Bee Colony Startup and Cost Analysis

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ABSTRACT

The increase in demand for European Honey bee pollination along with colony collapse disorder has caused bee pollination rental fees to greatly increase. This project intended to determine how effective and economically feasible it would be for almond growers to begin raising their own hives for pollination. It was determined the biggest challenges were organizing and finding employees who were knowledgeable about bee keeping. When looking at the cost it was clear that even with the current cost per hive the startup costs were still less than the total rental fees for a single pollination season.

Once the hives have been established it also would allow the grower to split hives in order to increase the total number of hives they have in order to slowly phase out the need the rent additional hives if needed.

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INTRODUCTION

Agriculture today is largely based on monoculture, which is the production of a single crop over a large are for many years. This also means that most growers like to grow plants that are genetically the same as the others around it. Today's farmers are able to produce fruits and vegetables that look identical to one another; as a result of this the crop can also generally be harvested at one time. Timing is crucial, in order for this to occur growers need to have their crops bloom all at once within a very short window of time. This short window of time occurs at the same time for many growers who are growing the same crops. Members of the Hyomoptera order that were found in the wild were once able to sufficiently pollinate farmers crops, now were not doing enough. Beekeeping has always been an important industry because of the honey production. But, as monoculture became more and more main stream the amount of bees required for pollination also increased. The Apiary industry now faces new challenges due to Colony Collapse Disorder. Colony Collapse Disorder is characterized by the sudden death and disappearance of worker bees. While this has been around for a while it hasn't been until recent years that bee keepers around the world have seen colonies die/ disappear in high numbers. Unfortunately the cause of this disorder is still unknown, but what is known are the factor that are thought to contribute to the loss of bee populations.

LITERATURE REVIEW

Colony Collapse Disorder

In the last couple years Colony Collapse Disorder has become a major concern. The characteristics of colony collapse are usually characterized by the loss of all or a majority or the adult bee population. Although its occurrence has become quite common, entomologists still struggle to determine the root of the cause. Currently there are many theories as to why this is occurring. The most common theories being that disease and pest pressure on the bees have become too strong. While others believe that the practice of monoculture has created food deserts in the case of wild bees. What we may see as a beautiful almond orchard with lush green leaves and growing almonds is in fact a food desert for bees. For most crops in agriculture you generally only have one bloom per year, during this time there is more than plenty for bees to eat. But, from bloom to petal fall is a very short window of time, meaning that once petal fall takes place bees no longer have a food source. The use of herbicides also plays a major role in this topic, since most weeds are sprayed prior to them blooming.

In commercially run colonies the hives never stay in one location for too long since they are only required for pollination. As a result the bees are overworked and stressed due to long and frequent travel times.

For over 30 years the number of honey bee colonies has been steadily decreasing. (Naug, 2009). The decrease in colonies can be seen in figure one.

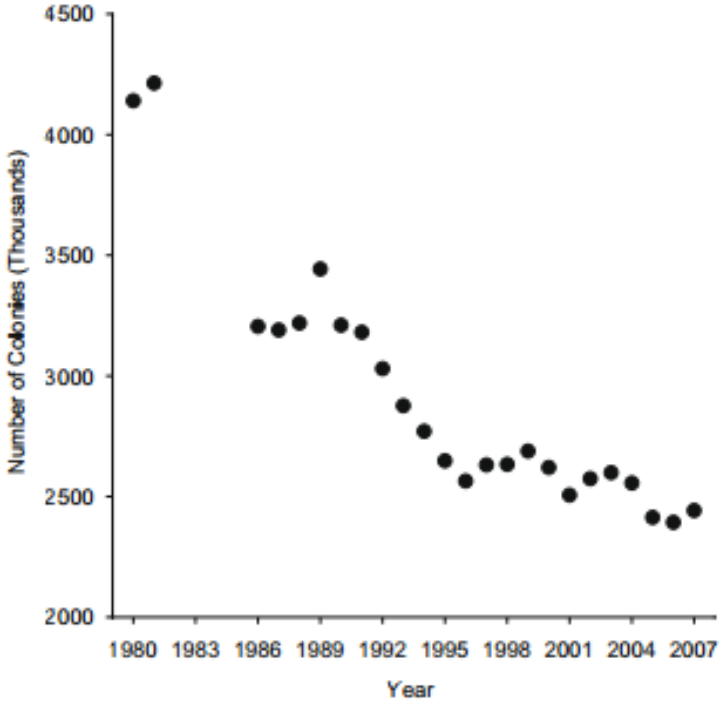

Figure 1. Estimated Honeybee Colonies in the United States (Naug, 2009)

Off Season Pollen Supplemental

There are certain times of the year where it becomes difficult for honey bees to forage for pollen. This is not simply used to make honey; pollen is a source of lipids, vitamins, and minerals. (Pernal, 1999) Without these nutrients the growth and development of the honey bee colony would be greatly stunted. It is also important to understand that the quality of pollen can also affect bee development. A study was conducted by Stephen Pernal along with Robert Currie in 1999; their goal was to determine the effect of fresh pollen versus one year old pollen diets on worker honey bees.

Worker bees play a key role in reproduction and success of honey bee colonies. While the queen bee has the capability of reproducing only males or only females, ultimately it is the worker bees that determine this. When the worker bees make the cell in which the larvae will be developing they alter the depth of the cell in order to control how many females versus males the queen will produce. When the queen bee inserts her ovipositor into the cell in order to lay an egg two possible situations can occur. The ovipositor can

be inserted into a cell that has a short depth, this will cause a sensory reaction which will fertilize the egg she is about to lay. If the cell is larger and the queen bees ovipositor fails to make that sensory connection then she will lay an unfertilized egg that will become a drone.

It was determine that in general bees had a preference for fresh pollen, as seen in figure two.

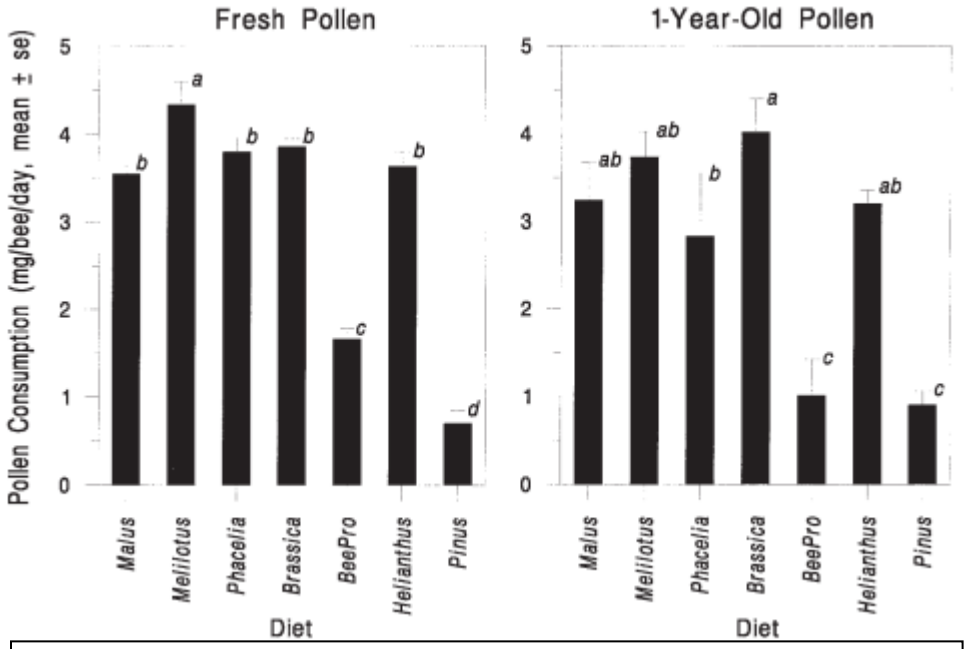

Figure 2. Honey Bee Consumption in Fresh vs 1 Year Old Pollen (Naug, 2009)

Disease and Pest Susceptibility

Parasitic mites along with other harmful predatory insects have had a large impact on colony populations. One of the most common diseases which affect honey bees is varroosis, this is also sometimes referred to as "snotty brood". (Genersch, 2010) Varroosis is caused by a parasitic mite. Unlike many other diseases, this one has a greater impact depending on the severity of the mite population in the honey bee colony. If left untreated a highly infected colony will only be able to survive for about two years. (Genersch)

Bee Box Cost

The cost of a bee box can vary depending on the size, style, and materials that are used to make the box. But, once bee boxes are purchased they are simply maintained and repaired, which helps reduce costs rather than purchasing new sets. The price per bee box also depends on the number of boxes that will be purchased.

An unassembled commercial grade hive bodies and supers range from $11.50/each to $15.95/each (Mann Lake). The difference in price is due to the change in size: as the size increases so does cost. The listed price above does not include the cost of the frames. The frames are where the bees build their honey comb, but they serve a greater purpose. By having removable frames in the boxes you can control how many bees you have in each box. Maintenance of the boxes is also improved since this reduces the possibility of bees building honey comb in unwanted areas of the box. Waxed frames have a cost range of about $30/per set of ten to $38.50/per set of ten. There are many types of frames made from different materials, all of which change the price of the frames. In some cases some frames are said to increase drone comb.

Almond Production

According to UC Extension all almond varieties are self-unfruitful. This means that two or more varieties are needed in order to have successful pollination. Along with this they also require bee pollination to spread the pollen from the other almond varieties. Verification that those 3 varieties can pollinate themselves due to timing should also be verified, meaning that there will be overlap in the pollination.

PROCEDURES AND METHODS

Hive Requirement per Calendar Year

January

- Hives are only opened to asses health and condition
- Determine quantity of honey, and provide feed if honey reserves are low
- Construction of new boxes

February

- Hive preparation for almond pollination
- Start pollen patty feedings in order to promote hive growth
- Mid February hives moved to orchard for almond pollination

March & April

- Bees are moved out of almond orchard after completion of bloom fertilization
- Bees are relocated to citrus orchards for pollination
- Hives can also be placed row crop fields at this time
- Hives should also be medicated if needed at this time
- Feed should be provided if need

May & June

- Hives should be inspected every two weeks during this time
- Super should begin to be removed if honey is to be harvested
- Hives which have been harvested should have enough honey to feed bees through winter
- Hive should also be inspected and medicated for intruders if necessary

October & December

- Relocate hives to winter
- Preparation and construction of new boxes and frames is started.

The yearly hive requirements are based on information provided by Terpstra Apiaries, which is located in Modesto, CA.

Cost of Materials and Maintenance

The cost of materials is very different for a back yard bee keeper to those that larger scale apiaries pay. The price per pox is currently $20 and $1 per frame. Each box contains ten frames.

Table. 1Box Breakdown Cost

	Cost Per One	Quantity	Total Cost
Boxes	$20	400	$8000
Frames	$1	3200	$3200
Tools	$15	10	$150
Bees	$110/3Lbs	400	$44,000

$$Total\ Cost\ Of\ Box\ and\ Frames = Total\ Box\ Cost\ + Total\ Frame\ Cost$$
$$Total\ Cost\ of\ Box\ and\ Frames = \$8{,}000\ + \$400 + \$150+$$
$$Total\ Cost\ of\ Box\ and\ Frames = \$8{,}550$$

It should be noted that this is only the cost of materials and does not take into account time required for assembly. If the boxes and frames are well taken care of they can last a very long time. This can be accomplished by repairing boxes that may have been damaged in the previous season. Repairs should be completed in the winter months when little work is required to maintain hives.

The only time new bee boxes are purchased is when bee keepers are preparing to increase their total number of hives. When purchasing bees they come in three pound increments, this also includes

Maintenance Cost

Maintenance cost includes any medications that may be needed in order to keep the bee's healthy, food supplements, and maintaining the bee boxes. The values that were given to me were on a yearly basis or monthly basis, the yearly values where then divided into average monthly cost. It is possible to have higher disease and pest pressure during specific times of the year depending on where in California the hives are located.

On average most employees make $10 (Terpstra). This value will be used to determine the cost of time spent maintaining the hives. This will be in addition to the cost of medication and feed.

Table. 2 Breakdown of Additional Cost

	Price/Month Or Season	Yearly Cost
Feed	$92	$1104
Medication	$120	$1440
Hive Maintenance	$200	$600

Hives are usually maintained during the winter months from November through January. It is for this reason that the table featured above has a monthly cost of $200 and only adds up to a total cost of $600. Additional costs that are not accounted for in the table above is the cost associated with the slab where bee keepers like to keep the hives over the winter months. While this is a very nice feature for a starting bee keeper it is possible to invest in that the following year in order to spread out the cost of starting their colonies.

Table 3. Total Cost and Additional Yearly Cost

Total Cost	$58,494
Total Yearly Cost With No Additional Boxes	$3,144

Cost of Rentals

In 2012 according to Farm press the average rental price per hive was $155. Almond growers require two hives per acre. A grower with 300 acres would require 600 hives during bloom for effective pollination. According to Dr. Garner a professor at California Polytechnic State University, the cost of almond pollination accounts for about 20% of the crops yearly expenses budget. With hive rental prices expected to rise, so will the budgeted amount set aside for pollination.

$$Total\ Rental\ Cost = Price\ Per\ Hive\ \times (Acres\ \times 2)$$
$$Total\ Rental\ Cost = \$155\ \times (200\ \times 2)$$
$$Total\ Rental\ Cost = \$62{,}000$$

The total rental cost is on a per year basis. Almonds have an average lifespan of twenty to twenty-five years. After this time the grower must determine if the cost of production exceed the revenue produced. This this is the case then the grower will proceed by removing the planting. Below are the calculations associated with the cost of pollination if the price were to remain at $155. The same calculations will be used to find the cost if the following ten years the price remains the same then is increased to $225. Lastly the same calculations will be used if the price were to increase to $250 for all twenty-five years.

Case 1

$$Rental\ Cost = \$155\ \times (200\ \times 2)$$
$$Rental\ Cost = \$62{,}000\ (year) \times 25\ years$$
$$Total\ Rental\ Cost = \$1{,}550{,}000$$

Case 2

$$Rental\ Cost = \$155\ \times (200\ \times 2)$$
$$Rental\ Cost = \$62{,}000\ (year) \times 10\ years$$
$$Rental\ Cost = \$620{,}000\ (for\ ten\ years)$$

$$Rental\ Cost = \$225\ \times (200\ \times 2)$$
$$Rental\ Cost = \$90{,}000\ (year) \times 15\ years$$
$$Rental\ Cost = \$1{,}350{,}000\ (for\ fifteen\ years)$$
$$Total\ Rental\ Cost = \$620{,}000 + \$1{,}350{,}000$$
$$Total\ Rental\ Cost = \$1{,}970{,}000$$

Cases 3

$$Rental\ Cost = \$250\ \times (200\ \times 2)$$
$$Rental\ Cost = \$100{,}000\ (year) \times 25\ years$$
$$Total\ Rental\ Cost = \$2{,}500{,}000$$

Although many bee keepers are facing challenges in maintaining their hives, it is evident from these calculations that pollination cost are going to greatly affect the cost of production for almond growers. It is estimated that within the next couple of years hive rentals will be greater than $200, so $250 for 25 years is a very conservative value (Dadant).

Site Selection for Hives

Hives that are being used for any kind of pollination are usually placed on pallets along the sides of the orchard or row crop field. Since bees are able to fly long distances in order to forage this does not reduce pollination. By keeping the bees in these locations it allows bee keepers to have easy access when dropping off hives and also once they need to be picked up. But the main reason for keeping bees along the edges of the orchard and fields is to reduce the amount of contact that the hives make with any chemicals that may need to be applied to the orchard. Companies such as Paramount Farming have implemented a no spray program in order to prevent the loss of hives due to pesticide applications. At the minimum it is recommended that if chemical applications are absolutely required, then you should apply chemicals that won't harm bees, and apply it late at night or before sunrise. Bees are particular about the types of conditions the forage in. In general bees stop foraging right before sunset; they begin foraging after sunrise or after the temperature reach a minimum of 70 degrees Fahrenheit.

During the winter the hives are kept in safe locations on concrete slabs. Because of the recent epidemic with colony collapse disorder you want to make sure that even in the winter months you are checking them on a regular basis. Having them close by also

allows treating them for different diseases and pest more efficient, since the problem can be corrected as soon as it is found. There has also increased the value of hives which has increased hive theft.

Figure 3. Hive site selection (Herrera, 2013)

Splitting Hives

Once the initial hives are purchased for the 400 box bee populations will grow in numbers by the following year. Although there is a variation in the number of bee depending on the season, in the summer they can reach numbers as high as 60,000 to 80,000 and in the winter have 20,000 to 30,000 (Backyard).

Splitting hives can begin once reared commercially queens are available. The goal of the split is to increase the number of hives, this means that an even split would be required. According to Bush Bees an even split is when you take half of everything (eggs, emerging brood, pollen, and honey). They key to this split is to place the two new hives vertically side by side and with the old box horizontally side by side with the two vertical boxes. The figure below will depict this style of layout.

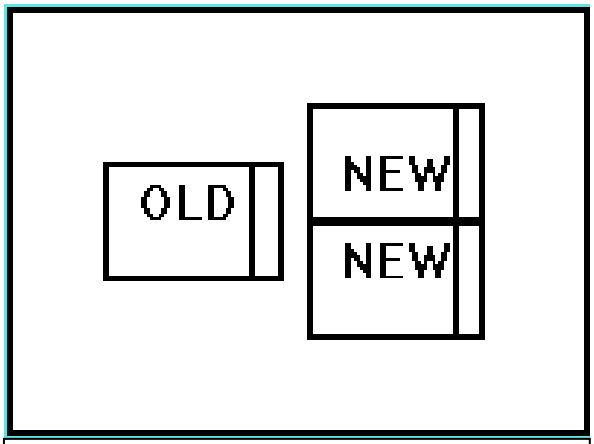

Figure4. Even Split (Honeybee World)

The number of times a hive can be split simply depends on how vigorously it is able to reproduce and build up in numbers. This means that not all of the hives will be able to be split the following year, especially when considering the effect of colony collapse disorder. The table below will show's a very conservative estimation on the number of splits and hive increase for the following five years.

Table. 4 Splitting Hives

	Initial	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Splits	0	35%	35%	35%	35%	35%
Total	400	540	729	984	1329	1794

It is possible that all four-hundred hives could be split resulting in a total of 800 hives within the first year, but, in order for this to occur all four-hundred hives would have to be reproducing vigorously. By having a 35% hive splitting rate per year will allow the hives that haven't thrived due to a disease, pests, pesticide residue contact, etc. to not stress due to the reduction in hive population.

RESULTS

In order to have any fruit set almond growers require bee pollination. Although this doesn't mean that they have to be European Honeybees that is currently the most popular because they are the easiest to manage from a bee keeping perspective. Bee keeping has become more challenging the last ten years due to many factors that have ultimately reduce the total number of colonies not only in the United States but also around the world.

During this time there was also an increase in almond plantings due to consumer demand increase. It has been found that almonds can reduce the risk of heart attacks and hypertension, they have also been found to help maintain weight (Medical News Today). The increase in almond plantings and decrease in colonies in the United States has as a result increased the cost of hive rentals for pollination. This has also affected other crops that require pollination during the same time as almonds.

The increasing cost of bee rentals is not the only concern many growers face, they also worry about hive shortages and possibly not having enough hives to properly pollinate their orchards. It is because of this that many growers are beginning to consider having their own colonies. This project was able to determine that the total cost per vive (which included the bees and queen, installation, feed, and medication) was $146, in comparison the to the rental cost of $155.

Even though the initial cost per hive was just less than the rental cost the yearly cost after purchasing was highly reduced. Something to consider is that for this project it was assumed that no honey would be sold; instead it would be left for the bees to consume during the winter months. This would allow the grower to not spend additional money on feed.

DISCUSSION

For smaller grower to have enough bees per hive once pollination is required they would need to purchase the bees and hives a year before in order to allow the bees to build up in numbers. When purchased the bees you only get three pounds of bees which is not a whole colony and one queen. The advantage that smaller growers have is that it would be less difficult to find a producer could provide them with enough starter bees for the hives; where as a grower with 2,500 acres will have trouble finding enough bees to start 5,000 hives.

When determining how many hives could be split was a particularly difficult decision to make. There is currently no real set standard as to how long it takes for hives to be able to be split or how many times. According to Bush Bees, whether a hive could be split depends on how well the hive was able to initially establish. Some hives have a particularly difficult time if they get infected with disease or pest, or if they simply are not building up in numbers as quickly as the other hives. They also stated that some hives are able to reproduce so quickly that they can be split up to five times in a single year. Ultimately, growers are going to be new at bee keeping and possibly make mistakes along the way; it will be a "Learn By Doing" process.

Something that should also be considered is that the prices used the cost of the bee boxes, frames, and tools were provided by Terpstra Apiaries. There could be variation based upon the quantity purchased, style, number of frames, and brand. In this case each box contained 8 frames. This could also be said for the cost feed and medication. It is very possible that some growers bees may come into contact with other infected bees more often and another grower. The quantity of feed required will vary based on food sources during the spring and summer months and also if the honey is going to be harvested in order to be sold. In this case no honey will be harvested.

Labor is a key component which was not mentioned in the project, for the specific reason being that very little information was available. Also there is a high probability that any employees which would be hired in order to care for the hives would require training and enrollment in a bee keeping course (many are available). Another challenged faced was determining the amount of time (cost) spent on relocating the hives. This was difficult to determine since this will vary greatly depending on the distance between the orchards, and the main location where the hives are kept over winter.

RECOMMENDATIONS

Learning how to care for hives is not always the easiest thing in the world to do, but, having the proper foundation could really help a new bee keeper. Growers could also team up with local bee keepers who are willing to apprentice them. This could be both beneficial for the bee keeper but also the grower. An agreement could be make where the bee keeper can rent out the growers hives for a fee. This would benefit the bee keeper by making profit off of the fee and also help the grower by providing him with an additional income from the bee rentals. Typically almonds have the varieties in each block and have an overlap of pollination. As a result of this the total pollination time is about a month and a half, meaning that the other ten moths the bees will require land to forage on or feed. By renting out the bees the grower will not only have the extra income but also provide the bees with land to forage on.

The cost of starting up a bee colony is still high since a lot must be invested before the bees will be able to come into use. I would recommend almond growers phase out the number of hives then rent and slowly increase the number of hives they own. This would help them increase their colony size over time while still allowing them to learn more about bee keeping without the fear of making a major mistake on a large investment. By also do this over a couple of years they can increase their population by splitting their hives and reducing the cost of purchasing bees from a commercial producer.

Bee keeping can also provide additional sources of income that could offset the cost of production and startup costs. There is the option of selling the honey, comb, or bees that have been split. While these are good sources of income I would not recommend selling the honey simply because it has been found that bees do much better when they are able to feed on the honey they made rather than the sugar water feed that is often provided to them. By removing the honey from the bees they are more prone to stress which is one of the factors that is believed to affect colony collapse disorder. But, this could be used as a temporary source of income for growers who are struggling to financially.

If money is not an issue another possible solution that would allow growers to get a large amount of hives would be to buy out a small bee keeper who may be going out of business. Because of disease and pest pressure many small bee keepers are not able to keep up and are barely making a profit. This would also allow the grower to keep the existing employees who are knowledgeable on the practices required to maintain the hives.

REFERENCES

1. Mann Lake Ltd., comp. "Hive Bodies and Supers." *2013 Catalog* 2013: 16-19. Web.

2. Pernal, Stephen F. "Pollen Quality of Fresh and 1-year-old Single Pollen Diets for Worker Honey Bees (Apis Mellifera L.)." 31.3 (2000): n. pag. Web. Oct.-Nov. 2013.

3. Honey Bee World. Honey Bee World Internet Home Page. <http://www.honeybeeworld.com/spring/splits.htm>, referenced May 20, 2014

4. Herrera, M. 2013. Site Selection Photograph. Robbins, CA.

5. Bush Bees & Farms. 2006. Bush Bees Internet Page. <http://www.bushfarms.com/beessplits.htm>, referenced May 6, 2014.

6. Backyard Beekeepers Association. Backyard Beekeepers Association Facts about Honeybees. <http://www.backyardbeekeepers.com/facts.html>, referenced May 9, 2014.

7. Medical News Today. 2013. Nutrition & Diet. <http://www.medicalnewstoday.com/articles/269468.php>, referenced May 26, 2014.

8. Dadant. 2013. Dadant News: Almond Growers Pay Record Prices Amid Bee Shortage. < http://www.dadant.com/news/almond-growers-pay-record-prices-amid-bee-shortage>, referenced March 15, 2014.

9. Cooperative Extension University of California – Sacramento County. 2000. Environmental Horticultural Notes – Why Fruit Trees Fail To Bear. 3 P.

10. Terpstra Apiaries. 2013-2014. Personal Communication. John Terpstra, Owner of Terpstra Apiaries, Modesto, CA.

Appendices A
Startup Cost Vs Rental & Growth

Acres	Hives (2 Per Acre)	Rental Cost (Per Yr)	Initial Cost	Yearly Cost (No Additional Hives)	With 35% Growth Yr 1 (New Hives)	Total Increase (Hives)	Cost For Yr 1 (With Add Hives)
20	40	$ 6,200	$ 5,840	$ 320	54	14	$ 2,364
40	80	$ 12,400	$ 11,680	$ 640	108	28	$ 4,728
60	120	$ 18,600	$ 17,520	$ 960	162	42	$ 7,092
80	160	$ 24,800	$ 23,360	$ 1,280	216	56	$ 9,456
100	200	$ 31,000	$ 29,200	$ 1,600	270	70	$ 11,820
120	240	$ 37,200	$ 35,040	$ 1,920	324	84	$ 14,184
140	280	$ 43,400	$ 40,880	$ 2,240	378	98	$ 16,548
160	320	$ 49,600	$ 46,720	$ 2,560	432	112	$ 18,912
180	360	$ 55,800	$ 52,560	$ 2,880	486	126	$ 21,276
200	400	$ 62,000	$ 58,400	$ 3,200	540	140	$ 23,640
220	440	$ 68,200	$ 64,240	$ 3,520	594	154	$ 26,004
240	480	$ 74,400	$ 70,080	$ 3,840	648	168	$ 28,368
260	520	$ 80,600	$ 75,920	$ 4,160	702	182	$ 30,732
280	560	$ 86,800	$ 81,760	$ 4,480	756	196	$ 33,096
300	600	$ 93,000	$ 87,600	$ 4,800	810	210	$ 35,460
320	640	$	$	$	864	224	$

		99,200	93,440	5,120			37,824
340	680	$ 105,400	$ 99,280	$ 5,440	918	238	$ 40,188
360	720	$ 111,600	$ 105,120	$ 5,760	972	252	$ 42,552
380	760	$ 117,800	$ 110,960	$ 6,080	1026	266	$ 44,916
400	800	$ 124,000	$ 116,800	$ 6,400	1080	280	$ 47,280
420	840	$ 130,200	$ 122,640	$ 6,720	1134	294	$ 49,644
440	880	$ 136,400	$ 128,480	$ 7,040	1188	308	$ 52,008
460	920	$ 142,600	$ 134,320	$ 7,360	1242	322	$ 54,372
480	960	$ 148,800	$ 140,160	$ 7,680	1296	336	$ 56,736
500	1000	$ 155,000	$ 146,000	$ 8,000	1350	350	$ 59,100
520	1040	$ 161,200	$ 151,840	$ 8,320	1404	364	$ 61,464
540	1080	$ 167,400	$ 157,680	$ 8,640	1458	378	$ 63,828
560	1120	$ 173,600	$ 163,520	$ 8,960	1512	392	$ 66,192
580	1160	$ 179,800	$ 169,360	$ 9,280	1566	406	$ 68,556
600	1200	$ 186,000	$ 175,200	$ 9,600	1620	420	$ 70,920
620	1240	$ 192,200	$ 181,040	$ 9,920	1674	434	$ 73,284
640	1280	$ 198,400	$ 186,880	$ 10,240	1728	448	$ 75,648
660	1320	$ 204,600	$ 192,720	$ 10,560	1782	462	$ 78,012
680	1360	$ 210,800	$ 198,560	$ 10,880	1836	476	$ 80,376
700	1400	$ 217,000	$ 204,400	$ 11,200	1890	490	$ 82,740
720	1440	$ 223,200	$ 210,240	$ 11,520	1944	504	$ 85,104
740	1480	$ 229,400	$ 216,080	$ 11,840	1998	518	$ 87,468
760	1520	$ 235,600	$ 221,920	$ 12,160	2052	532	$ 89,832
780	1560	$ 241,800	$ 227,760	$ 12,480	2106	546	$ 92,196

800	1600	$ 248,000	$ 233,600	$ 12,800	2160	560	$ 94,560
820	1640	$ 254,200	$ 239,440	$ 13,120	2214	574	$ 96,924
840	1680	$ 260,400	$ 245,280	$ 13,440	2268	588	$ 99,288
860	1720	$ 266,600	$ 251,120	$ 13,760	2322	602	$ 101,652
880	1760	$ 272,800	$ 256,960	$ 14,080	2376	616	$ 104,016
900	1800	$ 279,000	$ 262,800	$ 14,400	2430	630	$ 106,380
920	1840	$ 285,200	$ 268,640	$ 14,720	2484	644	$ 108,744
940	1880	$ 291,400	$ 274,480	$ 15,040	2538	658	$ 111,108
960	1920	$ 297,600	$ 280,320	$ 15,360	2592	672	$ 113,472
980	1960	$ 303,800	$ 286,160	$ 15,680	2646	686	$ 115,836
1000	2000	$ 310,000	$ 292,000	$ 16,000	2700	700	$ 118,200
1020	2040	$ 316,200	$ 297,840	$ 16,320	2754	714	$ 120,564
1040	2080	$ 322,400	$ 303,680	$ 16,640	2808	728	$ 122,928
1060	2120	$ 328,600	$ 309,520	$ 16,960	2862	742	$ 125,292
1080	2160	$ 334,800	$ 315,360	$ 17,280	2916	756	$ 127,656
1100	2200	$ 341,000	$ 321,200	$ 17,600	2970	770	$ 130,020
1120	2240	$ 347,200	$ 327,040	$ 17,920	3024	784	$ 132,384
1140	2280	$ 353,400	$ 332,880	$ 18,240	3078	798	$ 134,748
1160	2320	$ 359,600	$ 338,720	$ 18,560	3132	812	$ 137,112
1180	2360	$ 365,800	$ 344,560	$ 18,880	3186	826	$ 139,476
1200	2400	$ 372,000	$ 350,400	$ 19,200	3240	840	$ 141,840
1220	2440	$ 378,200	$ 356,240	$ 19,520	3294	854	$ 144,204
1240	2480	$ 384,400	$ 362,080	$ 19,840	3348	868	$ 146,568

1260	2520	$ 390,600	$ 367,920	$ 20,160	3402	882	$ 148,932
1280	2560	$ 396,800	$ 373,760	$ 20,480	3456	896	$ 151,296
1300	2600	$ 403,000	$ 379,600	$ 20,800	3510	910	$ 153,660
1320	2640	$ 409,200	$ 385,440	$ 21,120	3564	924	$ 156,024
1340	2680	$ 415,400	$ 391,280	$ 21,440	3618	938	$ 158,388
1360	2720	$ 421,600	$ 397,120	$ 21,760	3672	952	$ 160,752
1380	2760	$ 427,800	$ 402,960	$ 22,080	3726	966	$ 163,116
1400	2800	$ 434,000	$ 408,800	$ 22,400	3780	980	$ 165,480
1420	2840	$ 440,200	$ 414,640	$ 22,720	3834	994	$ 167,844
1440	2880	$ 446,400	$ 420,480	$ 23,040	3888	1008	$ 170,208
1460	2920	$ 452,600	$ 426,320	$ 23,360	3942	1022	$ 172,572
1480	2960	$ 458,800	$ 432,160	$ 23,680	3996	1036	$ 174,936
1500	3000	$ 465,000	$ 438,000	$ 24,000	4050	1050	$ 177,300
1520	3040	$ 471,200	$ 443,840	$ 24,320	4104	1064	$ 179,664
1540	3080	$ 477,400	$ 449,680	$ 24,640	4158	1078	$ 182,028
1560	3120	$ 483,600	$ 455,520	$ 24,960	4212	1092	$ 184,392
1580	3160	$ 489,800	$ 461,360	$ 25,280	4266	1106	$ 186,756
1600	3200	$ 496,000	$ 467,200	$ 25,600	4320	1120	$ 189,120

	Year 1	Year 2	Year 3	Year 4	Year 5
Acres 0	35%	35%	35%	35%	35%
Acres 400	540	729	984	1329	1794

Appendices B
Contract

California Polytechnic State University — November 7, 2013

BioResource and Agricultural Engineering Department — Herrera, Marisela

ASM Senior Project Contract — 004850816 ASM

Project Title

Bee Colony Startup & Cost Analysis

Background Information

Honey production has started becoming increasingly difficult in recent years. Bee keepers have had to deal with parasites and diseases affecting their honey production. Research has also been done in order to determine ways to increase production during off season months. This is done by placing pollen patties inside of the bee box, but, the key is to use pollen patties that are think but with a large surface area.

Statement of Work

This senior project will be divided into 2 phases. The first phase will be research and the construction of the bee boxes. The second phase of the project will be determining the effectiveness of running a small scale bee keeping operation, along with growth and development of the colony.

How Project Meets Requirements for the ASM Major

ASM Project Requirements - The ASM senior project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving.

Application of agricultural technology	The project will involve the application of management and wood working.
Application of business and/or management skills	The project will involve business/management skills in the areas of cost analysis, productivity analyses, and labor considerations.
Quantitative, analytical problem solving	Quantitative problem solving will include the cost analysis, insect behavior, and colony interactions with the environment.

Capstone Project Experience - The ASM senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses).

Incorporates knowledge/ skills from these key courses	129 Lab Skills/Safety, 321 Agriculture Safety, 418 Agriculture Systems Management I, PPSC 311 Agriculture Entomology, PPSC 441 Biological Controls, English 148 Reasoning and Professional Writing

ASM Approach - Agricultural Systems Management involves the development of solutions to technological, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving. (insert N/A for any area not applicable to this project)

Systems approach	This project will involve the agricultural entomology aspect of creating a bee colony, along with the integration of a business aspect.
Interdisciplinary features	The project touches on aspects of safe and proper bee keeping, and, financial stability.
Specialized agricultural knowledge	The project applies specialized knowledge in the areas of bee reproduction and colonization.

Project Parameters

1. Evaluate cost effectiveness of running a small scale operation
2. Cost analysis

List of Tasks and Time Estimate

TASK	Hours
Research in library on brush handling and cutting processes	10
Consult with bee keeping Professor	10
Design bee boxes	10
Cut Materials for Bee Boxes	15
Machine fabrication in shop	10
Introduce Queen Bee	20
Introduce Worker Bees	15
Evaluate Bee Production	20
Create Cost Analysis	40
Preparation of written report	30
TOTAL	180

Financial Responsibility

Preliminary estimate of project costs: $ *300*

Finances approved by (signature of Project Sponsor): _____

Final Report Due:	June 2014	**Number of Copies**:	3

Approval Signatures		**Date**
Student:		*11/7/2013*
Proj. Supervisor:		
Department Head:		