Developing an Advocacy Program for Hail Cannons in Agricultural Practices

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Abstract

The purpose of this project was to developing an advocacy program for hail cannons use in agricultural practices. The project was initiated to help farmers promote hail cannon usage within communities, so the farmer may protect their crops from hail damage. In order to capture a wide array of opinions, farmers throughout Kings, Tulare and Fresno counties completed a questionnaire to give background on current problems and statistics regarding hail cannons. An advocacy strategy was given to provide guidance for farmers to promote hail cannons. By utilizing the hail cannon advocacy strategy, farmers should notice their communities are more accepting of hail cannon use and be able to continue using hail cannons in the future.

Chapter One

Introduction

Although beneficial to the fresh fruit market, there has been some opposition to the cannons regarding the noise they emit. Hail cannons, in a sense, are a new technology to agriculture. Although originating in the 18th century, they have been modernized greatly over the past thirty years, the latter ten being the most significant (Eggers, 2011). These cannons are designed to disrupt the growth phase of hail by emitting a shockwave directly above the cannon.

The cannons are comprised of two parts: first is the combustion chamber, where the acetylene gas and air is ignited to initiate the sound wave. The second part is the cone, which is directly connected to the combustion chamber. The cone funnels the acetylene discharge (sound wave) directly above the cannon and can potentially protect 190 acres from hail damage (Newton systems). In theory, these crop saving machines seem to resolve the potential hail threat that generally occurs in the spring.

The weather has no mercy towards stone fruit crops and other forms of agriculture. This is seen in maturing fruit, when the slightest hail damage can destroy fruit intended for fresh produce markets. To those who are not directly affected by the damage hail presents, the inadvertent implications can potentially be devastating. Third-party implications can be anticipated because produce is very susceptible to scarring if struck by an outside source, such as hailstones. This scarred fruit, at best, is sold as a utility grade. Often it is discarded and will never reach the fresh fruit market. In severe cases of hail damage, fields with significant hail damage will go unpicked and left untouched for an entire year. In this type of situation, job loss may

occur in the harvesting sector of produce, and produce prices have the potential to increase in the grocery stores because of the product shortage.

The problem is not within the production side of agriculture or whether or not these anti-hail cannons work, but public acceptance of the tool. The cannons have proven themselves effective over the past several years when used properly. The problem stands within the communities of these hail cannons whose sound can be heard from a distance. An advocacy strategy is a necessary tool to promote these anti-hail cannons. Farmers need to work together with their neighbors in order to resolve differences about the noise that the cannons emit. There is a need for public awareness of the hidden implications hail damage has on the community outside of the obvious noise. Farmers must come together and explain to the public why there is a need for the hail cannons which includes defending the benefits cannons present.

Statement of the Problem

The fresh fruit industry has been trying to overcome the elements by deterring hail from potential crops with hail cannons. While farmers are attempting to trounce Mother Nature, neighbors and communities around farms utilizing hail cannons have found this agricultural practice a nuisance and unwanted due to the substantial noise emitted. There is a need for educating the public outside of the agricultural field that these cannons are necessary for the success of deterring hail. *The problem is that there is a lack of education about the hidden implications of hail damage, and a lack of cooperation between farmers and their communities about the noise pollution that the cannons emit. Combining these two elements will result in a hail cannon advocacy strategy that has not previously existed.*

The Importance of the Project

This project will be important in assisting farmers in developing a plan for addressing the issue and educating the public to promote the use of hail cannons for their agricultural practices. It will shed light on the aspects that need to be addressed to the public and how to communicate the need for the hail cannon apparatus to control hail damage. The unseen damages, such as job loss in the community, as well as the visual implications such as hail damage to the actual produce.

Purpose of the Project

The purpose of this project is to portray an appropriate strategy for gaining public approval of an agricultural tool that emits loud noise. In other words, to compose a strategy to promote hail cannons for crop protection and influence the public to perceive the cannons as a necessary tool, despite their noise.

Objectives of the Project

- The purpose of this project is to develop an advocacy strategy for farmers to present to the public, presenting the positive aspects of hail cannons for agricultural practices.

  a) Possible positive presentation methods of hail cannons for city meetings and other public venues.

b) Construction of a potential social media strategy for presenting hail cannons as a positive agricultural tool for preventing hail damage to crops.

- To provide information on what hail cannons are and how they work to prevent hail from damaging delicate pieces of produce.
- To present the implications of hail that affects the workforce and produce market if that hail is left to destroy crops.

Definition of Important Terms

Hail- Precipitation of ice pellets when there are strong rising air currents.

Hail Cannon- A hail cannon is a pseudoscientific device that generates a shock wave, alleged to disrupt the formation of hailstones in the atmosphere by funneling the vibrations from combustion into the atmosphere during the hail's growth phase.

SWOT Analysis- A SWOT analysis is a strategic planning method used to evaluate the strengths, weaknesses/Limitations, opportunities, and threats involved in a project or business venture.

Hypothesis

1) If farmers implement the strategies for advocating hail cannons, they will see a positive change in the public's opinion of their hail cannons.

2) Less informed community members might see the cannons as a commonly used agricultural practice and accept their usage.

3) If several of the community members accept the cannons, their acceptance may persuade others in the area and a general recognition of this necessary tool may occur.

4) To develop a public awareness of hail damage implications, regarding workforce and fresh produce market. Such as job protection that a single hail cannon will ensure and the amount of fresh produce that can be harvested.

5) The study will show an urgency for farmers to advocate hail cannons to ensure their longevity in protection of fresh produce crops.

6) Farmers need to assure the public that the hail cannons are used with the utmost discretion.

Summary

Neighbors and surrounding residential communities of the fresh fruit growers have been annoyed by the presence of hail cannons for several years now. Educating the public about these essential hail cannons may present this necessary crop saving tool in a positive manner. Sharing the implications of what a hailstorm presents could possibly change their opinion about what they once thought was a nuisance. Positive presentation methods are vital to bringing about a change that will increase popularity in the community for these cannons. A strategy needs to be comprised of positive implications, necessity, attempts for noise abatement, and community contact for acceptance of using this essential device.

Chapter Two

Review of Literature

To effectively promote hail cannons, a proven advocacy strategy will be necessary. It is important to have a guideline for advocacy in order to evaluate progress made towards the acceptance of hail cannons. By implementing the advocacy strategy in public settings and within the agricultural community, both problems will be identified. The problem within the public is that there is a lack of education about hail cannons and the implications of hail damage. The problem within agriculture is that farmers are not addressing issues that may arise from hail cannon use. By addressing both problems in an advocacy strategy, the utilization of hail cannons may become a socially accepted form of hail defense.

Advocating Hail Cannons for Agricultural Practices

There are seven key elements to advocate for a cause; they are listed in chronological order in provide guidance throughout the advocacy process.

1. Define the problem
2. Find an answer
3. Identify the target
4. Create a plan, including resources
5. Implement
6. Evaluate
7. Identify/Refine future plans (Connecticut Health Foundation, 2012)

With those steps in mind, the first order of business is to clearly define the issue. The problem is that there is a lack of education about the hidden implications of hail damage, and a lack of cooperation between farmers and their communities about the noise pollution that the cannons emit. Being able to identify the problem is the first step to being able to find an answer for both farmers and the communities involved.

Step 2: One answer to this is to educate the public about the usefulness that only hail cannons provide and the third party implications such as job loss that hail damage creates. According Bureau of Labor Statistics, as of 2007, there were 173,000 employees in the Fruit and Vegetable Preserving and Specialty Market (U.S. Department of Commerce Industry Report, 2008). This does not include a large amount of field employees that would be affected if there was no produce to harvest. This information is to demonstrate the large workforce that may be affected if hail damage is undefended. Farmers need to cooperate with their neighbors prior to hail cannon operation, so that neighbors know when they will be used. These two elements will result in a hail cannon advocacy strategy that has not previously existed.

Step 3: The target audience should be separated into two different categories: farmers and public. Farmers should be working together to communicate with neighbors and work to create positive relationships with those who might be affected by the noise emitted by hail cannons. The public should be informed about how the hail cannons work, why they are needed and the third party implications that go along with hail damage. Neighbors should be the first priority for notification because they are affected the most by hail cannon emissions.

Step 4: By creating a plan to notify neighbors, farmers have a better chance of reaching all of those who may be unintentionally affected by the noise. The farmers need to cooperate with the public in every opportunity that arises. That may be a city council meeting, county

meetings, and/or answering questions from reporters or being interviewed for a newscast. By reaching multiple levels of media and answering questions from the public, a general knowledge of hail cannons will be established throughout the community and may help make the hail cannons socially accepted.

Step 5: By implementing activities such as the city council meeting, county meetings, or news related media events to promote hail cannons, a general knowledge will be established. It is the farmers' responsibility to inform neighbors or those affected by hail cannons that they will be in operation for certain time period, or notifying them that there is a hail cannon located in a nearby location. After notifying neighbors, it is important to evaluate progress being made throughout the following year in case changes need to be made.

Step 6: Evaluating the processes mentioned in the steps above will be an ongoing process. The easiest way to evaluate the progress is to monitor the public's annual reaction to the hail cannons. If the public is not responding in a positive manner, the farmers may need to inform the public on a larger scale such as a larger newspaper or newscast. If the concern is coming from neighbors, a more significant alert may be needed. Farmers should pay close attention to where complaints are coming from in order to establish a quick resolution with their neighbors. After evaluating the neighbors and communities that may be affected, identification and refinement of notification and education methods are critical for an efficient informational system.

Lastly, step seven should identify and refine future plans. By observing the public's reaction throughout the year, farmers will know which sector of their target audience needs to be addressed. If the local neighbors are having problems with the noise, asking them what needs to be done to ease their discomfort can be helpful. Concern for their well-being shows neighbors

that the noise emitted is an unintentional discomfort. If it is the general public that is raising concern, press releases or city/county council meetings are possible venues for public awareness.

Hail Cannon Background

According to Eggers Hail Cannons from New Zealand, one of the leaders in manufacturing this device, anti-hail cannons have been used since the 18th century. They have been largely developed over the past thirty years, with the last ten being the most relevant. The cannons generate a shock wave that disrupts the formation of hail in the sky. Acetylene gas and air is fired in the lower chamber of the machine. The gas then passes through the neck and while it travels into and through the cone, it develops into a force that becomes a shock wave. The shock wave is shot directly above the cannon, disrupting the growth phase of hailstones. For the cannons to be effective, it is necessary that the cannon be activated before the approach of the storm. The device can be turned on manually, or via cell phone, Internet, or radar. The cannon will fire a shot every four seconds until the storm cloud passes. It is crucial that the cannon is on prior to the hail clouds' arrival. The cannon does not destroy hail, it merely disrupts the growth process, forcing the developing hail into slush or rain (Eggers, 2011). One hail cannon can potentially protect approximately 190 acres. They should be placed strategically where storms are generally anticipated to enter the field. If more than one cannon is needed, it should be placed no further than 500 meters away or 545 yards away (Wimer, 2008).

If they are not intrigued by the battle-like sounds, the public typically sees the cannons as a nuisance. However, what they perceive as a nuisance is saving hundreds of jobs and revenue for the area that is generated by the production and sale of protected produce. "Each cannon

protects the jobs of about 150 people, and in a bad year will be shot off about ten times," said Mike Jackson, a Central Valley fruit farmer who has several cannons placed throughout the valley. Vernon Peterson, another Kingsburg farmer, has a cannon 600 feet from his own home, and has said, "the noise is terrible, but necessary now that hail insurance has risen to about $1000 per acre" (Fienen, 2008). As for job creation, the Fruit and Vegetable Preserving and Specialty Markets alone hold approximately 173,000 jobs. This accounts for 12% of the total food manufacturing industrial works in the United States. However, this figure only represents those who work in the factory end of the spectrum, and it does not include those who are in the field, handling the produce several times throughout the year, or those in the box making industry, or those employed to sell the produce (U.S. Department of Commerce Industry Report, 2008). According to the California Department of Food and Agriculture, California's total production value of all fruits and nuts in 2010 was $13.3 billion. Natural disasters not visible to the public eye - such as hail storms - are often overlooked, but if even a fraction of the crops are injured due to this silent killer, California's income will be severely impaired. Not only does hail injure our state's economy, but the price of fresh fruit will escalate as well. The CDFA also determined that the average American consumes around 270 pounds of fruit and tree nuts annually. If fresh fruit is unavailable due to natural causes, the price of existing fruit will be much higher, impacting the budget of individual Americans as well ("Fruit and Nut crops," 2011).

Legally, California, along with the entire United States, has laws that supersede local authority. They are called the Right To Farm Statutes. According to the California Civil Code 3482.5 (a)(1) "No agricultural activity, operation or facility, or appurtenances thereof, conducted or maintained for commercial purposes, and in a manner consistent with proper and accepted customs and standards, as established and followed by similar agricultural operation in the same

locality, shall be or become a nuisance, private or public, due to any changed condition in about the locality, after it has been in operation for more than three years if it was not a nuisance at the time it began" (National Ag Law Center). This statute allows farmers to carry out their business and protect their investment as long as they follow accepted customs and standards. The problem with the statute, in this application, is that hail cannons, being as new as they are, may not be considered a proper and accepted custom or standard. This being said, farmers should be proactive by trying to abide by this law. By developing a form of social media to inform the general public of the hail cannons importance, there will be more information to shed light on their actual value.

There are noise abatement issues, as reported in Fienen's article, "Kings County Officials conducted decibel testing on the cannon located just off of Workman's property. County staff said during Thursdays meeting that it produced readings as high as 121 decibels at the cannon's site, with lower readings further away" (Fienen, 2008). Although loud, hail cannons are used in Kings County. They should be considered a significant source of noise during land use planning decisions. Hail cannons are identified as crop protection equipment and are not specifically regulated sound uses in Kings County (Kings County Planning, 2011).

The purpose of this project is to act as a guide for helping farmers advocate hail cannons. There are seven guided steps of advocacy, with each step including implementation strategies and possible objectives. This will also be an informational document about hail cannons, how they work, why they are important, the process of hail prevention and the aspects to consider before placing a hail cannon in a field. As positive public perception of these cannons is crucial for their survival in the future, there will also be tips for farmers to help cannons become an accepted farm practice in the public eye. Lastly, not only do farmers need to persuade the public

that the cannons are crucial for the production of fruit and vegetables, but they must also clarify that their are thousands of jobs at stake and by using cannons farmers have been and will continue to preserve jobs in the Central Valley and around the California.

Chapter Three

Methodology

In order to find out what the problem was with hail cannons, the underlying problem needed to be established. A survey was created that covered the basic strengths, weaknesses, opportunities and threats. This broad analysis (SWOT Analysis) covered the hail cannons' major points. After creating the SWOT analysis, the questionnaire was given to a board of three experts who viewed the questions then offered feedback on what was asked. The panel of experts were given the questionnaire on February 4th and 5th and were hand delivered to ensure the completion of the questionnaire and to ensure clarity of the questions asked. These experts also gave questions to possibly add depth to the questionnaire. The experts were: George Jackson, owner and founder of Kingsburg Orchards with 55 years of farming experience, John Diepersloot, owner of Elkhorn Farms with 26 years farming experience, and Brent Jackson, owner of Brent Jackson Farms with 28 years of farming experience. All of the experts on the panel specialize in stone fruit production and range from 48 years of age to 76 years of age.

Once the questionnaire was devised, six stone fruit farmers throughout Kings, Tulare and Fresno counties were then given the questionnaire to fill out and give back so that the answers could be aggregated. The questionnaire was hand delivered on the 11th and 12th of February, 2012 to all that participated to ensure completion and to provide clarification throughout the questionnaire if needed. All of the farmers who received the survey were willing to participate, acknowledging the fact that the problems regarding public relations for hail cannons were not going to fix themselves.

SWOT Analysis

The SWOT analysis was comprised of 23 questions. These questions were randomly placed throughout the questionnaire to break up answer patterns. The following is a list of the questions asked and the reasons the questions were asked in order. The questionnaire can be seen in the appendix.

1) How many hail cannons do you run annually?

   This was asked to see the range of cannon users.

2) If 0, skip to question number 15.

   This option was given so that non-hail cannon users would be involved in the survey.

3) How many storms will the typical cannon be used against in an average season?

   This question was asked to see the opportunities of using a hail cannon during a season.

4) Have you had significant hail damage while using hail cannons?

   This question is to see what the farmers had to say in regards to hail cannon protection.

5) If yes, please check the boxes below that apply.

   This was asked to see if it was the cannons' fault or if they do not work.

6) What is the approximate operational time length for a cannon during a storm?

   This strength was asked to demonstrate that the cannons were not operational for long periods of time.

7) Have you attempted to notify neighbors prior to operating hail cannons?

This opportunity was particularly important to show that farmers are attempting to work with their neighbors.

8) In your opinion, what would be the most likely/reasonable means to notify neighbors prior to operating hail cannons?

This was asked to reveal the various the opportunities of how to communicate with neighbors prior to operating hail cannons.

9) Have you attempted to dilute the hail cannons sound in any way?

This was asked to find weaknesses for the farmers to improve upon.

10) Have you found investing in a hail cannon has limited your crop damage?

This was asked to show validity in the hail cannons' usefulness.

11) Has your cannon ever misfired due to technical difficulties?

This was asked to see if hail cannons were accidentally fired, or malfunctioned occasionally.

12) Are you concerned about possible regulations on hail cannons?

This was asked to see if regulations were possibly the greatest threat to the usage of hail cannons.

13) Are you concerned about hail cannons becoming illegal farm tools?

This is another threat question directed to hail cannon usage.

14) Have any of your hail cannons been vandalized or destroyed?

This question was asked to see if local threats have been made and/or the neighbors' tolerance level assessed.

15) Have you had significant hail damage in the past?

This was asked to see what the farmers have encountered in the past and gives credibility to their experience.

16) In long-term perspective, what is the most affordable hail protection?

This was asked to see what the farmers view on hail protection was in regards to cost efficiency.

17) Approximately how many times a year will a potentially devastating storm affect a crop?

This was asked to determine the use of each cannon.

18) Have you seen visual damage to neighboring crops that were not using hail cannons?

This was asked to determine the strengths of using a hail cannon.

19) On average, what would the hail insurance rate be per acre, based on $100 of coverage?

This was asked to reveal how extreme the insurance rates are for hail insurance coverage.

20) Do you believe hail cannons are the most efficient investment to protect crops from hail damage?

This was asked to show what farmers think is the best crop protection from hail.

21) Have you lost public standing/popularity outside of agriculture due to your use of hail cannons?

This is a common threat to anyone that misuses an annoying tool. This question was used to check if farmers in this survey had overstepped their boundaries with hail cannon usage.

22) Do you have land that is leased that specifically prohibits the use of hail cannons?

This was to see if they were not using as many cannons as they would like due to their landlords' wishes.

23) Do you believe that farmers have the right to protect their crops?

This was asked to determine the strength farmers believe they have in protecting their crops.

Survey Recipients

The farmers who were asked to complete the survey were widespread from Kings, Tulare and Fresno counties. They or their businesses, ranged from organic to traditional farming operations, age of farmer, and large-scale to small-scale operations. Not all of the farmers that received the questionnaire use hail cannons as a tool to prevent hail damage. Here is the list of farmers who received the questionnaire:

- Jeff Bortolussi, a stone fruit farmer in Fresno and Tulare Counties.
- Kyle Friesen, a stone fruit farmer in Fresno County.
- Jeff Spomer, a stone fruit farmer in Kings, Fresno and Tulare Counties.
- Matt Jackson, a stone fruit farmer in Fresno County.
- Vernon Peterson, a stone fruit farmer in Tulare and Fresno Counties.
- Mike Jackson, a stone fruit farmer in Tulare, Fresno and Kings Counties.

Each of the survey recipients was guaranteed answer-anonymity prior to filling out the survey.

Summary

With the results of each questionnaire, a compilation of the answers will be formed to discover where a successful hail cannon advocacy program may be implemented. These answers will help to improve public relations for farmers and their non-agricultural neighbors. There was a comment section placed at the end of each survey, a respondent wrote, "Farmers need to be proactive communicating with neighbors. Cannons should only be started when threat is immanent and stopped as soon as threat passes. Non-Agriculture recognizes the need for protection and will honor respectful use." The respondents view on hail cannons has given light to what is this project is trying to accomplish. By forming an aggregate of the farmers' responses, a plan will be developed to capture this attitude towards hail cannon usage.

Chapter 4

Results and Discussion

The farmers were polled using a simple questionnaire. The farmers were to identify the number of hail cannons they own and use on an annual basis. The results are listed in Table 1. The majority of the farmers employ 1 to 2 hail cannons. It is important to note that one of the farmers indicated the use of 10 or more hail cannons. This can be explained as a function of the size of the farming operation. A hail cannon should be able to provide crop protection for approximately 190 acres.

Table 1. Responses: Number of hail cannons used annually.

Cannons used	Responses
0	1
1-2	4
3-5	0
6-9	0
10+	1

N=6

All of the questionnaire recipients who owned hail cannons, n=5, were to establish how many times each cannon was used annually. The results are located in Table 2. The majority of the farmers stated that the hail cannons would be used 3-5 times throughout the period of a year. One farmer indicated that he would use the cannons anywhere from 6-9 times during the year,

this could be explained as a general precaution or that this farmers location is susceptible to hail storms. The results show that most farmers expect to use their cannons from 3-5 times, but it is important to state that it is possible to have more than five storms in a year.

Table 2. Responses: Number of times hail cannon operated annually.

Cannon usage	Responses
1-2	0
3-5	4
6-9	1
10+	0

n=5

All of the farmers in the survey who utilize hail cannons during a storm concluded that they haven't received significant hail damage with the cannons being operational. Table 3 shows the results of the number of farmers who have had significant hail damage while utilizing hail cannons. Note that there could have been some hail damage, but nothing extreme enough to be labeled as significant.

Table 3. Responses: Significant hail damage while using hail cannons.

Yes	No
0	5

n=5

The farmers who use hail cannons were asked how long the hail cannons might be operational during a typical storm. Table 4 shows the results. The results varied from 40% saying less than 15 minutes, 40% saying 16-30 minutes and 20% saying 31-45 minutes. The majority of farmers stated that most storms would pass under 30 minutes. This isn't a concrete statement, with weather variables coming into play, storms could last upwards of 30 minutes but in the experience of these farmers, they agree that it is typically less than 30 minutes.

Table 4. Responses: Time length for a cannon during a storm.

Time	Responses
Under 15 minutes	2
16-30 minutes	2
31-45 minutes	1
46-60 minutes	0

n=5

Positive relations with neighbors are important to keeping the hail cannons operational. Table 5 shows the results of how many farmers have attempted to notify neighbors before operating cannons. 80% of farmers agreed to have informed neighbors in some method before operating their cannons. Some farmers who have not notified neighbors may be in an extremely rural area, which makes it difficult to locate neighbors that may be affected by the noise emitted.

Table 5. Responses: Attempting to notify neighbors before operating cannons.

Yes	No

4	1

n=5

In a general sense, the farmers who use hail cannons were asked what the most likely means of notifying neighbors would be if they were to do so. The results are shown in greater detail in Table 6, all of the answers were directed towards a personal statement, either through the phone or by word of mouth. The best notification seemed to be through word of mouth, where a farmer would mention it to a neighbor, and that neighbor would spread it around. Now that the cannons have been in operation for several years, neighbors can guess that when hail clouds are present, they can expect that hail cannons will be in use. Although a notification is always a hospitable thing to do, showing the neighbors that the farmer is trying to be respectful.

Table 6. Responses: Most likely/reasonable means of notifying neighbors before operation.

Medium	Responses
Radio broadcast	0
TV broadcast	0
Mass text	1
Word of mouth	1
Phone call	3

n=5

Investing in a hail cannon may run upwards of $40,000. Farmers were asked if this significant investment has limited hail damage enough to justify the purchase of each cannon.

Results are shown in Table 7. All of the farmers who answered, stated that investing in their cannon(s) has been worth the investment. It is important to estimate the coverage and price of a cannon for one year and compare that to other means of hail protection such as hail insurance. One hail cannon has the potential to cover 190 acres (Wimer, 2008). While hail insurance coverage can run upwards of $1000 for a single acre. Not only does the hail insurance cost exponentially more for coverage, but the jobs lost when fields go un-harvested have severe third party implications.

Table 7. Responses: Has investing in a hail cannon has limited your crop damage.

Yes	No
5	0

n=5

Reliability is a major concern if the cannons are to be operational. The farmers who utilize the cannons were asked if they ever have had technical difficulties with their cannons or if they have misfired in the past. Table 8 displays the results. 60% of cannon users in the questionnaire stated that they have not had problems with the cannons misfiring, but 40% said that they have. Whether it is a user error or mechanical error was not specified.

Table 8. Responses: Has your cannon ever misfired due to technical difficulties.

Yes	No
2	3

n=5

Government regulations are always a concern to any new farm equipment, but especially in the case of hail cannons where they can reach 121 decibels (Fienen, 2008). Table 9 shows the responses of how many questionnaire recipients were concerned about possible regulations on cannons. Four of the five that answered said that they were concerned about regulations.

Table 9. Responses: Concern about possible regulations on hail cannons.

Yes	No
4	1

n=5

The biggest threat to cannons would be if they became illegal farm tools. Table 10 displays the farmers concern about hail cannons becoming illegal farm tools. Three of the five farmers said they were worried about the hail cannons becoming illegal. It is important to note that these farmers are widespread throughout three counties. The two farmers that are not concerned may hold ground in Kings county where the cannons have been addressed, "Hail cannons are identified as crop protection equipment and are not specifically regulated sound uses in Kings County" (Kings County Planning, 2011).

Table 10. Responses: concern about hail cannons becoming illegal farm tools.

Yes	No
3	2

n=5

All of the questionnaire recipients were asked if they had personally had significant hail damage in the past. Table 11 displays the results. All of the farmers were unanimous in stating that they have had significant hail damage in the past. It is important to note that although they have had hail damage before, that most farmers purchase property that is spread out in case of such occurrences, in an attempt to have some of the storm miss their property.

Table 11. Responses: Significant hail damage in the past.

Yes	No
6	0

N=6

With an extensive array of farming practices now being asked about their hail coverage, the question was what they thought to be the most affordable medium of hail protection. Table 12 displays the results. The farmers were asked to check all that apply, everyone answered that they thought hail cannons were the most reasonable means of hail protection, even the farmer that does not utilize the cannons. Although The responses show that there was one farmer that thought that hail insurance was an affordable medium of protecting his crops from the damages hail present.

Table 12. Responses: What is the most affordable hail protection.

Medium	Responses
Hail insurance	1

Hail cannons	6
No protection	0
Shade cloth	0

N=6

In a general sense, the farmers were asked how many storms could potentially devastate a crop annually. Table 13 displays the results. The most common answer was 3-5 storms, while two said that 1-2 storms were possible and one said that 6-9 storms were not out of the question. It is important to realize that certain areas may hold different weather systems that could make hail more prevalent in certain areas.

Table 13. Responses: Number of storms that could potentially devastate a crop.

storms	Responses
1-2	2
3-5	3
6-9	1

N=6

An important question to ask is if the cannons are actually working. The questionnaire recipients were asked if they had seen visual damage to neighboring crops that were not under the protection of hail cannons. Table 14 shows the results. All six of the farmers agreed that they have seen hail damage to neighboring crops that were not under hail cannon protection, while the fields that were under protection had not been damaged.

Table 14. Responses: Visual damage to neighboring crops that weren't using cannons.

Yes	No
6	0

N=6

Cost-efficiency is a great way to highlight methods of farm practices that should be utilized. The questionnaire recipients were asked if, in their opinion, are hail cannons the most cost-efficient way to protect crops from hail damage. Results are displayed in Table 15. All of the farmers agreed that they felt hail cannons were the most cost-efficient way to protect crops from hail damage. Even the farmer who does not utilize hail cannons felt that they are the most affordable way to protect crops from hail damage. It is important to note that even though the farmer felt this way, he might be too close to city limits to feel comfortable using hail cannons or possibly is just comfortable with using hail insurance as a medium of hail protection.

Table 15. Responses: Hail cannons are the most cost-efficient way to protect crops from hail damage?

Yes	No
6	0

N=6

Strategy

Composing the SWOT analysis survey into an aggregate has given proof through the farmers' answers that the hail cannons are working to prevent the damages hail presents to the commercial fruit industry. The survey wasn't a complete SWOT analysis, it was a survey developed with a SWOT analysis in mind. Utilizing the strengths, weaknesses, opportunities and threats categories of a SWOT analysis into a survey to develop a well-rounded survey. All of the questionnaire recipients reported to have suffered significant crop damage prior to cannons and that they have limited, if any, crop damage since they implemented the cannons as a tool to fight the weather. The recipients were also unanimous in stating that hail cannons were the most affordable crop protection against hail, in comparison to hail insurance, no hail protection, shade cloth protection and using a plastic cover for hail protection.

The issue preventing hail cannons from being fully appreciated by farmers, as well as community members, is the noise that is emitted by the cannon every 4 seconds during a storm. According to four of the five survey recipients who utilize hail cannons, a positive aspect of this noise is that if the cannons are used only three to five times a year for under 30 minutes, although the cannon will sound off every four to six seconds, the cannons are not used very often annually. Although a typical cannon will face an average of three to five storms a year, the farmers have not seen hail damage while using their cannons properly. While on neighboring farms, survey recipients reported that they all had seen visual damage to their neighbors' crops that were not under the cannons' protection.

The most obvious weakness reported in the questionnaire were that only two of the five hail cannon users had attempted to dilute the sound or direct the sound upward

instead of outward. This is considered a weakness because without farmers attempting to dilute the sound, public perception of farmers is lessened, makes them seem to not care. Another weakness was that, on occasion, a hail cannon would accidentally be misfired due to technical difficulties. Misfiring cannot taint the hail cannon image. The cannons need to be a well-maintained machine that is used only when the threat is imminent then turned off after the threat passes. According to George Jackson, a farmer on the expert panel, "The easiest way to dilute the sound is to place a cannon in the field, that way the sound is broken up by the trees instead of being next to a road where the sounds may travel easier." (Jackson, 2012). Jackson has placed all of his cannons within his fields so that the trees break up the noise.

There are several threats that are a concern to the majority of the questionnaire recipients. The main concern is the regulations that may follow the hail cannons in the future. If the regulations placed on the hail cannons are too strict, they will be unfeasible. The secondary fear, which follows heavy regulation, is the possibility of outlawing these useful tools. Both scenarios can be avoided by keeping good relations with neighbors and alerting them before the cannons are put into use. The majority of the questionnaire recipients reported that the best medium of alerting neighbors of hail cannon usage would be to give them a phone call. The option of utilizing a radio announcement and/or TV announcement were disregarded.

Summary

The future is uncertain for hail cannons and it is imperative for farmers to maintain positive relations with their community members in order to continue to use hail cannons as a method of deterring hail damage. In order to maintain positive relations, farmers need to be open with neighbors by alerting them before operating the cannons. Making a few phone calls will show neighbors that farmers are trying their best to maintain their crops while respecting their neighbors' privacy. The phone call should include the day that the cannons will be operational and that they will be turned off as soon as the threat passes. An apology for the inconvenience would be helpful, but not necessary. The community members should know that farmers respect their desire to live in a quiet rural community but also recognize that the crops produced in the area need to be protected. Farmers should also be proactive beyond simply alerting their neighbors. Hail cannons are an innovative solution to protecting crops from hail, by finding alternative solutions to diminish the sound produced by the cannons, they may become more socially acceptable. Makeshift barriers have been placed above the cone of the cannon in some farming operations in order to project the sound waves vertically instead of horizontally. By trying to expand on that concept, hail cannon manufacturers may invent a more practical method of diluting sound that can be utilized in the future.

Chapter Five

Summary, Conclusions and Recommendations

Although hail cannons are not a new technology, they have improved drastically over the past 30 years. Hail cannons do not destroy hail; they merely send a shock wave into the storm clouds that prevents the hail from forming. The area potentially protected by one hail cannon is approximately 190 acres. Depending on the size of individual farming operations, hail cannons should be dispersed evenly throughout the acreage instead of trying to cover all of the area with one hail cannon. Areas with a higher hail risk should be concentrated on - such as the end of the field where the storm is anticipated to enter. The hail cannon will be rendered useless if unable to disrupt the growth cycle of hail prior to arrival. It is important to note that hail cannons are not scientifically proven machines, but have been heavily utilized over the past several years to prevent hail damage because producers have had success in using them.

Summary

This project was originally intended to develop a strategy to protect farmers from losing their right to utilize hail cannons. It has evolved into a strategy to coexist with neighbors to ensure the future of hail cannons. There is little published information about hail cannons, so in order to form recommendations, a survey based on the principles of a SWOT analysis was conducted and given to a panel of experts consisting of George Jackson, Brent Jackson and John Diepersloot. These farmers have been farming for over 25 years each. They have seen the damages hail presents and know that it is a silent killer to any farming operation. They

recognized the fact that hail cannons are noisy, but agreed that there should be a resolution within the farming community to promote good relations with neighbors. After the panel of experts gave their recommendations, a questionnaire was devised and given to six farmers. These farmers consisted of large-scale, small-scale, organic, traditional, hail cannon users, non-users, young and old farming operations. The farmers were guaranteed anonymity with their answers; they represent the types of farming operations throughout Tulare, Kings and Fresno Counties. The answers were put into an aggregate and exemplify how the farmers felt, and what they have seen within their communities and the implications of hail damage. The questionnaire, including the aggregate, is available in chapter four. Along with the results of the questionnaire, a copy of this project will be offered to the community and to farmers who would like to see the results of the questionnaire.

Conclusions

The conclusions offered explain the statements about the project that have been generated as a direct result of investigation. These results model the facts generated through the questionnaire. The future recommendations are a strategic plan for the farmers to implement to increase and standardize hail cannon usage while improving community relations. The recommendations will be solely opinion but will be in line with the facts generated from the questionnaire.

As described in Chapter Four, the questionnaire was explained individually to deliver facts about hail cannons and what farmers have found out by utilizing hail cannons or have witnessed about hail cannons. There have been several facts discovered through the

questionnaire that have never been discussed or compiled to prove. Although it is unable to be proven scientifically, all farmers - including those who do not utilize hail cannons for protection - were unanimous that hail cannons work and are the most cost efficient and affordable method of deterring hail damage from crops. All of the farmers that answered the questionnaire who have invested in hail cannons have limited their crop damage and have stated that they have seen damage to neighboring farms that are not using hail cannons. This statement alone shows that farmers are going to continue using the cannons unless government intervention occurs, such as regulation or disbandment.

Government interaction, whether it would be regulatory or as extreme as disbandment, has the farmers worried; although there was more concern shown about regulations for hail cannons than the possibility of hail cannons actually becoming illegal. Kings County Planning Commission has specifically stated, "Hail cannons are identified as crop protection equipment and are not specifically regulated sound uses in Kings County" (Kings County planning, 2011). Although Kings County stepped forward and supported the farmers' ability to protect their crops, farmers showed more concern about regulation than hail cannons becoming illegal.

Most of the farmers stated that they have notified neighbors in the past to let them know that there would be hail cannons operating in the nearby future. The majority of the farmers said that a phone call or word of mouth was the best medium of notifying neighbors of hail cannon usage. Radio and/or TV announcements were disregarded.

Recommendations

The problem is that there is a lack of education about the hidden implications of hail damage and a lack of cooperation between farmers and their communities about the noise pollution that the cannons emit. Combining these two elements will result in a hail cannon advocacy strategy that has not previously existed. This lack of an advocacy strategy has been identified as the main problem to address in regards to operating hail cannons for agricultural practices. To address this problem, farmers need to be proactive, displaying courtesy, consideration and discretion prior to operating cannons.

Traditionally, the agricultural field is better at dealing with problematic situations after they occur. Breaking the mold and devising a plan prior to anti-hail cannon efforts, farmers should band together and find a strategy that best suits their needs. Part of the strategy needs to include the farmers presenting hail cannon information and statistics to city and county meetings. By showing lawmakers that hail cannons are working will be important for the use of hail cannons in the future. Being courteous to neighbors is a lost trait in today's society. It is important that, as agricultural members in society, agriculturalists remember that courtesy should be a priority and not disregarded. By respecting boundary lines and proper placement of cannons, neighboring homes and communities will see that the farmers are doing what they can to avoid noise pollution. Notifying neighbors prior to hail cannon use will display consideration that is priceless when it comes to keeping positive relations. If the neighboring farms or homes that may be affected by the noise emissions see that the farmer is doing his/her best to respect their privacy, they will respect the farmer and his utilization of hail cannons. It is recommended to engage in face-to-face interaction with neighbors to notify them when hail cannons will be used, but if that solution is impractical, the questionnaire results stated the best method of notifying neighbors would be through a phone call or word of mouth.

Not all of the community members will be reached or will have sympathy for the farmers' attempt to protect their crops. It is recommended that farmers be ready to deal with negative press, and have a plan to deal with legal controversy - whether that be in the courtroom or city council meeting. Being prepared to address such incidents could make or break hail cannon usage in different areas.

The hail cannon image is one that can be easily damaged. In order to keep hail cannons at a tolerable level of use, it is the farmer's responsibility to never abuse the use of hail cannons. Hail cannons have shown that they are a viable resource to protect crops from hail damage. Although the noise is excessive, it is short lived and can be tolerated. With the efforts that farmers have made and should continue to improve upon, there is no reason why rural neighbors and farmers should not be able to coexist in harmony. To ensure that happens, farmers should work on building relationships with their neighbors and let them know when the hail cannons will be used. Taking that a step further, positive relationships take work, by dropping off some fruit as a sign of good intention, neighbors will see that farmers have good intentions in their practices and that even with the noise emitted, that they are not trying to be an inconvenience.

Works Cited

Connecticut Health Foundation (n.d.). *The Health Advocacy Toolbox*. Retrieved May 24, 2012, from http://www.cthealthpolicy.org/toolbox/Default.htm

Eggers, M. (2011, January 20). How Hail Cannons Work. *Hail Cannon Manufacturer*. Retrieved November 9, 2011, from http://www.hailcannon.com/how.html

Fienen, A. D. (2008, March 25). Sound Waves. *The Kingsburg Recorder*.

Fruit and nut crops. (2011, October 28). *California Department of Food and Agriculture*. Retrieved November 9, 2011, from Http://www.nass.usda.gov/statistics_by_state/California/Publications/california_Ag_statistics?2010cas-Frt.pdf

Kings County Planning (2011). Non-Transportation Noise. *Noise Element*. Retrieved November 15, 2011, from http://www.countyofkings.com/planning/2035%20draft%20general%20plan/Final%20Docs/08%20Noise%20Element.pdf

University of Arkansas School of Law (n.d.). States' Right-to-Farm-Statutes. *The National Agricultural Law Center*. Retrieved November 14, 2011, from http://www.nationalaglawcenter.org/assets/righttofarm/california.pdf

U.S. Department of Commerce Industry Report. (2008, June). *International Trade Association*. Retrieved November 9, 2011, from http://trade.gov/td/ocg/report08_processedfoods.pdf

Wimer, N. (2008). Hail Suppression Systems. *Newton Systems International*. Retrieved November 9, 2011, from http://www.newtonsystemsinternational.com/

Appendix A- Hail Cannon Questionnaire

Name:_____

Occupation:_____

County:_____

All information gathered throughout this survey is guaranteed anonymous; your name is needed to display who was involved in the survey but not what you answered. Answers will be aggregated to show: strengths, weaknesses, opportunities and threats that hail cannons face today. Upon completing the survey, any comments regarding hail cannons or possible strategies to gain a positive public perception on the use of hail cannons will be helpful.

1) How many hail cannons do you run annually?

[ ] 1-2
[ ] 3-5
[ ] 6-9
[ ] 10+

2) If 0, skip to question number 15.

3) How many storms will the typical cannon be used against in an average season?

[ ] 1-2
[ ] 3-5
[ ] 6-9
[ ] 10+

4) Have you had significant hail damage while using hail cannons?

[ ] Yes
[ ] No

5) If yes, please check the boxes below that apply.

[ ] surprise storm
[ ] night time hail
[ ] cannon ran out of acetylene
[ ] cannon was turned on to late
[ ] operator error
[ ] cannon malfunction
[ ] other, please briefly explain.

6) What is the approximate operational time length for a cannon during a storm?

[ ] 15 minutes or less
[ ] 16- 30 minutes
[ ] 31-45 minutes
[ ] 46-60 minutes
[ ] 1 hour or longer

7) Have you attempted to notify neighbors prior to operating hail cannons?

[ ] yes
[ ] no

8) In your opinion what would be the most likely/reasonable means to notify neighbors prior to operating hail cannons?

[ ] Radio announcement
[ ] TV announcement
[ ] Mass text message alert
[ ] Word of mouth
[ ] Phone call

9) Have you attempted to dilute the hail cannons sound in any way?

[ ] yes
[ ] no

10) Have you found investing in a hail cannon has limited your crop damage?

[ ] yes
[ ] no

11) Has your cannon ever misfired due to technical difficulties?

[ ] yes
[ ] no

12) Are you concerned about possible regulations on hail cannons?

[ ] yes
[ ] no

13) Are you concerned about hail cannons becoming illegal farm tools?

[ ] yes
[ ] no

14) Have any of your hail cannons been vandalized or destroyed?

[ ] yes
[ ] no

15) Approximately how many years have you been farming?

[ ] 1-5
[ ] 6-10
[ ] 11-15
[ ] 16-20
[ ] 20+

15) Have you had significant hail damage in the past?

[ ] Yes
[ ] No

16) In long-term perspective, what is the most affordable hail protection?

[ ] hail insurance
[ ] hail cannons
[ ] no hail protection
[ ] shade cloth
[ ] plastic cover

17) Approximately how many times a year will a potentially devastating storm affect a crop?

[ ] 1-2
[ ] 3-5
[ ] 6-9
[ ] 10+

18) Have you seen visual damage to neighboring crops that were not using hail cannons?

[ ] yes
[ ] no

19) On average, what would the hail insurance rate be per acre, based on $100 of coverage.

[ ] 4%-6%
[ ] 7%-9%
[ ] 10%-12%
[ ] 13%-15%
[ ] 16% or higher

20) Do you believe cannons are the most efficient investment to protect crops from hail damage?

[ ] yes
[ ] no

21) Have you lost public standing/popularity outside of agriculture due to your use of hail cannons?

[ ] yes
[ ] no

22) Do you have land that is leased that specifically prohibits the use of hail cannons?

[ ] yes
[ ] no

23) Do you believe that farmers have the right to protect their crops?

[ ] yes
[ ] no

Comments or ideas:_____
_____
_____