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Feasibility of Growing and Feeding High Oil Corn to Pigs

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Summary and Implications

A feasibility analysis on the growing and feeding of high-oil corn (HOC) to pigs was conducted. The cost to produce HOC is about 25 to 32 cents per bushel higher than for normal corn (NC), primarily due to 7 to 10 percent yield reduction for HOC. Diets made with HOC contain between 1.5 and 3 percent additional fat. Therefore, feed efficiency should be improved, on average, by 3 to 6 percent when HOC is substituted for NC. In most cases, daily gain should improve by 0 to 3 percent with HOC in the diet. High-oil corn grown in central Nebraska during 1997 averaged 6.2 percent oil (12 percent moisture). When HOC (6.2 percent oil) is used to replace NC in growing-finishing pig diets, it is worth 21 to 25 cents more than NC, assuming NC and 44 percent protein soybean meal cost $2.50 per bushel and $250 per ton, respectively. When NC and soybean meal cost $2 per bushel and $200 per ton, HOC is worth 17 to 20 cents more than NC. If HOC is used to replace animal or vegetable fat in pig diets, it is worth about 40 cents per bushel more than NC, if supplemental fat costs 20 cents per pound. The only economic benefit given to HOC was an increase in feed efficiency. These results suggest no

current economic incentive for producers to grow and feed HOC.

Introduction

High-oil corn (HOC) is the fastest growing segment of the value-enhanced corn market. DuPont is the primary company involved in HOC production, having licensed its HOC genes to 80 seed companies. The DuPont TOPCross system is the most common method of producing commercial HOC. This method involves planting a blend of two types of corn, the "grain parent" and the "pollinator."

The purpose of this study is to determine whether or not it is cost effective to raise HOC and feed it to pigs. In addition, the value of HOC as a fat source versus other sources of supplemental fat will be presented. Because of the limited amount of research results available on both the production and feeding of HOC, this is a progress report.

Producing High-Oil Corn

In general, the same production practices recommended for normal corn (NC) apply to HOC. TOPCross hybrids depend on the transfer of pollen from a male parent (the pollinator) to the male-sterile female parent (the grain parent). The males make up only 8 to 10 percent of the blends, so the number of plants contributing to pollen production is reduced. Some precautions with HOC may he warranted to ensure successful pollination, such as planting away from NC, to avoid cross pollination with low-oil types. There is, however, disagreement over the extent of separation needed, with estimates ranging from 0 to 200 feet.

Some people recommend an increased seeding rate for HOC. There is no good evidence to indicate optimum seeding rates for TOPCross corn are higher than for NC. Seeding rates above the optimum in dryland production can increase the severity of drought stress during pollination.

A HOC hybrid is likely to yield less than its low-oil counterpart. The yield loss is expected because of two factors: the physiological cost of making the oil and the competition between the male and female parents in blended hybrids.

Table 1. Added production cost (cents/bushel) of high oil corn (HOC) compared to normal corn (NC)[a].

Yield, Percent of NC	100	95	90	85
Planting rate of HOC				
Same as NC	6.8	19.6	32.5	45.4
+ 2,000 seeds per acre	7.3	20.1	33.1	46.0

[a]Technology fee of seed, $30 per bag; yield of NC, 150 bushels/acre; planting rate of NC, 27,000 seeds/acre; cost of production for NC, $2.50/bushel.

In the process of making oil instead of carbohydrate, carbon is lost. The loss of carbon is wasteful, so plant synthesis of corn oil is less efficient than carbohydrate production. All other things being constant, a 2.5 percent yield reduction would be expected for every I percent increase in oil content.

The second source of yield reduction is from the mixing of plants contributing to yield (the female parents) with plants that only contribute pollen. The male plants, which make up 8 to 10 percent of the blends, use resources — light, water and nutrients — at the expense of their neighbors. If the male and female parents are similar in size, the light intercepted by the female parent is likely to be reduced in proportion to the amount of the male pollinator present. Given the direct effect of light interception on photosynthesis, and photosynthesis on yield, a loss of approximately 8 to 10 percent can be expected.

Because the yield of HOC compared to NC is uncertain, it may be best to evaluate the impact of a range of yield reductions. It appears HOC will likely yield within a range of 85 to 100 percent of NC. That range was selected for evaluation and the results are presented in Table 1.

Because the production practices for HOC and NC are identical (except for isolation), the production costs per acre are the same, except for the seed. There is often a $30 per bag technology fee for HOC seed. This amounts to about $10 per acre. If HOC yields the same as NC, this $10/acre is the only added cost, and this amounts to 6.8 cents per bushel with a 150 bu/acre yield (Table 1). But, the HOC will most likely yield less than NC, resulting in fewer bushels with a slightly higher per acre cost. The decreased yield has much more impact on the production cost of HOC than does the technology fee on the seed. If HOC yield is of 90 percent of NC yield, the added production cost is 32.5 cents per bushel (this includes the 6.8 cent cost due to the technology fee). The added production costs would increase slightly if seeding rate was increased by 2,000 seeds per acre. Thus, the yield of HOC producers can expect is a key variable in their decision to adopt this technology.

Yield comparisons of HOC to NC are difficult to make, due to the isolation needed for HOC. In a study in Ohio, the average yield of high-oil varieties was 90 percent of the NC hybrids. Two NC hybrids in this experiment had high-oil counterparts. Considering only these two hybrids, the high oil versions averaged 92.3 percent of the yield of the NC hybrids.

The Kearney (Nebraska) Area Agricultural Producers Alliance conducted evaluations in six locations in 1997. The large plot tests contained up to 16 HOC varieties and two to four NC hybrids for yield comparison. The six plot average yield of HOC oil varieties was 90.8 percent of the average of NC yields.

Therefore, it seems that yields will likely be in the 90 to 93 percent range, given the current stage of the technology. This would result in added production costs of 25-32 cents per bushel for HOC.

The storage requirements for HOC are similar to those for NC. To gain the most benefit from feeding HOC, it

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must be stored separately from NC. This may result in additional cost or inconvenience for some producers.

Feeding High-Oil Corn to Pigs

Nutrient Composition and Quality

The nutrient composition of HOC and NC are similar with a few important exceptions. High oil corn contains more protein, lysine, fat and metabolizable energy than NC (Table 2). Because there seems to be significant genetic and environmental effects on the final nutrient content of HOC, a range in composition is presented.

Effect of High-Oil Corn in Swine Diets

Few data exist comparing the performance of pigs fed HOC (5.5 to 7.5 percent oil) to NC (3.5 to 4.2 percent oil). However, a large database exists on the effect of adding animal fat or vegetable oil to swine diets. Recent trials indicate pig performance is similar when the total amount of fat in NC-based diets is equalized to a HOC-based diet by fat supplementation. From this, we assume HOC in the diet would elicit a response similar to that observed when a similar amount of fat is added to a NC-based diet.

On the average, feed efficiency is improved by 2 percent for each 1 percent increment of added fat to the diet. Diets containing HOC contain between 1.5 and 3 percent added fat, depending on the oil content of the corn. Therefore, feed efficiency should be improved by about 3 to 6 percent when HOC is substituted for NC corn.

Generally when growing-finishing pigs are fed NC-based diets containing 1.5 to 3.0 percent added vegetable oil or animal fat (amount similar to that when HOC replaces NC in the diet), daily gain remains constant. In some cases, especially during hot weather, daily gain may increase up to about 3 percent. Until further data from HOC feeding trials are available, we suggest average daily gain will remain the same or may improve up to 3 percent when HOC replaces NC in growing-finishing pig diets.

Backfat thickness should not be altered when using HOC in the diet, unless the additional fat levels exceed 5 percent of the diet and the amino acid: calorie ratio in the diet is not maintained constant.

Because some producers may not have enough HOC to feed all of their pigs, they need to decide how to best utilize the corn in their operation. In general, growing pigs weighing from about 30 to 130 pounds and lactating sows would benefit the most from HOC as they have the most difficulty consuming enough calories to maximize performance.

As little as 2.5 percent added fat (50 pounds/ton) reduces dust in confinement buildings by about 25 percent. Reduced dust levels have improved health implications for both pigs and people. Also, small additions of fat in an ingredient or feed allows it to flow more easily.

Estimating the Economic Value of High-Oil Corn

In our analysis we credited HOC for improving feed efficiency only. Given the potential variation in the oil content of HOC varieties and in factors affecting feed conversion rates, economic values were estimated for a range of outcomes (Table 3).

Producers should use the results from the oil analysis of their HOC to choose which type is most like theirs (5.5 or 7.5 percent oil). For each type of HOC, a range in the improvement in feed efficiency is included in the analysis. Producers could, in some instances, expect a greater response in feed efficiency. For example, feed efficiency and daily gain are improved more by feeding fat to pigs during summer than during winter. If pigs are expected to be finished during the summer, it would be better to assume feed efficiency may improve by 7 percent (for 7.5 percent HOC). During the winter, however, the same HOC may only produce a 5 percent improvement in feed efficiency.

To calculate the economic value of HOC as a replacement for NC in growing-finishing pig diets, a total of 12 diets were formulated. All the diets contained 44 percent crude protein soybean meal as the sole source of supplemental protein. Four diets were formulated with NC to contain 1.00, .9, .8 and .7 percent lysine. Four diets were formulated with 5.5 percent fat HOC and four others with 7.5 percent fat HOC. The HOC-based diets contained the same ratio of lysine to metabolizable energy as the NC-based diets. An overall feed conversion rate of 3.0 pounds feed per pound of gain and an average daily gain of 1.8 pounds was assumed. The improvements in feed efficiency shown in Table 3 were applied to the HOC diets. The price of NC was $2.50/bu, 44 percent soybean meal was $250/ton, and other ingredients were at current market prices. The cost savings realized from improved feed conversion was attributed to HOC. Results are shown in Table 4.

Because the advantage of HOC results from an improvement in feed efficiency, the price of the major ingredients (corn and soybean meal) affect the added value of the HOC. To show impact of changes in ingredient prices, a range of added values for HOC, reflecting high and low corn and soybean meal prices is shown in Table 4.

Table 2. Composition of high-oil corn (HOC) and normal corn (NC)[a].

Item	HOC	NC
Protein,%	8.6 to 8.8	8.3
Lysine.%	.28 to 30	.26
Fat, %	5.5 to 7.5	3.9
Metabolizable energy, kcal/lb	1,580 to 1,635	1,555

[a]As-fed basis (12 percent moisture).

Table 3. Expected improvement in feed efficiency from feeding high-oil corn.

Corn oil content, percent[a]	Improvement in feed efficiency, percent
5.5	2 to 4
7.5	5 to 7

[a]12 percent moisture.

Table 4. Value (cents per bushel) of high-oil corn (HOC) compared to normal corn (NC).

Corn oil content, percent[a]	Improvement in feed efficiency, percent	Added value of HOC, cents/bu	
		Value	Range[b]
5.5	2	11	9 to 13
	4	21	17 to 35
7.5	5	25	20 to 29
	7	35	28 to 41

[a]12 percent moisture.
[b]Range in HOC values reflects a range of prices for NC corn and 44 percent soybean meal.
Low prices; NC = $2/bu and 44 percent soybean meal = $200/ton
High prices; NC = #3/bu and 44 percent soybean meal = $300/ton

Table 5. Potential added value of high-oil corn (HOC) due to a 3 percent increase in average daily gain.

Savings per pig per day, cents	Added value of HOC, cents per bushel
0	0
5	2
10	4

[a]Assumes no change in the through put of the building. The timing of pig placements is kept the same. Potential savings due to the shorter feeding period are in interest, utilities, and possibly labor.

For example, if a 5 percent improvement in feed efficiency is achieved, the added value of HOC is 25 cents per bushel (with $2.50/bu corn and $250/ton soybean meal). But, the HOC advantage drops to 20 cents/bu if NC is $2/bu and soybean meal is $200/ton.

The average oil content of HOC varieties in the Kearney Area Agricultural Producers Alliance field tests was 6.2 percent (12 percent moisture basis). Thus, feed efficiency should improve by 4 to 5 percent when fed to growing-finishing pigs. This would result in an added value of HOC of 21-25 cents (with $2.50/bu corn and $250/ton soybean meal). Earlier, we concluded that production costs would likely be 25 to 32 cents per bushel higher for HOC. Thus, growing and feeding HOC to swine does not seem to be economically feasible at the current state of the technology and recognizing increased feed efficiency as the only economic benefit.

The Effect of Increased Average Daily Gain

If pigs that are fed a diet containing HOC gain 3 percent faster than those fed diets containing NC, what is the economic benefit? The effect of an increase in average daily gain is analyzed as a “what-if” question, since the variability in feeding trial results does not produce a clear answer. In addition to uncertainty regarding any change in average daily gain, the economic value of reducing the length of the feeding period varies from producer to producer.

If producers obtain a 3 percent increase in average daily gain, they will likely realize an added value of HOC in the 0 to 2 cents per bushel range (Table 5). While an improvement in average daily gain is possible, it is doubtful most producers are able to derive a significant economic benefit from it.

High-Oil Corn Versus Other Sources of Added Fat

Producers who currently add fat to their pig diets can substitute HOC for NC to achieve the higher dietary fa levels. What is the economic value of HOC when it is used to replace added fat (animal or vegetable) and NC in pig diets? To answer this question, diets were formulated with NC and fat to contain the same metabolizable energy lysine and fat level as diets with 7.5 percent oil HOC. Diets were formulated in the same manner as described previously. Prices of $2.50/bu for NC and $250/ton for 44 percent soybean meal were used. Fat prices of 10, 20,30 and 40 cents per pound were used in the analysis. The economic value of HOC, compared to NC was calculated for each of the fat prices (Table 6).

The added values, or premiums, for HOC, when used to replace added fat (Table 6) are much greater than those when it was substituted for NC (Table 5). A fat price of 20 cents per pound results in a 44 cent/bu premium for HOC, clearly above the 25-32 cents/bu increase in production cost. Vegetable oils, which may cost 40 cents/pound, result in an 89 cent/bushel premium for HOC.

Table 6. Value of high-oil corn (HOC) compared to normal corn (NC) at various supplemental fat prices[a].

Fat price, cents/pound	Added value of HOC, cents/bushel
10	21
20	44
30	67
40	89

[a]NC = $2.50/bu; 44% soybean meal = $250/ton; feed efficiency with NC and no added fat = 3.0 lb feed/lb gain; HOC - 7.5% oil, 0.3% lysine.

Producers should use caution when interpreting the premiums for HOC in Table 6. It is assumed the producer can justify purchasing fat at, for example, 20 cents per pound and adding it to the diet. Therefore, if HOC can be included in the diet for less than a 44 cents per bushel premium, fat can be acquired less expensively with HOC. Table 4 simply allows one to determine quickly if HOC is more economical. It does not imply it is economically feasible to add fat at the prices shown.

Conclusion

High-oil corn is a developing technology. Results to date suggest that it may yield 90 to 93 percent of NC, resulting in a production cost 25 to 32 cents per bushel higher than NC. Producers might expect the fat content of HOC to range from 5.5 to 7.5 percent with an average fat content of 6.2

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percent (12 percent moisture basis). If the HOC is used to replace NC in growing-finishing pig diets, it is worth 21-25 cents more than NC, given a $2.50/bu price for NC and $250/ton for 44 percent soybean meal, and assuming the only economic benefit of HOC is an increase in feed efficiency. If HOC is used to replace animal or vegetable fat in pig diets, it is worth about 40 cents per bushel more than NC, if supplemental fat costs 20 cents per pound.

The current situation does ont encourage pork producers to grow and feed HOC. Further research is needed to verify the comparative yield level and oil content of HOC, as well as the variance of these measures. Additional field trials may decrease the variance between the expected versus actual yields and oil contents. In addition, further research may reduce or eliminate the yield gap between HOC and NC.

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