A Sustainable Agrifinance Solution?

Lending to reward environmental performance

Authors

Grace Brofman | Janelle Christensen | Haley Grant | Rebecca Reynolds | Alexandria Wilkins

Faculty Advisor

Kelsey Jack, PhD

March 2021

BREN SCHOOL UC SANTA BARBARA

Sustainable Conservation

This Group Project Report was submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management.

March 2021
Project Title: *A Sustainable Agrifinance Solution?*
Project Subtitle: Lending to reward environmental performance

As authors of this Group Project report, we archive this report on the Bren School's website such that the results of our research are available for all to read. Our signatures on the document signify our joint responsibility to fulfill the archiving standard set by the Bren School of Environmental Science & Management.

Grace Brofman

Haley Grant

Janelle Christensen

Rebecca Reynolds

Alexandria Wilkins

The Bren School of Environmental Science & Management produces professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a year-long activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Report is authored by MESM students and has been reviewed and approved by:

Kelsey Jack, PhD

Date

Acknowledgements

We would like to recognize the following individuals for their invaluable insight, encouragement, advice, and support over the course of this project. They have our deepest gratitude and appreciation.

Faculty Advisor
Kelsey Jack, PhD

Client
Sustainable Conservation
Kelli McCune, Conservation Incentives Project Director

External Faculty Advisor
Scott Jasechko, PhD

External Advisors
Emily Gardner, Deputy General Manager
Jessica Nesbitt, Commercial Credit Underwriter

Agrifinance Advisory Committee
Alex Echols, Agriculture Program Director
Brett Melone, Director of Lending
Nathan Weller, Director of Development and Impact
Massey Bambara, Retired
Jessica Nesbitt, Commercial Credit Underwriter

Special Thanks to
Heather Hodges, PhD
Jessica Rudnick, PhD
Tamara Voss, Associate Hydrologist

Title Page Photo Credit: Grace Brofman - *lettuce from Pescadero*

Abstract

California's agriculture industry both contributes to and is threatened by decreasing water quantity and quality. In the face of mounting industry and environmental compliance costs, agricultural lending firms may play a role in supporting, expediting, and simplifying farmers' ability to improve their environmental performance in compliance with California water policies, however, information regarding how agricultural lenders incorporate natural resource issues into their risk assessments is limited. The objectives of this project are to a) understand how the agrifinance industry accounts for environmental risk, and identify unrealized opportunities for improvement, and b) determine the most profitable loan-incentive product(s) for both borrowers and lenders.

In pursuing these objectives, we contribute to existing knowledge regarding lender incorporation of environmental-based risk considerations in the risk assessment process. Industry interviews coupled with an online questionnaire provide opportunity for both qualitative and quantitative assessment of the agrifinance industry's stance on environmental risk, and evaluation of the industry's readiness and willingness to consider loan products that incorporate environmental performance metrics. A financial model incorporating loan-incentive combinations allows for the analysis of both borrower and lender benefits under varied parameters. Ultimately, a range of potential impacts to groundwater quantity and quality of the Salinas Valley are estimated.

Table of Contents

List of Figures

List of Tables

Chapter 1: Significance and Objectives

Climate change combined with resource-intensive agricultural practices increases the production risk of farmers. Farmers tend to rely heavily on external credit to finance their operations; their production risk is thus shared with lenders, potentially lowering farmers' own incentives to minimize risk. Certain behavior changes targeting natural resource resilience, including responsible water and nitrogen management, may help lower risk. However, the low adoption rates of these practices indicates a disconnect between known risk-reducing benefits and their reflection in agricultural lenders' risk analyses and subsequent translation, or lack thereof, into loan offerings (Monast 2020).

California's Salinas Valley offers an opportunity to explore the potential for broad-scale implementation of loan programs designed specifically to encourage farmer-borrowers to conserve natural resources through optimized water and nitrogen management, reducing both farmer-borrower and lender risk, as well as supporting the sustainability of the region's severely depleted water resources. In 2018, our client Sustainable Conservation partnered with California FarmLink and the Resource Conservation District of Santa Cruz County to offer a new financial incentive program in the Salinas Valley. The pilot program sought "to promote adoption of performance-based metrics and monitoring of water and nutrient management on farms, with the goal of advancing water conservation and water quality protection, while supporting farmers". The uptake of this pilot has shown that Salinas Valley farmers are interested in these types of programs. Additionally, these types of programs have often been more easily accessible by wealthier, whiter farmers, and this pilot program is particularly important in the Salinas Valley (USGAO - Agricultural Lending 2019).

With this in mind, our project aims to answer the following questions:

1. What is the agrifinance industry's attitude toward loan products that encourage natural resource management?
2. How can these loan products be designed to meet the needs of both farmers and lenders?

This project has two main objectives which arise from our two research questions.

1. Understand how the agrifinance industry accounts for environmental risk, and identify unrealized opportunities for improvement.
2. Determine the most profitable loan-incentive product(s) for both borrowers and lenders.

In pursuing these objectives, we contribute to existing knowledge on the agrifinance industry's incorporation of environmental-based risk considerations in their business decisions and loan offerings. Industry interviews coupled with an online questionnaire provide opportunity for both qualitative and quantitative assessment of the agrifinance industry's stance on environmental risk, and evaluation of the industry's readiness and willingness to consider loan products which incorporate environmental performance. A financial model allows for the analysis of both farmer-borrower and lender benefits under varied parameters. Ultimately, a range of potential impacts to the groundwater quantity and quality of the Salinas Valley are estimated.

Our client, Sustainable Conservation, will use our findings to better understand the feasibility of scaling up environmental incentive-based lending programs. Should they decide to move forward, our findings can serve to inform our client's approach to designing these programs. Additionally, the results of our financial analysis of loan-incentive product combinations will provide support when communicating with agrifinance industry representatives in the future.

Chapter 2: Background

In this chapter we discuss the background of the problem this project investigates. This extensive background chapter showcases the interdisciplinary nature of this problem, and was written to provide an understanding of agriculture, policy, and water resources in the Salinas Valley as well as agrifinance practices related to environmental risk and future opportunities.

Our discussion begins with a brief overview of the economic contributions of agriculture in the Salinas Valley, and the challenges that farmers face in California. This leads us to the social and environmental impacts of regulations on water quantity and quality that may affect agriculture statewide, and specifically the Salinas Valley. Because policy and regulation can burden a limited group with the costs of compliance, we move on to a review of ways that agricultural water users in the Salinas Valley or Central Coast of California can reduce their consumptive water use. This section of our background focuses on methods such as land fallowing, crop change, and efficiency.

We then transition from agricultural practices and environmental regulation to a discussion of the agrifinance industry and its relationships with risk. While our project focuses on the agrifinance industry's practices concerning environmental risk, our discussion begins with a comparison of basic agricultural risk management and the risk management practices of financial institutions. Finally, our background concludes with an overview of current research on the potential role that the agrifinance industry can play in promoting on-farm conservation actions. A brief look at a pilot program that demonstrates this potential closes the chapter.

2.1 Agriculture in the Salinas Valley

Contributions to the Economy

California's agricultural sector is a major contributor to the state's economy, representing close to 3 percent of the state's GDP ("CDFA - California Agricultural Production Statistics" 2020). The Salinas Valley, known as "The Salad Bowl of the World," contributes over 50 percent of the nation's lettuce, 48 percent of its broccoli, and 28 percent of its strawberries ("Monterey County Farm Bureau - Economic Contributions" n.d.). Salinas Valley agriculture is invaluable to the local economy, as nearly 1 in 5 households in Monterey County are reliant on income related to agriculture ("Monterey County Farm Bureau - Facts, Figures & FAQs" n.d.). Due to these local and national benefits, Salinas Valley agriculture is valuable to California's economy and local and global food supplies.

Financial Challenges Faced by Farmers

Recognizing the most pressing financial challenges farmers face is crucial to this project. Specifically, the cost of land ownership in addition to acquired debt comprise a major source of farmers' financial challenges. At $10,000 per acre, California farmland is ranked as the 5th most expensive type of land in the United States. Few farmers are able to invest in the high upfront costs required to own land, leading to more farmland being rented than owned ("USDA - NASS -Land Values: Farm Real Estate Value by State, US" 2020). Land owners determine how a property is used, an important consideration for implementing long-term conservation practices. There is also a large disparity in farm size within the state. In California, "the largest 5 percent of properties account for 50.6 percent of California cropland, while the smallest 84 percent of properties account for 25 percent of cropland" (Macaulay & Butsic 2017).

Another major difficulty farmers face is debt. Farmers borrow funds to operate on and purchase agricultural land on the basis that the future harvest will provide income to cover the debts. While farms rely on credit, taking out many loans means paying more interest (Monast 2018). For this reason, increasing debt can be problematic. According to the USDA's Economic Research Service, "farm real estate debt is expected to reach $287.4 billion in 2021" and non-real estate debt is expected to be $154.3 billion in 2021 ("USDA ERS - Assets, Debt and Wealth" 2021). As of 2019, farm debt in the United States had reached $416 billion. At this time, more than half of all farmers had lost money every year since 2013, and lost more than $1,644 in 2019. Some farmers struggle from losing as much as $30,000 per month (Semuels 2019). As environmental policy is implemented, more regulatory and compliance costs are likely to increase this debt. We will discuss two such environmental policies in the next section: the Sustainable Groundwater Management Act and the Irrigated Lands Regulatory Program.

2.2 Water quantity and quality-focused regulations

Continued groundwater pumping and nitrogen fertilizer application have led to serious overdraft and water quality issues, putting local populations and the regional economy at risk of losing an essential resource. The Sustainable Groundwater Management Act (SGMA) and the Integrated Lands Regulatory Program (ILRP) are two policies which address these issues in the Salinas Valley and across the state. These policies also have cost implications for farmers. For example, a 2018 case study found that the compliance costs to one lettuce grower in the Salinas Valley increased 331 percent from 2006 to 2017 under the Irrigated Lands Regulatory Program and other regulatory programs (Hamilton and McCullough 2018). At the time of this study, SGMA-related fees have not been implemented, but when they are, regulatory fees will increase even further. As the dominant water regulatory programs in the region, ILRP and SGMA are each outlined below.

Irrigated Lands Regulatory Program

California's Irrigated Lands Regulatory Program (ILRP) was implemented in 2003. The original intent of the ILRP was to prevent degraded surface water quality as a result of agricultural runoff, which can transport nitrates, pesticides, salts, heavy metals, and pathogens to water sources. Groundwater-specific regulations were added to the program in 2012 (CVRWQCB 2021). The ILRP sets Waste Discharge Requirements (WDRs), which address reporting, data collection, treatment, and disposal of agricultural runoff (SWRCB 2021). WDRs are region-specific. There are several fees associated with the ILRP, usually on the order of several thousands of dollars, which growers must pay each year to remain compliant (SWRCB and RWQCB 2020).

Sustainable Groundwater Management Act (SGMA)

In 2014, the Sustainable Groundwater Management Act (SGMA) was signed into law, mandating the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (CA DWR n.d.). The mandate outlines six total undesirable results, including: chronic lowering of groundwater levels, groundwater-storage reductions, water quality degradation, seawater intrusion, land subsidence, and surface water depletion (USGS CA Water Science Center n.d.). In effect, SGMA creates a framework for groundwater management at the local level in an effort to end groundwater overdraft and halt other undesirable impacts by 2040.

Under SGMA, California is divided into hydrologic basins, which are further divided into different subbasins. Groundwater Sustainability Agencies (GSAs) manage these subbasins. While the Salinas Valley covers several subbasins, this project focuses specifically on the 180/400-Foot Aquifer Subbasin. Although it is unclear how responsibility for basin-wide compliance will be administered, it is evident that significant cutbacks need to be made. Historically, the average annual loss in groundwater storage in the 180/400-Foot Aquifer Subbasin is between approximately 11,700 to 12,600 acre-feet per year (SVBGSA 2020). In comparison, current groundwater budget calculations estimate an annual loss in groundwater storage of approximately 65,800 acre-feet per year. Efforts to decrease groundwater consumption will fall heavily on the agricultural sector as the largest consumer of groundwater resources in the basin (SVBGSA 2020).

Because of the pressure on agricultural producers to lower water use, there are a number of ways that SGMA may increase costs to farmers or decrease farmer profit. One way is by raising the cost of water. Increased cost drives down demand, forcing small farmers with limited budgets to change behavior before large farms who have the ability to spend more on water. SGMA can also mandate cutbacks via water allocations, resulting in less access to water and leading farmers to grow fewer crops, subsequently decreasing farmer profit. These impacts would disproportionately affect lower income farmers. If farmers are unable to afford necessary changes or cutbacks, many acres of land may fall out of production - up to one million acres in the San Joaquin Valley alone, according to one estimate (AQUAOSO 2020).

Negative externalities: Social and environmental impacts

The Salinas Valley is almost fully reliant on groundwater, and agricultural irrigation is one of the top users of groundwater, with 91.2 percent of groundwater resources going towards crop production in 2018 (MCWRA 2019). Consequently, agricultural production is one of the largest contributors to groundwater overdraft (Department of Water Resources Natural Resource Agency 2015). A report from UC Davis's Center for Watershed Sciences showed that over-application of synthetic fertilizers to crops has caused nitrate pollution of groundwater. In the Salinas Valley, farmers' fertilizer applications are attributed as the source of more than 75 percent of the nitrogen loading to the underlying aquifers (Harter and Lund 2012). On top of these stressors, climate change will likely alter precipitation patterns in California, resulting in more frequent and intense droughts (O'Daly et al. 2018). More drought will increase farmers' reliance on already overdrafted groundwater supplies, putting the nation's food supply and economy at risk.

2.3 Water Use Reductions

Policies such as ILRP and SGMA place added financial burden onto growers, many of whom are already operating on very thin margins. At the same time, legislation such as SGMA would not be able to reach its goal of statewide basin sustainability by 2040 without the participation of the agricultural sector, the largest consumer of the state's groundwater resources (Niles and Wagner 2017). Although it has yet to be determined how overdraft will be brought under control in the Salinas Valley, as is also the case in many basins state-wide, it is apparent that agricultural water users will be most heavily impacted by efforts to reach groundwater sustainability. By way of increased water prices, mandated cutbacks, or other mechanisms, many farmers will need to reduce on-farm water use. In this section we describe mechanisms that can achieve water use reductions, including: land fallowing, crop switching, adoption of new technologies, and increased water use efficiency.

Land fallowing and crop change

Some interventions, such as fallowing land and changing crops, are less desirable for reducing water use because they may have greater economic impacts on farmers. They are mentioned here because the cost of SGMA will inevitably force some farmers to choose these options.

Increasing water restrictions will ultimately require significant land fallowing in California's agricultural centers. Fallowing will be the best economic choice for some farmers, especially when part of a funded fallowing program which compensates farmers for taking land out of production. For example, in 2011, the USDA paid approximately $3 million to 2,327 farms that left their land fallow since 2006 (Markay 2012). These programs are often capable of paying farmers significantly more than they might otherwise make from growing crops. Such programs, however, may benefit only landowners as opposed to those who rent (James 2016).

Alternatively, growers may choose to reduce consumptive demand of water through crop switching, which occurs when a farmer transitions from a water-intensive crop to a more water-efficient crop that uses less water per acre. It can also refer to when a farmer shifts to a crop with equal water demand but which generates greater profit per unit of water., In this case the farmer meets required water reductions in other ways, such as through land fallowing or cover crops. Another mechanism farmers use with crop switching is deficit irrigation, or the deliberate under-application of water below a crop's water requirement (Cohen, Christian-Smith, and Berggren 2013). In the Salinas Valley, many growers are transitioning from high water use crops to wine grapes, which have proven responsive to deficit irrigation and generate more profit per unit of water (Prichard 2003). Crop switching can be challenging because it can take years of education and investment to switch crops. Wine grapes can take several years to establish, and the first harvest's wine may need to mature for two more years before the farmer can profit (Apallas 2016). This strategy could present a barrier too high for farmers to overcome, ultimately putting them out of business.

Increased efficiency

Increased water use efficiency encompasses a range of strategies. Efficiency improvements can be achieved through technology change, improved irrigation scheduling, and pressure change. As romaine and strawberries are two of the highest-acreage crops in the Salinas Valley, focusing specifically on efficiency improvements for these two crops can have a substantial impact on the Valley's overall water use.

Technology change for farmers who are using less water-efficient technologies can have large impacts. Farmers in the Salinas Valley typically use either sprinkler or drip irrigation. On average, sprinkler irrigation is about 78 percent efficient, whereas drip is 89 percent efficient (Cohen, Christian-Smith, and Berggren 2013). While most farmers in the Salinas valley have already switched to drip irrigation, ensuring that all farmers use drip irrigation where appropriate is one way to reduce water use throughout the valley.

For farmers who have switched to drip irrigation, many are still not as efficient as they could be. Some farmers use the incorrect pressure in drip lines as a result of poor water pressure management. Drip tapes are operated at low pressures, between 8-12 psi, meaning that even the slightest change in pressure can reduce the uniformity of water application When this happens, certain plants can be overwatered and others underwatered, reducing overall efficiency. The solution to this problem is simply training irrigators to more closely monitor and calibrate the pressure gauges on their drip systems (Hartz, Cahn, and Smith 2017).

Irrigation scheduling also has an impact on efficiency. Irrigation scheduling determines when and how much water is applied to a crop. Scheduling can be utilized to maximize irrigation efficiency by applying the exact water needed to achieve ideal soil moisture, minimizing runoff and evaporation. Optimal irrigation scheduling can also reduce energy costs, as water which may have previously been wasted is no longer being pumped (Evans, Sneed, and Cassel 1996). As 72 percent of crops in Monterey County already utilize drip irrigation (Monterey CFB n.d.), optimized irrigation scheduling is another way to achieve increased water use efficiency.

Likelihood of adoption

Farmers cite economic resources as the largest barrier to adopting sustainable practices (Drost et al. 1996). Studies on sustainable farming show that there are long term economic benefits for farmers, including reducing input costs, decreasing risk, boosting fertility, and promoting drought resilience, but switching is costly (Carlise et al. 2019). One reason switching to sustainable farming is expensive relates to the timeframe of benefits. Due to economic and policy barriers, farming has become incredibly unprofitable. According to the

USDA, in 2019 the mean farming profit was negative, and in 2020 it was a meager $1,187, meaning that any amount of money needed to switch to more sustainable practices is likely too much ("USDA ERS - Farm Household Income Forecast" 2021). Incorporating increased lender collaboration through financial incentives may be one avenue by which to decrease the economic burden on farmers and support California's agricultural economy.

2.4 Agriculture & Risk Management

On one side of the agrifinance process are the farmers who manage their operations to mitigate risks and maximize production yields. According to a report written by the USDA's Extension Risk Management Education and Risk Management Agency, the risks associated with agricultural production stem from five major sources: production, marketing, financial, legal, and human. A risk can be defined as "the chance of loss or an unfavorable outcome associated with an action." For farmers, risk management involves "optimizing expected returns subject to the risks involved and risk tolerance." Management of a farm depends on the consideration of risk-return tradeoffs, where the "preferred and optimal choice" is a balance between profit potential and the risk of loss (Crane et al. 2013). Our project focuses on the connection between natural resource management decisions made at the farm level and the subsequent risk to the agrifinance industry. If the agrifinance industry is unaware of natural resource risk to the farmer, which may be exacerbated by on-farm management practices and decisions, they cannot effectively manage the risk to their financial institution from agricultural business. For example, the overdraft of groundwater in the Salinas Valley limits future use of prime agricultural land, which may lead to a downturn in the agricultural economy and rising default rates. The following section focuses on common agricultural production and financial risk management practices.

Production Risk

Defined by Crane et al., agricultural production risk is "any production related activity or event that has a range of possible outcomes." Some major sources of production risk are weather, climate change, disease, and quality of inputs such as water or fertilizer. Farmers can control or minimize this risk through (1) management practices, (2) reducing production variability, and (3) transferring risk elsewhere (2013). Important management practices used to control and minimize risks are basic control and feedback strategies like chemical and fertilizer use, irrigation, timely operations, and preventative maintenance. Farmers also use strategies such as diversification, integration, and the application of improved technologies to reduce the variability of agricultural production.

The adoption of these strategies depend on market opportunities and the operation's available assets. Farmers can diversify their operations by growing different plant types or different combinations of crops and services, and integration may provide farmers the opportunity to specialize their products and enter additional markets. While improved technology does manage risks, it can only do so when the application of the technology lowers the business's total risk. The transfer of risk to someone else in the form of insurance is another common strategy for farm businesses to minimize their risk (Crane et al. 2013). There are many different types of insurance that an agricultural business can choose from based on their unique needs (Kime et al. 2019).

Financial Risk

Here, we discuss financial risk management for a farm business. Any connections to the agrifinance industry will be tied in towards the end of this discussion. From Crane et al. (2013), financial risk encompasses “any risk that threatens the financial health of the business.” This is a broad definition of risk which seems capable of including every action occurring on a farm. However, components of financial risk focus more on the cost and availability of capital, the ability to meet cash flow needs, the ability to maintain and grow equity, and the ability to absorb short-term financial shocks.

Financial ratios identified by the Farm Financial Standards Council (FFSC) provide a uniform way of conducting agricultural financial analyses. To assess a farm businesses financial risk, the ratios provide financial measures for liquidity, solvency, profitability and repayment capacity. When farmers pursue agricultural loans, they should be aware that the cost of debt creates an additional risk, interest rate risk. Interest rate risk can be managed by securing “favorable interest rates compared to market rates at any point in time” (Crane et al. 2013). Like most other borrowers, farmers prefer loans with the lowest interest rates that are available to them. These favorable interest rates' often depend on excellent financial ratios and the use of other risk management strategies that decrease the lender’s exposure to risk. Following this is a discussion of risk management practices used by the agrifinance industry.

2.5 Agrifinance Risk Management Practices

Agricultural finance, or agrifinance, encompasses the sector of financial services that serve agricultural production, processing, and marketing enterprises(“Agricultural Lending: A How-To Guide” 2015). When it comes to risk, the agrifinance industry is primarily concerned with the risks associated with production and yield, price and markets, and government policy change (Bankakademie Micro Banking Competence Centre 2010a). Financial institutions (FI) must acknowledge the full range of activities involved in getting produce to consumers as a part of providing useful services to their current and potential customers (“Agricultural Lending: A How-To Guide” 2015). Therefore, agrifinance products must be built on a solid foundation of agricultural and agribusiness knowledge to effectively serve their customer base of farmers as well as processors and other stakeholders in the agricultural industry (Bankakademie Micro Banking Competence Centre 2010b; “Agricultural Lending: A How-To Guide” 2015). This solid foundation starts off with understanding the farmers’ need for operating funds at the start of the growing season.

Referred to as farm debt, these are funds that farmers borrow to purchase fertilizer, water, crop seeds, labor, equipment, and land. Historically, farmers would borrow on the credit of their future harvest. Things are much the same today. Farmers borrow funds to operate on and purchase agricultural land on the basis that the future harvest will provide income to cover the debts. The agrifinance industry includes a limited range of actors who lend to farms. These actors are Farm Credit, Farmer Mac, commercial banks and Community Development Financial Institutions (CDFIs)[1]. The Farm Credit System (FCS) and commercial banks manage the majority of farm debt in the United States. FCS is the largest holder of real estate debt while commercial banks lead in non-real estate debt holdings (Market Intel 2019). Before we discuss how agrifinance institutions manage their risks, we will discuss the basics of loan products.

Financial institutions create their product offerings from the two basic types of loans: lines of credit and installment loans (Small Business Administration 2009). A line of credit describes when funds are released by the financial institution (FI) as needed up to a predetermined limit and within a specified time period (Small Business Administration 2009). In agrifinance, an annual operating loan is considered a line of credit. Farmer-borrowers use annual operating lines of credit to purchase crop seed, fertilizer, labor, or other operational expenses that occur before or during the growing season.

On the other hand, an installment loan is repaid in equal amounts during a “specified repayment period” on an initial lump sum at the start of the loan period (Small Business Administration 2009). The term of these loans can vary. A short-term loan is repaid within less than a year, and a long-term loan is repaid on a longer timeframe (Small Business Administration 2009). In agrifinance, these installment loans are used for equipment or land purchases and have terms that range from 1-30 years. Real estate loans are typically longer-term at 20-30 years, while equipment loan terms could range from 1-5 years, or longer, depending on the equipment purchased. Before a loan is approved, the borrower is provided with a loan agreement, or contract, that outlines the responsibilities of all signatory parties. Loan agreements often include covenants as “the provisions that set the responsibilities of the borrower within the loan agreement” (Small Business Administration 2009). Covenants can be positive, as actions that the borrower must agree to, or negative, as “restrictions placed on the borrower by the lender;” a combination of both positive and negative covenants is often used, and borrowers must agree to the covenants as a condition of accepting a loan (Small Business Administration 2009). Within agrifinance loan agreements, lenders cannot include covenants that recommend or require specific farming practices. This protects lenders from liability risks. The loan agreement is just one method the financial institution employs to address their risk level. Next, we will consider a few additional ways.

Like the farmer-borrowers they serve, agrifinance institutions often operate on narrow profit margins with mostly fixed costs. To stay in business they depend on mobilizing, lending, and recovering funds while “charging sufficient interest to cover the costs” of providing the loan service and maintaining the business (Bankakademie Micro Banking Competence Centre 2010c). Financial institutions carefully work to assure loan repayment from borrowers. Collateral, the “backup source of repayment for the loan,” is collected when a borrower defaults, or is unable to pay back the entire loan (Bankakademie Micro Banking Competence Centre 2010c, 2010a). Because there are risks associated with the collection

[1]CDFIs are “private financial institutions that are 100% dedicated to delivering responsible, affordable lending to help low-income, low-wealth, and other disadvantaged people and communities join the economic mainstream” (“What Is a CDFI?” 2013).

of collateral, a financial institution may focus their risk management strategy on serving clients who are least likely to default on a loan. Institutional measures to reduce the risk of default begin with an initial screening of potential clients' through the loan application, and continues with the loan eligibility, appraisal, and analysis processes (Bankakademie Micro Banking Competence Centre 2010d). A major part of this process is the loan analysis, which evaluates the feasibility of offering a loan to a specific individual.

As a part of the loan analysis, financial institutions look at the borrower's character, capacity, capital, collateral, and conditions (Bankakademie Micro Banking Competence Centre 2010d). This involves an in-depth look at the borrower's cash flow, business and management plans, past yields, and other information. Risks of most concern to agricultural lenders involve yield production, market prices, and government policy change (Bankakademie Micro Banking Competence Centre 2010a). All of these risks are at play in California, and more specifically the Central Coast, with increasing climatic change and the impending implementation of new policies, such as SGMA, and updates to the regional ILRP. The risk exposure of the agrifinance industry could be reduced through actions taken by farmer-borrowers to conserve natural resources which simultaneously reduce their own risk.

2.6 Agrifinance In Conservation

Banking, financing, and insurance institutions have become more aware of the economic risks their agricultural clients face regarding water-related issues. According to the World Economic Forum (WEF), water has been among the top ten risks to our global economy for five consecutive years (World Economic Forum 2019). "Resource scarcity, loss of biodiversity and degradation of ecosystem services[2] such as freshwater availability have started to present financially material[3] risks and opportunities for bankers, investors, and lenders" (Mulder and Clements-Hunt 2010).

Along with an increased awareness of economic risk due to water-related issues and increased public and consumer awareness of this topic, investors are increasingly interested in supporting companies to achieve positive environmental, social and governance (ESG) outcomes (Lang, Rodinciuc, and Humphreys 2017). The WEF recently released a report highlighting the role that institutional investment can play in addressing climate and societal risks. Lack of information to inform investment decisions is identified as a key challenge in capitalizing on these opportunities (World Economic Forum 2020). In addition, Mulder and Clements-Hunt identify "how the effects of environmental phenomena translate into tangible financial risk" is poorly understood in terms of financial materiality, or importance (2010).

---

[2] *Ecosystem services can be described as the goods and services provided by the natural environment (Mulder and Clements-Hunt 2010).*
[3] *Materiality is a finance and accounting concept that events or information that exceed an organizationally determined threshold may affect the company's, investor's, or stakeholder's decisions (Monast, Sands and Grafton 2018).*

A 2010 survey of financial sector practitioners found that biodiversity and ecosystem services concerns had become material, primarily in addressing reputational challenges. Reputational risk was followed by increased materiality of ecosystem services in regulatory risk, operational risk, credit risk, and legal liability concerns (Mulder and Clements-Hunt 2010). These material concerns are particularly important for institutions that have a large exposure or client base in industries dependent on environmental services, such as agriculture (Mulder and Clements-Hunt 2010).

Financial institutions should adequately value this relatively new form of liability in determining the creditworthiness of a client and integrate environmental services into routine risk analyses and management systems (Mulder and Clements-Hunt 2010). The agrifinance industry plays a critical role in the stewardship of environmental services in agriculture, but this role is not well understood (Coppess and Sherrick 2020). Some laws, such as lender liability laws, prevent banks from becoming too invested in the practices of the farms in their portfolio. These laws "generally prohibit participation in producers' management decisions, to avoid conflicts of interest or culpability for failure in performance" (Coppess and Sherrick 2020). This presents a challenge for banks who want to support more sustainable farming practices, but are also limited in their ability to influence these practices.

While the exploration of the agrifinance industry's involvement in environmental resource conservation efforts has only begun within the last five years, there have been a number of reports written by the Environmental Defense Fund (EDF), the AGree Economic and Environmental Risk Coalition (AGree), and other organizations. The bulk of this research is being done by technology companies, non-profit, and non-governmental organizations. Driven by the increasing amount of literature that shows farmers benefiting financially from conservation practices, the research on this topic tends to focus on how that knowledge can be used to encourage agricultural stakeholders, such as lenders, to incentivize increased farmer adoption.

The EDF report, Farm Finance and Conservation, provides an analysis of the impact conservation practices can have on farm budgets using case studies of midwestern grain farmers and their adoption of conservation practices, such as no-till and cover crop. These farmers found that conservation practices could reduce operational costs and, "in some cases, increased or more resilient yields" (Monast, Sands, and Grafton 2018). While there may be benefits, the report's examination into the farm financial system showed that these benefits are widely unacknowledged. If conservation practices can reduce costs and increase more resilient crop yields, then it should be clear that sustainable agricultural considerations are material to all aspects of the agrifinance industry (Monast, Sands, and Grafton 2018). More specifically, these practices provide opportunities for farmers to become more profitable, productive, and resilient. This means that farmers could be better able to pay off loans and other operational expenses, as well as reduce insurance claims and disruptions to agribusiness supply chains. This report provides the basis for further exploration into the role of agrifinance in support of sustainable agriculture.

In April 2019, AGree published a report, “The Role of the Banking and Financing Sector in Encouraging Conservation Practices and Transitions to Organic Production.” The purpose of the report “is to ascertain what, if any, incentive programs could be developed in the banking or investment sectors to facilitate farmers’ transitions to organic production or their adoption of conservation practices” (Woodard et al. 2019). The authors conducted more than 25 interviews with agricultural bankers and conservation experts exploring incentive programs such as interest rate reduction programs, structured financing, and guarantee funds. AGree’s findings suggest that there may be potential for these types of incentive programs to work in encouraging conservation practice adoption by farmers. However, their interviewees were skeptical about all suggested programs based on significant challenges with “monitoring, underwriting, tracking, standards, and verification” (Woodard et al. 2019). Pilot programs should be carefully crafted to target the appropriate stakeholder at the farm level to incorporate conservation practices for short- or long-term time frames and in partnership with “efforts to create standards and operational metrics and platforms related to conservation adoption” (Woodard et al. 2019).

Technology plays an important part in the research of agrifinance’s role in conservation efforts as they work to collect data about farm practices, such as water use, and develop tools to effectively communicate this data to other agricultural stakeholders. The tools and data services from technology companies, like AgKnowledge, Ag-Analytics and AquaOSO, are already working to provide data packaged for specific stakeholder audiences. In her paper, Susanne Frieidberg examines the limits of corporate food power in corporate food supply chain sustainability initiatives (2017). Friedberg notes that the involvement of individual corporate food companies in “multistakeholder activities reflects the failure of their traditional levers of corporate power to deliver the farm-level information and influence they need'' (2017). One of the results of corporate multistakeholder engagement was the development of tools like the Cool Farm Tool, Fieldprint Calculator, and the Stewardship Index for Specialty Crops. These tools better connect organizations “to farm-level data based on ‘sustainable agriculture’ and its measurable metrics” given that corporate entities are often far removed from decisions made by the farmers (Freidberg 2017). Like big food companies, corporate agrifinance institutions are removed from on-farm management decisions. Therefore, tech companies that develop and provide tools to targeted agricultural stakeholders is critical for bridging these information gaps.

The key stakeholders in the agricultural ecosystem can be described as farmers, agribusiness corporations, consumers and “AgTech innovators” (Cunningham 2019). Cunningham asserts that “agribusiness is undergoing a period of transformational change” through the use of technology and data to “increase the efficiency and sustainability of global food production,” and that this transformation is being hindered by an “asymmetry of priorities, cultures, and other fundamentals between the key constituents of the agriculture ecosystem” (2019). Her suggested solutions to move things forward highlight the need for (1) consumers to understand the complexity and costs of their demands for change, (2) farmers to have integrated outcome-based solutions supplied by trusted advisors, (3) large agribusiness corporations to take risks and make long-term investments in innovation, and (4) AgTech to learn to communicate effectively with their target audience of farmers and corporations to expand their reach (Cunningham 2019).

New tools are needed for farmers, landowners, and lenders to reduce risk and create value over the long term (Coppess and Sherrick 2020). Farmers and landowners need tools to improve their operational and farm management decisions, while lenders need tools to better inform their lending decisions. Specialized lending programs could be helpful for all parties. Some of these programs focus on bridging the farmer's immediate cash and operating needs with the long-term value, risk reduction, and potential asset returns from the farmer's conservation actions (Coppess and Sherrick 2020). Rabobank has a program that functions like a public-private partnership in order to limit risk as a farming operation switches from conventional to organic farming. The program uses offtake agreements, where a contract of yield purchase is established before the organic transition is complete, and allows the restructure of cash flow to align with future production (Coppess and Sherrick 2020; Monast 2020). While this type of program strictly applies to organic farming certifications and is supported by the associated standards, there may be opportunities to create similar programs which focus on agricultural conservation practices. There may be opportunities for the creation of conservation or sustainability impact analyses to promote lending for conservation actions. Additionally, there is the opportunity to leverage the agrifinance industry's material risk to climate change to motivate their action in support of changes to agricultural practices (Monast 2020).

The risk to the agrifinance industry from climate change is readily apparent. An EDF survey of 20 banks and several other financial institutions in 2019 shows that many of them already take a strategic approach to climate risk. However, not all of them. Monast recommends that financial institutions "assess risk at the lending institution level, understand the role of resilient agriculture in managing climate risk, and design lending programs or products that support farmers in building climate resilience" (2020). These new lending programs and products are about "realign[ing] lending structures to better match the needs of farmers who adopt practices that improve resilience," or natural resource conservation (Monast 2020). This realignment would reflect itself in the lender's portfolio risk. One of the major challenges that the agrifinance and agribusiness industries struggle with in making these changes is "short-termism" (Cunningham 2019). Because of the annual nature of agricultural cycles and business practices much of the focus in the industry is on "short-term rather than long-term profitability and value" (Monast 2020). Clearly, this is an aspect of the agricultural and finance industries where improvement can be made. As the literature states, "[m]ost farmers cannot farm without access to credit" (Coppess and Sherrick 2020). As long as farmers need loans, there is potential for lenders to promote sustainable stewardship.

Conservation Finance

Conservation finance[4] practices are helpful to researchers and stakeholders addressing the potential for the agrifinance industry to promote sustainable stewardship. In their discussion about conservation finance, Meyers et al. highlight certain conservation finance

---

[4] Defined by the Conservation Finance Alliance, conservation finance tools are the "mechanisms and strategies that generate, manage, and deploy financial resources and align incentives to achieve nature conservation outcomes" (Meyers et al. 2020).

strategies that are useful for working with private companies, like commercial lenders (2020). These strategies include return-based investments, risk management, or financial efficiency. Return-based investments for environmental resources can involve microfinance, "green loans," and impact investing. Environmental impact investing is of particular interest, as agricultural land can be defined as an "environmental real asset," a financial asset that "derives its value from its physical properties... that rely on ecological systems to generate cash flows" (Spence et al. 2017). There is significant growth expected for impact investing focused on sustainable agriculture, as well as increased opportunities for better engagement with the environmental science and management community (Spence et al. 2017). Financial efficiency strategies are used with other conservation finance strategies to "produce enhanced conservation results relative to cost" (Meyers et al. 2020). In regards to agrifinance and sustainable agriculture, a strategy for financial efficiency that stands out is integrated accounting, or reporting. Integrated accounting works to "better integrate all forms of capital into financial reports for companies and governments" (Meyers et al. 2020). This applies to the challenges agrifinance institutions face from a lack of material information about the environment on which to base their decisions.

Finally, we have the conservation finance strategies associated with risk management: blended finance and "pay for performance." Within the conservation finance framework discussed by Meyers et al., risk management strategies "seek to either leverage the risk abatement properties of well managed natural systems or use the strategies to improve the conditions of conservation of the natural environment" (2020). Blended finance is defined as "the use of catalytic capital from public or philanthropic sources" to "mitigate specific investment risks that are unable to proceed on strictly commercial terms" (Meyers et al. 2020; "Blended Concessional Finance" n.d.). This strategy uses different types of financing sources to fund a program through the combination of instruments such as grants, discounted lending or return rates, private investment, and financial guarantees (Meyers et al. 2020). An example of blended finance in agricultural finance is the U.S Department of Agriculture's (USDA) Farm Service Agency (FSA) Conservation Loan Program. The conservation loan can be used by farmers implementing conservation practices approved by the USDA's Natural Resource Conservation Service (NRCS), and requires farmers to develop an NRCS-approved conservation plan before the FSA can provide financing through an FSA-approved lender with a financial guarantee. This program uses a financial guarantee and, potentially, discounted lending and return rates to craft a blended finance strategy to encourage conservation practices on farms ("Conservation Loan Program: Fact Sheet" 2019). The financial guarantee is used to motivate the FSA-approved lender to provide loans to farmers that they would not normally accept as clients. The program serves multiple purposes by reducing the risk to the lender, providing loan access opportunities to riskier farmers, and promoting agricultural conservation.

Another conservation finance strategy to address risk management is the "pay for performance" concept, also referred to as "pay for success" or "impact bonds." Meyers et al. state that the concept of "pay for performance" solutions is where "private companies or NGOs take on the risk of implementing projects or programs that seek to achieve quantifiable public benefits under an established agreement with government or donors to pay for the cost of services, plus some profit margin, once the activities have been measured to be successful" (2020). This provides an exchange of financing for risk with the addition of rewards upon program success. The next section provides an overview of a "pay for performance" pilot program in Salinas Valley developed by Sustainable Conservation, California FarmLink, and the Resource Conservation District of Santa Cruz County (RCDSCC).

Pilot Program: Farm Environmental Performance Rebate Financing

Currently, agricultural conservation tactics are perceived as more of a cost, or a burden, to profit than a benefit (Coppess and Sherrick 2020). There are some mechanisms in place to incentivize farmers to use conservation practices. For example, there are some programs which farmers become eligible for only if they meet regulatory requirements for stewardship (Coppess and Sherrick 2020). Additional mechanisms are needed to help farms become sustainable while maintaining produce yields.

Sustainable Conservation partnered with California FarmLink and the RCDSCC to develop and demonstrate a new financial incentive concept. The purpose is "to promote adoption of performance-based metrics and monitoring of water and nutrient management on farms, with the goal of advancing water conservation and water quality protection, while supporting farmers (California FarmLink and Resource Conservation District of Santa Cruz County 2019)." As a part of the partnership, FarmLink was responsible for underwriting loans and allocating incentives while RCDSCC provided technical assistance, water and nutrient monitoring, and performance verifications for the participating farmers. Before the project's start, Sustainable Conservation, FarmLink and RCDSCC worked together to establish a tiered rebate structure that offers participating farmers a financial incentive through a cash back rebate on some interest paid for showing water and/or nutrient use efficiency improvement. The financial incentives were based on a 3-tiered structure:

1. **Enrollment, Implementation, and Baseline Establishment**: Farmers received cash back for enrollment in the program and the completion of a baseline evaluation of their water and nutrient management.
2. **Improve Performance**: Upon demonstrating improvement in water and nutrient efficiency, farmers received a percentage of their annual interest back on an operating or equipment loan through FarmLink.
3. **Maintain Benchmark**: Farmers who maintain their baseline water and nutrient efficiency performance from Tier 1 and Tier 2 are eligible for additional annual interest rebate for up to five years.

The pilot program conducted to test this financial incentive concept started in February 2018 with four farms and is still ongoing. Since the pilot program was developed in partnership with a CDFI, there may be opportunities to reach more farming operations through other financial institutions, such as commercial banks or Farm Credit, if they are able to adopt similar programs. In support of Sustainable Conservation's success in "driv[ing] collaborative solutions to meet the water needs of California's environment, people, and economy," our project explores the opportunity to scale concepts like the Farm Environmental Performance Rebate Financing Program to benefit farmers, businesses, and the environment across the Salinas Valley and the state of California.

Chapter 3: Agrifinance Industry Survey

We conducted a survey of the agrifinance industry to address our first objective: understand how the agrifinance industry accounts for environmental risk, and identify unrealized opportunities for improvement. This chapter covers the methodology of and results from our agrifinance survey. The discussion of our methodology will be split between our use of (1) advisory committee guidance, (2) industry interviews and (3) an online questionnaire to collect this primary data. The results discussion focuses specifically on responses from the online questionnaire.

The target population for our survey were individuals currently working in the agrifinance industry who have experience in designing agricultural business loan structures, collecting borrower information, performing loan risk assessments and structure justifications, or approving any of the aforementioned aspects of loan development. Our research into the agrifinance industry required intensive relationship-building and stakeholder engagement as we connected with corporate lending and finance professionals, regional agency representatives, and researchers. Our survey was approved by UCSB's Office of Research's human subject committee as an exempt research. All human subject research guidelines were followed during our study. Survey participants were asked to share their personal attitudes and opinions regarding the types of natural resource issues considered in their lending credit risk assessments and loan development procedures, and the agrifinance industry's willingness to consider including client environmental performance in their lending practices.

To help us gain access to those within the agrifinance industry, we worked with our client, Sustainable Conservation, to engage with an advisory committee, composed of five agrifinance professionals, in developing the design and research methodology for our target audience of finance professionals who work providing loans to farmers in California. The committee provided guidance on the development of both interview and online questionnaire questions as well as insight into the workings of agrifinance relationships with farmers and basic loan decision making practices. Multiple advisory committee meetings were held to discuss interview and questionnaire questions. The committee also provided assistance through introductions to potential interviewees and with the dissemination of our online questionnaire. They connected us to 4 professionals for the one-on-one interviews. The questionnaire was drafted from the main findings from the interviews, and was refined with the help of the advisory committee.

3.1 Methodology

Industry interviews

The interviews with agrificance industry professionals were conducted by two group members between August and September 2020 during a summer internship with Sustainable Conservation.

Independent online research was conducted to identify potential interviewees from agricultural lenders within California, the Salinas Valley, and the Central Coast. Potential interviewees were selected with the assistance of the advisory committee. We contacted 22 professionals across 11 different financial institutions, and 5 interviews were conducted. The conversations were recorded, transcribed, and responses were reviewed for main points and key findings to be translated into our questionnaire.

The interviews were conducted by video call using Zoom and WebEx depending on interviewee preference. Group members first contacted interviewees by email, either with an advisory committee member introduction or a cold email based on independent online research of agrifinance institutions in California. In the initial email, potential interviewees were provided with details about our study, a consent statement, and a request to schedule the interview. Interviewees were given time to consider the consent statement before agreeing to the ~30 minute interview.

During the interview, the interviewers followed a list of prepared questions as the basis for each interview conversation. Additional clarification questions were asked as necessary and as time permitted. All calls were recorded with the interviewee's consent and stored in a password protected Google Drive for an ~30 day period. All of the interviews were anonymized and transcribed from the recordings before they were deleted from secure storage for confidentiality and privacy.

Both group members were present for each interview: one as the main interviewer and the other as the note taker. Only one interviewee was present at each interview. After the interview, the interviewees received a follow-up email thanking them for their participation. At the invitation of the interviewee, some of the follow-up emails included additional questions or another video call inquiry from the group members based on the initial interview conversation.

Questionnaire

The questionnaire was created and administered through Qualtrics. Our questions were developed based on independent agrifinance industry research, insight from our advisory committee, and the responses from our industry interviews. The interview responses allowed us to further narrow the focus of our questionnaire by providing us with additional information to (1) remove irrelevant or unanswerable questions, (2) confirm our target audience and desired information, and (3) use some of the common interviewee responses to gauge agreement or disagreement from others in the industry.

We began collecting responses on November 16th, 2020, and the questionnaire was open for 9 weeks closing on January 15th, 2021. Potential participants were initially contacted with a brief message by email, posts on and individual messages sent through LinkedIn, or by social media posts on Twitter. Email invitations were sent to those individuals contacted for interviews during the summer as well as additional names collected from research. The initial questionnaire invitation included a brief introduction to the project and a link to access the online questionnaire. Additional reminder emails and social media posts were sent out at irregular intervals over the 9 weeks that the questionnaire was open. Initial and reminder emails, messages, and social media posts about the questionnaire were sent according to the following schedule:

- Initial outreach emails & social media posts: November 16th, December 2nd, and 18th - 22nd
- Reminder Emails: November 24th, January 7th and 11th

All communications with potential participants included a call for individuals to share the questionnaire with colleagues to expand the questionnaire's reach and increase the response rate. After the questionnaire closed, all communications with respondents ceased unless they were also an interviewee who expressed interest in receiving a copy of our final results and report.

Questionnaire responses were anonymized to maintain privacy and confidentiality. As a deterrent against individuals completing the questionnaire more than once, a question was included that asked if the individual had completed the questionnaire before. In addition, the first questionnaire question was an abbreviated statement of consent, with a link to access the full statement, for the respondent to agree to or deny. Participants were only able to access the rest of the questionnaire if they agreed to the consent statement.

Questionnaire analysis

Questionnaire responses were cleaned to remove attempts recorded by Qualtrics that did not contain any answers to questionnaire questions. From the initial total of 42 recorded attempts, this cleaning step removed 9 attempts without any answers to questionnaire questions. This resulted in an adjusted total of 33 questionnaire responses. All 33 responses were incomplete given the caveat that participants could choose not to answer questions on the questionnaire. 21 of the responses were considered complete with the completion of over 70 percent of the questions. Responses to the respondent location question were narrowed to 4 main groups based on the responses: Salinas Valley, California Central Coast, Within California, and Nationwide. We regrouped the responses and added a nationwide option as some respondents selected more than one answer to the question.

Based on the data types from the questionnaire (nominal, ordinal, or interval), we calculated the summary statistics for the responses. The majority of our questionnaire questions provide nominal or interval data. Therefore to measure central tendency, our analysis used median values for ordinal data and the mode for our nominal data. Cumulative frequencies were calculated for grouped ordinal data to show the distribution of responses through frequency tables, bar charts, and summary statistics. Range was used as the most appropriate method of measuring dispersion across questionnaire responses.

The analysis of our survey results focuses on the following topics:

- The influence of the industry interview findings on our questionnaire development,

- Industry willingness to consider different types of loan structures that incorporate environmental performance,
- Most likely loan types to be offered to clients with environmental performance incorporation,
- Criteria influencing client risk assessment, and
- Factors impacting the economic value of agricultural land.

3.2 Results

Industry interviews

Findings from the interviews that were used in the development of our questionnaire included clarifications on common agricultural lending practices, such as the following:

- Short term loans tend to be 12-18 months depending on the crop and apply simply to the production for that one crop harvest.

- The risk assessment process primarily takes into account the borrower's cash flow, liquidity, leverage to debt ratios which all amount to a calculation of the borrower's ability to repay the loan.

- Currently, lenders often "check" on an adequate availability of water based on paperwork.

- There are legal liability concerns for the lender if they give financial or operational advice or recommendations to their clients. Therefore, a loan product could reward good performance but can’t mandate specific actions.

From the interview conversations and the listed findings above, we made the following conclusions that were incorporated into the questionnaire for verification against a larger sample population of agricultural lenders:

- From the commercial banking perspective, it seems that lower, or "better," interest rates are seen as an incentive for agricultural producers to be "good" operators. This idea of “good” operation applies to the management of the agricultural business as a whole.

- Interviewees emphasized that it is not the role of for-profit banks to lower the barrier of entry to new farmers or provide other types of agricultural management support.

- From the interview responses, it seems like the crux of the considerations of natural resources, like water, are decided based on loan time frames.

- Long-term loans like farmland loans, or mortgages, are more likely to carefully examine the natural resource risks associated with the loan. Lenders expect to incur increased risk based not only on the length of the loan payoff schedule, but also because the repayment ability is dependent on those natural resources, in the form of soil health and water availability, over a longer period of time.

Questionnaire response & completion rate

Of the 42 individuals who accessed our online questionnaire via anonymous link through email or social media, 33 responded to at least one question. Given our decision to consider a response as complete if the respondent provided answers to at least 70 percent of the questionnaire, we consider 21 of the 42 responses as complete. Our completion threshold of 70 percent was determined by our use of optional questions. This gives us a completion rate of 50 percent. For our results analysis, which is explained further in the next section, we used all available responses for each given question. Therefore, the number of responses varies from analysis to analysis.

Demographics of questionnaire respondents

Demographic questions had the highest completion rate. The majority of our questionnaire responses were from our target audience of commercial agrifinance institutions with over $10 billion dollars in assets. Respondents had an average of 16 years of experience in the agrifinance industry. While 59 percent of our respondents work within California, only 7 percent have work experience within the Salinas Valley specifically. The most common job title from 32 percent our questionnaire respondents was “Relationship Manager.”

Main findings

Our discussion of main findings from questionnaire responses follow the order below:

- Industry willingness to consider different types of loan structures that incorporate environmental performance,
- Most likely loan types to be offered to clients with environmental performance incorporation,
- Criteria influencing client risk assessment, and
- Factors impacting the economic value of agricultural land.

How willing is the agrifinance industry to consider different types of loan structures that incorporate environmental performance?

Some lenders are willing to consider novel loan products with structures that incorporate a client’s environmental performance. When asked to select the type of loans incorporating water and fertilizer use efficiency that would most likely be offered to clients, responses show that an annual operating loan or a real estate loan may be the most likely candidates over an equipment loan (Figure 3.1). It is important to note that almost a quarter of the responses do not see the agrifinance industry offering any such loan to clients. This information helps to define a target population of farmers that the agrifinance industry may be most likely to work with in a loan program such as this. It also shows the variation in opinion within a small subset of the industry on this topic.

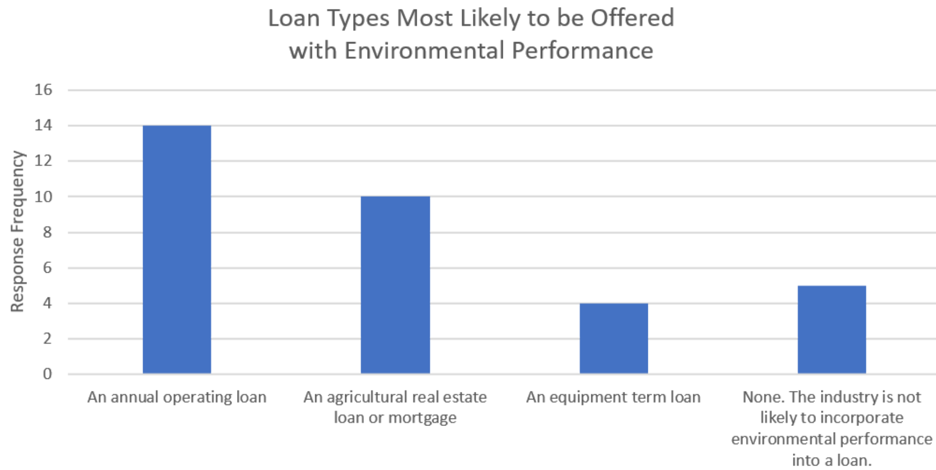

Figure 3.1. Graph shows questionnaire response opinions that suggest that annual operating and agricultural real estate loans are the most likely loans to be offered with incorporation of client water and fertilizer use efficiency.

Loan Types	f	%
An annual operating loan	14	42%
An agricultural real estate loan	10	30%
An equipment term loan	4	12%
None. Industry not likely to incorporate environmental performance into a loan.	5	15%
Total	33	100%

Table 3.1. Shows questionnaire response frequency (f) and percentage (%) for the most likely loans to be offered with incorporation of client water and fertilizer use efficiency.

What type of loan that incorporates environmental performance is most likely to be offered to clients?

To understand what lenders' attitudes were toward different types of loans that incorporate environmental performance, our questionnaire asked the respondents to rate the agrifinance industry's willingness to consider implementation of three types of loan programs that incorporate agricultural clients' environmental performance. From a comparison of the median ratings for the three types of loan programs, the responses showed what types of financial products lenders may be most willing to incorporate a client's environmental performance into. The loan with variable interest rates scored the lowest with a median rating of slightly unwilling. For a loan with more favorable terms the median rating was neutral, with lenders neither willing nor unwilling to consider this type of loan. We have defined more favorable loan terms as tenor, the length of the loan, or covenants, which are the actions or restrictions that the borrower agrees to when accepting a loan. Lastly, we have the median rating that agricultural lenders would be slightly willing to offer a loan with a partial rebate on interest paid.

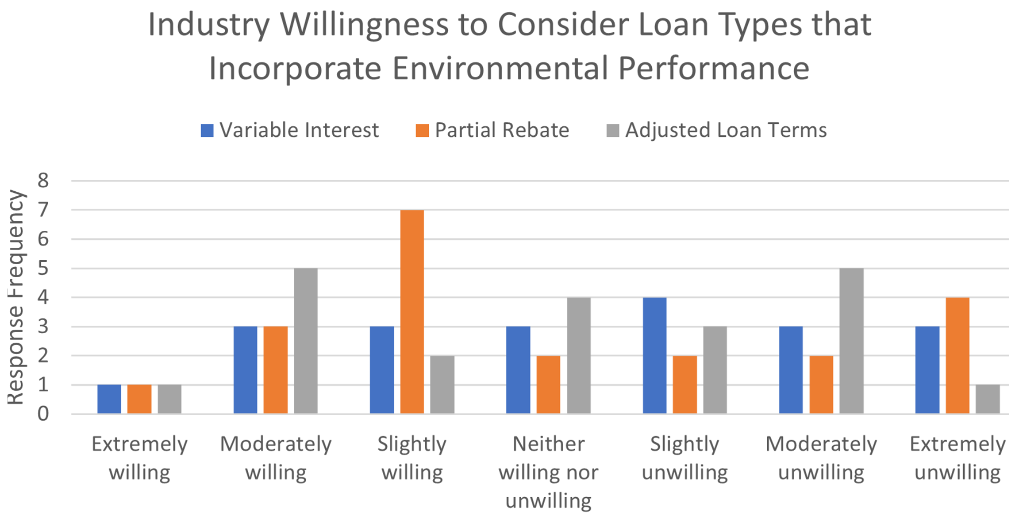

Figure 3.2. Graph shows questionnaire responses rating 3 types of loans structures on a likert scale of industry willingness to incorporate agricultural clients' environmental performance.

	Variable Interest		Partial Rebate		Adjusted Tenor	
Likert Scale	**f**	**%**	**f**	**%**	**f**	**%**
Extremely willing	1	5%	1	5%	1	5%
Moderately willing	3	15%	3	14%	5	24%
Slightly willing	3	15%	7	33%	2	10%
Neither willing nor unwilling	3	15%	2	10%	4	19%
Slightly unwilling	4	20%	2	10%	3	14%
Moderately unwilling	3	15%	2	10%	5	24%
Extremely unwilling	3	15%	4	19%	1	5%
Total	**20**	**100%**	**21**	**100%**	**21**	**100%**

Table 3.2. Table shows response frequency (f) and percentage (%) of responses for each likert response value. Adjusted tenor refers to the adjusted loan terms option in Figure 3.2.

What criteria most influence a client's credit risk assessment?

Our questionnaire responses agree with comments from our interviews and other industry research that the most influential criteria considered during an agricultural client's, or any borrower's, credit risk assessment include cash flow, debt, and capital. Surprisingly, from our analysis of the median response for each criteria, consideration of management plans was the third most influential factor after cash flow and debt. Capital was ranked as the fourth most influential factor by our questionnaire respondents. This result may suggest that there is flexibility within the industry to readjust their credit risk assessment process to include aspects of potential client's operations that are not explicitly related to finances. It may also suggest that operational management plans are beginning to carry more weight in assessing a potential client's risk to the lender. This could pose useful opportunities to work toward standards for sustainable and resilient agriculture in a way that lenders can readily understand.

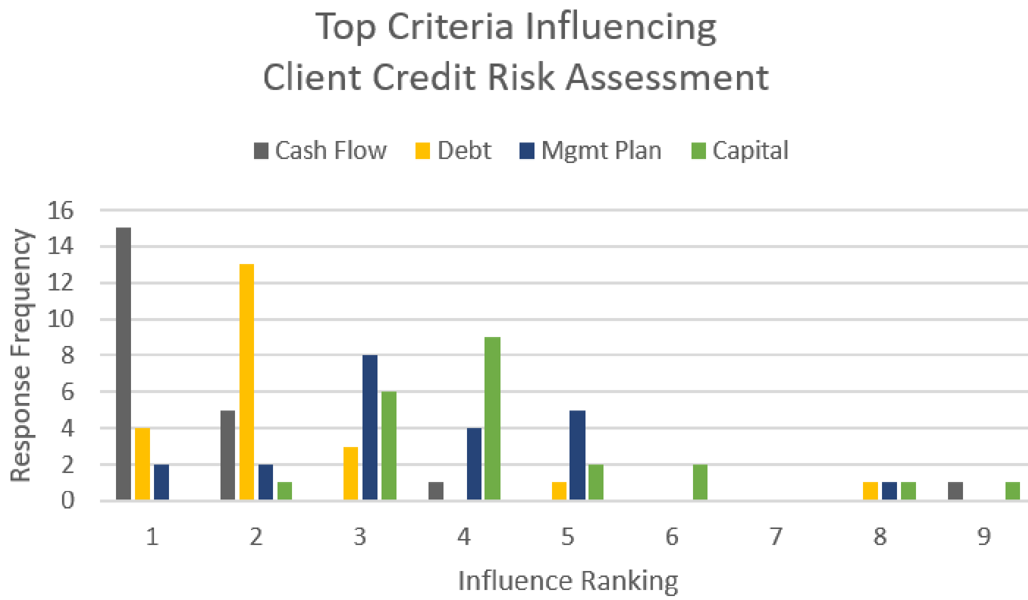

Figure 3.3. Graph shows questionnaire responses of the top 4 criteria that most influence client credit risk assessment. For the influence rankings, 1 denotes the highest influence and 9 the lowest influence in the credit risk assessment process.

	Cash Flow		Debt		Mgmt Plan		Capital	
Rank	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
1	15	68%	4	18%	2	9%	0	0%
2	5	23%	13	59%	2	9%	1	5%
3	0	0%	3	14%	8	36%	6	27%
4	1	5%	0	0%	4	18%	9	41%
5	0	0%	1	5%	5	23%	2	9%
6	0	0%	0	0%	0	0%	2	9%
7	0	0%	0	0%	0	0%	0	0%
8	0	0%	1	5%	1	5%	1	5%
9	1	5%	0	0%	0	0%	1	5%
Total	**22**	**100%**	**22**	**100%**	**22**	**100%**	**22**	**100%**

Table 3.3. Shows response frequency (f) and percentage (%) for the top 4 most influential client credit risk criteria from the questionnaire responses.

What factors most impact the economic value of agricultural property?

We found that water availability and quality are the top 2 factors that impact the economic value of agricultural property. This shows how much lenders value water resources. We provided our questionnaire respondents with a list of factors, which included natural resources and other factors important to the agricultural land environment. Respondents were asked to rank these factors from most important to least important in determining the economic value of an agricultural property. Water availability was ranked as having the most impact on the economic valuation of an agricultural property, while water quality came in at second over other factors such as local climate, soil health, slope of land, and distance to paved roads. Because lenders themselves care about these resources in their economic valuations, this adds weight to the idea that lenders should also consider resource conservation when evaluating a potential loan client.

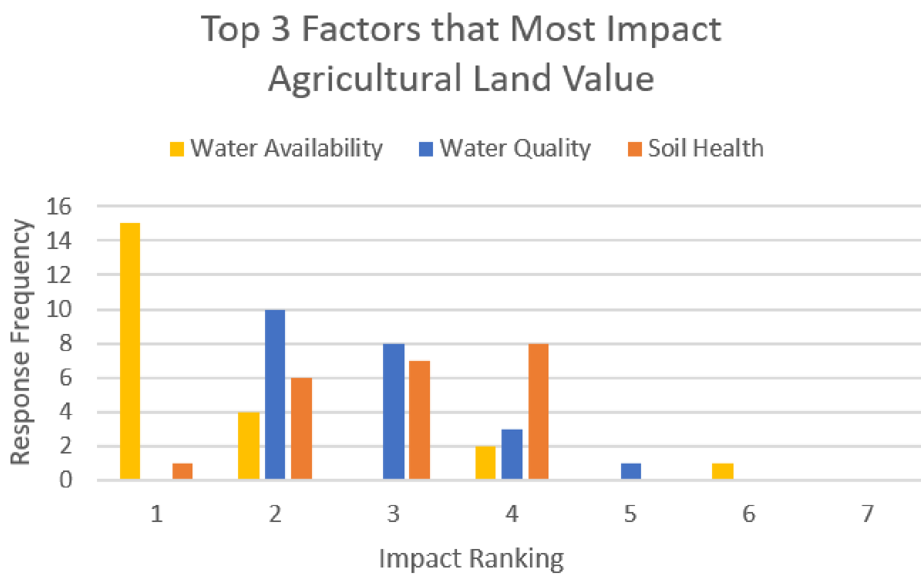

Figure 3.4. Graph shows questionnaire responses for the top three factors (water availability, water quality, and soil health) that impact agricultural property economic value. Here 1 denotes the highest impact ranking and 7 denotes the lowest.

	Water Availability		Water Quality		Soil Health	
Rank	**f**	**%**	**f**	**%**	**f**	**%**
1	15	68%	0	0%	1	5%
2	4	18%	10	45%	6	27%
3	0	0%	8	36%	7	32%
4	2	9%	3	14%	8	36%
5	0	0%	1	5%	0	0%
6	1	5%	0	0%	0	0%
7	0	0%	0	0%	0	0%
Total	**22**	**100%**	**22**	**100%**	**22**	**100%**

Table 3.4. Questionnaire response frequency (f) and percentages (%) for the top three factors (water availability, water quality, and soil health) that impact agricultural property economic value. Here 1 denotes the highest impact ranking and 7 denotes the lowest.

Some of our survey results directly inform our financial analysis. These are highlighted briefly before we move to the next portion of our report. First, we found that water availability and quality are the top 2 factors that impact the economic value of agricultural property. This supports the argument that lenders would benefit in the short- and long-term from borrowers' water stewardship practices. Second, some lenders are willing to consider novel loan products with structures that incorporate a client's environmental performance. This indicates that it is worthwhile to explore the profitability of these loan products to determine if they can benefit both the borrower and the lender. Last, the loans most likely to incorporate water and fertilizer use efficiency are annual operating loans and real estate loans. These results provided us with information used in our financial analysis to produce our final results.

Chapter 4: Financial Model and Analysis of Conservation Incentives

In order to scale up “pay for performance” conservation incentive programs, like the Farm Environmental Performance Rebate Financing program, we should evaluate lenders’ attitudes towards these incentives and incorporate their feedback into the program’s design. With the pilot program as our foundation, we used the primary data collected from conversations with our Advisory Committee members, responses from our agrifinance survey, and insights from the literature to guide the design and financial modeling of two conservation incentives.

4.1 Methodology

Our financial analysis sought to answer the second of our two research questions, which asks: How can loan products that encourage natural resource management meet the needs of both farmers and lenders? We addressed this question with three steps:

1. Design conservation incentives
2. Use an amortization table to calculate the borrower’s savings for each product
3. Use Customer Lifetime Value to calculate the lender’s profit for each product

Conservation Incentive Design

In our questionnaire, we asked respondents to evaluate three loans — an annual operating loan, an equipment loan, and a mortgage loan — based on the agrifinance industry’s willingness to pair them with an incentive. We also asked them to rate three incentives —a rebate on interest paid, a variable interest rate, or more favorable terms — based on the likelihood that the industry will adopt them. In this section, we completed a financial model to determine the economic benefits of each loan and incentive combination. These combinations will be referred to as “products.” We omitted the favorable loan terms incentive because this incentive could not be easily quantified.

For this model, we made assumptions for the principal amount, tenure, and interest rate for each loan. We based our assumptions on the 2018 EDF report, “Farm Finance and Conservation: How stewardship generates value for farmers, lenders, insurers, and landowners'' (Monast, Sands, and Grafton 2018), on the Farm Environmental Performance Rebate Financing program, and on insights from our advisors.

Principal amount

The pilot program mentioned above included a range of principals from $5,000 to $50,000. We wanted to see how an incentive affects loans with different size principals, so we equalled the annual operating loan, equipment loan, and mortgage loan to $1,200, $5,000, and $15,000 respectively. Principal amounts can vary greatly depending on the loan's purpose, the size of the farm, and the bank's capacity. As a result, our assumptions for principal are fairly arbitrary with the understanding that model inputs can change.

Tenure

The tenure of an annual operating loan, also called a "short-term loan," is one year (Monast, Sands, and Grafton 2018). Equipment loans, or "mid-term loans," range from 3 to 5 years, and mortgage loans, also called "long-term loans," can range from 10 to 30 years (Monast, Sands, and Grafton 2018). We chose to model an equipment loan of 5 years and a mortgage loan of 15 years, with the understanding that these inputs can change as well.

Interest rate

We used a 5 percent interest rate across all loans for better comparison. 5 percent was in the range for average interest rates for all three loans (Monast, Sands, and Grafton 2018).

Name	Principal	Tenure	Interest rate
Annual Operating Loan	$1,200	1 year	5%
Equipment Loan	$5,000	5 years	5%
Mortgage Loan	$30,000	15 years	5%

Table 4.1. The three loan types and their respectives principals, tenure, and interest rates. These assumptions served as our counterfactual loan products.

Next, we needed to define our assumptions for the incentives. These values are mostly arbitrary as well. An incentive amount will vary depending on the bank's capacity and the level of efficiency improvement. The calculations show the amount of savings possible given our assumptions.

Partial rebate

We assumed that 5 percent of interest paid in a year will be reimbursed to the farmer-borrower given efficiency improvement. We chose a small amount since lenders' margins are small. As the rebate increases, farmers-borrowers save more on interest, but the lender also loses that interest.

Variable interest rate

To make the two incentives comparable, we assumed our reduced interest rate equals 95 percent of the counterfactual interest rate. The variable interest rate is reduced because a smaller interest rate benefits the farmer-borrower, and thus serves as an incentive for improved environmental performance. Since each loan started with a 5 percent counterfactual interest rate, the new reduced rate for all loans was 4.75 percent.

Incentive	Description	Delivery
Partial Rebate	5 percent of counterfactual interest paid in a year	Single sum reimbursed at the end of each year
Variable Interest Rate	95 percent of counterfactual	Reduced rate for each year

Table 4.2. Description of the mechanisms and delivery methods of each incentive.

Once we established our six loan products, we needed to make assumptions about the program's design. We incorporated two points which our advisory committee members and interviewees emphasized. First, that commercial agrifinance institutions would likely not include specific farming practice requirements, and second, that commercial agrifinance institutions would likely need a third-party to certify the farmer-borrower's actions.

1. Including specific recommendations for farming practices in loan contracts can put an agrifinance institution at legal risk. We addressed this concern by creating two separate documents: a loan contract and an incentive contract. In this way, the incentive contract works as a promotional product that banks can add to existing loans. We also excluded any specific farming practice requirements from both contracts.

By establishing the incentive contracts as a separate and optional promotional product, we clearly define the loan-incentive's business goals for the lender: to attract new clients, and to retain new and existing clients. These goals aim to increase the institution's share of the market, thus strengthening their competitive advantage.

2. Rather than require specific practices, the incentive contract requires a farmer-borrower to obtain a certified conservation plan from the Natural Resource Conservation Service (NRCS) or a local Resource Conservation District (RCD) and present this plan to the lender at the start of the program. Additionally, all monitoring and reporting during the program requires NRCS- or RCD-verification. The reason why banks need third-party verification is because they lack the capacity to conduct this monitoring and reporting themselves, even though it is essential for the incentive program to work.

Incorporating a third party has precedent. Both the Farm Environmental Performance Rebate Financing program and the Farm Service Agency (FSA) conservation loan program involve a government agency as a third-party collaborator and verifier (NSAC 2019). As existing government agencies, the NRCS and all RCD's have an established history of providing funding and technical assistance to farmers across the United States (CARCD n.d.).

With these assumptions, we calculated the savings for a farmer-borrower for each product with an amortization table, and the profit for the lender with a Customer Lifetime Value calculation.

Borrower cost-savings calculation

We created an amortization table for each loan and incentive combination to calculate the savings on interest. Knowing potential savings is helpful for two reasons: (1) we create outputs that feed into the Customer Lifetime Value calculation, and (2) we learn the amount an incentive can put towards funding conservation practices. We completed our work in Google Sheets.

Calculating the interest payments for the equipment and mortgage loans was a similar process. These loans are both amortized loans, meaning the lender gives the farmer-borrower an upfront amount of principal which the farmer-borrower pays back over time in monthly payments of principal and interest (Kagan 2020). For these loans, we used financial functions built-in to Google Sheets. We used the PPMT function to calculate principal payments and the IPMT function to calculate interest payments. The total monthly payment is the sum of principal and interest and is constant for the entire loan.

The annual operating loan is considered a line of credit (LOC), which means the principal can be withdrawn at any time like a credit card (Hayes 2020). This required a different calculation than the other two loans. We used the average daily balance method to calculate interest payments (Irby 2020). This method requires specific timing and quantities of withdrawals. We assumed a hypothetical farmer-borrower takes out $100 about halfway through each month.

In this model both incentives start in the first year for best comparison. We designed our model to vary incentive amounts from year to year based on changes in the farmer-borrower's efficiency, but this feature was not used in our analysis. We assumed constant improvement that warranted an equal amount of incentive every year. We also assumed that all payments are paid in full and on time. We didn't account for farmer-borrowers who make early payments, extra payments, or pay more than the monthly amount, nor did we account for those who are late on payments or default.

Once our model was complete we calculated the savings. For the rebate, savings equals the amount of the rebate. The savings for the reduced interest rate equals the difference between interest with the counterfactual interest rate and interest with the reduced interest rate. For our final step, we brought these amounts into present-value terms.

Lender profit calculation

Next, we used a variant of the Customer Lifetime Value formula to estimate the lender's profit generated by each product and by each product's counterfactual. Customer Lifetime Value determines the economic worth of a new customer by projecting the net cash flows expected from that customer over time, accounting for net present value (Berger and Nasr 1998). The Customer Lifetime Value framework measures how changes in customer behavior, such as changes in retention, might influence the customers' profitability to the firm (Chang, Chang, and Li 2012). We were able to use this framework to simulate how a borrower's behavioral response may influence the lender's profit across products.

Customer Lifetime Value is comprised of two steps:

1. Project the expected net cash flows received from the borrower over time.
2. Calculate the present value of that stream of expected cash flows.

Generally, factors of Customer Lifetime Value formulas can be classified into three categories: revenue, costs, and retention rate (Kumar, Ramani, and Bohling 2004). In addition to integrating customer retention rates, our approach to evaluating Customer Lifetime Value assumed that marketing and customer retention costs were incurred annually at the time of revenue generation. These assumptions led to the development of our Customer Lifetime Value (CLV) formula:

$$\mathrm{CLV} = \mathrm{GC} * \sum_{t=0}^{n}\left[\frac{r^t}{(1+d)^t}\right]$$

GC is the expected yearly gross contribution margin per customer. This equals total annual revenues minus total annual costs, which we assumed occur simultaneously each year. The variable n is the length in years over which cash flows are projected, r is the yearly customer retention rate, and d is the yearly discount rate.

Loan	GC	n	r	d
Annual operating loan	2.54%*interest	1	75%	20%
Equipment	2.54%*interest	5	75%	20%
Mortgage	2.54%*interest	15	75%	20%

Table 4.3. Variable values for Customer Lifetime Value Calculation

To calculate the value for GC we multiplied the interest of each product by 2.54 percent, which is the average net interest margin for three major financial institutions in 2019 ("Bank of America Annual Report 2019" 2019; "Wells Fargo & Company 2019 Annual Report" 2019; "JP Morgan Chase & Co. Annual Report 2019" 2019; "Federal Reserve Statistical Release: Large Commercial Banks" 2020). A financial institution's net interest margin is the percentage of interest kept by the bank. The remaining interest covers the bank's operating expenses. We assumed the customer retention rate r equals 75 percent for each calculation because this is an average for the industry ("Customer Satisfaction: Retention Rates by Industry Worldwide 2018" 2018). This value can change in new scenarios, such as to model full customer retention equal to 100 percent. We also assumed the discount rate equals 20 percent because this was recommended by "Customer Lifetime Value: Marketing Models and Applications" (Berger and Nasr 1998).

4.2 Results

Amortization Schedule

The amortization schedule calculated the potential savings a farmer-borrower could gain from participating in this program. We can compare these amounts to the costs of conservation practices. If the savings on interest do not equal or exceed the costs of actions that increase efficiency, then costs may prohibit behavior change. Farmers may not join the program, or they may not be able to improve efficiency if they do. Indeed, a report by the U.K.'s Agriculture and Horticulture Development Board on farmers' decision-making stated that "direct financial incentives to adopt particular behaviors are often needed because there is a cost associated with change," and further that "it is clear that farmers must perceive that there is some sort of reward or incentive to change behavior, otherwise they may stick with the status quo" (Rose, Keating, and Morris 2018).

The following table (table 4.4) indicates savings amounts in present value terms for each product. The savings differ greater by loans but are similar among incentives. The difference in savings between loans can be attributed to the different amounts of principal and tenor across loans. The savings between two incentives can be similar to each other if the values of the incentives are equal. It is important to note that the savings still differ among equal-valued incentives, which may be due to the timing and subsequent discounting of each incentive.

Product	Principal	Term	Savings on interest	Savings on interest in present value terms
line of credit + rebate	$1,200	1	$1.50	$1.42
line of credit + reduced interest	$1,200	1	$1.50	$1.44
equipment + rebate	$5,000	5	$33.07	$29.68
equipment + reduced interest	$5,000	5	$34.30	$29.00
mortgage + rebate	$15,000	15	$317.57	$242.71
mortgage + reduced interest	$15,000	15	$349.97	$196.53

Table 4.4. The savings of a rebate equals the value of the rebate. The savings for a reduced interest rate equals the counterfactual interest minus the interest with the reduced rate.

Greater savings translate to reduced interest payments for the farmer-borrower. The interest payments for each product are visualized over time in the three following figures (figures 4.1, 4.2, and 4.3). These figures compare interest payments for a loan with an incentive (counterfactual) to interest payments when the incentives are added:

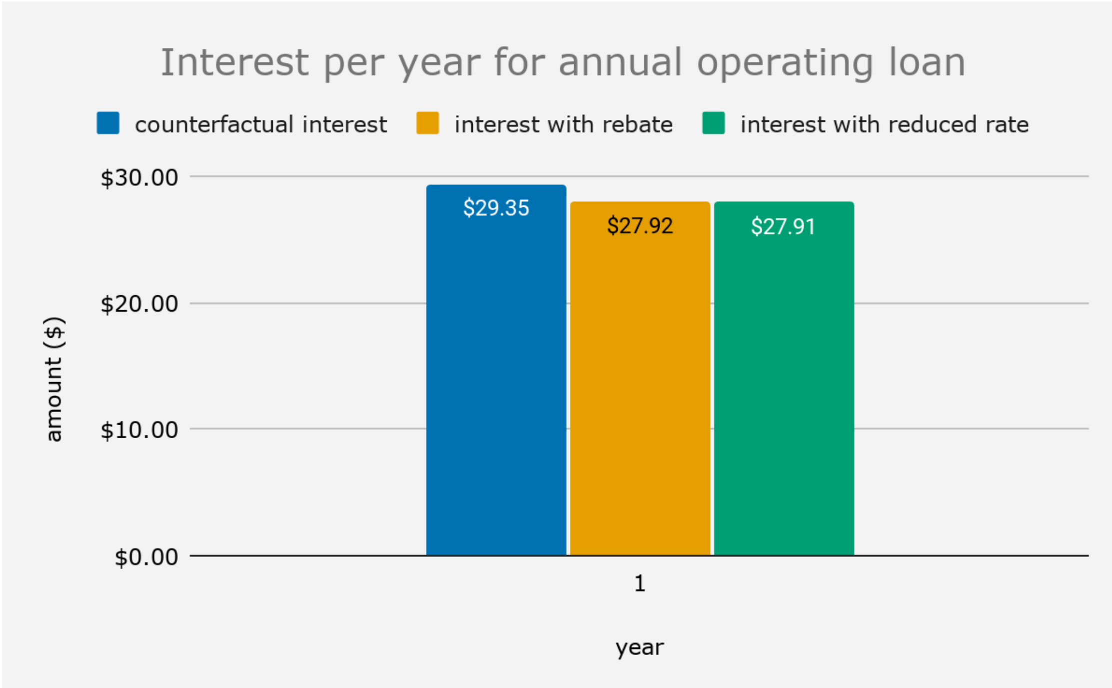

Figure 4.1. Interest per year for an annual operating loan under three scenarios: with no incentive (counterfactual), with a rebate, and with a reduced interest rate.

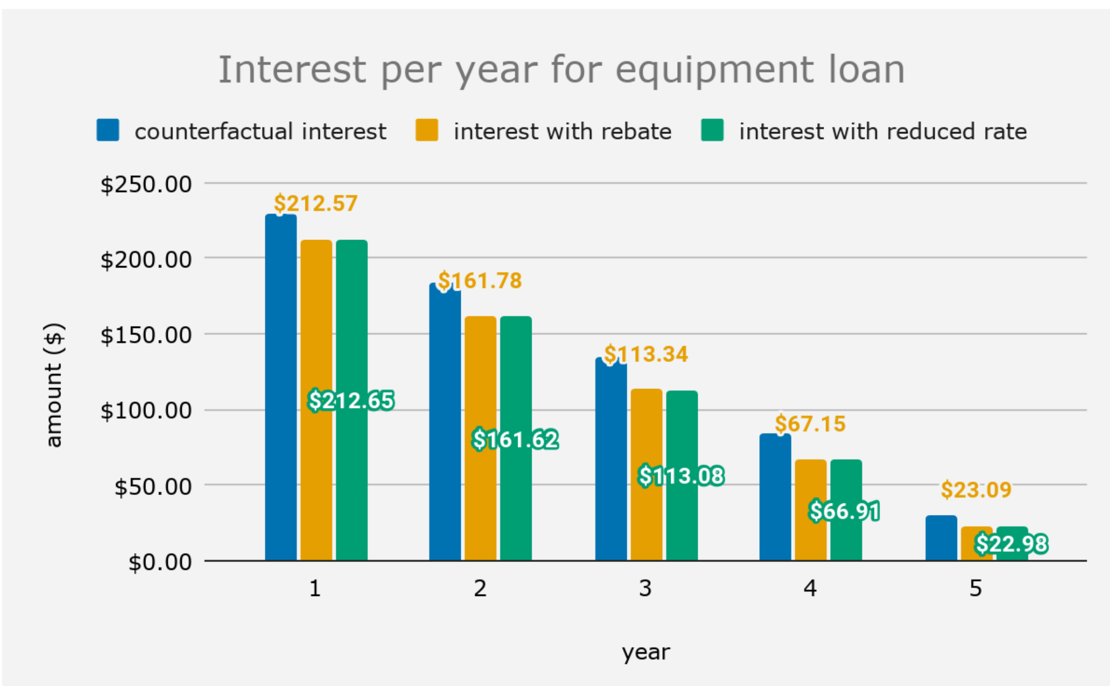

Figure 4.2. Interest per year for an equipment loan under three scenarios: with no incentive (counterfactual), with a rebate, and with a reduced interest rate.

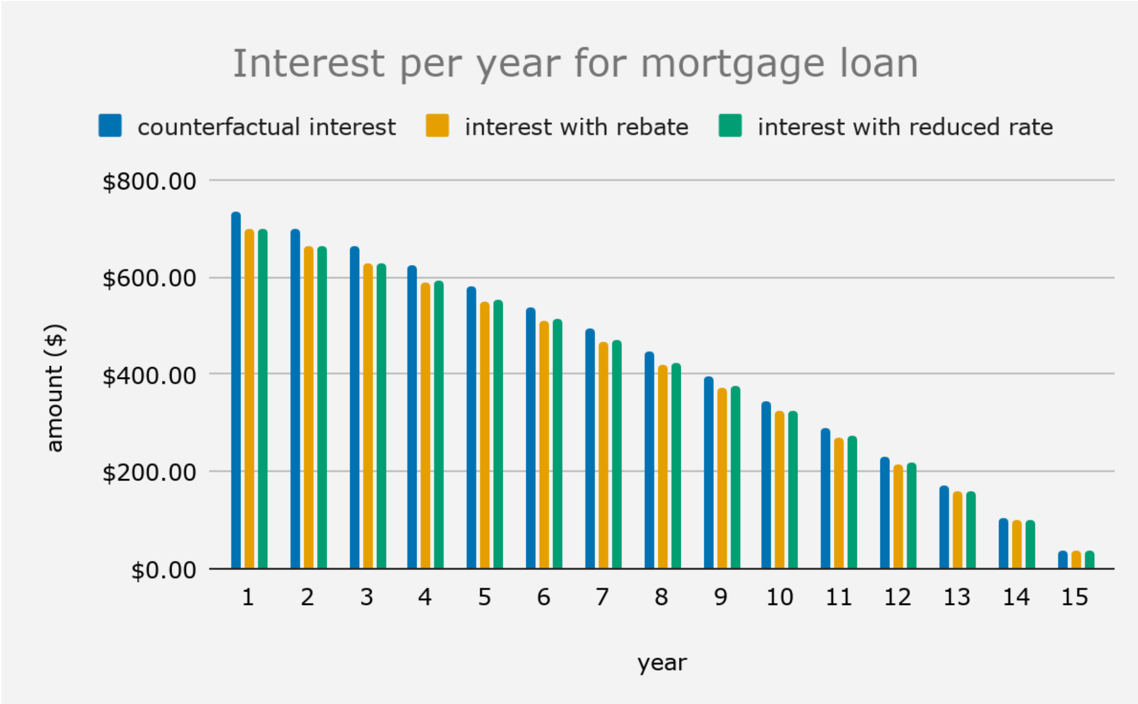

Figure 4.3. Interest per year for a mortgage loan under three scenarios: with no incentive (counterfactual), with a rebate, and with a reduced interest rate.

Our results indicate that the greatest differences between a rebate and a reduced interest rate may be the mechanism and timing of delivery. For example, a rebate payment is discounted at the annual time of delivery, but interest payments with a reduced interest rate are discounted every month. The values generated in our amortization table feed into the second half of the financial model, the Customer Lifetime Value calculation. This half of the model determines the value of this program for the lender.

Customer Lifetime Value

The Customer Lifetime Value evaluation calculated the lender's profit generated by customer uptake of each product. Every product and counterfactual generated positive outputs, meaning a lender could offer each product and still be profitable. What is important to lenders is how much profit they may lose after incorporating an incentive into a loan.

The following table displays the Customer Lifetime Value associated with each product and its counterfactual. We also included the maximum potential profit to the lender, equivalent to a client retention rate of 100 percent. Our results generally show that lenders' profit is less from loans that incorporate conservation incentives than loans that do not.

Product	Principal	Term	Total Interest Collected	Maximum Lender Profit	Customer Lifetime Value
line of credit	$1,200	1	$29.90	$0.63	$0.47
line of credit + rebate	$1,200	1	$28.41	$0.60	$0.45
line of credit + reduced interest	$1,200	1	$28.41	$0.60	$0.45
equipment	$5,000	5	$661.37	$11.40	$6.70
equipment + rebate	$5,000	5	$628.30	$10.83	$6.36
equipment + reduced interest	$5,000	5	$627.07	$10.82	$6.35
mortgage	$15,000	15	$6,351.43	$67.58	$28.37
mortgage + rebate	$15,000	15	$6,033.86	$64.20	$26.96
mortgage + reduced interest	$15,000	15	$6,001.46	$63.99	$26.91

Table 4.5. Baseline Customer Lifetime Value evaluation results, undiscounted sum of all interest payments collected, and the maximum possible profit to the lender for each product.

While lender profit was lower for loans with incentives, lenders may be able to gain profit back if incentives improve customer retention. The following figures show that lenders' profit increases as customer retention increases. Lenders can earn greater profits from loans that increase retention. Loans with conservation incentives may increase retention by requiring commitment in order to qualify for rewards, and also by reducing the chance of default through lowering interest payments. The simulation illustrates how the lenders' risk changes in response to borrower's behavior.

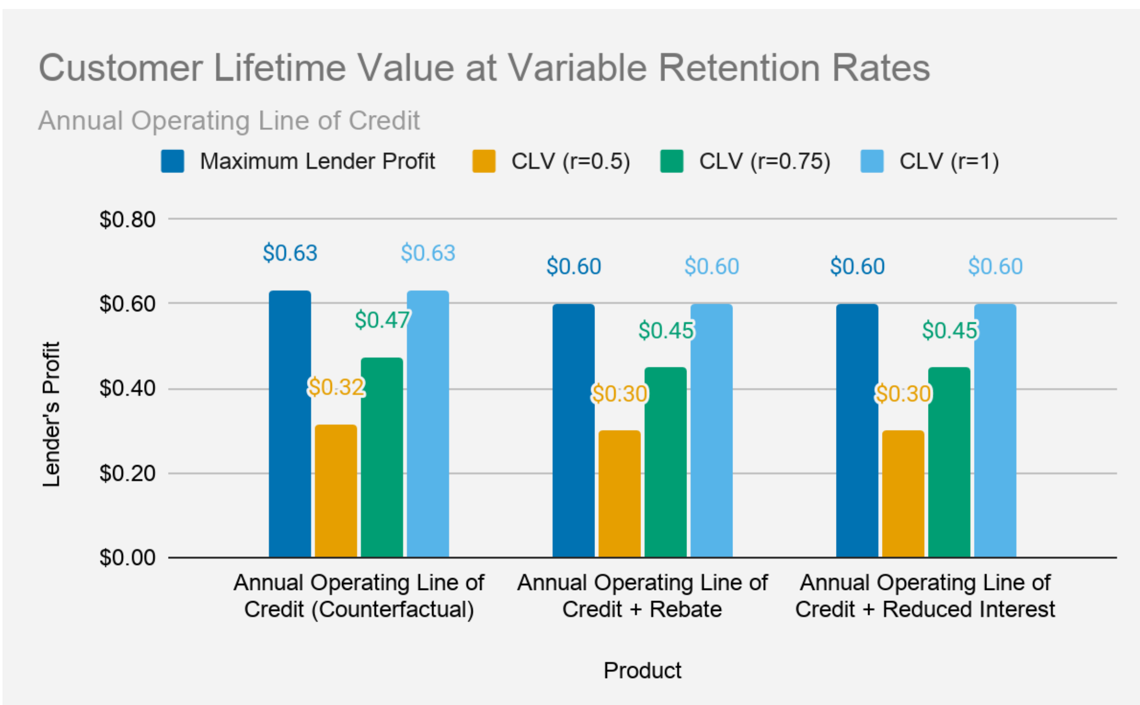

Figure 4.4. A comparison of the lender's maximum possible profit to Customer Lifetime Value outputs at retention rates of 50 percent, 75 percent, and 100 percent for the counterfactual annual operating line of credit, an annual operating line of credit offered with a rebate on interest paid, and an annual operating line of credit offered with a reduced interest rate.

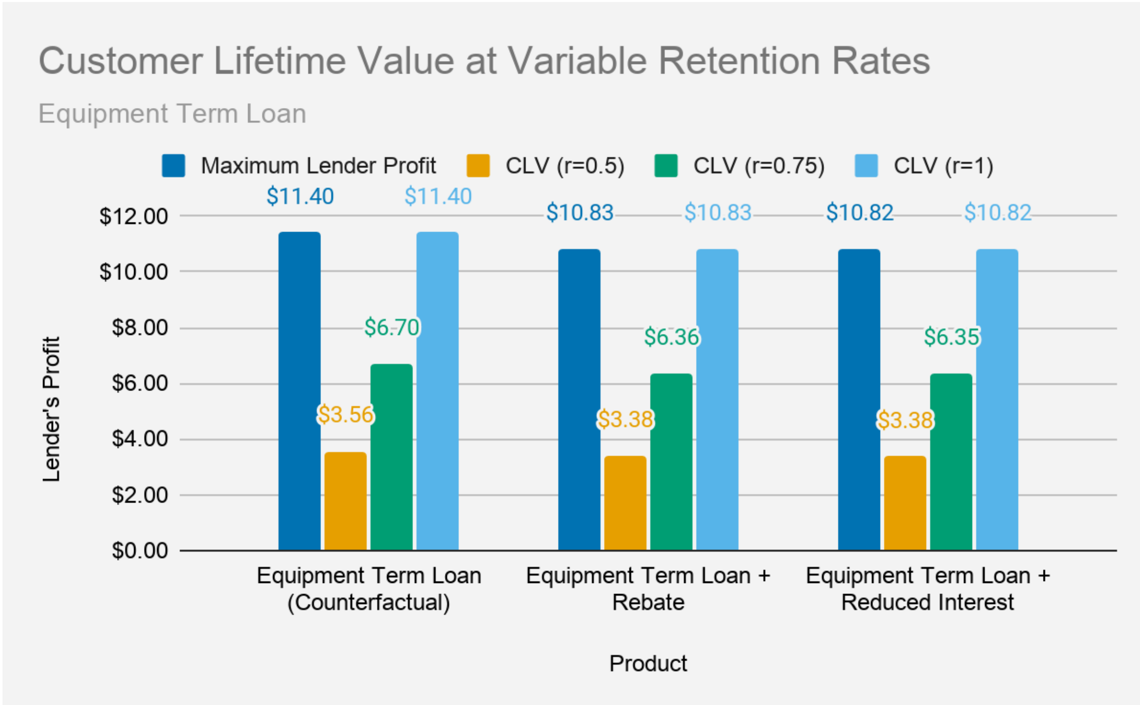

Figure 4.5. A comparison of the lender's maximum possible profit to Customer Lifetime Value outputs at retention rates of 50 percent, 75 percent, and 100 percent for the counterfactual equipment term loan, an equipment term loan offered with a rebate on interest paid, and an equipment term loan offered with a reduced interest rate.

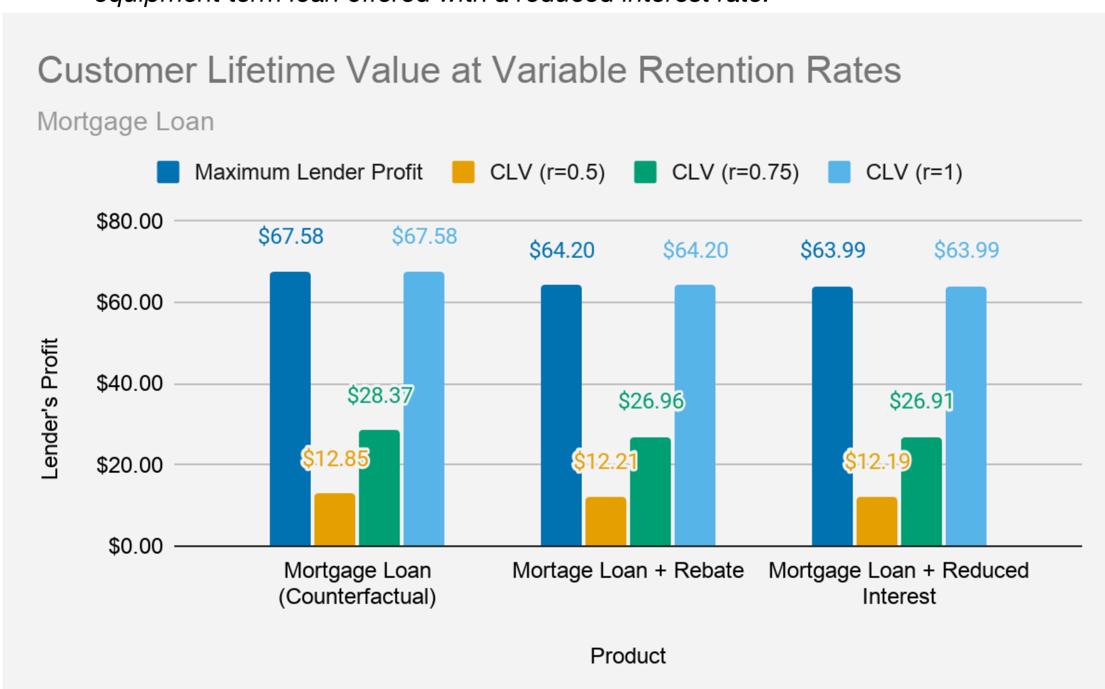

Figure 4.6. A comparison of the lender's maximum possible profit to Customer Lifetime Value outputs at retention rates of 50 percent, 75 percent, and 100 percent for the counterfactual mortgage loan, mortgage loan offered with a rebate on interest paid, and mortgage loan offered with a reduced interest rate.

Offering conservation incentive products may lead to the acquisition of new clients or the retention of existing clients. More exploration into borrower and lender uptake is a critical next step in understanding the total potential profitability that could result from these products. Furthermore, long-term studies have shown that lenders can benefit from supporting resilient agriculture through the realignment of their lending risk portfolios among other financial benefits (Monast 2020).

Determination of most profitable loan-incentive product(s)

We completed this financial analysis to address our project's second objective: to determine the most profitable loan-incentive product(s) for both borrowers and lenders. After completing this exercise, however, we believe this might not be possible. The two incentives we modeled can have equal value, and the savings generated from each were similar across loans, although they were not identical. The difference in savings may have to do with the different timing of incentives and subsequently the way they were discounted.

Since the incentives can have equal value, the major difference between them is the timing and delivery of benefits. A rebate delivers a year's worth of benefits in one amount at the end of the year, while a reduced interest rate delivers benefits in the form of reduced payments over the same time period. It would be interesting to know which incentive lenders and farmers prefer. Our questionnaire revealed that lenders may be more willing to incorporate a partial rebate than a variable interest rate into a loan. Additional surveys of lenders could be useful to determine why this preference exists. Likewise, surveys of farmers are needed to understand which incentives they prefer and why. Knowing these perspectives may help design "pay for performance" programs that are better for both lenders and farmer-borrowers.

Future iterations of this financial model should incorporate the financial benefits of conservation practices and agricultural efficiency. The Customer Lifetime Value calculation showed that lenders lose profit on a loan when they incorporate an incentive, but it did not include the long-term benefits of conservation practices which the incentive promotes, such as profits from improved yields or cost-savings from using less water and fertilizer.

Chapter 5: Water and Nitrogen Savings Estimates

5.1 Methodology

In order to get an idea of the kind of impact these financial incentive programs could have, we attempted to estimate how much groundwater (and subsequent nitrogen) could be saved within the 180/400 ft. Aquifer. This is a very rough estimate, and many assumptions are made in order to account for numerous uncertainties surrounding several parameters. Outlined below is an explanation of the parameters which were used, their data sources, and uncertainties and explanations for why we chose particular sources. Additionally, our rough calculations are provided.

For each crop, we defined the following parameters in order to make our calculations:

1. Crop acreage 180/400 ft. Subbasin (and SV?)
2. Crop water demand (crop coefficient)
3. Average amount of water applied
4. Irrigation efficiency to be achieved after improvements
5. Average amount of nitrogen applied
6. Nitrogen application rate to be achieved after improvements
7. Portion of those acres making these improvements (by choice or access to programs)
8. Current annual groundwater overdraft in the 180/400 ft. Aquifer

Crop acreage

In selecting our example farmer, we looked at what crops represent the highest value in the Salinas Valley. According to the (Monterey County Agricultural Commissioner 2019), the highest value crop is leaf lettuce followed by strawberries and head lettuce.

It is very difficult (if not impossible) to quantify the amount of a single crop grown in the 180/400 ft. Aquifer in an individual year, as acreage can change rather drastically from season to season (MCWRA 2018, 2019). This is a result of many farmers renting the land they work on. For example an individual landowner may rent a field to a strawberry farmer for one season and then to a farmer growing a different crop the next, due to the high pesticide inputs typical of strawberry crops. Additionally, many of the crop amounts reported are done so voluntarily, so there is not always a high confidence that the data is complete (Tamara Voss 2021).

Because of these annual changes in crop acreage, we were unable to find an exact acreage acreage for the 180/400 ft. Aquifer for strawberries and romaine. By cross-referencing multiple years of Monterey County Crop Reports and the Monterey County Water Resources Agency's annual Groundwater Extraction Reports (GEMS), we were able to reasonably estimate romaine and strawberry acreage within the 180/400 ft Subbasin.

Representative irrigation efficiencies

Again, this is something for which little definitive data exists. We have several estimates from various sources, which state that average farmers for romaine use anywhere from sub-crop water demand (Resource Conservation District of Santa Cruz County and Sustainable Conservation 2016) to 14 inches to almost 29 acre-inches, approximately 300 percent of the crop water demand. While the main measure of crop water demand we consider for the Salinas Valley is 8 acre-inches, this coefficient can change within the same basin according to underlying soil type/geology. The UC Davis Cost and Return Studies, which aim to provide typical characteristics for Monterey County farm practices, provide an average water use metric of 14 acre inches for romaine (UC Cooperative Extension 2019). This was chosen as our lower bound for water use. The largest sample of lettuce farmers taken by Sustainable Conservation finds that average water use is approximately 208 percent of crop water demand, or about 16.7 acre-inches. This was chosen as our upper bound, to account for the possibility that the population of farmers that the client works with have different irrigation habits than the "average" Monterey County farmer.

Even with these multiple data sources, a fair amount of variation in irrigation water use can be expected from year to year, along with fluctuations in precipitation and temperature. These natural differences can make it challenging to draw meaningful conclusions, especially across short time scales ("SISC Case Studies: Success Stories, Backed up with Real Data" n.d.).

Water efficiency improvement expectations

For this metric we encountered examples of romaine farmers achieving 100 percent or better water use efficiency ("SISC Case Studies: Success Stories, Backed up with Real Data" n.d., Resource Conservation District of Santa Cruz County and Sustainable Conservation 2016). At the same time, one expert in Monterey County farming practices has stated that it would be realistic for a rather inefficient water user to reduce water use by only about 10 percent, equivalent to one or two acre-inches (McCune 2020). We will use both cases in our calculations to account for this variability.

Representative nitrogen application rates

The nitrogen uptake for romaine along the Central Coast is 120-160 lb N/acre (Hartz, Cahn, and Smith 2017). For our calculations, these will represent the bounds of *achieved* application efficiency (while 100 percent efficiency is set at 140 lb N/acre, the midpoint). Our lower bound of *initial* nitrogen application will be 175 lb N/acre, the average application rate for Monterey County, according to a regional expert (McCune 2020). Our upper bound is set at 298 lb N/acre, the average nitrogen application rate in a study of 24 fields within Monterey and Santa Cruz Counties. Behavior in this sample varied widely, ranging from 144 - 567 lb N/acre (California FarmLink and Resource Conservation District of Santa Cruz County 2016).

A range of nitrogen application rates for strawberries was adopted from a study of Central Coast strawberry production which surveyed growers' nitrogen application rates. The lower and upper bounds are 125 and 430 lb N/acre, respectively (Bottoms et al. 2013b). 138 lb

N/acre represents a lower estimate 100 percent efficiency in this scenario. This number is adopted from studies of strawberry production in regions outside of the Central Coast (Bottoms et al. 2013b), as no conclusive studies of nitrogen application for strawberry crops are available within our study region. It has, however, been suggested that Central Coast strawberry crops may require higher nitrogen inputs as compared to other regions such as Florida and Argentina (Bottoms et al. 2013a). 220 lb N/acre is the upper estimate of 100 percent efficiency. This number represents the upper limit of a range provided for total seasonal nitrogen uptake by strawberry crops on the Central Coast.

Nitrogen efficiency improvement expectations

Similar to water use efficiency, it was not uncommon among case studies for farmers to achieve 100 percent efficiency, even after applying 200 percent or more of crop demand during the previous growing season (Resource Conservation District of Santa Cruz County and Sustainable Conservation 2016).

Participation metrics

While we cannot determine how many farmers will want to participate in these loan programs, we can get a rough idea of what proportion of farmers will have access to these programs. Using data from the USDA's Economic Research Service we were able to calculate which percentage of farm sector debt was held by commercial banks for real estate and non-real estate loans ("USDA ERS - Farm Household Income Forecast" 2021). We used these percentages as a proxy for the percentage of farms in the 180/400 ft. Aquifer that would have access to these programs. These percentages represent the upper bound in our water savings calculations. It should be noted that the data made available by the USDA ERS is representative of all farm sector debt, and is not broken down by farm size, crop type, or region.

Overdraft volume

The 180/400 ft. Aquifer's Groundwater Sustainability Plan estimates modern overdraft at 65,800 acre-feet per year (SVBGSA 2020). This is the volume which each crop's potential water savings will be compared against to understand the impact of efficiency improvements.

The equations used to calculate annual water and nitrogen savings are as follows:

Water savings = (initial water use - achieved water use) * (crop acreage) * (% participation)

The resulting volume can then be divided by the volume of annual overdraft in the 180/400 ft. Aquifer to find the percentage of annual overdraft achieved by these parameters.

Nitrogen savings = (initial nitrogen use - achieved nitrogen use) * (crop acreage) * (% participation)

The output of this calculation will not be translated further and will remain in units of pounds of nitrogen applied per acre. Ideally, with more research, this number will be translated to the amount of nitrate leaching abated, and in turn a measurement of water quality.

5.2 Results

Water Savings

We calculated the potential annual water savings for the 180/400 ft. Aquifer Subbasin based on parameter estimates for average water use, efficiency improvement potential, and participation percentage. The least-water-saved (lower) and most-water-saved (upper) scenarios are outlined for romaine and strawberries in the two tables below.

Romaine

	Initial water use (acre-in)	Achieved Water use (acre-in)	New efficiency	Water saved (ac-in/ac)	Romaine acreage	Participation	Water saved (acre-in)	Portion of annual overdraft
Lower	14	13	163%	1	10,000	5%	500	0.06%
Upper	16.69	8	100%	8.69	10.000	46.3%	40,235	5.1%

Table 5.1. Lower and upper estimates for annual water savings from romaine crops. Note that lower and upper estimates represent the smallest and largest likely volumes of water savings, as opposed to the smallest and largest value of each parameter.

Strawberries

	Initial water use (acre-in)	Achieved water use (acre-in)	New efficiency	Water saved (ac-in/ac)	Strawberry acreage	Participation	Water saved (acre-in)	Portion of annual overdraft
Lower	27.5	26.5	119%	1	2,218	5%	111	0.014%
Upper	34.8	22.35	100%	12.45	2,218	46.3%	12,785	1.62%

Table 5.2. Lower and upper estimates for annual water savings from strawberry crops. Note that lower and upper estimates represent the smallest and largest likely volumes of water savings, as opposed to the smallest and largest value of each parameter.

Our water-savings estimates show that under the best of circumstances, combined efforts by romaine and strawberry farmers in the Salinas Valley have the potential to reduce groundwater overdraft in the 180/400 ft. Aquifer Subbasin by ~4,400 acre-feet per year, equivalent to approximately 6.7 percent of the estimated annual overdraft in the Subbasin.

One major takeaway from this exercise is that by targeting those farmers who have the most inefficient water-use practices have the potential to contribute the most to lessening groundwater overdraft. Compare, for example, graphs 10 and 18 below. 10 and 18 represent theoretical initial water use (acre-inches per acre) before improvement. In each scenario, 100 percent efficiency is eventually achieved. It can be seen that the amount of water saved (represented by the blue triangle) by the population with an initial water use of

18 acre-inches/acre has the potential to save significantly more water than the population with an initial water use of only 10 acre-inches/acre.

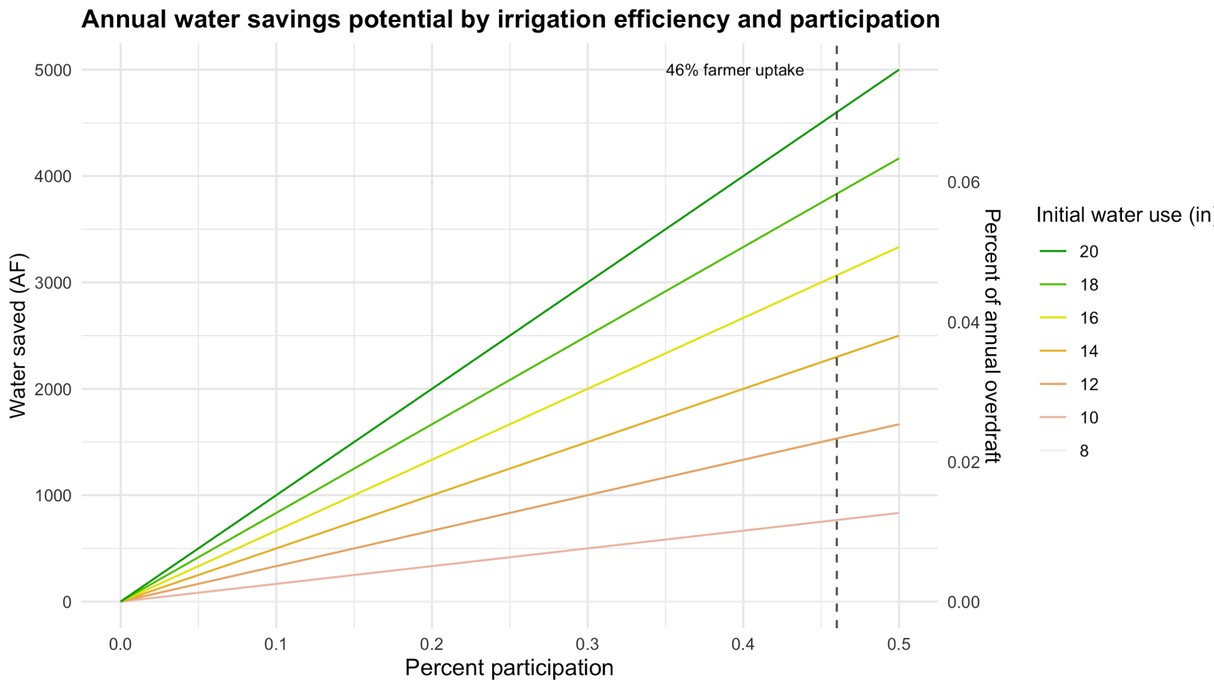

Figure 5.1. Annual water savings potential by irrigation efficiency and participation. Each line represents a different value of initial water application, in units of acre inches/acre. The dotted line represents 46% participation, equivalent to the portion of agricultural debt held by commercial lenders.

Nitrogen Savings

Nitrogen savings were calculated in much the same way as water savings, based on parameter estimates for average nitrogen application, efficiency improvement potential, and participation percentage. The least-nitrogen-avoided (lower) and most-nitrogen-avoided (upper) scenarios are outlined for romaine and strawberries in the two tables below.

Romaine

	Initial nitrogen application (lb N/acre)	Achieved nitrogen application (lb N/acre)	New efficiency	Nitrogen avoided (lb N/acre)	Romaine acreage	Participation	Nitrogen avoided (lb N)
Lower	175	160	114%	15	10,000	5%	7,500
Upper	298	120	85.7%	178	10,000	46.3%	824,140

Table 5.3. *Lower and upper estimates for annual nitrogen avoided from romaine crops. Note that lower and upper estimates represent the smallest and largest likely amounts of nitrogen avoided, as opposed to the smallest and largest value of each parameter itself.*

Strawberries

	Initial nitrogen application (lb N/acre)	Achieved nitrogen application (lb N/acre)	New efficiency	Nitrogen avoided (lb N/acre)	Strawberry acreage	Participation	Nitrogen avoided (lb N)
Lower*	125	125	100%	0	2,218	5%	0
Upper	430	138	100%	292	2,218	46.3%	299,865

Table 5.4. *Lower and upper estimates for annual nitrogen avoided from strawberry crops. Note that lower and upper estimates represent the smallest and largest likely amounts of nitrogen avoided, as opposed to the smallest and largest value of each parameter itself. *Note: for lower bound estimates, avoided nitrogen is zero. This is due to the wide range of values available regarding nitrogen use for strawberry crops, as described in section 5.1.*

Chapter 6: Discussion

6.1 Insights

Financial incentives in the context of a broader solution

Incorporating environmental incentives into lending schemes is just one part of a larger effort needed to achieve groundwater sustainability. This is true not only for the Salinas Valley, but for the rest of California's overdrafted basins, as well as many basins across the arid West. Lenders and farmers alone cannot facilitate the enormous water savings necessary to reach water quantity and quality objectives outlined by state and regional legislation. Much of this comes down to funding.

An estimated $350 billion is required over the next 50 years to adequately manage the state's water resources (O'Daly et al. 2018). While some mechanisms that encourage water savings already exist, historical funding trends are no longer adequate to support the level of investment needed. From 2006 to 2015, a mere 2 percent of the annual state budget was put toward water resource management (O'Daly et al. 2018). A greater commitment is needed to provide necessary relief for communities struggling to solve a problem created by many.

Beyond government resources, several other mechanisms can contribute to easing the groundwater burden. Public-private partnerships, for example, can facilitate water savings by providing funding for projects, such as infrastructure improvements, which farmers, irrigation districts, or regional entities could not afford on their own. While this involves risk on the investor's side, many private actors recognize an investment in water resource protection as an investment in business security (Bonneville Environmental Foundation n.d.).

Other mechanisms for groundwater resource protection

Water market tools and mechanisms have been gaining traction as water management strategies throughout the state. In theory, water markets have the potential to transform the ways in which our resources are used and valued, allowing for the price of water to be distilled and traded according to its revealed worth, while allowing for flexibility in managing a limited and unpredictable water supply through both short and long-term leases of water rights (Szeptycki et al. 2020). Successful examples of water market implementation in the midst of SGMA tend to have several enabling conditions which make implementation smoother and long-term success more likely. Among these are stakeholder support, funding, fixed water allocations, and market design expertise (Heard et al. 2019).

While water market tools and mechanisms are an exciting option to promote change and responsible management in many instances, they are sometimes incompatible with other goals, especially those related to social equity. For example, wealthy water users may be able to purchase the amount of water they need while poor water users will not. If a water market were to be explored in the Salinas Valley in the future, incorporating it as part of a broader “portfolio approach” would help to take advantage of the strengths of market tools while accounting for the needs of all users. However, given that it was not seriously considered during the formation of the Groundwater Sustainability Plan, later attempts at groundwater market implementation would likely be very challenging and encounter significant opposition from many stakeholders.

Financial model and analysis insights

Two questions came about during our financial calculation: (1) do the savings from an incentive cover the costs of conservation practices for the farmer-borrower, and (2) do the benefits of conservation practices equal or surpass the costs to the lender to offer conservation incentives? The savings of an incentive could fund the costs of actions that increase efficiency, such a technology or behavior change. We need to know the costs of actions to determine if an incentive can cause change. We also need to know the value of conservation actions to lenders in dollar amounts. When the costs and benefits of conservation actions are not priced, they cannot be included in a financial analysis.

We should also consider which combination of loan and incentive is best to increase efficiency. Our questionnaire responses most advocated for an annual operating loan, but it is uncertain if a short-term loan can successfully implement conservation practices. This is because the benefits of conservation practices can take years to develop. For this reason, a long-term loan may be preferable. At the same time, if annual operating loans are renewed continuously for the purpose of securing incentives, then pairing an incentive with a short-term loan may successfully implement conservation practices and benefit lenders with increased client retention.

Finally, our financial calculation showed that the savings of a rebate and a reduced interest rate can almost equal if the incentives are equal. This is interesting given that questionnaire respondents preferred the rebate over a reduced interest rate, More research is needed to understand this preference and further clarify the lending industry’s attitudes towards conservation incentives.

Market share of commercial banks

Though “[m]ost farmers cannot farm without access to credit” (Coppess and Sherrick 2020), not all farms take out loans from commercial banks. In 2016, commercial banks and the Farm Credit system combined held 80 percent of U.S. agriculture debt, with each holding about 40 percent (Monast, Sands, and Grafton 2018). Since commercial banks cannot capture the entire market, we need solutions that reach farms who lend with non-commercial banks. At the same time, commercial banks can offer an incentive as a marketing tool, thus setting themselves apart from their competitors, especially non-commercial banks who can’t offer the same incentives.

Encouraging adoption of agrifinance conservation programs

The Farm Service Agency (FSA) offers Conservation Loan Programs specifically to help farms implement NRCS-approved practices ("Conservation Loan Program: Fact Sheet" 2020), but this resource hasn't been widely adopted (Woodard et al. 2019). A lender interviewed in a separate study another paper stated that, "FSA programs can be viewed as difficult to administer, requiring onerous paperwork, and that they come with restrictions on behavior that could create risk and operating challenges for farmers" (Woodard et al. 2019). Programs need to consider lenders' input so they're easier to use and thus more successful. Indeed, the benefits of conservation practices "must convert into reduced cash flow risk, improvements in efficiency or asset value, or price premiums in order to be captured in a manner that can benefit farmers and landowners or be taken into consideration by lenders and investors" (Woodard et al. 2019). Perhaps the next step to close the gap between conservation science and implementation is making clearly known the economic benefits of these practices to farmers, lenders, and other stakeholders.

Data Limitations

Data limitations are a major challenge for lending incentives that target conservation. Without farm data, efficiency improvements can't be quantified or rewarded.

Both farmers and financial institutions keep detailed data, but accessing it is difficult due to its proprietary nature. Additionally, attitudes and norms in the agricultural industry can hinder good data collection. A recent study found that nearly half of farmers store their data on paper records, and of the farmers who use electric software, 70 percent had data gaps in necessary fields. The study also observed that farmers do not trust the government and private companies with their data. One issue is that farms don't profit from data sharing, but companies upstream of them do (Slattery, Rayburn, and Melhart Slay 2020).

Another challenge is a "profound analytics gap," or the inability to convert farm data into meaningful information for finance institutions (Woodard et al. 2019). Banks lack the means to interpret environmental data and as a result cannot incorporate it into their credit risk assessment. This gap could be bridged through investments "in the form of institutes to create standards, or companies to deliver and process these metrics for banks, investors, and insurance companies" (Woodard et al. 2019). When banks can better incorporate environmental metrics into their analysis, a lending incentive for conservation may be more scalable.

Lending incentives may help make agricultural data more transparent. The Farm Environmental Performance Rebate Financing pilot program required data recording as a prerequisite to qualify for incentives, for example. Neither farms nor banks, however, may be equipped to complete the necessary data monitoring and reporting for free. For this reason, requiring third-party certification from trusted partners like the NRCS in lending contracts can help collect data and make it more accessible.

Impacts on marginalized farmers

Social inequality within the agrifinance industry is paramount to this project. In the U.S., 98 percent of all farmland is owned by white people (Horst and Marion 2019). Farmers of color are "more likely to be tenants rather than owners, [own] less land, and [generate] less farm-related wealth than their white counterparts" (Horst and Marion 2019). On top of these racial inequalities, there are also gender inequalities in farming. Females own and operate less land and generate less income than white male farmers. Despite a lawsuit in 2019 to require more people of color and women in USDA's selection of loan recipients, historical trends haven't changed (USGAO 2019). Farmers make little profit, yet they are being challenged to improve efficiency and adopt conservation practices which can be costly. Additionally, the compliance costs of new regulations will disproportionately impact farmers who are in debt and have a lower income, which tend to be farmers of color and female farmers. A program that considers the need for farmers to have equal access to loans and prevents farmers from being forced further into debt will have cascading effects throughout America. It will make food systems more reliable, and will prevent already disadvantaged populations from bearing the burden of implementing sustainable practices across the U.S.

6.2 Recommendations for future research

Consideration of land ownership

In the United States, generally 60 percent of farmland is owned by farmers, while 40 percent is rented ("USDA ERS - Farmland Ownership and Tenure" n.d.). Farmers who are renters may not want to increase the land's value through conservation practices if this value only transfers to the land owner. A landowner could raise rent if a farm's conservation practices increase land value (Coppess and Sherrick 2020). Because of this, "the distinction between land managers, farm operators, and landowners should be carefully considered in structuring" pilot projects (Woodard et. al. 2019). Addressing potentially unequal benefit transfers is important to improve a program's uptake of scalability. For example, products could be designed specifically for land owners. More research is needed to determine how land ownership affects conservation incentives, but we suggest knowing how much farmland is renteed and how much is owned before undertaking a pilot program. A program's effectiveness may be impacted by this distinction.

Farmer population surveys

In order to further develop the ideas explored during the course of this project, we suggest a few improvements to our methodology based on the lack of data that we ran into on both sides of the relationship between the agrifinance industry and agricultural producers. Depending on the focus of future research in this area, there is a desperate need for additional farm-level data and information for the specific study area. In our case we focused on the Salinas Valley, where helpful data about farmer finances specific to the area are inaccessible. In addition, it is even more difficult to make accurate determinations of the acreage grown for any specific type of produce if attempting to limit the study to a certain groundwater basin. County level data was useful to gain a general understanding but not to formulate clear and targeted recommendations for future courses of action. To deal with this challenge, we suggest the survey of agricultural producers regarding their finances related to profits, conservation practices, water management, and fertilizer use. This survey of agricultural producers would also be useful in ascertaining their interest in and desire for incentives to support resilient or sustainable agricultural practices. Surveying farmers comes with its own set of challenges, so there may be other ways of accessing this type of raw data at the state or county level.

Agrifinance relationship development

For our survey and other interactions with the agrifinance industry, we were challenged by a lack of access to professionals in the industry as well as the proprietary nature of information about financial institutions. Further work with the agrifinance industry in examining their role in encouraging sustainable agricultural practices is necessary, and it demands the development and maintenance of strong relationships with multiple individuals in the institution. Working with multiple individuals within the same agrifinance institution should allow for an overlap of organizational and industry knowledge. Employees from all levels should be sought, including lenders who work closely with clients and those in leadership positions who can enact change. This provides a two-fold solution to this challenge which involves the development and implementation of a pilot program with a specific commercial agrifinance institution and select agricultural producers and/or landowners. This would provide, at a small and region-specific scale, the opportunity for third-party organizations to most accurately understand the relationship between agricultural clients and lenders around the topic of sustainable and resilient agricultural behavioral change. Hopefully, it would also provide a way to navigate the hurdle of privacy and proprietary information from both parties.

Implications of recommended future research

Related areas of study that were not relevant to our project but may be interesting to consider in future research include food waste and agricultural prospects outside of California. Pursuing these areas may help us to see the bigger picture regarding conservation in agriculture.

Food waste in the United States is estimated to be 30 to 40 percent of the food supply ("Food Loss and Waste" 2021). This waste is bad for the economy and our natural resources, including water. Although our project focused on increasing agricultural water efficiency to achieve sustainability, reducing food waste can have a similar impact. In 2015, the USDA and the EPA set a goal to reduce food waste by 50 percent by 2030 ("Food Waste FAQs" n.d.). If achieved, this reduction could have major impacts on the agricultural system, including reducing demand and thus using less water.

Making groundwater resources sustainable under SGMA could have impacts that extend beyond farmers going bankrupt. Inside of the agricultural community, there is talk of agriculture moving to other states where water is unregulated. Don Steward from UC Davis mentioned that he believes that agriculture will move to Nevada (2021). Additionally, groundwater pumping in Arizona is unregulated, and some large corporate farms have already begun moving there, lowering the levels of groundwater that may take thousands of years to recoup (James and O'Dell 2019). Agriculture moving to states that have unregulated groundwater use is ultimately moving the problem elsewhere, but not actually fixing the issue of sustainability.

Chapter 7: Conclusion

As California's groundwater resources become increasingly scarce, new strategies must be developed to ensure a reliable and resilient water future. As sustainability-focused resource management legislation increases the financial burden on the already vulnerable agricultural sector, creative solutions are needed to protect financially insecure farmers from further economic distress. The agricultural lending industry may present an opportunity for farmer-borrowers to receive valuable financial assistance in exchange for improved on-farm management of water and nitrogen inputs.

To investigate the feasibility and scalability of this proposal, we developed a survey aimed at understanding commercial lenders' attitudes toward environmental sustainability as it relates to agricultural lending practices. Analysis of the survey results helped inform the development of several loan products incorporating financial rewards in exchange for establishing and acting upon an approved on-farm conservation plan. These theoretical loan products were each modeled in order to determine the economic benefits to both the farmer and lender. Finally, the potential water savings was estimated incorporating a range of parameters including irrigation efficiencies, efficiency improvement potential, and participation.

Our analysis will serve to assist our client, Sustainable Conservation, in determining the scalability of incorporating "pay for performance" incentives into loan products, both in the Salinas Valley and more broadly. Additionally, our work will help to educate agricultural lenders of the potential impacts of these actions, in terms of both natural resource conservation, market segment resiliency, and their bottom line.

Our water-savings estimates show that under the best of circumstances, romaine and strawberry farmers in the Salinas Valley have the potential to reduce groundwater overdraft in the 180/400 ft. Aquifer Subbasin by ~4,400 acre-feet per year. This volume is equivalent to approximately 6.7 percent of the estimated annual overdraft in the Subbasin. However, considering our financial model and survey results analyses, achieving this significant number seems unlikely. Survey results showed that the majority of commercial agricultural lenders are lukewarm at best in regards to willingness to incorporate financial incentives based on environmental performance into loan structures. Further, calculations of lender benefits from these loan products through comparisons of Customer Lifetime Value do not present a convincing argument for new product takeup.

In general, commercial banks do not see themselves as the drivers of change, and therefore these new loan products. It is clear that the value of sustainable water resources is not accurately priced into the lending process, and there exists a motivation disconnect for the lender. Although many in the industry do recognize the need for change, a policy-driven approach which then forces lenders to act is likely a more realistic scenario. Nonetheless, industry-wide adoption is not necessary, nor advisable, in order to spur farmer buy-in. A lender who is able to bring these unique products to market may be able to capitalize on the eagerness of potential borrowers (who are either borrowing from another lender or not yet borrowing) to take advantage of more favorable loan terms and take steps toward lower-impact farming. Moving forward, a pilot project with a commercial lender partner can help to better understand the efficacy of this approach. Increased data collection efforts combined with survey dissemination to a broader audience, including farmers, can also offer insight into loan product design and program implementation.

References

"Agricultural Business Insurance." n.d. Penn State Extension. Accessed February 20, 2021. https://extension.psu.edu/agricultural-business-insurance.

"Agricultural Lending: A How-To Guide." 2015. Vietnam: International Finance Corporation, World Bank Group. https://www.ifc.org/wps/wcm/connect/2c6304b6-b061-420e-a54f-7d56eccb2695/Agricultural+Lending-A+How+To+Guide.pdf?MOD=AJPERES&CVID=l1-jZp.

Apallas, Alex. 2016. "The Life Cycle of a Wine Grape: From Planting to Harvest." WineCoolerDirect.Com. July 6, 2016. https://learn.winecoolerdirect.com/life-cycle-of-a-wine-grape/.

AQUAOSO. 2020. "Changes In California Agricultural Water Conservation Post SGMA." AQUAOSO. September 21, 2020. https://aquaoso.com/blog/changes-california-agricultural-water-conservation-sgma/.

"Bank of America Annual Report 2019." 2019. Bank of America.

Bankakademie Micro Banking Competence Centre. 2010a. "Lesson 1: The Challenges of Agricultural Lending." Rural Finance & Investment Learning Center. 2010. http://www.ruralfinanceandinvestment.org/sites/default/files/1164410190454_AgLend_Lesson1.pdf.

———. 2010b. "Lesson 2: The Importance of Agricultural Knowledge." Rural Finance & Investment Learning Center. 2010. https://www.rfilc.org/wp-content/uploads/2020/08/1164410268799_AgLend_Lesson2.pdf.

———. 2010c. "Lesson 3: The Loan Application." Rural Finance & Investment Learning Center. 2010. https://www.rfilc.org/wp-content/uploads/2020/08/1164410343362_AgLend_Lesson3.pdf.

———. 2010d. "Lesson 5: Loan Appraisal." Rural Finance & Investment Learning Center. 2010. https://www.rfilc.org/wp-content/uploads/2020/08/1164410465629_AgLend_Lesson5.pdf.

Berger, Paul D., and Nada I. Nasr. 1998. "Customer Lifetime Value: Marketing Models and Applications." Journal of Interactive Marketing 12 (1): 17–30. https://doi.org/10.1002/(SICI)1520-6653(199824)12:1<17::AID-DIR3>3.0.CO;2-K.

"Blended Concessional Finance." n.d. International Finance Corporation. Accessed February 26, 2021. https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/BF/Overview.

Bonneville Environmental Foundation. n.d. "Coca-Cola Water Testimonial." Accessed March 17, 2021. http://www.b-e-f.org/partner/coca-cola-company/.

Bottoms, Thomas G., Mark P. Bolda, Mark L. Gaskell, and Timothy K. Hartz. 2013a. "Determination of Strawberry Nutrient Optimum Ranges through Diagnosis and

Recommendation Integrated System Analysis." HortTechnology 23 (3): 312–18. https://doi.org/10.21273/HORTTECH.23.3.312.
Bottoms, Thomas G., Timothy K. Hartz, Michael D. Cahn, and Barry F. Farrara. 2013b. "Crop and Soil Nitrogen Dynamics in Annual Strawberry Production in California." HortScience 48 (8): 1034–39. https://doi.org/10.21273/HORTSCI.48.8.1034.
Bryant, Benjamin P., T. Rodd Kelsey, Adrian L. Vogl, Stacie A. Wolny, Duncan MacEwan, Paul C. Selmants, Tanushree Biswas, and H. Scott Butterfield. 2020. "Shaping Land Use Change and Ecosystem Restoration in a Water-Stressed Agricultural Landscape to Achieve Multiple Benefits." Frontiers in Sustainable Food Systems 4. https://doi.org/10.3389/fsufs.2020.00138.
California Association of Resource Conservation Districts (CARCD). n.d. "What Are RCDs?" California Association of Resource Conservation Districts. https://carcd.org/rcds/what-are-rcds/.
California Department of Food and Water Resources (CA DWR). n.d. "SGMA Groundwater Management." Accessed December 11, 2020. http://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management.
California FarmLink, and Resource Conservation District of Santa Cruz County. 2016. "Farm Practice Rebate Financing Program: Narrative Report."
California State Water Resources Control Board (SWRCB). 2021. "Waste Discharge Requirements Program." Ca.Gov. March 3, 2021. https://www.waterboards.ca.gov/water_issues/programs/waste_discharge_requirements/.
California State Water Resources Control Board (SWRCB), and Regional Water Quality Control Boards (RWQCB). 2020. California Code of Regulations. https://www.waterboards.ca.gov/resources/fees/water_quality/docs/fy1819_agland_fees.pdf.
Carlisle, Liz, Maywa Montenegro de Wit, Marcia S. DeLonge, Alastair Iles, Adam Calo, Christy Getz, Joanna Ory, et al. 2019. "Transitioning to Sustainable Agriculture Requires Growing and Sustaining an Ecologically Skilled Workforce." Frontiers in Sustainable Food Systems 3. https://doi.org/10.3389/fsufs.2019.00096.
"CDFA - California Agricultural Production Statistics." 2020. CDFA - Statistics. 2020. https://www.cdfa.ca.gov/Statistics/.
Central Valley Regional Water Quality Control Board. 2021. "Irrigated Lands Regulatory Program." Ca.Gov. February 1, 2021. https://www.waterboards.ca.gov/rwqcb5/water_issues/irrigated_lands/.
Chang, Wen, Chen Chang, and Qianpin Li. 2012. "Customer Lifetime Value: A Review." Social Behavior and Personality: An International Journal 40 (7): 1057–64. https://doi.org/10.2224/sbp.2012.40.7.1057.
Cohen, Michael, Juliet Christian-Smith, and John Berggren. 2013. "Water Supply to the Land: Irrigated Agriculture in the Colorado River Basin." May 2013. https://pacinst.org/wp-content/uploads/2013/05/pacinst-crb-ag-1.pdf.
"Conservation Loan Program: Fact Sheet." 2019. USDA Farm Service Agency. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/2019/conservation-loan-program-factsheet-19.pdf.

"———." 2020. USDA Farm Service Agency. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/conservation_loan_program-factsheet.pdf.

Coppess, Johnathan, and Bruce Sherrick. 2020. "Exploring the Regulatory and Policy Aspects of Agricultural Credit and Finance for Conservation Investments: A Discussion Paper for the AGree Economic and Environmental Risk Coalition." AGree Economic + Environmental Risk Coalition. https://foodandagpolicy.org/wp-content/uploads/sites/4/2020/05/AGree-E2-Banking-Policy-White-Paper.pdf.

Crane, Laurence, Gene Gantz, Steve Issacs, Doug Jose, and Rob Sharp. n.d. "Introduction to Risk Management – Understanding Agricultural Risk: Production, Marketing, Financial, Legal, Human." Extension Risk Management Education and Risk Management Agency, USDA. Accessed March 17, 2021. http://extensionrme.org/pubs/introductiontoriskmanagement.pdf.

Cunningham, Brook. 2019. "Bridging the Gaps: Finding Common Ground to Advance Agriculture for All." BRIDGING THE GAP, 10.

"Customer Satisfaction: Retention Rates by Industry Worldwide 2018." 2018. Statista. May 2018. https://www.statista.com/statistics/1041645/customer-retention-rates-by-industry-worldwide/.

Department of Water Resources Natural Resource Agency. 2015. "California Groundwater Update 2013." Natural Resource Agency Department of Water Resources. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/California-Groundwater-Update-2013/California-Groundwater-Update-2013---Statewide.pdf.

Drost, Daniel, Gilbert Long, David Wilson, Bruce Miller, and William Campbell. 1996. "Barriers to Adopting Sustainable Agricultural Practices." Journal of Extension 34 (6). https://www.joe.org/joe/1996december/a1.php.

Evans, Robert, R E Sneed, and D K Cassel. 1996. "IRRIGATION SCHEDULING TO IMPROVE WATER- AND ENERGY-USE EFFICI...," June, 12.

"Federal Reserve Statisical Release: Large Commercial Banks." 2020. Federal Reserve Board. December 31, 2020. https://www.federalreserve.gov/releases/lbr/current/.

"Food Loss and Waste." 2021. U.S Food and Drug Administration. FDA. February 23, 2021. https://www.fda.gov/food/consumers/food-loss-and-waste.

"Food Waste FAQs." n.d. Accessed February 28, 2021. https://www.usda.gov/foodwaste/faqs.

Freidberg, Susanne. 2017. "Big Food and Little Data: The Slow Harvest of Corporate Food Supply Chain Sustainability Initiatives." Annals of the American Association of Geographers 107 (6): 1389–1406. https://doi.org/10.1080/24694452.2017.1309967.

"Groundwater Extraction Summary Report 2019." 2021. Monterey County Water Resources Agency (MCWRA). https://www.co.monterey.ca.us/home/showpublisheddocument?id=99942.

Hamilton, Lynn, and Michael McCullough. 2018. "A Decade of Change: A Case Study of Regulatory Compliance Costs in the Produce Industry." Agribusiness, December. https://digitalcommons.calpoly.edu/agb_fac/155.

Hanak, Ellen, Alvar Escriva-Bou, Brian Gray, Sarge Green, Thomas Harter, Jelena Jezdimirovic, Jay Lund, Josué Medellín-Azuara, Peter Moyle, and Nathaniel Seavy. n.d. “Water and the Future of the San Joaquin Valley: Overview,” 16.

Harter, Thomas, and Jay Lund. 2012. “Addressing Nitrate in California’s Drinking Water: Executive Summary.” University of California. 2012.

Hartz, T K, M D Cahn, and R F Smith. 2017. “Efficient Nitrogen Fertility and Irrigation Management of Cool-Season Vegetables in Coastal California,” 13.

Hayes, Adam. 2020. “Line of Credit (LOC).” Investopedia. August 19, 2020. https://www.investopedia.com/terms/l/lineofcredit.asp#:~:text=A%20line%20of%20credit%20(LOC)%20is%20a%20preset%20borrowing%20limit,an%20open%20line%20of%20credit.

Heard, Sarah, E.J. Remson, Matthew Fienup, and Siobhan King. 2019. “SGMA’s First Groundwater Market: An Early Case Study from Fox Canyon.” San Francisco, CA: The Nature Conservancy. https://www.scienceforconservation.org/products/fox-canyon-groundwater-market/.

Hillier, Amy E. 2003. “Redlining and the Homeowners’ Loan Corporation.” Journal of Urban History 29 (4): 394–420.

Horst, Megan, and Amy Marion. 2019. “Racial, Ethnic and Gender Inequities in Farmland Ownership and Farming in the U.S.” Agriculture and Human Values 36 (1): 1–16. https://doi.org/10.1007/s10460-018-9883-3.

Irby, Latoya. 2020. “Average Daily Balance Finance Charge Calculation.” The Balance. July 2, 2020. https://www.thebalance.com/average-daily-balance-finance-charge-calculation-960236.

James, Ian. 2016. “Imperial Valley Farmers Being Paid by IID to Fallow Fields.” The Desert Sun. March 19, 2016. https://www.desertsun.com/story/news/environment/2014/03/17/imperial-valley-farmers-being-paid-by-iid-to-fallow-fields/6512183/.

James, Ian, and Rob O’Dell. 2019. “Megafarms and Deeper Wells Are Draining the Water beneath Rural Arizona – Quietly, Irreversibly.” December 5, 2019. https://www.azcentral.com/in-depth/news/local/arizona-environment/2019/12/05/unregulated-pumping-arizona-groundwater-dry-wells/2425078001/.

“JP Morgan Chase & Co. Annual Report 2019.” 2019. JP Morgan Chase & Co. https://www.jpmorganchase.com/content/dam/jpmc/jpmorgan-chase-and-co/investor-relations/documents/annualreport-2019.pdf.

Kagan, Julia. 2020. “Amortized Loan.” Investopedia. October 30, 2020. https://www.investopedia.com/terms/a/amortized_loan.asp.

Kime, Lynn F., John A. Adamik, Jayson K. Harper, and Callihan M. Dice. 2019. “Agricultural Business Insurance.” Penn State Extension. April 30, 2019. https://extension.psu.edu/agricultural-business-insurance.

Klein, Kerry. 2019. “California Water Cutbacks Could Take Large Area Of Farmland Out Of Production.” NPR.Org. December 26, 2019. https://www.npr.org/2019/12/26/791560787/california-water-cutbacks-could-take-large-area-of-farmland-out-of-production.

Kumar, V., Girish Ramani, and Timothy Bohling. 2004. “Customer Lifetime Value Approaches and Best Practice Applications.” Journal of Interactive Marketing 18 (3): 60–72. https://doi.org/10.1002/dir.20014.

Lang, Kristin, Andreea Rodinciuc, and Joshua Humphreys. 2017. Impact Investing in Sustainable Food and Agriculture across Asset Classes: Financing Resilient Value Chains through Total Portfolio Activation.

Macaulay, L., and V. Butsic. 2017. “Ownership Characteristics and Crop Selection in California Cropland.” California Agriculture 71 (4): 221–30.

Markay, Lachlan. 2012. “USDA Gives Millions to Farmers Who Aren’t Actually Farming.” The Daily Signal. July 9, 2012. https://www.dailysignal.com/2012/07/09/usda-gives-millions-to-farmers-who-arent-actually-farming/.

Market Intel. 2019. “Who Holds Farm Debt?” January 24, 2019. https://www.fb.org/market-intel/who-holds-farm-debt.

McCune, Kelli. 2020. “Back-of-Envelope Calculations for Lettuce,” April 27, 2020.

Méndez-Barrientos, Linda Estelí, Alyssa DeVincentis, Jessica Rudnick, Ruth Dahlquist-Willard, Bridget Lowry, and Kennedy Gould. 2020. “Farmer Participation and Institutional Capture in Common-Pool Resource Governance Reforms. The Case of Groundwater Management in California.” Society & Natural Resources 0 (0): 1–22. https://doi.org/10.1080/08941920.2020.1756548.

Meyers, David, John Bohorquez, Tracey Cumming, Lucy Emerton, Onno van den Heuvel, Massimiliano Riva, and Ray Victurine. 2020. “Conservation Finance: A Framework.” Conservation Finance Alliance. https://static1.squarespace.com/static/57e1f17b37c58156a98f1ee4/t/5e8c97ecf33f8960fc2cbda3/1586272239963/Conservation+Finance+Framework.pdf.

Monast, Maggie. 2020. “Financing Resilient Agriculture,” September, 49.

Monast, Maggie, Laura Sands, and Alan Grafton. 2018. “Farm Finance and Conservation: How Stewardship Generates Value for Farmers, Lenders, Insurers and Landowners.” Environmental Defense Fund. https://www.edf.org/sites/default/files/documents/farm-finance-report.pdf.

Monterey County Agricultural Commissioner. 2018. “Montery County Crop Report 2018.” https://www.co.monterey.ca.us/home/showdocument?id=78579.

———. 2019. “Monterey County Crop Report 2019.”

“Monterey County Farm Bureau - Economic Contributions.” n.d. Monterey County Farm Bureau. Accessed May 13, 2020. http://montereycfb.com/index.php?page=economic-contributions.

“Monterey County Farm Bureau - Facts, Figures & FAQs.” n.d. Monterey County Farm Bureau (Monterey CFB). Accessed February 21, 2021. http://montereycfb.com/index.php?page=facts-figures-faqs.

Monterey County Water Resources Agency (MWRCA). 2019. “Groundwater Extraction Summary Report 2018.” https://www.co.monterey.ca.us/Home/ShowDocument?id=85416.

Mulder, Ivo, and Paul Clements-Hunt. 2010. “CEObriefing: Demystifying Materiality,” October, 20.

National Sustainable Agriculture Coalition (NSAC). 2019. “Conservation Loans: Helping Farmers and Ranchers Finance Natural Resource Conservation Projects on Their

Land." National Sustainable Agriculture Coalition. June 2019. https://sustainableagriculture.net/publications/grassrootsguide/credit-crop-insurance/conservation-loans/.
Niles, M., and C. Wagner. 2017. "Farmers Share Their Perspectives on California Water Management and the Sustainable Groundwater Management Act." California Agriculture 72 (1): 38–43.
O'Daly, William, Frank Keeley, Charlie Olivares, Carole Rains, and Robert Stoltz. 2018. "California Water Plan: Update 2018," December, 58.
Prichard, Terry. 2003. "Winegrape Irrigation Scheduling Using Deficit Irrigation Techniques," 19.
Resource Conservation District of Santa Cruz County and Sustainable Conservation. 2016. "2015-16 Lettuce Data Comparison."
Rose, David C., Connor Keating, and Carol Morris. 2018. "Understanding How to Influence Farmers' Decision-Making Behaviour: A Social Science Literature Review, Report for the Agriculture and Horticulture Development Board." UEA Consulting Ltd. https://projectblue.blob.core.windows.net/media/Default/Imported%20Publication%20Docs/FarmersDecisionMaking_2018_09_18.pdf.
Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA). 2020. "Salinas Valley Groundwater Basin 180/400-Foot Aquifer Subbasin Groundwater Sustainability Plan."
Semuels, Alana. 2019. "'They're Trying to Wipe Us Off the Map.' Small American Farmers Are Nearing Extinction." Time. November 27, 2019. https://time.com/5736789/small-american-farmers-debt-crisis-extinction/.
"SISC Case Studies: Success Stories, Backed up with Real Data." n.d. Stewardship Index for Specialty Crops. Accessed March 7, 2021. https://c49757da-0b3d-4f73-8c7a-f641a378029d.filesusr.com/ugd/917763_7eb4b87952f9484ba1414a739e71b55b.pdf.
Slattery, Drew, Kinsie Rayburn, and Christy Melhart Slay. 2020. "Farmer Perspectives on Data: A Roadmap for Engaging with Farmers to Scale the Collection and Sharing of Farm-Level Production Data." Trust in Food, a Farm Journal Initiative. https://www.trustinfood.com/wp-content/uploads/2020/05/Farmer-Data-Perspectives-Research_final.pdf.
Spence, Liz, Belton Copp, Xander Kent, Daniel Vermeer, and Martin W. Doyle. 2017. "Environmental Impact Investing in Real Assets: What Environmental Measures Do Fund Managers Consider?" NI R 17-01. Durham, NC: Duke Nicholas Institute for Environmental Policy Solutions. https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_r_17-01.pdf.
Steward, Don. 2021. Personal communication.
Szeptycki, Leon, David Pilz, Rachel O'Connor, and Bea Gordon. 2018. "Environmental Water Transactions in the Colorado River Basin." Stanford Water in the West. December 19, 2018. https://waterinthewest.stanford.edu/publications/environmental-water-transactions-colorado-river-basin.
Tamara Voss. 2021. Personal communication.
UC Cooperative Extension - Agricultural Issues Center. n.d. "Sample Costs to Produce and Harvest Romaine Hearts - 2019."

https://coststudyfiles.ucdavis.edu/uploads/cs_public/7a/c9/7ac93a02-6ad3-439a-a74d-2bcf9e40180c/2019romainehearts-final-7-8-2019.pdf.
U.S. Government Accountability Office (USGAO). 2019. “Agricultural Lending: Information on Credit and Outreach to Socially Disadvantaged Farmers and Ranchers Is Limited.” Government GAO-19-539. Government Accountability Office. https://www.gao.gov/assets/gao-19-539.pdf.
U.S. Small Business Administration. 2009. “ABCs of Borrowing Money: Financial Management Series.” March 2009. https://www.sba.gov/sites/default/files/ABCs%20of%20Borrowing_0.pdf.
“USDA - NASS -Land Values: Farm Real Estate Value by State, US.” 2020. United States Department of Agriculture National Agricultural Statistics Service (USDA - NASS). August 6, 2020. https://www.nass.usda.gov/Charts_and_Maps/Land_Values/farm_value_map.php.
“USDA ERS - Assets, Debt, and Wealth.” 2021. USDA Economic Research Service. February 5, 2021. https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/assets-debt-and-wealth/.
“USDA ERS - Farm Household Income Forecast.” 2021. February 2021. https://www.ers.usda.gov/topics/farm-economy/farm-household-well-being/farm-household-income-forecast/.
“USDA ERS - Farmland Ownership and Tenure.” n.d. USDA Economic Research Service. Accessed March 18, 2021. https://www.ers.usda.gov/topics/farm-economy/land-use-land-value-tenure/farmland-ownership-and-tenure/.
USGS CA Water Science Center. n.d. “Sustainable Groundwater in California.” Accessed March 16, 2021. https://ca.water.usgs.gov/sustainable-groundwater-management/.
“Wells Fargo & Company 2019 Annual Report.” 2019. Wells Fargo.
“What Is a CDFI?” 2013. Opportunity Finance Network. October 2, 2013. https://ofn.org/what-cdfi.
Woodard, Joshua, Bruce Sherrick, Johnathan Coppess, and David Muth. 2019. “The Role of the Banking and Financing Sector in Encouraging Conservation Practices and Transitions to Organic Production.” AGree, April, 34.
World Economic Forum. 2019. Global Risks 2019: Insight Report. http://www3.weforum.org/docs/WEF_Global_Risks_Report_2019.pdf.
———. 2020. “Incentivizing Food Systems Transformation.” World Economic Forum. January 17, 2020. https://www.weforum.org/reports/incentivizing-food-systems-transformation/.