SAFEGUARDING CALIFORNIA: IMPLEMENTATION ACTION PLANS

Agricultural Sector Plan

Agricultural Sector Plan

Introduction

California benefits from one of the most valuable and diverse agricultural industries in the world, producing over 400 different commodities which were valued at $54 billion in 2014. Over a third of the United States' vegetables and two-thirds of its fruits and nuts are grown in California (CDFA, 2015). Furthermore, 20% of U.S. milk is produced in California (CDFA, 2015). Livestock products (dairy products, meat, eggs and wool) and specialty crops (fruits and vegetables, tree nuts, dried fruits and horticulture and nursery crops, including floriculture production) epitomize California agriculture and are exported throughout the world contributing to local, national and global food security. Agriculture is successful in California due to the unique climate, prime soils, innovative farming techniques and critical irrigation infrastructure. The state's many microclimates allow for production of a diversity of food crops, in some cases, year-round production.

Impacts from climate change threaten the agricultural industry in California. The great diversity of the state's agriculture does lend some resilience to the sector as a whole, but also increases the complexity of adaptation due to the varied impacts to individual crops or livestock animals. Research in California indicates that agriculture is vulnerable to climate change as well as other pressures such as urban development. Several studies predict declines in crop yields during the 2050 and 2100 timeframes (Deschenes and Kolstad, 2011; Medellin-Azuara et al, 2011; Lobell et al, 2006).

In order to protect California's resources, including agriculture, from the impacts of climate change, the state has developed a three-pronged approach to climate change policy: reduce emissions, facilitate adaptation to climate change impacts, and outcome-based scientific research to direct policy for both mitigation and adaptation efforts (CNRA, 2014). *Safeguarding California: Reducing Climate Risk*, the state's adaptation strategy produced by the California Natural Resources Agency (CNRA) in coordination with many other state agencies, provides a summary of potential impacts to California from climate change and builds a foundation for ensuring that California's economic sectors build resilience. Its recommendations help guide state government's actions to aid in the transformations that will safeguard California's agricultural sector from climate change. Many initiatives serve the dual role of both mitigating greenhouse gas emissions while increasing

adaptive capacity, illustrating the comprehensive movement to ensure a thriving and productive agricultural industry in the state despite ongoing and inevitable climate impacts.

This implementation plan is a crucial step in realizing this positive future in the face of climate change. It succinctly lays out the vulnerabilities that the State must help build resilience against, and goes on to outline specific actions to address the recommendations presented in *Safeguarding California*. Most importantly, the plan details initiatives that will be implemented and provides insights into how adaptation can be tracked over time.

Vulnerability Assessment

The first step in addressing climate change is to analyze impacts and the vulnerabilities they create. California has undertaken many vulnerability assessments, so this section will only give a high-level overview of climate change impacts and vulnerabilities. Specific resources to help further understand the climate threats faced by agriculture are cited.

It must be noted that changes in climate lead to complex multi-factorial impacts on the agricultural sector such as changes in the way that plants interact with pests or beneficial species (such as pollinators). There may be unforeseen impacts because ecosystems, including those on working lands, are dynamic and highly variable throughout California. Impacts will occur in tandem and some may have synergistic or feedback effects.

EXTREME HEAT AND TEMPERATURE CHANGE

According to a recent vulnerability assessment completed by the United States Department of Agriculture (USDA) Southwest Regional Climate Hub, the average maximum temperature in California is expected to increase by 2-4°C by 069 (2015). Record warm temperatures are becoming more common, impacting both crops and livestock. Increases in temperature beyond optimal ranges cause losses. In livestock, heat waves and extreme temperature lead to heat stress, lower milk or egg production and changing disease epidemiology (CNRA, 2014). Crops are also impacted by increasing temperatures; the severity is dependent on the crop and developmental stage of the crop during the heat event. For example, winter chill hours, which are necessary for tree fruit and nuts to complete dormancy, have decreased since the 1950s resulting in

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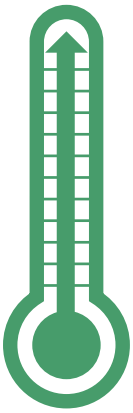
reduced yields (Baldocchi and Wong, 2008). In some scenarios, by 2100 chilling hours could be reduced by 80% from 1950 (Hatfield et al, 2014). California's premium winegrape regions will also be affected by increasing temperatures as grape varietals are sensitive to climate. A study estimated that suitable winegrape growing regions in California could shrink significantly by 2050, 60% in some scenarios (Hannah et al, 2013).

Changes in temperature and precipitation patterns may allow for pest and disease distributions to change or for new invasive species to become established in California where once they could not (CDFA, 2013). State and federal programs to exclude, detect and eradicate invasive species from California will be stretched as incidences increase. Several studies predict that some endemic pest generations will increase with increased temperature. One example includes navel orangeworm, a pest of walnuts and almonds, which will increase from 2-3 generations per year in 1950 to 5 generations per year before 2100 (Luedeling et al, 2011). These additional pest pressures will likely lead to increased pesticide use, an environmental concern and also an additional cost to farmers, and strain the ability of existing state programs to manage and control pests.

Other farm inputs may also increase in cost. Research shows that elevated atmospheric CO_2 levels can reduce the nutritional quality of forage crops such as alfalfa and pasture; leading to higher feed costs for livestock operators. Furthermore, elevated atmospheric CO_2 decreases the effectiveness of glyphosate, a commonly used herbicide (i.e., Round-up) which most likely will lead to increased use or higher concentrations of applications (Hatfield et al, 2014). Droughts can also exacerbate weed problems because weeds utilize water that would otherwise be used by drought-stressed crops, resulting in the need for more effective weed-control tools.



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CLIMATE CHANGE
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A recent study shows that climate change has doubled the likelihood of extreme heat in the Central Valley; in particular nighttime temperatures are observed to be higher since the 1960s due to climate change. These high nighttime temperatures sustain heat exposure for vulnerable populations who may not have access to affordable air conditioning. The study's authors conclude that agricultural workers are at increased risk of mortality due to sustained heat events because nighttime offers no relief from heat stress (Mera et al, 2015).

EXTREME WEATHER EVENTS

Extreme winter storms and floods present a clear danger to agriculture. A report by the U.S. Geological Survey (USGS) found that a single extreme 1000-year winter storm could cause up to $725 billion in damages to the California economy,

much of that from flooding in the Central Valley. Climate change makes it more likely that California will experience extreme events like the Great Flood of 1862, which covered much of the state's prime agricultural land in up to twenty feet of water (Ingram, 2012; Porter et al, 2011). In more recent history, flooding in 1997 caused substantial losses to the agriculture sector including;

- Crop losses totaled $107 million, with the largest losses being walnuts, wine grapes, winter wheat, and alfalfa.
- Livestock losses were another $12 million.
- Damages to farm infrastructure (irrigation systems, roads, buildings, and fences) totaled $109 million (Porter et al, 2011).

Climate scientists have shown that climate change will cause more precipitation to fall in fewer but heavier events, increasing flood risk and making water management more difficult. Soil erosion often results during heavy precipitation events as the soil's ability to take in the water is exhausted. Soil is lost as the sediment flows downstream; causing pollution from nutrients and sediment-loading downstream (Hatfield et al, 2014). Strategies to improve soil water holding capacity in combination with modernization of flood control infrastructure could help mitigate soil erosion and capitalize on floodwaters for groundwater recharge.

DROUGHT

Because California has a Mediterranean climate, with little or no precipitation falling during the late spring and summer months, agriculture is dependent on the collection and movement of water for crops and livestock needs. Elevated temperatures in the region will undoubtedly negatively impact water storage in snow pack, necessitating changes to the way water is managed, delivered and used in the state as evident from the current ongoing four-year drought (see the Water Sector Plan for more information).

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In 2014 and 2015 California agriculture experienced the greatest ever reduction in water availability due to low stream flows and low reservoir levels.

- Statewide losses due to drought in 2014 included 17,100 total agricultural jobs and $2.2 billion.
- Net water shortages for agriculture in the 2014 drought most severely affect the Central Valley with at least 410,000 acres lost to fallowing and $800 million in lost farm revenue (Howitt et al, 2014).
- In 2015, 542,000 acres were estimated to be fallowed – which is 114,000 more acres than in 2014.

- Direct agricultural costs of drought in 2015 are estimated be about $1.84 billion and 10,100 direct seasonal jobs. When multiplier effects are considered, losses to all economic sectors are as high as $2.74 billion and nearly 21,000 total jobs (Howitt et al, 2015).

During times of drought, groundwater is more heavily relied on to maintain agricultural production (and to keep crops and livestock alive). Unfortunately groundwater depletion represents a terrible vulnerability to climate change and results in secondary impacts such as aquifer collapse and subsidence. NASA recently announced that the rate of subsidence in the Central Valley has increased due to the drought with some areas in the San Joaquin Valley sinking a foot in less than a year (Farr et al, 2015). Subsidence represents permanent loss of water storage since the depleted aquifer collapses under the weight of the earth above. This is directly opposed to agricultural adaptation to climate change and leaves the industry less resilient to future water scarcity. One of the most practical and cost effective methods for ensuring aquifers are sustainable into the future is utilizing on-farm groundwater recharge during months of heavy precipitation. The practice of groundwater recharge on agricultural lands is critical to ensuring long term use of groundwater for multiple purposes and future generations. Programs that incentivize farmers or streamline permitting for water recharge projects may facilitate this activity in areas where the benefits can be maximized.

SEA-LEVEL RISE

In fertile coastal and estuarine farmland—like that found in the Bay Delta and along the central coast—sea-level rise will combine with other impacts to heighten harmful effects like salinity intrusion into surface and groundwater. In the Pajaro Valley on California's Central Coast studies indicate that saltwater flows into the groundwater basin at a rate of 200 feet per year (Wallace and Lockwood, 2010). This is to the detriment of the high-value vegetable and fruit growers in the region who are adapting with water conservation, but also must cope with impaired water quality and future uncertainty. In the Sacramento-San Joaquin Delta, drought reduces the volume of water flowing out to the ocean and allows for saline water to creep inland, impacting sensitive ecosystems and farms both in the Delta and also in areas that receive irrigation water from the Delta such as the South San Joaquin Valley. Groundwater recharge projects during increased precipitation events on farms have been shown to mitigate saltwater intrusion.

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Current Actions to Prepare for Climate Impacts

Safeguarding California: Reducing Climate Risk identifies high-level actions needed to protect California agriculture from the impacts of climate change. The California Department of Food and Agriculture (CDFA), state and federal partner agencies have engaged on several of these actions. CDFA has developed outreach and incentive programs such as the Healthy Soils Initiative, the State Water Efficiency and Enhancement Program (SWEEP), the Dairy Digester Research and Development Program (DDRDP) and he developed tools and partnerships that support adaptation efforts. These efforts are listed in Table 1 and discussed in depth in the following sections.

Table 1. Summary of Adaptation Activities to Date

Actions are not listed in any order of importance. Ongoing activities (F and G) are not discussed in further detail since the ongoing work on those items is outside of state agencies.

RECOMMENDED ACTIONS FROM *SAFEGUARDING CALIFORNIA*	ACTIONS TAKEN TO DATE
A. Develop Best Management Practices That Reduce Climate Risks	CDFA – The Healthy Soils Initiative CDFA – Specialty Crop Block Grant Program
B. Development Incentive Programs for Sustainable Practices for Resilience	CDFA – State Water Efficiency and Enhancement Program (SWEEP) CDFA – Dairy Digester Research & Development Program (DDRDP) CEC – Water Energy Technology (WET)
C. Implement Resilient Water Management	CDFA – SWEEP DWR – Agricultural Water Use Efficiency 2014 Sustainable Groundwater Management Act
D. Reduce Farmland and Rangeland Conversion	The California Land Conservation Act of 1965 DOC – The California Farmland Conservancy Program DOC – High Speed Rail Agricultural Land Mitigation Program Strategic Growth Council- Sustainable Agricultural Land Conservation Program OPR – General Plan Guidelines Update CDFA – Benefits of Farmland Conservation whitepaper
E. Develop New Technologies	USDA/Colorado State University Comet-Planner Pest and Invasive Species Monitoring and Forecasting

F. Collect and Preserve Agricultural Genetic Material	Ongoing activity at federal level and through the State University systems
G. Invest in Improvements to Adaptive Agricultural Equipment	Ongoing activity at the industry level and at universities

A. DEVELOP BEST MANAGEMENT PRACTICES THAT REDUCE CLIMATE RISKS

California's farmers and ranchers are already responding to climate impacts, but the State can help by compiling and developing a set of best practices to reduce climate risk. These management techniques will build local and regional resilience in California's 43 million acres of agricultural land. The **Healthy Soils Initiative** is the central piece of CDFA's efforts to develop climate-smart management practices.

Governor Brown introduced the Healthy Soils Initiative in his proposed budget for the 2015 – 2016 fiscal year. The purpose of the Healthy Soils Initiative is to build the organic matter content in soils which offers multiple benefits that contribute to food security and climate change resilience. Soils that are rich in carbon, or soil organic matter (SOM), are more resistant to erosion (such as could occur in an extreme wind or precipitation events), have greater water retention (providing resiliency during water scarcity) and provide nutrients to crops, among numerous other ecosystem benefits.

Consistent with this initiative, several actions have been identified to:

- Protect and restore soil organic matter in soils with management practices such as no till and cover crops to ensure climate change mitigation and food and economic security
- Identify sustainable and integrated financing opportunities, including market development, to facilitate increased soil organic matter
- Provide for research, education and technical support to facilitate healthy soils
- Increase governmental efficiencies to enhance soil health on public and private lands
- Ensure interagency coordination and collaboration

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CDFA, as the lead agency for the Healthy Soils initiative, has outlined both short and long-term goals for a healthy soils program including developing and demonstrating best management practices (such as utilizing cover crops, conservation tillage, and increased use of soil amendments) for sequestering carbon and creating soils that are resilient to climate change impacts.

The Healthy Soil Initiative is a multi-agency effort and has the potential to have beneficial cross-media effects on water resources, climate change adaptation and mitigation, nutrient management and waste reduction. Maximizing these co-benefits, particularly within disadvantaged communities, is an objective for the program. The Healthy Soils Initiative will require close collaboration with stakeholders. As the initiative develops, a better understanding of how soils play a role in climate change resiliency and food security will be realized. CDFA is positioned to share that understanding with agricultural stakeholders.

CDFA also administers federal funding in the **Specialty Crop Block Grant Program**. This money is designated to research, outreach and education projects that enhance the competitiveness of California's specialty crops. There are several funding categories, one of which is focused on environmental stewardship and conservation including the development of management strategies that facilitate specialty crop adaptation to climate change impacts.

B. DEVELOP INCENTIVE PROGRAMS FOR SUSTAINABLE PRACTICES FOR RESILIENCE

Safeguarding California reported that action is needed to develop incentive programs for sustainable, science-based practices that create resilience to climate impacts for croplands and rangelands. The State is successfully pushing forward on research, pilot programs, and grants that provide farmers with the financial and technical support they need to implement sustainable practices that are good for their bottom line, Californians, and the climate.

As the Healthy Soil Initiative develops, a better understanding of how soils play a role in climate change resiliency and food security will be realized. CDFA is positioned to share that understanding with agricultural stakeholders.

Senate Bill 103, emergency drought legislation from March 2014, designated $10 million from the Greenhouse Gas Reduction Fund for CDFA to disperse to farmers for the implementation of irrigation practices that save water and reduce greenhouse gas (GHG) emissions. The resulting program, the **State Water Efficiency and Enhancement Program** (SWEEP), promotes both climate change mitigation and adaptation through water management and energy efficiency, making agriculture more resilient to the impacts that climate change will have on water and energy resources.

CDFA designed SWEEP to provide grants for irrigation improvements that conserve water (e.g., conversion of flood irrigation to micro irrigation or implementation of water management tools) with energy efficiency components (e.g., conversion of diesel pumps to electric or renewable energy sources) that reduce GHG emissions. These projects have allowed farmers to effectively manage water resources and create resiliency in their operations through the use of on-farm technologies (e.g., soil water sensors and irrigation scheduling).

The development of the SWEEP is consistent with the recommendation of CDFA's Climate Change Consortium to incentivize such practices that can improve water management (CDFA, 2013). The Consortium was a group of farmers and scientists who were brought together in 2011 by CDFA to evaluate climate change impacts and provide feedback to the department on what is required by the agricultural community to adapt to climate change.

CDFA's leadership in developing SWEEP also connects with broader cross-sectoral and intergovernmental efforts that involve state action to adapt to climate change through agricultural water management. The **Water-Energy Technology** (WET) Program, for instance, will provide financial assistance to implement innovative technologies on farms that will lead to water savings and reduced GHG emissions. The WET Program complements SWEEP by incentivizing conversion to low pressure drip systems that can save water and reduce energy and greenhouse gas emissions and other innovative technologies. CDFA is working with the Department of Water Resources, California Water Resources Control Board and the Energy Commission, the entities administering the program, to maximize its impact on building resilience on farms.

CDFA is also working on incentivizing practices to obtain both mitigation and adaptation on California dairies through the **Dairy Digester Research and Development Program** (DDRDP).

Dairy anaerobic digesters are poised to become a larger contributor to California's renewable energy portfolio. By utilizing methane to create renewable energy, they mitigate methane greenhouse gas emissions and also help the industry adapt to a changing climate. Digesters can provide dairy operators with an additional income source which offers economic security and on-farm diversification. Additionally, the by-product of digestion, digestate, is a useful soil amendment which can contribute to healthy soils and improve crop health. The expansion of anaerobic digesters in California will also assist the energy and transportation sectors adapt to climate change by providing a renewable and flexible fuel source which will be essential as California's population increases.

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In 2014, CDFA was provided $12 million from the Greenhouse Gas Reduction Fund to provide grants for digester development and to fund research and demonstration projects that study and facilitate changes in manure management practices at California dairies that will directly result in greenhouse gas emission reductions: and, facilitate improved understanding of the scientific and technical aspects of dairy digesters to provide

information about their economic feasibility, widespread implementation and environmental benefits.

In July 2015, CDFA announced that four new dairy digester projects would receive funding, in addition to one existing defunct digester that would receive funds to help re-start operation. CDFA expects the program to continue as a climate change adaption and mitigation measure.

C. IMPLEMENT RESILIENT WATER MANAGEMENT

CDFA continually engages with stakeholders and irrigation specialists regarding the best methods to promote water efficiency in agricultural systems. CDFA has a responsibility to promote sustainable agriculture in California and through conversations with irrigation experts, farmers and ranchers, and agency partners it has become clear that agricultural water use in California is complex and solutions must be regionally driven. Implementation of improved water management must balance a variety factors such as groundwater recharge, surface water delivery and allocation systems, crop type and productivity and wildlife management.

The SWEEP program, mentioned above, is one effort by CDFA to incentivize improved water management on farms. The Department of Water Resources is administering the **Agricultural Water Use Efficiency Program** (Ag WUE) which provides funding to agricultural water suppliers to make improvements to conveyance systems. This program delivers a critical piece of statewide agricultural water management and facilitates flexibility in agricultural water management to the benefit of all Californians.

Historic legislation passed and signed by Governor Brown in 2014, the **Sustainable Groundwater Management Act**, initiated an important process of strategic groundwater management in California. The ongoing drought has drawn attention to this critical need in California. The Department of Water Resources and the State Water Resource Control Board have been tasked with leading the effort which revolves around integrated regional water management.

Moving forward, CDFA will continue to investigate innovative water management strategies that agricultural operators are utilizing throughout the state to deal with specific water quantity concerns and new technologies that can contribute solutions. California's substantial investments in water management will certainly have broad benefits for the agriculture sector; for more information on this comprehensive effort, see the water sector's implementation plan for *Safeguarding California*.

D. REDUCE FARMLAND AND RANGELAND CONVERSION

According to *Safeguarding California*, reducing the rate of farmland conversion will buffer against climate risks by supporting smart growth, reducing unsustainable sprawl, and promoting sustainable food systems and ecosystems. Farmland conservation is a critical component of ensuring food security. Since California's farmland is so

unique, it will be imperative for California to have sufficient farmland in the right locations to allow for food production and flexibility as impacts of climate change become more severe (CDFA, 2015). Recent research showing that, acre-to-acre, urban areas emit seventy times more greenhouse gases than farmland in California emphasizes the important role that farmland conservation has to play in our climate change policy (Jackson et al, 2012).

Rangeland, a category of farmland, offers many ecosystem services such as wildlife, including pollinator, habitat and protection of biodiversity, carbon sequestration opportunities and water and nutrient cycling. Rangeland conservation is a strategy that offers adaptation potential to the agriculture, biodiversity, and water sectors.

The **California Land Conservation Act** of 1965 (known as the Williamson Act) allows landowners to enter into restrictive land use contracts with local governments. These contracts limit the use of the land to agricultural production, compatible uses, or open space. In return, the landowner benefits by having the property taxed based upon the value of its agricultural production and not its potential market value, which always includes some speculative value. Participating landowners are protecting 16.3 million acres (California Department of Conservation, 2013). The **California Farmland Conservancy Program**, has also been a valuable tool in providing permanent protection of important farmland in the state, with over 70,000 acres currently under permanent agricultural conservation easements, as a result of state and partner investments.

The Department of Conservation has developed a new program, the **High Speed Rail Agricultural Land Mitigation Program**, which is designed to mitigate agricultural land loss due to California's High Speed Rail Project through the use of agricultural land easements on agricultural land of similar location, size and quality as farmland that is lost as a result of building California's high speed rail system.

In 2014 the State took an additional step to promote farmland conservation. The **Sustainable Agricultural Lands Conservation** (SALC) program is administered by the Strategic Growth Council and the Department of Conservation. This program was developed with input from multiple state agencies, including CDFA. The Strategic Growth Council allocated $5 million in the 2014-2015 fiscal year from the Greenhouse Gas Reduction Fund for the program. During the 14-15 fiscal year, The SALC program included $1 million for cities and counties for farmland conservation planning. A second component of the program included $4 million for the purchase of agricultural conservation easements. In future years, this comprehensive program will also include a third component; payments to landowners for utilizing management practices that reduce GHG emissions. This

program is not only designed to reduce GHG emissions, but also strengthen agriculture's adaptive capacity by protecting prime farmland from development.

E. DEVELOP NEW TECHNOLOGIES

CDFA is a key partner in creating new technologies to build resilience in California's working lands. CDFA worked with USDA and Colorado State University to develop a new tool called **COMET-planner**. This tool has been designed to enable farmers to assess the GHG emission reductions from implementing various land management practices. Some of the practices incorporated in COMET-Planner include conservation tillage, strip tillage, cover cropping, windbreak establishment and habitat restoration, among others. The development of tools to help agriculture adapt to climate change is one of the recommendations referenced in the Climate Change Consortium final report (2013).

Climate change is expected to lead to temporal and geographical shifts in not only food production but also impacts from pests and invasive species. One recommendation outlined in the Climate Change Consortium final report states that CDFA should "develop and adopt **pest forecasting tools** that account for the effects of climate change." CDFA has initiated preliminary efforts to evaluate and understand pest and invasive species movement with climate change using internal pest detection databases. CDFA will evaluate other new technologies to optimize and reuse waste energy in agricultural operations to ensure food security.

Next Steps

Despite the broad range of efforts being undertaken by state government to reduce climate risk, adaptation to climate impacts is an ongoing process that will require substantial resources and ingenuity to continually advance. *Safeguarding California* makes clear that adaptation is an iterative process; it will require broadening and improving upon current efforts as climate impacts continue to grow more extreme and expose additional vulnerabilities. This section details the research questions and additional actions that the State will undertake as it continues its mission to safeguard California's people, environment, and economy.

RESEARCH NEEDS

Demonstration Projects

CDFA's Climate Change Consortium provided a suite of recommendations regarding climate change adaptation. There are management practices in the scientific literature used in other regions of the world that may have applicability in California for climate change adaptation. Demonstration projects that can provide

proof-of-practice are needed in California to test the adaptation strategies and economic benefits/limitations of these practices. Types of demonstrations include (CDFA, 2013):

- Structural, mechanical, or biological methods to reduce crop heat stress;
- Crop training systems for perennial crops to protect them from heat stress and sunburn;
- Cover cropping and crop rotations that can efficiently utilize irrigation systems and prevent runoff;
- Water conservation and/or efficiency outcomes of grower use of soil moisture monitoring, on-farm water storage, and improved irrigation uniformity;
- Benefits of habitat restoration in large-scale agricultural systems.

Co-composting of Dairy Manure and other Organic Wastes

The California 4th Climate Change Assessment for Research scope of work includes a proposal submitted jointly by CDFA and CalRecycle regarding co-composting of dairy manure and food waste. This research relates to several statewide policies including the diversion of organic waste from landfills and the Healthy Soils Initiative. This proposal seeks to quantify the water retention benefits and GHG reductions of aerobically composted food waste and manure in comparison to non-composted manure and food waste. Increasing the moisture-holding capacity of soil is a drought adaptation strategy as it will promote water conservation and improved crop health.

Economic and Environmental Costs, Benefits, and Risks of Climate Change Adaptation

The California 4th Climate Change Assessment for Research scope of work includes research regarding the economic risks posed by climate change to California's major food crops and the likely costs of adaptation strategies. The purpose of this proposal is to provide growers and the agricultural community information needed to inform the decision-making process regarding farming practices in relation to climate change impacts. The research proposal seeks to answer the following:

The California 4th Climate Change Assessment for Research scope of work includes research regarding the economic risks posed by climate change to California's major food crops and the likely costs of adaptation strategies.

- Identification of where specific major crops grown in the state are vulnerable to climate change impacts including potential economic loss;
- Potential practical barriers and economic cost (including potential resources to cover the costs) for specific large acreage specialty crops to be relocated (including infrastructure considerations) to other regions of the state if climate change-related impacts (e.g., increased

temperature, flooding, reduced winter chill hours) render the current growing regions unsuitable in the future;

- Evaluation of current California conditions and climate analogs (at 50 years and 100 years in the future) through modeling to determine if specific adaptation measures can be used and potential economic cost of those measures;
- Model projections of where specialty crops will be best-suited under future climate conditions in consideration of agronomic variables and natural resources (e.g., soil type, topography, water availability);
- Benefits of maintaining wild or restored habitat in agriculture areas to lessen climate change impacts to agriculture and help adapt to a changing climate (e.g., quantifying in dollar amount the benefits of establishing native pollinator or beneficial predator habitat);
- Impact of climate change on rural and urban food security in disadvantaged communities throughout the state;
- Identify regions of California with the greatest vulnerability to loss of agricultural employment opportunities;
- Identification of potential partnerships and resources (e.g., conversion of food processing facilities to accommodate crop shifting) as adaptation measures to address climate change impacts to specialty crop agriculture in California.

ADDITIONAL ACTIONS

1. Identification of management practices for adaptation

Farmers commonly participate in community learning, learning from others' experiences. CDFA will work with partner agencies such as the USDA Southwest Climate Hub to develop a management practice forum and online reference tools. Demonstration projects will be beneficial to prove the efficacy of potential adaptation practices in California. To complement demonstration projects, a forum for agriculturalists to share their on-farm experiences and experiments regarding water efficiency measures, crop heat stress strategies, alternative crops, among others, would be valuable and help with the implementation of management practices as potential adaptation strategies.

CDFA will consult with agricultural operators, agronomists (potentially local and international) and other stakeholders, including conservation groups, regarding management practices that have been demonstrated to provide adaptive capacity. CDFA will compile the known literature on the practices and post these in an interactive user-friendly tool for growers and ranchers.

CDFA will work with partner agencies such as the USDA Southwest Climate Hub to develop a management practice forum and online reference tools. Demonstration projects will be beneficial to prove the efficacy of potential adaptation practices in California.

CDFA will then solicit critical feedback from California agriculturalists regarding the potential benefits of the practice. CDFA will develop outreach programs and materials to complete the development of such tools and services.

2. Coordinate a Joint Water Management Incentive Program with the Department of Water Resources

CDFA initiated discussions with the Department of Water Resources (DWR) to coordinate a joint grant program that would maximize the water savings benefits and funding available from both agencies. The joint project would direct funding to both a water supplier, such as an irrigation district to make improvements or modernizations to conveyance infrastructure, and to the agricultural operations along that conveyance system to make on-farm improvements to save water and energy. Through this effort, CDFA and DWR hope to demonstrate the maximum benefits that can be achieved from irrigation modernization efforts. Discussions to date have focused on the feasibility and coordination of this effort.

3. Utilize a sub-committee of the Environmental Farming Act Science Advisory Panel, including farmers and researchers, to develop compost application use rates to support a CDFA incentives program on soil health

At the July 17, 2015 meeting of the Environmental Farming Act Science Advisory Panel (SAP) CDFA was directed by the panel to form a sub-committee to development recommendations on composting guidelines. The value of compost as a soil amendment has been recognized qualitatively and to some extent quantitatively. In order to support the Healthy Soil Initiative, CDFA will convene a technical scientific sub-committee to make recommendations on application rates for compost to agricultural lands. The objective of this sub-committee is to propose compost use application rates that can be used to support a CDFA inventive program on healthy soils application. There is also overlap with climate adaptation as compost has been recognized as an amendment that can improve soil structure, water-holding capacity and nutrient availability to crops. CDFA will ensure to take into consideration the environmental concerns, including unintended consequences, of compost addition to croplands and rangelands as part of this effort with the Environmental Farming Act Science Advisory Panel.

CDFA initiated discussions with the Department of Water Resources (DWR) to coordinate a joint grant program that would maximize the water savings benefits and funding available from both agencies.

4. Pest and Invasive Species Forecasting and biodiversity enhancements

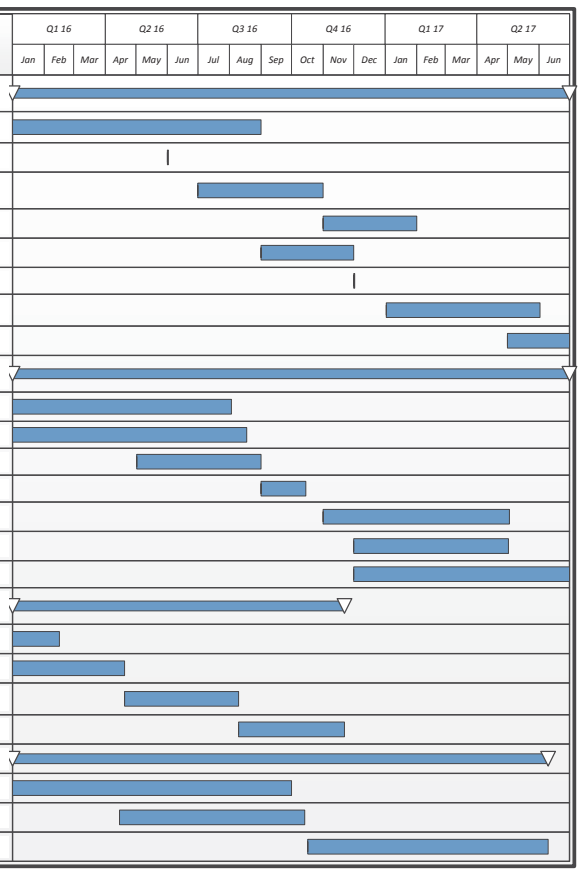
According to the Climate Change Consortium final report, CDFA should develop and adopt pest forecasting tools that account for the effects of climate change. CDFA will provide resources into understanding any correlations that exist between internal databases and observed climate changes

in California. The efforts will be ongoing with the intention of adopting predictive models that assist the Department's pest and invasive species programs to effectively control pest and invasive species populations and mitigate food crop loss. The Department also recognizes the importance of pollinators and existing biodiversity at the interface of agriculture. The Department will continue to evaluate methods to enhance native pollinators as part of their Ecosystem Services work.

TIMELINE

The figure below is a timeline of activities related to the agricultural Safeguarding Implementation Plan

ID	Task Name	Start	Finish
1	**1. Promote Management Practices**	**1/1/2016**	**6/30/2017**
2	Consult with agronomists and partners for an established management practice	1/1/2016	8/31/2016
3	Post on CDFA's website	6/1/2016	6/1/2016
4	Post case studies for practice	7/1/2016	10/31/2016
5	Compile all information on practice into short summary document to post	11/1/2016	1/31/2017
6	Consult for 2nd management practice	9/1/2016	11/30/2016
7	Post 2nd practice on CDFA's website	12/1/2016	12/1/2016
8	Post case studies for 2nd practice	1/2/2017	6/1/2017
9	Summary document for 2nd practice	5/1/2017	6/30/2017
10	**2. CDFA/DWR Joint Water Management Grant Program**	**1/1/2016**	**6/30/2017**
11	Draft Joint RFP	1/1/2016	8/2/2016
12	Stakeholder and Public workshops	1/1/2016	8/17/2016
13	Application Period	5/2/2016	8/31/2016
14	Joint Review	9/1/2016	10/14/2016
15	Project Installations	11/1/2016	5/2/2017
16	Project Verifications	12/1/2016	5/1/2017
17	Invoicing & Closeout	12/1/2016	6/30/2017
18	**3. EFA SAP Subcommittee Recommendations on Compost**	**1/1/2016**	**11/21/2016**
19	Form subcomittee	1/1/2016	2/15/2016
20	Coordinate information on compost application rates for 3 CA crops	1/1/2016	4/19/2016
21	Work with NRCS to develop interim conservation practice standard for compost	4/20/2016	8/9/2016
22	Incorporate the interim practice into any CDFA Healthy Soils Initiative Incentive Programs	8/10/2016	11/21/2016
23	**4. Pest and Invasive Species Monitoring and Forecasting**	**1/1/2016**	**6/9/2017**
24	Correlation studies using pest detection databases and observed changes in climate	1/1/2016	9/30/2016
25	Research predictive models that can be used for pest forecasting	4/15/2016	10/13/2016
26	Evaluate cost of developing grower tools using the correlation and model studies	10/17/2016	6/9/2017



Monitoring and Evaluation

While *Safeguarding California* informs efforts to expand the state's capacity to adapt to climate change impacts, there are many challenges in monitoring and evaluating that capacity. Both climate change impacts and the initiatives undertaken by state government are continually changing. Tools like Cal-Adapt.org show that climate change will lead to worsening impacts at least until the end of the century and almost certainly much longer. At the same time, human behavior and government responses will also necessarily evolve as a new climate emerges and the depth of understanding grows. To track how effectively social systems deal with both ongoing trends and the intensifying events like storms and drought that characterize many climate impacts, a broad set of metrics will need to be developed. This section will begin to explore the relevant monitoring and evaluation already done, the impacts and considerations that must be taken into account to adequately assess resilience, and a few metrics that would inform assessments of adaptation initiatives so far.

Ongoing monitoring efforts already help evaluate what climate adaptation actions need to be taken. The OEHHA Indicators report shows trends in climate impacts, including winter chill, freezing level elevation, extreme heat events, annual air temperature, and annual precipitation. These indicators can be compared to other monitoring efforts underway in state government. CDFA tracks related factors through the California Agricultural Statistics Report, the Pest Prevention Environmental Impact Report and crop and livestock pest and disease occurrences, the Department of Conservation maps farmland quality and protection status throughout out the state. Studying the relationships between various indicators can illuminate the vulnerabilities that state government can help address.

The following specific metrics are examples of the types of data that state government can use to assess the efficacy of its adaptation efforts for the agricultural sector:

- Crop yields, trends and revenues
- Volume of water conserved through the State Water Efficiency and Enhancement Program
- Energy generation from the methane produced by dairy digesters funded through the Dairy Digester Research and Development Program.
- Increases in soil organic matter accomplished through the Healthy Soils Initiative
- Viability of farmland in emerging climate regimes (financial and biological sustainability)

- Farmer engagement and participation in management of resources and in adaptation efforts
- Interaction with online climate tools such as COMET-planner and forums
- Track health impacts from extreme heat to agricultural workers
- Track incidence of plant and animal pests and diseases including changes in distribution, new introductions and establishments in consideration of climatic changes
- Farmland conversion rates near city centers
- Food Security, or the access to enough safe and nutritious food for an active, healthy life.

Climate change is inevitably going to transform California's agricultural sector. The goal of agricultural adaptation efforts should be sustainability and continued vibrancy in the agricultural community at all farm sizes. Engagement with stakeholders must be an underlying theme throughout all state activities in order achieve successful proliferation of information and elicit collaborative efforts. CDFA will continue to engage with partners and stakeholders to find new ways to build resilience in the sector.

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