How Many Honey Bee Colonies Can a Farmer Afford for a Collective Cotton Pollination Bee Yard?

Beekeeping Finance: Pollination

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The farmer will have a positive impact on his profit margin if the cost of honey bees (Apis mellifera) is less than the value of the increase in production (for both yield plus quality) for his crop. Hence, without bees you may be impacting the profit margin of your operation. Cost of colonies can impact a farmers' profit margin. The farmer may have to back-off on the number of recommended colonies due to cost. Question is, what are the absolute maximum number of colonies that a farmer can afford based on his costs and revenue, and the minimum number of colonies to properly pollinate a farmer's crops?

In this analysis, we determined the actual farmer primary variable cost factors, the most recent revenue factors, and varied the impact of increases in yield and quality due to honey bees (Apis mellifera), to determine the increase in revenue and profit for the crops. Soybeans, cotton, and sunflower were addressed. We finally only analyzed cotton, since the yield research benefits of soybeans are variable, and the farmer was not planning on harvesting the sunflowers. We used the research recommended number of colonies, and varied the yield + quality for the cotton until a positive farm operation return was obtained. The yield + quality crop increase percentages were compared to the research numbers to determine if the results were greater or less than the research results. This analysis also incorporated the notion of co-op renting of honey bees (Apis mellifera) by one or several farmers to reduce the colony cost per farmer.

Bees cruise in a 2 to 3 mile (1280-1920 acres) range. The bees also gather nectar and pollen from the closest sources to the colonies. Bees exhibit flower fidelity, where they typically visit the same type of flower on each foraging trip.

The land is fairly flat in the Swansea, South Carolina area. So, the bees are probably foraging close to a 2 to 3 miles' circle. We considered having several smaller bee yards rather than just one larger bee yard. More farmers may be happier with several smaller yards dispersed around the area since the distance from the colonies to the crop will be shorter. Also, in addition to yield, farmers should have an increase in crop quality.

Crop Bloom Timing

The farmer needs to be cognizant of crop bloom timing.

For example, if a farmer is growing sunflowers that are blooming at the same time as your cucumbers and squash, the bees will probably go more to the sunflowers since they have rich and more nectar. Cucumbers and squash do produce rich nectar but not very much. Hence, your sunflowers will get pollinated more at the expense of your cucumbers and squash. The bees will probably allocate some foragers to the cucumbers and squash, but not as many since they will allocate more foragers to the sunflowers.

In the North, South Carolina area, we found that small bumble bees were chasing the honey bees away from the sunflowers. However, the honey bees were still pollinating some of the smaller sunflower heads.

We need to analyze which crops are more important, and the bloom timing. Yes, bees are opportunists. We need to determine when each crop blooms, and what crops have over-lapping blooms. The number of colonies and bees in each colony, will also impact the crops' pollination.

Co-Op bee renting

If we have 2 bee yards with 5 colonies in each yard with 4 farmers contributing:

2 yards' x 5 colonies = 10 colonies, 10 colonies x $55/hive = $550, $550/ 4 farmers = $137/farmer

If we have 1 bee yard of 10 colonies with one farmer contributing:

1-yard x 10 colonies x $55/hive = $550, $550/1 farmer = $550

Farmer Purchase and Maintain Colonies, or Rent Decision

A basic hive + 3 supers (boxes to store honey in) + bees, will cost around $400. If the farmer is charged $55-$65/hive or $55 next year, we have $400/$55 per hive per season or bloom rent = 7.27 years to payback the $400 cost you will have into the hive. The $400 cost per hive typically will be reduced the more and grade of bee equipment you purchase. Also, the beekeeper can reduce his negative cash flow by splitting colonies rather than purchasing packages.

The current (2015-2016 Bee Informed Partnership Survey) United States national colony mortality rate is around 44% per year; that is for summer and winter. Hence, you can figure around 40% of the bees will die every year. If you have 10 colonies that mean about 4 colonies will die every year. Four colonies * $100 per 3 lb. package of bees is another $400 per year to maintain the 10 colonies.

Hence, for 10 colonies we have:

($400 cost / hive * 10 colonies) + $400 to replace 4 dead colonies bees + $25 * 4 cost to replace the 10 brood chamber frames for 4 dead outs = $4,500.

$4,500 / ($55 * 10) rent per bloom for 10 colonies = 8.18 years' rental to pay for the colonies and bees. This does not include gas, paint, time to assemble and work colonies, and overhead.

Determining how many colonies to have at each location.

The farmer association will vote to determine how many colonies the farmer association will pay for at each location. If a farmer wants more than the association votes on, then he will have to pay the additional amount.

Results

We analyzed the costs with the farmer picking the cotton, and with a third party picking the cotton. The numbers show for non-irrigated cotton, at a 5% yield + quality increase, results in an additional positive cash flow from bees for the farmer picking the cotton. For non-irrigated, we found it takes 11% increase in yield + quality to have a positive overall cash flow from operations with respect to the costs for a third party picking the cotton. Part of the 11% is for the farmer to overcome a deficit from a third party picking the cotton; i.e. the farmer was already about 5.9% in the negative / red prior to applying the honey bee colonies.

For irrigated cotton at a 3% yield + quality increase, results in an additional positive cash flow from bees. This is at $55 per hive pollination rental, one farmer paying, and 0.4 colonies per acre (1 colony/hectare). For cotton, the farmer can typically make more profit with irrigation. Bees contribute to the profit of the operation.

If we increase the number of colonies per acre to 1, at $55 per hive pollination rental, and one farmer paying, for non-irrigated cotton, we have:

- Farmer pick the cotton, and a positive $ increase yield due to bees – cost of colonies, at 12% increase in yield + quality. This results in an 11.2% variable profit margin.

- Third party pick the cotton, and a positive $ increase yield due to bees – cost of colonies, at 18% increase in yield + quality. This is unworkable. This results in a 0.7% variable profit margin, but the bees will probably not increase the yield + quality by 18%.

Hence, from the analysis it appears the farmer can only tolerate 0.4 to 1.0 colonies per acre rental, and the farmer will have to pick the cotton to be profitable. Two colonies per acre is not affordable by the farmer, i.e. the bee cost is greater than the resulting realistic yield value. With the third party picking the cotton, the issue is that the farmer was already in the "red," with a negative profit margin prior to applying the honey bees.

If irrigation is available, irrigation is certainly the method of choice with a 7% increase in yield + quality. This 7% increase in yield + quality for irrigated cotton results in a positive, $ increase yield due to bees – cost of colonies, for both farmers pick and third party pick. A 7% increase in yield + quality due to bees is realistic.

At 0.4 colonies per acre, the percent yield + quality increases that we used were on the low side for both irrigated and non-irrigated cotton compared to the research findings. Hence, we would expect a larger profit based on pollinating bees. If the weather and other factors are negatively impacting yield, honey bees may not improve the crop. Part of the issue is what competing plants are blooming at the same time as the cotton. In the latter half of July and first part of August when the cotton blooms, there is usually a dearth in bloom from other plants in the Swansea, South Carolina area. This means that a 0.4 up to 1.0 colonies per acre may indeed work.

This spreadsheet can be used for other crops. The costs and revenue numbers just need to be changed, but the basic analysis is the same. There will be variations in results due to the yearly weather, but this analysis shows that honey bees will contribute positively to the bottom line profit of the cotton farming operation.

Cotton provides a solid pollen flow that enables the bees to pull out beeswax frames of splits, and build the splits up, when fed syrup during the South Carolina summer dearth.

Spreadsheet and Spreadsheet Discussion

The spreadsheet is divided into two main sections; non-irrigated cotton (dry cotton) and irrigated cotton. Within each main section, are sections on costs and revenue. Within each costs sections, are sections on: labor cost as a percent of revenue (not used), labor cost with farmer picking and

labor cost without farmer picking or a third party picking, ginning cost per acre, fertilizer cost per acre, chemical cost per acre, seed cost per acre, “gas” cost, and colony cost per acre. Within each revenue section are: crop selling price, crop yield, increase in crop yield due to pollination, total revenue, total gross variable profit with and without picking, gross variable profit margin with and without picking, pollination colony cost impact on gross variable profit margin with picking and without picking, $ yield increase due to bees - cost of hives with picking and without picking, and direct cost as % of revenue with picking and without picking.

Inputs are identified by orange or salmon colored cells. The increase in crop yield due to pollination per acre was varied until total profit and total gross variable profit= Total revenue - Total cost with farmer picking and without picking, turned positive. This was done for various costs and number of colonies.

				number of acres		input into cells with this color	does not include fixed overhead expenses - machinery, land, tax, etc.		
	cotton-dry planting variable cost			1000					
	% of revenue agreement	labor cost as % of revenue	grand total labor costs based on % revenue	labor cost per hour w/picking	# labor hours w/picking	total labor cost w/picking	total labor cost w/o picking	# labor hours w/o picking	picking cost total labor cost w/o picking
employee	0.00%	$ -	$ -	$ 14.00	694	$ 9,716.00	$ 14.00	$ 278	$ 3,886.40
employee	0.00%	$ -		$ 14.00	694	$ 9,716.00	$ 14.00	$ 278	$ 3,886.40
employee	0.00%	$ -		$ 14.00	0	$ -	$ 14.00	$ -	$ -
				$ 14.00	0	$ -	$ 14.00	$ -	$ -

drop off $1.65/ac fuel ie reduce acre by 1000 ac	labor $8400/ 1000ac								
cost of picking per acre	ginning price per acre	cost of fertilizer per acre	cost of chemicals per acre	cost of seed per acre	number of acres	total fertilizer , chemical, and seed cost	gas number of gallons	cost of gas per gallon	total gas cost
$ 75.00	$ 75.00	$ 142.45	$ 105.00	$ 82.00	1000	$ 404,450.00	3500	$ 1.65	$ 5,775.00
	75	142.45	105	82					

cost of picking per acre									
$ 100.00	$ 75.00	$ 142.45	$ 105.00	$ 82.00	1000	$ 504,450.00	2500	$ 1.65	$ 4,125.00

number of colonies									
number of farmers renting bees	cost of colonies	number of colonies per acre	total number of colonies	total colony cost	total colony cost per farmer	total costs hourly	total colony cost as % of total cost	total costs : % revenue	total colony cost as % of total cost
1	$ 55.00	$ 0.40	400.00	$ 22,000.00	$ 22,000.00	$ 451,657.00	5%	$ 432,225.00	5%
		0.4							
1	$ 55.00	$ 0.40	400.00	$ 22,000.00	$ 22,000.00	$ 538,347.80	4%	$ 530,575.00	4%

	yield price								
number of acres	crop selling price per lb.	crop selling price per bale	number of bales per acre	base crop lbs. yield per acre	increase in crop yield due to pollination per acre	increase in crop price due to higher quality crops per acre due to pollination			
1000	$ 0.6500	$ 305.50	1.60	750	11%	0			
	0.5686			685	7				

total yield per acre lbs	total revenue	total gross variable profit= Total revenue - Total cost with farmer picking	gross variable profit margin with picking	pollination colony cost impact on gross variable profit margin with picking	$ yield increase due to bees - cost of hives with picking	direct cost as % of revenue with picking

832.5	$ 541,125.00	$ 89,468.00	16.5%	4.1%	$ 31,625.00	83%

total gross variable profit= Total revenue - Total cost w/o farmer picking - contract out	gross variable profit margin w/o picking	pollination colony cost impact on gross variable profit margin w/o picking	$ yield increase due to bees - cost of hives w/o picking	direct cost as % of revenue w/o picking
$ 2,777.20	0.5%	4.1%	$ 31,625.00	99%

number of acres		
1000	input into cells with this color	does not include fixed overhead expenses - machinery, land, tax, etc.

cotton-irrigated planting variable cost

	% of revenue agreement	labor cost as % of revenue	grand total labor costs based on % revenue	labor cost per hour w/picking	# labor hours w/picking	total labor cost w/picking	total labor cost w/o picking	# labor hours w/o picking	picking cost total labor cost w/o picking
employee	0.00%	$ -	$ -	$ 14.00	694	$ 9,716.00	$ 14.00	$ 278	$ 3,886.40
employee	0.00%	$ -		$ 14.00	694	$ 9,716.00	$ 14.00	$ 278	$ 3,886.40
employee	0.00%	$ -		$ 14.00	0	$ -	$ 14.00	$ -	$ -
				$ 14.00	0	$ -	$ 14.00	$ -	$ -

difference

drop off $1.65/ac fuel ie reduce acre by 1000 ac

labor $8400/1000ac

cost of picking per acre	ginning price per acre	cost of fertilizer per acre	cost of chemicals per acre	cost of seed per acre	number of acres	total fertilizer , chemical, and seed cost	gas number of gallons	cost of gas per gallon	total gas cost
$ 75.00	$ 75.00	$ 142.45	$ 105.00	$ 82.00	1000	$ 404,450.00	3500	$ 1.65	$ 5,775.00
	75	142.45	105	82					

cost of picking per acre									
$ 90.00	$ 75.00	$ 142.45	$ 105.00	$ 82.00	1000	$ 494,450.00	2500	$ 1.65	$ 4,125.00
	$ -	$ -	$ -	$ -	difference	$ (90,000.00)		difference	$ 1,650.00

number of colonies

number of farmers renting bees	cost of colonies	number of colonies per acre	total number of colonies	total colony cost	total colony cost per farmer	total costs hourly	total colony cost as % of total cost	total costs : % revenue	total colony cost as % of total cost
1	$ 55.00	$ 0.40	400.00	$ 22,000.00	$ 22,000.00	$ 451,657.00	5%	$ 432,225.00	5
		0.4							
1	$ 55.00	$ 0.40	400.00	$ 22,000.00	$ 22,000.00	$ 528,347.80	4%	$ 520,575.00	4
				difference	$ -	$ (76,690.80)			

yield price

number of acres	crop selling price per lb.	crop selling price per bale	number of bales per acre	base crop lbs. yield per acre	increase in crop yield due to pollination per acre	increase in crop price due to higher quality crops per acre due to pollination	total yield per acre lbs
1000	$ 0.5686	$ 267.24	2.98	1400	3%	0	1442
	0.5686						

total revenue	total gross variable profit= Total revenue - Total cost with picking	gross variable profit margin with picking	pollination colony cost impact on gross variable profit margin with picking	$ yield increase due to bees - cost of hives with picking	direct cost as % of revenue with picking
$819,921.20	**$ 368,264.20**	**44.9%**	**2.7%**	**$ 1,881.20**	**55%**

total gross variable profit= Total revenue - Total cost w/o picking	gross variable profit margin w/o picking	pollination colony cost impact on gross variable profit margin w/o picking	$ yield increase due to bees - cost of hives w/o picking	direct cost as % of revenue w/o picking
$291,573.40	**35.6%**	**2.7%**	**$ 1,881.20**	**64%**

Research Search Analysis

Soybeans

The research is unclear as to whether honey bees (Apis mellifera) increase yield and quality of soybeans. There is recent research that indicates honey bees do have a positive impact (1,2,3,4,5,6,7,8). McGregor (9) has no recommendations for honey bee pollination of Soybeans. Reference (3) indicated an 8% to 18% yield improvement. Reference (4) concluded that honeybee pollination in the soybean increased the seeds production (18% increase). Reference (5) indicated that cross-pollination varied from as low as .09% to 1.63% based on a two-year average. Reference (5) concluded that honey bees are not required to pollinate soybeans. Reference (6) indicated a short-term Canadian study found honey bees' presence was associated with higher yields in food-grade soybeans, Australian researchers demonstrated yield increases of 10%-40%, and the 2005 Brazilian study indicated a 50% increase was seen with cages.

Cotton

The research is clear that honey bees (Apis mellifera) do have a positive impact on both cotton yield and quality (10, 11, 12, 13). McGregor (14) recommends honey bee pollination (1-2.5 colonies per acre). Reference (10) study suggests a significant positive impact of supplemental honey bees on cotton yield. Reference (13) found bees increased cotton production on the organic farm by more than 12% for fibre weight and over 17 seed number. Reference (11) concluded honey bee pollination include increases in the percentage of bolls per 100 flowers,

more seeds per boll, more seed per cotton flower. In addition, Reference (11) recommended one hive per hectare.

Sunflower

The research supports honey bees (apis mellifera) does have a very positive impact on sunflower yield and quality (15, 16, 17, 18, 19, 20). Reference (17) found higher production of seeds in sunflowers with introduction of colonies of bees. Reference (15) recommended 1-2.5 colonies per hectare. Reference (19) recommended two colonies per acre.

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