level of management is necessary to recover cost of irrigation and to produce increased net returns. All factors associated with production that limit yield potential must be determined and minimized. Yield-limiting factors must be addressed and continually reevaluated.

Irrigation

Eliminating water stress from the crop is critical to producing high yields. Irrigation should be conducted prior to water stress for the entire growing season. Growers lose yield potential when they are reluctant to start irrigation. With a 30 percent chance of rain, some growers will not irrigate; however, there is greater than a 70 percent chance it will not rain a significant amount. Even if it does rain, generally only a small portion of the soybean acreage is being irrigated at any one time.

Producing High Yields

Irrigated soybean production offers the greatest chance of producing high yields. A few growers in the state averaged 50+ bu/A over their entire soybean acreage the last few years with good management including proper irrigation. Growers who have irrigation available for soybean production should strive to consistently produce 50+ bu/A yields.

Management Keys for Irrigated Systems

1. Make sure the field has adequate surface drainage prior to investing in irrigation. Extended wet periods, especially following irrigation, can have devastating effects on the poorly drained areas.
2. Use high-yielding, recommended varieties of differing maturity groups.
3. Follow fertilizer and lime recommendations based on annual soil test.
4. Control pests including foliar diseases with systemic fungicides if warranted.
5. To minimize pest problems, especially on silt loam soils, it is generally wise to utilize crop rotation with at least a one-year rotation of corn, sorghum, rice or cotton between two-year successive soybean crops.
6. Irrigate timely to prevent stress, even prior to bloom (R2) and through seed development (R6) by utilizing the University of Arkansas Computerized Irrigation Scheduling Program.

Table 16.4. Costs and Returns by Production System, SRVP, 1984-98					
Production System	No. Bu/A	Yield Bu/A	Expenses[1]	Returns Above Total Expenses[2]	Returns Above Total and 25% Rent[3]
Irrigated Full Season	138	46.9	$184.20	$108.20	$35.10
Irrigated Doublecrop	57	43.6	164.96	106.88	38.92
Dryland Full Season	36	28.0	114.54	60.02	16.38
Dryland Doublecrop	10	26.1	98.36	64.18	23.55
Irrigated Early Season	4	48.4	205.71	95.51	20.21
Dryland Early Season	13	31.7	117.34	80.25	30.85

[1]Total expenses include direct and fixed expenses.
[2]Based on 10-year season average price of $6.23 per bushel.
[3]A 25 percent crop share rent was assumed with no cost sharing.

Production System Economics

The Soybean Research Verification Program (SRVP) uses the different production systems discussed in this chapter. The SRVP fields are commercial fields across the state that have received a high level of timely management. The overall goal of the program is to produce the highest net returns possible in each field.

Agronomic and economic results from 1984 through 1998 SRVP are presented in Table 16.4. Yield averages presented for the different production systems represent the high level of management and demonstrate the long-term yield potential present with available technology. Across all three irrigated production systems, the 199 SRVP fields averaged 46 bu/A compared to the state irrigated average of 33.3 bu/A. The 59 SRVP dryland fields across the three production systems averaged 29 bu/A compared to the state dryland average of 23.5 bu/A.

Production expenses are a major factor in determining net returns. SRVP production costs have been maintained at a reasonable level for the production systems. The three dryland production systems have total (specified and fixed) expenses that averaged $112/A. To ensure positive net returns in dryland systems, production expenses must be controlled. In the SRVP, this has been accomplished by reducing tillage, utilizing reduced-rate weed control recommendations, proper seeding rates and variety selection and timeliness of all inputs to ensure cost effectiveness.

Total expenses across all three irrigated production systems have averaged $180/A. The total expense figure in the ESPS reflects a high weed control cost associated with one of the four fields, but the lowest expense was associated with the irrigated DCSPS. This lower expense is due to an average savings of $8/A for operating costs and $10/A less ownership (equipment) costs.

SRVP returns above total expenses, including a 25 percent crop rent, are also presented in Table 16.4. These long-term average returns across all production systems suggest that irrigated FSSPS and DCSPS production systems have average returns above total expenses of $40/A greater than these same production systems made in dryland conditions. The irrigated production systems had an average net return of $35/A after assigning a 25 percent land rent, while the dryland fields averaged $21/A.

The SRVP has produced soybeans with profitable net returns in six different production systems. The highest net returns have been associated with the three irrigated systems, and lowest but positive net returns have been obtained in the three dryland systems. Increasing yield while minimizing production expenses has been one of the major objectives of the SRVP.

Conclusion

Several production systems are available to growers. One of the major challenges is to determine which factor(s) is either limiting yield or contributing to higher production cost in the farming operation or in a specific field. Addressing the factor(s) will increase production efficiency in a step-by-step process. The recent advances in “site specific” or “precision agriculture” technology should further result in improved identification of yield-limiting factors, enabling the Arkansas producer to increase soybean production efficiency with both higher yields and, hopefully, lower production cost. With the soybean production and marketing technology today, there are many situations whereby the Arkansas soybean producer can accomplish both objectives simultaneously.