Strip Intercropping of Corn and Soybeans in the U.S. – Potential Profitability?

Barry Ward, Dr. Brian Roe, Dr. Marv Batte
Department of Agricultural, Environmental and Development Economics,
The Ohio State University

The Ohio State University
Agricultural, Environmental and Development Economics
Ohio State University Extension

Strip Intercropping Production Solution

Strip Intercropping Production Solution (SIPS)

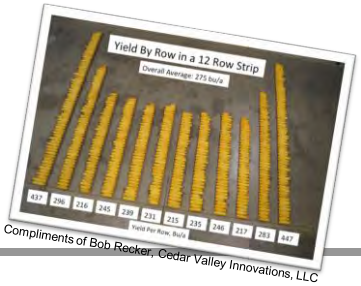
- ***Background***
- ***Economic Model***
- ***Current Findings***
- ***Key Insights***

SIPS – Background

Changes in Production Practices

- Intercropping tall and short crops may allow for more efficient capture of sunlight to increase yields.
- Evidence suggests intercropping corn and soybeans increases corn crop yields, although degree of yield improvement varies with strip width.
- For farms using large equipment implementing SIPS will require:
  - Equipment solutions to accommodate narrower, 4 or 6 row strips (planters, sprayers, and combines)
  - Enhanced production planning as fields may be visited twice per function per season (i.e., once to plant corn, once for soybeans).

"It would not surprise me, in a short period of time, to drive down the road and see corn and soybeans planted in strips."
David Bullock, Ag Economist
University of Illinois
(10-17-11, Corn and Soybean Digest).



Compliments of Bob Recker, Cedar Valley Innovations, LLC

Table 1. Yield Effects for Corn and Soybean from the Extant Literature

Source	Moisture Status/Management	Crop Year	Unit	Corn Outer Row	Corn 2nd Row	Corn Inner Rows	Soy Outer Row	Soy 2nd Row	Soy Inner Row
Lesoing and Francis 1991	Below normal moisture	1988	Bu/ac	107.9 (+10%)	NR	97.7	22.8 (-5%)	NR	24.1
Lesoing and Francis 1991	Below normal moisture	1989	Mg/ha	145.5 (+30%)	NR	111.7	29.6 (-22%)	NR	38.1
Lesoing and Francis 1991	Near normal moisture	1990	Mg/ha	138.6 (+16%)	NR	119.2	30.1 (-23%)	NR	39.2
Lesoing and Francis 1991	Irrigated	1988	Mg/ha	175.3 (+19%)	NR	147.1	26.9 (-2%)	NR	27.6
Lesoing and Francis 1991	Irrigated	1989	Mg/ha	243.8 (+31%)	NR	186.4	29.6 (-31%)	NR	43.0
Lesoing and Francis 1991	Irrigated	1990	Mg/ha	219.9 (+28%)	NR	172.1	26.5 (-26%)	NR	35.9
West and Griffith 1992	Normal Moisture-Regular Mgt.	1986 - 1990	Mg/ha	213.7 (+20%)	186.1 (+5%)	177.6	37.3 (-22%)	46.4 (-3%)	47.6 (51.0)[a]
West and Griffith 1992	Normal Moisture-High Mgt.	1986 - 1990	Mg/ha	227.8 (+27%)	183.2 (+2%)	179.1	37.3 (-22%)	46.4 (-3%)	47.6 (51.0)[a]
Bullock and Bullock 2013[b]	Normal moisture	2009	Mg/ha	310.7 (+41%)	250.1 (+14%)	219.9	52.6 (-15%)	57.4 (-8%)	62.1
Bullock and Bullock 2013[b]	Below normal moisture	2010	Mg/ha	255.1 (+51%)	194.4 (+17%)	165.7	33.5 (-57%)	49.4 (-16%)	58.9

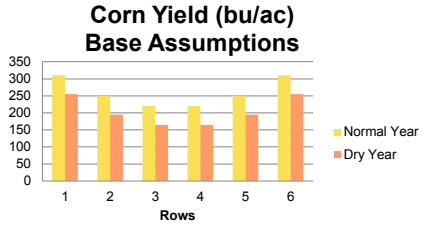
SIPS - Background

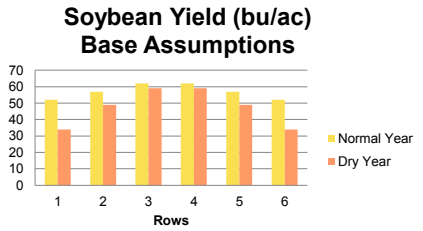
Yield Response

- Assumptions for 6-row system based on University of Illinois research.

Potential Yield Effects (bu/ac)				
	Corn		Soybeans	
Row	Normal Year	Dry Year	Normal Year	Dry Year
1st (edge)	310	255	52	34
2nd	250	195	57	49
Center	**220**	**165**	**62**	**59**

Source: Dave Bullock, University of Illinois (journal article submitted for review) and Bob Recker (Corn and Soybean Digest, 2012).





Gross Revenue Comparisons – Underlying Assumptions

- We created a spreadsheet to calculate total field yields and gross revenues assuming strip intercropping with various strip widths.
  - We used outer row, 2nd row, and center row estimates for corn and soybeans from University of Illinois.
  - A typical year and Dry year results were modeled separately
  - Two levels of prices were used – Both reflect the long-term historical ratio of Soybean / Corn prices of 2.5
    - $4 and $10 - Lower Corn / Bean price scenario
    - $7 and $17.50 Higher Corn / Bean price scenario

Gross Revenue Comparisons – Underlying Assumptions

- Gross revenue calculated by varying
  - # of 30" rows per strip (4 to 16)
  - Price levels
    - Lower: $4 corn, $10 bean
    - Higher: $7 corn, $17.50 bean
  - Yields effects (U. Illinois results)

	Corn		Bean	
Row	*Normal*	*Dry*	*Normal*	*Dry*
1st (Edge)	310	255	52	34
2nd	250	195	57	49
Center/Single Crop	220	165	62	59

- Differences in costs for strip intercropping not yet considered.

The Ohio State University
Agricultural, Environmental and Development Economics
Ohio State University Extension

Gross Revenue Comparisons:
Typical Weather, Lower Prices[a]

- Single crop yields modeled as equal to "center row" of strips
- Headlands for strip intercropping were all soybeans.

	Strip Width				
	4-row	6-row	8-row	12-row	16-row
System	**Gross Revenue per acre**				
1 field corn, 1 field bean	$747	$747	$747	$747	$747
2 fields Intercropped	$827	$798	$782	$765	$755
Absolute Difference	**$80.00**	**$51.00**	**$35.00**	**$18.00**	**$8.00**
% DIFFERENCE	**10.71**	**6.83**	**4.69**	**2.41**	**1.07**
headlands (passes x rows)	2X4	2X6	2X8	2X12	2X16
a Corn (bean) prices per bushel are $4.00 and $10.00.					

Gross Revenue Comparisons:
Typical Weather, Higher Prices[a]

- Single crop yields modeled as equal to "center row" of strips
- Headlands for strip intercropping were all soybeans.

	Strip Width				
	4-row	6-row	8-row	12-row	16-row
System	**Gross Revenue per acre**				
1 field corn, 1 field bean	$1,312	$1,312	$1,312	$1,312	$1,312
2 fields Intercropped	$1,447	$1,396	$1,369	$1,339	$1,321
Absolute Difference	**$135.00**	**$84.00**	**$57.00**	**$27.00**	**$9.00**
% DIFFERENCE	**10.29**	**6.40**	**4.34**	**2.06**	**0.69**
headlands (passes x rows)	2X4	2X6	2X8	2X12	2X16
a Corn (bean) prices per bushel are $7.00 and $17.50.					

The Ohio State University
Agricultural, Environmental and Development Economics
Ohio State University Extension

Gross Revenue Comparisons:
Dry Weather, Lower Prices[a]

- Single crop yields modeled as equal to "center row" of strips
- Headlands for strip intercropping were all soybeans.

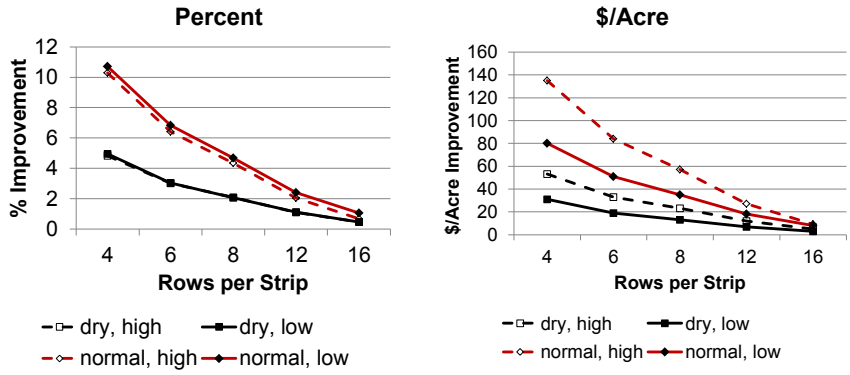
	Strip Width				
	4-row	6-row	8-row	12-row	16-row
System	**Gross Revenue per acre**				
1 field corn, 1 field bean	$625	$625	$625	$625	$625
2 fields Intercropped	$656	$644	$638	$632	$628
Absolute Difference	**$31.00**	**$19.00**	**$13.00**	**$7.00**	**$3.00**
% DIFFERENCE	**4.96**	**3.04**	**2.08**	**1.12**	**0.48**
headlands (passes x rows)	2X4	2X6	2X8	2X12	2X16
a Corn (bean) prices per bushel are $4.00 and $10.00.					

Gross Revenue Comparisons:
Dry Weather, Higher Prices[a]

- Single crop yields modeled as equal to "center row" of strips
- Headlands for strip intercropping were all soybeans.

	Strip Width				
	4-row	6-row	8-row	12-row	16-row
System	**Gross Revenue per acre**				
1 field corn, 1 field bean	$1,094	$1,094	$1,094	$1,094	$1,094
2 fields Intercropped	$1,147	$1,127	$1,117	$1,106	$1,099
Absolute Difference	**$53.00**	**$33.00**	**$23.00**	**$12.00**	**$5.00**
% DIFFERENCE	**4.84**	**3.02**	**2.10**	**1.10**	**0.46**
headlands (passes x rows)	2X4	2X6	2X8	2X12	2X16
a Corn (bean) prices per bushel are $7.00 and $17.50.					

Gross Revenue Improvements Compared to Single Cropping



Intercropping Equipment Assumptions

Baseline Scenarios

Traditional Complement (5313 ac corn/soybeans)

- 308 hp FWA tractor
- 248 hp FWA tractor
- 16-row folding planter (with splitters to plant beans)
- Self-propelled sprayer with 88.5 ft. booms
- 402 hp combine (8-row corn head, 36 ft small grain platform)
- 892 bu grain cart
- 46 ft pull-type fertilizer spreader
- 24 ft chisel plow
- 46.9 ft field cultivator
- 16-row N sidedress applicator

Small Scale Complement (5313 ac corn/soybeans)

- 5, 50 hp tractors
- 3, 6-row planters
- 5, 15 ft 3-point boom sprayers
- 3, 6.5 ft chisel plows
- 3, 15 ft field cultivators
- 2, 302 hp combines (6 row corn head, 30 ft small grain platform)
- 4, 200 bu grain carts
- 2, 22 ft fertilizer spreader
- 3, 6-row sidedress N applicators

SIPS – Economic Model

Approach and Assumptions

Approach

- Corn and soybean budgets used to compare SIPS vs. traditional equipment.
- Revenue comparison based on Illinois study findings and historical range of corn/soybean prices.

Assumptions

- 50-50 corn/soybean crop mix with rotation.
- Corn planted from 4/15 – 5/15.
- Soybeans planted from 5/15 – 6/15.
- For SIPS
  - Machinery complement necessary to match traditional scale.
  - Requires multiple sets of tractors and implements to ensure timeliness of planting, spraying and harvest.
- 5% field efficiency improvement on strip operations from smaller equipment.

SIPS - Current Findings

- Incentive for farmers to adopt strip intercropping comes from estimating corn and soybean production in 6-row strips.
- Reference estimates are included for
  - Traditional mono-culture enterprise
  - Strip Intercropping Production System poly-culture
- Assumptions:
  - Yields and gross revenues as estimated in previous slides.
  - Other than labor and machinery costs, all other poly-culture costs are assumed the same as for mono-cultures.
    - Seed, fertilizer, pest control costs may differ
  - Scale chosen to match optimal scale of traditional mono-culture enterprise.

SIPS – Cost Comparisons

Labor and Machinery

Comparison	Standard	Strip
Acres	2665	2665
Total field hours	1187	2716
b/w field transition	181	383
Total Hours	1368	3098
hrs/ac	0.51	1.16
Total Wage Bill	$21,714	$40,278
Wage/ac	$8	$15
Machinery cost/ac	$79	$163
Fuel Price	$3.50	$3.50
Fuel cost/ac	$32.66	$44.66
Machinery, Fuel, Lub, On Machine Labor Costs/ac		
Total	$119.81	$222.77
ratio		1.86
difference (relative to standard)		$102.97

SIPS - Current Findings

Net Return Differences

Returns, net of Labor and Machinery Costs ($/ac)

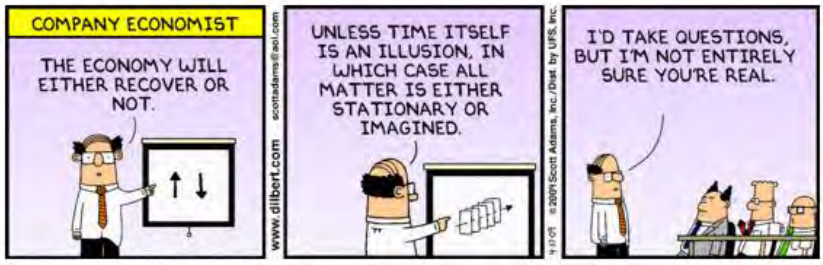
6-row strip

Conditions	Gross Revenue Difference	Net Revenue Conventional Production in Strips[c]
Typical Weather, High Prices[a]	$84	($6)
Typical Weather, Low Prices[b]	$51	($39)
Dry Weather, High Prices[a]	$33	($57)
Dry Weather, Low Prices[b]	$19	($71)
Average of Above Cases	$47	($43)

[a] Corn and soybean prices are $4/bu and $10/bu.
[b] Corn and soybean prices are $7/bu and $17.50/bu.
[c] Represents difference compared to monoculture with conventional 8-row equipment.

Next Steps

- Explore literature for different yield estimates
- Add Costs, including consideration of:
  - If crops planted on same date
    - Yields decrease as optimal plant dates missed
      - For planting, same date may allow for single pass planting by alternating seed type on existing planter
  - Added costs for higher seeding rates, higher fertilizer application rates, higher costs for pest control
  - If crops are planted at near optimal calendar dates
    - Multiple trips to same field will decrease efficiency
  - In some areas where soybeans mature first, headlands may always need to be in soybeans
  - Use of Small Autonomous Equipment may limit inherent cost-side inefficiencies associated with smaller equipment
- Consider different bean/corn price ratios
  - Long run average is 2.5
  - Ranges from 2 to 3, with lower more favorable to strips



Source: Dilbert

- Barry Ward (614) 688-3959
- ward.8@osu.edu
- http://aede.osu.edu/our-people/barry-ward
- http://aede.osu.edu/research/osu-farm-management