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## THE ECONOMICS OF ADDING MORE CORN TO CORN-SOYBEAN ROTATIONS

Some farmers are considering adding more corn to their rotations. This consideration likely arises because corn has generally been more profitable than soybeans in recent years. The recent introduction of soybean rust into the United States may also increase interest in adding more corn to rotations.

This paper shows how to evaluate the economic advisability of adding more corn to 1/2 corn – 1/2 soybeans rotations. The 1/2 corn – 1/2 soybeans rotation is chosen as the benchmark because many Illinois farmers use this rotation. A budgeting approach that includes short- and long-run components is detailed. Planting more corn may increase returns in the first year and reduce returns in future years. Hence, there is a need to look at both short- and long-runs. Then, other economic considerations in adding corn are discussed.

### Budgets

Economic evaluation of adding more corn begins with budgets for corn-after-soybeans, corn-after-corn, and soybeans. Both corn-after-soybeans and corn-after-corn budgets are required because corn returns depend on the previous crop.

Table 1 shows budgets for central Illinois farms having high productivity farmland. The corn-after-soybeans and soybeans budgets are taken from an *Illinois Farm Economics: Facts and Opinions* article entitled “2004 Corn and Soybean Revenue and Cost Estimates”. Budgets represent projections based on averages for Farm Business Farm Management (FBFM) grain farms located in central Illinois having high productivity farmland. Most central Illinois farms plant about 50% of their acres in corn and 50% in soybeans, suggesting that these budgets reliably represent corn-after-soybeans and soybeans budgets.

The corn-after-corn budget is a modification of the corn-after-soybeans budget. The corn-after-corn yield is 10% lower than the corn-after-soybeans yield. Some farmers may argue that a 10% yield drag is too high. Yield drags potentially vary from farm-to-farm; however, a great deal of agronomic research suggests that 10% is a realistic loss number (A later sensitivity analysis varies yield drag). The corn-after-corn fertilizer cost is increased by \$10 per acre to account for the loss of the “soybean credit” in calculating nitrogen requirements. This credit increases nitrogen needs for corn-after-corn compared to corn-after-soybeans (see *Illinois Agronomy Handbook*). Overall, the corn-after-corn budget has a \$149 per acre return (i.e., revenue less variable costs in Table 1), \$48 per acre less than corn-after-soybeans.

Two caveats should be kept in mind when using the budgets in Table 1. First, the budgets represent averages. Yields and costs vary considerably across farms. Hence farmers should use their own budgets in conducting their analyses.

**Table 1. 2005 Projected Revenue Less Variable Costs, Central Illinois with High Productivity Farmland.**

	Corn- After- Soybeans	Corn- After- Corn	Soybeans
Yield per acre	173	156	49
Price per bushel	\$2.25	\$2.25	\$5.20
	\$ per acre		
Revenue	\$389	\$351	\$255
Variable costs			
Fertilizer and lime	\$65	\$75	\$24
Pesticides	40	40	25
Seed	38	38	29
Drying and storage	16	16	5
Machinery repair, fuel, and hire	<u>33</u>	<u>33</u>	<u>28</u>
Total variable costs	\$192	\$202	\$111
Revenue less variable costs	\$197	\$149	\$144

Second, these budgets include only variable costs. Not included are fixed costs such as machinery depreciation. Machinery depreciation will not change with small changes in crop rotations but could vary with large modifications in rotations. For example, shifting from a 1/2 corn – 1/2 soybeans rotation to a continuous corn rotation for the entire farm may necessitate equipment changes. If dramatic shifts in rotation are planned, changes in fixed costs should also be included in the analysis.

### Short- and Long-Run Return Analysis

The return analysis considers the 1/2 corn – 1/2 soybeans rotation as a benchmark. The economic question addressed is whether moving to a rotation with more corn results in higher returns. The analysis is divided into short- and long-run components, followed by a sensitivity analysis.

**Short-run returns:** The short-run analysis considers returns for the upcoming year. For farmland with soybeans as the preceding crop, returns in Table 1 indicate that corn is the most profitable alternative. Corn-after-soybeans has a \$197 per acre return compared to \$144 for soybeans. For farmland with corn as the preceding crop, returns in Table 1 indicate that corn is the most profitable crop. Corn-after-corn has a return of \$149 per acre, \$5 higher than the soybeans return. The short-run analysis indicates that planting corn is more profitable on all acres. Note, however, that the return difference between corn-after-corn and soybeans is small.

The short-run analysis does not consider the impacts of next year's rotations on the following year's returns. Hence, the short-run analysis does not indicate that planting more corn is profitable in the long-run.

**Long-run returns:** The long-run analysis evaluates returns after the first year, assuming that the farm reaches a stable rotation. Rotations change the amount planted to corn-after-soybeans, the cropping sequence that usually has the highest returns. In the long-run, a 1/2 corn – 1/2 soybeans has one-half of

its return from corn-after-soybeans and one-half from soybeans. A 2/3 corn – 1/3 soybean rotation has one-third of its return from corn-after-soybeans, one-third from corn-after-corn, and one-third from soybeans. The 2/3 corn – 1/3 soybean rotation has one-sixth less acres in corn-after-soybeans.

**Table 2. Per Acre Returns for Alternative Rotations.<sup>1</sup>**

Rotation	Per Acre Return
1/2 corn - 1/2 soybeans rotation <sup>2</sup>	\$171
2/3 corn - 1/3 soybeans rotation <sup>3</sup>	\$163
Continuous corn <sup>4</sup>	\$149

<sup>1</sup> Based on budgets shown in Table 1.

<sup>2</sup> Equals one-half the corn-after-corn return (\$197) plus one-half soybean return (\$144).

<sup>3</sup> Equals one-third the corn-after-soybeans return (\$197), plus one-third the corn-after-corn return (\$149), plus one-third the soybean return (\$144).

<sup>4</sup> Equals the corn-after-corn return (\$149).

Table 2 shows per acre returns from three long-run rotations given budgets in Table 1. The 1/2 corn – 1/2 soybeans rotation, with an average return of \$171, has higher returns than the 2/3 corn – 1/3 soybeans rotation (\$163 per acre) and continuous corn (\$149). The long-run analysis suggests that the 1/2 corn – 1/2 soybeans rotation is the most profitable rotation.

Three points need to be made about the long-run analysis. First, the long-run analysis is based on budgets shown in Table 1. These budgets represent projected 2005 conditions. In some cases, 2005 conditions may not represent long-run conditions. If this is the case, prices and yields should be modified to more accurately reflect long-run returns.

Second, the continuous corn return in Table 2 assumes that the corn-after-corn budget in Table 1 is applicable to all continuous corn situations. Specifically, it is assumed that corn after one year of corn is the same as after two years and so on. If corn yields depend on two or more preceding crops, the long-run analysis becomes more complicated than that shown in Table 2.

Third, results in Table 2 indicate that 1/2 corn – 1/2 soybeans rotation is the most profitable in the long-run. If corn-after-corn returns have higher returns such that the analysis indicates that more corn should be added to a 1/2 corn – 1/2 soybeans rotation, the long-run analysis in Table 2 will indicate that continuous corn is the most profitable rotation. In essence, the above analysis indicates all or nothing. The 1/2 corn – 1/2 soybeans rotation is most profitable when the corn-after-corn return is less than the average of corn-after-soybeans and soybeans returns. Otherwise, the continuous corn rotation is the most profitable rotation.

**Short-run versus long-run considerations:** Adding more corn to a 1/2 corn – 1/2 soybean rotation often increases short-run returns and decrease long-run returns, presenting farmers with a tradeoff. This tradeoff can be treated as a discounting problem in which future returns are discounted to the present. In most cases, long-run returns will outweigh short-run returns because long-run returns are applicable to multiple years.

**Sensitivity analysis:** Long-run results depend on many factors. Yield drag and soybean returns are of current interest. Some individuals believe a 10% yield drag for corn-after-corn is too high. The recent introduction of soybean rust into the United States may indicate that soybean returns will decrease because yields may decrease and applications of fungicide will be required.

A sensitivity analysis is presented in Table 3. This analysis shows decreases in per acre soybean returns to break-even for different percent yield reductions for corn-after-corn, given that all other parameters are the same as in Table 1. If the corn-after-corn yield drag is 10%, soybean returns can decrease by no more than \$43 per acre for the 1/2 corn – 1/2 soybean rotation to be economical in the long-run. If soybean costs returns decrease by more than \$43, adding corn to a 1/2 corn – 1/2 soybeans rotation increases returns.

At a 10% yield drag, the soybean return decrease is \$43. The introduction of soybean rust may decrease soybean returns. If soybean rust decreases returns by more than \$43 per acre, either through increases in costs or decreases in yields, then moving to more corn increases long-run returns.

Lower corn-after-corn yield reductions cause the soybean return decrease to become smaller. With a 4% corn-after-corn yield drag, the soybean return decrease is a -\$3 per acre. This indicates that soybean returns have to increase by at least \$3 per acre, otherwise planting more corn is the more profitable alternative.

### Budgets for Other Regions

Tables 1, 2, and 3 are reproduced in appendices for northern, central Illinois with low productivity farmland, and southern Illinois categories. Break-even soybean return decreases for a 10% yield drag for corn-after-corn are \$43 per acre for northern Illinois, \$43 for central Illinois with low productivity farmland, and \$55 per acre for southern Illinois.

In general, characteristics of farms that will find switching to more corn can be identified. Farms with relatively high yields (above 165 bushels per acre for corn and above 45 bushels for soybean) who have corn yields divided by soybean yields above 3.4 may find adding more corn advantageous.

### Other Considerations

In some cases both the short- and long-run analyses may indicate that adding more corn increases returns. If this occurs, there are still considerations that may warrant maintaining a 1/2 corn – 1/2 soybeans rotation. These considerations include risk, machinery costs, labor and price adjustments.

**Risk:** Corn returns have higher variability than soybean returns. Moreover, corn-after-corn has more yield variability than corn-after-soybeans. Hence, adding corn-after-corn to a rotation will increase risks.

**Machinery costs:** Adding a significant amount of corn to a rotation may change equipment requirements. The size of planting equipment may have to be increased to plant all corn within the optimal planting window. Also, planting more corn will slow harvest and may require additional investment in harvesting equipment. Changing equipment requirements could change equipment costs.

**Table 3. Soybean Return Decreases that Cause Adding More Corn to Increase Returns.<sup>1,2</sup>**

Corn-After Corn Percent Yield Drag	Decrease in Per Acre Soybean Returns
0%	-\$33
2%	-\$21
4%	-\$3
6%	\$11
8%	\$29
10%	\$43
12%	\$61
14%	\$75

<sup>1</sup> Based on budgets in Table 1.

<sup>2</sup> This is a long-run analysis. Take a 10% yield drag for corn-after-corn as an example. Soybean returns have to decrease by more than \$43, either through a yield loss or cost increase, before planting more corn become profitable after the first year.

Moving totally to continuous corn could reduce other machinery costs. Specialized soybean equipment such as soybean heads for combines, grain drills, and split-row planters could be eliminated from the machinery complement. Whether eliminating these items outweighs any necessary equipment size increases is an open question.

**Labor:** Moving to significantly more corn likely will increase labor requirements, particularly during harvest. Hence, labor costs could increase.

**Price adjustments:** A large switch in acres from soybeans to corn would likely cause a price response, causing corn returns to be lowered compared to soybean returns. Hence, any major supply response could change prices causing the 1/2 corn – 1/2 soybeans rotation to be more profitable.

### Summary

This paper presents a methodology for evaluating whether adding more corn to a rotation is advisable. Analyses include short- and long-run components. The long-run component is more difficult to meet than the short-run component. Farms with relatively high yields and with high corn-soybean yield ratios may find adding more corn advantageous.

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### Appendix 1: Tables 1, 2, and 3 for Northern Illinois.

**Table N-1. 2005 Projected Revenue Less Variable Costs, Northern Illinois.**

	Corn- After- Soybeans	Corn- After- Corn	Soybeans
Yield per acre	166	149	46
Price per bushel	\$2.20	\$2.20	\$5.10
	\$ per acre		
Revenue	\$365	\$328	\$235
Variable costs			
Fertilizer and lime	\$61	\$71	\$23
Pesticides	42	42	25
Seed	39	39	30
Drying and storage	14	14	5
Machinery repair, fuel, and hire	<u>39</u>	<u>39</u>	<u>33</u>
Total variable costs	\$195	\$205	\$116
Revenue less variable costs	\$170	\$123	\$119

**Table N-2. Per Acre Returns for Alternative Rotations.<sup>1</sup>**

Rotation	Per Acre Return
1/2 corn - 1/2 soybeans rotation <sup>2</sup>	\$145
2/3 corn - 1/3 soybeans rotation <sup>3</sup>	\$137
Continuous corn <sup>4</sup>	\$123

<sup>1</sup> Based on budgets shown in Table 1.

<sup>2</sup> Equals one-half the corn-after-corn return (\$170) plus one-half soybean return (\$119).

<sup>3</sup> Equals one-third the corn-after-soybeans return (\$170), plus one-third the corn-after-corn return (\$123), plus one-third the soybean return (\$119).

<sup>4</sup> Equals the corn-after-corn return (\$123).

**Table N-3. Soybean Return Decreases that Cause Adding More Corn to Increase Returns.<sup>1,2</sup>**

Corn-After Corn Percent Yield Drag	Decrease in Per Acre Soybean Returns
0%	-\$31
2%	-\$19
4%	-\$1
6%	\$13
8%	\$25
10%	\$43
12%	\$57
14%	\$69

<sup>1</sup> Based on budgets in Table 1.

<sup>2</sup> This is a long-run analysis. Take a 10% yield drag for corn-after-corn as an example. Soybean returns have to decrease by more than \$43, either through a yield loss or cost increase, before planting more corn become profitable after the first year.

**Appendix 2: Tables 1, 2, and 3 for Central Illinois with Low Productivity Farmland.**

**Table C-1. 2005 Projected Revenue Less Variable Costs, Central Illinois with Low-Productivity Farmland.**

	Corn- After- Soybeans	Corn- After- Corn	Soybeans
Yield per acre	164	148	46
Price per bushel	\$2.25	\$2.25	\$5.20
	\$ per acre		
Revenue	\$369	\$333	\$239
Variable costs			
Fertilizer and lime	\$66	\$76	\$24
Pesticides	41	41	25
Seed	38	38	30
Drying and storage	13	13	4
Machinery repair, fuel, and hire	<u>35</u>	<u>35</u>	<u>29</u>
Total variable costs	\$193	\$203	\$112
Revenue less variable costs	\$176	\$130	\$127

**Table C-2. Per Acre Returns for Alternative Rotations.<sup>1</sup>**

Rotation	Per Acre Return
1/2 corn - 1/2 soybeans rotation <sup>2</sup>	\$152
2/3 corn - 1/3 soybeans rotation <sup>3</sup>	\$144
Continuous corn <sup>4</sup>	\$130

<sup>1</sup> Based on budgets shown in Table 1.

<sup>2</sup> Equals one-half the corn-after-corn return (\$176) plus one-half soybean return (\$127).

<sup>3</sup> Equals one-third the corn-after-soybeans return (\$176), plus one-third the corn-after-corn return (\$130), plus one-third the soybean return (\$127).

<sup>4</sup> Equals the corn-after-corn return (\$130).

**Table C-3. Soybean Return Decreases that Cause Adding More Corn to Increase Returns.<sup>1,2</sup>**

Corn-After Corn Percent Yield Drag	Decrease in Per Acre Soybean Returns
0%	-\$29
2%	-\$15
4%	\$3
6%	\$15
8%	\$29
10%	\$43
12%	\$61
14%	\$75

**Appendix 3: Tables 1, 2, and 3 for Southern Illinois.**

**Table S-1. 2005 Projected Revenue Less Variable Costs, Southern Illinois.**

	Corn- After- Soybeans	Corn- After- Corn	Soybeans
Yield per acre	139	125	42
Price per bushel	\$2.30	\$2.30	\$5.30
	<u>\$ per acre</u>		
Revenue	\$320	\$288	\$223
Variable costs			
Fertilizer and lime	\$64	\$74	\$25
Pesticides	35	35	23
Seed	39	39	27
Drying and storage	7	7	4
Machinery repair, fuel, and hire	<u>37</u>	<u>37</u>	<u>35</u>
Total variable costs	\$182	\$192	\$114
Revenue less variable costs	\$138	\$96	\$109



**Table S-2. Per Acre Returns for Alternative Rotations.<sup>1</sup>**

Rotation	Per Acre Return
1/2 corn - 1/2 soybeans rotation <sup>2</sup>	\$124
2/3 corn - 1/3 soybeans rotation <sup>3</sup>	\$114
Continuous corn <sup>4</sup>	\$96

<sup>1</sup> Based on budgets shown in Table S-1.

<sup>2</sup> Equals one-half the corn-after-corn return (\$138) plus one-half soybean return (\$109).

<sup>3</sup> Equals one-third the corn-after-soybeans return (\$138), plus one-third the corn-after-corn return (\$96), plus one-third the soybean return (\$109).

<sup>4</sup> Equals the corn-after-corn return (\$96).

**Table S-3. Soybean Return Decreases that Cause Adding More Corn to Increase Returns.<sup>1,2</sup>**

Corn-After Corn Percent Yield Drag	Decrease in Per Acre Soybean Returns
0%	-\$9
2%	\$5
4%	\$19
6%	\$29
8%	\$43
10%	\$55
12%	\$69
14%	\$79