A DEMAND ANALYSIS FOR THE NEW DOW AGROSCIENCES INSECTICIDE,
SULFOXALFLO, AMONG CALIFORNIA PEST CONTROL ADVISORS

Presented to the
Faculty of the Agribusiness Department
California Polytechnic State University

In Partial Fulfillment
Of the Requirements for the Degree
Bachelor of Science

by
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June 2012
ABSTRACT

Sulfoxaflor, the new Dow Agrosciences insecticide, is within months of United States EPA registration. This is a product that provides both “knockdown” and residual control of a variety of “piercing and sucking” insects that affect many crops grown in California. The research for this project was done in order to determine if California pest control advisors (PCAs) have a real demand for sulfoxaflor for pest management within the following crops of interest: cotton, tomatoes, peppers, leafy vegetable and cole crops, strawberries, citrus crops, almonds, and walnuts. The data was gathered through the in-depth personal interview of 86 California PCAs located all throughout the state where the specific crop segments are produced. The interviews included questions about crop-specific acreage quantities, pests treated for, and materials used in the management of these pests. After each interview, the PCAs were then given a technical presentation on sulfoxaflor after which they were given a survey asking whether or not they would use sulfoxaflor in their operations and what price they felt it should be sold for. The responses of all the interviewees were gathered and averages were taken for quantifiable responses and frequency distributions were generated for qualitative responses. The analysis revealed that a demand for sulfoxaflor indeed exists within the cotton, tomato, pepper, leafy vegetable and cole crop, strawberry, and citrus crop industries but not in the almond and walnut industries. This is consistent with the hypothesis that was formulated because of the low impact that sulfoxaflor’s target pest have on almond and walnut production. The implications of the study are that Dow Agrosciences should market sulfoxaflor heavily in California, especially in the leafy vegetable and cole crop industries as well as the strawberry industries because of the very high production values and low pest tolerance associated with these crops
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INTRODUCTION

An English political economist and reverend by the name of Thomas Malthus was among the first thinkers to express concern about population growth and its effects on society. His theory was that the world’s population was growing at a rate so great at which, eventually, it would be impossible to produce enough food to sustain itself (Malthus 1798). This belief was a source of great scandal and fear to the people of his time. However, since Malthus coined his theory approximately 200 years ago, the world agriculture industry has continued to prove him wrong. This is because among the factors that Malthus failed to consider before drawing his conclusion was the ingenuity of the human race, which has progressively given rise to technology promoting increased agricultural productivity.

Companies like Dow Agrosciences are in the business of bringing human ingenuity to fruition as they tackle today’s most pressing challenges facing agricultural production. Their products are designed to take the issues faced by the growers of the world’s food and fiber head on, and to increase the efficiency and success of their operations. The new Dow Agrosciences product, sulfoxaflor, is the company’s latest example of a cutting-edge chemistry, aimed at targeting the “piercing and sucking” pests that are especially a major issue in California’s high-valued specialty crops.

The sulfoxaflor line of products under the brand names Closer and Transform will soon be one of Dow Agrosciences’s newest additions to its list of chemistries that have helped world agriculturalists maintain insect control since 1989. Sulfoxaflor, with its revolutionary mode of
action, will be used for the rapid knock down and long term residual control of “piercing and sucking” insects such as aphid and lygus that have continued to plague the growers of great varieties of crops. This report is designed to provide information regarding certain key crop segments that Dow Agrosciences has come to view as possible markets for the sulfoxaflor line and to verify and test the marketing assumptions regarding them.

Statement of the Problem

The crop segments that Dow Agrosciences has come to view as possible markets for sulfoxaflor are cotton, tomatoes and peppers, citrus, almonds and walnuts, leafy vegetables and cole crops, and strawberries. All are produced commercially within the state and represent high production values. Is there truly an economic demand for sulfoxaflor to provide insect pest control for each of these targeted crops?

Hypothesis

A majority of greater than 50% of surveyed California pest control advisors that work extensively with one or more of the crops of interest will be willing to treat at least 50% of his or her acres with sulfoxaflor with the exception of the pest control advisors that work with almonds & walnuts.
Objectives of the Study

1. Provide Dow Agrosciences with key information that can be valuable in the development of the product-launch strategy for sulfoxaflor
2. Define which crops sulfoxaflor will be most utilized in
3. Obtain data regarding the prices at which sulfoxaflor can be expected to sell for
4. Compile information regarding the industry’s use and opinion associated with competing products

Significance of the Study

California is one of the most unique and optimal states for agricultural production. According to the United States Department of Agriculture (2011), the Golden State alone is responsible for 49% of the nation’s vegetable and melon production and over half of the fruit and nuts produced in the country. People often do not realize the scope of agriculture and how much it affects their everyday lives. The annual per capita consumption of fresh vegetables in the United States is 170 pounds/year and 270 pounds/year for fresh fruits and nuts (Tolomeo et al. 2011). What even fewer are aware of are the inputs that are required for production of this proportion.

A highly productive agricultural system is essential for sustaining the demand for the state’s high-quality produce. This means that pest damage to elevated degrees simply cannot be tolerated. According to the Environmental Protection Agency (2011), in 2007 12.5 billion dollars were spent in the United States on pesticides, 4.3 billion of which were spent specifically
on insecticides. Insecticides play a very important role in food production in this nation because of the very large-scale nature of the American agricultural industry. In 2007, approximately 355,000 farms were using insecticides in their operations. Because the usage of insecticides is so extensive, it is extremely important to ensure that these products are used as safely as possible. Many insecticides that have been classified as restricted use products, like some organophosphate insecticides, are being phased out and substituted with modern chemicals that are not such a threat to human health (Kogan 1998). Between 2000 and 2007, organophosphate insecticide usage has decreased by nearly 50% (Grube et al. 2011).

Sulfoxaflor has been developed to provide excellent control of some of the most damaging pests of California’s high-valued crops. Its new mode of action provides for rapid knock-down activity and long-term residual efficacy which can reduce the need for frequent chemical applications (Babcock et al. 2011). Aside from reducing the environmental impact of insecticides, this can lead to reduced input costs which can translate to lower food prices at the grocery stores for consumers. The revolutionary chemistry behind sulfoxaflor makes it possible for the product to be as effective as it is, while exhibiting minimal impacts on non-target organisms (Yuanming et al. 2011). Sulfoxaflor, once introduced into California agriculture production, can make a great impact on an industry that already plays such a dynamic role in the lives of the consumers of California’s fruits, nuts, and vegetables.
Chapter 2

REVIEW OF LITERATURE

Addressing the Implications of Population Growth

The challenges faced by world agriculture become more intense with every day that passes. As the human population grows, so too does the demand for the world’s resources. It is now estimated that within the next 50 years, the world may see its human population double (Pimentel et al 1992). A population increase of this magnitude may very well put a crippling strain on the world’s food and natural resource supply if nothing is done. Currently there are approximately 1 to 2 billion malnourished people in the world. These numbers will only increase if food production does not accompany the growth of the world population. As urban spaces expand and the human population continues to increase, less and less space becomes available for food production. Cropland is the source of 99% of the human diet, and a shortage of this precious resource can only be overcome if actions are taken to dramatically improve the productivity of the little remaining cropland (Pimentel et al 1992).

Methods for managing this situation must be focused on the conservation and efficient utilization of the world’s resources especially in regards to land, water, and energy. A highly productive and sustainable agricultural system is instrumental in fulfilling greater food demand while land availability decreases. An approach that does not solely rely on technological advancements, but couples scientific innovation with wise and efficient practices can yield the greatest results (Pimentel et al 1992).
Farm productivity must continue to respond to the pressure of population rise. Insecticides such as sulfoxaflor are crucial to agriculture’s ability to sustain the needs of the world’s population because they help ensure that the greatest possible amount of food can be extracted from the land. In this day and age, the world cannot afford to lose substantial crop yields to insects and other pests. The future relies on increasing education and developing safe and effective tools that can lead to greater output, less waste, and fewer hungry humans.

The Rise of Pesticide Usage in American Agriculture

According to the FAO (2011), total world agricultural production has grown over 140% within the past 50 years despite the decreases in rural cropland due to urban sprawl. This demonstrates a strong correlation with the advent of large scale pesticide application which began in the early 1900s. As innovations such as power-driven sprayers and aerial application technology became available, more and more acreage began to adopt the practice of pesticide usage. By the 1950s the major field crops of the United States such as corn and soy beans accounted for the majority of pesticide utilization (Hall 1964).

In 1945 DDT became available to the public for civilian/agricultural use. This sparked a massive transition in the American agricultural industry toward the reliance on chemical control of agricultural and domestic pests that had historically posed great threats to crops and human health. However, this was all taking place in an era when there was still little known about pesticides in relation to modern understanding. The period from the late 1940s through the mid-1960s has been called “the dark ages of pest control (Kogan 1998).” Farmers would spray DDT according to calendar schedules, school children were lined up and deloused by being sprayed
with DDT, and this use of the chemical was continued until it eventually began to lose
effectiveness. At first it was thought that applying more of the insecticide would help fix the
problem, but 100% control was never achieved. This phenomenon eventually led to the rise of
revolutionary research in insecticide resistance and triggered the extensive developments of
numerous new pesticides throughout the 1950s and 1960s (Hall 1964).

Emergence of Insecticide Resistance

Insecticide resistance is one of the greatest challenges facing modern agricultural
production today. Between 1958 and 1970 alone, the number of known insecticide-resistant
species increased from 35 to 104 (Brown and Pal 1971). Among the insecticides being resisted
at the highest levels include the widely used, broad spectrum organophosphates. Insecticide
resistance poses a problem from many angles because it typically leads to higher rates of
chemical application that can result in negative health and environmental impacts and can also
contribute toward the rise of “super resistant” pest populations.

It has been determined that insecticide resistance arises from a mutation in the genetics of
individuals within an insect population that becomes manifested as a result of some type of
selection pressure from insecticides (Brown and Pal 1971). The standard methods for testing this
conclusion include mathematical/computer modeling that can accurately simulate the effects of
natural occurrences in the insects’ environment. Continued experimentation demonstrates that in
a population of insects, the vast majority of the individuals are susceptible to the insecticide and
a very small minority are resistant. After prolonged application of the insecticide, susceptible
individuals are exterminated, leaving the few resistant individuals to reproduce and build a resistant population (Denholm 1992).

Since detection of insecticide resistance first began, great efforts have been made to combat it. Early attempts were futile. But as time has gone on, resistance management practices have risen to a whole new level of sophistication and are actively in use nearly everywhere large-scale agricultural production takes place. Chemical manufacturing companies like Dow Agrosciences are continually pursuing new modes of action that can be used to rotate with existing chemistries in order to keep insecticide resistance at manageable levels. Increasing the number of effective options for treatment reduces the risk of resistance development because the likelihood that an insect will be resistant to every different chemical that it is targeted by is very low (Denholm 1992).

**Integrated Pest Management**

Before the age of large-scale industrial farms and broad spectrum pesticide usage, farmers engaged in pest control that was focused on the biology of the various pests detected and the implementation of cultural practices that could help manage pest damage from a culmination of multiple strategies. The term “pest control” was perceived as “the set of actions taken to avoid, attenuate, or delay the impact of pests on crops or domestic animals (Kogan 1998).” As time went on, the rise of pesticides lead to the ability for larger amounts of land to be treated with comparable efficacy. As a result, methods for control utilized in the past which stressed natural means of pest management became viewed by many as obsolete. As knowledge of
pesticides increased, however, the importance of nature’s role in pest control resurfaced and the prevailing strategies of chemical means of control began to be reconsidered.

The integrated control concept was triggered by the great pitfalls of the single-dimensioned management model of pesticide application as the only means for control. “Resistance, resurgence of primary pests, upsurges of secondary pests, and overall environmental contamination” associated with the widespread use of organosynthetic insecticides were the primary factors that contributed to the rise of a new pest management system (Kogan 1998). Integrated pest management (IPM) was conceived as a system in which pest control decisions were made using an approach that included various methods of control while taking into consideration ecological principals as well as social and economic factors. This model considers biological and chemical control as “supplementary to one another as the two edges of the same sword,” and holds that chemical application for pest control should be executed as little as possible in order to avoid interfering with the processes of pest control that occur naturally (Kogan 1998).

Carrying out IPM involves several steps, which, when executed properly, should provide the most positive and effective means of pest control (Kogan 1998). The first step is scouting or monitoring the site. In this step, present pests should be detected and quantified. The next step is identification. Identification of the pest is very important so that they may be clearly differentiated from beneficial organisms. Identification should then be followed by a pest situation assessment where decisions on how to control the pest are made depending on the scope of the damage. The next step is implementation. During the implementation step, the pest control decision is executed in a timely and appropriate manner. The final step of IPM is evaluation. The evaluation is performed in order to determine whether the actions taken were
effective and to identify any problems that may have affected the strategy. Following the steps of IPM maximizes the effectiveness of pest control by incorporating both biological and chemical methods so that an important balance is maintained that allows for the control of pests while maintaining biodiversity, sustaining the effectiveness of chemicals used, and decreasing environmental contamination (Kogan 1998).

Organic Agricultural Production

Modern agriculture has moved in the direction of pest control through the use of synthetic chemicals partially as a result of the shift experienced by the agriculture industry from small scale production on many farms, to very large-scale production on relatively few farms. However this direction has become a source of rising concern regarding the long-term health implications associated with the consumption of food treated with pesticides and has brought about a widespread movement for organic agricultural production. Organic production methods stress the implementation of biological practices for crop production and do not incorporate the use of synthetic pesticides (Letourneau and Goldstein 2001). Although biological control methods for agricultural pest suppression do not pose significant risks for human health or environmental degradation, the ability for these organic practices to effectively result in satisfying the ever-increasing human demand for agricultural products is questionable.

In an experiment conducted by Letourneau and Goldstein (2001), pest damage and arthropod community structure in conventionally farmed tomatoes were compared to that of organically farmed tomatoes. The study consisted of obtaining random samples of pest damage and arthropod populations on a total of 18 commercial tomato farms located in California’s
central valley. Of the 18 farms sampled, 9 contained conventionally farmed tomatoes and 9 contained organically farmed tomatoes. The samples were taken from the interior of the fields in order to avoid possible contamination associated with edge effects. After data collection and analysis, the results demonstrated that pest damage did not differ significantly between the two methods of tomato production but insect populations were indeed higher in the organically grown farms (Letourneau and Goldstein 2001).

The use of insecticides is typically designated to be an option of last resort when all preceding steps of IPM protocol have already either been exhausted to no avail, or determined to be too economically burdensome to execute on a very large scale. Although biological control methods are effective in controlling pests, the effort exerted to implement these measures is substantial. In smaller scale production, biological control methods can indeed be justifiable as is demonstrated by the success seen in organic farms. However, it is very important to note that organic farming operations only represent 1-2% of California agriculture (Letourneau and Goldstein 2001). The remaining 98% of agricultural production requires the use of pesticides when necessary to ensure that all who demand agricultural produce are receiving quality food at affordable prices.

**Technical Overview of Sulfoxaflor**

Sulfoxaflor, a new insecticide discovered and produced by Dow Agrosciences, is in its final stages of development for all major crop groups. Dow Agrosciences has already submitted an application for sulfoxaflor’s registration to the United States Environmental Protection Agency and anticipates full registration for California in 2014. Sulfoxaflor is part of chemical
class of insecticides known as the sulfoxamines, a group that has not previously been associated with crop protection chemistries. It exhibits a mode of action that is unique among all other insecticides as it kills target pests by interacting with the insects’ nicotinic acetylcholine receptors in a manner which is contrasting to that of neonicotinoid insecticides (Babcock et al. 2011).

Sulfoxaflor has the capability to kill insects upon contact and also by ingestion. It is xylem-mobile and is especially effective in controlling aphids, lygus, scales, whiteflies, and a wide variety of other sap-feeding or “piercing & sucking” insects. Because sulfoxflor is novel chemistry, there are no target pests that have resistance to it, including insects that are resistant to insecticides in groups such as carbamates, organophosphates, and pyrethroids (Yuanming et al. 2011). In addition, sulfoxaflor has been found to exhibit no significant impact on beneficial arthropods such as lady beetles, parasitic wasps, and spiders. Tests have also demonstrated that sulfoxaflor does not cause damage to a variety of analyzed crops as no phytotoxicity was observed in vegetative vigor and seed emergence. Most importantly, mammalian toxicology studies have shown that sulfoxaflor, when used according to proposed label rates, poses low risk to humans (Babcock et al. 2011).

Determining an Economic Demand

California’s unique climate makes it a favorable location for the production of a large variety of crops. Among the crops that California is most recognized for are the high-valued specialty crops such as fruit, nuts, and berries. What make these products so special are the environmental and cultural practices that are necessary to produce them effectively. The
products are also very valuable because of the extent to which maintaining their high quality is pursued. Because the demand for these products in terms of both quantity and quality is so high, pesticides play a crucial role in their production. However, pesticides used in markets such as these must fulfill especially high standards because many of the crops that they are applied on are consumed fresh, without being cooked or processed. Nevertheless, California has become a key battleground among chemical manufactures competing in its highly profitable pesticide market.

For a potential good or service to enter into the marketplace, it must first be determined that a demand for it exists (Spence et al. 1976). The same is true for pesticides. A new pesticide should only be marketed if there is a viable economic need for the pest control that it provides. Therefore, if a chemical manufacture that developed a new insecticide to target thrips in citrus were to attempt to market the product in a state like Wyoming, where citrus is not typically produced, it can be assumed that the outcome would not be profitable. However, once a potential market is identified in a different state, there is still no guarantee that the product will be successful. Perhaps the citrus producers in this particular area are completely satisfied with the current products for thrip control or it could be that the price for the new insecticide is simply too high and not economically justifiable. To confidently establish that there is a demand for the insecticide, this type of information must be obtained through the collection and analysis of data.

The In-Depth Personal Interview

Interviews are one of the most common methods for data collection. In many cases, conventional interviews are highly structured and consist of a survey or questionnaire that is
centered on obtaining clear answers to a list of specific questions. This type of interview is typically referred to as a quantitative interview (DiCicco-Bloom et al. 2006). However other interviewing methods that demonstrate less structure can also be effective means of gathering information because they allow for less restricted answers and a generally more open flow of information. Qualitative interviews, for example, are interviews that “seek to foster learning about individual experiences and perspectives on a given set of issues (DiCicco-Bloom et al. 2006).” There are various forms of qualitative interviews but semi-structured qualitative interviews are normally the most widely used interview style for qualitative research projects. These types of interviews typically take place during pre-determined dates, times, and locations and are normally centered on a list of open-ended questions that are prepared by the interviewer prior to the meeting. These interviews are also designed to generate more questions that may arise throughout the course of the conversations. The semi-structured interview should be conducted only one time for an individual or a group and should last a minimum of 30 minutes (DiCicco-Bloom et al. 2006).

The proper execution of an effective semi-structured qualitative interview typically involves several steps. The first step for conducting a quality semi-structured qualitative interview is the selection of interviewees. According to DiCicco-Bloom and Crabtree (2006), the sample of the interviewees should be relatively invariant and share “critical similarities related to the research question” so that the interviews result in the “shared understandings of a particular group.” After selecting the interviewees, establishing rapport is the next step in conducting a successful semi-structured qualitative interview because it enables the creation of a “safe and comfortable environment for sharing the interviewee's personal experiences and attitudes as they actually occurred (DiCicco-Bloom et al. 2006).” Once rapport has been
established, the interview process begins. The goal of the interview is that it produces a “personal and intimate encounter in which open, direct, verbal questions are used to elicit detailed narratives and stories (DiCicco-Bloom et al. 2006).” Gathering information while listening carefully and encouraging the interviewee to speak are the primary tasks of the interviewer.

All interviews are conducted to obtain a better understanding of the interviewee. However the degree to which the interviewee should be understood is different in relationship to the aim of the research and the background of the researcher. Qualitative research aims to achieve a better understanding of something through the exploration of how it is perceived. The qualitative interview allows for the generation of a conceptual body of knowledge that is derived from the investigator’s interpretation and analysis of descriptive accounts of personal experiences shared by the interviewee. This combines the emotions, logic, and ethics of the sample to derive a more complete image of the subject and provide for a deeper understanding of the research question (DiCicco-Bloom et al. 2006).

Pesticides have undoubtedly contributed to revolutionizing world-wide agricultural production. Since the advent of their large-scale application, many positive and negative situations pertaining to their use have emerged which collectively have contributed to a much wider scope of the knowledge and understanding of their functions and capabilities. The new Dow Agrosciences insecticide, sulfoxaflor is designed to be a product that combines the most contemporary information regarding insecticide properties to provide excellent control of the pests impacting many of California’s specialty crops while promoting environmental awareness and resistance management (Yuanming et al. 2011). If this is indeed the case, the findings of this
study will determine just how marketable sulfoxaflor will be in the dynamic California production agriculture industry.
The product launch of the new Dow Agrosciences insecticide, sulfoxaflor is tentatively scheduled for 2014 in California. The primary objective of this study was to assess whether or not there is an actual demand for sulfoxaflor among California pest control advisors (PCAs) that work with the specific crop segments in question. This report was also designed to provide information regarding the approximate prices the PCAs would be willing to pay for sulfoxaflor in terms of grower price per acre, and to identify any existing products that sulfoxaflor would either rotate with or displace. The crop segments in question were cotton, tomatoes and peppers, citrus, almonds and walnuts, leafy vegetables and cole crops, and strawberries. The hypothesis was that an actual demand for sulfoxaflor exists among PCAs that work with cotton, tomatoes and peppers, citrus, leafy vegetables and cole crops, and strawberries and that an actual demand for sulfoxaflor does not exist among PCAs that work with almonds and walnuts.

Procedures for Data Collection

The extensive research required for this report consisted, in part, of obtaining data through the in-depth personal interviews of 86 California PCAs that work with either one or more of the crops of interest. The people interviewed represented several geographical regions of California where the various crops of interest are produced. The interviewees were all employed by either agricultural chemical distribution companies, in-house farming operations, or
self-employed as independent consultants. The interviews took place from July 6, 2011, and September 10, 2011. Each interviewee was contacted prior to the interview to determine the interview’s time and location. All interviews were conducted face-to-face and occurred between normal business hours during weekdays only. The locations where the interviews took place ranged from restaurants, to offices, to farm sites.

The data gathered was a compilation of the responses given by the PCAs regarding questions about the crops they work with, the pests they treat for, and the products they use, as well as the corresponding dosage rates, prices, and product satisfaction levels associated with the materials mentioned. After these initial questions were asked, the PCAs were then given a technical presentation on sulfoxaflor to inform them on the product’s history, technical attributes, mode of action, and anticipated time of product launch. Followed by the technical presentation were questions regarding the interviewee’s opinions on sulfoxaflor’s value in terms of grower price per acre, the percentage of their crops they would elect to treat at these prices, and the products that would be rotated with and/or displaced by sulfoxaflor. A full list of the interview questions can be found in the appendix.

Secondary data utilized in this report included acreage totals from the National Agricultural Statistics Service of the United States Department of Agriculture. The data provides information regarding the crops of interest in terms of their respective acre quantity in production within the state of California during the 2010 growing season. The purpose of this is to create an outlook for the scope of sulfoxaflor’s potential market opportunity if an economic demand for it were to be determined within the state.
MEDAT (Microsoft Excel Data Analysis Tools) was the data analysis package used for processing the gathered interview responses. The quantifiable responses of the interview questions were summed individually and divided by the corresponding number of responses to obtain the arithmetic mean of the answers to each question. Quantifiable responses were produced for the questions pertaining to the quantity of acreage treated, frequency of applications per season, dosage rates of current products, satisfaction ratings of current products, and the value which the interviewed PCAs assigned to sulfoxaflor. Because the interviews were large in number and because the interviewees were selected from various locations within the state where the crops of interest were produced, the average of the responses was determined to be an accurate reflection of the positions held by the industry as a whole.

The qualitative data obtained from the interview questions was analyzed more complexly. The several open-ended questions asked to the PCAs yielded various responses. There were many responses that were similar and others that were very unique. In order to extract a general interpretation of the answers as a whole, the responses were placed into a frequency distribution and analyzed. The most common answers were identified and explained. Among the questions which yield responses were analyzed in this manner were those pertaining to the interviewees’ preferred products for the control of specific pests, the reason why the particular product was favored, their reasons for the prices at which they valued sulfoxaflor, and the product/s that the interviewees indicated sulfoxaflor would most likely rotate with or displace.

Special emphasis was given to the responses associated with the question regarding the acreage percentage of the relevant crops that the PCAs treat for target pests. If the average of the
responses indicated that greater than 50% of the PCAs treat at least 50% of their acres for target pests in cotton, tomatoes and peppers, citrus, leafy vegetables and cole crops, and strawberries and less than 50% of their acres in almonds and walnuts, then the hypothesis would be accepted.

Assumptions

This study assumes that the particular crop segments in question are those that could pose the greatest marketing opportunities for sulfoxaflor. It is also assumed that the prices of pesticides are relatively similar throughout the state. Because sulfoxaflor is designed to control “piercing & sucking” type pests, only economically significant crops in which these types of insects tend to be an issue could justify a potential demand for sulfoxaflor. The sample is assumed to be an accurate reflection of the agricultural pest control industry. It consisted of 86 individuals whose selection requirements were very specific as they are all were licensed PCAs working with one or more of the crops of interest within various regions of the state.

Limitations

Although the methodology of this study could contribute toward assessing whether or not a demand exists for sulfoxaflor throughout the nation as a whole, the crop segments of importance in this study were selected to reflect the potential future for this product in California and do not include other crops in which sulfoxaflor could be marketable that are produced in greater amounts outside the state.
Chapter 4

DEVELOPMENT OF THE STUDY

Cotton

According to 2009 California Department of Food and Agriculture statistics, California is the growing site of 190,000 acres of cotton. In 2009 California cotton lint production accounted for over $277 million (CDFA 2011). The vast majority of California cotton is grown within the counties that comprise California’s San Joaquin Valley.

In the investigation to gauge the future of sulfoxaflor in the California cotton market, a total of 22 PCAs from this rich agricultural region who primarily work in cotton crop protection were interviewed. Figure 1 demonstrates the number of cotton PCAs interviewed in each county.

In the interviews conducted, it was found that every PCA spoken with treated his or her cotton for aphid. Of these, over half treated at least 80% of their acres and less than a quarter treated fewer than 50% of their acres. The interviews also revealed that the preferred treatment method for aphid control among the men and women questioned was one to two applications of Assail® at the rate of 1.3oz/acre. Those who treated for aphid using Assail® cited its good residual control, efficacy, and its minimal impact on beneficial insects as their primary motives for using it. On average, Assail® was given a satisfaction rating of 8.85/10 for aphid control in cotton and had an average grower price per acre of approximately $13.
After given the brief technical presentation on sulfoxaflor, 21 out of the 22 cotton PCAs spoken with were willing to answer the follow-up questions regarding the product. Figure 2 illustrates the responses of the PCAs interviewed when asked what they thought sulfoxaflor was worth in terms of grower price per acre. The chart demonstrates that $15 per acre was the most common response. When asked why they chose the price they did, the two most common responses were to maintain competitiveness with other products and because of sulfoxaflor being a new type of chemistry. When asked what percentage of their cotton acres would receive an aphid treatment with sulfoxaflor at the grower price per acre of $15, over 70% of the PCAs said that they would treat at least half of their total cotton acres and one third of the PCAs would treat at least 90% of their total cotton acres. When asked what product sulfoxaflor would either rotate with or displace in their current aphid control program, the two products mentioned most frequently were Assail® and Carbine®.

Lygus is a major pest affecting cotton production in CA. Every cotton PCA interviewed treated at least 75% of his or her cotton acres at least two but even up to five times per season on average. Figure 3 shows that nearly 81% of the PCAs interviewed treated every acre under their care for lygus. The most commonly mentioned product used for lygus control by the cotton PCAs spoken with was Carbine®. On average, Carbine® was applied two to three times per growing season at the rate of 2.8oz/acre and grower cost per acre of $13. The average overall
satisfaction rating given to Carbine® for lygus control in cotton was 7/10. The top reason given for the preference of Carbine® was its minimal impact on beneficial insects.

When asked what grower price per acre sulfoxaflor should be valued at for lygus control in cotton, the average of the responses was $17 at which price the interviewees would treat an average of 87% of their acres. The reasons for the prices given were for competitiveness, sulfoxaflor being new chemistry, and because of the lack of currently effective options. When asked what percentage of their cotton acres would obtain a lygus treatment with sulfoxaflor at the grower price per acre of $11, 64% of the respondents said they would treat every acre. If sulfoxaflor were to currently be on the market, the PCAs interviewed indicated that it would most likely rotate with or displace Carbine®.

The general notion sensed among the cotton PCAs interviewed was that whitefly is not a very pressing concern in their operations. 10 out of the 22 cotton PCAs spoken with did not treat for whitefly at all and only four out of the twelve that did treat for the pest did so on over 50% of their acres. Figure 4 illustrates the responses given by the PCAs when asked what product was preferred for whitefly control. Among the twelve PCAs that did treat for whitefly, the average grower per acre that sulfoxaflor was valued at for whitefly control in cotton was $21 and the average percentage of their total cotton acres that would be treated at this price was 34%. Knac® and Assail® were indicated as the main products that sulfoxaflor would most likely rotate with or displace in their whitefly control programs.
Tomatoes

The state of California contained 348,500 acres of tomatoes in 2009 according to the CDFA (2011). In 2009 the total value of California tomato production was $1.5 billion (CDFA 2011).

For the tomato analysis, 14 PCAs in locations ranging from Kern County, in the very south of the San Joaquin Valley, to Stanislaus County, located in the northern area of the valley, were interviewed in depth as to identify sulfoxaflor’s demand in this major industry (see figure 5).

Of the fourteen PCAs spoken with, nine treated every acre for aphid and three did not treat at all. Of the remaining two PCAs, one treated 70% of his acres for aphid and the other, 15%. The preferred aphid treatment for tomatoes was one to two applications of Admire® at the rate of 7oz and average grower price per acre of $11. The average satisfaction rating given to Admire® for aphid control in tomatoes among the PCAs interviewed was 8.6/10. Reasons given for the use of Admire® were its efficacy, ease in application, minimal impact on beneficial insects, and for its cost-effectiveness.

After listening to the technical presentation on sulfoxaflor, the PCAs who had indicated that they treated their tomatoes for aphid were asked to state what they believed the product to be worth in terms of grower price per acre. They were also asked to state what percentage of their acres they would treat at that respective price. With competitiveness being the motivating factor for the prices stated, the responses averaged $16.75/acre. At the particular prices given, the PCAs indicated that an average of 77% of their total cotton acres would be treated with
sulfoxaflor. These same PCAs were then asked what percentage of their acres they would treat if the grower price per acre were to be $18. With this slightly higher price, the average of the responses decreased to 75%. When asked what product sulfoxaflor would most likely rotate with or displace for aphid control in tomatoes, Admire® and Assail® were the two products most frequently mentioned.

Unlike in cotton, lygus did not seem to be a very big threat to the majority of the tomato PCAs interviewed. Of the 14 PCAs spoke with, only three treated for lygus. Of the three PCAs that did treat for lygus, one treated all of his acres, one treated half of his acres, and the third treated 20% of his acres. Warrior® was favored for lygus control in tomatoes because of its lower cost and was given an average satisfaction rating of 6.5 out of 10. Asana® was mentioned because it provides a quick knock down and its satisfaction level given by the PCA who used it was 8/10. When asked what grower price per acre sulfoxaflor should be valued at for lygus control in tomatoes and what percentage of their acres they would be willing to treat at the corresponding price, the averaged responses indicated a treatment of 57% of the crop at the grower price per acre of $12.33. The PCAs cited competitiveness with current products as the reason for prices at which they valued sulfoxaflor. The average acres the PCAs would be willing to treat fell to 40% when asked what percentage of their tomato acres would be treated if sulfoxaflor’s grower price per acre were to be $18 for lygus control. It was also indicated that Warrior® and Asana® would be rotated with or displaced by sulfoxaflor if it were to be currently available on the market.

Out of the 14 PCAs interviewed on tomatoes, only one treated for whitefly. Furthermore, the one individual that treated for whitefly only did so on 10% of his total acres.
Therefore it is likely that sulfoxaflor does not have a very high potential for profitability in the tomato market for whitefly management.

**Peppers**

25,500 acres of peppers were grown in the state of California in 2009 according to the CDFA, that yielded a total pepper production valued at $28 million (CDFA 2011). Peppers are grown in relatively small amounts all over the state. In comparison with the other crops investigated in this report, pepper acres represent a significantly smaller portion of the state’s agricultural production. Therefore the number of PCAs that were interviewed on peppers was less than that for other crops, maintaining proportionality.

In the investigation of sulfoxaflor’s possible position in the pepper industry, six PCAs were interviewed. five of the six pepper PCAs questioned treated 100% of their pepper acres for aphid. Like tomatoes, the preferred product for aphid treatment in peppers was Admire®. Those who used Admire® were applying the product twice through the season at the rate of 7oz/acre. Admire®’s average grower price per acre was $15 and the average satisfaction rating given to it by the pepper PCAs for aphid control was 9.3/10. The PCAs indicated that they favored Admire® because of its ability to provide broad-spectrum control, cost effectiveness, and ease of application.

On average, the pepper PCAs valued sulfoxaflor at the grower price per acre of $19 after being given the technical presentation on the product. The reason cited for valuing sulfoxaflor at this price was to maintain competitiveness. At the prices given by the PCAs themselves, they indicated that an average of 50% of their acres would receive a treatment for aphid with
sulfoxaflor. When asked what percentage of their pepper acres would be treated were sulfoxaflor to cost $18/acre, the responses averaged 53%. When asked what product sulfoxaflor would most likely rotate with or displace, the responses were nearly split between Admire® and Movento®.

Five out of the six pepper PCAs interviewed indicated that they treated their peppers for lygus. Figure 6 demonstrates that half of the pepper PCAs interviewed treated all of their acres. The PCAs were split when asked what product they used for lygus control in their peppers as is illustrated by figure 7.

When asked what sulfoxaflor’s grower price per acre for lygus control in peppers should be, the responses averaged $18/acre. At this price, the PCAs indicated that they would be willing to treat an average of 51% of their pepper acres for lygus with the product. When asked what product sulfoxaflor would most likely rotate with or displace for lygus control in peppers, again the responses were split evenly between Vydate®, Asana®, Thionex®, Orthene®, and Acephate®.

Four of the six pepper PCAs interviewed indicated that they treated for whitefly. Among those that said they treated for this pest, two treated all of their acres, one treated half of his acres, and the other treated 20% of his acres (see figure 8). The two products used for whitefly
control in peppers mentioned by the PCAs were Movento® and Knac®. The PCAs expressed that their satisfaction with these products was based on the good residual control that each provides. On a satisfaction scale of one to ten, Movento was given a nine and Knac an eight for whitefly control in peppers.

When the pepper PCAs were asked what sulfoxaflor would be worth to them for whitefly control in peppers in terms of grower price per acre, the responses averaged $22.50. It was also indicated that at these prices, an average of 68% of their acres would be treated. This percentage then fell to 50% when the pepper PCAs were asked what percentage of their acres would obtain a treatment for whitefly if sulfoxaflor’s grower price per acre were to be $40. Movento® was the product that most of the PCAs indicated would most likely rotate with or be displaced by sulfoxaflor, were it to be currently on the market.

**Leafy Vegetables & Cole Crops**

Agriculture on California’s central coast is predominantly characterized by a vast variety of vegetable production. In 2009 there were 447,700 acres of leafy vegetables & cole crops in California which constituted a total production value of nearly $5.6 billion (CDFA 2011). Determining the existence of a demand for sulfoxaflor in the vegetable industry consisted of interviewing 21 PCAs from up and down California’s central coast who specialize in leafy vegetable & cole crops.
Out of the 21 leafy vegetable & cole crop PCAs interviewed, 20 treated for aphid. Of those 20, 17 treated every acre (see figure 9). Movento® and Admire® were the two products mentioned most frequently by the PCAs when asked which products were preferred for aphid treatment (see figure 10). Movento® was given an average satisfaction rating of 9/10 because of its overall efficacy, residual control, and short post-harvest and re-entry intervals. An average satisfaction rating of 8.75/10 was given to Admire® for aphid control because of the timing of when it is most efficacious, its cost-effectiveness, and its ease in application.

After the vegetable & cole crop PCAs listened to the technical presentation on sulfoxaflor, they were asked to give their opinion on what they believed the product to be worth in terms of grower price per acre for aphid control in vegetables & cole crops. The 20 responses that ranged from $20 to $50 averaged $27.95. At the prices mentioned, the PCAs indicated that an average of 74% of their acres would be treated for aphid with sulfoxaflor. When asked what percentage of their acres would receive an aphid treatment if sulfoxaflor were to have a grower price
per acre of $18, 65% of the PCAs indicated that they would treat over 90% of their total acres (see figure 11). When asked which product sulfoxaflor would most likely rotate with or displace for aphid control in vegetables, Movento® was the product most frequently mentioned.

When the 21 PCAs interviewed were asked what percentage of their total vegetable & cole crop acres received treatment for lygus, the average of the responses was 39% with five of the PCAs indicating that they did not treat any of their acres for lygus at all. The PCAs who did treat for lygus indicated Lannate® and Warrior® as the top two products for lygus control in their vegetables. Lannate® and Warrior® received average satisfaction ratings of 8.8/10 and 8.75/10, respectively because they are both fast-acting, both provide broad spectrum control, and are both cost-effective.

After listening to the technical presentation on sulfoxaflor, the PCAs valued it at an average grower price per acre of $21.88 for lygus control. The reasons given for the prices at which the interviewees valued sulfoxaflor were maintaining competitiveness and valuing new chemistry.

At this price, they indicated that they would be willing to treat an average of 36% of their total vegetable & cole crop acres for lygus with the product. When asked what percentage of their acres would receive a lygus treatment if sulfoxaflor's grower price per acre were to be $18 for lygus control, the percentage did not change. There were several products mentioned when asked what materials sulfoxaflor would most likely rotate with or displace for lygus control in vegetables & cole crops. Among the most mentioned products were Lannate®, Warrior®, and Mustang® (see figure 12).
The responses given when asked about whitefly treatment suggested that whitefly does not pose a great threat to vegetables. Only two out of the 21 vegetable & cole crop PCAs interviewed indicated that they treated for whitefly at all. Out of the two that said they treated for this pest, one treated every acre with two applications of Assail® at the rate of 2oz and grower price per acre of $15. The other only treated about 20% of his acres for whitefly. The treatment that the ladder implemented consisted of two applications of Mustang® at the rate of 4.3oz/acre and grower price per acre of $9. Assail® was used by the first because of it being a good rotational partner with other chemistries and Mustang® was used by the second because of the broad spectrum control that it provides. These products were given satisfaction ratings of 6/10 and 8/10 respectively by their respective users.

When asked about what sulfoxaflor’s grower price per acre should be for whitefly control in vegetable & cole crops, one valued the product at $40 and the other at $10. Both indicated that these prices were given for the reason of competitiveness and both indicated that 10% of their total vegetable acres would receive a treatment at these prices. When asked about which product sulfoxaflor would most likely rotate with or displace, the individual that valued the product at $40 said that sulfoxaflor would rotate with or displace Oberon® and the other indicated that Admire® would be rotated with or displaced by sulfoxaflor. When asked what percentage of their total vegetable acres would receive a whitefly treatment with sulfoxaflor if its grower price per acre were to be $40, the PCA that had valued Closer at $10 said he would not treat any of his acres with the product.
Strawberries

Like vegetables, strawberries are also predominantly found on the central coast of California. In 2009 there were 39,800 acres of strawberries in production within California that gave forth a production value of over $1.7 billion (CDFA 2011). This is very high valued crop that largely enters the export market. Therefore berry quality is taken extremely seriously. Every one of the 12 strawberry PCAs interviewed expressed their willingness to exhaust all measures in order that their fields are kept as clean as possible.

Nine out of the twelve strawberry PCAs interviewed indicated that they treated their fields for aphid. Of the 9 that treated, over half of them indicated that over 90% of their acres received aphid treatment (see figure 13). Admire® was liked for its efficacy and ease of application and Assail® was mentioned because of its minimal impact on beneficial insects. Actara® was favored by some because of its ability to provide broad spectrum control with systemic efficacy and Provado® used because of its cost-effectiveness.

After obtaining information on sulfoxaflor through the technical presentation, the strawberry PCAs were asked to place a value on sulfoxaflor in terms of grower price per acre. Their responses averaged $30 per acre and when asked what percentage of their acres would obtain a treatment at this price, their responses averaged 31%. The PCAs indicated that the prices at which they valued sulfoxaflor were based on maintaining competitiveness and valuing the fact that it is a new type of chemistry. When the strawberry PCAs were asked what percentage of their acres would receive a treatment for aphid if sulfoxaflor were to have an $18
grower price per acre, the average amount of acres that would be treated increased to 41%.
Admire® was indicated as the product that sulfoxaflor would most likely rotate with or displace for aphid control in strawberries.

Like what is true for cotton, lygus is a very serious issue in California strawberry production as well. Among the strawberry PCAs questioned, all but one treated for lygus. Out of those who treated for lygus, over 80% of them indicated that they treated every acre (see figure 14). The two products mentioned most frequently for lygus control in strawberries were Rimon® and Brigade®. Those who treated with Rimon® were applying it four to six times on average at the 12oz rate and average grower price per acre of $23.50. The PCAs who used Rimon® were doing so because it is relatively new chemistry, it provides broad spectrum control, and it has low impact on beneficial insects. Those who used Brigade® for lygus treatment applied it three to five times on average at the rate of 1lb and average grower price per acre of $20. Reasons given for Brigade®’s use included its cost-effectiveness and its ability to provide broad spectrum control. It was communicated that currently, a “stand out” product for lygus control in strawberries just does not exist. Among the strawberry PCAs spoken with, Rimon® received an average satisfaction rating of 7/10 for lygus control and Brigade® received an average satisfaction rating of 6.75/10.

When asked what sulfoxaflor should be valued at in terms of grower price per acre for lygus control in strawberries, the interviewees made evident, the true seriousness of the problem that lygus poses to strawberry production. The average of the responses was $50 per acre. There was even one PCA who went as far as to place an $80 grower price per acre value on sulfoxaflor
if it were to prove to be very effective for lygus control. These high prices were given mostly because of the lack of effective options for lygus control in strawberries. When asked what percentage of their strawberry acres would receive a lygus treatment if sulfoxaflor were to have a grower price per acre of $18, the responses averaged 81%. Rimon®, Brigade®, and Assail® were the 3 products indicated by the PCAs that would most likely be rotated with or displaced by sulfoxaflor.

Although not as serious a problem as lygus, whitefly is also a common pest that has a significant impact on strawberry production. Eight out of the twelve strawberry PCAs interviewed indicated that they treated for whitefly and of those that treated, half did so on every acre. The most implemented control measure among those that treated for whitefly was one to two applications of Admire® at the rate of 14oz and average grower price per acre of $20.50. Reasons cited for the use of Admire® for whitefly control in the strawberries included its ease in application, cost-effectiveness, and good overall efficacy. Admire® was given a satisfaction rating of 8/10 on average for whitefly control in strawberries.

The average grower price per acre that sulfoxaflor was valued at by the strawberry PCAs for whitefly control was $29, at which they would treat an average of 40% of their total strawberry acres. If sulfoxaflor’s grower price per acre were to be $40 for whitefly control, the acreage percentage that the PCAs said would receive a treatment decreased to an average of 39%. When asked what product sulfoxaflor would most likely rotate with or displace for whitefly control in strawberries, Admire® was the product most frequently mentioned.
Citrus

California is known for its high quality fresh market citrus production. California is second only to Florida in total citrus production (CDFA 2011). In 2009, there were 410,600 citrus acres in the state which combined to make up a total production value of over $1.2 billion (CDFA 2011). Although aphid, lygus, and whitefly are not typical pests that impact citrus production, there are two other “piercing and sucking” pests that are. Depending on the geographic region where the citrus is being grown, both citricola scale and red scale can pose dynamic threats to the quality of citrus crops. 19 PCAs were interviewed in the pursuit of determining whether a demand exists for sulfoxaflor within the California citrus industry.

Out of the 19 PCAs spoken with, 11 indicated that they treat their citrus for citricola scale. Five out of the eleven PCAs that said they treated for citricola scale indicated that they treated every acre and all five of them were located in the San Joaquin valley. There were no PCAs located outside of the San Joaquin valley that treated more than 20% of their acres for citricola scale. The most common treatment mentioned for citricola scale was one application of Lorsban® at the rate of 4pts and average grower price per acre of $20. Lorsban® users cited its fuming action, broad spectrum control, and good overall efficacy as reasons for the products favorability. The average satisfaction rating that Lorsban® received from the citrus PCAs for citricola scale control was 8.3/10.

All of the citrus PCAs interviewed were given a technical presentation on sulfoxaflor after which they were asked to value the product in terms of grower price per acre for citricola scale management. The 11 PCAs that indicated that they treated for citricola scale valued sulfoxaflor at the average grower price per acre of $34 which they said would be competitive
with the other scale products on the market (see figure 15). At the prices given, the PCAs indicated that they would treat an average of 43% of their acres. If sulfoxaflor were to have a grower price per acre of $55, two out of the 11 PCAs that said they treated for citricola scale indicated that they would not treat any of their acres with the product and the remaining nine indicated that they would treat an average of 37% of their acres. When asked what product sulfoxaflor would most likely rotate with or displace for citricola scale control, Lorsban® was the material most frequently mentioned.

Red scale is a common issue among citrus grown all over the state. 18 out of the 19 PCAs interviewed indicated that they treated their citrus for red scale. Among those who treated for red scale, 11 treated every acre, as demonstrated by figure 16. As was the case for citricola scale, Lorsban® was again the most used product for control. However Lorsban® for red scale treatment was being applied once at the rate of 12pts and had a grower price per acre of $50. It was communicated that Lorsban® was the main product for red scale control because of its cost-effectiveness and it was given an average satisfaction rating of 7.85/10. Among those who placed Lorsban as their number one product, Esteem was the most frequently mentioned secondary product for red scale control. It was being applied once at the rate of 16oz and average grower price per acre of $82.50. Esteem’s average satisfaction rating was 8.5/10. Esteem was not the number one product for red scale control primarily because of its high cost.
Sulfoxaflor for red scale control was valued at the average grower price per acre of $47 by the citrus PCAs after they had listened to the technical presentation about the product. At the prices given by the PCAs, they indicated that an average of 54% of their total citrus acres would receive a treatment. When asked what percentage of their total acres would be treated with sulfoxaflor for red scale if it were to have a grower price per acre of $80, eight out of the 18 PCAs who treated for red scale would not treat any of their acres with sulfoxaflor and the other 10 would only treat an average of 49% of their total citrus acres. The product most frequently mentioned when asked what material sulfoxaflor would most likely rotate with or displace for red scale control in citrus was, once again, Lorsban®.

Almonds

Almonds are among the most highly valued crops in California. California alone produces over 80% of the world's almond supply (CDFA 2011). As of 2009, there were a total of 720,000 almond acres in the state with a total production value of nearly $2.3 billion (CDFA 2011). These totals are expected to rise even more within the coming years in order to address the world's rising demand for almonds. “Piercing and sucking” pests associated with almond production include San Jose scale as well as plant bugs. In investigating sulfoxaflor's market potential in this dynamic industry, almond PCAs from five counties within the state where almonds are gown were interviewed in depth (see figure 17).
When the almond PCAs interviewed were asked what percentage of their almond acres are treated for San Jose scale, over half indicated that they did not treat for this pest at all. Among those who did treat for San Jose scale, three treated at least 90% and the other four treated acreage percentages ranging from 5% to 60%. When asked what the preferred treatment for San Jose scale was, the most frequent response was one application of Seize® at the rate of 5oz and average grower price per acre of $39.75. Seize® being new chemistry in addition to its good general efficacy were both reasons cited for why it was preferred for San Jose scale control in almonds. The average satisfaction rating given to Seize® by the PCAs spoken with was 9.25/10.

After being given the technical presentation on sulfoxaflor, the PCAs were asked to give their opinion on the product's worth in terms of grower price per acre for San Jose scale control in almonds along with stating the percentages of their almond acres that would receive a treatment with the product at the specific prices mentioned. The values given to sulfoxaflor for San Jose scale control ranged from $12 to $50 and averaged $28.86. At the specific prices given, the almond PCAs indicated that 36% of their acres would receive a treatment for San Jose scale with sulfoxaflor on average. When asked what percentage of their total almond acres would receive a treatment for San Jose scale if sulfoxaflor were to have a grower price per acre of $18, one individual who had originally valued the product at $12 per acre indicated that he would not treat any of his acres with the product if it were to cost $18 per acre. As a result, the average of total acres treated if sulfoxaflor were to cost $18 per acre fell to 32%. When asked what product sulfoxaflor would most likely rotate with or displace for San Jose scale control in almonds, Seize® again was the most common response.
The quantity of almond PCAs interviewed that indicated that they treated for plant bugs was the same as the amount that treated for San Jose scale. The specific plant bug that the PCAs communicated was being treated for was leaf-footed plant bug. Those who treated for this pest indicated that an average of 54% of their acres received a treatment. The most common product used for plant bug control among the PCAs interviewed was Lorsban®. It was being applied once at the rate of 4pts and had an average grower price per acre of $30. Reasons cited for Lorsban®'s use in the treatment of this pest were its ability to provide a rapid knock-down and good overall efficacy. Lorsban®'s average satisfaction rating for plant bug control in Almonds was 9/10.

The prices sulfoxaflor was valued at for plant bug control in terms of grower price per acre ranged from $8 to $25. The average among these values was $15 per acre at which price the PCAs indicated an average of 59% of their acres would get receive a treatment. If sulfoxaflor were to have a grower price per acre of $18 for plant bug control, the almond PCAs questioned indicated that the average percentage of their acres that would receive a plant bug treatment would fall to 37%. Lorsban® was indicated as the product that sulfoxaflor would most likely rotate with or displace for plant bug control in almonds.

Walnuts

Although not as large as the almond industry, California's walnut production represents another high valued agricultural sector with a very important export market. According to 2009 statistics from the CDFA, there are 223,000 acres of walnuts in production within California that contribute to a total production value of over $738 million. In determining sulfoxaflor's possible
fit in the walnut industry seven PCAs were interviewed from four different counties in which
walnuts are grown.

Six out of the seven walnut PCAs interviewed said that they treated for scale. However
not one PCA indicated that he treated 100% of his acres. The greatest acreage percentage treated
among the walnut PCAs spoken with was 35%. The number one product for scale control in
walnuts among the PCAs questioned was Seize®. In this case Seize® was being applied once at
the rate of 4oz and average grower price per acre of $45. Those who used Seize® said that there
are few effective options for scale control in walnuts and that Seize® provides good general
efficacy with minimal impact on beneficial insects. Seize® was given an average satisfaction
rating of 8.6/10 for scale control in walnuts.

After the walnut PCAs were given the technical presentation on sulfoxaflor, they were
asked to value the product in terms of grower price per acre for scale control. Their responses
averaged $22.86 per acre. At the prices mentioned, they indicated that an average of 18% of
their walnut acres would receive a treatment with sulfoxaflor for scale control. When asked what
percentage of their walnut acres would receive a scale treatment were sulfoxaflor to cost $18 per
acre, those who had originally valued the product at less than $18 per acre expressed that they
would not treat any of their acres and the total average percentage of walnut acres that would be
treated fell to 15%. When asked what product sulfoxaflor would most likely rotate with or
displace for scale control in walnuts, the two most frequent responses were Seize® and
Lorsban®.

When asked what percentage of their walnut acres were treated for plant bug, all but one
PCA said that they did not treat for plant bug at all. The one PCA who did treat for plant bug
was only doing so in about 15% of his acres. These results for plant bug in walnuts were not
convincing and therefore give reason to believe that there should not be a high expectation for sulfoxaflor to be utilized significantly for plant bug control in walnut production.

Three out of the Seven walnut PCAs interviewed indicated that they treated their walnuts for aphid. However these three were only treating five to ten percent of their acres. Among the walnut PCAs spoken with, Lorsban® and Provado® were the only two products being used for aphid treatment in walnuts. Lorsban® was chosen because of its fuming action and Provado® was liked for being new chemistry. Both received an average satisfaction rating of 10/10 for aphid control in walnuts.

When asked what they felt sulfoxaflor was worth in terms of grower price per acre for aphid control in walnuts, all three PCAs that treated for the pest gave the price of $20. They cited competitiveness as the motive for giving this particular price. They indicated that at the grower price per acre of $20, an average of 8% of their walnut acres would be treated with sulfoxaflor for aphid control and this percentage did not change when they were asked the same question with sulfoxaflor having the hypothetical grower price per acre of $18. When asked what product sulfoxaflor would most likely rotate with or displace for aphid control in walnuts, their responses were split between Lorsban®, Provado® (see figure 18).
Chapter 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The sulfoxaflor line of products will soon be one of Dow Agrosciences’s newest additions to its list of chemistries that have helped world agriculturalists maintain insect control since 1989. Sulfoxaflor, with its revolutionary mode of action, will be used for the rapid knock down and long term residual control of “piercing and sucking” insects such as aphid, lygus, and other pests that have continued to plague the growers of great varieties of crops. The research performed for this report required traveling to the various geographical regions of California where the different crop segments are grown and meeting one-on-one with the PCAs who work extensively with one or more of the crops of interest. The data gathered was a compilation of the responses given by the PCAs regarding questions about the crops they work with, the pests treated for, the products used, as well as the corresponding dosage rates, prices, and product satisfaction levels associated with the products. The data analysis suggested that sulfoxaflor is likely to find success in tomatoes & peppers for aphid and lygus control. There was overwhelming evidence that this product will be greatly embraced by the cotton, strawberries, and leafy vegetable & cole crop industries for aphid and lygus control as well. Thus, the hypothesis is confirmed because the only crop segments found not to be good markets for sulfoxaflor after the analysis were almonds and walnuts.
Conclusions

The responses gathered from the PCAs questioned indicated that sulfoxaflor is likely to be a great success in the cotton and strawberry industries for lygus control, and in the leafy vegetable & cole crop industries for aphid control. Although not as overwhelmingly convincing, responses also demonstrated that sulfoxaflor will contend for aphid and lygus treatment in tomatoes and peppers as well. Aside from strawberries, none of the crops investigated in this report had very significant whitefly issues. In regards to sulfoxaflor’s future in the citrus industry, the results were slightly less clear. Citricola scale is only a problem in citrus production within certain geographical areas of the state. In the areas where this pest was an issue, the PCA responses indicated that sulfoxaflor will likely be a viable option for treatment. Red scale is a pest that poses a threat to citrus production in nearly all areas of the state where citrus is grown.

The PCAs were clear in communicating that sulfoxaflor would be an excellent fit in the citrus industry for red scale treatment if proven effective because of the lack of many options currently available for the effective treatment of this pest. However when the suggested grower price per acre of $80 for red scale control was proposed to the citrus PCAs, nearly half of them indicated that they would not treat any of their acres with sulfoxaflor at all. The conclusion arrived at in the analysis of the almond and walnut industries was that there is not a concrete fit for sulfoxaflor in these crop segments. The amount of almond and walnut PCAs that treated a significant amount of their acres for scale was far surpassed by the amount of PCAs that did not treat for scale at all. The leaf footed plant bug was only an issue among a few of the almond PCAs interviewed to on west side of the central San Joaquin Valley and the aphid pressure in the
walnuts was very minimal. Tables 1 and 2 summarize the crop segments in which Dow Agrosciences can expect a demand for sulfoxaflor to exist and those in which a demand for sulfoxaflor does not exist.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>FIT+ = very likely fit</th>
<th>FIT = likely fit</th>
<th>X = fit unlikely</th>
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<tbody>
<tr>
<td>Cotton</td>
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<tr>
<td>Aphid: FIT+</td>
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<td>Lygus: FIT+</td>
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<td>Whitefly: X</td>
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<td>Peppers</td>
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<td>Aphid: FIT+</td>
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<td>Lygus: FIT</td>
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<td>Whitefly: X</td>
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<td>Tomatoes</td>
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<tr>
<td>Aphid: FIT+</td>
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<td>Lygus: X</td>
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<td>Whitefly: X</td>
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<td>Leafy Veg &amp; Cole Crops</td>
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<td>Aphid: FIT+</td>
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<td>Lygus: FIT</td>
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<td>Whitefly: X</td>
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Table 2

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<tr>
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<th>FIT+ = very likely fit</th>
<th>FIT = likely fit</th>
<th>X = fit unlikely</th>
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<tbody>
<tr>
<td>Strawberries</td>
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<tr>
<td>Aphid: FIT</td>
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<tr>
<td>Lygus: FIT+</td>
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<tr>
<td>Whitefly: FIT</td>
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<tr>
<td>Almonds</td>
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<tr>
<td>San Jose Scale: X</td>
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<tr>
<td>Plant bug: X</td>
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<td>Citrus</td>
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<tr>
<td>Citricola Scale: FIT (region dependent)</td>
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<td>Red Scale: FIT+ (very price dependent)</td>
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<td>Walnuts</td>
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<tr>
<td>Scale: X</td>
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<td>Plant bug: X</td>
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<td>Aphid: X</td>
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Recommendations

It is not recommended that sulfoxaflor be marketed extensively as a whitefly treatment material because out of all the crops analyzed, strawberries was the only group that the PCAs indicated whitefly was a problem in. With respect to sulfoxaflor’s position in the citrus industry, it is recommended that this product’s pricing be strongly reconsidered if Dow Agrosciences moves to highly pursue its use as a red scale management material. This recommendation is made on the basis of the great reduction in willingness to use sulfoxaflor communicated by the PCAs when they were asked how many of their acres they would treat if the material were to have a grower cost per acre of $80. It is also recommended that sulfoxaflor not be marketed for pest management in almonds and walnuts because of the lack of evidence indicating a demand for it exists within these two crop segments.
References Cited


### PCA __________________County _________________ Crop ______Almonds & Walnuts____

### Almonds & Walnuts

**Scale**

<table>
<thead>
<tr>
<th>What % of your acres get treated for scale?</th>
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<tr>
<td>How many applications per crop?</td>
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<th>What is the top product you recommend for scale?</th>
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<th>What is the typical rate and typical grower cost/acre?</th>
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<th>Why is this product your #1 recommendation?</th>
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<tr>
<th>On a scale of 1-10, how satisfied are you with this product?</th>
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### Lygus/Plantbug

<table>
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<tr>
<th>What % of your acres get treated for lygus/plant bug?</th>
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<tr>
<th>How many applications per crop?</th>
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<table>
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<tr>
<th>What is the top product you recommend for lygus/plant bug?</th>
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### After Sulfoxaflor Presentation

<table>
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<tr>
<th>What is this product worth in terms of grower price/acre?</th>
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<table>
<thead>
<tr>
<th>(scale) _______ (lygus/plant bug) _______ (other) _______</th>
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<table>
<thead>
<tr>
<th>Why this price?</th>
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</table>
At these prices, what percentage of your crop would get a treatment?

(scale) __________________ (lygus/plant bug) __________________ (other) ____________________

If both scale and lygus/plant bug treatment cost $18/acre, what percentage of your affected acres would get a treatment?

(scale) _____________________________ (lygus/plant bug) _____________________________

What product will Sulfoxaflor most likely rotate with? _________________________________

What product will Sulfoxaflor displace? _____________________________________________
PCA ___________________ County ___________________ Crop ________________ Cotton ________

Cotton

(Aphid)

What % of your acres get treated for aphid? ______ How many applications per crop? ______

What is the top product you recommend for aphid? ________________________________

What is the typical rate and typical grower cost/acre? ________________________________

Why is this product your #1 recommendation? ________________________________

On a scale of 1-10, how satisfied are you with this product? ________________________________

(Lygus/Plantbug)

What % of your acres get treated for lygus/plant bug? ________________________________

How many applications per crop? ________________________________

What is the top product you recommend for lygus/plant bug? ________________________________

What is the typical rate and typical grower cost/acre? ________________________________

Why is this product your #1 recommendation? ________________________________

On a scale of 1-10, how satisfied are you with this product? ________________________________

(Whitefly)

What % of your acres get treated for whitefly? ________________________________

How many applications per crop? ________________________________

What is the top product you recommend for whitefly? ________________________________

What is the typical rate and typical grower cost/acre? ________________________________

Why is this product your #1 recommendation? ________________________________
On a scale of 1-10, how satisfied are you with this product? _______________________

(After Sulfoxaflor Presentation)

What is this product worth in terms of grower price/acre?
(aphid) _______________ (lygus/plant bug) _______________ (whitefly) _______________

Why this price? ________________________________________________________________

At these prices, what percentage of your crop would get a treatment?
(aphid) _______________ (lygus/plant bug) _______________ (other) ______________

If both scale and lygus/plantbug treatment cost $18/acre, and whitefly treatment cost $40/acre what percentage of your affected acres would get a treatment?
(aphid) _______________ (lygus/plant bug) _______________ (whitefly) _______________

What product will Sulfoxaflor most likely rotate with? _______________________________

What product will Sulfoxaflor displace? ________________________________
PCA __________________County ____________________ Crop ______Strawberries______

Strawberries

(Aphid)
What % of your acres get treated for aphid?______ How many applications per crop? ______
What is the top product you recommend for aphid? ________________________________
What is the typical rate and typical grower cost/acre? ______________________________
Why is this product your #1 recommendation? _________________________________
On a scale of 1-10, how satisfied are you with this product? __________________________

(Lygus/Plantbug)
What % of your acres get treated for lygus/plant bug? ______________________________
How many applications per crop? __________________________________________________
What is the top product you recommend for lygus/plant bug? ___________________________
What is the typical rate and typical grower cost/acre? _______________________________
Why is this product your #1 recommendation? _________________________________
On a scale of 1-10, how satisfied are you with this product? __________________________

(After Sulfoxaflor Presentation)
What is this product worth in terms of grower price/acre?
(aphid) ____________(lygus/plant bug) ____________ (whitefly) ________________
Why this price? __________________________________________________________________
At these prices, what percentage of your crop would get a treatment?
(aphid) ____________ (lygus/plant bug) __________ (other) ______________
If both scale and lygus/plant bug treatment cost $18/acre, and whitefly treatment cost $40/acre what percentage of your affected acres would get a treatment?

(aphid) ________________  (lygus/plant bug) ________________  (whitefly) ________________

What product will Sulfoxaflor most likely rotate with? ________________________________

What product will Sulfoxaflor displace? ________________________________
PCA ___________________ County _________________ Crop ___Tomatoes & Peppers_____

**Tomatoes & Peppers**

(Aphid)

What % of your acres get treated for aphid? _____ How many applications per crop? _____
What is the top product you recommend for aphid? ________________________________
What is the typical rate and typical grower cost/acre? ____________________________
Why is this product your #1 recommendation? _________________________________
On a scale of 1-10, how satisfied are you with this product? ________________________

(Lygus/Plantbug)

What % of your acres get treated for lygus/plant bug? _____________________________
How many applications per crop? ________________________________
What is the top product you recommend for lygus/plant bug? ______________________
What is the typical rate and typical grower cost/acre? ____________________________
Why is this product your #1 recommendation? _________________________________
On a scale of 1-10, how satisfied are you with this product? ________________________

(Whitefly)

What % of your acres get treated for whitefly? _________________________________
How many applications per crop? ________________________________
What is the top product you recommend for whitefly? __________________________
What is the typical rate and typical grower cost/acre? ____________________________
Why is this product your #1 recommendation? _________________________________
On a scale of 1-10, how satisfied are you with this product? _____________________________

(After Sulfoxaflor Presentation)

What is this product worth in terms of grower price/acre?

(aphid) ________________ (lygus/plant bug) ________________ (whitefly) ________________

Why this price? __________________________________________________________________

At these prices, what percentage of your crop would get a treatment?

(aphid) ________________ (lygus/plant bug) ________________ (other) ________________

If both scale and lygus/plantbug treatment cost $18/acre, and whitefly treatment cost $40/acre what percentage of your affected acres would get a treatment?

(aphid) ________________ (lygus/plant bug) ________________ (whitefly) ________________

What product will Sulfoxaflor most likely rotate with? _______________________________

What product will Sulfoxaflor displace? ___________________________________________
PCA ________________  County ________________  Crop ___Leafy Veg/Cole Crops____

Leafy Veg/Cole Crops

(Aphid)
What % of your acres typically get treated for aphid? __________________________________
How many applications per crop? ________________________________________________
What is the top product you recommend for aphid? _________________________________
What is the typical rate and a typical grower cost/acre? _____________________________
Why is this product your #1 recommendation? _______________________________________
On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate
your satisfaction with this product? ______________________________________________
What is the #2 product you recommend for aphid? _________________________________
What is the typical rate and typical grower cost/acre? ______________________________
Why is this product your #2 recommendation? ______________________________________
On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate
your satisfaction with this product? ______________________________________________

(Whitefly)
What % of your acres typically get treated for whitefly? _____________________________
How many applications per crop? ________________________________________________
What is the top product you recommend for whitefly? _______________________________
What is the typical rate and a typical grower cost/acre? _____________________________
Why is this product your #1 recommendation? ______________________________________
On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate your satisfaction with this product? ________________________________

What is the #2 product you recommend for aphid? ________________________________

What is the typical rate and typical grower cost/acre? ________________________________

Why is this product your #2 recommendation? ________________________________

On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate your satisfaction with this product? ________________________________

(Lygus/Plantbug)

What % of your acres get treated for lygus/plant bug? ________________________________

How many applications per crop? ________________________________

What is the top product you recommend for lygus/plant bug? ________________________________

What is the typical rate and typical grower cost/acre? ________________________________

Why is this product your #1 recommendation? ________________________________

On a scale of 1-10, how satisfied are you with this product? ________________________________

(After Sulfoxaflor Presentation)

What is this product worth in terms of grower price/acre?

(aphid) __________________ (whitefly) __________________ (lygus/plant bug) __________________

Why this price?

________________________________________________________

At these prices, what percentage of your crop would get a treatment?

(aphid) __________________ (whitefly) __________________ (lygus/plant bug) __________________

If aphid and lygus treatment cost $18/acre, and whitefly treatment cost $40/acre what percentage of your affected acres would get a treatment?

(aphid) __________________ (whitefly) __________________ (lygus/plant bug) __________________

What product will Sulfoxaflor most likely rotate with? ________________________________

What product will Sulfoxaflor displace? ________________________________
PCA _____________________ County __________________ Crop ___________Citrus___________

Citrus

(Citricola Scale)

What % of your acres typically get treated for citricola scale? ____________________________

How many applications per crop? ______________________________________________________

What is the top product you recommend for citricola scale? ______________________________

What is the typical rate and a typical grower cost/acre? _________________________________

Why is this product your #1 recommendation? _________________________________________

On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate
your satisfaction with this product? __________________________________________________

What is the #2 product you recommend for citricola scale? ______________________________

What is the typical rate and typical grower cost/acre? _________________________________

Why is this product your #2 recommendation? _________________________________________

On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate
your satisfaction with this product? __________________________________________________

(Red Scale)

What % of your acres typically get treated for red scale? ________________________________

How many applications per crop? _____________________________________________________

What is the top product you recommend for red scale? _________________________________

What is the typical rate and a typical grower cost/acre? ________________________________

Why is this product your #1 recommendation? _________________________________________
On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate your satisfaction with this product? _____________________________________________

What is the #2 product you recommend for red scale? ________________________________

What is the typical rate and typical grower cost/acre? ________________________________

Why is this product your #2 recommendation? _______________________________________

On a scale of 1-10 with 1 being not satisfied, and 10 being very satisfied, how would you rate your satisfaction with this product? _____________________________________________

(After Sulfoxaflor Presentation)

What is this product worth in terms of grower price/acre?

(citricola scale) _____________________________ (red scale) _____________________________

Why this price? __________________________________________________________________

At these prices, what percentage of your crop would get a treatment?

(citricola scale) _____________________________ (red scale) _____________________________

If citricola scale treatment cost $55/acre, and red scale treatment cost $80/acre what percentage of your affected acres would get a treatment?

(citricola scale) _____________________________ (red scale) _____________________________

What product will Sulfoxaflor most likely rotate with? ________________________________

What product will Sulfoxaflor displace? _____________________________________________