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Sustainable Agriculture through Data Analytics

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Abstract

There is an increasing need for sustainable agriculture in light of climate change and growing populations. Certified B Corporations meet the highest standards of verified social and environmental performance, public transparency, and legal accountability to balance profit and purpose. This paper describes a student-learning project that developed an Environmental Management System (EMS) using data analytics to improve a family-owned farming business's decision-making process for efficient natural resource allocation, as well as the reporting requirements associated with their B Corporation Certification. This project's primary resource is water reporting, but it may be expanded to include other resources.

Introduction

Agriculture sustainability is an ever-increasing concern due to climate change, the desire to eradicate hunger due to poverty, and the goal of increasing the general wellbeing of humans (Rockström et al., 2017). One of the key challenges facing agriculture in the 21st century is the ability to farm sustainably while meeting increased food demand. The UN Sustainable Development Goals require an increase of global food production through sustainable means to meet a global population of nine to ten billion people in 2050 (Foley et al., 2005; IAASTD, 2008; Tilman et al., 2011; Pardey et al., 2014).

According to Rockström et al. (2017), human pressures on the environment are causing climate change as well as population growth, consumption growth, environmental change, and food security which are 'interconnected forces' that provide a framework to identify salient factors of sustainable agriculture. Agriculture has been identified as both the driver of climate change (Tilman et al., 2011; Foley et al., 2005; Godfray and Garnett, 2014; Kuyper and Struik, 2014) and the key to reducing human contributions to the degradation of the environment (Rockström et al., 2017). Hence, researchers are calling for paradigm shifts to attain global sustainability (Rockström et al., 2017; Steffen et al., 2015) locally, regionally, nationally, and globally (Folke et al., 2005). One such example is the call by Rockström et al. (2017), based on strong, scientific justification, for a shift from a primary focus on enriching production to a model with sustainability at the core of the strategy for agriculture development. According to the Intergovernmental Panel on Climate Change (2007), drought periods have been increasing in already drought-prone areas due to climate change, adding greater stress on food security systems (Rosegrant and Cline, 2003; Ericksen 2008). California is one of these areas where droughts pose a threat to the agricultural status quo (UNDP, 2004; Dilley et al., 2005; Helmer and Hilhorst, 2006). As an increasing food supply is required to meet the increasing demand for food, the agricultural status quo is defined as a rise in production to meet this requirement (FAO, 2000). This disruption has consequently affected food security (Tubiello et al., 2007). Water scarcity related to climate change is and will continue to be a key challenge for California in the coming years. Recently, the California Department of Water Resources (DWR) announced that water allocations requested

by farmers would be reduced to five percent of the requested amounts for the year 2021 due to drought conditions (Saam, 2021). In many ways, agriculture is the frontline for the challenge of climate change.

As our society continues to face these (and other) environmental issues related to climate change, we will need to adapt our current water management and usage to be more sustainable and more efficient. One such opportunity to adapt is to develop data-driven systems to record water usage and analyze the data in real-time to meet this goal. This paper outlines a student-learning project that sought to develop an environmental management system (EMS) that uses data analytics to track the usage of resources by a family-owned farming business. We posit that the EMS will benefit the client in achieving and maintaining B Corporation certification as it aligns with their mission. The B Corporation certification designation signifies that an organization adheres to strong sustainability and social responsibility standards (B Lab, 2021a).

Literature Review

Data science and analytics are becoming commonplace in the agricultural industry as the challenge of climate change pushes the industry to adopt new techniques. The adoption of new technologies is aided by the lowering of barriers such as cost. This project focuses on how data analysis techniques can be applied to sustainable agriculture. To better understand this environment, a review of previous research around the nexus of sustainability, agriculture, and data analytics will be explored in the following section.

Sustainable Agriculture

The World Commission on Environment and Development (WCED, 1987) defines sustainability as the process of developing in a manner that meets the society's current needs without compromising the needs of future generations. A significant threat to the needs of future generations is climate change (IPCC, 2021). According to Tahat et al. (2020), a key contributor to climate change is the development of food and agricultural land — a result of developing or underdeveloped economies' rapid population increases and infrastructure growth. These efforts increase demand for food and agricultural land development, contributing to the pressure on climate change and natural resources. Yunlong and Smit (1994) state agriculture has caused environmental changes that impact sustainability efforts; however, it also has a major role in a society's sustainability efforts.

According to Tahat et al. (2020), sustainability measures may help meet food agricultural needs worldwide without compromising the planet's natural resources. These authors further argue that one of the major goals of sustainable agriculture is to increase crop productivity while mitigating climate change and preserving ecosystems. Smit and Smithers (1994) hold similar views, defining sustainable agriculture as the practice of producing agricultural products in a way that minimizes the destruction of the "natural resource base" so it can be fruitful for the foreseeable future. As part of their effort to measure sustainability in agriculture, Yunlong and Smit (1994) further defined sustainable agriculture in terms of three sets of agricultural constraints: biophysical, socio-political, and economic and technological. The authors emphasize that sustainability involves "the continued productivity and functioning of ecosystems" (ecological), "the continued satisfaction of basic human needs[…] as well as higher-level social and cultural necessities" (social), and the presence of sufficient economic incentives to produce agricultural products (economic). Sustainable agriculture is an alternative methodology that places emphasis on developing new practices that are harmless or beneficial to the planet's natural resources (Tahat et al., 2020).

In an effort to mitigate the damage of climate change, international organizations, governments, and individual institutions have instituted policies to encourage sustainable natural resource management (Song et al., 2017). As reflected in the literature, considerable research efforts have been placed into sustainable agriculture to understand the meaning, salient factors, and practices. According to Song et al. (2017), big data is a possible aid to climate scientists, policy makers, and other stakeholders involved in sustainability. Keeso (2014) also refers to big data as a powerful, yet underutilized, tool for sustainable agriculture.

Sustainability and B Corporation

The Sustainable Business Network (2021) states that the integration of sustainable business strategies demonstrates the organization's ethics and sustainability goals, which may address global issues. Global issues include human rights issues, environmental climate change, and gender and income inequality. Palmer and Flanagan (2016) categorize initiatives set for a business to attain sustainability as "the three Ps": people, planet, and profit.

In addition to pursuing better social and environmental change, sustainability initiatives may contribute to an organization's overall success. Sustainability initiatives for an or-

ganization begin with identifying what sustainability means to them, taking into consideration their mission and goals. Organizations must then figure out how to incorporate sustainable practices into their operations while also building a culture of sustainability. The Sustainable Business Network (2014) has identified a number of advantages for organizations that implement sustainable measures. Some of these measures benefit outward-facing activities such as relationships with consumers and stakeholders, improved brand value, and reputation for green measures. Other advantages help organizations with market awareness such as consumer demand, market advantages, and understanding emerging trends. Additional benefits identified include helping organizations improve operations through activities such as reducing resource allocations, compliance with procurement and fulfillment processes, planning for business continuity, managing risk, and promoting change and innovation.

B Lab, founded in 2006, has sought to assist businesses in demonstrating and improving their commitment to positive, societal impacts by awarding a certificate of achievement known as B Corporation Certification (B Lab, 2021b). In order to earn the certificate, every business is required to demonstrate its social and environmental performance, accountability, and transparency with a minimum score of 80 points on the online B Impact Assessment tool (B Lab, 2021b).

Sustainability and Data Analytics

Sustainability efforts may be enhanced through the analysis of big data; however, this is an emerging area that needs to be explored through further application and research. Big data is defined as large data sets that can be examined and analyzed to reveal underlying trends and patterns through analytics (Lioutas and Charatsari, 2020). Analytic tools, specifically tailored for big data, enable data-driven decision-making through visualizations and data exploration. Raut et al. (2019) link big data analytics and sustainability to sustainable business management practices.

Early research indicates that big data analysis in agriculture has the potential to increase economic returns by enhancing farmers' decision-making performance (Wolfert, 2017); reducing input costs, and increasing yields (Ribarics, 2016); and has a significant, positive impact on the economic performance of farm enterprises (Lioutas and Charatsari, 2020). Moreover, research on the impact of big data use in agriculture has changed the perspective on sustainable agriculture (Lioutas and Charatsari, 2020). Machine learning and data analytics methods are beginning to be used in agriculture for descriptive and predictive purposes to aid decision-making and sustainability efforts. Machine learning, according to Mohri et al. (2018), is the scientific study of algorithms and computational models run on computers to progressively improve the model's performance based on historical data. In particular, Sharma et al. (2020) ascertain that data analytics in the form of machine learning techniques have been applied to sustainable agricultural endeavors resulting in optimal resource allocation. The researchers further assert that machine learning can provide multiple benefits from improving sustainability, increasing transparency, adding traceability, and increasing access to supply chain information.

For these reasons, applying analytical methods to agricultural farming data is a suitable solution to optimize sustainability in this project. Specifically, descriptive, and diagnostic analytics were used to discover insights. Data visualizations were developed for descriptive analytics and discovering what happened based on historical data. Drill down and data mining techniques were also used for diagnostic (or why) purposes. Data analytics and the associated techniques will be leveraged to help the client maintain a B Corporation Certification. The project details and process are outlined in the following section.

Project Overview

A local farm organization sought assistance from undergraduates in a data analytics group to achieve and maintain a B Corporation Certification through the development of an EMS system. This collaboration was initiated through a grant awarded to the California Water Institute and an agreement with the client. The farm is a third-generation, family-owned business that produces almonds, tomatoes, pistachios, garlic, and other crops. This farm has continued to invest in land, water, infrastructure, food processing, and technology as a part of its commitment to sustainability. Their decision to pursue a B Corporation Certification is a tangible way of demonstrating these efforts.

In alignment with the B Impact Assessment criteria and continuous improvement efforts, the client would benefit from updating its processes as new technologies have emerged since their initial water and irrigation usage procedures were implemented. These technologies may help track resource consumption in a more streamlined, intelligent manner. At the outset of this project, the farm's foreman recorded crop irrigation attributes such as field, crop, meter readings, on and off dates, etc. with paper and pencil from the fields. The data was then stored in both electronic spreadsheets and physical

binders. At the end of each week and each season, this data was transferred from the written notes to a Microsoft Excel sheet for further analysis and archival. This process produced data validation issues and inhibited the real-time analysis of resource inputs.

The project objectives for the EMS were to: determine an industry baseline for each area of interest; document the innovative practices of the company; measure the amount of each resource used; and establish a reduction goal moving forward. The resource areas addressed in the EMS are water, fertilizer, land and life, pesticides, and greenhouse gas emissions. The first phase of the project, and the focus of this paper, was to tackle the development of the water and irrigation subsystem. The following section will describe the process of the data collection and analysis under the constraints laid out by the client.

The EMS solution needed to meet the client's specifications to fit in their current environment and processes, and thus, defined the constraints as minimize costs, streamline processes, minimize data entry errors, address the foreman's limited internet access, and minimize future updates of the project. None of these were more paramount than the inability to purchase data visualization software due to budget restrictions; thus, the optimal solution would need to consider open-source or low-cost software. The client sought a streamlined workflow whenever possible to minimize updates and maintenance. These constraints forced the system to be configured in a way that could collect data while automating repetitive tasks and procedures. A streamlined process would minimize employee input except in the data entry and decision-making steps. Along with this, the penultimate objective would be to ensure only valid, accurate data gets input into the system. The benefits from instituting a streamlined process include time savings and greater efficiency. The final constraint was the lack of internet accessibility in the fields (where the data collection would occur), so any solution needed to be accessible offline via mobile devices.

The EMS (conceptualized in Figure 1) system will build upon the current processes but will better leverage the technology available. The automation of existing processes is to be supplemented with data visualization to monitor water usage and to enable more sustainable irrigation. The overall automation process for water tracking should collect field-specific irrigation data, then sync with other relevant crop data specific to the client's farm in a spreadsheet, sync with external weather data from California Irrigation Management and Information System (CIMIS), and then update the visualizations in the Excel workbook.

The water tracking subsystem (Figure 2) consists of four phases 1) Data Entry, 2) Data Processing, 3) Data Analysis, and 4) Decision-making. The data entry phase is when the crop foreman enters the field-specific data such as the on and

Figure 1

EMS Overview

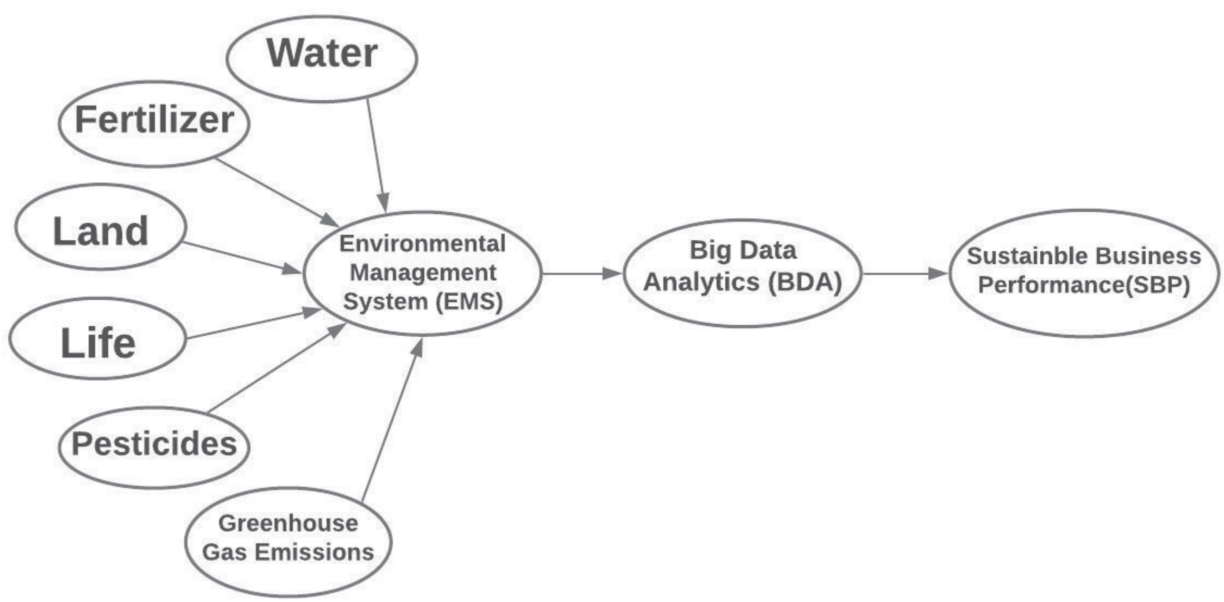
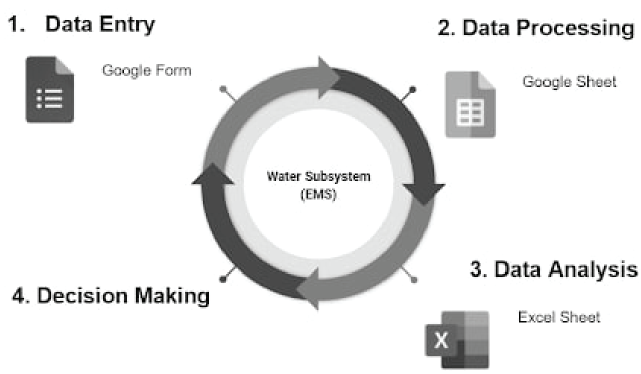


Figure 2

EMS Water Subsystem Flowchart



off dates for water irrigation from the fields via a Google Form on their mobile device.

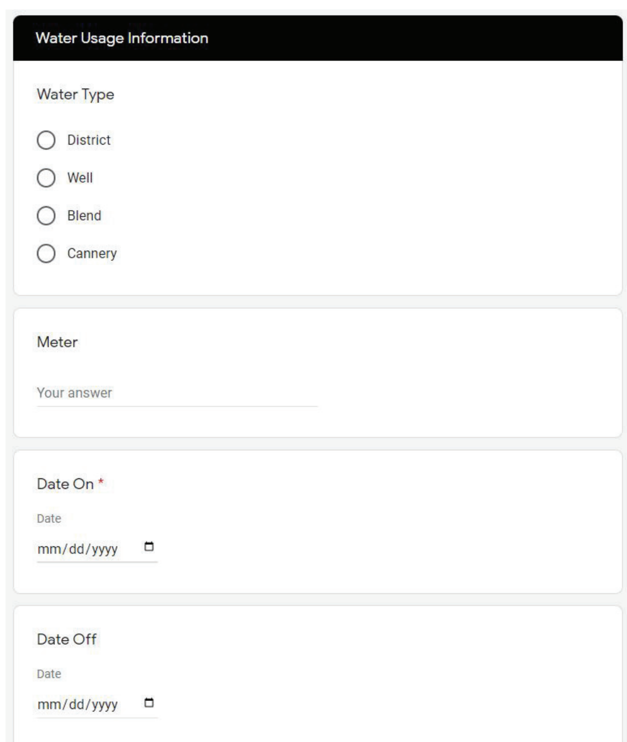
A portion of the form used to collect irrigation data is presented in Figure 3. This software was selected because it is free to use as part of the Google program suite and because Google Forms can be filled out on a mobile device without a Wi-Fi connection, thus meeting two key constraints. Data entry occurs at two distinct times, at the initiation and termination of irrigation; thus, the Google Form needs to be editable while also ensuring that each irrigation occurrence is collected as one record in the system. This form has multiple dependencies based on which user (typically a foreman in the farm setting) is inputting data; this reduces the complexity for the user by removing irrelevant fields from their section. The recorded information includes the various data for water, crops, and fields. If the foreman has completed the form while being offline, it is later synced to the system when a connection is available. The benefit of automating data entry includes minimizing errors in this process, whereas data validation processes serve to verify the entered data. These two activities work jointly to ensure accurate data is available for timely visualizations and correct calculations for items such as actual evapotranspiration for crops.

The Data Processing phase begins once a response is filled out in the Google Form. The responses are stored in a connected Google Sheet. In this sheet, a programming script automatically runs to affix the proper crop to each entry based on the field selected. The crops currently assigned to a field are accessed via a VLOOKUP function that pulls the most up-to-date crops. As crops are rotated, the crops assigned to which field are updated annually in a separate table. Another key script is in place to email an editable link to enable a foreman to complete their Google Form responses. These emails include the foreman's name and the field in the subject line to reduce the confusion when multiple Google Forms are filled out in quick succession. There are two additional scripts, one that emails a list of uncompleted entries weekly (to ensure that all entries have been completed once started) and another that moves the data into an archive worksheet. Once the data is processed, the archived data is synced from Google Sheets to Microsoft Excel, and the dashboards are updated in the Excel Workbook.

As a critical component of the system, the link to CIMIS data merits a much more in-depth discussion of its significance to the overall EMS. CIMIS is a program under the California Department of Water Resources tasked with maintaining and storing data from over 145 weather stations in California to assist irrigators in managing their water resources. The water subsystem will combine the client and CIMIS data to automate the calculation of the farm's actual evapotranspiration (ETc). The CIMIS data serves as a baseline for required water use levels, and the dashboards can show this by linking it to crop data. The CIMIS data provides reference values that can be converted to values specific to the

Figure 3

Water Irrigation Google Form



client's crop data, allowing the EMS dashboards to compare the amount of water required to replace water lost through evapotranspiration. According to the CIMIS (n.d.), evapotranspiration is the water lost by a plant due to evaporation from the soil as well as transpiration from the plant itself. The amount of water loss depends on plant type, foliage density, plant height, and soil quality which are difficult to measure precisely. Thus, a standardized measurement is necessary. This measurement is known as reference evapotranspiration (ETr) and is a calculation derived from a standardized field of grass or alfalfa surfaces near a CIMIS reference station that records additional data such as weather, wind, and solar radiation. This data is provided by CIMIS on an hourly or minute-by-minute basis for each of its stations.

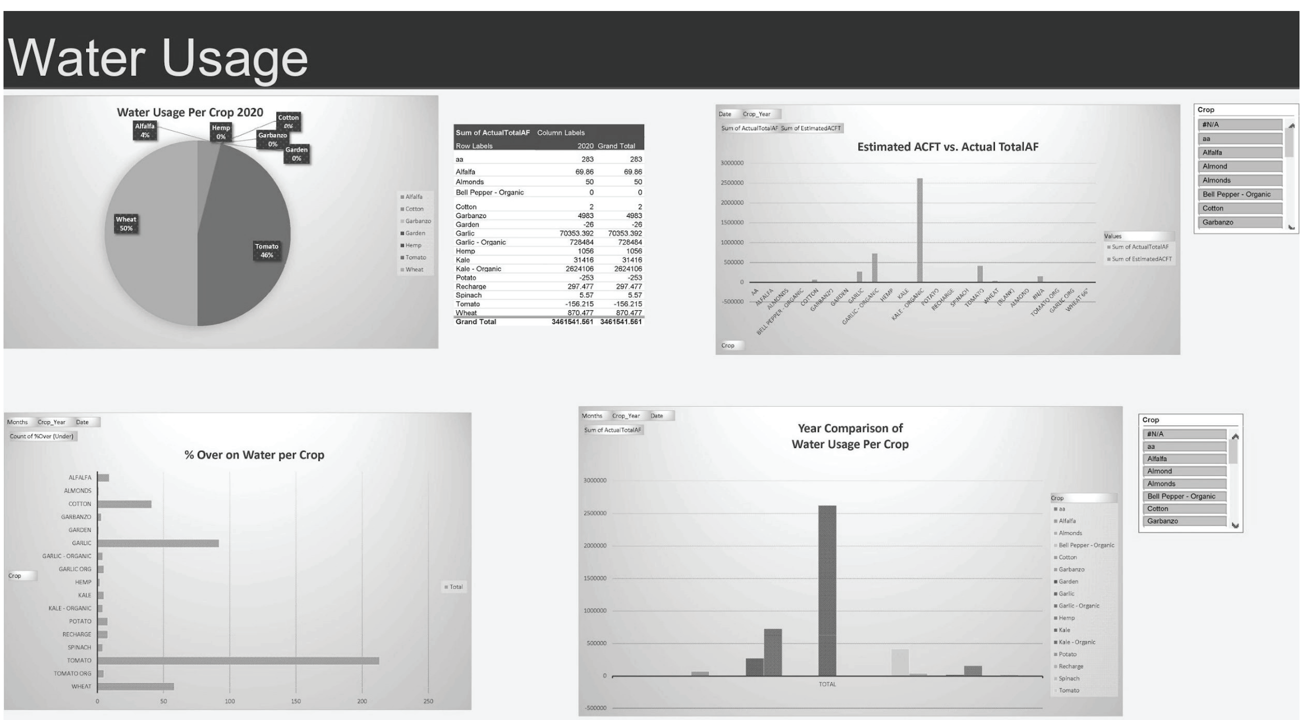
CIMIS data enables an irrigator to convert a standardized, reference evapotranspiration measurement to an actual evapotranspiration (ETc) for a specific crop using crop factors, namely crop coefficients (Kc). The client must currently manipulate the data manually, and the conversion requires several steps. The goal is to automate this process. The ETr values were obtained from the California Irrigation Management Information System (CIMIS) via an API. Once the data is accessed, it is converted from a JSON format into a more easily manipulable format. The ETr value is then multiplied by the Kc for the crop in question at its stage of growth to calculate the final ETc. Lastly, the ETc data is entered into the Microsoft Excel dashboard to be used as a baseline.

Data analysis is the third phase. Data is transferred, in real-time, ensuring that the client has up-to-date water usage and comparisons. The dashboards are configured to display actual water versus budgeted water in various scenarios, such as water usage per crop. An example dashboard visual is shown in Figure 4. Furthermore, a higher-level view of water usage can be analyzed through visualizations of the total amount of water estimated, used, and wasted from one year to the next. The automated system with dashboards improves the client's overall water management. The foreman will be able to estimate the required water more accurately for irrigation using visualized historical data. Ordering the correct amount of water at the correct time will lower the farm's costs and prevent overirrigation. Furthermore, timely water ordering can prevent issues with delivery of the water to their fields. Consequently, the farm is better able to meet the standards set by B Corporation and the B Impact Assessment.

These takeaways lead to the fourth phase of Decision

Figure 4

Sample Dashboard with Dummy Data



Making, in which the user can make informed decisions in real-time. For this subsystem of the EMS, end-users can visualize the efficiency of their water usage, see whether their actual water usage exceeds their budgeted water usage, and filter the data by crop and year. Automating the data entry process will provide real-time monitoring of water usage, allowing them to make adjustments before errors occur, such as extreme over or under usage. These insights drive the client's decisions for current or future production and can be reported to stakeholders such as the B Corporation team.

Preliminary Results

The team's deliverable was to create a system to automate the process of collecting and analyzing water usage data. The automated water subsystem collects data from the field and syncs it with the data analysis system to provide real-time access to water sourced from surface water or groundwater. These dashboards provide deeper insights, ensuring that the crops requiring the most irrigation receive it; thus, the dashboards better enable the farm to achieve optimal yields. The dashboard displaying the percentage of water overuse, for example, measures the water allocation per crop. The farm can use this information to determine whether one crop uses more water than another, comparable crop. This insight will aid in achieving an optimal water mixture under rapidly changing conditions such as drought conditions, climate change, and other crop priorities.

The newly developed water use tracking system has been delivered to the client and is in the process of being implemented. The farm earned B Corporation status during the course of the project. It is expected that the EMS will assist in maintaining the certification by monitoring the use of resources and revisiting their objectives. The EMS provides a comparison of water usage across different years, across fields of the same crop in the same year, water usage throughout a single crop year (for all crops), and the actual water used versus the amount the farm estimated from this subsystem.

Discussion

The team demonstrated a practical application of data analytics by developing the EMS to contribute to the sustainable agriculture realm. The insights provided by the system described in this paper may assist farmers in sustainably producing high-quality products. This project models how addressing ecological needs for sustainability can meet the economic needs of producers without jeopardizing society's need for quality produce as suggested by Yunlong and Smit (1994).

Although the primary goal of this project is to assist irrigators in conserving resources such as water, there are additional advantages. The dashboards for this subsystem may provide insights into greenhouse gas emissions, as more groundwater pumped for irrigation necessitates more electricity. This electricity is frequently derived from fossil fuels, which contribute significantly to greenhouse gas emissions. Dashboards such as these will provide insight into agricultural operations and the numerous input factors that affect yield volumes as well as how those operations impact the environment.

Conclusions

A new Environmental Management System for small-scale farms was developed using data analytics. In its current development stage, the EMS monitors water usage. The project was successfully delivered to the client with preliminary results being positive. The farm has earned and is attempting to maintain a B Corporation certification, as described in the paper. With only one EMS subsystem completed (water and irrigation), the team can continue to optimize the data collection, data storage, and data analysis tools to meet any changing requirements. As the data for the current and future crop years are collected, it will be used to update the EMS on an annual basis, then archived for future reference as historical data. Automation and integration of the other planned subsystems to track fertilizer usage, pesticide usage, air and climate impacts, waste management, and impacts upon soil and wildlife will be included in future work. Small-scale efforts, such as this farm's development of a water and irrigation tracking system, are critical to re-aligning the agriculture industry to focus on sustainability.

Sustainability has become a pressing issue across a variety of human activities as a result of climate change, growing populations, and other threats to our resources. Utilizing data analytics and the tools developed for working with large, intricate datasets to make more informed, less wasteful resource allocation decisions is one tool for developing sustainable agriculture practices. Currently, the farm included in the project is seeing improvements from the new processes, tools, and methodology. This system provides a preliminary demonstration of bringing data analytic techniques to agriculture, one that provides a model for others to address sustainability, tackle climate change, and add value to our communities.

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Impacts of Student-Led Sustainability Efforts at Fresno State

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Abstract

As California State University, Fresno (Fresno State) continues to develop institutional capacity to improve sustainability within the contexts of the Association for the Advancement of Sustainability in Higher Education (AASHE), the university mission, and strategic objectives identified by the California State University (CSU), student activism has played a critical role in establishing the groundwork for current efforts. Despite progress towards an overarching goal of integrating sustainability into all parts of the institution, near constant turnover within the institution and student-led organizations often leaves uncertainties about institutionalization, with questions often arising about the respective roles of faculty, staff, and students. It is also often unclear whether the sustainability efforts contributed by students act to empower them or if it serves as an additional burden. In our research, we compare a case-study of our student-led efforts towards the integration of sustainability at Fresno State to a landscape analysis of integrative sustainability efforts findable across websites of all other CSUs. The aim of this paper is to examine the current roles that students are playing in both campus and system-wide sustainability efforts. Case study and landscape analysis results suggest that while students look to their campuses to provide sustainability leadership, youth-led efforts are apparently the most numerous in advancing efforts across the CSU system. This supports more contemporary views of students and the need for asset-mindedness, as well as the idea that educational institutions--who are charged with leading sustainability (i.e., AASHE)--can increase equity and reduce student burdens by recognizing, supporting, and intentionally collaborating with leading student efforts.

Introduction

> *"It's one thing to encourage youth to participate, to come to events like this, but it's an entirely different thing to provide a space where youth feel empowered to drive change. We need to start recognizing young people for the value that they are."* -Ernest Gibson, COP26

> *"Our generation wanted to not only change the world but to save it."* -Greta Thunberg

Efforts to achieve institutional sustainability at Fresno State can be characterized as a *bottom-up* approach made by successions of student leaders and activists who have played a critical role in establishing the framework for change. These

efforts share much in common with other youth-led organizations such as Fridays for Future, Sunrise Movement, and Future Coalition, as well as student-led activism that has been facilitated on other CSU campuses (e.g. the Stanislaus Eco Warriors or Channel Island's Green Generation Club). The Chancellor's Office provides important guidance, encouraging campuses to "integrate" sustainability within everyday academic, student, and facility-based operations (CSU Sustainability Policy, 2014). Unfortunately, these directives remain ambiguous in specifically mapping how sustainability goals can be achieved within the greater scope of Fresno State policy. The progressive pathway undertaken by student leaders at Fresno State between 2013-2021 led to collaborative decision-making roles with campus administration to find creative ways to apply funding and empower students to re-imagine their roles in building resiliency against the uncertainties and challenges from changes in our air quality, water and climate (Jasechko & Perrone, 2021; see also Hanak et al., 2017; Meixner et al., 2016; Lo & Famiglietti, 2013).

While students at Fresno State are leading campus climate action and sustainable change, the most common advancement of sustainability is often described as a *top-down* (Rowe & Hansen, 2016) academic process (Augustine, 2021; see also Buckley & Michel, 2020; AASHE 2010), where the institution creates a sustainability officer role and/or a sustainability institute (Fu, et al., 2020) responsible for beginning the coordination of sustainability across all sectors of the institution. Subsequently, campuses tend to join consortium networks like the Association for the Advancement of Sustainability in Higher Education (AASHE) and sign the American College & University Presidents' Climate Commitment, which then support sustainability-related development and accounting methods for senior leadership who possess an immediate ability to influence strategic planning and subsequent resource allocations for progressive advancements across several intersectional components of campus: academic affairs, student affairs, facilities, and administration.

Even at its best iteration, this typical top-down growth pattern misses the guiding narrative and lived-experiences from the youth that institutions serve: our students. Solutions and strategic planning without strong involvement from student leadership raises questions about their enfranchisement and the ability of the university to actualize youth power (Stone, 2021; see also Thew et al., 2020). Paradoxically, in the absence of a top-down initiative, institutions can have impactful, student-led movements that push sustainable advancement (Rowe & Hansen, 2016), although this approach can disproportionately burden students (Cheong et al., 2016; see also Mitra et al., 2014; Mein, 2018; Thew et al., 2020). Here, we share a case study of the history of sustainability on our campus and explain how student leadership served institutional advancement when there was a perception that senior leadership was lacking. By mapping out both historical efforts and our most recent "road show," we also show that student-led sustainability efforts can be as institutionally transformative as more typical top-down approaches, while allowing for more inclusive and empowering roles for our young activists at all levels of the university. Then, we compare our history with a landscape analysis of sustainability across all CSU campus websites, in order to give a better sense of how students are contributing to their local campus efforts. We use the results to then infer the respective role our students are playing in driving much-needed, sustainable campus advancement.

Fresno State's Institutional Setting

Fresno State is a Hispanic Serving Institution (55% Hispanic students) and an Asian American and Native American Pacific Islander-Serving Institution (12%), with the campus consistently ranking as one of the nation's topmost institutions in social mobility and equity (CollegeNET, 2020; see also Fresno State, 2021). Our actual graduation rates greatly exceed expected graduation rates estimated from incoming student metrics including financial support and other demographic information. This gives Fresno State a unique role in promoting social mobility, reducing achievement gaps, and promoting a more equitable and successful future for the diverse community we serve.

As currently written, the mission of the California State University (CSU) is to "advance and extend knowledge, learning, and culture, especially throughout California[...] prepare significant numbers of educated, responsible people to contribute to California's schools, economy, culture, and future[...] promote an understanding and appreciation of the peoples, natural environment, cultures, economies, and diversity of the world" (California State University, n.d.). Here in California's agriculturally rich Central Valley, challenges are presented in our region's high rate of food insecurity (Crutchfield et al., 2016), a disproportionately high number of the state's failing water systems (Reese, 2018), and some of the highest incidences of respiratory issues in the state and nation (Alcala et al., 2018, 2019; see also Schwartz et al., 2009). In line with our mission, Fresno State has to provide new skills, knowledge, and mindsets to prepare 25,000 students each year to meet the local and global challenges presented

by climate change, losses of biodiversity, population growth, limited water resources, health issues, energy inequities, extreme poverty and displacement (Joint Center for Political Economic Studies, 2012; see also UNDESA, 2019).

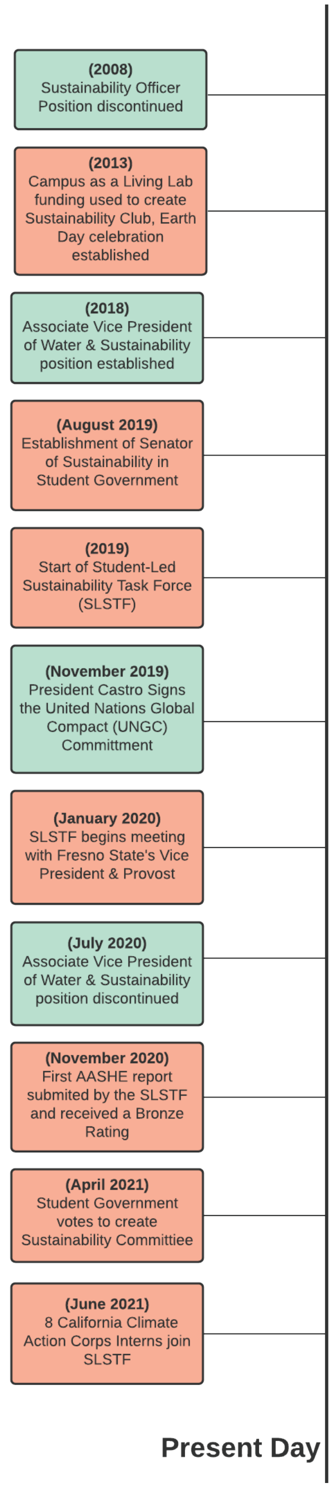
Sustainability Timeline at Fresno State

Following many other institutional trends, Fresno State's sustainability efforts began with a typical administrative-level type of sustainability coordinator position (Figure 1). There was a Sustainability Officer position in 2008, which was discontinued due to budget contractions during the recession. In its absence, three faculty leveraged CSU Chancellor's Office Campus as Living Lab funding to establish Fresno State's Sustainability Club in 2013, reviving an annual Earth Day celebration on campus and slowly growing to tackle much larger campus goals and community events. In 2015, students from the club demanded more high-level campus coordination by advocating for a new Associate Vice President (AVP) for Water & Sustainability position, which was successfully established in 2018 (Fresno State). This position enabled coordination at high levels and was a creative solution by the Provost at the time, who modified an existing water directorship to include sustainability in the position's scope of work. During his brief tenure, the AVP for Water & Sustainability worked closely with the Sustainability Club to connect students and faculty with university administration, and he collaborated with the club on strategic planning for the 2018-2019 school year. These goals included creating a catalog of best practices being implemented successfully at other college campuses, conducting a sustainability literacy test of the Fresno State Student body, and expanding club engagement across all eight colleges.

During this time (2019), the Sustainability Club began reaching more students and created a network between faculty and student organizations, such as the Associated Students, Inc. (ASI) and the Fresno State Chapter of the National Association for the Advancement of Colored People, to further integrate sustainability across the campus. Citing an institutional stagnation of critical sustainable advancement university-wide, student activists quickly turned their attention toward both educating the general student population as well as advocating for university-wide change. Identifying a need for broader student governance involvement, the Sustainability Club collaborated with ASI to create a new senator position. This major advancement was the result of a successful referendum vote to create a Senator of Sustainability position, which passed with 89% of student voters in support (Casey, 2019). With this new position established, Sustainability Club of-

Figure 1

Timeline of Sustainability Events at Fresno State



Note. Visual representation of the history of sustainability at Fresno State. Green highlights administrative-led events whereas orange highlights student-led events. A more detailed timeline can be found on the Fresno State Sustainability Website. Timeline is not to scale.

ficers and the Senator of Sustainability planned to advance sustainability beyond student efforts. This led to the establishment of a student-led Sustainability Task Force (SLSTF) using remaining Campus as a Living Lab funds to recognize students' efforts of networking, brainstorming, disseminating information, and finishing sustainability related projects that benefit the campus. By creating the SLSTF, the Sustainability Club was able to focus primarily on the original intent of providing students with a sense of social belonging and identity instead of advocating for more sustainability on campus, alleviating some of the intense burden carried from other competing involvements. This solidified the distinction between the Sustainability Club and the SLSTF, with the latter taking on more administrative and institutional responsibilities.

In early 2020, the SLSTF held their first meeting with the current Vice President Administration and CFO and Provost to discuss and collaborate on sustainability efforts across campus, alongside the AVP for Water & Sustainability and an additional staff member from Facilities and Operations Management. This initial meeting was the start of a unique, impactful working relationship between students and higher administration. Encouraged to speak candidly with administrators, the SLSTF worked towards a common vision of supporting new and more integrative work to help disseminate knowledge of sustainability across campus (Figure 2). These meetings continue to this day, despite unexpected challenges due to the COVID-19 pandemic and the loss of two key positions; in July 2021, Fresno State Lost both their AVP for Water and Sustainability as well as the lead sustainability staff from Facilities and Operations Management. This raised uncertainty about institutional top-down support for sustainability moving forward but the SLSTF moved forward and gathered data for Fresno State's first AASHE STARS report, eventually meriting the campus a bronze rating. Despite being lauded as leaders and recognizing the novelty of their youth-led transformative impact, questions also began to emerge as to whether this type of student-led work introduces elements of exploitive over-reliance on students. This was a large undertaking led by students, and in this contribution we make an effort to raise awareness of this new paradigm in higher education where students can lead major campus efforts, while also using our experience along with content across CSU websites to help recommend a newer understanding of student roles in the context of integrating sustainability within academic institutions. Specifically, we address how students can remain involved and empowered to make important societal changes without overburdening them with disproportionate pressures and challenges of being changemakers within the institution.

Figure 2

Graphic Depicting Sustainability at Fresno State

Note. Visual representation of sustainability at Fresno State's campus. The graphic was made as an educational tool to communicate what "sustainability" means for the campus. The graphic took about one year to develop, going through several iterations, with support and feedback from campus communications and higher administration. Student leaders use the graphic to explain sustainability in relation to the AASHE STARS framework and for campus outreach.

Research Methods

Fresno State Student Sustainability Literacy Survey

Serving as a barometer for student familiarity and favorability regarding topics of sustainability on campus, the SLSTF conducted a Student Sustainability Literacy Survey–with the objective of gauging student interest and understanding of sustainability–at the first Fall Sustainability Symposium hosted by the Sustainability Club in 2019. The survey was designed to assess cultural and literacy markers, which was modeled after a similar assessment used by CSU Sacramento (Agostinho et al., 2017), so that results could be shown to high-level administration on campus. The survey was started in November 2019, and ongoing outreach for student participation occurred through Earth Day (April 22, 2020). The survey was maintained through Fresno State's Office of

Institutional Effectiveness for data maintenance and quality assurance. Specific information on the survey, assessment questions, and more detailed information can be found in section EN-6 credit of Fresno State's AASHE STARS report.

CSU-wide Sustainability Landscape Analysis

The Landscape Analysis Survey was conducted June-July 2020 by the SLSTF with guidance from a professor within Fresno State's Media, Communications & Journalism Department. A landscape analysis can be helpful in assessing an organization's efforts, especially for comparison to efforts being done by other similar and/or competing entities (see Garcia et al., 2020 and references therein). The analysis entailed thorough review of each CSU campus website and documentation of content found within the sites for reporting on these nine categories:

1. AASHE STARS Standing
2. Clubs and Events
3. Commitment Statement
4. Intersectionality
5. Graphic or Logo
6. Majors and Minors
7. Presence in Facilities and Operations
8. Presence in Student and Faculty Governance
9. Sustainability Definition

While it is possible for campuses to be included in this analysis who exhibit sustainability in these topics but who lack web accessibility and/or outdated web content, the landscape analysis still allows for a meaningful overview of how the CSU campuses are (or were) publicly communicating their respective sustainability efforts during the 2020 summer timeframe.

Fresno State Sustainability Student Time Survey

In April 2020, the Sustainability Club President, who was also working in the SLSTF, interviewed some of the most active Sustainability Club members and officers to survey what other obligations they held, and the degree of time commitment dedicated to extracurriculars in addition to course workload. Ten students were surveyed regarding daily and weekly hours spent on academic course load, student research, campus involvement, time spent doing work related and unrelated to campus sustainability, and daily personal responsibilities.

Campus Outreach Sustainability "Road Show"

A key aspect of the SLSTF work was, and still is, educating students, faculty, staff, and the community on the meaning of sustainability and the importance of integrating sustainability across all campus efforts. Following the achievement of the AASHE STARS bronze rating, the Vice President and Provost encouraged an informational outreach effort by the SLSTF–coined as the *Sustainability Road Show*–which was a methodology developed to move outreach beyond student-to-student class visits and club tabling so as to encourage more cross-campus interactional engagement with faculty, staff, and student government. By sharing efforts with other parts of campus, the SLSTF could expand current understanding of how sustainability applies to all parts of the institution. Target audiences of the Road Show included the Campus Planning Committee, Leadership Roundtable, President's Cabinet, Curricula Committee, GE Committee, Academic Affairs Leadership Team, Alumni Association, and Council of Chairs. All groups except the GE Committee scheduled student-led presentations, with additional follow-up presentations requested by student and faculty governments, Athletics, and Advancement and Communications.

Results

Fresno State Student Sustainability Literacy Survey

The survey conveyed that over 70% of participants had a passion for sustainability or at least a considerable interest. When asked the degree of influence various factors had in shifting student attitudes regarding sustainability, respondents chose from categories such as: media; campus initiatives; college instructors/coursework; community activism (off-campus); campus activism; peers; family; high school instructors/classes. It was found that peers remained most influential in shifting positive attitudes toward sustainability, followed by college instruction then campus activism (Figure 3).

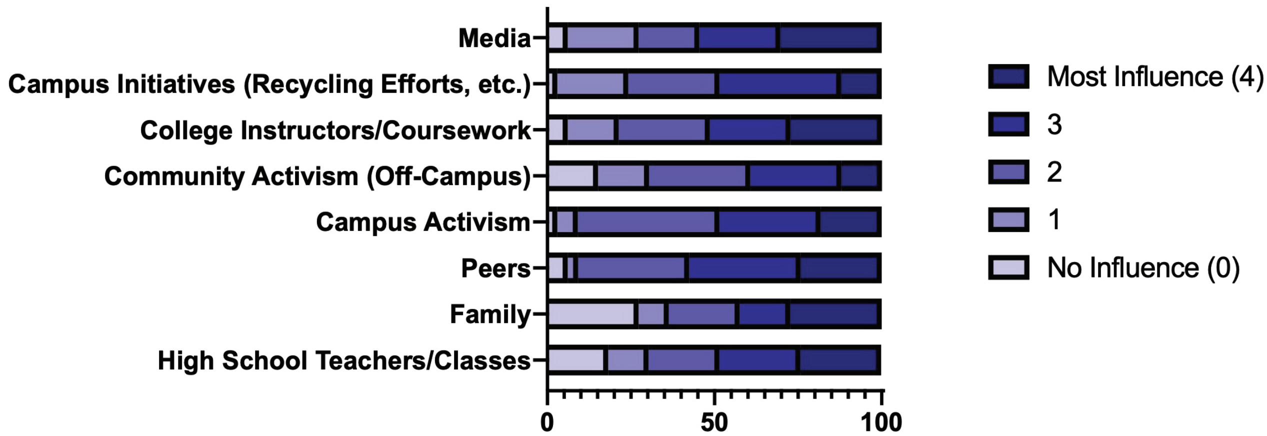
Similarly, when asked about their thoughts on the role of universities, 72.7% of respondents strongly agreed universities should be sustainability role models in their daily operations. However, only 42.4% of respondents agree that Fresno State was doing a good job of modeling sustainability in its daily operations (Figure 4).

CSU-wide Sustainability Landscape Analysis

Nearly all CSU campuses are making significant progress in the integration of sustainability into their daily practice and are all at different stages in this transition. Data and qualitative summaries of the full analysis are available in Supplemental A,

Figure 3

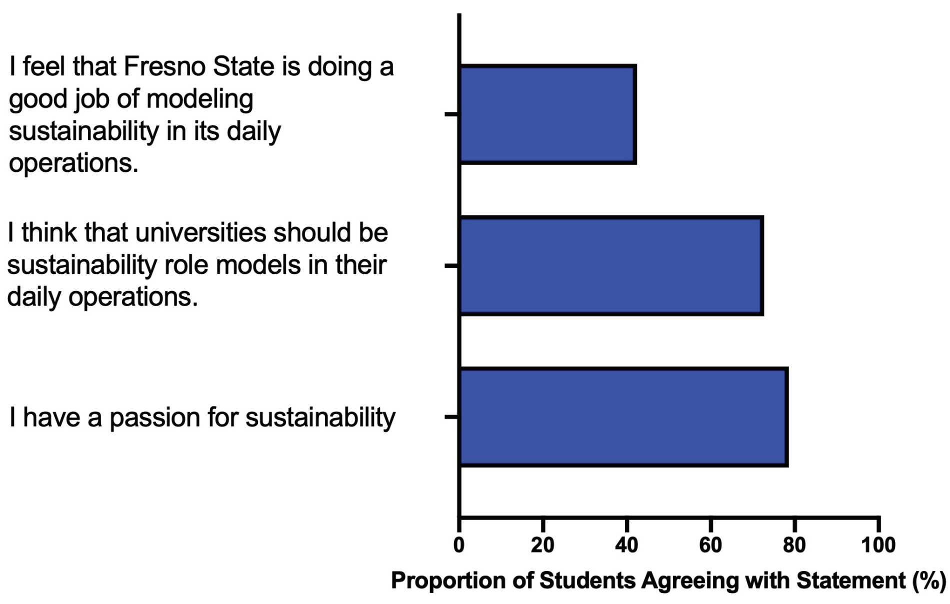
Assessment of Primary Influences of Student Attitudes Toward Sustainability (n=42).



Note. Breakdown of Student Influences on Sustainable Attitudes by Category.

Figure 4

Student Sustainability Literacy Survey (n=42)



Note. Attitudes regarding sustainability amongst the student population at Fresno State.

with the main findings across the nine categories summarized in table 1. Overall, most CSU campuses have some presence of the three-pronged sustainability definition (i.e., people, profit, planet), with 17 of the 23 campuses active and ranking silver or above in AASHE STARS. Additionally, most campuses (18 out of 23) have student clubs related to sustainability. About half the campuses (13 of 23) have sustainability representation in student governance, with slightly less representation appar-

Table 1. *Main Findings of Website Landscape Analysis across 23 CSU Campuses.*

Content Area:	Main Findings for June-July 2020 Websites:
AASHE STARS Standing	7 gold campuses, 10 silver, 4 bronze, and 2 participating
Clubs and Events	18 campuses have at least one club or internship program related to sustainability, with 14 of those having multiple programs on campus. 13 campuses have Earth Day/Week events. Chico has a notable yearly "This Way to Sustainability Conference."
Commitment Statement	Few campuses (~2) are externally committed (Second Nature or AAUPC), with a few more (~4) mentioning CSU-wide sustainability policy.
Intersectionality	4 campuses with messaging that includes the idea of sustainability as increasingly being embedded within social justice issues.
Graphic or Logo	7 campuses with a sustainability graphic or logo. Only 1 graphic, Chico's, actually embeds sustainability within the university's mission and strategic priorities.
Majors and Minors	8 campuses with "sustainability" related majors and/or minors; 3 campuses with bachelors or masters "sustainability" degree labels. 11 campuses with sustainability-related bachelor degrees, 9 campuses with related minors, 7 campuses with graduate degrees, 3 campuses with GE pathways, and 3 campuses with sustainability-related certificates.
Presence in Facilities and Operations	4 campuses with sustainability in facilities, appearing well integrated to other sustainability efforts on campus. 5 campuses with sustainability in facilities, unconnected to other campus efforts (link)
Presence in Student and Faculty Governance	13 campuses with sustainability committees and/or student senator position; 7 campuses with faculty committees in faculty governance and/or at the university. A few (~2) with campus-wide presidential or cross-governance and operational collaboration.
Sustainability Definition	Three-prong definition is most commonly used, like "people, profits, and planet," reflecting the common rhetorical device of sustainability experts who use the three-legged stool as a symbol.

ent in analogous faculty structures (about seven). Half of the campuses similarly have sustainability-related majors and/or minors. Less frequently found are commitment statements, graphics, and intersectionality demonstrating the coordinated integration of sustainability across campus entities.

Fresno State Sustainability Student Time Survey

Our survey revealed that students involved in sustainability activism at Fresno State were also exceeding expectations in academic and extra-curricular activities, on top of other familial or household commitments. Students must take a minimum of 12 units as an undergraduate to be considered a full-time student, according to FAFSA. Of the ten students surveyed, nine were taking more than 12 units (average units taken: 16; maximum units taken: 21). Given that each unit represents about three hours of work each week, a student taking 15 units is easily committing 45 hours to school each week. We found that six of the 10 students surveyed were actively involved in at least two clubs, primarily in leadership capacities. Most students also held paid employment in some capacity, either on or off-campus. Taking into account time for meals, personal care, transportation, and sleep, we found that students were significantly encumbered with responsibilities. After totaling all the hours students were participating in daily activities, we found that students spend on average 21.19 hours a day (n=10) working on their responsibilities and health (Figure 5). These students are not only working a full schedule of classes, study time, extra-curricular activities, and work but also leading Fresno State's integration of sustainability.

Campus Outreach Sustainability "Road Show"

As of June 2021 the SLSTF presented to over 300 unique

Figure 5

Student Activist Responses Regarding Time Commitments

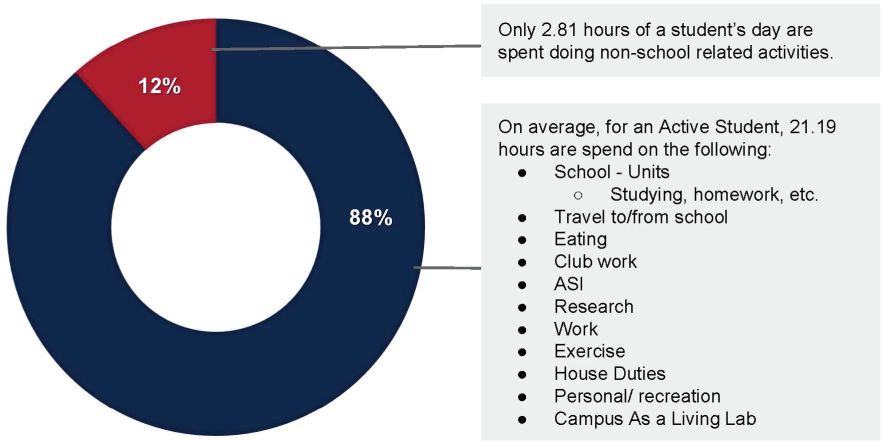


Table 2. *Sustainability Roadshow Meeting Accounting Sheet. Note.* These meetings were intended to share sustainability efforts across campus, introducing Fresno State's AASHE STARS report, and provide recommendations for improvement.

Date	Measure	Count	New Connection	Notes
9/1/20	People	5	5	Initial Group
9/10/20	People	41	41	CSM 10 BOND
9/11/20	People	38	38	CSM 10 BOND
10/28/20	People	8	3	VP + Provost
11/16/20	People	10	7	Faculty Executive Senate
12/9/20	People	10	0	VP + Provost
12/10/20	People	25	13	W&S Committee
2/1/21	People	82	76	Faculty Senate
2/3/21	People	30	26	AALT
2/9/21	People	23+	22+	Presidents Search Forum
2/22/21	People	3	0	VP + Provost
2/24/21	People	22+	22+	ASI
3/11/21	People	5	5	Lecturer Appreciation and Virtual Service Fair
3/15/21	People	10	7	Cabinet
3/23/21	People	6	5	Athletics
3/24/21	People	27	26	Campus Planning
3/25/21	People	30+	30+	TWTS

students, faculty, staff and campus administrators. This outreach series (Table 2) enabled the SLSTF to meet with a variety of stakeholders at different levels within the institution. With every meeting, new perspectives and ideas were expressed and the efforts towards integrating sustainability continued to grow. This allowed the students' voice to be expressed among faculty, staff, and stakeholders that are key in influencing the changes being made so that they can better

align their work and collaborate to benefit the students in which they serve.

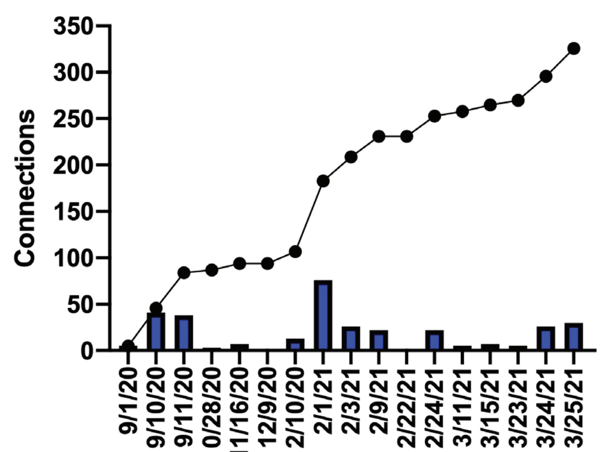
Discussion

Results of the combined analyses indicate a large degree of interest in sustainability among Fresno State students, and that most students tend to view universities as exemplary models for the integration of sustainability (Figure 4). Existing concurrently, however, is the perception that Fresno State is not meeting expectations in this regard. This may seem inconsistent with the system-wide AASHE STARS participation, and even Fresno State's recent Bronze rating, although it is consistent with landscape analysis findings that the most numerous efforts are founded in student-led efforts; clubs, internships, committees, and student senate positions (Table 1). The high number of campuses with active student-involvement (13 campuses hold Earth Day events; 18 campuses have at least one student sustainability-related club) relative to the lower number of campuses with ancillary academic (seven campuses with faculty committees), operational (nine campuses with sustainable facilities), and/or presidential-level involvement (six campuses with sustainability commitments) exemplify this high priority of sustainability across CSU student populations. Despite the fact that students often represent a large demographic of campus populations, our findings show that more student governments are directly engaged in sustainability efforts than their faculty equivalents (13 vs. seven, Table 1), suggesting that student-led efforts towards helping campuses improve and better integrate sustainability warrant more support and recognition (i.e., Stone, 2021 and Thew et al., 2020). It may also suggest that student- and youth-led sustainability work can perhaps be used as an indication of whether or not an institution has asset-based mindsets (Mein, 2018). The prominence of student impact is also consistent with the findings of our Fresno State Student Sustainability Literacy Survey, where students self-report that it is their peers--their fellow students--who are the most influential in positively shifting their attitudes towards sustainability (Figure 3). If students and peer-support are truly more influential in affecting more sustainable behaviors, this may mean that student-leadership can play an even more impactful role than current curricula in reducing an individual's lifetime greenhouse gas emissions (i.e., Cordero, 2020).

Although the content presented online at the time of our analysis may not reflect the true breadth of campus sustainability initiatives, our findings suggest that student-led efforts appear to be prevalent across the CSU system and provide an overall sense of how committed and inclusive each respective university is to achieving sustainability goals. While the landscape analysis indicated there are areas (i.e. course development & sustainability GEs) that other campuses are outperforming Fresno State in, we found that the relationships between our students and higher administration was comparatively unique. While other CSUs typically engage student input through an intermediary sustainability coordinator, Fresno State students are able to collaborate directly with senior leadership. Furthermore, such collaboration and quarterly discussions held between Fresno State students and higher administration have fostered the development of subject-expertise in the SLSTF, which further bolsters the impact and reach of our student leaders. This is apparent in the outcome of the Sustainability

Figure 6

New Connections Over Time



Roadshow, where students met with students, staff, and faculty, reaching over 300 unique people in less than one academic year (Figure 6). The more stable rates of forming new connections in Figure 6 may reflect the influence of finals, midterms, and increased scarcity of time. Given the already high demands on our students' time (Figure 5), it is likely that a slowdown of progress can be mitigated with full-time staff positions specifically dedicated to campus sustainability. This would ensure more timely, equitable, and consistent progress, especially given the rapidity with which ambitious change is needed (UNEP, 2021).

Though the timeline presented in figure 6 depicts successful progress that has occurred over the most recent academic year, it is also important to keep in mind the near decade-long efforts in which students have persisted and

diligently worked to establish trust, foster collaboration, and create campus precedents. Combining longer-term campus timelines and contextual histories (Figure 1) with shorter-term outreach metrics like Figure 6, it may be possible to quantify or better qualify rates of institutional transformation. Compared to where the campus was almost a decade ago, the recognition and support of sustainability as a top university priority is a culmination of bottom-up change affected by successive groups of student leaders. The critical relationships and history students have been able to build over both short and long time spans (Figure 1 and Figure 6) have further enabled a legacy and an inspirational outlook for campus sustainability. Students of Fresno State's Sustainability Club, SLSTF, and ASI have continually demonstrated their ability to produce actionable practices and policy adjustments, often outpacing parallel work by other campus committees and entities. Although student influence has led both rapid and long-term change, it is vital that work remains meaningfully coordinated across all the different parts of campus. Given the sheer importance of students in this work, their collaboration with the President, Vice President, Provost, faculty, and staff is crucial in further developing successful solutions. Students excited and anxious to see and be part of sustainable change should be supported to be part of taking action. Likewise, it is imperative that administrators view students as the leading assets they are (Mein, 2018) and remain actively receptive to working with students to develop effective solutions to these complex socio-environmental issues and challenges.

As important as students are in driving progress, it is important to consider the implications and potential burdens such work may bear on the student experience and, by extension, university learning outcomes. The results of the Fresno State Sustainability Student Time Survey indicate that students are overworked and spread thin between competing priorities of their sustainability work, coursework, clubs, committees, family commitments, social needs, employment, and self-care (Figure 5). Given the institutional setting of Fresno State, this added burden of sustainability work is not placed upon "typical" college students, but instead a diverse population of underrepresented, first generation, and Pell-eligible students. Research shows that such groups face significant barriers to civic integration and political power (Mitra et al., 2014) yet, within the context of our bottom-up approach, these students who already bear disproportionate disparities can be looked upon as sustainability experts and leaders. Research also shows that when viewed through asset-minded frameworks, these same student groups become valuable contributors to the wellbeing of their communities (Mein, 2018 and references therein). Furthermore, the integration of sustainability into coursework presents another tremendous opportunity for reducing student time burdens, while also connecting curriculum to real world problems. A full institutional integration of environmental and climate justice, social justice, and economic problem-solving within courses has the potential to produce an entire generation of well-equipped graduates capable of developing solutions tailored to issues of any age. Tailoring curriculum to include these sustainability topics (i.e., UNESCO, 2017) while also increasing the amount of available sustainability-related internships and service-learning courses allows students to more meaningfully engage with curricular material and leave lasting impacts on their campus and community. Overall, the net effect of higher education can then alleviate unnecessary burdens on its student leaders, which then can empower students to be even more timely and effective in addressing our imperative and intersecting social and environmental crises (i.e., COP26).

Conclusion

Although a perception exists amongst student populations that Fresno State is not leading in the integration of sustainability, students have demonstrated that they are capable of affecting positive change in their own interest and in the greater interest of the University mission. The student-led sustainability efforts at Fresno State started as a grassroots and bottom-up approach, but have evolved dramatically over the past few years, leading to the establishment of paid positions and elevated responsibility. In this paper, we suggest it is necessary for the work of the students to be recognized and compensated in a way that empowers students to advance sustainability without being overburdened and detracted from other tasks.

Landscape results show that students have been key in making institutional changes within the campus community at Fresno State, across the CSU, and in other higher education environments. Activism and work provided by students not only contribute towards reaching sustainability goals, but can also be impactful on the general student population by ensuring expectations of meaningful learning experiences are met. It is necessary that these student-led initiatives are supported from the top-down and the work of the campus does not hinder student success. Fresno State is continuously evolving to develop the skills and talents of student leaders, supporting their efforts, and working towards a more sustainable future at both the grassroots and institutional level.

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A Closer Look at CSR Practices in Sustainable Fashion: A Guideline for Apparel Brands

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Abstract

While it might be greenwashing that impedes consumers' eco-consumption, the researchers posit that this gap is also due to fashion brands' weak corporate social responsibility (CSR) communication and inconsistent understanding of CSR activities. This study aims to 1) determine the ease with which consumers can navigate sustainable fashion brand websites to find corporate social responsibility activities, and 2) construct a framework that clearly identifies CSR activities, its dimensions, and the business operation stages at which they occur. Website content analyses were conducted on 27 sustainable fashion brands in the United States to find a correlation between how websites present CSR activities and how consumers may perceive and identify them. A framework was proposed to better understand current CSR activities and guide future development through literature reviews and definition analyses (CSR definitions in the past 40 years). This study seeks to better understand the effectiveness of CSR presentation on brand websites, to create consistency among CSR activities, and to provide consumers, scholars, and market practitioners with a tool to implement and identify CSR activities.

Introduction

Sustainable fashion is considered the antithesis of fast fashion. While fast fashion relies on low prices, quick merchandise turnover, and exploitation of people and the planet, sustainable fashion aims to slow down fashion and address the unethical nature of fast fashion (Kim & Oh, 2020). H&M, Zara, and Forever 21 are among some of the more popular global fast fashion brands (Su & Chang, 2018) while Patagonia is known for its sustainable practices and commitment to corporate social responsibility (CSR). Sustainable fashion is a term used interchangeably with eco-fashion, sustainable clothing, green fashion, ethical fashion, and more (Kim & Oh, 2020; Lundblad & Davies, 2016). In many ways, sustainable fashion implements corporate social responsibility to address human rights violations, inequity, poor product quality and longevity, and negative environmental impacts throughout the supply chain–all of which are prevalent issues in fast fashion (Henninger et al., 2016). For instance, several sustainable fashion companies implement eco-friendly textiles, integrate

renewable energy along the supply chain, implement fair labor standards, and seek partnerships with other sustainable organizations to increase accountability and transparency. Although there is growing interest among consumers to shop sustainably, there remains a gap between consumer attitude and behavior; that is, consumers have an interest in environmentally friendly products but do not apply those principles in practice (Chan & Wong, 2012; Lee et al., 2020). One of the reasons may be consumers' perception of greenwashing, resulting from suspicious claims of being eco-friendly (Chen et al., 2016). According to Aji & Sutikno, greenwashing refers to a deceptive marketing tactic used to "promote the perception that a company and its products or services are environmentally safe or 'friendly'" (Aji & Sutikno, 2015, p. 433). In addition, the cost factor can be a reason why consumers are reluctant to switch from fast fashion to sustainable fashion. Sustainable clothes are usually more expensive to purchase than fast-fashion clothes due to several factors such as higher supply chain standards and product quality. However, the researchers posit that the attitude-behavior gap is also due to fashion brands' weak CSR communication and inconsistent understanding of CSR activities.

This study is important because it evaluates the ease with which consumers can identify CSR activities on sustainable fashion brand websites. Currently, there is little guidance as to how companies can implement CSR activities (Battacharya et al., 2009). Hence, the CSR framework (matrix) in this paper attempts to provide a stronger, more consistent understanding of CSR activities, CSR dimensions, and the business operation stages at which they occur to guide companies' strategy development. Relevant existing literature has explored the importance of green marketing to bridge the attitude-behavior gap (Lee et al., 2020), rationale behind consumer purchasing decisions (Chan & Wong, 2012; Su & Chang, 2017), strategies that retailers use to position sustainability and CSR (Chang & Jai, 2015), CSR performance along the supply chain (Chan et al., 2020), the importance of CSR in business operations (Bhattacharya et al., 2009; Becker-Olsen et al., 2006), and the variations of CSR definitions and concepts (Carroll & Shabana, 2010; Dahlsrud, 2008). However, there are few studies that measure how easily and consistently consumers can identify CSR activities, and few propose a way to organize such information with a systemic framework. This study sets a foundation to further investigate these areas of opportunities in the fashion industry with the hope of increasing consumers' CSR knowledge. Thus, the researchers propose two research questions: (a) how easily identifiable are CSR activities on brand websites? and (b) can we develop a systematic framework to guide CSR activities for apparel brands?

Literature Reviews

Defining CSR

Though there is no singular definition of CSR (Carroll, 1999; Chaudhri & Wang, 2007; Dahlsrud, 2008), it is generally accepted as a construct through which companies "integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis" (Commission of the European Communities, 2001). Carroll's (1999) review traced CSR's origins and evolution in academic literature. He suggested that, despite a boom of CSR-related terms and definitions from the 1950s through the 1970s resulting in alternative themes such as corporate social performance (CSP), corporate citizenship, stakeholder theory, and business ethics theory, CSR "continues to serve as a core construct but yields to or is transformed into alternative thematic frameworks" (p. 268). His review demonstrated that CSR is essential to business language as its concept serves as a foundation to understanding other CSR-related themes and theories. Similarly, in their analysis of the development of CSR, DeBakker, Groenewegen, and Den Hond (2005) proposed that CSR also became interchangeable with corporate social rectitude, sustainable development, triple bottom line, and corporate citizenship.

The abundance of CSR definitions and terms tends to create inconsistency of what constitutes CSR (Dahlsrud, 2008). Consequently, CSR continues to be a contested concept in academic literature (Okoye, 2009; Tang, 2015). The researchers of this study propose that this inconsistency potentially contributes to consumers' lack of knowledge, thereby influencing the attitude-behavior gap. In other words, if CSR was understood more consistently among brands and consumers, brands may be able to implement and communicate their CSR practices more effectively to increase consumer knowledge. This increase in consumer knowledge could help close the attitude-behavior gap; that is, consumers may be more willing to apply their eco-friendly attitudes towards their purchasing decisions.

Nevertheless, CSR remains a fundamental part of business operations in all industries. For the purposes of this study, the researchers looked at CSR as it relates to sustainable fashion and focused on Dahlsrud's (2008) in-depth analysis of CSR definitions. The 37 definitions contained in their research range from 1980 to 2003. Through a word frequency count, Dahlsrud found five CSR dimensions: environmental, social, economic, stakeholder, and voluntariness. They also refer to each dimension in the following ways: the environmental dimension pertains to the natural environment; the social dimension pertains to the relationship between business and society; the economic

dimension refers to "socio-economic or financial aspects related to CSR and business operations" (p. 4); the stakeholder dimension concerns stakeholders or stakeholder groups such as employees, suppliers, customers, and communities; and the voluntariness dimension encompasses actions beyond legal obligations. Carroll explained that, although scholars may revise or adapt existing CSR definitions as new literature emerges, "it is hard to imagine that these new concepts could develop apart and distinct from the groundwork that has been established over the past half century" (Carroll, 1999, p. 292). These dimensions provided a theoretical foundation for the framework proposed in this study.

In this paper, the researchers proposed that there is a need to re-examine the definition of CSR and its dimensions. First, the 37 definitions Dahlsrud analyzed were from 1980 to 2003. With a paradigm shift, CSR has been expanded into every stage of a business operation. Thus, an updated analysis is needed for the current business environment. Secondly, a lack of the cohesive definition could contribute to consumer confusion. With all the different CSR activities taking place, the five dimensions might not be sufficient. There might be a need to develop a more comprehensive framework to systematically organize the various activities.

CSR and Sustainable Fashion

Sustainable fashion seeks to correct and mitigate damages in the fast fashion industry (Lundblad & Davies, 2016). Fast fashion thrives on short-cycle fashion products, low costs, and quick merchandise turnover–all of which perpetuate environmental damage and labor exploitation in fast fashion brands' business practices (Peters et al. 2021). According to Kim and Oh (2020), there has been a rising trend in responsible consumerism, which conveys consumers' interests in brands or companies that encourage responsible decision-making. This trend was so significant that it was recognized by Forbes as one of the six global trends in 2019 (Danziger, 2019). This indicates an increasing interest in sustainability in many industries, including the fashion industry. For example, this rising trend in responsible consumerism can be found in the public's increased concern over fast fashion's pollutive and unethical practices, putting pressure on fast fashion brands to address those concerns. Kim & Oh (2020) discuss that many fast fashion brands, such as H&M and Zara, have responded to this trend by implementing sustainable clothing collections and textile recycling programs; however, due to greenwashing concerns, many are skeptical of fast fashion brands' attempts to include eco-friendly products and initiatives.

Chang and Jai (2015) further suggest that consumer interest in sustainability is also due to growing environmental and social concerns. This increase in consumer demand is related to studies indicating that CSR activities are positively linked with improved financial performance (Becker-Olsen et al., 2006). In addition to financial benefits, CSR positively impacts its stakeholders, the environment, and future generations in the long-term (Chang & Jai, 2015). For instance, the development of environmentally related CSR practices has encouraged companies to be more aware of ecological issues, resulting in larger investments to mitigate the company's negative environmental impacts (Shabbir & Wisdom, 2020). Additionally, Battacharya et al. (2009) explained that there is evidence that socially responsible companies are more likely to attract investors. A variety of activities have been implemented by fashion brands, such as supporting communities, empowering workers, and recycling used garments, depending on their fields and interests of businesses. As a result, consumers may feel confused and/or overwhelmed with the activities from different companies. Thus, this study aims to develop a systematic framework that presents common themes of the activities. The organized information can provide consumers a holistic way to learn about the CSR practices proposed by companies.

CSR and Web Communication

According to Chaudhri and Wang, there is a "need for transparent and proactive communication of CSR" due to globalization and varied definitions of CSR (Chaudhri & Wang, 2007, p.234). They also argued that CSR communication is a vital way for companies to demonstrate to their stakeholders that they strive to go beyond the bottom line to meet societal demands, particularly with sustainability. However, Chaudhri and Wang (2007) found that most companies do not take full advantage of company websites as CSR information is often hidden or not clearly presented. Additionally, Coope (2004) posited that communicating CSR activities via web communications is just as important as implementing CSR activities. The same article discussed that communicating CSR on websites is also an important tool for companies to improve investor relations, since investors are increasingly acknowledging the financial viability with CSR. Lastly, Coope (2004) proposed five best practices for online CSR communication: (1) "content is accessible and easy to use"; (2) "content is available in multiple formats"; (3) "content is dynamic and interactive"; (4) "CSR section is prominent and well promoted"; and (5) "content has consistent and engaging design" (p. 25).

Due to increasing stakeholder interest in CSR, web communication could help companies develop a better brand image. Companies can leverage their websites to effectively com-

municate CSR activities to their customers and stakeholders, thereby adding value to the brand and encouraging responsible consumerism.

Method

Study 1

Sample

Study 1 addressed our first research question: How easily identifiable are CSR activities on brand websites? The researchers employed a qualitative content analysis to examine CSR information available on brand websites. A total of 27 fashion store brands from the United States were analyzed for CSR website content. Initially, 112 brands were collected from the Sustainable Apparel Coalition's (SAC) list of Brands & Retailers members. This list represents companies that use the SAC to measure sustainability practices such as reducing environmental impact and increasing social justice. To ensure the comparison and result is valid, and the sample shares a similar business model, the list was refined. In addition, to ensure that a variety of activities can be included in our analysis, the selection criteria employed are: 1) U.S. based apparel and/or footwear brands (so that they exhibit a similar business culture), 2) owns a private label, and 3) only sells their products in their own brand specialty stores. The deletion process excluded department stores (n = 13), luxury and non-apparel retailers (n = 41), and companies headquartered outside the United States (n = 62). After the deletion process, the list of 27 retail apparel/footwear brands operating in the United States was developed.

Procedure

To enhance the credibility of the study findings, the websites were independently analyzed by two researchers to identify CSR-related activities. The CSR activities were entered into a coding sheet that allowed the researchers to compare their results and reach an agreement on which activities were classified as CSR. Intercoder reliability rate (IRR) and percent agreement were calculated for each brand. IRR is "a practice in which multiple researchers code the data, engage in techniques to encourage consistency, and determine the degree to which they are coding data similarly" (Tracy, 2020, p. 276). It is calculated by taking the number for activities identified by both researchers (agreements) and dividing it by the total number of activities that were identified (Tracy, 2020). This process helped confirm the CSR activities, CSR dimensions, and business operation stages that were subsequently used to develop the CSR framework for Study 2.

Study 2

Procedure

Study 2 was developed to examine the second research question: Can we develop a systematic framework to guide CSR activities for apparel brands? The objective is to develop a framework that systematically organizes the CSR activities and identifies common themes to categorize them. Firstly, the researchers utilized literature reviews to develop a base framework, a matrix. The matrix includes three aspects: (1) Y-axis, the five CSR dimensions; (2) X-axis, the business operation stages at which they occur; and (3) content, CSR activities used in the sustainable fashion industry (Figure 1).

The dimensions of the Y-axis were refined based on a definition analysis and word frequency count on 75 definitions. Thirty-seven came from sources dated between 1980-2003 (Dahlsrud, 2008) and the remaining 38 definitions were collected from peer-reviewed sources from 2004-2020. Definitions were subsequently processed through a text analysis by using a data mining algorithm. The simple algorithm can inspect all 75 definitions and provide a list of word frequency counts. The word frequency count revealed the most commonly used terms, revealing the discrepancies, similarities, and evolution of CSR themes in academic literature from 1980-2020. Through this process, in addition to literature reviews, CSR dimensions were established to determine who is affected by CSR activities.

The dimensions of the X-axis were refined based on the business operation stages at which CSR activities occur (when), the study expanded on Open Systems Theory which examines an organization's relationship with its environment in terms of inputs, throughputs, and outputs (Weber & Waeger, 2017). To determine the specific stages used in the X-axis, this article incorporated patterns that emerged in the website content analysis which indicated the operation stages at which CSR activities are most likely to occur. Lastly, the CSR activities in the center of the matrix were derived from the website content analysis.

Results and Discussion

Study 1

The results showed that, generally, websites had landing pages titled "sustainability," "corporate responsibility," or "social responsibility" while other websites integrated CSR activities throughout the website or in their "About Us" sections. Some websites are able to clearly communicate their CSR strategies, such as Lands' End, HanesBrands Inc., Under Armour, New Balance, and The Children's Place as they received over 90% IRR; however, some of these brands had

less CSR indicators than others. For instance, Lands' End's website contained 10 CSR indicators while HanesBrands Inc. contained 25. Table 1 illustrates that the range of the IRR was from 35% to 100% with an average of 69 (SD = 17.73). A correlation was evaluated between the total CSR indicators presented on the website and the IRR. The results showed that there is no correlation between them, ß = 0.09 (p = 0.64). The clear website communication does not build

Figure 1

Business Operations Stages.

Dimensions (Who)	**Business Operation Stages (When): Corporate Management**	**Business Operation Stages (When): Product Design**	**Business Operation Stages (When): Manufacturing**	**Business Operation Stages (When): Packaging & Distribution**	**Business Operation Stages (When): Customers**
Environmental *(natural environment, environmental stewardship)*	Climate Action Plan, Higg Index (sustainability "scorecard"), climate risk management, headquarters green building standards (LEED), B-Corp Partnerships w/ environmental NGOs	Environmentally Preferred Materials and Policies (Conflict minerals, apparel fabric certifications, organic and fair-trade textiles, recycled and regenerative fibers, traceability, sustainable supplier requirements, responsibly sourced leather) Circularity principles (cyclability, waste avoidance, disassembly, refurbishment, versatility, durability)	Waste, Energy & Carbon, Water (Chemical management, bluesign® system, renewable energy, certified dyeing, water reduction, waste diversion, traceability) LEED certified manufacturing centers; owned and operated factories, farms, and mils	Product Packaging (Recyclable or compostable packaging, low-waste options) Energy efficient distribution centers (LEED certified)	Upcycling and Recycling Return Programs Repair Programs Secondhand options or programs (thredUP, Rethread)
Social *(community, social concerns)*	UN Global Compact, employee engagement, Higg Index, B-Corp	Product testing for user safety, responsible sourcing, advocacy t-shirts	Diversity & inclusion, women factory workers' health, safe factory conditions, transparency statements w/ data to support social impact		Activism and philanthropy (Pledging% of Sales, programs to support underresourced communities, Black Lives Matter, LGBTQ+ support, point of sale donation-match programs, diversifying the outdoors)
Economic *(financial, profits, economic development)*	Stock information, financial transparency, investor relations, B-Corp, brand partnerships, impact portfolio			Efficient Logistics, Transportation, and Operations	Brand partnerships and collaborations

Figure 1 Continued

Dimensions (Who)	Business Operation Stages (When): Corporate Management	Business Operation Stages (When): Product Design	Business Operation Stages (When): Manufacturing	Business Operation Stages (When): Packaging & Distribution	Business Operation Stages (When): Customers
Stakeholder *(employees, suppliers, customers)*	Diversity & inclusion recruitment, employee donations, corporate governance, worker wellbeing, transparency statements, workplace surveys, non-financial reporting	Product quality testing, responsibly sourced apparel materials	Active Factory List, Global Contract Factory List, fair trade programs, owned manufacturing, training suppliers Social Responsibility Policies (Xinjiang, Uzbek and Turkmen Cotton Policy, working conditions, anti-discrimination, fair pay, suppler excellence)	Responsible Shipping (Packaging guidelines, container loading and optimization standards, control management systems)	Membership benefits
Legal *(required by state, federal, or int'l Jaw)*	SEC Filings (if IPO), Business Commerce Regulations	Compliance Regulations (depends on state)	CA Transparency Act, UK Modern Slavery Act, Laws and Regulations for Manufactureres, Importers, Distributors	Fair Packaging and Labeling Act	Consumer Protection Laws (environmental claims, deceptive ads, "Made in USA"

on the number of CSR indicators presented. While websites with less CSR information could create less confusion among consumers, the website content analysis indicated that content organization with clear labels and dedicated landing pages are important to help consumers identify CSR information.

In addition to increasing consumer knowledge and brand performance, a more straightforward presentation of CSR practices could support and bring awareness to sustainability issues such as environmental pollution, transparent supply chains, and fair wages. For instance, we found during our website coding phase that Patagonia, a well-renowned sustainable clothing brand, met 100% of their electricity needs with renewable energy and diverted 149 tons of plastic waste from entering the ocean ("Environmental & Social Footprint", n.d.).

Furthermore, through this study, the researchers learned that most sustainable fashion brands' websites lack the structure, and organization needed to better present their CSR activities to consumers. Without proper structure, consumers can miss out on important information that could otherwise increase consumer knowledge and boost the brand's return on CSR investments. Thus, it is necessary to clearly present CSR activities on company websites.

Study 2

The result of the definition analysis helped finalize the dimensions of the Y-axis for the CSR framework. The findings suggest that the Y-axis contains five CSR dimensions: environmental, social, economic, stakeholder, and legal. Dahlsrud (2008) conducted a similar word frequency analysis with 37 CSR definitions in their article, which yielded five dimensions of CSR: voluntariness, stakeholder, social, environmental, and economic (see table 2, Years 1980-2003). The researchers conducted two more analyses with CSR definitions published during Years 2004 to 2020 and Years 1980 to 2020. The analysis for Years 2004 to 2020 is to gain a better understanding of the change in CSR definitions. The analysis for Years 1980 to 2020 is to confirm the weight of the identified dimensions.

While most of the most mentioned keywords in CSR definitions remained the same, our word frequency count yielded no strong support for "voluntary" as a CSR dimension (table 2). Table 2 included the top 15 most used words in CSR definitions by years. The results show that "business" was the number one word used in the definitions ($f_{1980\text{-}2020}$ = 49), followed by "social" ($f_{1980\text{-}2020}$ = 37) and "stakeholder" ($f_{1980\text{-}2020}$ = 35). Alternatively, the word frequency count re-

Table 1

Intercoder reliability rates.

Brands	Total CSR indicators	Inconsistent cells	Intercoder Reliability Rate (%)[a]
Abercrombie & Fitch	39	7	82.05
allbirds	5	2	60.00
American Eagle Outfitters	22	6	72.73
Brooks	22	5	77.27
Columbia Sportswear	36	7	80.56
Eileen Fisher	34	14	58.82
Gap Inc.	19	4	78.95
Guess	21	12	42.86
Hanes Brands Inc.	25	2	92.00
J. Crew	11	5	54.55
Jockey	6	2	66.67
L.L. Bean	13	7	46.15
Land's End	9	0	100.00
Levi's	13	5	61.54
Merrell	9	3	66.67
New Balance	21	2	90.48
Nike	15	7	53.33
Outerknown	8	4	50.00
Patagonia	17	11	35.29
Pearl iZumi	5	2	60.00
Ralph Lauren	23	13	43.48
Red Wing Shoes	5	1	80.00
Reformation	21	2	90.48
Sperry	4	1	75.00
The Children's Place	10	1	90.00
Tommy Bahama	8	2	75.00
Under Armor	12	1	91.67

[a] Intercoder reliability = total agreements divided by total codes

vealed that "policy" started to emerge in academic definitions of CSR between 2004-2020, indicating that there may be interest to implement more legal requirements in CSR. As such, the researchers modified the dimensions in our matrix to include "legal" as a dimension to reflect the results from our word frequency analysis and changing social contexts.

The researchers found that adding a legal dimension to the matrix may also help consumers and practitioners distinguish between voluntary actions and legal obligations. Under the paradigm of sustainability, businesses have been keenly showing their voluntary compliance in developing CSR activities/ strategies. The Y-axis helps identify who, or

what, is affected or benefited by CSR activities. For example, compostable packaging falls under the environmental dimension because the activity directly affects the environment as compostable packaging decreases packaging waste that would otherwise contribute to landfill pollution. Another example is that the Uzbek and Turkmen Cotton Policy belong in the stakeholder dimension because it demonstrates that the brand does not do business with suppliers who source cotton from forced labor in Uzbekistan.

Along with the data collection, the researchers found that CSR activities take place in different stages of a business operation. As the Y-axis helps identify who, or what, the X-axis focuses on when or "in what stage" the activities take place. The scope of fashion business is complex in that it involves many industries, from raw materials, to design, to manufacturing and production, to retail management, and to consumer services (Stone & Farnan, 2017). Some fashion businesses only focus on a part of the process (i.e., cotton farms and textile vendors), whereas a ready-to-wear company, especially those owning a private label (i.e., J.Crew and Gap. Inc.), involves many stages such as business management, product development, distribution, and customer service. The X-axis represents "when" the CSR activities occur during its product life cycle and contains five business operation stages: corporate management, product design, manufacturing, packaging and distribution, and customers. The five stages provided an additional dimension to organize the CSR activities.

For instance, activities that focus on improving quality and longevity through CSR activities, such as using environmentally preferred materials, enhanced product testing, and responsibly sourced materials, were categorized in the product design stage. In other words, during the product design stage, those strategies/activities can be implemented to enhance the CSR performance. Furthermore, the researchers found that, under product design, brands favored sustainable approaches to product design with recycled or upcycled textiles, organic cotton, innovative textiles, and strict fiber standards, to name a few. Under the customers stage, brands offer their consumers a means to decrease waste and promote a circular economy with CSR activities such as upcycling/recycling and repair programs.

Lastly, the framework connects the five CSR dimensions with the five business operation stages to clearly identify

Table 2

Word frequency count for definitions between years 1980-2003 (Dahlsrud, 2008) and 2004-2020.

Top 15	Years 1980-2003 (n = 37)	Frequency Count (*f*)	Years 2004-2020 (n = 38)	Frequency Count (*f*)	Years 1980-2020 (n = 75)	Frequency Count (*f*)
1	business	25	business	24	business	49
2	stakeholder	18	social	20	social	37
3	society	18	stakeholder	17	stakeholder	35
4	social	17	practice	12	society	28
5	community	16	policy	11	community	24
6	environment	15	society	10	company	23
7	company	14	company	9	environment	19
8	operation	10	economic	9	impact	19
9	impact	10	impact	9	responsibility	18
10	environmental	9	community	8	practice	18
11	economic	8	organization	8	economic	17
12	employee	8	environmental	7	operation	13
13	corporation	8	activity	7	policy	13
14	beyond	8	responsibility	6	beyond	13
15	value	7	corporate	6	corporation	12

CSR activities. For instance, CSR activities that concern the environmental dimension during the manufacturing stage include: chemical waste management, renewable energy, water conservation, and waste diversion. Additionally, CSR activities relevant to the stakeholder dimension under the corporate management stage include: diversity and inclusion recruitment, worker well-being, and corporate governance standards. The framework pinpoints when CSR activities occur, and who/what they affect; however, it also clearly presents areas where CSR activities are lacking. While there is an abundance of activities in the environmental dimension across all business operation stages, there is little to be found in the economic dimension and in the customers' stage of operations. Market practitioners can use this to their advantage by developing CSR activities to address those areas of opportunities, and consumers can use the framework to make well-informed purchasing decisions.

Conclusion

As discussed thus far, CSR is a multidimensional concept. Therefore, if a succinct definition is desired, it must be broad enough to cover all its aspects. Based on our findings, CSR can be defined as strategies developed in every stage of a business operation that result in beneficial outcomes in favor of the environment, stakeholders, society, economy, and legislation without damaging each other. However, instead of a succinct definition, the researchers of this study proposed to use a two-dimensional index, a matrix that consists of two axes, to examine the nature of CSR. The X and Y axes consist of sub-dimensions that can enhance consumers' understanding of CSR.

It is important to note that this study's website content analysis took place between September 2020 to June 2021. In addition to human error, websites change over time with modifications in website content affected this research's IRR and consistency of information. For future studies, this could be addressed by setting a specific timeframe in which to code the websites and implementing a method of tracking website changes during that time frame. The framework and method could also be expanded to account for unorganized CSR presentation on websites and to recognize more CSR activities in the fashion industry. Although the researchers observed a theme of recurring CSR activities, the activities in the framework do not reflect all possible CSR activities available in the fashion industry. With a larger database of companies, however, researchers could potentially identify lesser-known CSR activities. Expanding the scope of the study could provide a more holistic and comprehensive view of how CSR is understood and implemented in the fashion industry.

In sum, the findings in this paper are important in understanding how CSR practices affect broader sustainability issues and studies. This paper could relate to studies that explore sustainable fashion as an alternative model to fast fashion in order to enhance environmental, social, and corporate sustainability. This study could also be beneficial to consumer research as it relates to sustainability. There are various studies that attempt to expand on the consumer-behavior gap and understand how consumers perceive fast fashion. The framework proposed in this study could contribute to those emerging types of research.

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Benefits of Cover Cropping Systems in Walnut Orchards as Sustainable Agricultural Practice

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Abstract

In recent years, walnut orchards implemented cover crops in between rows to improve soil's quality, lessen soil's erosion, increase organic matter, manage nutrient movement and availability, enhance water retention, and expand microbe, insect, and flora diversity. Commonly selected cover crops in California are from families Poaceae, Brassicaceae, and Fabaceae. Considerations should be made when choosing a particular cover crop mixture to enhance multiple benefits and improve sustainable practices in orchard settings. An experiment was conducted in a walnut orchard to compare functionality and benefits of three systems multi-crop, monocrop, and no vegetation cover crop system. The following components were evaluated: cover crop and weed biomass, cover crop species field distribution, ability to provide better coverage, and weed suppression properties. Statistical analysis was conducted using one-way ANOVA and post-hoc Tukey test. Brassica mixture, clover, and grasses showed highest presence in field conditions and excellent weed competition attributes, while peas and faba beans had low presence and did not compete well growing in a mixture with other cover crops. Multi-crop treatment demonstrated dry and wet biomass as well as greatest weed suppression. Recommendations include carefully considering current practice in walnut orchards to seasonally include vegetation cover rather than bare soil, and to choose multi-crop cover rather than monocrop. Implementation of multi-crop species as a sustainable practice would increase soil's quality, improve biological management through rise of natural beneficial predators, and enhance integrated pest management methods.

Introduction

Cover cropping has become more widely adopted by farmers as its various benefits have been validated with the passage of time and attested through research and adaptation of sustainable agricultural practices (Ingels et al., 1998). Conventional production orchards have been typified by a lack of tolerance for anything other than a single crop grown over the course of decades, which makes it difficult to consider cover crop as a standard practice. Although cover

crops have been implemented in orchards since the early 20th century, the development of fertilizers and pesticides in the 1940s and 1950s decreased their presence (Grant, 2006). With a more sustainable purpose, cover crops in orchards became more frequently used in the last 40 years (Ingels et al., 1998). The most common cover crops applied in walnut orchards are grasses, brassica plants, and legumes.

English walnuts (*Juglans regia*) from the family Juglandaceae are the most common commercially produced nuts (DiTomaso & Healy, 2007). English walnuts were introduced in California in the 1770s, though the first walnut orchard was planted in San Diego in 1843. Their origin can be traced back to Eastern Europe, Central Asia, and the Persian region (Tufts et al., 1946). California is a major walnut producer and international exporter (USDA NASS, 2019). In 2019, the USA was the second largest walnut producer in the world, producing 592,390 metric tons of walnuts on 147,710 hectares (FAOSTAT, 2019).

The most utilized cover crops are grasses (Poaceae) because these plants have several mechanisms to enhance soil quality and prevent water loss (Van Sambeek, 2017). Additionally, grasses are hardy plants that can withstand drought or water scarcity. Grass cover crops include cereal crops that are fast growing, can tolerate freezing temperatures, are strong weed competitors, and are compatible in a mix with other broadleaf cover crops (Brennan and Smith, 2005). Popular grass cover crop selections include ryegrass (*Lolium sp.*) and tall fescue (*Festuca arundinacea*) that can serve as a forage (DiTomaso & Healy, 2007; Ingels et al., 1998). Other applied cover crops are brassicas (Brassicaceae) and leguminous plants (Fabaceae). Brassicas can rapidly increase biomass by producing deep taproots, which enhance their weed suppression abilities and alleviate soil compaction (Brennan and Smith, 2005; Boydston & Al-Khatib, 2005). Deep root systems can extract nitrogen from deeper and shallow soil strata, therefore, enhancing the nutrient cycling process (Ugrenovic et al., 2019). In the spring, brassicas stipulate pollination, provide a diverse habitat that attracts pollinators and other beneficial insects, and can assist with honey production in young orchards during the first few years (Ellis & Barbercheck, 2014). Studies have elucidated additional beneficial characteristics such as biofumigation and allelopathic properties (Ugrenovic et al., 2019). Legumes have a major role in the process of biological nitrogen fixation enhancing available forms of ammonia and nitrates that is crucial for the nutrient cycle and plants' healthy growth and development (Peoples & Craswell, 1992). This sustainable practice increases soil's fertility and reduces fertilizer requirements over time (Goh et al., 2008). The use of a variety of grasses, brassicas, and leguminous plants as a cover crop mix in appropriate ratios can furthermore provide multiple benefits in an orchard environment. Overall, the purpose of employing cover crops in orchards is to lessen economic costs and increase benefits such as crop yield, healthy growth, and development.

The cover crops considered and applied for this study were based on the desire to gain improvements from each plant family in the walnut orchard. The multi-crops selected were a mixture of oats, barley, triticale (water retention, crop companion), mustards (weed suppression, pollination), bell beans, peas, and clover (nitrogen amendment). Single cover crop consisted of bell beans attributing to the ability to provide nitrogen. There were several objectives for the utilization of cover crops in the walnut orchard: 1) to compare the cover crop treatments (multi-crop and monocrop) with the no vegetation control group in the walnut orchard, 2) to assess the field distribution of the different crop species planted to determine which system would provide greater cover and weed suppression in the walnut orchard, and 3) to quantify which system had the greater biomass. We hypothesized that the multi-crop treatment would provide the greatest weed suppression and yield the largest biomass compared to the monocrop treatment, and that the monocrop treatment would serve as a better weed competitor compared to the no vegetation control group.

Literature Review

Walnut Benefits

Walnuts are a highly valued commodity due to their nutritional importance and health benefits (Fatima et al., 2018). Nuts are rich in fats and proteins, 65 and 15 percent respectively (Sen & Karadeniz, 2015), as well as in polyphenols and organic compounds that contain antioxidant properties, inhibit oxidation, and consequently decrease atherosclerosis (Fatima et al., 2018). Other studies demonstrate walnuts' health benefits such as managing diabetes, lowering inflammation of blood vessels, and lowering blood pressure for an overall improvement of the cardiovascular system (Blomhoff et al., 2006; Yang et al., 2009).

In the process of growth and development, the walnut shell and husk protect the nut. After the harvest, both shell and husk are discarded as a waste product. However, new studies are showing a different potential using walnut husk, shells, and leaves as an alternative material to dye clothing and hair. Juglone represents the main ingredient that pro-

vides a strong color for cotton, viscose, and wool materials (Bukhari et al., 2017). This sustainable and ecologically aware practice has a wider range of applications from dyeing textile materials to developing hair and cosmetic products.

Cover Crop Benefits

Family Poaceae

Characteristics of grasses include large seed production and growth in semi-shaded conditions, which allows vegetation coverage to be present in walnut orchards throughout the year (Grant, 2006). Grass cover crops can develop long fibrous roots, break compacted soil, prevent erosion, and absorb nitrogen and potassium from deeper strata (Muhandiram et al., 2020). Removal of winter crops such as winter rye and wheat in the fall can deplete nitrogen from walnut orchard, on average 78.5 kilograms of nitrogen per hectare. Sustainable practices to mitigate nitrogen loss include harvesting and leaving grass in the field as a mulch, decomposable organic material, and companion planting with legume plants (Van Sambeek, 2017; Granatstein et al., 2014). A multispecies cover crop compared to a single species cover crop has more benefits especially in increasing microbe diversity and maintaining healthy soil (Van Sambeek, 2017; Finney et al., 2017).

Grasses such as narrow-leaved monocots have good weed competition properties (Grant, 2006). One study found that grasses showed better or equal weed suppression compared to herbicide usage when tested in greenhouse and field conditions. Red fescue was more competitive in greenhouse conditions compared to perennial ryegrass with other weeds. However, in field conditions both grass species demonstrated equal effectiveness in combating weeds in orchard settings compared to chemical management (Tworkoski & Glenn, 2012). It would be advantageous to use the weed suppressive abilities of grasses and reduce chemical usage for a heathier and more sustainable orchard management.

Family Brassicaceae

Brassicas, most commonly mustards and rapeseeds, form basal rosette, have erect growth, higher biomass, and large number of flowers (DiTomaso and Healy, 2007). Mustards have a long tradition as cover crops in walnut orchards and are typically applied for pollination purposes, enrichment of pollinators, mainly bees and butterflies, and beneficial insect species like parasitic wasps, green lacewings, and ground predatory beetles (Redhead et al., 2020). Increasing insect diversity can enrich the orchard's ecosystem and enhance biological management as one of its integrated pest management tactics (Ellis and Barbercheck, 2014; Redhead et al., 2020).

In California, a specific program known as "Beewhere" has been applied to keep track of beekeepers' hives within orchards. This system was developed in 2017 with the goal of creating an awareness of beekeepers and pest control applicators' role in orchards as insecticides are applied more frequently in the spring. Furthermore, the County Agricultural Commissioner's office temporarily prevents spring usage of neonicotinoids, nerve system acting insecticides, as they are more harmful to insect pollinators (BeeWhere-California, 2021). Established at the state level, this process has granted additional protection for insect pollinators and beneficial predators.

Mustard species implemented as cover crops in orchards can rapidly increase biomass and cover up to 80 percent of soil (Ugrenovic et al., 2019). As such, they represent excellent weed competitors (Brennan & Smith, 2005; Boydston & Al-Khatib, 2005). Brassicas are known for their biofumigant properties, i.e., the ability to release phytotoxic substances into a soil, mainly glucosinolates, which then convert into isothiocyanates and decrease soil pathogens, nematodes (Ugrenovic et al., 2019), weed seed germination and growth of other weed species (Al-Khatib et al., 1997). Al-Khatib's team (1997) conducted an experiment testing the biofumigant and allelopathic properties of mustard, rye, and wheat species as cover crops before planting a pea crop. After harvesting the cover crops, peas were planted as a regular crop in the spring. Crop and weed biomass were compared one month after planting the principal crop. This study confirmed that the pea crop had the highest yield and lowest weed presence when mustards, more specifically white mustard and rapeseed, were used as cover crops. This demonstrated the potential of applying brassicas as cover crops that would suppress weed competitors. Other studies have supported the efficacy of rapeseed and mustards species exhibiting these characteristics whether used as cover crops or applied in soil as a manure amendment (Van Sambeek, 2017; Ugrenovic et al., 2019). These practices are opening doors to lowering the amount of pesticide usage and implementing sustainable integrated pest management practices in orchard settings.

Family Fabaceae

Legumes are short-lived crops that can withstand harsh winter weather and extra wet spring seasons with the main role to provide nitrogen for the principal crop via the pro-

cess of biological nitrogen fixation (Peoples & Craswell, 1992; Perrone et al., 2020). Legume plants form a symbiotic relationship with *Rhizobia,* a soil bacteria that forms nodules on plant's roots (Perrone et al., 2020). Nitrogen is restored back to the soil decreasing the need for additional fertilizer application (Goh et al., 2008). A higher amount of nitrogen can be provided to walnut trees via direct planting of legumes, compared to mowing and leaving plant residue, to decompose (Grant, 2006; Anderson et al., 2006). Walnut's nitrogen demand starts increasing in late March and beginning of April making legumes a good option to lessen its impact (Anderson et al., 2006).

In a study conducted by a Japanese team, five different legume plants were tested for their biomass, nodule formation and nitrogen fixation capacity using the acetylene reduction activity (ARA) method (Rutto et al., 2003). The scientists used three vetch species: airy, narrow leaf (*Vicia villosa* and *V. angustifolia*) and Asian milk vetch (*Astragalus sinicus*), and two clover species: red and white (*Trifolium pratense* and *T. repens*). Wet and dry biomass were measured by comparing the shoots and roots of the five species. Red clover and hairy vetch recorded the highest biomass, both wet and dry weight, while narrow leaf vetch showed the lowest results. At harvest, entire plants were removed from the soil, roots separated from the plants, nodules separated from the roots and partitioned into five different groups depending on the size from the smallest to largest. Although Asian milk vetch demonstrated the largest number of nodules, they were small compared to red clover's nodules that were the largest of them all. After the flowering stage, all plants revealed a decrease in nodule formation. The ARA method showed variations in nitrogen production by all five species, where white clover showed a significant increase in March and April compared to other species (Rutto et al., 2003). This demonstrates the potential usage of clovers in walnut orchards when it is the most required by the trees. Aside from nutrient amendment, legume plants are good in weed suppression and preventing soil erosion (Thorup-Kristensen et al., 2003; Grant, 2006). As seen in a previous study, both red clover and hairy vetch demonstrated good soil coverage, prevention of soil erosion and weed suppression properties (Rutto et al., 2003). Another study confirmed the efficacy of white clover and hairy vetch as plants that can be highly competitive with weeds while developing smaller biomass (Van Sambeek, 2017). Faba beans can represent soil's nitrogen booster, fixing up to 200 kilograms of nitrogen per hectare (Karkanis et al., 2018). However, studies have shown that faba beans are weak weed competitors and struggle with the influence of abiotic factors. Therefore, faba beans would not be recommended as a monocrop cover crop (Frenda et al., 2013; Karkanis et al., 2018). In comparison, cowpeas, which are good weed competitors, used less water than other legumes when growing, which makes it a good conservative water usage cover crop (Van Sambeek, 2017).

Typical leguminous plants used in California orchards as cover crops are vetches, clovers, peas, and beans that attract pollinators when in bloom and beneficial predators of pests in orchards (Ellis and Barbercheck, 2014). White and strawberry clover legumes often provide vegetation cover in walnut orchards throughout the year. Clovers have the most positive impact on pollinators as they provide an abundance of high-quality pollen and nectar (Van Sambeek, 2017). Nonetheless, mowing is necessary when doing floor sanitation and field management such as tree pruning and removal of navel orangeworm's (NOW) mummy nuts in the fall and early winter (Grant, 2006). NOW is a major economic, severe pest in walnut orchards (Stern et al., 1959). A study conducted by Sibbett and Steenwyk (1993) showed that in years when weeds were left in orchard NOW mummy nuts had less emergence in the spring compared to an orchard floor with no vegetation cover. Having cover crops as vegetation cover can lower the presence of mummy nuts and be seen as an additional sanitation method (Sibbett & Steenwyk, 1993). Careful consideration should be given to current practices in a walnut orchard to determine which benefit can be gained from integrated pest management practices. This can lead to early season mowing or keeping cover crops until early spring.

Cover Crop Disadvantages

The disadvantages to legumes are attracting pests like the stink bugs, leaffooted bugs, and lygus bugs as well as potentially requiring more water for crop growth (Bugg & Waddington, 1994). However, aside from stink bugs that can occasionally feed on immature nuts (Van Sambeek, 2017), these insects are not harmful to walnut trees (Grant et al., 2020) and, as such, can be classified as a non-economic, rare pest category (Stern et al., 1959). According to Stern (1959), pest populations of this category never reach economic threshold as they maintain constantly low population densities, and no management is implemented to remove them from walnut orchards. Cereal and legume crops can serve as a habitat for the root nematode species from the genus *Pratylenchus*; however, they are not showing economical damage to walnut roots (Grant, 2006; Stern

et al., 1959). Although cover crops can capture water from walnut trees, they can increase water holding capacity in the soil (Grant, 2006). Preferably cover crops would be used in the winter months with the expectation that winter rains would decrease the need for additional orchard and cover crop irrigation (Altieri et al., 2018). Water usage by cover crops is less in walnut compared to almond orchards due to greater canopy, higher moisture, and better water preservation (Grant, 2006).

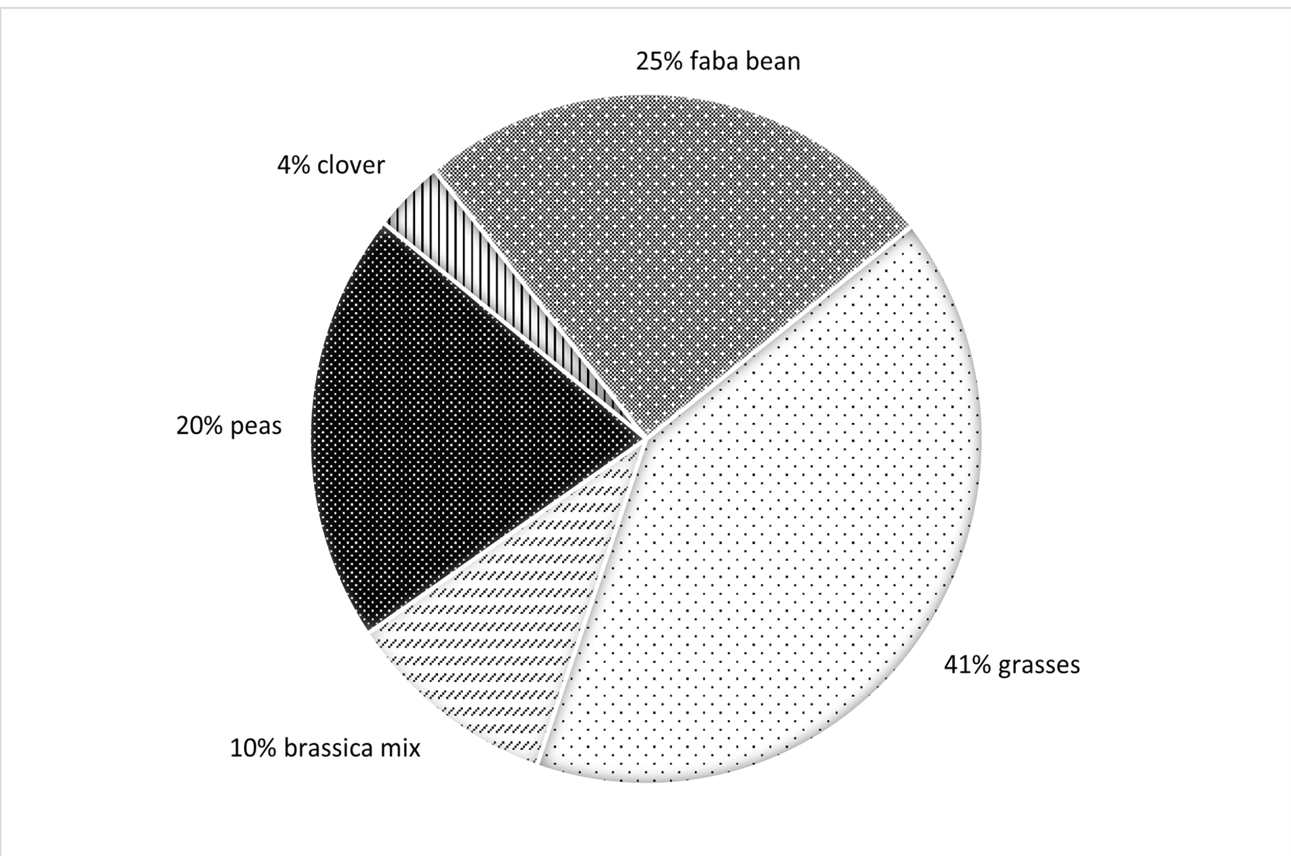
Methods

Location and Treatments

The one-year long experiment was conducted at a walnut orchard in northern Chico, CA (39.798362° N, 121.902541° W). Cover crops were planted with a grain drill in the beginning of November 2019. The two treatments consisted of multi-crop cover and monocrop cover, and the control consisted of no vegetation cover to compare these two systems. Treatments and control were alternated every two rows for planting in between the walnut orchards. The multi-crop treatment, Lockwood Seeds 22.7-kilogram bag of Orchard Mix was sowed into the soil at a rate of 84 kilogram of seeds per hectare. The mix consisted of nine different seed species from the families Poaceae (cayuse oats, UC132 oats, UC937 barley, forerunner triticale), Fabaceae (PK crimson clover, magnus peas, dundale peas, faba beans), and Brassicaceae (W. brassica mix) with a varying percentage distribution based on higher germination rates (Figure 1). For the monocrop cover, faba bean Baglietto Seeds 22.7-kilogram bag was sowed into the soil at a rate of 134 kilogram of seeds per hectare and inoculated with

Figure 1

Percentage of multi-crop seeds of planted species as present in Lockwood Seeds Orchard Mix.



Note. This mixture contained in successive order from greatest to least amount grasses, bell bean, peas, brassica, and clover. This distribution is based on germination rates known for each crop.

N Dure premium inoculant. The multi-crop treatment was not inoculated.

Experiment Setup

The walnut orchard area where the experiment took place included six rows containing two rows for each treatment (multi-crop, monocrop) and control (no vegetation cover). The experimental area was divided into five blocks where square meter transects were placed using a complete randomized design. Rows were 9 meters wide and 280 meters long with each block being 18 meters wide and 56 meters long. There were five transects per row, totaling 30 transects.

Data Collection

During this experiment, the following data was collected: quantitative distribution of crops and weeds per transect during seedling and mature plant stage, crop biomass, and weed biomass. Distribution data was collected on two separate occasions January 20, 2020 and February 29, 2020. On March 7, 2020 final harvest data was collected using 30-centimeter square transects. Crops and weeds were harvested from each transect (subsample) followed by biomass measurement. From field, fresh plant subsamples from each transect were placed on an Ohaus Defender 5000 hybrid scale to collect weight data. Crops and weeds were placed in properly labeled paper bags and moved to a drying oven. After two weeks, dry samples were weighed.

Results

Seed and Crop Distribution

The distribution of the multi-crop mixture, which was sown on November 7, 2019, was examined after sowing to observe how the seed densities affected crop distribution. Two distribution counts were completed after crops had grown considerably, January 20, 2020 and February 29, 2020 respectively (Table 1).

Crop and Weed Density

The multi-crop treatment yielded the greatest density distribution of vegetative cover over weeds in comparison to the monocrop treatment for the months of January and February. In January, the multi-crop and monocrop treatment vegetative cover in comparison to weed coverage was 80 percent and 33 percent of crop, respectively. In February, vegetative cover was 71 percent for multi-crop and 19 percent for monocrop.

Wet and Dry Biomass

The multi-crop treatment yielded the greatest wet biomass when compared to both monocrop treatment and no vegetation control. Multi-crop and monocrop treatments demonstrated greater cover presence than the no vegetation control (Figure 2). The multi-crop cover yielded the greatest dry biomass compared to the other two systems. Dry biomass of the multi-crop and monocrop cover treatments demonstrated similar cover presence over weed presence to that of wet biomass (Figure 3).

ANOVA Analysis

The conducted statistical analysis in this experiment was one-way ANOVA. A post-hoc Tukey test was performed to analyze statistical significance of crop vs weed wet and dry biomass for the multi-crop treatment, monocrop treatment, and the no vegetation control. The data for biomass showed a statistically significant difference between multi-crop treatment and no vegetation control ($p < 0.01$). Conducting the Tukey test only on multi-crop and monocrop treatments showed a statistically significant difference ($p < 0.01$) (Table 2).

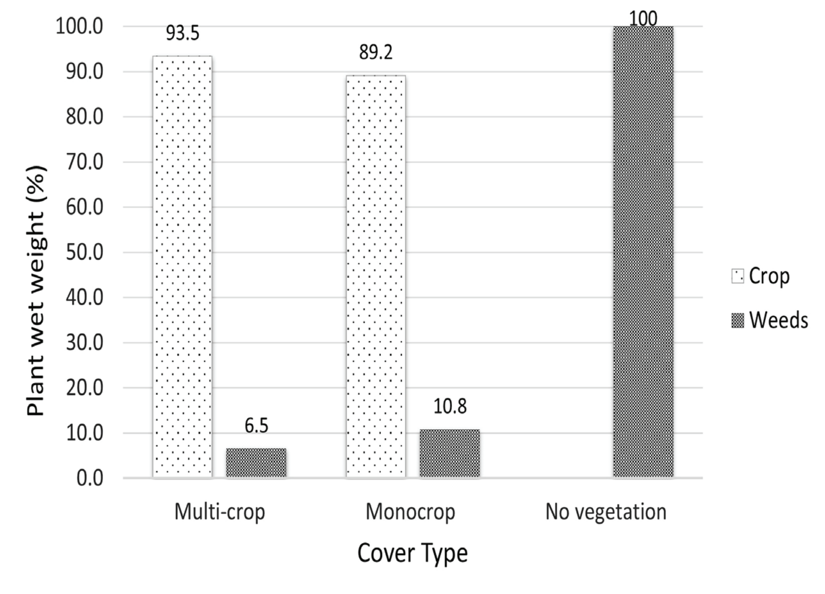
Table 1

Percentage of multi-crop seed distribution at planting, and field crop distribution at two different days after planting (DAP) periods.

Plant Type	Seed Bag Distribution (%)	Crop Distribution 64 DAP (%)	Crop Distribution 104 DAP (%)
Grasses	41	30.83	29.27
Brassicas	10	46.44	42.33
Peas	20	3.85	5.40
Clover	4	17.37	19.88
Faba beans	25	1.51	1.46

Figure 2

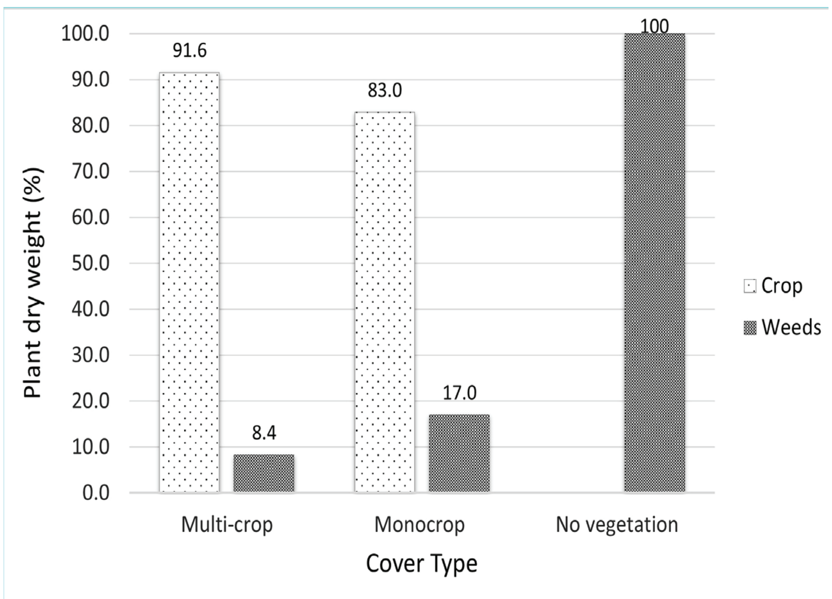
Wet biomass percentage of crops and weeds from each cover crop system collected on March 7, 2020



Note. Distinguishing crop and weed weight. The no vegetation control group was composed solely on weeds while multi-crop and monocrop treatments included both crop and weed plants.

Figure 3

Dry crop and weed weight, collected on March 7, 2020



Note. Presented in three different cover crop systems multi-crop treatment, monocrop treatment, and no vegetation control. Crop and weeds were present in treatment groups while the control group consisted of weeds only.

Table 2

Post-hoc Tukey test p values of wet and dry biomass

Treatment Pair	Wet Biomass	Dry Biomass
multi-crop vs no vegetation	0.004	0.001
multi-crop vs monocrop	0.001	0.001

Note. Comparison is made between treatments and control as well as between both treatments. All statistically significant differences recorded p values less than 0.01.

Discussion

Planted certified seed mixture contained amounts that varied for each type of crop in accordance with germination rates as seen in Table 1. Brassicas and clovers had a low seed planting distribution that significantly increased in field distribution. Although grasses slightly decreased their field distribution after planting, they demonstrated a strong presence and competitiveness when mixed with other crops. Peas and faba beans had a high seed planting distribution that decreased significantly in field conditions, which demonstrated their weak competitiveness with crops and weeds. It was observed that the multi-crop treatment had greater crop coverage and weed suppression than the monocrop treatment without vegetation cover system. This could be due to the variety of the mixture containing species that germinate quick enough to suppress weed growth as confirmed by various case studies (Rutto et al., 2003; Brennan & Smith, 2005; Boydston & Al-Khatib, 2005; Grant, 2006). Even though the monocrop treatment had a lower amount of crop over weed density, the faba beans had greater canopy and height than the weeds.

The multi-crop treatment had the greatest wet and dry crop biomass as seen in Figures 2 & 3. It should be noted that both treatments (multi-crop and monocrop) had greater wet and dry crop biomass than the no vegetation cover system. Having multi-crop coverage in the young walnut orchard provided great weed competition, attraction of beneficial insects, pollinator presence, and overall healthier soil as confirmed by other studies (Grant, 2006; Ellis & Barbercheck, 2014; Van Sambeek, 2017; Finney et al., 2017; Streit et al., 2019). The monocrop cover had similar benefits though the presence of beneficial insects and pollinators was weaker, which could be due to underdeveloped faba bean flowers.

Conclusion

Implementation of multi-crop coverage is the best practice to obtain numerous benefits. The experiment provided supporting evidence for this since the multi-crop treatment was superior in results, followed by the monocrop treatment. The variety of compatible crops in a multi-crop system leads to achieving a combination of benefits that contributes to the health of the soil. Grasses are good crop companions, assist with weed suppression, increase water retention, and improve soil vigor. Brassicas have biofumigation and allelopathic properties, attract pollinators and beneficial predators, and are excellent weed competitors. Legumes provide biological nitrogen fixation and attract pollinators but also potential pests. Depending on the species, some legumes are good weed competitors (clovers) while others are poor weed competitors (faba beans and peas). Faba beans, which are poor weed competitors in early stages, as monocrop will still provide various benefits once more fully developed, such as nitrogen amendment, pollination, and increased biodiversity in walnut orchards. However, choosing clover may be a better option as it provides greater weed suppression. Choice of cover crop will vary depending on the age of the walnut orchard, nonetheless, a form of vegetative cover is more favorable than leaving bare soil conditions. Cover cropping is a sustainable approach towards soil health of walnut orchards, which will establish long-term benefits and support an integrated pest management system. In conclusion, there is much to gain from the use of cover crops, especially in a young walnut orchard where walnuts are not fully yielding, and crops will be grown for various years.

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The Emotional Curriculum of Climate Justice Education: An Existential Toolkit

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Abstract

While we tend to focus on the physical impacts of climate change, our ecological crisis is also taking a significant emotional toll. This executive summary outlines ways that anxiety, fear, hopelessness, and guilt impact student learning in Environmental Systems and Societies (ESS) Programs and immobilizes young people from getting engaged in climate solutions. We also suggest that ESS curriculum is itself partly responsible for these spiraling emotions among students. In response to the need to better understand this emotional register of teaching and learning about our climate crisis, we outline a set of college-level teaching strategies – titled an "Existential Toolkit for Climate Justice" —whose purpose is to help students and educators develop the resilience to cope with our climate emergency.

Overview

As the effects of climate change, biodiversity loss, and environmental injustice are felt by more people around the world (IPCC, 2021), despair about our future is on the rise. A raft of new studies identifies climate disruption as a mental health crisis (Clayton & Karazsia, 2020; Leiserowitz et al., 2018; Clayton et al., 2017). Within higher education, these emotional impacts are most pronounced in the field of ESS, where teachers and students are confronted with heartbreaking material at every turn (Pihkala, 2020; Wu et al., 2020). Processing and applying this difficult material across learning contexts can give rise to existential, emotional, and intellectual challenges that are too seldom made explicit in our teaching.

Feelings of hopelessness, guilt, and nihilism not only compromise creative thinking and learning; they can also immobilize people from taking the kind of collective action needed to promote climate justice (Wallace, 2020; Davenport, 2017). Yet, educators across disciplines typically lack the knowledge and resources to help students deal with these difficult emotions. Indeed, many persist in communicating the scale and urgency of environmental problems without addressing their impact on students' ability to learn or respond in meaningful ways (Eaton et al., 2016; Hickman, 2020). As exemplified by the COVID pandemic and recent movements for racial justice, our challenge today is to ensure that students don't just have the analyses and content they need to address the climate crisis, but that they also have the existen-

tial tenacity to stay engaged in climate work and navigate the long emergency ahead.

Toward a pedagogy of emotional and collective resilience

We recognize that it is unconventional for Environmental Systems and Societies (ESS) curriculum to focus on affective, psychological, and existential skills. However, many educators are themselves partly responsible for their students' spiraling emotions. For example, by narrating climate change as the fault of a generic "humanity" rather than extractive structures that exacerbate human inequality too (Higgins, 2020; Harris, 2019), or by teaching students to eliminate their individual impacts on the planet through ecological footprint exercises, or by relentlessly pressing the urgency of these problems, ESS instructors fuel students' guilt, fear, and misanthropy (Ray, 2020; Kelsey, 2020; Kretz, 2017). These same instructors then wonder why their students find their courses disempowering, depressing, and anxiety-producing (Ray, 2018).

Proposed Resources for Climate Educators

To better understand and address this emotional register of teaching and learning about our climate crisis, we are curating a toolkit of college-level teaching strategies that help students across disciplines build resilience for a climate-changed future. Contributions have been submitted by educators from across disciplines, as well as activists, artists, psychologists, game designers, writers, and others actively integrating emotion into climate justice programming and teaching. These resources, which collectively aim to support students and educators confronting the existential fallout of climate injustice and disruption, will be published in 2022 as an edited collection titled *An Existential Toolkit for Climate Justice Educators*. Tools range from poetry- and arts-based activities to mindfulness practices, templates for workshops and discussion groups, creative writing assignments, service learning through community-based partnerships, and more.

What distinguishes our collection from existing resources on climate anxiety and grief is that the *Existential Toolkit* will offer teaching strategies and resources tailored specifically for college-level educators, rather than general/personal strategies for coping with climate despair. These are meant to be broadly accessible resources for all disciplines (as well as for those in non-academic or co-curricular settings), and for instructors/facilitators without prior experience addressing mental health dimensions of climate change.

In curating these resources, our team has selected assignments and strategies that students themselves identified as effective through written feedback and testimonials. In particular, we prioritized tools that students said helped them develop a sense of agency and hope, enabled them to generate visions of a just and livable future, or helped them channel distress into collective action. While the considerable diversity of these interdisciplinary contributions makes it difficult to summarize a specific "solution" for producing those student outcomes, there are two prominent trends shared across resources featured in the collection.

First, these interventions acknowledge and make visible the often invisible and unacknowledged emotional dimensions of learning about climate breakdown and injustice. Too often, we do not voice difficult eco-emotions, which creates a sense of loneliness and powerlessness (Harvey et al., 2020; Hickman, 2020). Moreover, as psychologists like Davenport (2017), Lertzman (2015) and Randall (2009) argue, ecological losses that are not fully confronted and processed can lead to numbness, repression, cynicism, and apathy. Put another way, failing to acknowledge our pain in response to this crisis is yet another form of climate "denial." Opportunities for authentic conversation and deep listening, where students are welcomed to share those feelings, not only helps them overcome this denial, but student testimonies also identify such exchanges as comforting, empowering, and as sources of creative inspiration. Moreover, by explicitly acknowledging learners' emotional responses to course material, resources featured in our *Existential Toolkit* establish such emotional content as a legitimate subject of classroom discussion. This counteracts the tendency to pathologize climate anxiety and empowers students by reframing their distress as a "moral emotion" – a healthy and indeed compassionate response to the existential threats we face (Atkinson, 2021). Finally, centering emotion in the classroom allows students to connect with course materials in personal, idiosyncratic ways, thereby enriching and deepening their engagement with it (Cavanagh, 2016).

The second trend we have identified across contributions to this toolkit is an emphasis on building community. Indeed, student testimonies identify this aspect as the most empowering outcome across a range of classroom interventions. In the process of sharing difficult emotions or engaging in other activities that build trust and community with their peers, students say they feel less isolated and therefore more empowered to take action. They recognize that they don't have to shoulder the burden of climate action alone and can be part of a greater community working toward solutions in solidarity with each other (Ray, 2020; Brown, 2017).

Project Impact

In developing the *Existential Toolkit for Climate Justice Educators,* we aim to provide resources for navigating the affective terrain of teaching and learning about power, privilege, identity, epistemological diversity, climate injustice, and ecological grief. This project will also enhance student learning and feelings of agency in seeking climate solutions and empower the Climate Generation to avoid despair and burnout as they take up the difficult work ahead.

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From Blame to Dialogue: In Quest of Intergenerational Justice on Climate Sustainability

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Abstract

Conversations about rapid climate disruption can become side-tracked by blame-seeking: who or what nations or cultures or age brackets are most responsible for global warming? This paper seeks to move beyond blame and uncover the importance of fostering solidarity among generations to uncover our shared responsibility for climate sustainability. By understanding the intersectional context of how past injustices inordinately impacted various communities, we can move towards constructive dialogue and shared practical experiences to foster justice among generations. The Three R's of Equitable Intergenerational Development can initiate this, which strives to mitigate transgenerational climate injustices. Through intergroup contact, intergenerational respect seeks to mitigate climate disruption and emphasize a more equitable and inclusive political, economic, social, and natural environment among all generations.

How do Generational Perspectives Differ on Climate Disruption?

It is a common trope to speak as if each generation is its own discrete entity reflecting oppositional attitudes to other generations. Human culture is of course far more dynamic than this, but generational experiences do shape our contrasting perceptions of the seriousness of key issues. An 85- year-old with numerous grandchildren will view human overpopulation differently than a millennial agonizing over whether to have children at all. Serious engagement with climate disruption requires that we abandon our aged-based silos and embrace intergenerational dialogue and cooperation.

The twin roots of climate disruption are resource overconsumption and human overpopulation: too many humans consume too much in the way of land, energy, and finite resources. The current climate catastrophe stems from a history of Western industrial development that has greatly benefitted the present generation at the expense of future generations (Davies, 2020). Our descendants will bear the environmental costs of the conveniences we enjoy, implying a lack of awareness on our part of the intergenerational solidarity necessary to help us envision long-term solutions. Will the changes in policy and practice necessary to address overconsumption be made equitably between generations?

How Might We Assess Intergenerational Contact on Climate Issues?

Climate disruption is an intersectional systemic issue. It is a result of both (1) scientific ignorance leading to the abuse and unraveling of Earth's delicate ecosystems, and (2) a capital-

ist-industrial model premised upon the assumption of eternal economic growth that rejects the integral relationship between economy and ecology (Daly & Cobb, 1994). Addressing the causes and consequences of climate disruption requires recognizing intersections of generations, genders, ethnicities, religions, nationalities, socioeconomic levels, and geographical contexts. In observing the current polarization on climate issues, research reveals that "70% of adults aged 18 to 34 say they worry about global warming compared to 56% of those aged 55 or older" (Ballew et al., 2019). Based on observing interactions between different generational cohorts, how might we assess the ways in which individuals participate in efforts to mitigate climate change?

One fruitful way to explore intergenerational contact is to look at how access to educational resources on climate science changes the dialogue. Children's early exposure to the scientific treatment of climate issues can generate conversations that extend from schools into households. Similarly, open dialogue and shared practical experiences of healing the land create constructive empathy. The wisdom and experience of age complement and enrich the dynamism and imagination of youth to enable us to build an integrated vision and plan of action for addressing the multifaceted challenge of climate disruption.

What are the Three Rs of Equitable Intergenerational Development?

As climate disruption accelerates, equitable intergenerational development is one key to ensuring ecological stability for future generations. According to Sultana (2021), "the lived experiences of climate injustices demonstrate the differential marginalisations occurring among and within communities" (p. 120). Through the processes of recognition, reprioritization, and reconciliation, we can address environmental injustices more inclusively with unified plans for developing and implementing transgenerational solutions.

First, since we are applying a model of intergenerational development to climate issues, we should *recognize* that economic development in the United States often doomed places to become uninhabitable sacrifice zones (Lerner, 2010). The National Housing Act (1934) formed the Federal Housing Administration whose color-coded maps suggested varying levels of risk across communities. The red or "hazardous" zones in which home loans were denied were disproportionately inhabited by families of color. Today, these neglected neighborhoods can be 5 to 20 degrees hotter in the summer than the more affluent, whiter neighborhoods of the same city. This is due to a lack of trees and an abundance of heat-trapping pavement (Plumer & Popovich, 2020). Without taking the appropriate actions now, these neighborhoods will further devolve into uninhabitable heat-emitting scars exacerbating the effects of a warming climate on future generations.

Second, in the context of these social inequalities that plague generations, we can *reprioritize* areas of investment to ensure an equally sustainable future for all. Emphasizing urban greenery, cool materials, and shading to mitigate urban heat will save energy and keep cities cooler for generations (Yenneti et al., 2017).

The third step in this tripartite model involves actively *reconciling* disparities and moving to a greener new deal. Islam (2015) contends that, social inequality shapes behavior within and between households, communities, and nations, each of which influences environmental sustainability. Pursuing multilateral development in such a way that promotes uniform expansion among all communities will support future generations. Organizations such as the Sunrise Movement accentuate the intersectionality of historical neglect and climate issues. It supports a climate action plan which seeks to generate green jobs and reach net-zero carbon emissions by 2030 (Green New Deal, 2019). Active reconciliation of inequalities over time can influence behavior that fosters solidarity among generations on environmental sustainability.

What Sacrifices Are Required of Different Generations for Climate Sustainability?

If voluntary population reduction fails, nature will trim our excess through famine, resource wars, epidemics, and forced ecological migration. This raises questions in intergenerational ethics: can a young couple decide that they cannot responsibly have children? What considerations of intergenerational justice are raised, such as obligations to future generations (Gosseries & Meyer, 2009)? How might religious traditions engage with delicate questions about population (Hess, 2019)? How will an aging population be cared for? What intergenerational and intercultural sensitivities on issues of reproductive justice are raised between the global south and the global north (Eriksen, 2015)?

Implementing Intergenerational Justice and Climate Sustainability

Mitigating the effects of climate change will require a cooperative approach in that everyone will be better off working together. Intergenerational climate issues range from protecting the interests of unborn generations in Colombia who risk in-

heriting a failing Amazonian Rainforest to representing elderly women in Switzerland who are more vulnerable to increasing temperatures (Slobodian, 2020). Emphasizing restorative justice for underrepresented communities promotes intergenerational solidarity on climate sustainability by inspiring common interests and shared responsibility. A unified pursuit of intergenerational equity remains necessary in considering sustainable solutions and a livable future for all.

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Strategic Energy Master Planning for Carbon Neutrality

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Abstract

Universities across the United States are generating goals to be more sustainable and carbon neutral. The energy used in existing buildings on campus amount to a large volume of greenhouse emissions and must be reduced to help achieve neutrality goals. Strategic Energy Master Plans are instrumental to support these goals through the development of recommendations to reduce energy. Calculating the energy use intensity for existing buildings, a main component of a Strategic Energy Master Plan, can help the campus understand where energy is being used the most. With this information the highest energy consuming buildings can be the focus of renovations to improve energy efficiency to reduce emissions. This study evaluated existing building energy use at California State University, Chico and made energy efficiency recommendations on 12 campus buildings. The information was also used to identify where the campus may fall short of their neutrality goals and provided additional recommendations to meet them.

Overview

California State University, Chico (Chico State) has had the goal to be carbon neutral by 2030 since they joined the President Climate Commitment in 2007 (Chico State, 2021). As the second oldest campus in the California State University System and with over 3,352,457 square feet of buildings, including seven historical buildings over 85 years old, Chico State buildings use a large amount of energy. With the aging buildings and the energy needed to heat, cool, light and power the building space, how can Chico State achieve their carbon neutrality goal?

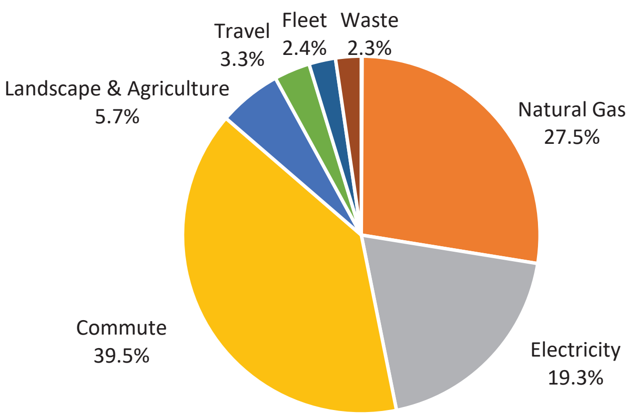
To aid in planning, Chico State updated their Climate Action Plan (CAP) in 2020 (Chico State, 2021) that provides recommendations on how to achieve neutrality by 2030 for all emission types. In order to implement the CAP, some of the measures require greater detail from an energy management perspective. This is where a Strategic Energy Master Plan (SEMP) is beneficial as it is specific to managing and reducing energy usage to meet a desired goal (Association of Energy Engineers, 2020). The two plans complement each other to provide guidance and recommendations to implement for all emission sources (Patterson, 2021).

Greenhouse gas emissions are measured in metric tons of carbon dioxide equivalent (MTeCO2). In 2017-2018 Chico State greenhouse gas emissions were 20,867 MTeCO2, and Figure 1 shows the emissions breakdown per category. The SEMP and this research focus on natural gas and electricity emissions. Natural gas emissions were 5,733 MTeCO2 or 27.5%, and electricity were 4,025 MTeCO2

or 19.3%, equating to 9,758 MTeCO2, or 46.8% of total campus emissions.

Figure 1

Campus emissions 2017-2018.



According to the California Coalition for Adequate School Housing (CASH) calculating the Energy Use Intensity (EUI) for the campus and individual buildings is one of the first steps in understanding where energy is being used across campus (CASH, 2009). EUI is calculated as an energy use per square foot per year, typically in BTU/SF, which allows electricity, natural gas, and other energy sources to be converted to one whole number. The EUI allows a campus to benchmark its energy use and compare individual buildings against the benchmark to determine higher and lower energy use buildings. By prioritizing the higher energy buildings for renovation, it will conserve the most energy and bring down the EUI average in a shorter amount of time. Annual energy consumption and square footage of buildings was required for the calculations and was received from Chico State's campus energy manager through their energy management system. This paper focuses on the research associated with evaluating the energy in existing buildings to understand if the campus will meet their targeted goals and make recommendations to achieve neutrality by 2030.

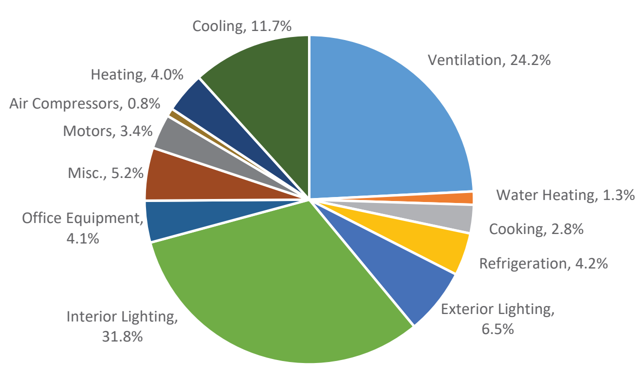
Research Methods

This research replicates the methods developed by CASH to benchmark the electricity use of the existing buildings on campus. The steps included compiling annual energy data, establishing an energy average or benchmark, identifying which buildings are performing more or less efficiently than others and then performing audits to make recommendations for renovations for those buildings (CASH, 2009). Using the 12-month electricity data and square footage, the campus average EUI was calculated and used to determine the baseline energy consumption. The next step was to calculate the EUI for each building on campus using the same data set. The resulting data was sorted by highest to lowest EUI to determine which buildings used the most energy.

Buildings that exceeded the baseline average energy use were audited for energy and energy conservation measures (ECM's) were developed. Based on the ECM estimated energy savings per building, emission reductions were calculated. Figure 2 from the California Energy Commission (CEC) shows how energy is used for a typical college campus in PG&E's service territory (CEC, 2006). ECM's typically consist of recommendations on similar categories like heating, cooling, lighting and office equipment. After existing building energy and emissions were calculated, the results were analyzed to determine where the campus is in terms of meeting carbon neutral goals. If goals were met, then the campus is on track to meet their sustainability goal. If goals were not met, then additional recommendations must be proposed to meet neutrality goals.

Figure 2

College electricity use for PG&E service area.



Discussion of Results

After receiving information from Chico State, it was determined that some buildings did not have energy sub-

metering in place to provide natural gas data for individual building consumption. Also, several buildings did not have 12 months of accurate electricity data. Based on this, several buildings were removed from the study and the EUI was modified to only calculate electricity per square foot (kWh/SF). After this there was a total of 44 buildings in this study. The total annual electricity for campus was 29,061,121 kWh, with total square footage of 3,352,457 SF, calculating an av-

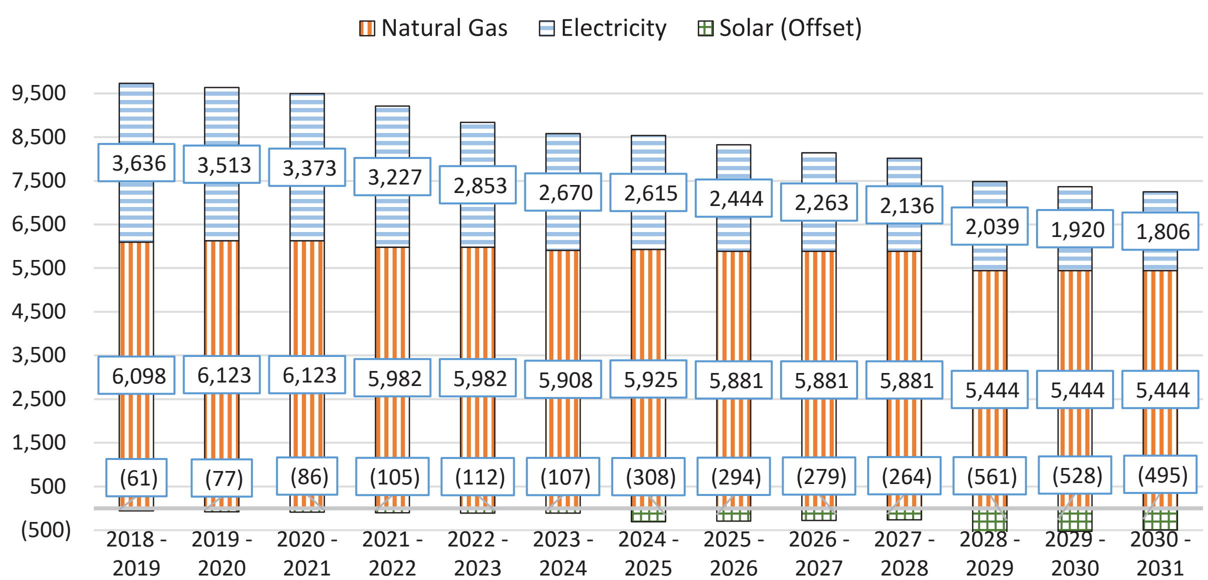
Table 1

Highest electrical EUI buildings at Chico State.

Campus Building	Annual Electricity (kWh)	Building Size (SF)	EUI (kWh/SF)	Annual Electricity ($)
Gateway Science Museum	1,121,669	9,656	116.16	$ 174,531
Butte Station	61,744	1,212	50.94	$ 9,607
O'Connell Technology Center	1,431,156	75,683	18.91	$ 222,687
Nettleton Stadium	130,397	8,364	15.59	$ 20,289
Langdon Engineering Center	677,473	58,249	11.63	$ 105,414
Bell Memorial Union & Bookstore	1,454,319	133,677	10.88	$ 226,292
Holt Hall	1,393,789	130,850	10.65	$ 216,873
Selvester's Cafe	92,692	9,388	9.87	$ 14,422
Wildcat Recreation Center	1,050,103	109,000	9.63	$ 163,396
Meriam Library	2,560,401	269,018	9.52	$ 398,398
TOTAL	**9,973,743**	**805,097**		**$ 1,551,909**

Figure 3

Emission forecasts incorporating ECM recommendations and Master Plan.



erage EUI of 8.67 kWh/SF. Building EUI was calculated and when the buildings were sorted to determine higher energy use, there was a total of 12 buildings above the average. Two buildings were removed from the list as they were found to be in the recently updated Master Plan to be demolished and rebuilt by 2030.

The remaining 10 buildings are shown in Table 1 with the highest EUI at the top. These buildings totaled 9,973,743 kWh or 34.3% of campus kWh use, and 1,284 MTeCO2, which is 13.2% of campus emissions. ECM recommendations included LED lighting upgrades, additional lighting controls, occupancy sensors and HVAC upgrades for each building. By incorporating the recommended ECM's for the 10 buildings, the campus could reduce electricity by 3,216,075 kWh, or $537,480 per year.

Based on the calculations and results of this research and SEMP, Chico State will be short of their carbon neutral goal. Figure 3 forecasts the emissions for the campus as a result of the recommendations from this study. In order to achieve this goal, the campus needs to maximize solar installations, or other renewable energy, in order to offset the remaining campus energy use. Additionally, natural gas is seen to continue to be the largest generation of emissions. How the university uses natural gas to heat buildings will be another primary factor in determining the speed at which carbon neutrality is possible and is a future research topic.

With the SEMP and CAP, Chico State has taken the first step in generating a plan to achieve their desired goal of being carbon neutral. Implementation is the next phase and will help reinforce Chico State as a continued leader in sustainability.

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