Determining Impact of Small-Scale Sustainability Efforts

Sponsor

Fundecooperación para el Desarrollo Sostenible

Team Members

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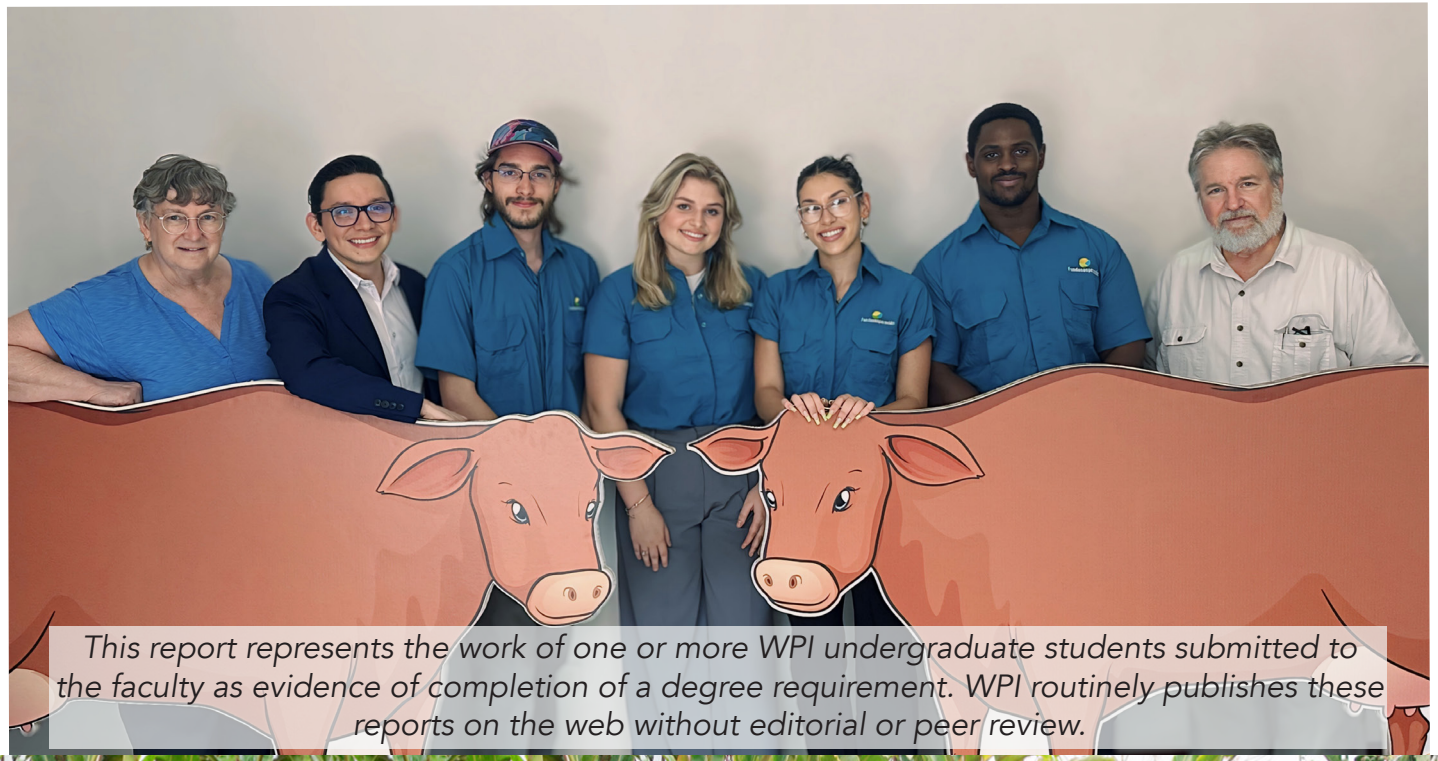
Abstract

The goal of our project was to create a methodology that would measure the impact of sustainable development practices in Costa Rica. The practices in question are used by the clients of Fundecooperación para el Desarrollo Sostenible (FDS), an NGO whose mission is to finance sustainable development by giving loans to micro, small, and medium sized enterprises in Costa Rica. FDS wants to know how to assess the impact of the sustainable development practices they've been financing so that they may make more informed decisions about their credit program in the future. Our team conducted extensive research and interviews on sustainable practices and indicators that show their impact. We also analyzed and worked inside FDS's database to consider the changes needed for our methodology.



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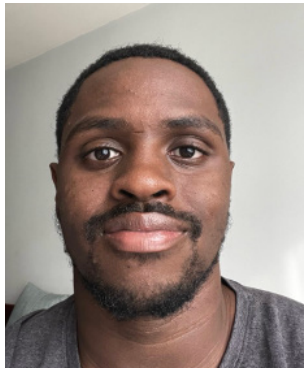
Authorship

Hello! I'm Juliana Fox from Oxford, Massachusetts, majoring in Industrial Engineering with a Minor in Business. During my enriching time in San Jose, Costa Rica, I not only broadened my knowledge of sustainability and its diverse initiatives but also delved deeper into database organization and data collection, honing exceptional teamwork and leadership skills along the way. Beyond academics, I had the pleasure of exploring waterfalls, hot springs, and beautiful beaches. This experience holds immense value as I can apply its lessons to my future professional journey. Finding deep satisfaction in knowing that our team has actively contributed to measuring the impact of sustainability practices has been truly rewarding!

My name is Maksymilian Robidoux. I'm from Leicester MA and I am majoring in Mechanical engineering. My skills lie in CAD design and hands on work with anything mechanical. I also have experience in manufacturing and in a surface finishing lab. Being in Costa Rica has been an amazing experience with all the sights I got to see around the country. My favorite place to be was around lake Arenal with its perfect weather and amazing views. Costa Rica is a place I will be coming back to.

Hello! My name is Sophia Lally, and I am a Biomedical Engineering major from Chatham, New Jersey. Having the opportunity to immerse myself in Costa Rican culture and community was a unique and special experience for me. This opportunity is one for which I will be forever grateful. The people I met and the experiences I had are going to have a lasting impact on me for the rest of my life. Beyond the cultural aspect, I had the chance to broaden my experience and knowledge of working in a professional setting Participating with a local non-governmental organization focused on sustainability gave me access to an education that could not be replicated in a classroom. I am going to miss the beautifully vibrant sunrises and sunsets, but I am glad I had the chance to assist in a good cause while in Costa Rica.



Hello! I'm Vaughn Weston, a Management Information Systems major from New Haven, CT. This project has been a wonderful and invaluable experience for me and the profession I hope to practice in the future. Studying MIS means I'm no stranger to working in databases, but getting to see and work within an actual business's Salesforce database showed me a lot of things I never saw or considered back in Worcester. This project also opened my eyes to just how important sustainability is and how difficult it is to achieve. I got to see firsthand how our sponsor's efforts were improving not just the lives of clients, but their animals and environment as well. I'm very proud and thankful to have contributed to our sponsor's mission and am excited to see how the framework we built can be improved upon in the years to come!

Introduction

Despite Costa Rica's commendable efforts in promoting environmental conservation and sustainability, the country is facing increasingly severe consequences of climate change. Rising temperatures, changing rainfall patterns, and more frequent extreme weather events are adversely affecting its rich biodiversity, ecosystems, and agriculture. Rising temperatures and altered precipitation patterns create favorable environments for the proliferation of disease-carrying mosquitoes, exposing the population to increased health risks[1]. Altered rainfall patterns and extreme weather events can also impact water quality, resulting in the spread of waterborne diseases, affecting the health of those who consume contaminated water. The changing precipitation patterns and extreme weather events are disrupting agricultural activities, leading to food shortages and changes in the availability of certain food items, affecting the nutritional health of the population[2].

These climate-related occurrences pose a considerable threat to small-scale farmers and businesses in Costa Rica, as their livelihoods and community contributions depend on the revenue and output generated. Unfavorable climate events can significantly disrupt income and inflict harm until production is restored. To withstand such challenges, local farmers and enterprises must enhance their farming techniques and embrace sustainable practices. This involves building up reserves of assets and implementing improvements that alleviate the impact of unexpected climate events[3].

Fundecooperación para el Desarrollo Sostenible (FDS) is a non-governmental organization (NGO) dedicated to addressing these environmental challenges by providing credit to micro, small, and medium-sized enterprises (MSMEs), small farms, and other programs with a specific focus on supporting climate resilience and sustainality projects. Their credit programs not only facilitate the gaining of assets but also actively promote and allow for the implementation of sustainability practices. These practices, spanning livestock, agriculture, and green development in urban environments, are designed to enhance climate resilience and support sustainability initiatives[4].

FDS is currently evaluating the outcomes of its dedicated efforts toward fostering a more sustainable community and assessing the organization's impact on its clients and the environment. FDS has begun collecting financial reports, measures of CO2 emissions, and other various data, as well as conducting risk analysis of the MSMEs partnering with the organization. Our goal is to create a methodology for measuring and displaying the impact of FDS sustainability practices on their clients and the environment by creating a data collection tool to be utilized within their database.

FDS and Sustainability

The full scope of this project entails an in-depth review of relevant literature prior to addressing our team's objectives. First, we will delve into the profound impacts of climate change on Costa Rica and how it has affected the communities, businesses, and agricultural sectors. We will then observe how FDS is addressing the current issue by implementing sustainability practices and programs. The organization prides itself on addressing the 'three pillars of sustainability' in carrying out its initiatives. Finally, we will discuss metrics that will measure FDS's impact on vulnerable groups based on the outlined indicators[5].

Effects of Climate Change on Costa Rica

Climate change in Costa Rica poses significant challenges, with elevated temperatures and shifting weather patterns directly impacting the environment and residents' daily lives[6]. Despite progress in poverty reduction, 23% of households, equivalent to 380,000 homes, still live below the national poverty line[7]. Climate change exacerbates poverty levels, particularly affecting subsistence farmers and smallholders, making adaptation difficult[8].

Changes in precipitation patterns contribute to water scarcity, affecting agriculture and household water access. Communities reliant on agriculture face challenges due to reduced water availability[9]. The interconnected challenges emphasize the need for comprehensive climate change measures to protect community health and resilience.

Fundecooperación

FDS follows the United Nations' 17 Sustainable Development Goals (SDGs) to serve as a guideline for their own projects and practices. There are 17 goals including no poverty, zero hunger, clean water and sanitation, affordable and clean energy, climate action, and more[10]. On the path to accomplishing these goals, FDS has 54,000 beneficiaries in Costa Rica, and has given 400 million colones (over $750k USD), in grants, to families living in extreme poverty[11].

During the credit allocation process, displayed in *Figure 1*, clients can contact FDS through various channels, via phone or through their website (step 1). Upon receiving the application, an

***Figure 1**: FDS's Credit Application Path (Fundecooperación)*

advisor will verify the submission of all required documents (Step 2). Subsequently, the client is required to undergo a credit analysis from a bank and a risk analysis from Agroclimatica, a bioclimatic data platform based in Denmark that provides Risk Scores based on data from climate, soil, crop, livestock, and productivity readings (Steps 3 and 4)[12]. An assigned analyst will conduct a technical analysis to assess the feasibility of credit allocation (Step 5). Once the technical analysis is concluded and the credit details are finalized, the requested amount will be distributed to the client (Steps 7 through 9). FDS will maintain communication and provide support throughout the entire payback period (Step 10). The support given can come in the form of FDS suggestions about what practices the client can implement to be more sustainable.

As displayed in *Figure 2*, FDS has given loans to MSMEs across a wide spectrum of fields with livestock and agriculture being the most prominent, accounting for about 62% of their clients as of 2024, displaying a clear prioritization of livestock and agriculture. Developing the most impoverished regions of the nation is unattainable without ensuring that communities have access to the

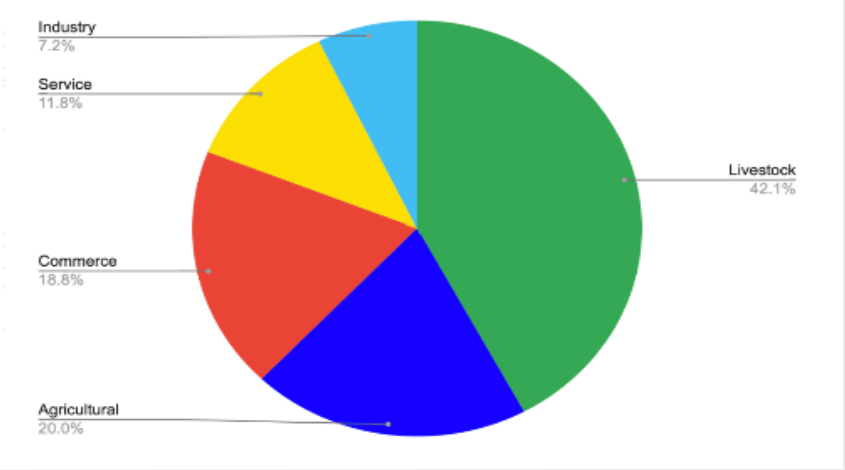


***Figure 2**: FDS client distribution by industry*[29]

resources they need, thus it is vital for FDS to provide the support necessary to develop livestock and agriculture sustainably.

FDS has supported numerous projects, notably initiatives involving coffee farmers in the Coto Brus region. Support from FDS has facilitated environmental enhancements, leading to heightened production and profitability for these farmers[3]. Indigenous farmers cultivating crops for personal use, such as corn, cocoa, sugar cane, wheat, pepper, and oranges, have embraced innovative farming techniques to boost production. This includes minimizing cultivated areas, providing focused care to existing crops, and planting trees on unused land to enhance resilience against droughts and heavy rains[13].

In the tourism sector, Florblanca, a resort in Provincia de Puntarenas, Santa Teresa, Costa Rica, supported by FDS, is committed to sustainable practices. Over the years they have implemented various projects including Solatube technology installed on many office roofs to illuminate the spaces with natural light. UV lamps were installed to purify the water, so all taps have clean drinking water, and an irrigation system allows Florblanca to reuse the treated water in their gardens avoiding the consumption of drinkable water in landscaping. Because of these projects Florablanca undergoes evaluation through the Costa Rica Tourism Institute's certification program for Sustainable Tourism (CST)[14].

Agroclimatica

The company Agroclimatica is a sustainability focused company based in Denmark. They started as a trading company in the year 2000, and in 2016 created a methodology that effectively correlates climate data with soil conditions, crop behavior, livestock specificities, and good agricultural practices. Agroclimatica is aligned with the UN's sustainability goals, and has an international influence in the Americas, Asia, and Europe. They provide data on CO2 emissions and risk analysis for FDS clients[12].

The Three Pillars of Sustainability

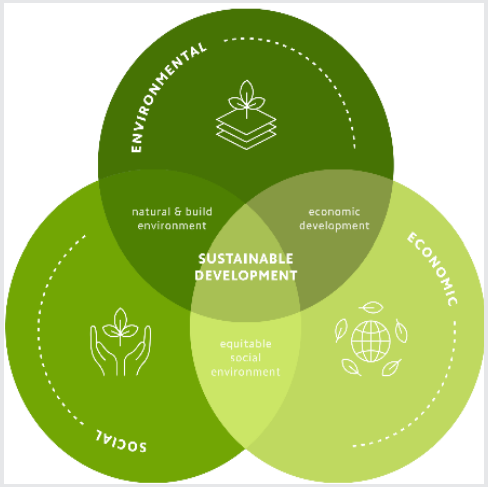


Figure 3: The interconnection of the Three Pillars of Sustainability[1]

The concept of the three pillars of sustainability originates from the understanding that achieving sustainable development requires a holistic approach encompassing economic, social, and environmental dimensions. The significance of this concept to the UN Sustainable Development Goals (SDGs) lies in its alignment with being able to address global challenges appropriately and through a balanced approach. By creating and implementing the three-pillar framework, the UN can better structure efforts towards achieving the SDGs. This further helps to ensure that economic growth considers social equity and environmental protection. Ultimately the interconnection of these pillars, *Figure 3*, guides the formulation of policies and the implementation of actions that promote sustainable practices worldwide not only in an economical sense but in one that is also socially inclusive and environmentally responsible[15].

The **environmental** pillar of sustainability focuses on mitigating risks and assessing the environmental impact of MSME operations, including efforts to save energy, preserve agricultural resources, assess carbon footprints, and reduce greenhouse gas emissions[17].

The **social** pillar prioritizes individual and community well-being, promoting social equity by addressing disparities based on gender, race, ethnicity, sexuality, and socioeconomic status. It emphasizes inclusive practices, fair labor conditions, community engagement, empowerment, and access to healthcare, education, and resources for improved well-being[17].

The **economic** pillar highlights businesses' role in addressing climate change, acknowledging their historical impact as major polluters. Sustainable practices, balancing social and environmental considerations with profitability, are crucial for achieving long-term sustainability. Efficient and sustainable growth practices are key to finding the necessary balance[17].

A case study published by a team of researchers, who led a Solar Thermal Electricity project in Mexico, found that "assessing the three sustainability pillars" aided in "implementing the required actions and measures to improve the sustainability performance of the project" (Rodríguez-Serrano et al., 2017). With this information we can confidently base our further research around these pillars[18]. With this information we can confidently base our further research around these pillars.

Key Indicators of Sustainability

To assess the general impact of Fundecooperación's initiatives we have identified various indicators for each of the three pillars of sustainability. These indicators will measure the impact on their respective categories.

Environmental Indicators

Fundecooperación gathers various metrics from their clients, including data on **CO2 emissions**. Carbon dioxide (CO2) is a greenhouse gas that absorbs solar energy, contributing to climate change. Reducing CO2 emissions has a positive impact, and MSME emissions are assessed by examining factors like energy consumption, fuel usage, waste management, recycling practices, livestock, and fertilizer usage[19]. Organizations often employ risk calculators, typically sourced from third-party companies, to determine these values. Currently, FDS utilizes tools developed by Agroclimatica to aid in tracking CO2, enabling comparisons between different organizations or industries and monitoring progress over time[20].

Costa Rica is a global example of **waste reduction** and

environmental sustainability. The country employs a comprehensive approach, emphasizing recycling and responsible waste management. Significant investments in infrastructure, including waste separation and recycling facilities, facilitate environmentally friendly waste disposal. Government policies and educational programs also raise awareness about waste reduction[21]. Community engagement is crucial, encouraging citizens to participate in recycling programs and adopt eco-friendly practices. Costa Rica's commitment to environmental responsibility and innovative solutions has led to significant progress in creating a cleaner and more sustainable future.

Measuring waste reduction involves various methods, such as **tracking the use of multi-use sustainable products** instead of single-use items. Assessing the volume of recycled waste is another key metric. The U.S. Environmental Protection Agency offers guidelines for waste assessments, including the "Waste Sort" technique, which involves **sorting and weighing waste samples**[22]. Utilizing such methods can help evaluate the impact of Fundecooperación's programs on reducing waste.

FDS is actively involved in financing methods to reduce **water usage**, such as improved water distribution systems, encompassing water supply, efficient storage, irrigation, solid waste management, storage tanks, and other practices conducive to integrated and sustainable water management[11]. Understanding how much water is consumed and where it is allocated helps in implementing measures to conserve and sustainably use water resources, one of FDS's sustainability initiatives. Thus, we find it crucial to recognize water usage as a metric for measuring FDS's success given its impact on the SDGs. Water usage can be measured through different forms of water meters or, for an open irrigation system, by multiplying the application rate by the duration of the irrigation or by measuring the drop in reservoir level[23]. This application rate can be determined differently depending on the irrigation method farmers use.

Agriculture is a huge focus of Fundecooperación (see *Figure 2*), so our team also identified indicators of the **agricultural effects** of sustainable development practices. FDS can use indicators to measure the farm's productivity and the health of crops and livestock. For example, FDS has funded the establishment of foodbanks and a type of grass called Cuba 22[11], which allowed agricultural producers to, in some cases double and triple the number of animals they could raise doing the same amount of work. Indicators have also been used to investigate how resilient farms are to climate change's effects on Costa Rica. Resilience in this context can be defined as how well in response to disturbance from climate change, farms can "maintain, recover, and improve their integrity and functionality"[24]. There are many potential indicators for resilience alone such as crop diversity and herd fertility. Such indicators can be measured by counting the number of crops produced each year and for herd fertility the number of newborns (calves) birthed per year per productive female[25]. Agriculture is the basis for where our food comes from, thus we must know if sustainable development practices are resulting in higher or lower yields in the attempt to mitigate climate change, health, or other variables.

Projects dedicated to enhancing sustainable energy and energy efficiency use new technologies to diminish **energy consumption**, mitigate pollution, and foster the adoption of alternative energy fuels and sources. Energy usage spans across various sectors, encompassing electricity for building operations, equipment, and agricultural necessities like power for facilities, air conditioning, and manufacturing equipment.

The assessment of energy consumption relies on the business's power meter, as reported by the utility in kilowatt hours and

it is important to ensure that the energy is derived from sustainable sources[26]. This approach not only addresses energy efficiency but also emphasizes the importance of sustainable practices.

Social Indicators

A significant challenge faced by the nation is the substantial portion of the population living below the national poverty line, highlighting the pressing need for **poverty alleviation** efforts. The Research Institute in Economic Sciences of the University of Costa Rica (IICE-UCR) discovered that "by the end of 2022, the number of poor households in the country could have reached 24% or 25%"[7]. Hence, a primary objective for FDS has consistently been to elevate individuals out of poverty. Their core focus revolves around helping "people turn dreams into reality and improve living conditions hand in hand with sustainable development" [11]. To measure the effect FDS has on this aspect, metrics such as income levels, employment rates, and asset accumulation will be measured. The government program Fideimas provides information on poverty through a certification to guarantee the credit loaned out to impoverished clients will be paid back through a bank if the clients can't pay[34]. FDS also has the option of getting a poverty report through the government.

Equal opportunity is pivotal in Costa Rica for fostering a society where individuals from all backgrounds can thrive and contribute to national development. A commitment to equal opportunity allows the country to leverage its diverse population, promoting social cohesion and economic prosperity. Ensuring fair access to education, employment, and resources broadens the talent pool, fostering innovation and sustainable growth. This commitment aligns with Costa Rica's dedication to social justice and human rights, fostering an inclusive and harmonious society free from systemic barriers. To measure FDS's impact, metrics such as women's empowerment, gender equality, disability inclusion, accessibility, racial and ethnic diversity, LGBTQ+ inclusion, and immigrant inclusion can be considered.

Economic Indicators

While **profits** cannot be the sole deciding indicator with which we can see the effects of Fundecooperacion's practices, it cannot simply be ignored. If profits fall too far for the sake of being climate friendly, people will go out of business as their work becomes unsustainable. There are many factors that play varying roles in a business's profitability. It would be difficult to definitively prove changes in profit are a result of FDS and certain sustainable development practices being implemented. However, finding out if there is any correlation between taking the FDS loan and profit is valuable information that can indicate a positive or negative relationship between the two.

Some FDS programs are intended to help reduce the costs associated with operating small farms and businesses. **Cost reductions** can be realized in areas such as utility bills. With the purchase of updated equipment, the small farmer may see a reduction in maintenance costs and downtime. Upgraded and enhanced equipment could also help to increase the productivity of farms[27]. Additionally, using energy and water more efficiently will reduce costs. Examples of this may include implementing enhanced insulation for improved air conditioning and introducing irrigation systems that reduce water waste.

Costa Rica is subject to severe weather events that increase the risk of negative impact to MSMEs in terms of profitability and sustainability. FDS programs support funding improvements for irrigation, the adoption of new green technologies, and planting trees, all of which are directed towards helping to reduce the risk.

These programs can also help increase income during times of low productivity. As a result, when a severe weather event occurs or if yields are lower than normal, the MSME and dependent communities have stored funds available to cover them during these periods of reduced income. FDS conducts these risk analyses through the company Agroclimatica as previously mentioned.

FDS Data Tracking

FDS currently utilizes **Salesforce** and **Excel** to store their data. Salesforce is a cloud-based Customer Relationship Management (CRM) database known for effective data management, tracking, organization, and analysis[28]. It organizes data using objects and records, with objects akin to tables and records resembling rows in a spreadsheet. Fields, stored in columns, encompass data such as revenue or business owner names. The analytics cloud allows users to create insightful dashboards for data visualization.

Salesforce's account feature is crucial, representing the companies or individuals a user engages with. Each account has contacts and lists the individuals associated with that account. This linking of records across multiple accounts facilitates data organization and display, surpassing spreadsheet capabilities[28].

FDS employs Excel for the organization and compilation of their raw data. The technical analysis and credit assessment processes are entirely conducted within the Excel platform. The findings from those processes must be transferred to Salesforce. FDS then transfers their information from Salesforce and Excel to Power BI to produce comprehensive data analytics. Power BI, a business intelligence software specializing in data visualization, offers vigorous tools and dashboards.

Our Project Approach

Our project's main goal was to create a methodology to measure and demonstrate the impact of FDS's credit program on various stakeholders, including MSMEs, farmers, and local communities. Our plan consisted of developing a data collection tool and inputting that data into the existing database, offering quantitative insights into the economic, social, and environmental outcomes of FDS initiatives. The new data FDS will collect with our provided methodology enables them to make informed decisions, track progress, and showcase the positive transformations resulting from their dedicated efforts towards sustainable development in Costa Rica. To reach our goal, we organized our approach into fulfilling three different objectives:

1. Observe and identify what information FDS currently has in their database to establish a baseline
2. Define specific indicators to measure and evaluate the impact of FDS practices
3. Create tracking sheets to accurately display the impact of FDS sustainability practices

Observation of Existing Data

Reviewing Existing Program Data

Most of the FDS' information concerning their sustainability efforts is stored in Salesforce, their current database. Collaborating with the FDS team provided valuable insights into acquiring existing data for achieving the project's ultimate objective. We examined lists of clients, their industry types, and the practices they employed. Additionally, we thoroughly reviewed files supplied by

FDS, including the Agroclimatica risk analysis, client credit reports, and technical analyses. Through observing these data and the accompanying documents, we identified a broader range of indicators. This expanded set of indicators allows for a meaningful comparison with those presented in our literature review.

Database Findings

Once we gained access to their database, we planned to use some of the information our sponsor had collected on their clients' sustainability. However, very little data in their database was quantifiable, making the goal of measuring the impact of sustainable development practices very difficult. The database was structured in such a way that many questions about sustainability had answers like very good, good, bad, very bad, or even just yes or no. The database was structured in such a way that many questions about sustainability had answers like very good, good, bad, very bad, or even just yes or no. This can be seen in *Figure 4*, displaying their technical analysis after we translated it. It contained several questions with multiple-choice or yes/no answers, such as one that asked if the client maintains a bank account to manage project income, to which the recorded answer was a simple "yes".

ance	Weight:	8.8%	Qualification:
Element to evaluate		Weight	Parameter
they affect external economic variables? (exchange rate, imports, FTA)?		15%	No
nts: approximate number of clients		5%	More than 10 clients
pliers: approximate number of suppliers		5%	More than 4 suppliers
es the client master/know the break-even point of the business?		15%	Yeah
at are the payment methods you offer to your clients?		15%	Counted
you maintain a bank account to manage project income?		15%	Yeah
tail of the level of debt (formal and informal) of the business		15%	Between 0% and 10%
counting/Financial Statements		15%	Clear and regular records

Figure 4: *Example of FDS Client* ***Technical Analysis*** *(translated from Spanish)*[29]

Additionally, data was not always uniform across clients, even if they were in the same sector of business. In the data collection process, most questions analysts ask are specific to the individual client and are primarily asked to check up on how clients are doing and maintain good relationships with them. This isn't a bad thing necessarily, but it comes with the consequence of being unable to compare one client to another in terms of the effectiveness of their sustainable practices. To show changes in the sustainability of its clients, the database needs more fields and inputs that can be directly compared across multiple clients.

The most developed, organized, and quantifiable information in FDS's database was found in the credit analysis, risk analysis, and the data from Agroclimatica. The Agroclimatica report is a spreadsheet with data on all clients which includes the humidity and temperature of their locations, their business sector, and most notably their CO2 emissions. The risk analysis is also done by Agroclimatica. This report assesses the risks posed to clients in the realm of climate-related challenges and other areas.

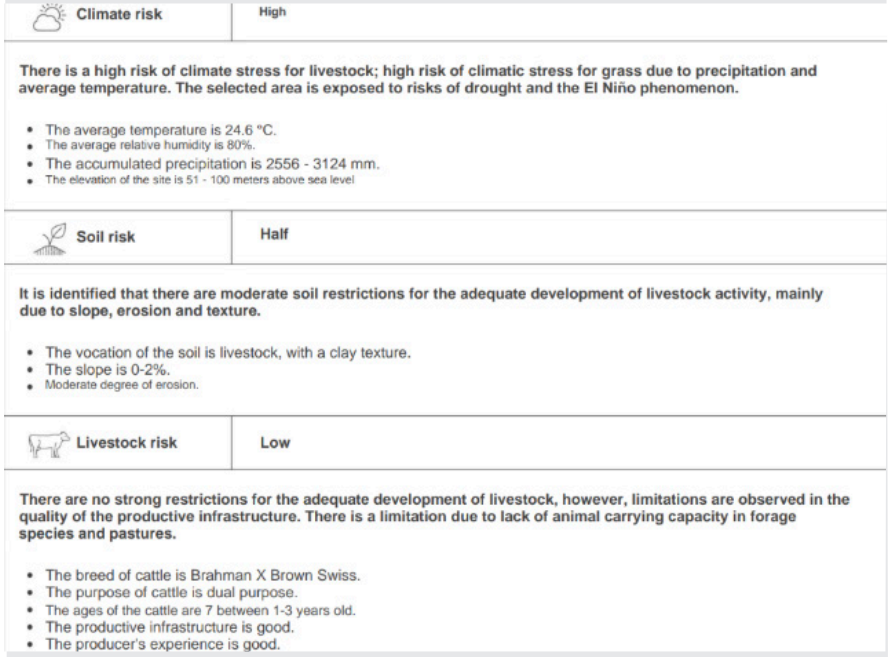


Figure 5*: Agroclimatica* ***Risk Analysis***

In *Figure 5*, the analysis displays information on local weather patterns like heavy rain, high humidity, or droughts in a client's location. Entities such as livestock, soil quality, and specifically how they are affected by the climate are also listed. Additionally, the analysis records the carbon footprint of a client's activity and produces an overall risk score for that client which is used to help FDS decide which practices their clients should implement. *Figure 6* to the right shows a client who had a high risk score of 7.22.

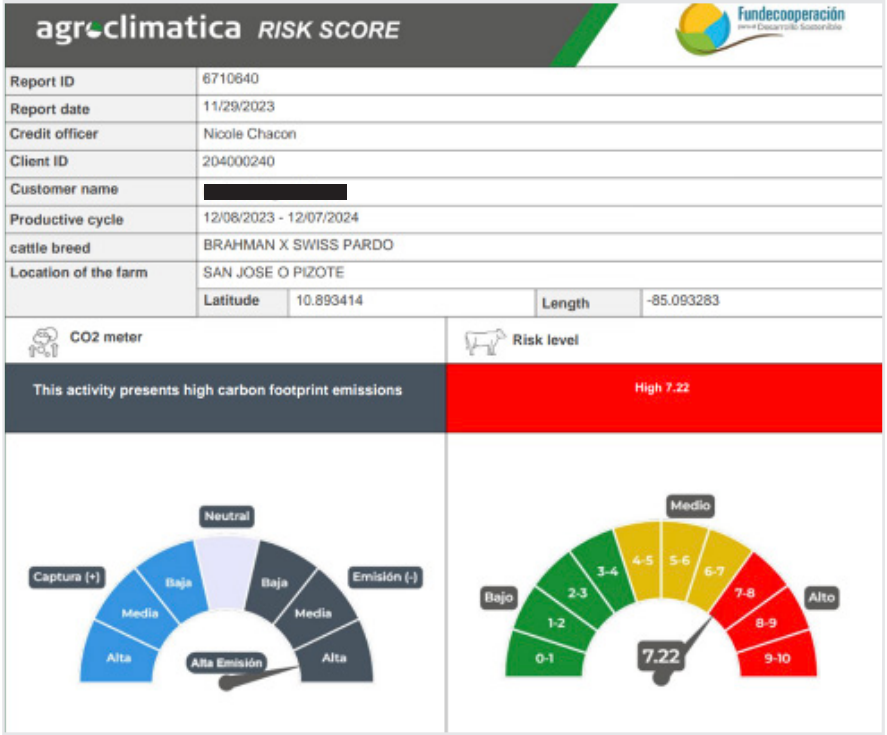


Figure 6**: Agroclimatica **Risk Analysis

Finally, FDS conducts a credit analysis for every client with the primary objective of figuring out how feasible it is for a client to pay back the FDS loan. In this analysis, information such as the client's income statement, assets, credit history, etc. help in describing a client's economic standing. This data is updated regu-larly, however FDS does not track how much of the loan is distributed to each of the implemented practices. For example, they could not tell if all their credit was being allocated to the specific sustainability practices recommended by the loan advisors or if some of the money was used for other purposes.

From our database review, we were able to confirm 4 indicators that could be measured and had the biggest effect on sustainability. Those indicators were CO2 emissions, waste reduction, energy consumption, and water usage. Emissions are currently tracked using Agroclimatica, and energy and water can be generally tracked by any Costa Rican who pays an electricity bill or is connected to city water. Everyone generates waste and there are multiple ways to reuse or track that waste (recycling, composting, etc.).

Defining Specific Indicators

Identifying Metrics

Through a comprehensive literature review, we examined existing reports on environmental, social, and economic sustainability to identify indicators of impact on these three pillars. We conducted a thorough review of the existing FDS programs' metric-related data. This involved examining data and reports presented within their database, analyzing tracked metrics, and identifying any gaps for new data collection. This approach was crucial as FDS possessed a substantial amount of available data that enabled us to address where there was any missing data.

Identifying Indicators

In our specific project with FDS, we recognized the importance of grounding our impact assessment metrics in established literature related to the three pillars of sustainability. Utilizing scholarly articles, reports, and publications specifically pertaining to sustainable development initiatives within the context of small farmers and MSMEs, like FDS's beneficiaries, allowed us to focus on the assessment of these types of programs. Thus, when looking at information FDS currently has it was crucial to keep this in mind when trying to establish a baseline.

Literature Review Outcomes

Upon completing our comprehensive literature review, we pinpointed four concrete indicators that effectively depict the impact of sustainability practices. These measurable indicators include CO2 emissions, water usage, waste reduction, and energy consumption. They offer quantifiable insights into the contributions of FDS clients to their carbon footprint, resource conservation, waste minimization, and energy efficiency. By monitoring these factors, FDS can gauge the effectiveness of suggested practices in addressing risks for their clients and their impact on the environment. This monitoring not only contributes to the overall environmental well-being but also fosters cost savings through heightened efficiency, thereby reinforcing the economic viability of sustainable practices. These indicators will also provide a quantifiable means of assessing the effectiveness of FDS's sustainability initiatives and serve as crucial tools aligning with the economic, social, and environmental pillars of sustainability.

Assessing the Effectiveness

To create an effective tool to identify and measure the impact of FDS's sustainability programs, specific data collection and analysis methods were performed by our team. By conducting interviews and comparing all the presented data, we assessed the feasibility of collecting the desired data from the clients.

Impact Evaluation Interviews

Impact evaluation provides insights into each of Fundecooperación's practices, and assists in decision-making on whether to continue, discontinue, replicate, or increase their involvement [30]. This involved systematically assessing the outcomes of Fundecooperación's intervention. We interviewed three clients with varying relationships with FDS from long-time partners to newcomers who are only just beginning to receive FDS's support. We began by defining the purpose and scope of the specific practice implementations, defining relevant indicators, looking into data collection methods, and formatting specific evaluation questions (seen in Appendix A in the Supplementary Materials file). These questions served to find out how easy and accessible measuring our proposed indicators would be for the clients.

Comparing Data

We conducted three interviews as part of our research methodology, aiming to enhance our understanding of the practical aspects surrounding the measurement of our proposed sustainability indicators. Through these interviews, we searched for insights into the feasibility and accessibility of implementing these indicators from the perspective of potential clients. By comparing the feedback gathered during these interviews with the findings from our previous research and database analysis, we aimed to gain a holistic understanding of the challenges and opportunities associated with measuring and implementing these indicators in real-world scenarios.

FDS and Client Relationships

***Figure** 7: Karla and Her Cow Margarita on her Farm Finca La Providencia*

In the interview with Karla, as shown in *Figure 7*, the owner of Finca La Providencia, the collaboration between Fundecooperación and the farm emerges as a crucial aspect of their operations. Fundecooperación's involvement extends beyond financial support, including technical assistance and guidance aimed at improving the farm's sustainability practices. Karla highlights the importance of this collaboration, emphasizing how it has facilitated the implementation of innovative approaches to dairy production.

One notable area of collaboration between Fundecooperación and Finca La Providencia is in the realm of environmental conservation. Karla discusses how Fundecooperación has supported the farm in implementing strategies to minimize its environmental footprint, such as promoting sustainable land management practices and biodiversity conservation. This partnership underscores Fundecooperación's commitment to fostering environmentally responsible agricultural practices within the region.

Moreover, Fundecooperación's collaboration with Finca La Providencia extends to initiatives aimed at improving community livelihoods. Karla mentions how Fundecooperación has facilitated training programs for local community members, providing them with valuable skills and knowledge related to sustainable agriculture. This emphasis on community engagement reflects Fundecooperación's holistic approach to development, which seeks to empower local stakeholders and foster inclusive growth.

Overall, Fundecooperación's support for Finca La Providencia represents a mutually beneficial partnership aimed at promoting sustainable development within the agricultural sector. By leveraging technical expertise and financial resources, Fundecooperación has been an important operation in supporting the farm's efforts to enhance its sustainability practices and contribute

to the well-being of both the environment and the local community.

Interview Results

In the context of Karla's interview at Finca La Providencia, data collection plays a crucial role in monitoring the farm's sustainability practices and assessing the impact of Fundecooperación's collaboration. Karla mentioned several key indicators that they track, including water usage, waste management, and energy usage. These indicators provide valuable insights into the farm's environmental footprint and its commitment to sustainable practices such as rotational grazing, living fences, and rainwater collection. Additionally, Karla emphasizes their use of biodegradable, natural, chemical-free products for cleaning and cow pest control, prioritizing their commitment to eco-friendly, sustainable practices.

***Figures 8** (left) **& 9** (right)**:** Milking Technology purchased with FDS loan*

Fundecooperación's support has enabled Finca La Providencia to implement various technologies and practices aimed at enhancing sustainability, such as improved milking technologies, as shown in *Figures 8 and 9*, and investments in livestock. These specific milking technologies have permitted Karla to efficiently collect milk while having less negative impact on her cows' health while decreasing the chances for it to become contaminated with bacteria. Karla keeps diligent records of all spendings, and activities related to these initiatives, maintaining written documentation in binders. However, in the aspect of measuring the efficiency of the practices, challenges will be faced in attributing changes in various indicators to specific loans or practices due to the farm's implementation of multiple interventions.

Contrasting with Karla's meticulous record-keeping, the beauty salon owner interviewed does not engage in any data collection or tracking of indicators. The salon, which operates as a home-based business, received funding from Fundecooperación for infrastructure improvements but cannot differentiate between energy or water usage for the salon versus the household. This lack of data collection obstructs the salon's ability to assess its environmental impact or measure the effectiveness of its investments.

Similarly, El Trapiche, a sugar mill enterprise (*Figure 10*), has yet to officially partner with Fundecooperación and does not engage in any data collection practices. Despite operating for twenty years, the mill does not track any indicators related to sustainability or environmental impact. However, the mill's utilization of waste cane material to fuel its operations aligns with sustainable practices, although without formal documentation or measurement.

Figure 10: *El Trapiche Sugar Mill Owned by currently onboarding FDS Clients*

These contrasting examples highlight the importance of in-depth data collection applications in evaluating the effectiveness of sustainability initiatives and financial investments. While Finca La Providencia demonstrates diligent record-keeping and monitoring of key indicators, the beauty salon and El Trapiche emphasize the challenges posed by a lack of data collection structure. Moving forward, efforts to promote sustainable development should prioritize development and support for data collection and monitoring tools to ensure informed decision-making and accountability.

Measurable Practices

To accomplish the goal of measuring the impact of the practices FDS prescribed to its clients, we needed to know exactly what those specific practices were. FDS had a list of all the practices their clients use with their credit program, from tracking fish, to using seed banks, and organic fertilizers just to name a few. After translating all 82 of them, our team individually researched every practice to get an understanding of how they function, how they can be measured, and most importantly how they affected our indicators for sustainability. For example, organic farming is a plant and animal-based farming method to provide the nutrients necessary for crops to grow without chemical fertilizers or pesticides. This results in healthier and more fertile soil but a 25% decrease in crop yield. It also sequesters carbon and allows for a 30% increase in biodiversity when compared to conventional farming[31]. This research allowed us to determine the effects these practices had on our sustainability indicators. The second question we needed to answer was whether these indicators could be measured by FDS or their clients. In this example, we determined biodiversity and carbon emissions to be unrealistic for the clients who use this practice, many of whom are small farmers, to measure. However, any farm can calculate their crop yield, and there are inexpensive soil tests which can determine their health or fertility[32].

For further organization of these practices, we looked at what sector of business FDS's clients fall into. The five major sectors are livestock, agriculture, service, commerce, and industry. The previous organic farming practice was an example of a practice implemented by clients operating in the agricultural sector. Livestock farmers would use practices related to pasture management, improved feed, or aquaculture. Livestock and agriculture make up the bulk of FDS's clients and that is also reflected in where most of the practices are targeted. Industrial sector practices would relate to turning raw materials into consumable goods, so an example of an industrial practice was adopting a seafood traceability program. Ecotourism is a service sector practice that focuses on tourism which supports local business and culture while also being mindful of carbon footprint and energy consumption. In the Commerce sector, waste management and rain harvesting are the prominent practices. It is also important to note some practices can be used across multiple sectors. For example, solar panels for generating electricity and heating water can be used by restaurants in the service sector or stores in the commerce sector. *Figure 11* demonstrates how we organized some of the practices across sectors. The process of organizing these practices by sector and how they affect sustainability was the basis for our method to track and collect data from FDS clients.

Sector	Practices
Livestock	Fog collectors, Forage Pastures, Forage Banks, Pasture Management and Rotational Grazing, Permaculture, Protected Environment for Livestock, Respect for the minimum maturity sizes of species, Silage, Sustainable Forest Management, Trees in Pastures, Aquaculture, Beekeeping
Agriculture	Agricultural Drainage, Agricultural Terraces, Agrosilvopastoral System, Coffee Fertilization Practices, Biodigestors, Conservation Agriculture, Crop Diversification, Crop Rotation
Commerce	Waste management, water harvesting
Industry	Seafood Traceability Program,, Filter Presses, Fire Break Strips, Fishing Methodology Without Hooks, Fishing Only Non-Endangered Species
Service	Ecotourism

***Figure 11**: Example of Practices (not all 82) organized by Sector*

Our team aimed to provide FDS with a tool they can use to measure the impact of their sustainability practices, which means the next step in our project was to devise a method for collecting the necessary information and storing it in their database. This involved researching FDS funded practices to figure out which sustainability indicators are most directly affected by each practice and organizing them in accordance with their effect on the three pillars of sustainability as well as the sector of business in which they were used. When FDS fills out a tracking sheet with information on their client, they will need to store it in their database. This means we also made sure to create a format by which data collected from the tracking sheets could be stored in their Salesforce database. We worked very closely with FDS's analysts and IT personnel to figure out how to best organize the tracking sheets in Salesforce in a manner that remained efficient for analysts to regularly input data.

Comparing Data

We compared the current data supplied by FDS with the data our team collected through our interviews. Once these results were recorded and analyzed, we presented them to Fundecooperación and allowed them to use the findings to inform decision-making, program development, or policy decisions. By involving the stakeholders, our evaluation's validity and relevance will be enhanced.

Tracking Sheets

To effectively track the quantitative data that would indicate the impact of FDS' sustainability practices, our solution was to develop data collection sheets that would serve as the basis for data collection going forward as FDS acquires new clients. The format of the sheets was outlined after conducting interviews with clients and FDS staff, looking at client credit allocation, sample files, the Agroclimatica risk analysis data, and the FDS Salesforce database. In doing so, we identified key points of information that should be considered and noted when trying to track data that will indicate sustainability impact. We found this was the most applicable solution given FDS did not have a regulated method of data collection, as discussed in our database findings section.

We created two data collection sheets. The first, *Figure 12*, is for the initial data intake of a new client, called EcoEval, with information regarding their finances, risk analysis, and our four main indicators: CO2 emissions, Water Usage, Waste Reduction, and Energy Consumption. The second tracking sheet lists the FDS employed sustainability practices and their indicators, which will be measured yearly. This new data collection process is designed to streamline information gathering over time, allowing FDS to observe and note changes consistently during the loan. After advisors fill the sheets with the required information, it will be easily entered into Salesforce with our new profile outline. This approach not only maintains efficiency in visits between advisors and clients, as the questions to be asked are clearly outlined, but also can facilitate meaningful comparisons with data from other clients who share similar characteristics, such as the type of organization, their risk types, or practices, as displayed and accessed from our new Salesforce profiles.

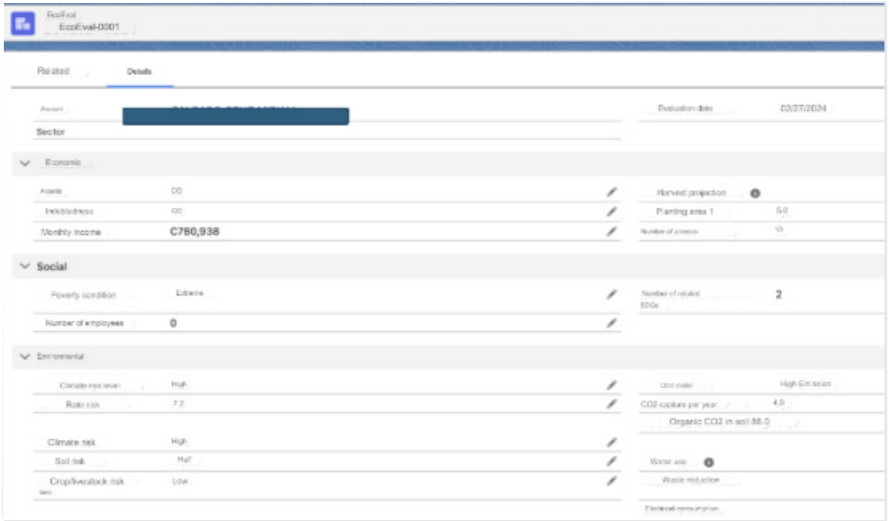


Figure 12: *Example EcoEval Salesforce Profile (Trnslslated)*[29]

Metrics and Indicators

The metrics and indicators were derived from researching the practices and the three pillars of sustainability. Some metrics are used to determine the change in the sustainability indicators of the clients through the EcoEval and others to determine the impact of the practices.

FDS will use the EcoEval, shown in *Figure 12*, to determine the change in the sustainability indicators of the clients. The EcoEval will record their name, industry type, and size of land. Income, assets, and debts will be tracked through information from their bank and the general records they keep. Carbon dioxide emissions and their risk assessment will be done through the company Agroclimatica. The clients keep records of energy and water usage through the utility companies. Water usage is more difficult to track if the client isn't on city water and is getting their water through a reservoir or a well. FDS will also be tracking the clients' waste generation if they maintain records of this information. Animal quantity is another indicator on the EcoEval and is determined by counting the number of animals on a farm. The last thing that will be tracked is their economic standing through a bank, and how it changes over the period of the FDS loan. The EcoEval is broken up into three categories: economic, social, and environmental to go along with the three pillars of sustainability. One issue we have run into is many businesses are run out of the client's home, so they have no way of separating home and business usage of energy, water, and waste.

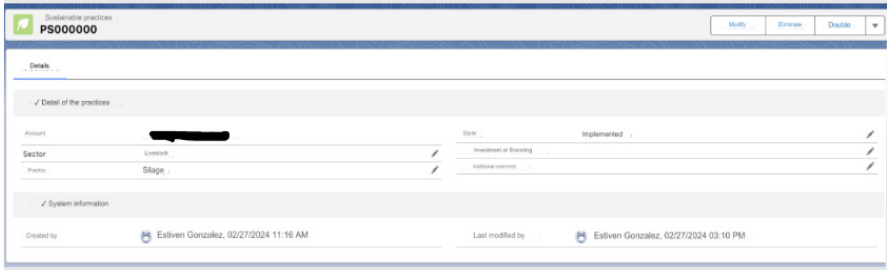


Figure 13*: Salesforce Profile for Practices*[29]

In the second tracking sheet, shown in Figure 13, the indicators identified as relevant to the **sustainability practices** FDS has funded will be tracked. Only the practices FDS helped implement will be looked at. Some of the practices include crop rotation and irrigation systems. The indicators we have selected include crop yield, which is determined by the quantity of crops per acre. Livestock yield involves products produced from, for example, cows or sheep including milk, wool, and meat. Poultry yield tracks eggs produced and meat. Aquaculture yield includes products produced by fish and all farmable aquatic life including fish, shellfish, and caviar. Soil quality can be determined through tests to measure the health and fertility of the soil where the crops are grown. This includes nitrogen, phosphorus, and potassium levels. Erosion and topsoil retention can be determined by measuring the thickness and depth of the topsoil layer. It can also be determined visually.

Pests and disease are important metrics to track as they strongly affect crop yield and crop health. Pests also affect livestock health with mosquitos, ticks, and disease outbreaks that can wipe out entire herds and fields. Pest can be tracked by counting the number of pests present on the crops visually or by using a trap. Disease can be determined by visually looking at symptoms of the crops, such as wilting, discoloration, or the presence of fungal growth. There are also innovative technologies that use digital imaging and remote sensing to determine the health of a crop33. Herd fertility is directly linked to animal health and is determined by how many pregnancies a herd has in a year.

For the purpose of assigning these indicators, we researched how specific practices impact sustainability. In the livestock sector practices like forage pastures and creating silage have indicators such as herd fertility, animal quantity, and livestock yield. We assigned these indicators because both practices involve improvements to what animals eat, allowing for clients to have more animals, that have more meat or milk, and have enough nutrition to remain fertile. For agriculture, practices like crop rotation and organic farming have the following indicators: crop yield, soil health, soil fertility, and water usage. These practices are focused on making changes in the structure and treatment of soil and its contents, which have a range of effects from making it easier for water to travel in soil to decreasing crop yield as compared to traditional farming. These changes in soil also affect its health and fertility. Adopting a seafood traceability program is a practice used in the fishing industry and its impact is seen with fish yield and diseases. Tracking fish from the ocean through the supply chain will allow businesses to make sure they aren't losing fish and that they're being handled properly during the process.

Ecotourism is used in the service sector which focuses on supporting local business and culture while being mindful of energy consumption and carbon footprint, hence we selected CO2 emissions and energy consumption to be indicative of the practice's effectiveness. Finally in the commerce sector, waste management is indicated by waste reduction, water usage, and CO2 emissions. Depending on how waste is recycled or disposed of water could be used, emissions may increase if trash is burned.

An observation we made which would prove very useful in the future was that when we separated practices into the five sectors, practices within the same sectors shared many of the same indicators. In livestock, we found that some combinations of livestock yield, poultry yield, animal quantity, aquacultural yield, and herd fertility were indicative of multiple practices. For example, creating silage shares the same indicators with forage pastures. Similarly, forage pastures and silage practices in the agricultural sector shared the same indicators of crop yield, soil fertility and health, and water usage. The agricultural sector also included topsoil retention and crop diversity, while some indicators were useful across multiple sectors like water usage. With the focus of FDS's practices on these two sectors, there were few indicators exclusive to industrial, commerce, and service sectors.

It was a challenge to determine the changes caused by the practices with no outside factors affecting the indicators which could have been affected by unusual weather or a compounding effect from multiple practices. Another issue was that a lot of the credit allocated was linked to infrastructure and didn't have any effect on sustainability like improvements and the acquisition of equipment or the repair and creation of new buildings.

Implementation

Fundecooperación will be directly inputting the informat-

-ion collected from the clients on the indicators into Salesforce. The tracking sheets for EcoEval and the practices will be linked to the accounts as objects. Inside of the objects representing practices, a new object was created for tracking the indicators. We originally organized practices by sector to create an overlap in the indicators to help facilitate analysis and to filter out the indicators that are not related. However, during the implementation process we realized it would be very tedious to have analysts filter through over 80 practices to get indicators they need. We made a slight alteration in which we instead grouped indicators into the five sectors using the common indicators for practices implemented in the same sectors. These sectors include livestock, agriculture, commerce, service, and industry. Inside the EcoEval object, the indicators and the metrics used to measure them are recorded in fields. This time we separated the fields into social, economic, and environmental indicators as seen in *Figure 12* (Social Economica, and Ambiental in Spanish).

Analysis will be done over the payback period of the credit, with new tracking sheets for the EcoEval and the practices being created annually. Two new dashboards will be created for each client to visually show how the indicators change over time. The sample dashboard in *Figure 14* shows tables, bars, and line graphs demonstrating changes over time in indicators such as assets, debt, water usage, climate risk, electrical consumption, and more. There will be separate dashboards to display the data from the EcoEval and the data from the practices, with the general format being the same.

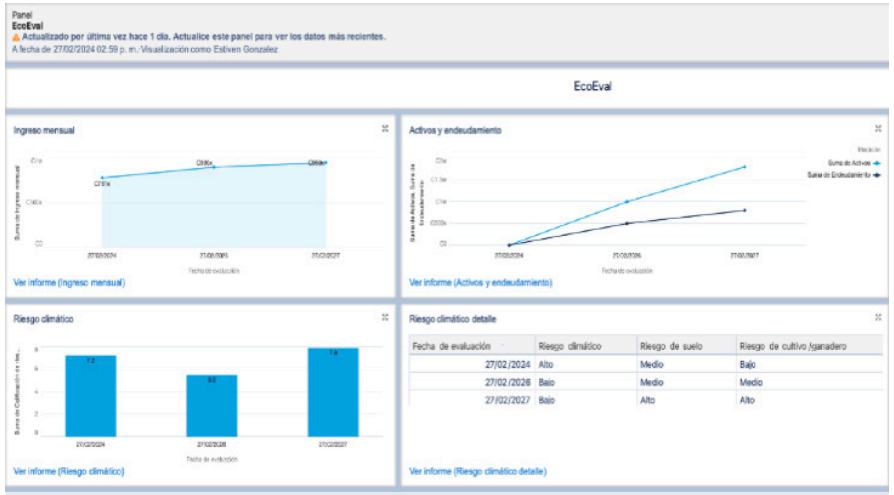


***Figure 14**: EcoEval Dashboard*[29]

Conclusion

Over the course of this project, our team conducted extensive research on FDS, climate changes effects on Costa Rica, FDS, and how the Salesforce database works. We identified all the information FDS had in their database relevant to the project. Then we researched all of FDS's practices to understand how they impact sustainability and how to measure that impact. We went on to create meticulously organized data FDS collection sheets and formatted them into FDS's database. This would permit FDS to effortlessly navigate through the statistics reflecting the impact of their initiatives. They will also be able to efficiently enter the data into the Salesforce client profile given the required information has become streamlined across all five sectors. With a well-organized data collection sheet, we provide FDS with an improved data collection method enabling them to better assess the impact of their sustainability practices.

Recommendations

After creating the tracking sheets, we recognized areas for further development and analysis of the data collected using these methods.

We recommend that after FDS collects enough profiles' required information, they conduct analyses using various Salesforce tools. As presented in the example EcoEval dashboard, FDS will be able to visualize the data and track trends in the displays. In doing so they will be able to make informed decisions on whether practices are effective or if they should add more practices to reduce a client's risk or improve their level of sustainability. Additionally, they can compare the data from multiple clients in similar sectors who are utilizing similar practices.

To continue tracking CO2 emissions and to identify any new risks associated with clients, we would advise FDS to run Agroclimatica risk analyses on a yearly basis so they can keep collecting this data crucial to identifying the impact of their practices.

Educating their clients on the importance of employing these sustainability practices and what sustainability is in general would tremendously aid in their impact on the community given the lack of knowledge presented by some of the interviewees. In turn, FDS would minimize future risks posed to clients and would further ensure FDS stays compliant with a long-term commitment to acting responsibly in the realm of sustainability.

Acknowledgements

Our sincere appreciation goes to our generous sponsor Estiven González Jiménez from the Fundecooperación team. His unwavering support and insightful guidance were instrumental in realizing the success of our project, adding immense value to our experience in Costa Rica. Working closely with the Fundecooperación team was a true pleasure, and we extend our best wishes for their continued success, including their endeavors with further advancing their sustainability practices and Salesforce database.

A special thank you to Fundecooperación for graciously providing us with a collaborative office space and embracing our team into their dynamic community. Finally, we express our profound gratitude to our esteemed advisors, Professors Holly Ault and James Chiarelli, for their invaluable counsel, expert perspectives, and unwavering encouragement throughout the past five months. Their mentorship has been pivotal in shaping our journey.

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