Sustainable Farm Operation Strategies for Gills Onions

A 2011 Group Project Proposal

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Abstract

Gills Onions, based in Oxnard, California, is the largest onion processing company in the United States. Since its inception 25 years ago, the company has been firmly committed to environmental stewardship and leadership. In accordance with these values, Gills Onions completed a project with the Bren School in 2010 to initiate a zero waste strategy at their processing facility and administrative offices. Gills Onions is now looking to the Bren School to examine the environmental impacts of their farming operations from the seed to the factory door. This Group Project will collect and organize data from the three California growing regions that supply Gills Onions, located in Monterey, Fresno and Imperial Counties, as well as an onion bulb propagation facility located in the state of Indiana. Our goal is to establish a baseline for current water use, fertilizer use, pesticide application, energy consumption, and waste generation. The project will also serve as a pilot project for the Stewardship Index for Specialty Crops (SISC), incorporating the above data and assessing additional metrics such as biodiversity. After establishing a baseline for each region, the project will identify opportunities for efficiency measures and alternate management practices. With this information, Gills Onions will be able to reduce the environmental impact of its operations while generating a cost savings for farmers.
Executive Summary

California produces nearly half of U.S.-grown fruit, nut and vegetable crops and leads the nation in farm revenues. In 2008, California industry generated $36.3 billion in revenue and $100 billion in associated economic activity. California also leads the country in onion production, growing 35% of the U.S. total. In 2008, over 45,000 acres were planted with onions in Fresno, Imperial, Los Angeles, Kern, Monterey Counties, generating a net income of $267,707,000 (NASS, 2008). While agriculture is a significant source of revenue for the state's economy, it does come at an environmental cost. The expansion of the industry has been accompanied by large increases in water, fertilizer, pesticide, fossil fuel and energy use. Each of these inputs raises a number of associated environmental consequences and political issues.

Since its inception 25 years ago, Gills Onions has been firmly committed to environmental stewardship and leadership. The company has been recognized for innovation and excellence in sustainability by the Energy Solutions Center, the California Environmental and Economic Leadership Award bestowed by Governor Schwarzenegger, and the Golden State Award for Engineering Excellence from the American Council of Engineering Companies. In accordance with these values, Gills Onions completed a zero waste analysis of its processing facilities with the Bren School in 2010. Gills Onions is now looking to the Bren School to examine the environmental impacts of its farming operations. In combination with the Bren School 2010 Zero Waste project, this analysis will ultimately provide Gills Onions with a comprehensive understanding of the environmental impact of their business from the seed to the finished product.

This project will collect and analyze data from the three California growing regions in Monterey, Fresno and Imperial Counties as well as an onion bulb production facility located in the state of Indiana. Currently, the three growing regions have different record-keeping practices for things such as water and agrochemical use. We will assess Gills Onions’ current farming practices in terms of the following:

1) Establish a baseline of the current inputs used in farming operations including:
   - Water use: quantify amount used and source of water, irrigation practices
   - Soil enhancements and management practices: fertilizer, tillage practices, crop rotation etc.
   - Pest management: pesticides, herbicides, fungicides
   - Energy use and efficiency: farm machinery, transportation, cooling and storage

2) Quantify and assess the environmental impacts of these inputs, including:
   - Atmospheric emissions
   - Water quality issues
   - Water consumption
   - Impacts on biodiversity
3) Identify opportunities for improvement/efficiency measures that would lessen environmental impact of the operation and result in cost savings for the business.

4) Provide recommendations that the client can share with the broader agricultural industry including The Stewardship Index for Specialty Crops (SISC).

5) Examine current policy and market forces that may affect their operations.

This project will directly benefit growers contracted with Gills Onions, and will be useful for California agriculture as a whole. A farmer’s bottom line is affected by paying for inputs such as water, fertilizer and fuel. By collecting a baseline of inputs and suggesting improvements, this project will supply growers and Gills Onions with information that will allow them to use resources more efficiently and save money. The methodology used in this study will guide growers contracted with Gills Onions on how they can easily track and report their resource use.

Project Objectives

The main objective of this project is to establish the baseline of inputs used for Gills Onions current farming operations. The project scope begins with bulb propagation and includes soil preparation, planting, harvesting and sorting. It ends with transport of fresh onions to the processing plant door. Our analysis boundaries will include the seedling propagation facility in Indiana and the three growing regions in California:

- Brawley, Imperial Valley
- King City, Salinas Valley
- Huron and Firebaugh, San Joaquin Valley

**Objective 1** - This study will serve as a pilot project for the Stewardship Index for Specialty Crops (SISC) and will collect baseline data in the following categories:

- *Water use:* quantify use of water, determine sources and irrigation practices
- *Soil, nutrients, and water quality:* quantify use of fertilizer, examine soil preparation and tillage practices, and assess water quality issues
- *Pest management:* quantify use of pesticides, herbicides, and fungicides.
- *Energy use and air quality:* quantify fuels and atmospheric emissions from machinery, transportation, cooling, and storage
- *Waste:* quantify waste generated in production process
- *Biodiversity analysis:* vegetative cover and land management practices.

**Objective 2** - After establishing a baseline for each region, we will quantify and assess the environmental impacts of the growing operations from a life cycle perspective.
Objective 3 - We will identify opportunities for increasing efficiency of water, energy, fertilizer, and pesticide use, and suggest alternative management practices that will reduce resource consumption. We will also analyze the cost benefit ratios for these various solutions to identify ones that may be cost-neutral or cost-saving over the short or long term. This will both lessen the environmental impact of the operations and result in cost savings for the business.

Objective 4 - We will create a final report and presentation containing recommendations to Gills Onions that can also be shared with the broader agricultural industry, including the SISC forum.

Project Significance

Since its inception 25 years ago, Gills Onions has been firmly committed to environmental stewardship and leadership. The company has been recognized for innovation and excellence in sustainability by the Energy Solutions Center, the California Environmental and Economic Leadership Award bestowed by Governor Schwarzenegger, and the Golden State Award for Engineering Excellence from the American Council of Engineering Companies. In accordance with these values, Gills Onions completed a zero waste analysis with the Bren School in 2010. Zero waste encompasses a strategy that aims to maximize recycling, minimize waste, and reduce consumption of materials, energy and water.

Gills Onions is motivated to pursue zero waste initiatives not only because of increasing customer demand, regulatory pressures and economic incentives, but also because it wants to be accountable for its environmental impacts. In order to meet these market demands and serve as a leader in sustainability, Gills Onions now wants to evaluate and understand the environmental impacts of its growing operations, but currently does not have the capacity to do so. In combination with the Bren School 2010 Zero Waste project, this analysis will ultimately provide Gills Onions with a comprehensive understanding of the environmental impact of their business from the seed to the finished product.

The first step towards assessing resource use is to establish a baseline of current practices. This project will collect and organize data from three growing regions in Monterey, Fresno and Imperial Counties. Currently the three growing regions have different record-keeping practices for things such as water and agrochemical use. Gills Onions does not have the manpower to consolidate these records, nor do growers have the time to calculate more advanced resource usage such as energy consumption. The methodology used in this study will guide growers contracted with Gills Onions on how they can easily track and report their resource use.

This project will directly benefit growers contracted with Gills Onions, and will also be useful for California agriculture as a whole. A farmer’s bottom line relies on paying for inputs such as water, fertilizer and fuel. By collecting a baseline of inputs and suggesting improvements, this project will supply Gills Onions and the agriculture community at large.
with valuable information that may allow them to use resources more efficiently and save money.

In addition, farmers are faced with increasing demand from parent companies, consumers, and government agencies to demonstrate the sustainability of their operations. To meet this demand, it is essential that growers, parent companies, and policy makers know how to report and evaluate the environmental impacts of their operations. The Stewardship Index for Specialty Crops (SISC) is currently developing metrics to help the industry measure, communicate, and track sustainability. The SISC is a consortium of stakeholders, including growers, suppliers, trade associations, environmental and public interest groups, and university researchers. The SISC project does not aim to identify a level of performance that is "sustainable" but to provide ways to record practices and increase sustainability. Our project has been chosen as an official pilot project for SISC. We plan to provide feedback on the value and relevance of these metrics to SISC and compare their reporting to our more advanced analysis. Ultimately, this Bren group project will contribute to the development and advancement of the knowledge needed to promote sustainable agriculture in California.

**Stakeholders**

This study offers the opportunity to link with other professionals interested in reducing the environmental impact and increasing the efficiency of farming operations. The Stewardship Index for Specialty Crops serves as a gateway to over 400 people signed up to contribute to their metrics. These include:

- Environmental organizations such as American Farmland Trust, Defenders of Wildlife, Environmental Defense Fund, and World Wildlife Fund. Growers, suppliers, and trade organizations include Community Alliance with Family Farmers, Produce Marketing Association, United Fresh Produce Association, Western Growers Association, and the Wine Institute.

- Large purchasers such as Wal-Mart, Sysco, Heinz, and the Food Marketing Institute are also keeping abreast of the SISC metrics and contributing to their formulation.

- Government and university organizations including: the Sustainable Agriculture Information Service, the Natural Resource Conservation Service, UC Davis Sustainable Agriculture Research and Education Program, the University of California Cooperative Extension Agents.

**Literature Review**

**Agriculture in California**

California produces nearly half of U.S.-grown fruit, nut, and vegetable crops and leads the nation in farm revenues. In 2008, the industry generated $36.3 billion in revenue and $100 billion in associated economic activity. About 25.4 million acres are cultivated in the state, covering about 25% of the total land area. California also leads the country in onion production, growing 35% of the U.S. total. In 2008, over 45,000 acres were planted with
onions in Fresno, Imperial, Los Angeles, Kern, Monterey Counties, generating a net income of $267,707,000 (NASS, 2008). While agriculture is a significant source of revenue for the state's economy, it does come at an environmental cost. From 2003 to 2009, vegetable production (in tons) in California has increased by over 42% while cropland area has increased by only 7.5% (NAAS 2010). The expansion of the industry has been accompanied by large increases in water, fertilizer, pesticide and fossil fuel energy use. Each of these inputs raises a number of associated environmental consequences and political issues.

Population growth and climate change pose additional threats to agriculture in the state. California's population could increase by anywhere from 7.5 to 33 million people by 2050 (CDWR 2009). This will increase the demand for food in the state, while diminishing oil and water supplies could lead to increases in food prices. Climate change models predict that the state will have an increase in temperatures of 1.5-4.5°C by 2100, a mean annual change of 0.05°C. In this timeframe, spring snow pack in the Sierra Nevada is expected to decline by 30%-40% (Hayhoe et al., 2004, Mote et al., 2005). Scientists predict that this will change the type of crops grown in the state, decrease crop yields, spread pests and invasive weeds, increase soil erosion and diminish productivity of agricultural lands. A study conducted by the California Climate Change Center applied the Statewide Agricultural Production Model and predicted that by 2050, the effects of climate change will reduce irrigated land by 20%, water availability by 20%, and overall farm revenues by 11% (Hewitt et al., 2009). In addition to these direct costs of water, the levees in the Delta region are in dire need of repair and could fail in the event of an earthquake. Homes and farms could be flooded by brackish water, ruining valuable property and farmland (Buchanan 2009).

**Water**

Water use and allocation has been a constant battle in the state, and today's politicians are tasked with balancing the water needs of 24 million Californians, providing irrigation water for the $36 billion/year agricultural industry, and leaving sufficient instream flows to sustain ecological health (Howitt and Sunding, 2003). Three consecutive years of drought between 2007 and 2009 left state reservoirs at an average of 68% of total capacity. Although 2010 was a wet year, due to past water scarcity, according to the California Department of Water Resources (CDWR) "an estimated 6,900 to 8,900 jobs will be lost, with income losses between $486 and $619 million... and groundwater pumping costs are forecasted by DWR modeling to increase between $109 and $115 million" this year (CDWR 2010a).

Approximately 80% of California’s water is used to irrigate 9.85 million acres of land (CDWR 2010a). Because agriculture is such a large user of water in the state, this sector has a significant environmental impact on ecosystems that depend on freshwater resources. A complex system of dams and aqueducts are the basis for 80% of the state's water use. These structures have a host of environmental impacts, including altering the natural flow of rivers by reducing instream flows, altering the timing of runoff, and impairing aquatic and riparian habitats for fish and other species (CDWR 2009a). The diversions are so drastic that the Public Policy Institute of California calculated that there is a 70 to 90% chance that fall-run salmon fisheries in the Central Valley will not be viable by 2050. Battles have played out in the courts, pitting environmentalists interested in protecting endangered species such as the delta smelt against farmers protecting their livelihood (Grader 2010).
Another environmental impact of agricultural water use is the over-extraction of groundwater in the Delta region and the Salinas Valley. This has lowered the water table elevation to below sea level and created saltwater intrusion in wells, threatening this valuable resource for future generations. The California Department of Water Resources estimates that about 2 million acre feet more ground water is pumped each year from underground aquifers than naturally recharges (CDWR 2009b).

In addition to in-state waters, the Colorado River supplies 17 million people in Southern California and is the basis for agriculture in this part of the state. In 2005, California used about 3.5 million-acre-ft from the Colorado River, about 21% of the total river water allocated between seven states and Mexico (CDWR 2009a). Since California is at the end of the line, it has been able to use more than its allocation in years when other states did not use their entire allotment. In recent and dry years however, southwestern states have begun to use their full allotment of water and at times river does not make it to its outlet at the Gulf of California. Water diversion has taken its toll on the estuary near the Colorado River mouth, and has reduced wetlands and riparian forests there by 90% of the pre-dam extent. Scientists calculate that to sustain avian and aquatic species of concern at the river’s mouth, baseflow of 50,000 acre-feet annually is required, with an occasional flood of at least 260,000 acre-feet in May or June (Wheeler 2007).

Salts from natural sources and agricultural runoff carried in the Colorado River also pose environmental harm to aquatic life. Under Section 303 of the Clean Water Act, states must monitor water quality parameters including salinity every three years. Saline waters also threaten farms and can lead to salinization, water logging, and alkalinization of soil; these processes reduce the productivity of the land (Schuck 2006).

Water use Efficiency Strategies

Excessive irrigation wastes water and money, can leach out important nutrients such as nitrogen, reduces root growth, and causes water logging and salt buildup in the root zone. Insufficient irrigation reduces the productivity of the soil and lowers evapotranspiration in plants, reducing crop yields and farmer income (CDWR, 2010b). Postel (1997) estimates that technology like precision sprinklers and drip irrigation systems can increase efficiency by 60-70%. The California Water Plan 2009 Update estimates that efficiency could save up to 0.1-0.8 million acre feet of water per year (a total savings of $0.3-4 billion through 2030) and that 3.8 million acres in California could be converted to micro-irrigation (CDWR 2009a).

According to the University of California at Davis Vegetable Research and Information Center, an onion crop requires 61-76 cm of water. Irrigation technologies used in the state include sprinkler, furrow, and surface/subsurface drip, also known as microirrigation. Decades of research indicate that drip irrigation is the most efficient way to irrigate onion crops (Ayers 1999, Patel et al. 2009, Al-Jamal et al. 2001). Onions roots are typically unbranched and shallow, less than 30 cm deep, and subsurface drip irrigation applies water directly to the root zone. This can reduce water and nutrient runoff and evaporation, improve yield and crop quality, reduce fungal diseases, and allows for greater control of the applied water (Ayers et al. 1999). In experiments, Patel and Rajput (2009) found the most effective depth for growing onions to be 10 cm. After planting seeds, the ground must be
kept moist until germination occurs, taking anywhere from 10-21 days (Voss, 1999). After
the initial pre-emergent phase, irrigation proceeds as needed (usually 1-3 times/week) until
maturity, where the tops of the onions fall over. Near the time of harvest, growers must
carefully adjust irrigation needs: yields will be reduced if the plants are under-watered, and if
over-watered onions can split, cause decay, or delay maturity (Voss, 1999).

To create an irrigation scheduling plan, farmers rely on weather reports, field based
assessments and technology. Growers in California are aided by 120 weather stations
managed by the California Irrigation Management Information System (CIMIS). CIMIS is an
online database which collects and stores measurements of solar radiation, air temperature,
relative humidity and wind speed, taken every minute. The system also estimates parameters
such as evapotranspiration, which farmers can use to calculate their plant watering needs
(CDWR 2010). A sight inspection of the health of the crop is another important means to
determine watering needs.

In-field measurements include the Feel and Appearance Method, whereby growers analyze
the soil texture and water content by touch and compare it to guidelines set by the Natural
Resource Conservation Service. Growers can also take soil cores with a hand-push probe
and calculate the total moisture using the Gravimetric Weight Method. Software for smart
phones is being developed to help growers determine the diameter of emitters that will help
them use water more efficiently (Molina Martinez et al. 2009). Electrical resistance blocks,
granular matix sensors, tensiometers, and data loggers are more advanced technologies
available to farmers, with costs ranging from $25 to $500. High value crops and large farms
employ more expensive means of monitoring irrigation and fertilizer needs, including using
remote sensing, time domain reflectometers, and infrared thermometry (Morris, 2006).

**Fertilizers**

According to the National Agricultural Statistics Service, in 2006 approximately 9.7 million
lbs of nitrogen, 4.5 million lbs of phosphorous, 798,000 lbs of potash, and 715,000 lbs of
sulfur fertilizers were applied to onion fields in California (NASS 2008). While agricultural
non-point pollution consists of many pollutants, such as metals, pesticides and sediments,
nutrients are of particular concern because of their detrimental effect on water quality. The
Environmental Protection Agency states that "agricultural nonpoint source pollution was the
leading source of water quality impacts on surveyed rivers and lakes, the second largest
source of impairments to wetlands, and a major contributor to contamination of surveyed
estuaries and ground water." (EPA 2005). This non-point nutrient pollution can be directly
traced back to agricultural fertilization practices.

One of the most pervasive problems with agricultural fertilizers in California is the observed
increase in nitrate levels in surface waters and groundwater resources. California has
designated specific “Nitrate sensitive areas” where nitrate pollution has been identified as
especially detrimental, Salinas Valley as well as the east side of the San Joaquin can both be
found on this list. These areas are deemed “sensitive” for two reasons: either they have very
high levels of nitrate contamination or they have a high number of people who rely on local
water resources as drinking water (CDFA, 2010).
In addition to the water quality impacts of fertilizer use, there are also the resulting greenhouse gas emissions of nitrous oxide (N\textsubscript{2}O). N\textsubscript{2}O has a global warming potential that is 296 times that of carbon dioxide (IPCC 2006). This potency is derived from its persistence in the atmosphere (120 days), its heat trapping effects, and its contribution to ozone destruction (USEPA 2007). N\textsubscript{2}O currently accounts for 6% of the total amount of greenhouse gases emitted globally (IPCC 2007).

Nitrogen application for onions in California ranges from 100 – 400 lbs/acre. Phosphorus application rates can be as high as 200 lb/acre in deficient soils. Cow manure is also commonly applied at a rate of 5-10 tons/acre to provide early season nitrogen and micronutrients (Voss, 1999). Generally, fertilizer ratios for the California onion planting season are as follows: 1/3 at planting, 1/3 at 3-4 leaf stage, 1/3 at mid season (Voss, 1999). Applying excess nitrogen late in the season can cause problems such as delayed maturity, decreased storability, and splitting. Since onions are highly sensitive to ammonia, fertilizers with high ammonia content should be avoided. Tests such as petiole analysis can be conducted to determine nutrient needs; however, direct observation of the crop appears to be a more common way of determining a crop's nutrient demands.

**Fertilizer Strategies**

Site-specific management of fertilizer application can improve fertilizer efficiency and effectiveness. This involves determining an appropriate amount of fertilizer based on crop type, climatic variables, and soil chemistry. Practicing site-specific fertilizer management ensures crop yields and reduces the amount of residual fertilizers in soils. In addition to the benefit of reduced N\textsubscript{2}O emissions, this strategy also improves water quality of nearby water bodies.

Given the cost of fertilizers, it would be advantageous for Gills Onions’ growers to reduce their application rates where feasible. Moreover, it would behoove growers to understand political drivers and mandates such as impending Total Maximum Daily Loads (TMDLs), to reduce excess fertilization due to proximity to sensitive drinking supplies. Wang and Keller (2007) have created a model, AgInput, that allows for a more detailed quantitative understanding of fertilizer needs and appropriate application rates. This model may be utilized as a tool to identify growing regions where fertilizer savings are possible. Furthermore, a simplified AgInput model could be tailored to design more efficient fertilizer programs for Gills Onions growers based on the soil types, crop variety, etc. in each region.

**Pesticides**

Some of the major environmental impacts of agriculture derive from the use of pesticides, a broad category including agrochemicals such as insecticides, fungicides, and herbicides. In 2006, onion farms in California used a total of 65 tons of herbicides, 26.5 tons of insecticides and 72 tons of fungicides (NASS, 2007). The top five counties in California, in order of most pesticides used in 2007, were Fresno, Kern, Tulare, Monterey and Madera (Brooks, 2008). All five support a large amount of agriculture.
While pesticides have played an important role in increasing the productivity of agriculture, they also introduce the risk of a variety of significant effects on humans and on other organisms in the environment. Pesticides are, by design, highly toxic compounds. In humans, exposure to different pesticides may raise the risk for a range of both short and long-term detrimental health effects, including sensory symptom disruption, ocular irritation, dermatologic reactions, liver damage, respiratory problems, increased cancer risk, risk to the fetus, endocrine disruption, immunological impacts, and many others (Calvert, 2008; Gilden, 2009). Farmers and farm workers are at a particularly high risk given their high levels of exposure during mixing, application, or coming into contact with pesticides during other duties.

It is not only humans who are at risk, because pesticides often migrate into the surrounding environment. Other organisms bear a large share of the unintended consequences of pesticide use. There are numerous examples of species whose populations have suffered significantly from pesticide contamination. The California condor is a classic example of a species that is on the brink of extinction primarily due to its consumption of a pesticide, DDT, that thins the eggshell and prevents birds from hatching successfully (lpfw.org). DDT has since been outlawed and is no longer used in this country. However, there is evidence that even legal and cutting-edge pesticides can cause significant harm. One study of the relationship between biodiversity loss and pesticide use found that the hot spots of species loss in Canada contained 90% of their herbicide treated croplands. The statistical effect of herbicides was significant above and beyond the effect of agriculture, population density, and habitat loss (Gibbs, 2009).

Pesticides often end up in water bodies as a result of runoff, and can be highly toxic to aquatic organisms. One study of soils in California’s Central Valley detected pyrethroid pesticides, a particularly hydropophobic and toxic type of pesticide that has been increasing in use, in 75% of the sediment samples (Weston, 2004). Pesticides that are relatively insoluble in water also have the potential to bioaccumulate, which results in the toxin becoming increasingly more concentrated in organisms higher up in the food chain. Another problem with pesticides is their potential persistence in the environment. This persistence means that they can continue having harmful effects for many years after they are applied (Pepper, 2006).

There is also the danger that pests may become immune to pesticides over time, amplifying pest problems and creating the need to use increasingly toxic pesticides to compensate or increase tilling practices, which results in increased erosion. This problem is currently occurring with the popular weed killer glyphosate, better known as Roundup (Nueman, 2010).

Pesticide Strategies

Given the potential for such serious health and environmental effects, there is a movement towards looking for ways to decrease pesticide use and integrate it with non-toxic approaches to pest control. This method is generally referred to as Integrated Pest Management (IPM). IPM involves using a combination of techniques to reduce pesticide application. Prevention, by employing methods like crop rotation and planting pest-free
stock, is also important. Once the decision is made to use pesticides, an effort is made to use less toxic ones and ones that are specifically targeted to the pest in question, thereby decreasing the potential for unintended effects (epa.gov).

Gills Onions' growers, like most farmers, depend on pesticides to prevent and treat pest infestations. Onions are particularly susceptible to certain pests in California, such as thrips, onion maggots and the diseases downy mildew, pink root, and other bacterial rots (Voss, 1999). Onions are also uniquely vulnerable to weed infestation since they have a very long growing season, inviting both summer and winter weeds, and because it takes them such a long time to establish complete ground cover (Voss, 1999). It is customary to treat for weeds with a pre-emergent herbicide, and to treat for other pests with a combination of preemptive and responsive pesticide applications (Voss, 1999). Gills Onions is concerned about the potential impact of these pesticides, and wants to reduce the potential for negative consequences. Our group will assist them by researching the toxicity of the specific pesticides they are currently using and investigating ways in which they can reduce their pesticide use.

Energy Use

In the United States, agriculture is largely supported by the use of non-renewable resources (Pimentel, 2008). Estimates of agricultural consumption of fossil energy range from about 1% to 7% of the total fossil energy consumption of the United States (Schnepf 2004; Heykoop, 2001; Pimentel 2008). According to the EPA, agriculture also contributes about 15% of the total U.S. greenhouse gas emissions; including 30% of all CH\textsubscript{4} emissions and 76% of N\textsubscript{2}O emissions (EPA 2009).

Energy use in agricultural production can be divided into two categories: direct uses and indirect uses. In 2002, about 65% of the energy used in agriculture was consumed as direct energy, mainly in the form of diesel, gasoline or electricity (Schnepf, 2004). This energy was consumed by onsite growing operations including field preparation, chemical application, harvesting, storage and cooling (Hulsbergen et al., 2001). Diesel fuel is the dominant direct energy source, and made up about 27% of farm energy use in 2002 (Schnepf, 2004). Diesel is used to power farm machinery including tractors, combines, mowers and large trucks (Pimentel, 2002). The second largest direct energy source is electricity, used to power onsite facilities as well as small operating equipment such as irrigation pumps. In California, irrigation can consume a significant amount of energy, in some cases accounting for 70% to 90% of electricity use in crop farming (Brown, 2005; De Gryze et al., 2009). Finally, gasoline, natural gas and liquefied petroleum comprise the remaining 17% of energy consumed to power small vehicles, equipment and other operations (Schnepf, 2004).

Indirect energy use refers to fossil energy consumed beyond the farm for manufacture of production inputs, including fertilizers, pesticides, equipment and seed stock (Hulsbergen et al. 2001). The most significant indirect use of energy is synthetic fertilizers, particularly nitrogen fertilizer, which is the primary fertilizer used in the United States (Pimentel, 2002). Natural gas is a major feedstock for nitrogen fertilizer, making fertilizer production extremely energy-intensive (Schnepf, 2004). Fertilizers accounted for about 29% of
agricultural energy use in the United States in 2002, but can vary from 33% to 85% of indirect energy use depending on the crop and production practices (Pervanchon, 2002). Pesticides generally make up a much smaller proportion, about 2% of total energy use, (Helsel, 2002) but this figure can vary depending upon the type of pesticide, the crop and the cultural practices of the grower (Pervanchon, 2002).

The energy consumption of equipment production, maintenance and repair has been found to account for about 2.4% of total energy consumed in agricultural operations (Bowers, 2002). Equipment is often considered in lifecycle assessment based energy analysis of food production. However, because growers already have an inventory of machinery, this item is more difficult to address through management practices and is often excluded from sustainability metrics intended for industry use (Pervanchon, 2002). The energy used in seed production is also highly variable and can range from 1% to 13% of indirect energy use (Pervanchon, 2002; Tzilivakis et al., 2005).

There are several important economic and environmental benefits to growers and society as a whole that can be realized by reducing energy use and improving energy efficiency in agriculture. First, energy efficiency is an important cost saving strategy for growers. The share of energy cost in total agricultural operating costs in the United States is around 14.7%, but can vary by product and production method (Schnepf, 2004). Because agricultural operations and inputs are dependent upon fossil fuels, rising fossil fuel prices will likely result in increased costs of production for agricultural operations across the country (Heykoop, 2001). Reducing energy use and employing energy efficient technologies can result in important cost savings for growers. Furthermore, reducing dependence upon external energy inputs is an important risk management strategy that can protect growers from variability in energy and fuel markets.

Second, reducing fossil energy use in agriculture is an essential element in reducing greenhouse gas emissions and improving air quality both locally and regionally (Tzilivakis et al., 2005). Growing concerns regarding global climate change have encouraged development of energy efficiency technologies and renewable energy sources for use in agriculture (University of California Davis, 2009).

Energy Use Strategies

The first step in reducing energy use is to evaluate and understand major sources of energy use in an agricultural operation. Assessing current energy use establishes a baseline and allows growers to identify and prioritize areas to target energy use reduction (Brown and Elliot, 2005).

Once the baseline is established, there are a wide range of strategies, practices and technologies that growers can implement to reduce energy use and improve the energy efficiency of their operations. The greatest area for potential energy efficiency improvements is in field operations. Direct energy use can be reduced through the implementation of more energy efficient vehicles and equipment. For example, installing a pump system with more efficient motors has the potential to improve irrigation pumping efficiency by 20% (Pacific Gas and Electric, 1997).
Renewable energy sources such as solar, wind and biofuels can further reduce dependence on fossil fuels as a direct energy source. Numerous vineyards in California have installed photovoltaic systems to power harvesting and processing equipment and warehouses; now some crop farmers in the state are beginning to follow suit (Glover, 2010).

Indirect energy use can be reduced by encouraging crop management practices that reduce the amount of chemical inputs required (Pimentel, 2008). Practices such as reduced tillage, cover cropping, crop rotation, and composting that encourage soil conservation and nutrient retention can decrease the amount of synthetic fertilizers that need to be applied to a crop (Pimentel, 2008). These strategies have the dual benefit of reducing the environmental impact of growing operations and resulting in cost savings for the growers (Brown and Elliot, 2005).

**Sustainability Metrics**

Compared to other industrial processes, agricultural production has numerous facets which make it difficult to assess its environmental impact such as its extensive land use, variation in farmer production practices, and reliance on many dynamic natural variables such as soil, temperature, water availability, and the presence of pests (Nemecek and Kagi 2007). Different stakeholder needs, priorities, and values also complicate the assessment of sustainable agriculture. Certain agricultural sustainability metrics may be more appropriate for specific contexts (Wilson et al. 2007). Yet specialized evaluation results in a proliferation of indicators, many of which are not evaluated for their scientific relevance and feasibility, thus reducing their utility and operationalization (Doherty and Rydberg 2002). Furthermore, some methodologies use absolute cut-off criteria which results in an exclusionary system that fails to reward leading sustainable farmers and create incentives for continuous improvements (Snoo 2006). For instance, Gills Onions reviewed certification with such programs as the Food Alliance and Scientific Certification Systems but did not pursue certification because they limited access to conventional growing methods.

The above mentioned factors illustrate that there is a definite need for improving existing market-oriented methodologies to assess agricultural sustainability. Indicators should be comprehensive in environmental themes, take into account the sensitivity of the environment and the farming pressure, highlight the causes of impacts, and enable the elaboration of action plans. Studies demonstrate that indicators which consider a lot of aspects simultaneously are more useful in addressing the complexity of the agricultural systems (Bastianoni et al. 2007). Effective indicators are also categorized as relevant, understandable, reliable and based on accessible data which can be gathered in a timely manner (Sustainable Measures 2010).

**Sustainability Metric Strategies**

Several U.S. organizations including The Stewardship Index for Specialty Crops, Field to Market, and Leonardo Academy have begun recent initiatives to study, measure and implement sustainable practices for the agricultural industry. All three initiatives are
developing indicators to estimate the environmental, social, and economic outcomes of agriculture.

The Stewardship Index for Specialty Crops initiative is an industry-wide, supply-chain focused system of performance-based metrics for measuring sustainability across all specialty crops. The SISC pilot project will test eight out of the eleven draft metrics including Energy (on-farm only), GHG (non-farm only), Air Quality, Pesticides (on-farm only), Water Use, Soil, Nutrient & Water Quality, Biodiversity, and Waste. Draft metrics are still under development for Human Resources; Water Quality and Water Use (non-farm); Energy and GHG (non-farm); Pesticides (non-farm); Packaging; Green procurement and fair price; and Community (SISC 2010).

The Field to Market initiative is organized and facilitated by the Keystone Center, a non-profit dedicated to developing collaborative solutions to societal issues. While SISC is focused on specialty crops, the Field to Market metrics is developing indicators for four commodity crops including corn, cotton, soybeans, and wheat. It has developed national-scale metrics to measure outcomes for five environmental indicators: land use, soil loss, irrigation water use, energy use, and greenhouse gas emissions (Field To Market 2009).

At the same time, Leonardo Academy is providing a national Sustainable Agriculture Standard, SCS-001, under the rules of the American National Standards Institute (ANSI). In contrast to SISC and Field to Market which are performance based, Leonardo Academy’s standard also seeks to define best sustainable practices and provides a life-cycle impact assessment tool that encourages producers and handlers to apply the most efficient methods for growing, transporting and handling crops (Scientific Certification Systems 2009).

The SISC initiative is an ideal fit for Gills Onions because of the inclusive nature of its program and its focus on performance-based metrics which allows the company to participate and publicly demonstrate its commitment to sustainability. The SISC initiative eventually intends to harmonize its metrics with those from other organizations. To ensure thorough data analysis and suitability of metrics for Gills Onions, our group will compare SISC metrics and life cycle analysis tools with Field to Market and Leonardo Academy. A goal of the SISC pilot project is to assess the effectiveness of its defined metrics by soliciting feedback through participant questionnaires. To help meet this objective, our group will also provide comments to SISC on the effectiveness of its metrics.

**Policy Implications**

In analyzing the environmental impacts of a farming operation, it is important to consider the environmental regulations that the company faces, to better understand how these restrictions affect the company’s economic decisions, the choice of products that they apply to their fields, and their mobility in making changes. The environmental regulations facing the California farming community range from air quality standards, which affect machinery choices, to water quality guidelines, which may affect establishment of Best Management Practices (BMPs). Farmers also face additional regulations regarding economic trading, food
safety, and farm worker labor standards, which may ultimately impact the resources that can be committed to the greening of their farm operations.

California’s farming community is affected by the Clean Water Act since farming operations represent a significant source of nonpoint pollution in their watersheds. Although the CWA does not directly regulate the discharge of non-point sources, it does establish the framework for states to set TMDL standards. These TMDL standards are unique to a given watershed, and signify the level of pollutants that should be tolerated to enter the waterway, given the waterway’s designated use (EPA, CWA 2010). The Porter-Cologne Water Quality Control Act is California’s policy to regulate all nonpoint sources of pollution, in an attempt to meet the TMDL standards established under the CWA. Porter-Cologne states that any activities or factors that affect water quality are subject to regulation, and establishes The Regional Water Quality Control Boards (RWQCBs) as the regulatory bodies for sources of non-point pollution. Polluters must file a report of waste discharge with their RWQCB to obtain mandatory waste discharge requirements (WDRs). However, the California Water Code allows the RWQCBs to grant conditional waivers for WDRs if the waiver is not against public interest (Gerstein, 2005).

Irrigation return water from agricultural practices falls under a conditional waiver from WDRs. The purpose of this conditional waiver is to establish a preliminary program for agricultural dischargers, in which individual dischargers or coalition groups will evaluate and implement BMPs that will address the water quality objectives of the watershed. Once a greater understanding of BMPs’ effects on water quality is established, the conditional waiver program may lead to the adoption of individual or general WDRs (CCRCD, 2005).

The farming regions that we will be analyzing are each part of different watersheds, which are regulated by separate Regional Water Quality Control Boards (RWQCBs). Each of these RWQCBs have coalitions groups in place to disseminate BMPs within the watershed. Farmers that irrigate their land must either belong to a coalition or obtain an individual WDR permit (San Joaquin Delta and Delta Water Quality Coalition, 2010). Members of the coalition are generally required to report what BMPs they are using and how they are working. Coalitions also organize grower meetings and pesticide application workshops.

In the Imperial Valley, there are ten hydrologically isolated drain shed areas. These are each monitored for TMDL compliance, and each have a coalition group that meets twice a year to discuss BMPs. This systems allows the RWQCB to identify which drain shed areas are in or out of TMDL compliance, what BMPs are being implemented, and how successful these practices are in improving water quality (ICFB, 2010). In the Imperial Valley, the current TMDL concerns are the Salton Sea Nutrient TMDL and the silt/sediments TMDLs for drains and rivers in this region (Khaled, 2009). In the San Joaquin valley, there are TMDLs in place for Selenium levels and Organochlorine (OC) pesticides (CEPA, 2009). In the Salinas watershed, which includes King City, the TMDLs of concern are for the organophosphate (OP) pesticides chlorpyrifos and diazinon and for nutrient loads (California SWRQB, 2010).

California farmers are also very concerned with water allocation policies. The concern has been amplified by recent drought years and restricted water allocations to the Central Valley.
In November 2009, the California legislature passed a four bill and one bond measure package to promote state water projects and restore the infrastructure and ecosystems in the Delta. Within the water package, The Sustainable Water Use and Demand Reduction (SBX7 7) is the main legislation that addresses reductions in agricultural water use through water conservation and efficiency programs. This bill sets significant goals for increasing water use efficiency in cities. However, it is more lenient towards agricultural water suppliers (AWS). The bill requires AWS to create agricultural water management plans by December 31, 2012, 2015 and every 5 years thereafter. Among new reporting guidelines, AWS are required to report current and planned efficiency measures, quantity of water delivered to customers, and demonstrate how customers are charged at least in part based on the quantity of water used. There are many loopholes within the legislation, including Chapter 4, Section 10608.48 which indicates that “Agricultural water suppliers shall implement additional efficient management practices... if the measures are locally cost effective and technically feasible” (SBX7 7 2009).

The agricultural community in Central California has largely come out in favor of the new Water legislation because of the new infrastructure development outlined in the plan, which will provide California with additional water storage areas. The Central California farming community may be less subject to water allocation restrictions in drought years with the construction of a substantial water storage system. In November 2010, California citizens will vote on the Safe, Clean and Reliable Drinking Water Act of 2010, an $11.1 billion general obligation bond that will fund the four bills, including $125 million dedicated to agriculture water use efficiency programs and the construction of water storage facilities (CDWR, 2009).

California farmers must also comply with air quality restrictions imposed by the California Air Resources Board (CARB). New restrictions from the CARB are in development as a result of the amended Toxic Control Measure for Stationary Compression Ignition Engines. These new regulations will set stricter emissions standards to lower the diesel particulate matter (PM) and NOx emissions from farm vehicles (CARB, 2009). According to the CARB, the plan to reduce emissions will be presented to the Board near the end of 2010. The upcoming regulations add to the financial uncertainty that California farmers face; complying to the new standards will mean costly investments in new farm vehicles, or retrofitting of vehicle engines.

When considering the economic investments that onion farmers will be willing to make to increase the sustainability of their operations, it is important to consider financial uncertainty. Aside from the unknown costs of updating farming equipment, or meeting operational standards for BMPs, there is also extreme volatility in the market price of onions. For example, between October of 2006 and April of 2007, onion prices soared 400%. Then, in March of 2008, the onion market price took a 96% crash. This market volatility is due to many factors, including rates of production, and weather variability, but may also in some part be due to the ban on onions futures trading (Birger, 2008).
Approach

Utilizing historical data supplied by Gills Onions farming operations, we will quantify the environmental impact of inputs including: water use, energy, pesticides, and fertilizers. These will be analyzed to determine their contribution to onion crop yields. The timing and application methods for inputs will be characterized across the three regions to identify best management practices that will maximize yields and minimize inputs and waste. Quantifying all the inputs and outputs of the farming operation will create a baseline that will allow Gills Onions to track and improve its sustainability efforts over time. The study will include the following steps:

1. Identify the boundaries of our analysis
   - Consult with Gills Onions to identify which farming operations will be included in our analysis.
   - Perform site visits to all 3 farming regions in Brawley, Imperial Valley; King City, Salinas Valley; and Huron and Firebaugh, San Joaquin Valley.
   - Document and list all farming management practices
   - Consult with SISC to review sustainability metrics
   - Perform a gap-analysis to compare SISC metrics with other sustainable agriculture metrics such as Field to Market and Leonardo Academy's ANSI Sustainable Agriculture Standard (SCS-001).
   - Determine which metrics we plan to include in our evaluation and provide rationale.

2. Establish a baseline for Gills Onions farming practices
   - Obtain farming operation data from Gills Onions. Each farming operation currently tracks and records all farming practices including fertilizer, insecticide and pesticide application, water usage and management practices. At Dresick Farms in the San Joaquin region, information has been recorded using Tiger Jill, an agriculture management software program from Orange Enterprises, Inc.
   - Due to inter-annual climate variability and a four year crop rotation schedule, we will attempt to obtain 10 years of records. We will gather information on precipitation and categorize "Wet, Dry and Normal Year" with information from California Irrigation Management Information Service, the Department of Water Resources or other available sources of data.

   - Water: Collect data about water usage at all 3 of Gills Onions growing regions. The nature of this data may vary by region, but should include information about amount of water applied to crops per day, cost per acre foot of water, and total annual usage. We will analyze water usage in each region separately in order to compare differences based on climate, soil type, onion variety, and water availability.
   - Fertilizer: Collect data for the 3 different regions regarding the types of fertilizers used and what nutrients they supplied. We will consider time of year when they were applied, application methods, and compare soil types between growing regions.
- **Pesticides:** Collect data regarding the different types of pesticides used in each growing region, the amounts used, mode of application, the time of year when they were needed, and the pests for which they were applied.

- **Energy:** Collect data about energy usage at all 3 growing regions. We will be looking specifically at machinery used for tillage, planting, harvesting, refrigeration, and pumps for irrigation. We will also collect data regarding the transport of machinery between growing regions. We will obtain data regarding the amount of fuel used and fuel costs.

- **Waste:** Collect data from all 3 growing regions regarding the onion waste generated from harvesting, storage, and transport to processing plant, including amount, reason why onion became waste, and what was done with onions after they became waste. We will also collect information regarding other types of waste generated as part of growing operations such as irrigation drip tape.

- **Onion Harvest Yield:** Collect data regarding overall harvest yield from each growing region and analyze in relation to the inputs of water, pesticides, and fertilizer.

- **Indiana Operations:** Contact will be made with the Indiana operation from which Gills Onions purchases its pre-grown bulbs, and we will request the same data as listed above, as appropriate given the differences in growing operations since the Indiana operation is presumably taking place in a greenhouse.

3. Analyze the life cycle impacts of Gills Onions' farming practices.

- Perform a life cycle analysis for energy usage of the farming machinery, energy used to transport machinery between growing regions, energy required to produce pesticides and fertilizers, and the fuel consumed in transporting onion bulbs to California from Indiana.

- Use The Climate Registry’s General Reporting Protocol to assess greenhouse gas emissions from stationary combustion, mobile combustion and electricity use for each growing operation.

- Examine the life cycle impacts of the onion waste generated through growing operations.

- Conduct a life cycle analysis for each type of waste measured, such as irrigation drip tape, which is used once per year and then recycled.

- Analyze the environmental impacts of fertilizers and pesticides that may drift into the environment or migrate into water sources.

4. Evaluate potential opportunities for growing operations to reduce both detrimental impacts on the environment and report costs of implementation

- Identify which areas offer the greatest opportunities for optimizing environmental and economic benefits based on above analysis

- Determine specific strategies and technologies to reduce costs and negative impacts

- Conduct financial analysis to determine true cost of implementing solutions by comparing resource use savings versus the fixed capital investment costs and variable costs
• Perform scenario analysis and evaluate solutions based on estimates of future pricing of inputs and policies like cost sharing programs
• Categorize effectiveness of solution as either neutral or raised cost

➢ Water: Analyze water usage against crop yield to determine if it is possible to grow onions with less water intensive practices, and investigate potential water reduction strategies such as measurement of soil moisture levels.
➢ Fertilizers: Evaluate the usage of slow-release fertilizers. We will consider the different soils found in each growing region to see if we can identify fertilizers that target the specific nutrient needs of onions in that region. We will also analyze the relationship between harvest yield and input levels of water, pesticides, and fertilizer to see if there is an optimal range for each input that maximizes harvest yield with minimum harm to the environment.
➢ Pesticides: Assess the use of less toxic or more targeted pesticides as well as the use of Integrated Pest Management techniques.
➢ Energy: Examine farm machinery fuel efficiency at varying speeds and make recommendations regarding optimal speeds. The USDA National Resources Conservation Service has a tillage energy estimator that compares the energy implications of conventional tillage versus alternative tillage techniques, which will aid us in doing a full analysis of this possibility.
➢ Waste: Determine the major sources of waste, and look for ways to reduce material waste, increase reuse or recycling, reduce loss of onions to waste, and consider possible alternate uses for onion waste.

5. Make Recommendations

• Report findings to Stewardship Index for Specialty Crops. We will use the SISC data collection methods as a guide in the collection of our baseline. As we carry out the project, we will provide them with feedback regarding the metrics including their ease of use and applicability.
• Review recommendations with Gills Onions.
• Create guidelines for growers contracted with Gills Onions to report resource use.
• Give recommendations to growers on implementing best management practices.

Deliverables

The group will produce a set of deliverables providing the following information:

• Assembly of data files and paperwork necessary to participate in the pilot study of the Stewardship Index for Specialty Crops.
• Baseline data regarding the water, fertilizer, pesticide, and energy inputs as well as waste and onion yield for the Gills Onions growing operations and the Indiana seed facility.
• Identification of methods and procedures that will aid Gills Onions in tracking future resource use.
• Identification of areas in which Gills Onions has the potential to improve efficiency and reduce costs.
• Analysis of how current and possible future policies may affect the growing operations.

Group Management & Structure

Group members will hold the following roles for Spring and Summer 2010. Role assignments will be re-evaluated at the beginning of Fall Quarter 2010 and reassignments will be made if necessary.

Project Manager: Brannon Walsh
The project manager will provide organizational methods and delegate tasks to meet project deadlines according to the Timeline described below. The project manager will lead (or delegate another member to lead) all meetings using the agendas as a reference to insure productive and efficient meetings. The project manager will also have final decision making power if the group is unable to reach a consensus.

Financial Manager: April Price
The Financial Manager is responsible for the group’s budget, contracting with any outside contractors or vendors, and all other financial transactions. The financial manager will provide group members with procedures necessary to get reimbursed for travel, printing and other individual uses of group funds.

Data Manager: Seth Lalonde
The Data Manager is responsible for organizing all data saved on the Bren Server, on Dropbox and on Google Docs, for keeping group records up to date and for ensuring uniform file naming.

Web Manager: Jocelyn Gretz
The Web Manager is responsible for maintaining the group website up-to-date and responding to all public inquiries generated by the website.

Secretary: Ashley Henderson
The Secretary is responsible for taking notes at all meetings and recording action items determined at each meeting.

Scheduler: Ashley Henderson
The Scheduler is responsible for scheduling all group meetings, reserving a meeting room and equipment if necessary and sending a notification through email or Corporate Time to all invitees.

Internship Coordinator: Mariah Mills
The Internship Coordinator is responsible for organizing the summer internships with Gills Onions, including duties, schedules, pay rate etc.

Advisor: James Frew
The group advisor will attend one weekly meeting, provide feedback and guidance on group progress and scope, and review all project deliverables as they are due.

External Advisors: Arturo Keller, Sangwon Suh, and Hank Giclas
The external advisors will meet with the group one or two times per quarter to provide feedback on overall project strategy, methodology and technical approach.

Meeting Structure

Frequency
Two regularly scheduled meetings will be held each week, one per week with the Advisor and one without the Advisor. Meetings with the client via conference call will be scheduled once per month.

Scheduling
Meeting time, day and location for regularly scheduled meetings will be agreed upon by the group at the beginning of each quarter based on availability and scheduling considerations. Additional meetings will be scheduled through Corporate Time by the Scheduler.

Agenda
Agendas for meetings will be created in a Google document that is accessible to the entire group. Each group member is responsible for adding their items to the agenda before the meetings begin however, there will be an opportunity at the beginning of each meeting for people to contribute additional items. All members should bring their own copy of the agenda, either a print-out or notes. Agendas will always include the following topics: updates/questions for the Advisor and updates/questions for the client, Gills Onions.

Minutes
The Secretary will be responsible for taking minutes at all meetings including recording action items. The secretary will save a copy of meeting minutes into the Group’s DropBox folder.

Systems to ensure deadlines are met
- All major deadlines will be entered into the group members Corporate Time account by the Project Manager.
- Tasks will be divided among group members and internal task deadlines will be set during the regularly scheduled group meetings.
- At the beginning of each weekly meeting, the Project Manager will briefly review any upcoming deadlines. The Project Manager will be responsible for ensuring that all group members understand their assigned tasks and complete the tasks on time.
- If a group member is unable to meet a deadline, they will notify the group as soon as possible so that necessary arrangements can be made to ensure the task is completed.
**Conflict Resolution Process**
In order to minimize the potential of conflicts arising within the group, all members will to the best of their ability maintain honest and open communication, engage in active listening and show respect for other group members. At the beginning of the weekly group meeting, there will be an opportunity for group members to raise concerns or issues that apply to the group. If a conflict does arise, the conflicting members will attempt to resolve the conflict individually. If this is not successful, these individuals may contact in order the Project Manager, the Advisor, and the Bren Administration.

**Procedures for documenting, cataloging, and archiving information**
Documents, contact information, messages, calendar, website, budget projections, and expenditures must be accessible to all Group Project members. This is an important task. If there are delays or failures, the entire project can be adversely affected.

- Collaborative working documents will be kept in a Google Document until all text has been added, at which point the assigned editor will pull the document into MS Word for final formatting and editing.
- Other shared documents will be saved in the appropriate subfolder of the Group’s Dropbox folder.
- Documents will be named with the date in the international date format YYYYMMDD followed by the file name, and version if needed.
- The Data Manager will be responsible for organizing and maintaining all documents that are archived and kept on the Shared Drive.

**Guidelines for interacting with faculty advisors, external advisors and clients**

*Advisor*
The group will hold a weekly meeting with Advisor James Frew. If there are no pressing matters to discuss with the Advisor in a given week, Professor Frew will be notified via email with a status update for that week and the group may meet alone. All documents will be submitted early enough so that Professor Frew has at least 1 week to review the material and provide feedback.

*External Advisors*
The group will meet with the external advisors at least once per quarter. The scheduler will be responsible for organizing and scheduling this meeting. Individual group members may contact the external advisors if needed for technical advice, and will provide the group with a brief summary of the interaction at the next group meeting.

*Client*
Teleconferences will be held to update the client on the project status at least once per month. More frequent teleconferences or meetings may be scheduled as necessary to address specific issues. The client will be cc’d on all email correspondence to the growing regions, external partners and collaborators.
Milestones

Spring Quarter 2010

<table>
<thead>
<tr>
<th>Task</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Proposal to Advisor and Review Committee</td>
<td>June 1, 2010</td>
</tr>
<tr>
<td>External Advisor Meeting</td>
<td>June 3, 2010</td>
</tr>
<tr>
<td>Final Proposal Review Completed</td>
<td>June 10, 2010</td>
</tr>
<tr>
<td>Web Site Operational and Up to Date</td>
<td>June 11, 2010</td>
</tr>
<tr>
<td>Final Proposal Submitted</td>
<td>June 11, 2010</td>
</tr>
<tr>
<td>Submit Peer Evaluations</td>
<td>June 11, 2010</td>
</tr>
<tr>
<td>1 Page Summary of Proposal Review Meeting</td>
<td>June 11, 2010</td>
</tr>
</tbody>
</table>

Summer 2010

The following tasks will be accomplished by the summer interns:

- Complete site visits to the King City and San Joaquin growing operations.
- Coordinate with SISC to gather the data necessary to participate as a pilot project
- Collect all baseline data regarding water, fertilizer, pesticide, fertilizer, energy use, and waste for three growing regions and Indiana facility.
- Organize all baseline data into appropriate databases.
- If time permits, start LCA analysis and research for pesticides, drip tape and other inputs

Fall Quarter 2010

<table>
<thead>
<tr>
<th>Task</th>
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<tbody>
<tr>
<td>Team Progress Review</td>
<td>Late September 2010</td>
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<tr>
<td>Submittal of materials for SISC pilot</td>
<td>November 1, 2010</td>
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<tr>
<td>Progress Review</td>
<td>Mid November 2010</td>
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<tr>
<td>Written Progress Report</td>
<td>Early December 2010</td>
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<td>Peer Evaluations</td>
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Winter Quarter 2011

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<tr>
<td>Draft of Final Report to Advisor</td>
<td>5th week of Winter Quarter</td>
</tr>
<tr>
<td>Program Abstract to GP Coordinator</td>
<td>End of Winter Quarter</td>
</tr>
<tr>
<td>File Final Report with Bren School</td>
<td>End of Winter Quarter</td>
</tr>
<tr>
<td>Project Brief</td>
<td>End of Winter Quarter</td>
</tr>
<tr>
<td>Project Poster</td>
<td>End of Winter Quarter</td>
</tr>
<tr>
<td>Peer Review Evaluations</td>
<td>End of Winter Quarter</td>
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<tr>
<td>Advisor Evaluations</td>
<td>End of Winter Quarter</td>
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Spring Quarter 2011

<table>
<thead>
<tr>
<th>Task</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft Power Point to Advisor</td>
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</tr>
<tr>
<td>Invitations</td>
<td>TBD</td>
</tr>
<tr>
<td>Public Presentation</td>
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**Budget**

<table>
<thead>
<tr>
<th>Operational Costs</th>
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<tbody>
<tr>
<td>Transportation*</td>
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<tr>
<td>Phone Calls</td>
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<td>Miscellaneous</td>
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<table>
<thead>
<tr>
<th>Presentation and Printing Costs</th>
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<tbody>
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<td>Printing</td>
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<tr>
<td>Poster</td>
<td>$300</td>
</tr>
</tbody>
</table>

| Total Project Costs          | $1230  |

*Gills onions will reimburse group members for transportation costs.

Budget Justification:

Transportation:
We plan to travel to each of the three growing regions and to the Oxnard processing plant on an as needed basis. We will use our transportation budget to cover these costs.

Phone Calls:
We will plan conference calls with our client and advisory committee on an as needed basis. Our budget will cover these costs, allowing us to host calls from Bren.

Miscellaneous:
We foresee incidental costs arising, including purchases of supplies and/or services.

Printing:
We plan to divide the $200 allocated for printing costs among each of the six group members. This money will be used for day-to-day printing of literature and document drafts. We have budgeted a total $300 for the final printing of our project poster and briefs.

Poster:
We have allocated $300 towards the printing of our final poster and additional drafts.
Thank you to our Advisor, Professor James Frew, Bren School of Environmental Science & Management, and our External Advisory Committee:

Arturo Keller, Bren School of Environmental Science & Management
San Won Su, Bren School of Environmental Science & Management
Hank Giclas, Western Growers
Andrew Arnold, Sure Harvest
Rob Neenan, United Fresh Produce Association
Works Cited


CCRCD- Contra Costa Resource Conservation District “Conditional Waivers of Waste Discharge Requirements For Discharges from Irrigated Lands Within the Central Valley Region” (February, 2005). Retrieved May 14, 20101 from http://www.ccrcd.org/Irrigated%20Ag/Ag_Waivers.htm#Rationale


SBX7 7. 2009. California State Legislature, Seventh Extraordinary Session


