EVOLUTION OF THE TEXAS COTTON GINNING INDUSTRY

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Introduction

Even early in its history the cotton gin created a booming industry and it seemed that everyone wanted to own, build, or operate one. The equipment was not as advanced as it is today and even with the efficiency it brought over hand processing, there needed to be many gins to process the cotton that was produced. The U.S. processed 750,000 bales of cotton in 1820, but that number increased to over 15 million bales in 2015 (USDA-NASS). According to the USDA *Cotton Ginning Statistics*, there were approximately 30,000 gins in the U.S. during the early 1800s. However, that number has decreased steadily since then to 671 gins in 2015. Although the process has changed little, scale and speed have increased exponentially. Many gins have been lost to consolidations and closures. Because technological innovation means farmers need fewer gins as well as the growth of the average number of bales that can be produced by a single farmer, the ginning industry has under gone important change.

These technological changes have included the installation of newer technology which increased the number of bales that can be processed by a single gin and technologies that can monitor this process without needing people to oversee every step. Gins have also capitalized on the new module technology that allows the bales to sit in the field longer after harvest and decreased transport costs and/or increased the feasible transport distance. This means that the gins have more time to process the large volumes of cotton being produced. Overall, these changes have led to a rapidly changing industry, making the average number of bales processed by a gin increase and the average number of gins in operation decrease. However, the speed of change has not been universal across the cotton producing states, it is most pronounced in the largest producing areas, of which Texas is the largest. The purpose of this paper is to review the historical changes in Texas with a view towards the future of the cotton ginning industry in Texas.

Background Research

From before there was a word for the action, cotton ginning was created to help remove seeds from fiber. As long ago as 500 AD evidence is found of tools that ancient Asians, Africans, and North Americans used to gin cotton called *charkha* which consisted of a roller made of wood or iron and a flat piece of wood or stone (Cassels, 1862, p. 19). Between the 12^{th} and 14^{th} century the dual roller gin appeared in India and China and the Indian version was spread throughout the Mediterranean cotton trade by the 16^{th} century (Britton, 1992, p. 15). By the 18^{th} century the simple cotton ginning method was introduced to the South (Aiken, 1973, p. 196-224).

However, what most people think about when they think of a cotton gin falls more closely in scope to the mechanical "cotton engine" created by Eli Whitney (Woodbury, 1960, p. 235-253). His design of the machine allowed locks of seed cotton to be put in the top of a mechanism and pushed through to a set of wire "teeth" which combed out the seeds (Woodbury, 1960, p. 235-253). Whitney's machine then went through several stages of change to get to where the gin is today. This included a lot of new innovations, such as saws to clean the cotton instead of wire teeth, and larger configurations that allowed the machine to become even more efficient. The main change was the larger configuration, which allows for more cotton to be processed by a single gin at a higher rate of speed. Gins have also implemented monitoring systems to make sure everything is working with the gin so that people do not have to constantly monitor each individual gin, checking for malfunctions.

To the industry as a whole, the introduction of modules has also improved and changed how cotton is processed by the gin. The module technology allows cotton to sit longer in the field before it has to go to the gin for processing. This allows fewer gins to process the same amount of cotton because they can spread out the ginning instead of trying to process cotton fast enough to not delay harvest. Because of module technology, the number of gins could decrease while the amount of cotton remained the same. However, farmers began planting more acres of cotton because the gin could process them better and improved tractor technology made it easier. So at this point the number of gins decreased and the amount of cotton produced has increased.

The newest innovation in harvesting is the round bale technology which allows the cotton to sit even longer after harvest before they are sent to the gin for processing and further reduces transport costs. Again this, among other, technological innovations allows farmers to produce more acres of cotton, thus increasing the amount of cotton produced. The gins at this time also continue to get larger and faster to handle the amount of cotton produced by farmers. The new harvesting technology is again expected to increase gin size and decrease gin numbers while the amount of overall cotton produced could safely continue to increase because of improved storage technology.

Previous Analysis and Hypotheses

A study by Ethridge, Roy, and Myers (1985), using a Markov Chain Analysis, estimated future gin numbers as the module harvesting technology was introduced. The study concluded that there are four factors that will affect the number and average size of gins. The changes in the cost of labor, changes in the cost of energy, the proportion of cotton production, and the progression of time combine to create gradual technological changes. For this type of analysis, the non-stationary Markov chain procedure was used because it provides the ability to examine the effects of outside forces on the cotton ginning industry's structure. The study predicted increased movement of gins out of the small gin state and into the dead gin state. It also predicted an increase in the number of gins in the large gin category even though the total number of gins will continue to decrease. In fact, most other predictions state similar ideas and only differ in the amount of time it takes these predictions to be realized. For the industry, this will mean fewer jobs due to mechanization and the overall reduction in the number of gins. It also means that there will be a greater demand in cotton gin sales and servicing of the new technology.

Overall, the previous studies correctly predicted the continued decline in overall gin numbers. In this paper, we review recent data. But, rather that focus on aggregate numbers, we disaggregate the data by county. One hypothesis is that the overall trend in gin numbers declining will be present in larger cotton producing counties, but less prevalent in smaller, more marginally producing counties. In the smaller, more isolated counties, gin numbers are already small, but those gins are required to gin small amounts of cotton. Smaller numbers of bales to be ginned mean it is not cost efficient to have larger gins, and relative isolation from larger producing counties means there it is less cost efficient to transport that cotton elsewhere. Facing less pressure from larger gins, the small number of smaller gins can continue to operate. In counties with larger cotton production, there is more pressure for gins to get larger, which has led to a greater overall decrease in gin numbers.

Results

This study will determine if these results of the Markov Chain Analysis conducted by Ethridge, Roy, and Myer (1985) can be supported by looking back on what has happened in the recorded history of the ginning industry. The data was all gathered from the USDA NASS database and was manipulated to show the number of gins in one county, the amount of cotton processed through those gins, and the number of bales processed per single gin in that county. Counties were selected based on the size of the cotton farming operations in that county so that both small and large cotton producing counties could be represented.

The expectation for further reduction in gin numbers seems drastic but if we look back on the past evidence, these results are not farfetched. Because of the vastly different sizes of ginning operations within the state, data from Texas cotton ginning operations will be used to demonstrate how those changes occur. Also, Texas is the largest cotton producing state, so for this study Texas will be used to determine the reason and extent to which the cotton ginning industry is changing in the United States. This will give a clearer picture of what is happening on a much larger scale in the United States. In Texas the number of cotton gins decreased from 472 in 1991 to 206 in 2015. See Table 1. The total bales ginned went up from approximately 4 million in 1991 to approximately 5 million in 2015, and exceeded 8 million bales in 2005 and 2007. See Figure 2. This supports the Markov Chain Analysis theory that as gins become more efficient and the cotton production industry increases production, the number of gins can go down and the average number of bales ginned can go up. This gives us a broad overview of what is happening within Texas, but the trends differ depending on whether a specific county is large or small on the ginning production scale.

Let's look at several counties who demonstrate very different reactions to this change. See Table 3. The first four counties are in the large gin category because they all contain more than ten gins within their county lines. The first county is Lubbock County with 18 gins at the first count in 1991. Since then the number of operating gins has decreased by nearly one-half to 10. See Figure 4. It is similar to Texas in the trend line. The number of gins has gone down and number of bales ginned has gone up.

The same is true for the next county as well. Lynn County employed 15 gins in 1991 and now has only 6. See Table 5. However it still enjoys a fairly large bale per gin ratio. When using bales per gin, although that is not explicitly shown on these graphs, it is important to remember that the number also rises or drops with the number of running bales produced. This ratio is found by dividing the number of bales in a given county by the number of operating gins within the county. This ratio will be referred to in order to show the relationship and relative trend of the two lines shown here. See Figure 6. Although Lynn County is smaller than Lubbock County and Texas as a whole, it follows the same trend line as will be true for most of the counties examined.

The next county in the large gin division is Hockley County which had 12 gins in 1991 and has since moved to 7. See Table 7. The trend line, although more steady in the middle years from 2004 to 2010, still shows the number of gins decreasing and the number of bales per gin increasing. See Figure 8.

The final county examined for the large gin category is Hale County which had 20 gins in 1991. See Table 9. Unlike the other counties, however, it has moved down in number of gins as well as in bales per gin. This is not the same as trend lines seen thus far and there could be many reasons for that. See Figure 10. It was most likely caused by the increased production of corn and sorghum and the decreased production of cotton within the county. It is still unclear why this trend line shows a negative impact but it should not be replicated in other counties with the number of gins and the number of bales per gin both decreasing at a rapid rate. Despite this one view of what can happen to large gins the overall productivity trend is positive and due to the high cotton production of the region surrounding and within those counties, they are able to maintain a higher number of gins.

So to sum up, large gin counties by 2015 show that cotton production is still high but there have been reductions in the number of gins due to consolidations and the average number of gins in those counties has gone down.

Now moving on to the smaller gin counties. It is sometimes hard to get data tables for the small counties to determine the bales per gin. For most small counties, they import cotton from multiple counties around their area. This being said, these counties usually don't have good data numbers for Running Bales Ginned. It can however be assumed that if the counties only have one gin that all or most of the cotton produced in that county goes through that gin. It can also be assumed that the available technology changes at the same rate of the other gins in Texas and the rest of the United States. If this is the case then it makes sense that these counties can only support one or two gins instead of the larger number like the 9 or 10 gins that larger cotton producing counties can sustain. The first county we will examine in this category is Mitchell County. Mitchell County began in 1991 with 4 gins and has since been down-graded to 3. See Table 11. The number of gins in this county has remained relatively steady. The reason this county has such a stable number of gins is because the cotton production for this county is very limited. With such a limited amount of cotton planted and harvested in this county and the counties around it, a very small number of gins can be supported but this number of gins is not as fast changing as in some of the larger counties. So the trend in Mitchell County is a small but consistent number of gins and similarly small changes in the number of bales per gin because of production fluctuations and less need to increase ginning speed. See Figure 12. The Running Bales Ginned is dependent on the amount of cotton produced which is sometimes hard to keep consistent in smaller counties.

The next county is Brazoria County which started with 3 gins and went down to 2 gins. See Table 13. This county shows the same consistent number of gins as the last county. The Running Bales Ginned line shows a lack of cotton ginned which infers that the gins in this county are shipping cotton in from neighboring counties or are barely producing enough to scrape by and allow them to stay open. See Figure 14.

The next county is Hall County which began in 1991 with 5 gins and has since moved down to 3. See Table 15. Although the trend line looks a little bit different in this graph, it shows a growing number of bales per gin and a shrinking number of gins. This is the same trend that was seen in the Texas total and in the large counties. See Figure 16. This county might be different than the other small counties examined because it began with a larger number of gins compared to the other counties. This makes the trend easier to see within the data. It might also have something to do with a more consistent number of bales produced within the county which had to be ginned and allowed for more technology to be incorporated.

The final county we will look at is Knox County. The number of gins and production in this county has gone down drastically over the years. See Table 17. This is an example of a county moving from a state where they can support a ginning operation to a dead gin state where the operation of a gin is not feasible because the production of cotton has virtually disappeared. See Figure 18. For many small ginning counties this is their fate. They will begin moving toward this state just like large gin counties will begin losing gins as they become more and more efficient. These small county gins have lasted but most of the time by taking cotton from neighboring counties that no longer have a cotton gin of their own. However, as the future progresses, more of the counties that behave similarly will also begin to lose their gins. This is because as cotton transportation gets better, modules can travel further to get to another, larger, more efficient gin.

Conclusions

The future for agriculture will continue to be full of technological inventions that will be implemented on all fronts. There will be more dedication to finding ways for things to run as quickly and efficiently as possible. This includes gins which will become more consolidated and faster. The number of gins will drop because the capability of one newly upgraded gin will more than make up for what multiple gins did before and continue the trend seen in the previous examples. Another possibility for the future of the ginning industry is a move toward longer potential ginning seasons. As technology improves to let cotton sit longer after harvest, gins could further decrease in number and produce a higher bale per gin ratio, assuming producers and buyers can adjust to the change.

Table 1: Data gathered from USDA NASS for Texas to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	4626500	472	9801.91
1992	3226750	405	7967.28
1993	4996900	423	11813.00
1994	4845700	404	11994.31
1995	4413500	391	11287.72
1996	4294450	372	11544.22
1997	5080350	360	14112.08
1998	3558550	354	10052.40
1999	5020450	348	14426.58
2000	3900850	306	12747.88
2001	4232800	301	14062.46
2002	4981500	286	17417.83
2003	4274850	273	15658.79
2004	7618050	282	27014.36
2005	8333750	283	29447.88
2006	5751650	258	22293.22
2007	8144900	271	30054.98
2008	4400900	235	18727.23
2009	4578700	229	19994.32
2010	7763600	252	30807.94
2011	3527600	220	16034.55
2012	4961900	226	21955.31
2013	4100400	211	19433.18
2014	6101900	212	28782.55
2015	5797000	206	28140.78
Average	5141340 Bales Ginned	303.2 Gins	18222.9104 Bales/Gin

Figure 2: Dataset and graph of the total Texas number of gins and number of bales ginned.

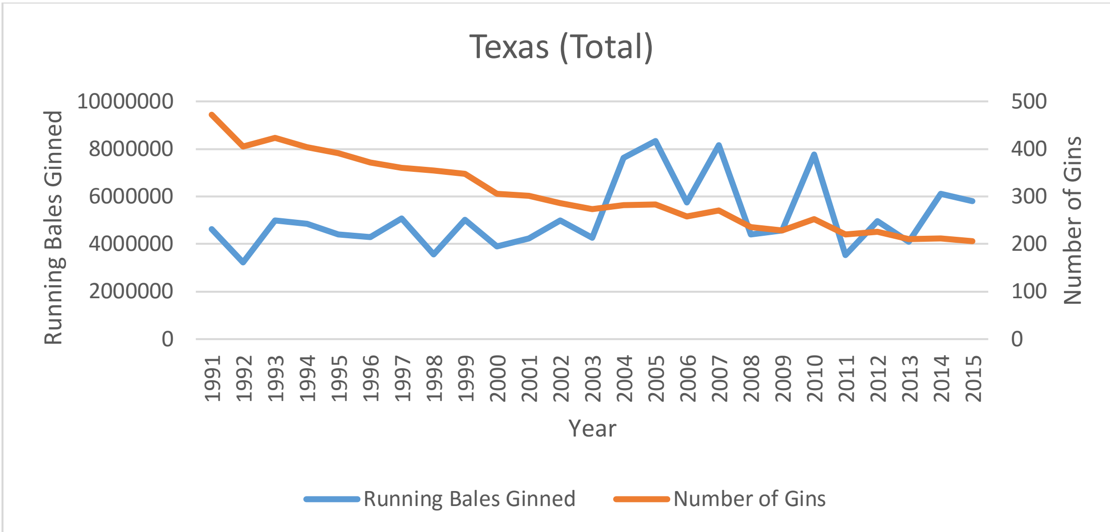


Table 3: Data gathered from USDA NASS for Lubbock to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	180050	18	10002.78
1992	72300	15	4820
1993	323650	18	17980.56
1994	291750	17	17161.76
1995	241950	18	13441.67
1996	262050	18	14558.33
1997	260600	14	18717.86
1998	216500	16	13531.25
1999	248200	15	16546.67
2000	205950	14	14710.71
2001	161450	12	13454.17
2002	275150	12	22929.17
2003	201350	12	16779.17
2004	579800	11	52709.09
2005	582200	13	44784.62
2006	338900	10	33890
2007	629600	10	62960
2008	412850	10	41285
2009	400300	10	40030
2010	578300	11	52572.73
2011	164750	10	16475
2012	337650	10	33765
2013	342350	10	34235
2014	442650	10	44265
2015	505300	10	50530
Average	330224 Bales Ginned	12.96 Gins	28085.4216 Bales/Gin

Figure 4: Lubbock County dataset and graph which show a similar trend to the Texas total.

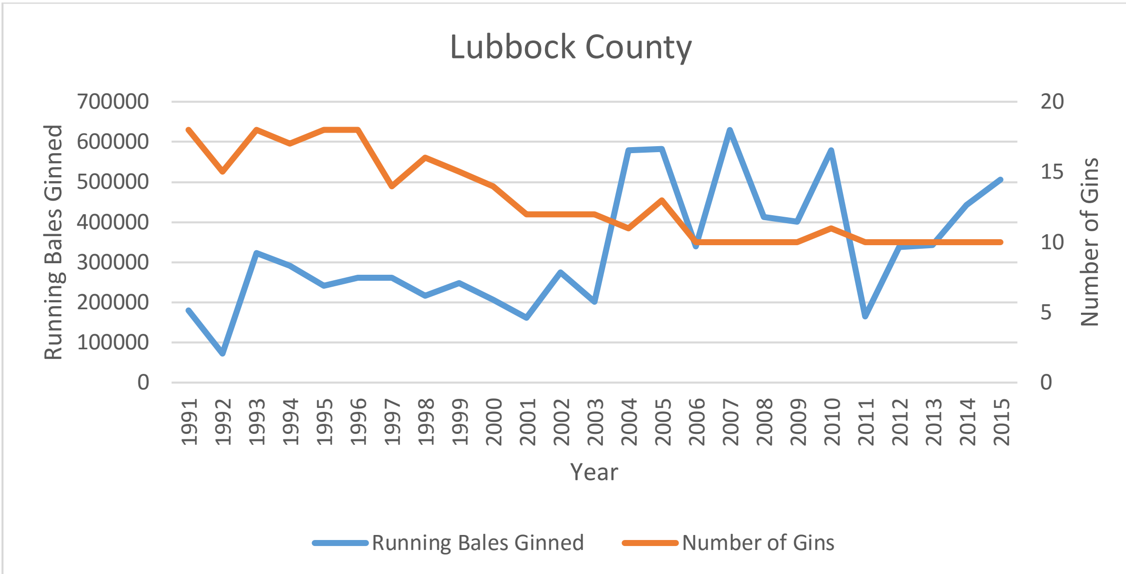


Table 5: Data gathered from USDA NASS for Lynn County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	147750	15	9850
1992	194700	13	14976.92
1993	262150	11	23831.81
1994	175500	12	14625
1995	185750	11	16886.36
1996	206950	10	20695
1997	284100	10	28410
1998	151300	11	13754.55
1999	185050	10	18505
2000	130650	10	13065
2001	56450	9	6272.22
2002	217200	9	24133.33
2003	170650	7	24378.57
2004	303700	8	37962.5
2005	383950	7	54850
2006	101850	6	16975
2007	412300	6	68716.67
2008	155450	6	25908.33
2009	179250	6	29875
2010	288200	6	48033.33
2011	69900	6	11650
2012	169150	6	28191.67
2013	128850	6	21475
2014	154550	6	25758.33
2015	297950	6	49658.33
Average	200532 Bales Ginned	8.52 Gins	25937.5168 Bales/Gin

Figure 6: Lynn County dataset and graph which shows what the smaller end of a large county dataset and trend line.

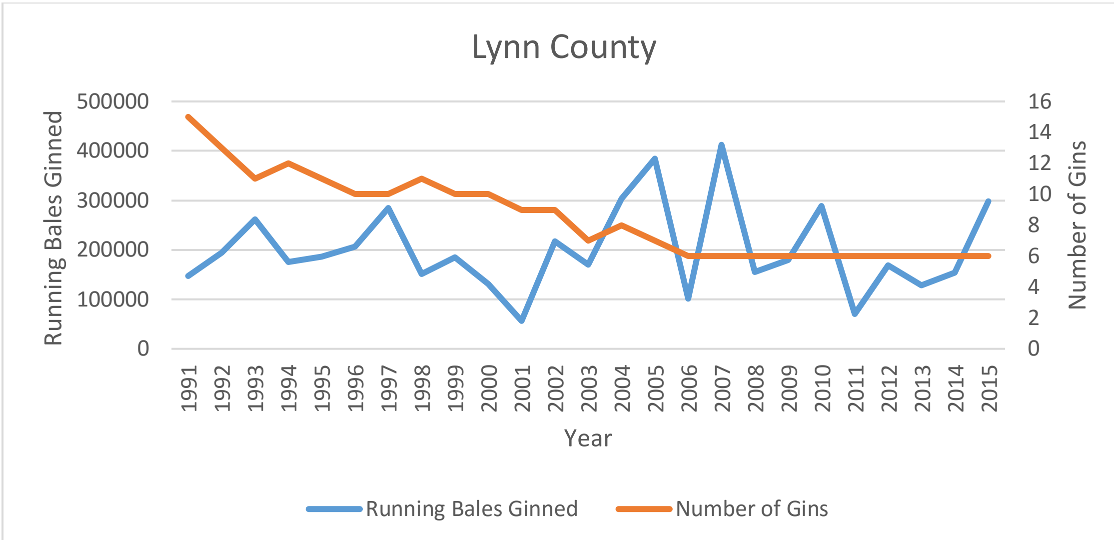


Table 7: Data gathered from USDA NASS for Hockley County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	170250	12	14187.5
1992	92500	12	7708.33
1993	262900	12	21908.33
1994	245900	11	22354.54
1995	276350	13	21257.69
1996	290650	11	26422.72
1997	273500	11	24863.63
1998	209200	11	19018.18
1999	202300	12	16858.33
2000	161600	10	16160
2001	175200	8	21900
2002	247350	8	30918.75
2003	173950	7	24850
2004	469700	8	58712.5
2005	480250	9	53361.11
2006	362450	9	40272.22
2007	540750	8	67593.75
2008	338750	8	42343.75
2009	336050	8	42006.25
2010	521750	8	65218.75
2011	111300	7	15900
2012	232100	7	33157.14
2013	232600	7	33228.57
2014	294900	7	42128.57
2015	377150	7	53878.57
Average	273872 Bales Ginned	9.24 Gins	37664.5184 Bales/Gin

Figure 8: Hockley County dataset and trend line similar to other large counties.

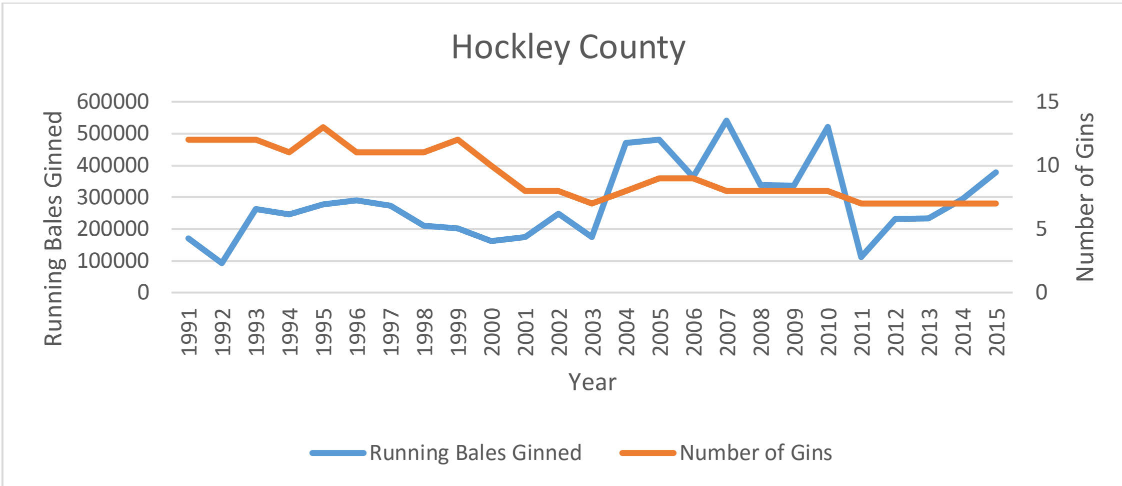


Table 9: Data gathered from USDA NASS for Hale County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	241150	20	12057.5
1992	18100	12	1508.33
1993	319700	19	16826.32
1994	327100	18	18172.22
1995	230350	19	12118.42
1996	323400	19	17021.05
1997	286650	17	16861.76
1998	360450	16	22528.13
1999	371900	16	23243.75
2000	310250	13	23865.38
2001	401850	14	28703.57
2002	405350	16	25334.38
2003	199500	12	16625
2004	457150	15	30476.67
2005	537900	12	44825
2006	530100	13	40776.92
2007	376150	12	31345.83
2008	354500	10	35450
2009	319950	11	29086.36
2010	474450	10	47445
2011	280850	9	31205.56
2012	247500	9	27500
2013	183850	9	20427.78
2014	218000	8	27250
2015	155150	7	22164.29
Average	317252 Bales Ginned	13.44 Gins	24912.7688 Bales/Gin

Figure 10: Hale County dataset and graph show a decrease in the number of gins and the number of bales ginned which is not the same trend we have seen in any of the other examples.

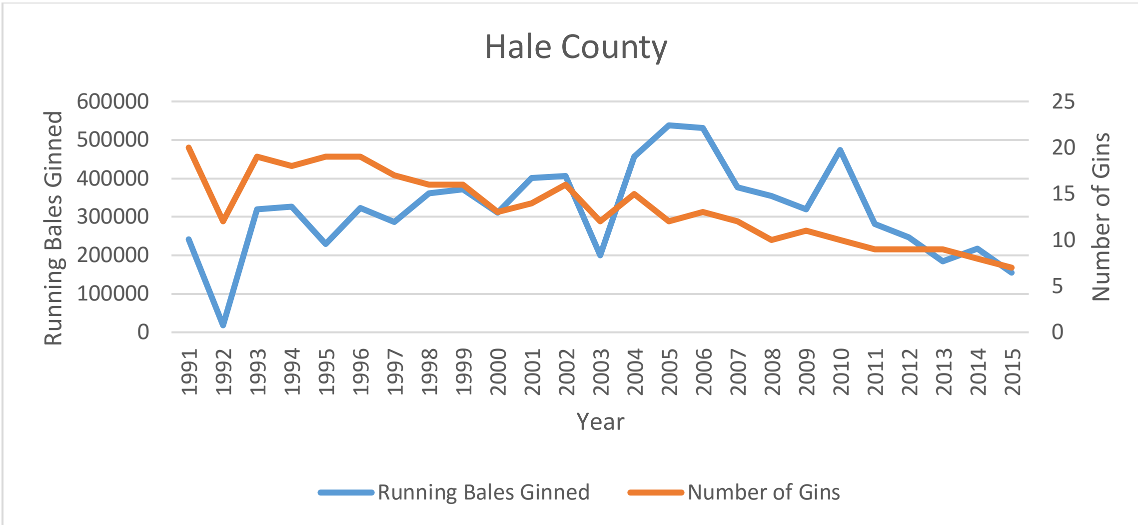


Table 11: Data gathered from USDA NASS for Mitchell County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	25450	4	6362.5
1992	36500	3	12166.67
1993	18300	3	6100
1994	24800	3	8266.67
1995	20600	3	6866.67
1996	10350	3	3450
1997	41700	3	13900
1998	0	2	0
1999	18400	3	6133.33
2000	4050	3	1350
2001	20100	3	6700
2002	27900	3	9300
2003	32450	3	10816.67
2004	49350	3	16450
2005	73600	3	24533.33
2006	21100	3	7033.33
2007	102650	3	34216.67
2008	35100	3	11700
2009	39200	3	13066.67
2010	60900	3	20300
2011	3950	3	1316.67
2012	45300	3	15100
2013	0	3	0
2014	0	2	0
2015	0	3	0
Average	28470 Bales Ginned	5.92 Gins	9405.1672 Bales/Gin

Figure 12: Mitchell County dataset and graph show the relative trend of small cotton production counties.

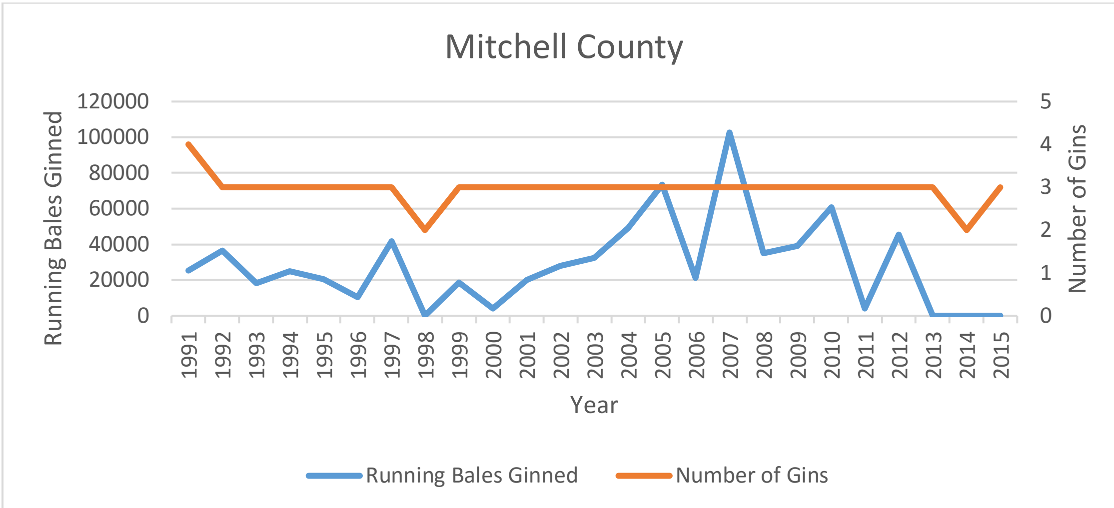


Table 13: Data gathered from USDA NASS for Brazoria County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	0	3	0
1992	13450	3	4483.33
1993	9250	3	3083.33
1994	15050	3	5016.67
1995	18950	3	6316.67
1996	12200	3	4066.67
1997	12700	3	4233.33
1998	5550	3	1850
1999	24600	3	8200
2000	20600	3	6866.67
2001	24350	3	8116.67
2002	20800	3	6933.33
2003	10800	3	3600
2004	20850	3	6950
2005	17950	3	5983.33
2006	0	2	0
2007	0	3	0
2008	0	2	0
2009	0	2	0
2010	0	2	0
2011	0	2	0
2012	0	2	0
2013	0	2	0
2014	0	2	0
2015	0	2	0
Average	9084 Bales Ginned	2.64 Gins	3028 Bales/Gin

Figure 14: Brazoria County dataset and graph show a similar trend to the previous small counties.

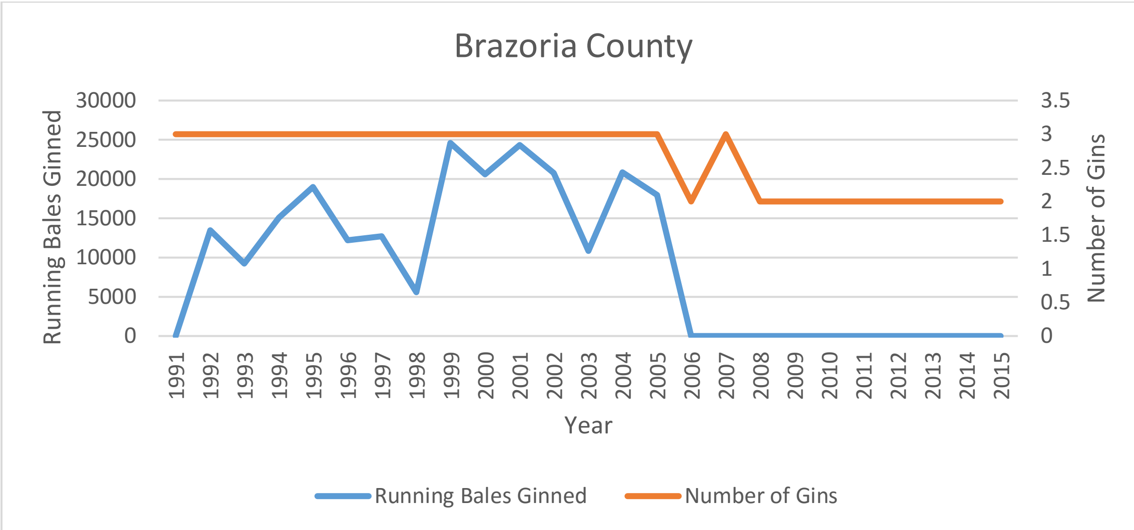


Table 15: Data gathered from USDA NASS for Hall County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	49900	6	8316.67
1992	57500	5	11500
1993	63300	5	21100
1994	38250	5	7650
1995	33800	5	6760
1996	64100	5	12820
1997	58350	5	11670
1998	24350	3	8116.67
1999	65800	5	13160
2000	0	4	0
2001	23450	4	5862.5
2002	48050	4	12012.5
2003	51350	3	17116.67
2004	76000	4	19000
2005	91750	3	30583.33
2006	0	3	0
2007	97250	3	32416.67
2008	0	3	0
2009	88000	3	29333.33
2010	91000	3	30333.33
2011	0	3	0
2012	0	3	0
2013	61700	3	20566.67
2014	89350	3	29783.33
2015	83500	3	27833.33
Average	50270 Bales Ginned	3.84 Gins	14237.4 Bales/Gin

Figure 16: Hall County dataset and graph show a slightly different variation for the same trend seen previously.

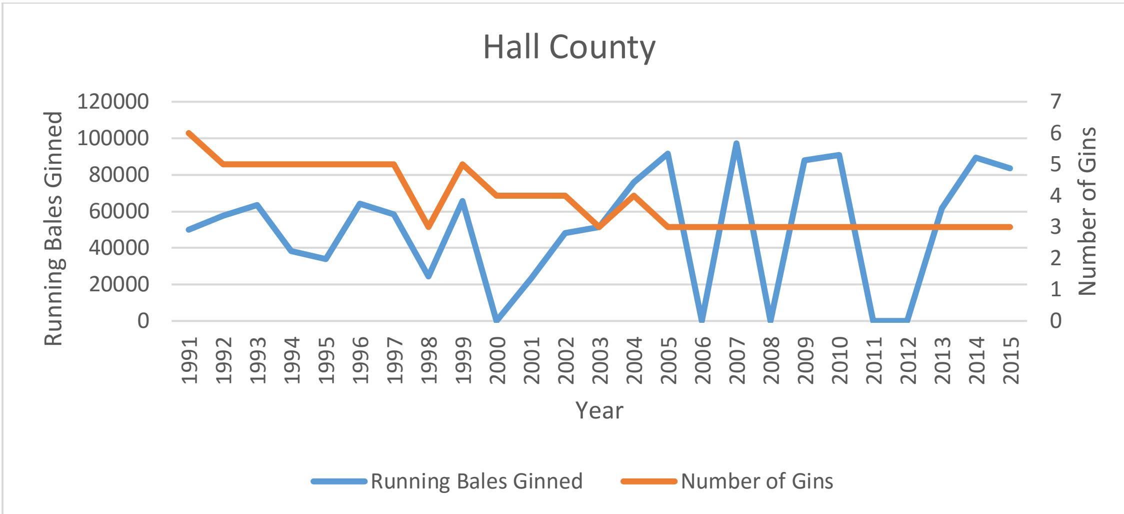
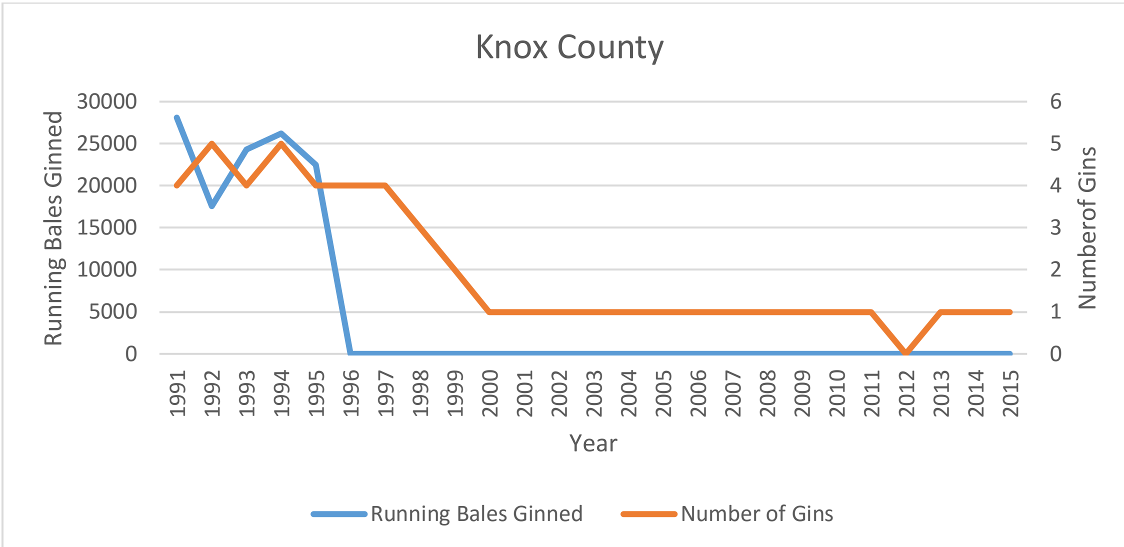


Table 17: Data gathered from USDA NASS for Knox County to determine the changes in the number of bales produced per gin, the average number of gins, and the total number of bales ginned.

Year	Running Bales Ginned	Number of Gins	Bales per Gin
1991	28100	4	7025
1992	17550	5	3510
1993	24300	4	6075
1994	26250	5	5250
1995	22450	4	5612.5
1996	0	4	0
1997	0	4	0
1998	0	3	0
1999	0	2	0
2000	0	1	0
2001	0	1	0
2002	0	1	0
2003	0	1	0
2004	0	1	0
2005	0	1	0
2006	0	1	0
2007	0	1	0
2008	0	1	0
2009	0	1	0
2010	0	1	0
2011	0	1	0
2012	0	0	0
2013	0	1	0
2014	0	1	0
2015	0	1	0
Average	4746 Bales Ginned	2 Gins	1098.9 Bales/Gin

Figure 18: Knox County dataset and graph show a gin moving from small gin state to a dead gin state.



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