Hedging Our Bets on Urban Agriculture: A Cost-Benefit Analysis of the UC Gill Tract Community Farm

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ABSTRACT

Urban agriculture has grown in popularity as the solution for all the economic, social, and environmental problems of increased urbanization. However, it often diverts scarce resources away from other necessary urban development projects such as housing, infrastructure, and businesses. Although other qualitative studies found that urban agriculture has many social benefits, few studies have attempted to perform a full cost-benefit analysis on an urban agriculture project that also includes its economic and environmental impacts. This makes it difficult to compare urban agriculture projects to other development projects for land-use planning purposes. The UC Gill Tract Community Farm (UCGTCF) was selected for a cost-benefit analysis because it was established through a land-use conflict and no studies have been conducted before to measure its value to the community. Using a willingness-to-pay survey, field observations, and harvest yield tabulation, I found that for the 2014-2015 growing season, the UCGTCF had an economic value of -$63,695 based on marketable goods and services, but when nonmarketable goods and service were factored in, the UCGTCF had a total value that ranged from $285,186.92 - $556,136.46. In addition, certain categories of goods and services tended to be more influential on farm participants' experiences at the UCGTCF than others. The results of this analysis indicate that the UCGTCF is a valuable investment of resources by the local community, and demonstrates that nonmarket valuation systems have the potential to influence policy by leveling the playing field between for-profit and non-profit projects like urban agriculture.

KEYWORDS

environmental economics, non-market valuation, urban agriculture, urban land-use conflict, community development

INTRODUCTION

Increased urbanization around the world is putting enormous pressure on local, regional and global ecosystems through intensified use of resources and waste production. The industrial food system greatly contributes to this pattern of unsustainable growth by separating food consumers from producers, blinding both to the environmental, economic, and social consequences of large-scale monoculture. Consequently, there has been a push to develop more sustainable food systems, especially local or regional food economies centered around self-sustaining cities (Donald et al. 2010). Urban agriculture is currently a popular means of developing local sustainable food systems in cities. Supporters of urban agriculture claim it provides numerous benefits and can solve many of the problems associated with the industrial food system. However, urban agriculture projects must compete with other development priorities for access to land, resources, and funding, and deal with unfavorable zoning and land use policies (Angotti 2015). Many question the value of directing scarce resources to urban agriculture, which they see as a high-cost, low-return venture, and diverting resources from projects that fulfill pressing urban needs, like low income and market rate housing, or projects with high profitability. Therefore, creating support for urban agriculture as a policy priority for sustainable cities requires policy makers to determine whether urban agriculture projects are actually a good use of resources.

We lack rigorous research, and particularly quantitative data, to assess the relative costs and benefits of urban agriculture (Rogus and Dimitri 2015). Many qualitative studies support the claim that urban agriculture provides social benefits (Draper and Freedman 2010). For example, urban agriculture can promote health (Armstrong 2000, Brown and Jameton 2000, Alaimo et al.

2008, Poulsen et al. 2014), enhance education and youth development programs (Wright 2006, Allen et al. 2008, Brown-Fraser et al. 2015, Weissman 2015), increase cultural exchange (Poulsen et al. 2014), improve community relations and atmosphere (Ohmer et al. 2009, Flachs 2010, Okvat and Zautra 2011, Carney et al. 2012, Poulsen et al. 2014, Brown-Fraser et al. 2015), and beautify urban landscapes (Poulsen et al. 2014). There are fewer studies on the environmental and economic benefits of urban agriculture. However, those studies do suggest that urban agriculture has the potential to mitigate air pollution and carbon emissions, (Lin et al. 2011), increase biodiversity (Clarke and Jenerette 2015, Potter and LeBuhn 2015), and stimulate local economic growth (Brinkley 2012, Algert et al. 2014, Vitiello and Wolf-Powers 2014). Despite all these potential benefits, the lack of quantitative analyses of urban agriculture projects makes it difficult for urban planners to compare its pros and cons to other projects for decision-making (Draper and Freedman 2010, Laurans et al. 2013, Haase et al. 2014).

The UC Gill Tract Community Farm (UCGTCF), a plot of land owned by the University of California, Berkeley in the city of Albany, has a unique history and context that makes it an ideal site for a quantitative study on urban agriculture's value. From 1889-1928, the land was farmed by the Gill family. After being acquired by UC Berkeley in 1928, it was used for wartime and student housing and agricultural research, including the College of Natural Resources' notable Integrated Pest Management Program (SEAL Students 2014). Budget constraints and lack of student housing prompted UC Berkeley to draft development plans for the Gill Tract in 2004 (UC Regents n.d.), sparking protests from community members, students, professors, researchers, and other urban agriculture proponents. These protests cumulated in a farm occupation from April-May 2012 when hundreds of activists, including local community members and students of the Occupy the Farm movement broke into the Gill Tract and began

farming and distributing the food (SEAL Students 2012). Following this high-profile event in addition to some lawsuits and arrests, university officials were willing to negotiate with Occupy the Farm members. The development plan was ultimately amended to transfer the northern section of the Gill Tract to UC Berkeley's College of Natural Resources. In this northern section, the UCGTCF was established in April 2014, and is currently used for food production, community and education events, and research (UC Berkeley Public Affairs 2012a, 2012b, 2012c, 2012d, SEAL Students 2014). However, some advocates also want the southern portion to be included in the community farm, and the UCGTCF's land was guaranteed for only 10 years, after which its use will be reevaluated. Since the UCGTCF's value has not been completely assessed, local policymakers do not have a baseline to compare the farm's value to that of other uses for the land. Therefore, a necessary first step in determining the best use of the land is to measure the full value of the UCGTCF and determine whether it has been a valuable investment of resources thus far.

My central research question is what is the value of the UCGTCF? To answer my central research question, I will pose three subquestions: does the UCGTCF provide the services commonly found in urban agriculture studies? what are the costs and benefits of the UCGTCF? is the UCGTCF a valuable use of scarce resources? To answer these questions, I collected data on the benefits stakeholders believe the farm provides and the benefits they actually experience from the farm, the quantitative value stakeholders place on those benefits, and the costs of operating the farm. By answering these questions, my research provides a minimum starting value for the UCGTCF on which other researchers can build upon for continued evaluation of the farm's value.

History of Urban Agriculture and the Gill Tract

The urban agriculture movement has deep and far-reaching historical roots; Mayan and Aztec cities supported themselves through extensive urban agriculture (Barthel and Isendahl 2013). However, modern urbanization since the 1800s has pushed agricultural activity outside of the city proper, and land use within cities is strictly regulated through planning and zoning ordinances. This has created two spheres of life, the urban and the rural, with intensified land use in both. One product of intensification was industrial agricultural, which is now criticized for contributing to major environmental and public health hazards. In an effort to disenfranchise industrially-produced food and to combat climate change, many people are turning back to urban agriculture as a means of healthier food production (Colasanti et al. 2012, Angotti 2015).

The UCGTCF is a product of the urban agriculture movement. The land on which it sits was originally part of the Ohlone tribe's territory. Then in 1820, it was given as a land grant to a Spanish colonist. The land grant survived the Mexican War for Independence and the Treaty of Guadalupe-Hidalgo, after which the land was parceled out for development. In 1889, Edward Gill bought the remaining 100 acres of land and established a nursery and farmed the land with his family. The land, now called the Gill Tract, remained in the family until 1928 with the death of Edward's son, John. The University of California then bought the land in 1928 and has been the primary land owner until now (SEAL Students 2014).

Under the University of California, the Gill Tract was again subdivided for various development projects, such as Ocean View Elementary School, Albany City Council Hall, and University Village. However, the most significant use of the Gill Tract was for conducting

agricultural research. In 1939, the university allocated 39 acres of the Gill Tract to what was then the College of Agriculture for research. Then in 1944, the university established the Biological Control Experiment Station, where ground-breaking research on biological pest management techniques was performed. Research from this station saved the state of California millions of dollars in combating Klamath weed, for instance, and the site was praised for being the only institution of its time that provided training and research in biological control (SEAL Students 2014). However, as more land and money were diverted toward housing and other capital projects, the Biological Control Experiment Station was eventually closed in 1997 and demolished in 2007 (SEAL Students 2012). The Gill Tract's jurisdiction was given to the university's Capital Projects Division, which manages the university's built environment (UC Regents n.d.). The northern 10 acres of the Gill Tract continued to be reserved for research by the United States Department of Agriculture and faculty of the new College of Natural Resources. The southern portion, where the Biological Control Experiment Station once stood, was converted to recreational fields or left fallow until new development plans were drawn up for approval in 2004, including plans for more recreational facilities, housing, and retail space (SEAL Students 2014).

As the University of California was creating these development plans, local community members, non-profit organizations, and university faculty and students were developing alternatives plans for the Gill Tract. The most significant of these was the Bay Area Coalition for Urban Agriculture's 1997 proposal, which called for a collaborative effort between the University and the Coalition to build a center for sustainable urban agriculture and food systems at the Gill Tract. The center would serve as a research and education hub for both academics and community members (Bay Area Coalition for Urban Agriculture 1997). Although the proposal

did not bear fruit, hopes for a community research center for urban agriculture never disappeared. In April 2012, as the university received approval from the Albany City Council for University Village Senior Living and Marketplace project, members of Occupy the Farm took over the Gill Tract in protest and to demand open dialogue for alternative uses of the land (SEAL Students 2012). At first the university responded with eviction notices and police action, but ultimately agreed to dialogue. In September 2012, the northern portion of the Gill Tract was transferred from the Capital Projects Division to the College of Natural Resources, where Dean Keith Gilless sought to establish a collaborative urban agriculture project with the community (UC Berkeley Public Affairs 2012d). After months of discussion between administration, faculty, students, and community members, the UC Gill Tract Community Farm was formally established with a planting day on April 26, 2014 (SEAL Students 2012) with guaranteed use of the Gill Tract land and support from the University for 10 years. Since then, a Stewardship Council, made up of community members, university affiliates, and volunteer-based working groups has overseen the agricultural activities, research, and educational programming at the farm. However, the controversial nature of the farm's establishment causes some supporters to worry over its future. A thorough investigation of the value created by the farm can help to determine whether the farm should continue operations after the 10-year collaborative deal ends.

Literature Review

As urban agriculture has grown in popularity, so has research on urban agriculture's costs and benefits. There have been many studies on the benefits of urban agriculture projects

throughout the United States, and these benefits can be categorized into three primary groups – environmental services, social and cultural benefits, and economic benefits.

Social benefits are by far the most commonly researched category of urban agriculture benefits, usually in qualitative studies (Draper and Freedman 2010). In public health, urban agriculture provides space and opportunity to promote healthier dietary habits and lifestyles (Armstrong 2000, Brown and Jameton 2000, Poulsen et al. 2014). Specific benefits include increased access to fresh fruits and vegetables (Alaimo et al. 2008), alleviation of food insecurity (Carney et al. 2012, Poulsen et al. 2014), and increased knowledge of food preparation techniques and culture (Poulsen et al. 2014).

In addition enhancing health, urban agriculture can also enhance educational experiences through hands-on learning (Wright 2006). Several studies also recorded positive impacts on youth development (Allen et al. 2008, Brown-Fraser et al. 2015, Weissman 2015). Having a farm on-site or near college campuses provided campus dining facilities with an ultra-local source of food and space to conduct field research in various departments like plant genetics, ecology, and agricultural sciences (Barlett 2011).

Urban agriculture may also promote community building through partnerships between non-profit organizations, charities, churches, educational institutions, and neighborhoods. Participants of urban agriculture projects experienced improved interpersonal relationships, increased sense of community, built stronger social networks (Ohmer et al. 2009, Flachs 2010, Okvat and Zautra 2011, Carney et al. 2012, Poulsen et al. 2014, Brown-Fraser et al. 2015), and even reduced crime (Gorham et al. 2009). Finally, urban agriculture projects were found to improve the aesthetic quality of the neighborhoods in which they were located and they served as sites for recreation and sources of creative inspiration (Poulsen et al. 2014).

Environmental and economic benefits have been less widely studied than social benefits, but there have been some interesting findings regarding these types of benefits. For instance, even small urban agricultural plots may have the potential to mitigate air pollution and climate change (Lin et al. 2011), and urban agriculture has been associated with increased biodiversity because it creates and preserves habitat (Clarke and Jenerette 2015, Potter and LeBuhn 2015). Two other studies discussed the potential for urban agriculture to be a source of economic revitalization (Algert et al. 2014, Vitiello and Wolf-Powers 2014) and only one actually attempted to quantify those benefits, though only for peri-urban farms (Brinkley 2012). Virtually none of the studies reviewed specifically considered urban agriculture's impact on waste, soil and water health, urban heat island effect, the land values, or the value of research grants put into institutional projects, or managed to measure all the costs and benefits of urban agricultural and compare them before and after the projects' establishment. This presents a problem because there is no consistent standard to determine whether an urban agriculture project is a good investment of limited urban resources.

Theory of Environmental Economics

To understand whether urban agriculture is a sustainable and socially beneficial investment, it is useful to quantify its costs and benefits. However, most of urban agriculture's benefits are not easily quantifiable. This is problematic because modern city planners and policymakers make most decisions based on quantitative evidence. The field of environmental economics provides some frameworks to solve this issue. Environmental economics assumes that human behavior and preferences can be revealed through how much they are willing to spend or

be compensated to preserve or forego some environmental good. There are certainly criticisms about putting dollar values to environmental goods that can have infinite existence or aesthetic value, but using environmental economics methods, at least a minimum value can be established as a basis for comparison against other projects (Berck and Helfand 2011, Salles 2011, Wainger and Mazzotta 2011, Gómez-Baggethun and Barton 2013, Johnston et al. 2013, Laurans et al. 2013, Satz et al. 2013, Laurans and Mermet 2014, Villa et al. 2014, Wong et al. 2015). The primary tool in this study will be using a willingness-to-pay survey in order to place a lower bound of the total value of the UC Gill Tract Community Farm.

METHODS

Study Site

My study site is the UC Gill Tract Community Farm (UCGTCF), a 1.5-acre urban farm located at San Pablo Avenue between Marin Avenue and Buchanan Street, in the city of Albany, California (Figure 1). It sits on the Gill Tract, a parcel of land owned by the University of California, Berkeley that is administrated by the University's Real Estate Office. The farm itself is currently administrated by the College of Natural Resources and managed by a Stewardship Assembly consisting of University affiliates (students, faculty, administrators, researchers, and staff) and community members.

The primary activity on the farm is vegetable production. There are five fields, each with five rows that are about 20 feet long and 4 feet wide, dedicated to growing an array of vegetables year-round. There is also a smaller children's garden, a spiral-shaped medicinal herb garden, and

10 permaculture beds. Supporting structures include deer-proof fencing, turkey netting, two solar panels, a tool and storage shed with a sheet-metal roof extension, and compositing piles. New seedlings are started at the Oxford Tract Greenhouses at 1751 Walnut Street, Berkeley before being transplanted into the ground at the UCGTCF. The farm is open to the public Sunday through Thursday, at various hours during different seasons. Volunteers help with farm operations and are compensated with farm produce. There is also a weekly farm stand on Sunday afternoons, where people can get farm produce in exchange for donations. Leftover produce is donated to various charities, churches, and food banks in the East Bay. The farm manager, Jon Hoffman, is employed through the University, and oversees day-to-day farm operations. The greenhouse manager, Christina Wistrom, is also employed through the University. Ms. Wistrom coordinates the work between the UCGTCF and the Oxford Tract Greenhouses, and also maintains the water supply, tracks university spending for the farm's operational costs, and authorizes use of keys and access codes at the farm and greenhouses.

The UCGTCF hosts a variety of community and educational activities. Many farm members participate in food justice and food sovereignty issues, and use the UCGTCF as a space to bring awareness to these issues and to create change through various means, such as donating produce from the farm, community meetings, and protests. Some farm members also hold educational events at the farm to teach agroecological methods, urban gardening techniques, and medicinal herb uses. Many schools and community organizations partner with UCGTCF to bring youth, the disabled, and others out to fulfill community service projects, to learn about the environment, to rehabilitate, or to do internships. The University of California, Berkeley has at least two classes that actively use the space to fulfill the experiential learning portion of their curricula. There are also several community celebrations throughout the year during which

hundreds of people may gather to hear speakers, attend performances, and enjoy the food and atmosphere of the farm.

The UCGTCF also serves as a research space for agriculture, as well as exploration of advancing robotic technology, media production, and social studies. Researchers of all levels from different institutions may present their proposals to a research working group, which evaluates the feasibility and value of their research to the UCGTCF's mission, and assists them in implementing their research.

Figure 1. Map of the Gill Tract. The area marked "Community Farm" is the current location of the UC Gill Tract Community Farm. "Agricultural Research" is the portion being used by UC Berkeley and USDA researchers. "Area Under Discussion," also known as the South Side, is currently slated for development by UC Berkeley's Real Estate Office (SEAL Students 2014).

Data Collection

I used a willingness-to-pay survey (Appendix A), semi-structured interviews and personal communication, textual analysis, and data analysis of the UCGTCF's organization records to collect cost and benefits data in three categories: economic, environmental, and social. Economic data was defined as costs and benefits associated with the production of marketable goods and services. Environmental data was defined as costs and benefits associated with impacts the farm has on the local ecosystem. Social data was defined as the costs and benefits people associate with the farm that do not fall under the economic and environmental definitions.

The UCGTCF's Stewardship Assembly keeps records of the types, weights, and destinations of all produce harvested from the farm, as well as records on the number of volunteer hours accumulated each day, the amount of income received through grants, donations, and fundraisers, and the cost of farm equipment, seeds, and resources such as water and compost. In Fall 2015, a group of UC Berkeley students in the Undergraduate Research Apprentice Program collected Economic Assessment data by tabulating harvest yields, calculating their value, and interviewing UCGTCF staff and researchers to get clearer budget and cost data. I used their findings in addition to the UCGTCF records as the source of my economic data.

Time and skill constraints prevented me from collecting environmental data directly from the UCGTCF. Instead, I asked for farm participants' willingness to pay for some environmental services in my survey and used their responses as a proxy for the value of environmental costs and benefits from the UCGTCF.

The goal of the survey (Appendix A) was to identify the services people received from the farm and how much they valued them. All the surveys had warm-up questions regarding the

level of the respondent's involvement at the UCGTCF. These were followed by questions about a list of 18 common services that other studies found to be associated with urban agriculture and that were frequently mentioned in UCGTCF publications or in conversations with Stewardship Assembly members. The services were categorized into six categories: Food Quality and Access; Health Impacts; Educational Opportunities; Community Development and Social Justice; Ecosystem Services and Biodiversity; and Cultural, Spiritual, and Aesthetic Value. Respondents were asked to rank on a scale of 1-5 how much they agreed with a statement that the UCGTCF was providing each of the 18 services listed. If they did not think the UCGTCF provided such a service at all, they would rank the service 1; if they thought the UCGTCF did provide such a service, they would rank the service 5. Then the respondents were asked how much they would be willing to donate per month for the UCGTCF to continue providing each of those 18 services. They answered by choosing one of six donation ranges: $0-$5, $5-$10, $10-$25, $25-$50, $50-$100, $100+. The last section of the survey contained demographic questions.

I distributed paper surveys at the UCGTCF and digital questionnaires through UCGTCF's online communication mediums (email, Facebook, blog). The digital survey had additional questions to determine whether the respondent had actually visited the UCGTCF. Respondents who had not visited the UCGTCF were given alternative questions regarding the importance of certain services from urban agriculture in general, followed by valuation and demographic questions.

Data Analysis

To analyze economic data, I added the monetary value of the operating costs from May 2014 – December 2015 to the value of farm revenue during that period. I also found the potential value of the produce harvested in that period by multiplying the weight of each item harvested by the price of each item and then summing the values. To be consistent with the Fall 2015 URAP students, I also assumed the price of these produce to be the same as the retail prices from the Park Slope Food Coop (Appendix B). For UCGTCF produce that was not sold by the Park Slope Food Coop, I assumed their price was the same as the retail prices found in the online marketplaces Good Egg and FarmBox SF which source their produce from mostly organic, California farms that are similar to the UCGTCF. I used retail prices rather than bulk prices because UCGTCF produce consumers tend to harvest and distribute produce in amounts more similar to personal consumption rather than bulk consumption. Finally, the URAP students found the hourly value of volunteer labor in California to be $26.87, so I calculated the value of volunteer hours from May 2014 – November 2015 by multiplying the total number of volunteer hours by $26.87.

To analyze the social and environmental data from the survey, I first entered all responses into Excel spreadsheets. To determine how much each of the 18 services in the survey contributed to farm participants' experience of the UCGTCF, I averaged the ranking data from the paper surveys and the "online and visited" surveys only. To determine the value of those 18 services, I summed the minimum donation amounts and the maximum donation amounts that all respondents selected for each service. I then multiplied those sums by 12 to get the annual value of these 18 services. Finally, I summed the annual value of each of the 18 services together to get

the total annual value of all 18 services. To analyze how demographic factors influenced each respondents' willingness to donate, I calculated summary statistics for all questions and created graphs in Excel to identify any trends.

RESULTS

Components of the UCGTCF Experience

UCGTCF was more effective at providing certain goods and services to farm participants than non-participants. A service ranked greater than 4.0 on average meant that participants agreed or strongly agreed that the UCGTCF provided that service, whereas a service ranked less than 4.0 meant participants were neutral, disagreed, or strongly disagreed that the UCGTCF provided that service.

The highest ranked services were "Opportunities to farm or garden" (4.94), "Beautiful green space" (4.89), "Safe place to work or play" (4.85), "Educational workshops for the public" (4.85), "Improve air quality" (4.70), "Student learning opportunities" (4.69), and "Address food security, justice, and sovereignty issues" (4.69) (Table 1). Two were categorized as Health and Safety services; two were categorized as Educational Opportunities; one was categorized as a Community Development and Social Justice service; one was categorized as a Cultural, Spiritual, or Aesthetic Value; and one was categorized as Ecosystem Services. The lowest ranked services were "More food variety" (2.83), "Food donations" (3.61), and "Medicinal herbs" (3.83)

(Table 1). These were services categorized under Food Quality and Access; Community Development and Social Justice; and Cultural, Spiritual, or Aesthetic Value; respectively.

Table 1. Relevance of a Selection of Non-Market Goods and Services to UCGTCF Participants. Survey respondents ranked each good or service from 1-5, 1 being the least applicable to their farm experience and 5 being the most applicable. I added up the rankings that each choice received and averaged over the number of survey respondents to produce an average ranking for each choice.

Good/service	**Average rank**
Healthier food	4.43
Tastier food	4.33
More food variety	2.83
Improve health	4.45
Opportunities to farm and/garden	4.94
Safe place to work or play	4.85
Student learning opportunities	4.69
Research opportunities	4.22
Educational workshops for the public	4.85
Food donation	3.61
Address food security, justice, sovereignty issues	4.69
Community belonging	4.49
Protect cultural/Spiritual heritage	4.39
Provide medicinal herbs	3.83
Beautiful green space	4.89
Wildlife habitat	4.59
Improve air quality	4.70
Cooling environment	4.46

Economic Costs & Benefits

Based on the data collected by Fall 2015 URAP students at the UCGTCF, I found that the UCGTCF had negative economic value (Table 2). From May 2014 –December 2015, the UCGTCF harvested 14,430 lbs of fresh produce. Using retail prices of organic produce, the total value of UCGTCF's produce was $36,770. In addition to the value of produce alone, there was $2,400 of cash in-flow from Farm Stand donations and $4,250 of grant money. However, operation costs for the UCGTCF were greater than the money brought in. These costs included the farm manager's salary, cost of equipment and seeds, and cost of water, including a water

leak, totaling $70,607. The net economic value of UCGTCF for the 2014-2015 year was -$27,187.

Table 2. Value of Economic Costs & Benefits at the UCGTCF. These data were collected by UC Berkeley URAP students working on UCGTCF's Economic Assessment project, and stored in the UCGTCF's Google Drive files (Appendix B).

Economic Factors	**Value**
Produce Harvested	$36,769.86
Farm Stand Donations	$2,400.00
Grants	$4,250.00
Farm Manager Salary	-$20,000.00
Farm Equipment	-$2,100.00
Seeds	?
Water	-$7,800.00
Miscellaneous expenses	-$1,200.00
One-time installations	-$21,103.00
Estimated expenses, May-December 2014	-$18,412.00
Total	-$27,195.14

Social & Environmental Costs & Benefits

The survey showed that UCGTCF participants were willing to donate most for goods and services related to Community Development and Social Justice, followed by Health & Safety, Ecosystem Services, and Educational Opportunities (Table 3).

I found the total value of these nonmarket goods and services ranged between $73,260 and $204,732. In addition to the value of these goods and services, I also included the value of volunteer hours contributed to the farm from 2014 – 2015 which was $378,329.60 (Table 3). After adding up all of these social and environmental values, the total value was from $451,589.60 – $583,061.60.

Table 3. Value of Non-Marketable Goods & Services at the UCGTCF. Survey respondents indicated a minimum and maximum amount they would be willing to donate every month for the services in each category. I added up their responses and performed calculations to get the annual value.

Social &Environmental Factors	Minimum Annual Value	Maximum Annual Value
Food Quality & Access	$8,940	$27,840
Health Impacts	$12,960	$35,700
Educational Opportunities	$12,540	$35,100
Community Development & Social Justice	$13,140	$36,000
Ecosystem Services	$13,080	$35,172
Cultural & Aesthetic Value	$12,600	$34,920
Subtotal	$73,260	$204,732
Total volunteer hours contributed	14,080	
Value of volunteer hours in California	$26.87	
Value of volunteer hours at UCGTCF	$378,329.60	
Total	$451,589.60	$583,061.60

Total Value of the UCGTCF by Cost-Benefit Analysis

After summing the economic, social, and environmental costs and benefits, I found that the UCGTCF produced goods and services worth at least $424,394.46 – $555,866.46 from May 2014 – December 2015 (Table 4).

Table 4. The Costs and Benefits of the UCGTCF. A composite table made using Tables 2 and 3.

Category	Minimum Value	Maximum Value
Economic Factors	-$27,195.14	-$27,195.14
Social & Environmental Factors	$451,589.60	$583,061.60
Total	$424,394.46	$555,866.46

DISCUSSION

The UCGTCF provides the services that are commonly found in other studies on urban agriculture, which supports the claims made by stakeholders about the farm's benefits to the

community. At least half of all survey respondents were willing to donate significant amounts of money to support the farm, suggesting that the UCGTCF provides important goods and services that are highly valued by those who receive them, particularly low-income participants. Given these findings, I argue that the UCGTCF is a worthwhile investment of university and community resources, and that policymakers should consider preserving the UCGTCF in perpetuity.

Urban Agriculture as a Social Enterprise

The UCGTCF's stated mission is to "… conduct collaborative community-driven research, education, and extension focused on ecological farming and food justice, and to foster equitable economies, a healthy environment, and increased resilience in vulnerable communities, both urban and rural" ("UC Gill Tract Community Farm" n.d.). This shows that the UCGTCF is primarily a social rather than a commercial or economic enterprise, like many other community gardens or urban farms (Allen et al. 2008, Draper and Freedman 2010, Gray et al. 2014, Lyson 2014, Oberholtzer et al. 2014). The high scores for social services in the category ranking data (Table 1) and willingness to pay data (Table 3) showed that most farm participants' values align with the mission statement, and the farm effectively delivers those social services to them. Thus, the UCGTCF is fulfilling its intended function in the community.

Another explanation for the high scores for social services is that most people who visit the UCGTCF do not actually depend on the farm for their primary source of food, but come to support the farm's active role in promoting food and environmental justice in the local community. Therefore, through their participation in daily farm operations and community or

education programming, they experience the social benefits more than other benefit categories. Goods and services such as health promotion, research, and ecosystem conservation are less explicitly embedded in the UCGTCF's operations and programming, making it harder for farm participants to recognize their roles in the farm experience.

Measures of the UCGTCF's Value

Analysis of the UCGTCF's budget showed that the farm has low economic value, meaning the UCGTCF is currently losing more money than it is gaining. This is most likely due to the way that the UCGTCF is currently being managed. Most services offered by the UCGTCF are free to the public because the UCGTCF is primarily a social enterprise which adheres strongly to the ideals of food sovereignty and food justice, so they try to remove as many access barriers to the farm as possible, including financial barriers. The UCGTCF's ideals are similar to those of many other food justice-oriented urban agriculture projects (City Slicker Farms n.d., Growing Power n.d., Phat Beets n.d., Urban Adamah n.d., Bradley and Galt 2014), but the inability to be economically self-sufficient make it very difficult for the UCGTCF to continue providing its services for the long-run and, thus, decreases the UCGTCF's revenue generating value.

Nearly all of the services UCGTCF provides are considered non-marketable, so I estimated the value of the non-market benefits from the UCGTCF and added that to the UCGTCF's market value to derive a net value of $424,394.46 – $555,866.46 from May 2014 – December 2015. This estimate implies that the services from the UCGTCF would have a minimum value of $424,394.46 per year if its services were sold in the market, and that its

annual replacement cost (Berck and Helfand 2011), the cost for another entity to provide similar services if the UCGTCF did not exist, was $424,394.46 – $555,866.46. Therefore, while the UCGTCF doesn't seem to be a cost-effective in terms of revenue generation, it does save the overall economy at least $424,394.46 per year.

Surprisingly, some rankings did not correlate with willingness-to-pay values, which may be accounted for by people being unable to fully articulate nonmarket values in market/dollar terms, an error in survey design, or another factor like socioeconomic status discouraged respondents from offering more money for things that they value. These are possible explanations are similar to the issues that critics have pointed out with attempts to put market values on non-market goods (Zhang and Li 2005, Laurans and Mermet 2014). Despite these issues, using this willingness-to-pay method at least provides a baseline to measure the non-market value of the UCGTCF. Furthermore, this shows that projects do not always have to have high market or economic value to be meaningful investments. Projects are often assessed based on how much revenue they generate over their lifetimes, but there are other values and benefits that are important to include in project assessment, such as community development impacts, environmental impacts, and educational value.

The fact that willingness-to-pay did not correlate with gender, ethnicity, or educational attainment indicates that those demographic characteristics of UCGTCF participants have little influence on how they valued services provided by the UCGTCF. However, willingness-to-pay had a slight negative correlation with income level, with lower-income participants being willing to pay more than higher-income participants. This implies that low-income participants value the UCGTCF's services more. This can inform decisions regarding the future of the UCGTCF and

which areas of service can be expanded or reduced to better meet the goals and needs of UCGTCF's target community.

Long-term Sustainability & Broader Implications of UCGTCF

Although UCGTCF may not be as profitable in the short term as other development projects, the benefits that it provides are similar to those of other urban farms and community gardens, and are worth substantial investment. Community garden participation is correlated with higher civic engagement (Blair et al. 1991), so UCGTCF may also become a training ground for the next generation of community leaders, reflecting long-term value that is difficult to measure. The educational, research, and community development opportunities offered will help accumulate important social capital that will build value over time. These benefits are especially important for the communities around the UCGTCF, such as West Berkeley, Oakland, Albany, and Richmond, all of which have high rates of poverty, asthma, and crime (Community Assessment Planning and Evaluation Unit 2015). Having the UCGTCF easily accessible may allow community members, particularly youth, to not only supplement their diet with free produce, but also have opportunities to develop culinary, leadership, and community service skills. And the aesthetically pleasing outdoor environment of the farm may confer therapeutic benefits to those living in stressful socioeconomic situations characteristic of these communities (Brown and Jameton 2000).

On the other hand, there are valid concerns about using urban agriculture as a means to increase self-sufficiency and alleviate food-related issues, because urban planners and local governments need to also consider other urban needs, such as industrial and residential

development, and be wary of pollution effects associated with urban agriculture (Mok et al. 2013). But, if the benefits of an urban agriculture project like the UCGTCF can be shown to outweigh its costs, these concerns may be diminished.

In particular, if there was a way to fully capture the non-market value of UCGTCF, then the UCGTCF should be preserved perpetually as a valuable asset to UC Berkeley and the local community. It might be worth considering adding an entrepreneurial or product marketing component to the UCGTCF to increase its economic value by providing more jobs and supplemental income for community members (Hanna and Oh 2000).

One lesson that urban agriculture activists and organizations fighting for land access can draw from the UCGTCF is that it is important to document all the evidence for their claims regarding the value of the farm thoroughly, so they can make more robust arguments to policymakers. Many other urban agriculture projects receive support from governments and NGOs (Saldivar-Tanaka and Krasny 2004), and being able to concretely describe and quantify UCGTCF's effectiveness is necessary to obtaining such support. After the data collection period for this study ended, I learned that the UCGTCF was awarded a grant of $30,000 for educational programming. This could only have been achieved through scrupulous documentation of the UCGTCF's activities and budgets, highlighting the importance of accurate and detailed record-keeping for the UCGTCF and other urban agriculture groups.

The land-use conflicts over the UCGTCF may motivate land policy consultants, administrators, or local governments to include a wider variety of "costs and benefits" when preparing EIRs or economic assessments of land use, so that they do not overlook any opportunities for alternative land uses and reduce the risk of complicated political or legal disputes that drain local resources. It may be necessary to devise new formulas for creating EIRs

or economic assessments that allows project leaders or land use policymakers to consider nonconventional forms of land use and urban development that may not have high "economic" value but are beneficial in other ways. By doing so, city planners may more effectively allocate resources between development projects to address both economic and social needs of all city residents, particularly the disadvantaged and underserved.

Limitations & Future Directions

The conclusions drawn from this study are limited in scope by the type of data available and the backgrounds of study participants. While personal observations indicate that the UCGTCF attracts a highly diverse population, it was difficult to recruit a similarly diverse subpopulation for the survey. This biased the survey results toward the values of a certain demographics, specifically those who identify as white, middle-class, employed, and not actively involved in the farm's daily operations. Many of the numerical data (budgets, yield-to-price conversion, willingness-to-pay amounts) were estimated and do not completely capture the real value of services and activities provided by the UCGTCF. Also, original data on the UCGTCF's impact on local businesses, ecosystem services, and public health were not available, so the value of these impacts could not be properly accounted for. Therefore, the conclusions from this study can only be applied to the unique circumstances of the UCGTCF and for particular subpopulation of farm participants.

Despite these limitations, this study does set the stage for further study of the UCGTCF's value and impact on the community. Longitudinal studies on health differences, and particularly comparisons between people who actively participate in the farm and those who do not, could

verify whether the UCGTCF helps improve people's health or food security. There is also a need to rigorously quantify the UCGTCF's impact on local biodiversity and ecosystem functions and determine whether urban farms have positive or negative environmental value. Finally, the opportunity costs of keeping the UCGTCF on the Gill Tract should also be accounted for in future studies in order to have a more complete and robust cost-benefit analysis.

CONCLUSION

The UCGTCF was born out of an intense land-use conflict, but despite being less than two years old, the farm has had a tremendous impact on the local community in various ways. In a region where land is scarce, the UCGTCF's existence demonstrates that our evaluation of what constitutes a valuable investment of land and resources should not always rest on financial outcomes. Rather, it may sometimes be more valuable to invest resources in projects that bring benefits directly to the local community, both to the people and the environment. By doing so, policymakers and community leaders may be able to broaden the tools available to them to help their communities become more sustainable and resilient in the future.

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APPENDIX A: SURVEY INSTRUMENT

Hello, my name is Deborah Yang. I am an Environmental Sciences major at UC Berkeley doing my senior thesis on the value of urban agriculture at **The University of California Gill Tract Community Farm (UCGTCF)**. This survey will be anonymous, and all information collected will only be used for my senior thesis. You can skip any question you want. If you have any questions, please contact me at deborahy000@berkeley.edu. Thank you for your help!

SECTION A: YOUR INVOLVEMENT AT THE UCGTCF

How often do you go to the UCGTCF?
Choose only one

- ☐ This is my 1st time
- ☐ Daily
- ☐ Once a week
- ☐ 2-5 times a week
- ☐ 2-3 times a month
- ☐ Once a month
- ☐ 2-3 times a year

Are you a regular volunteer at the UCGTCF?
(volunteer at least once a week)

☐ Yes ☐ No

Are you a member of a UCGTCF working group?

☐ Yes ☐ No

Are you in the Stewardship Council or Stewardship Assembly?

☐ Yes ☐ No

SECTION B: WHAT IS THE UCGTCF WORTH TO YOU?

Do you agree or disagree with the following statements about SERVICES provided by the UCGTCF?

*Choose: Strongly Disagree **(1)**, Disagree **(2)**, Neutral **(3)**, Agree **(4)**, Strongly Agree **(5)***

How much would you be willing to DONATE PER MONTH so the UCGTCF can continue providing each of these services?
*Choose: **A)** $0-$5 **B)** $5-$10 **C)** $10-$25 **D)** $25-$50 **E)** $50-$100 **F)** $100+*

CATEGORY	SERVICES	AGREE? (1-5)	DONATION (A,B,C,D,E,F)
Food Quality & Access	The UCGTCF provides healthier food than my local grocery store		
	The UCGTCF provides tastier food than my local grocery store		
	The UCGTCF provides more food variety than my local grocery store		
Health, Safety, & Recreation	The UCGTCF helps me improve my health & well-being		
	The UCGTCF provides opportunities to farm and garden		
	The UCGTCF provides a safe place to work or play at		
Educational Opportunities	The UCGTCF provides students hands-on learning opportunities through classes, field trips, internships, and/or volunteering		
	The UCGTCF provides opportunities to conduct research		
	The UCGTCF provides useful educational workshops		
Community Development & Social Justice	The UCGTCF provides opportunities to address food security, food justice, and/or food sovereignty issues		
	The UCGTCF increases my sense of belonging in the local community		
	The UCGTCF donates food to me or my organization		
Cultural, Spiritual, & Aesthetic Value	The UCGTCF protects the cultural and/or spiritual heritage of the land		
	The UCGTCF provides medicinal herbs that are important to my culture		
	The UCGTCF is a beautiful green space		
Ecosystem Services & Biodiversity	The UCGTCF preserves habitat for wildlife		
	The UCGTCF improves the local air quality		
	The UCGTCF creates a cooler environment by lowering air temperature		

Are there any other services provided by the UCGTCF that were not listed above? How much would you donate for each of those?

Please rank how important each of the following CATEGORIES of services provided by the UCGTCF are to you.
*Rank from **1 (most important)** to **6 (least important).***

Food Quality & Access _____
Health, Safety, & Recreation _____
Educational Opportunities _____
Community Development & Social Justice _____
Cultural, Spiritual, & Aesthetic Value _____
Ecosystem Services & Biodiversity _____

SECTION C: MORE ABOUT YOU

What is your gender? _____

What is your age? _____ years

Do you identify as Hispanic, Latino/a, or Spanish?
☐ Yes ☐ No

How do you describe your race?
Check all that apply
☐ Black/African American
☐ Asian
☐ White
☐ Native Hawaiian or Pacific Islander
☐ American Indian or Alaska Native
☐ Other: _____

Which of the following do you identify as?
Choose up to 3
☐ Student
☐ Educator
☐ Researcher
☐ UC Administration or Staff
☐ Local community member
☐ Local government
☐ Parent
☐ Activist
☐ Visitor from another state or country
☐ None of the above

What is the highest level of education that you have attained?
☐ Less than high school
☐ High school, GED, or equivalent
☐ Some college or Associate's degree
☐ Bachelor's Degree
☐ Graduate or professional school

What is your primary source of income or financial support?
Check only one
☐ Job
☐ Parents or Relatives
☐ Retirement Funds
☐ Social Welfare Programs
☐ Other _____

If you selected "Job", what is your annual income?
If you did not select "Job", what is the annual amount of financial support you receive from that source?
☐ Less than $10,000
☐ $10,000 - $14,999
☐ $15,000 - $24,999
☐ $25,000 - $49,999
☐ $50,000 - $74,999
☐ $75,000 - $99,999
☐ $100,000 - $149,999
☐ $150,000 or more

Do you live in University Village?
☐ Yes ☐ No

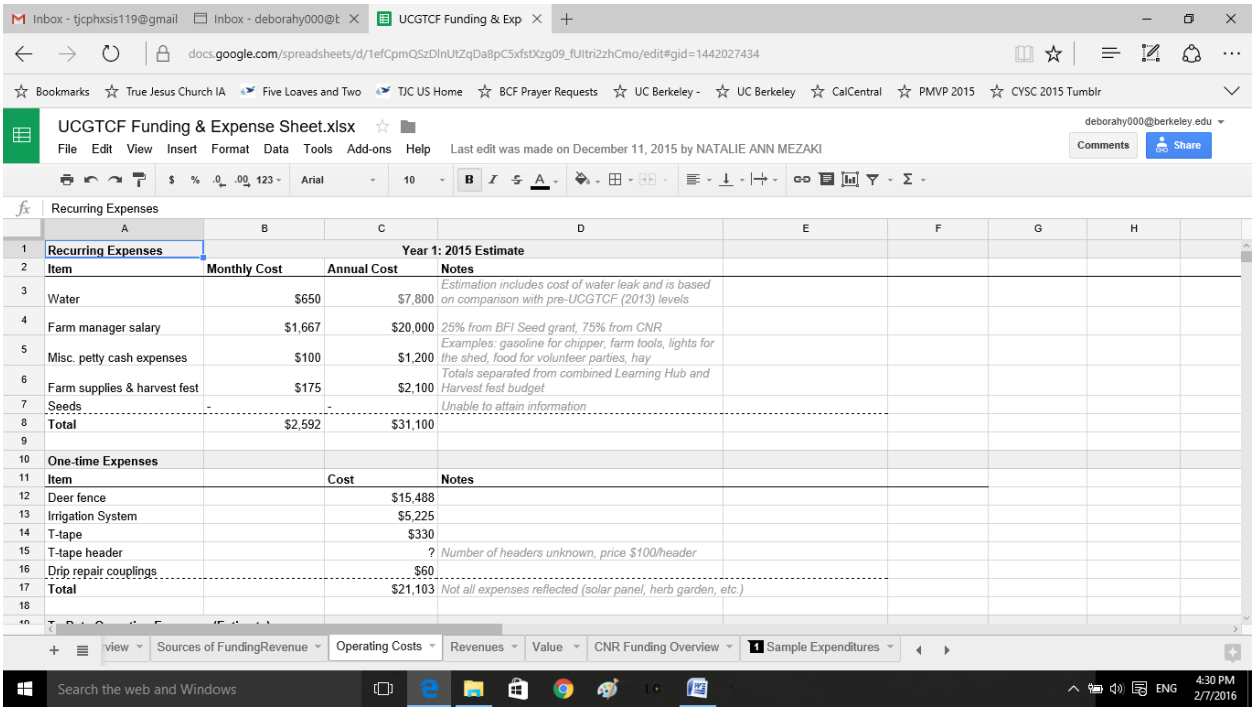
If you answered "No" to the previous question, what are the cross-streets closest to your home and your zip code?
Example: Center and Shattuck, 94704
_____

How many people live in your current household, including yourself?
_____

How many children under 18 years old live in your current household?
_____

COMMENTS:

APPENDIX B: URAP STUDENTS' DATA TABLES FROM GOOGLE DRIVE

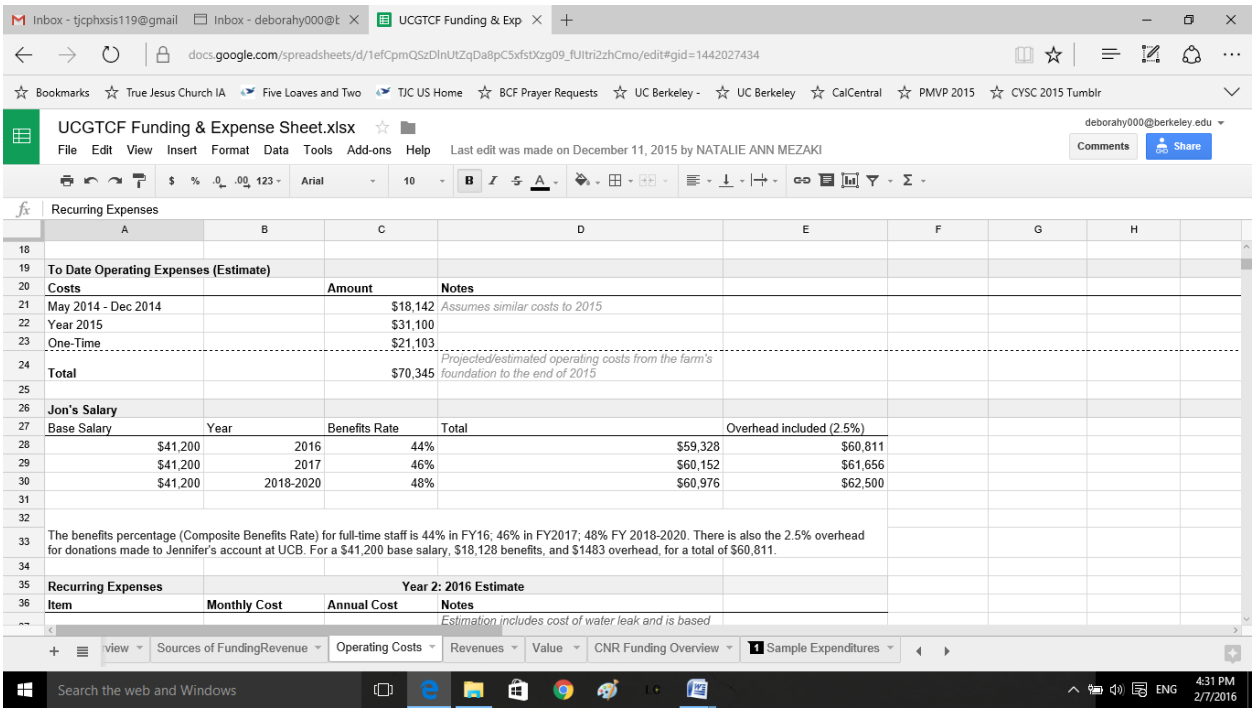


UCGTCF Funding & Expense Sheet.xlsx

Recurring Expenses

	A	B	C	D
1	**Recurring Expenses**		**Year 1: 2015 Estimate**	
2	**Item**	**Monthly Cost**	**Annual Cost**	**Notes**
3	Water	$650	$7,800	*Estimation includes cost of water leak and is based on comparison with pre-UCGTCF (2013) levels*
4	Farm manager salary	$1,667	$20,000	*25% from BFI Seed grant, 75% from CNR*
5	Misc. petty cash expenses	$100	$1,200	*Examples: gasoline for chipper, farm tools, lights for the shed, food for volunteer parties, hay*
6	Farm supplies & harvest fest	$175	$2,100	*Totals separated from combined Learning Hub and Harvest fest budget*
7	Seeds	-	-	*Unable to attain information*
8	**Total**	$2,592	$31,100	
9				
10	**One-time Expenses**			
11	**Item**		**Cost**	**Notes**
12	Deer fence		$15,488	
13	Irrigation System		$5,225	
14	T-tape		$330	
15	T-tape header		?	*Number of headers unknown, price $100/header*
16	Drip repair couplings		$60	
17	**Total**		$21,103	*Not all expenses reflected (solar panel, herb garden, etc.)*
18				

Sheet tabs: view | Sources of FundingRevenue | Operating Costs | Revenues | Value | CNR Funding Overview | Sample Expenditures

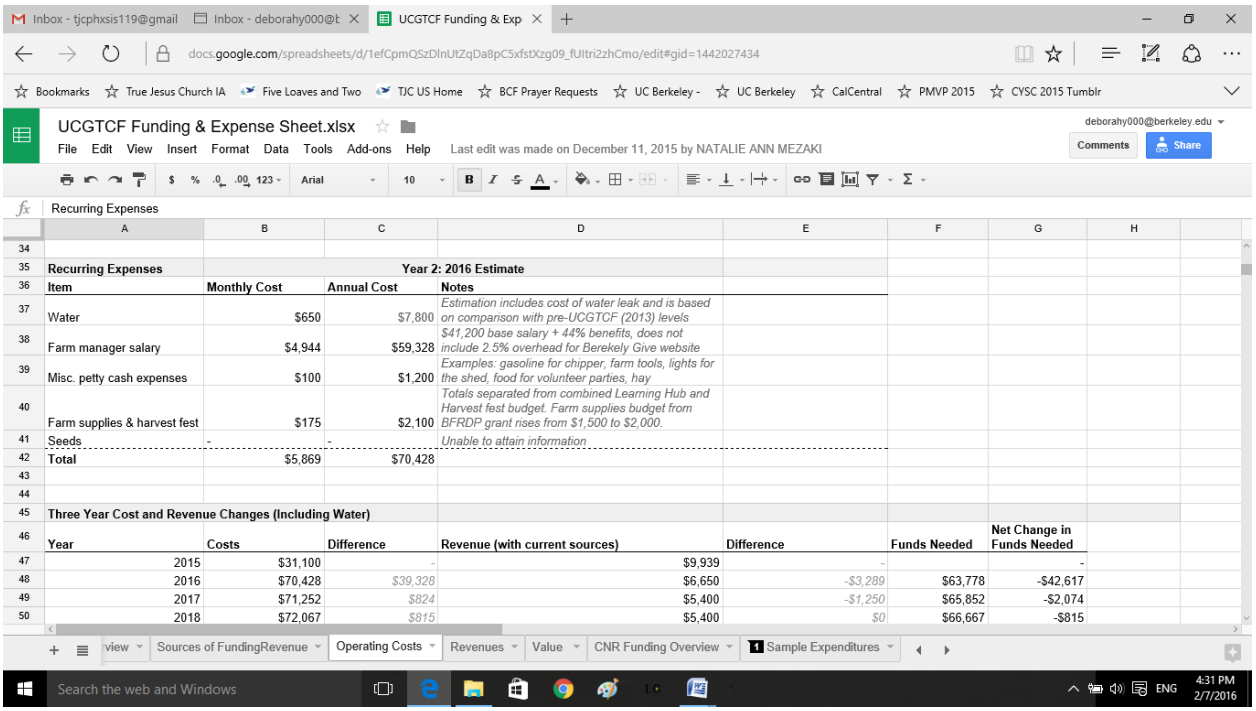


UCGTCF Funding & Expense Sheet.xlsx

Recurring Expenses

	A	B	C	D	E
18					
19	**To Date Operating Expenses (Estimate)**				
20	**Costs**		**Amount**	**Notes**	
21	May 2014 - Dec 2014		$18,142	*Assumes similar costs to 2015*	
22	Year 2015		$31,100		
23	One-Time		$21,103		
24	**Total**		$70,345	*Projected/estimated operating costs from the farm's foundation to the end of 2015*	
25					
26	**Jon's Salary**				
27	Base Salary	Year	Benefits Rate	Total	Overhead included (2.5%)
28	$41,200	2016	44%	$59,328	$60,811
29	$41,200	2017	46%	$60,152	$61,656
30	$41,200	2018-2020	48%	$60,976	$62,500
31					
32					
33	The benefits percentage (Composite Benefits Rate) for full-time staff is 44% in FY16; 46% in FY2017; 48% FY 2018-2020. There is also the 2.5% overhead for donations made to Jennifer's account at UCB. For a $41,200 base salary, $18,128 benefits, and $1483 overhead, for a total of $60,811.				
34					
35	**Recurring Expenses**		**Year 2: 2016 Estimate**		
36	**Item**	**Monthly Cost**	**Annual Cost**	**Notes**	
				Estimation includes cost of water leak and is based	

Sheet tabs: view | Sources of FundingRevenue | Operating Costs | Revenues | Value | CNR Funding Overview | Sample Expenditures



UCGTCF Funding & Expense Sheet.xlsx

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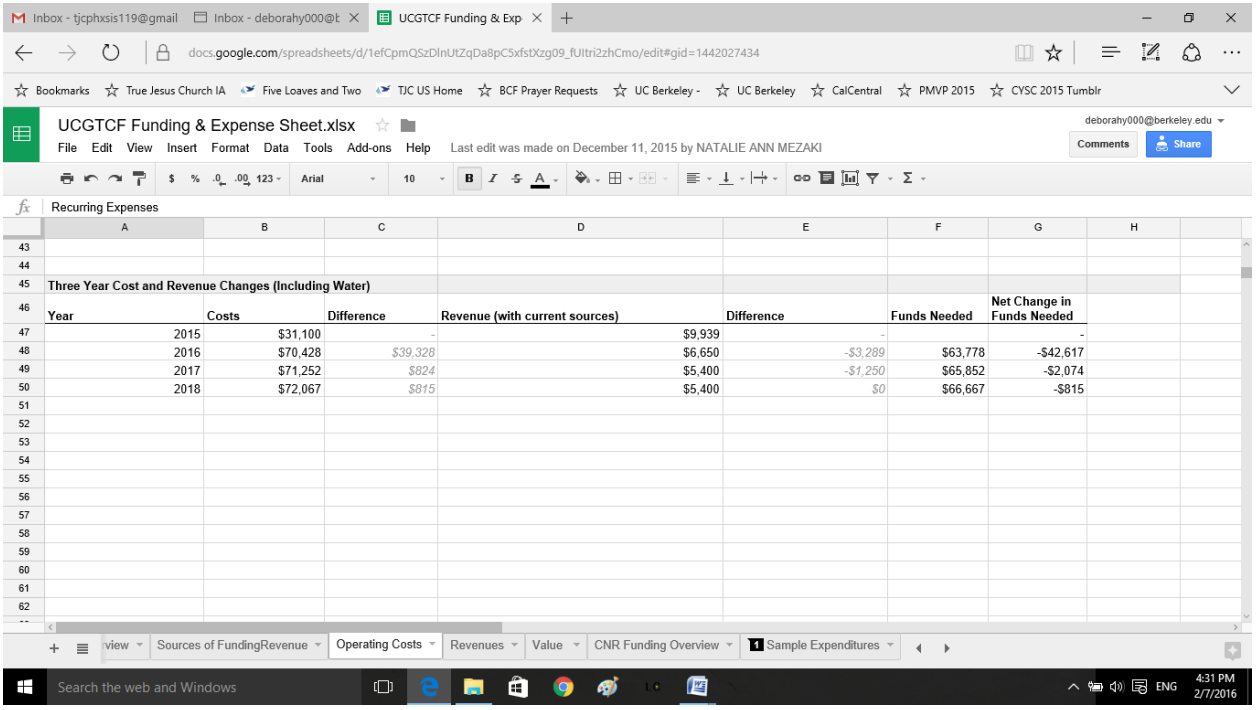
Recurring Expenses

	Recurring Expenses		Year 2: 2016 Estimate	
36	**Item**	**Monthly Cost**	**Annual Cost**	**Notes**
37	Water	$650	$7,800	*Estimation includes cost of water leak and is based on comparison with pre-UCGTCF (2013) levels*
38	Farm manager salary	$4,944	$59,328	*$41,200 base salary + 44% benefits, does not include 2.5% overhead for Berekely Give website*
39	Misc. petty cash expenses	$100	$1,200	*Examples: gasoline for chipper, farm tools, lights for the shed, food for volunteer parties, hay*
40	Farm supplies & harvest fest	$175	$2,100	*Totals separated from combined Learning Hub and Harvest fest budget. Farm supplies budget from BFRDP grant rises from $1,500 to $2,000.*
41	Seeds	-	-	*Unable to attain information*
42	**Total**	$5,869	$70,428	

45	**Three Year Cost and Revenue Changes (Including Water)**						
46	**Year**	**Costs**	**Difference**	**Revenue (with current sources)**	**Difference**	**Funds Needed**	**Net Change in Funds Needed**
47	2015	$31,100	-	$9,939	-		-
48	2016	$70,428	*$39,328*	$6,650	*-$3,289*	$63,778	-$42,617
49	2017	$71,252	*$824*	$5,400	*-$1,250*	$65,852	-$2,074
50	2018	$72,067	*$815*	$5,400	*$0*	$66,667	-$815

Sources of FundingRevenue | Operating Costs | Revenues | Value | CNR Funding Overview | Sample Expenditures



UCGTCF Funding & Expense Sheet.xlsx

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Recurring Expenses

45	**Three Year Cost and Revenue Changes (Including Water)**						
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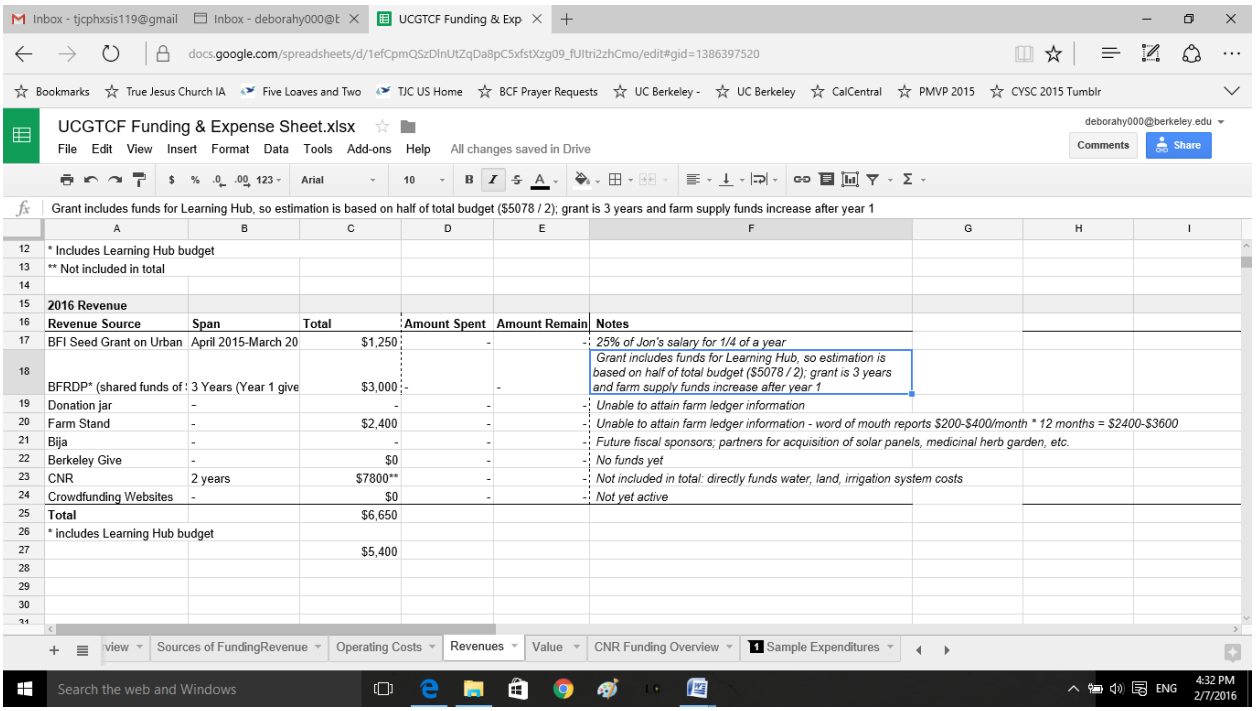
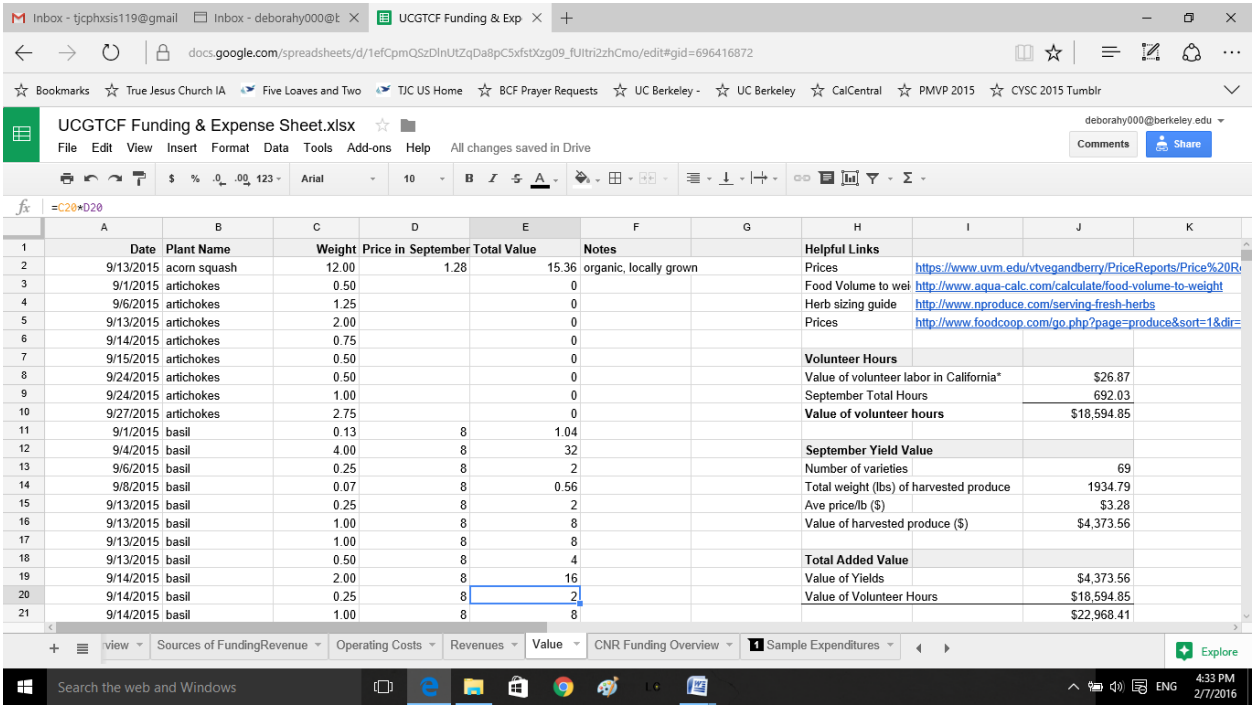
Sources of FundingRevenue | Operating Costs | Revenues | Value | CNR Funding Overview | Sample Expenditures



UCGTCF Funding & Expense Sheet.xlsx

Grant includes funds for Learning Hub, so estimation is based on half of total budget ($5078 / 2); grant is 3 years and farm supply funds increase after year 1

	A	B	C	D	E	F	G	H	I
12	* Includes Learning Hub budget								
13	** Not included in total								
14									
15	**2016 Revenue**								
16	**Revenue Source**	**Span**	**Total**	**Amount Spent**	**Amount Remain**	**Notes**			
17	BFI Seed Grant on Urban	April 2015-March 20	$1,250	-	-	*25% of Jon's salary for 1/4 of a year*			
18	BFRDP* (shared funds of	3 Years (Year 1 give	$3,000	-	-	*Grant includes funds for Learning Hub, so estimation is based on half of total budget ($5078 / 2); grant is 3 years and farm supply funds increase after year 1*			
19	Donation jar	-	-	-	-	*Unable to attain farm ledger information*			
20	Farm Stand	-	$2,400	-	-	*Unable to attain farm ledger information - word of mouth reports $200-$400/month * 12 months = $2400-$3600*			
21	Bija	-	-	-	-	*Future fiscal sponsors; partners for acquisition of solar panels, medicinal herb garden, etc.*			
22	Berkeley Give	-	$0	-	-	*No funds yet*			
23	CNR	2 years	$7800**	-	-	*Not included in total: directly funds water, land, irrigation system costs*			
24	Crowdfunding Websites	-	$0	-	-	*Not yet active*			
25	**Total**		$6,650						
26	* includes Learning Hub budget								
27			$5,400						
28									
29									
30									



UCGTCF Funding & Expense Sheet.xlsx

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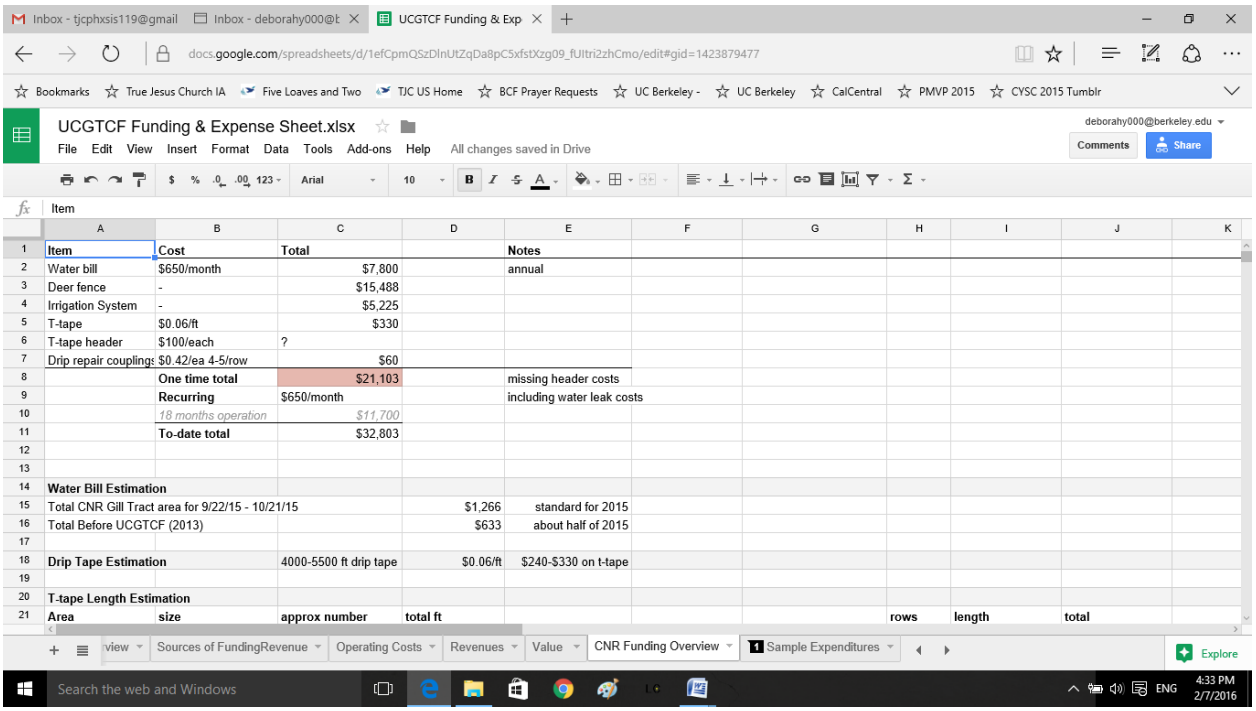
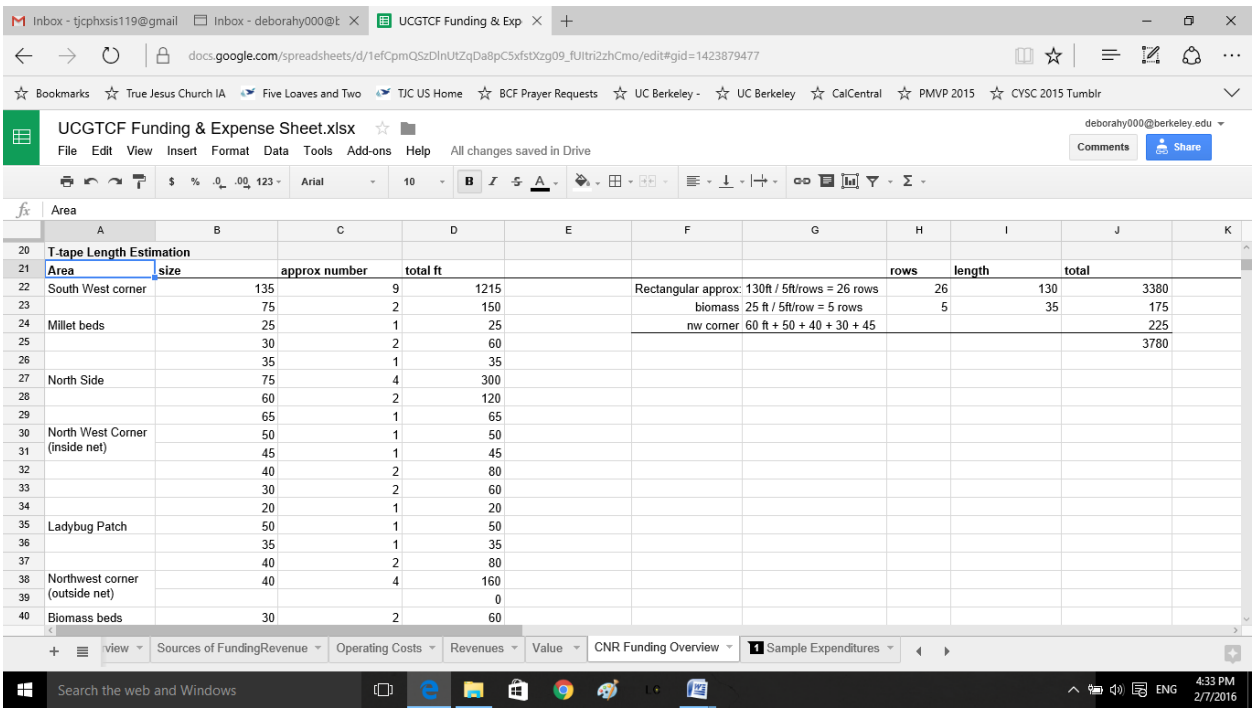
	A	B	C	D	E	F	G	H	I	J	K
1	**Date**	**Plant Name**	**Weight**	**Price in September**	**Total Value**	**Notes**		**Helpful Links**			
2	9/13/2015	acorn squash	12.00	1.28	15.36	organic, locally grown		Prices	https://www.uvm.edu/vtvegandberry/PriceReports/Price%20R		
3	9/1/2015	artichokes	0.50		0			Food Volume to wei	http://www.aqua-calc.com/calculate/food-volume-to-weight		
4	9/6/2015	artichokes	1.25		0			Herb sizing guide	http://www.nproduce.com/serving-fresh-herbs		
5	9/13/2015	artichokes	2.00		0			Prices	http://www.foodcoop.com/go.php?page=produce&sort=1&dir=		
6	9/14/2015	artichokes	0.75		0						
7	9/15/2015	artichokes	0.50		0			**Volunteer Hours**			
8	9/24/2015	artichokes	0.50		0			Value of volunteer labor in California*		$26.87	
9	9/24/2015	artichokes	1.00		0			September Total Hours		692.03	
10	9/27/2015	artichokes	2.75		0			**Value of volunteer hours**		$18,594.85	
11	9/1/2015	basil	0.13	8	1.04						
12	9/4/2015	basil	4.00	8	32			**September Yield Value**			
13	9/6/2015	basil	0.25	8	2			Number of varieties		69	
14	9/8/2015	basil	0.07	8	0.56			Total weight (lbs) of harvested produce		1934.79	
15	9/13/2015	basil	0.25	8	2			Ave price/lb ($)		$3.28	
16	9/13/2015	basil	1.00	8	8			Value of harvested produce ($)		$4,373.56	
17	9/13/2015	basil	1.00	8	8						
18	9/13/2015	basil	0.50	8	4			**Total Added Value**			
19	9/14/2015	basil	2.00	8	16			Value of Yields		$4,373.56	
20	9/14/2015	basil	0.25	8	2			Value of Volunteer Hours		$18,594.85	
21	9/14/2015	basil	1.00	8	8					$22,968.41	



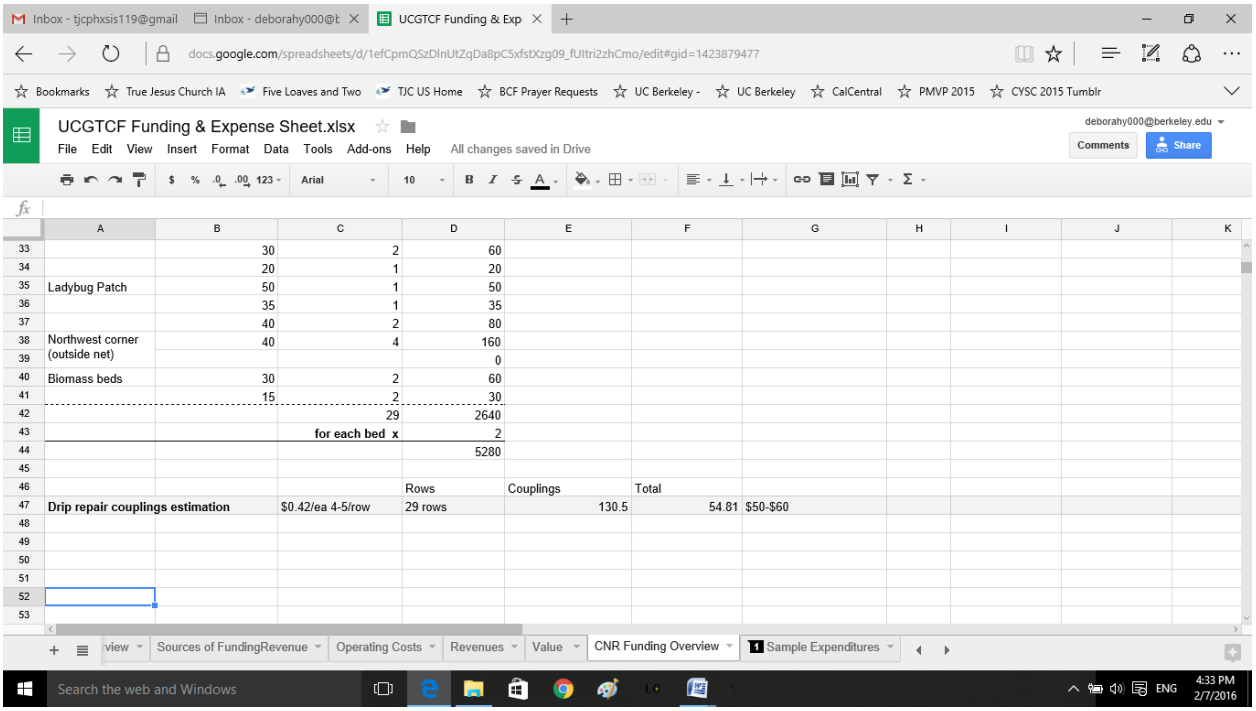
UCGTCF Funding & Expense Sheet.xlsx

Item	Cost	Total		Notes
Water bill	$650/month	$7,800		annual
Deer fence	-	$15,488		
Irrigation System	-	$5,225		
T-tape	$0.06/ft	$330		
T-tape header	$100/each	?		
Drip repair couplings	$0.42/ea 4-5/row	$60		
	One time total	$21,103		missing header costs
	Recurring	$650/month		including water leak costs
	18 months operation	*$11,700*		
	To-date total	$32,803		
Water Bill Estimation				
Total CNR Gill Tract area for 9/22/15 - 10/21/15			$1,266	standard for 2015
Total Before UCGTCF (2013)			$633	about half of 2015
Drip Tape Estimation		4000-5500 ft drip tape	$0.06/ft	$240-$330 on t-tape
T-tape Length Estimation				
Area	**size**	**approx number**	**total ft**	



UCGTCF Funding & Expense Sheet.xlsx

T-tape Length Estimation									
Area	**size**	**approx number**	**total ft**				**rows**	**length**	**total**
South West corner	135	9	1215		Rectangular approx:	130ft / 5ft/rows = 26 rows	26	130	3380
	75	2	150		biomass	25 ft / 5ft/row = 5 rows	5	35	175
Millet beds	25	1	25		nw corner	60 ft + 50 + 40 + 30 + 45			225
	30	2	60						3780
	35	1	35						
North Side	75	4	300						
	60	2	120						
	65	1	65						
North West Corner (inside net)	50	1	50						
	45	1	45						
	40	2	80						
	30	2	60						
	20	1	20						
Ladybug Patch	50	1	50						
	35	1	35						
	40	2	80						
Northwest corner (outside net)	40	4	160						
			0						
Biomass beds	30	2	60						



	A	B	C	D	E	F	G	H	I	J	K
33		30	2	60							
34		20	1	20							
35	Ladybug Patch	50	1	50							
36		35	1	35							
37		40	2	80							
38	Northwest corner (outside net)	40	4	160							
39				0							
40	Biomass beds	30	2	60							
41		15	2	30							
42			29	2640							
43			**for each bed x**	2							
44				5280							
45											
46				Rows	Couplings	Total					
47	**Drip repair couplings estimation**		$0.42/ea 4-5/row	29 rows	130.5	54.81	$50-$60				
48											
49											
50											
51											
52											
53											