

US Department of Agriculture Climate Change Adaptation Plan June 2012

I. Introduction

Role and Mission of USDA

The US Department of Agriculture (USDA) provides leadership on food, agriculture, natural resources, rural development, nutrition, and related issues through its evolving service role at the nexus of traditional rural American food and fiber production and the emerging economic opportunities in renewable energy, broadband, and recreation. The vision statement of the USDA Strategic Plan calls for the Department “to expand economic opportunity through innovation, helping rural America thrive; to promote agriculture production sustainability that better nourishes Americans while also helping to feed others throughout the world; and to preserve and conserve our Nation’s natural resources through restored forests, improved watersheds, and healthy private working lands.” Climate change has the potential to confound USDA efforts to meet these core obligations and responsibilities to the Nation.

Rural America is rapidly transitioning to a diverse and competitive business environment driven by an increasing sophisticated consumer market. The economic vitality and quality of life in rural America depends on a financially healthy agricultural system and access to agricultural and emerging markets. US farmers, ranchers and foresters ensure that all of America and many other parts of the world have nutritious and safe food, adequate energy sources, and fiber products sufficient for the needs of a rapidly increasing population. Climate change adaptation is essential to sustain these capabilities.

Background

A growing body of evidence shows that US climate has changed substantially since 1900, that this change is accelerating, and that even greater change is likely to occur in the next 100 years¹. Climate change has the potential to disrupt USDA’s efforts to meet the core obligations and responsibilities articulated by its mission, and goals. The vulnerability of USDA operations and programs to climate change will be highly dependent on the magnitude and pattern of climate changes, as well as on changes in climate extremes. Changing precipitation and temperature patterns as well as increasing atmospheric greenhouse gas concentrations affects forest and agro-ecosystems at national, regional, and local scales. These changes may have significant implications for USDA program participation and costs. Such projections are accompanied by a great deal of uncertainty so policies will need to be flexible enough to adapt to this uncertainty.

USDA is well-positioned to meet the requirements of the federal agency climate change adaptation guidance. The Department’s Strategic Plan for 2010-2015 provides a strong foundation for climate change adaptation planning. Two Agency Priority Goals for targeted

¹ DRAFT -- Climate Change and Agriculture in the U.S.: An Assessment of Effects and Potential for Adaptation. Technical Submission to the National Climate Assessment 2012.

or accelerated attention in 2012 and 2013 align with the strategic goals set forth in the USDA's Strategic Plan 2010-2015 and also address climate change adaptation.

All four goals of USDA's Strategic Plan have objectives that articulate opportunities and challenges associated with climate change adaptation. Strategic Goal 2 specifically addresses the challenges of climate change and opportunities associated with addressing greenhouse gas emissions "to ensure that our National Forests and private working lands are conserved, restored, and made more resilient to climate change." The Plan calls for the Department to capitalize on opportunities presented by the Nation's efforts to develop markets for ecosystem services. The USDA Strategic Plan further calls on the Department to lead efforts to mitigate and adapt to climate change through Goals 1, 3, and 4.

The following are the USDA Strategic Planning Goals and Objectives that relate to climate change:

Strategic Goal 1: Assist Rural Communities to Create Prosperity so they are Self-Sustaining, Repopulating, and Economically Thriving

Objective 1.1 – Enhance Rural Prosperity;

Objective 1.2 – Create Thriving Communities;

Objective 1.3 – Support a Sustainable and Competitive Agricultural System.

Strategic Goal 2: Ensure our National Forests and Private Working Lands are Conserved, Restored, and Made More Resilient to Climate Change while Enhancing our Water Resources

Objective 2.1 – Restore and Conserve the Nation's Forests, Farms, Ranches, and Grasslands;

Objective 2.2 – Lead Efforts to Mitigate and Adapt to Climate Change;

Objective 2.3 – Protect and Enhance America's Water Resources;

Objective 2.4 – Reduce the Risk from Catastrophic Wildfire and Restore Fire to its Appropriate Place on the Landscape.

Strategic Goal 3: Help America Promote Agricultural Production and Biotechnology Exports as America Works to Increase Food Security

Objective 3.1 – Ensure US Agricultural Resources Contribute to Enhanced Global Food Security;

Objective 3.2 – Enhance America's Ability to Develop and Trade Agricultural Products Derived from New Technologies;

Objective 3.3 – Support Sustainable Agriculture Production in Food-Insecure Nations.

Strategic Goal 4: Ensure that All of America's Children Have Access to Safe, Nutritious, and Balanced Meals

Objective 4.3 – Protect Public Health by Ensuring Food is Safe;

Objective 4.4 – Protect Agricultural Health by Minimizing Major Diseases and Pests to Ensure Access to Safe, Plentiful, and Nutritious Food.

USDA issued an addendum to the 2010-2015 Strategic Plan that contained three additional “priority strategic goals”. Two of these goals have a relationship to climate change.

Priority Strategic Goal 2: Further accelerate the protection of clean, abundant water resources by implementing high impact targeted (HIT) practices through Farm Service Agency (FSA), Forest Service, and Natural Resources Conservation Service (NRCS) programs on 4 million acres within critical and/or impaired watersheds and quantify improvements in water quality by developing and implementing an interagency outcome metric within 2-4 pilot watersheds.

This priority goal supports USDA and Administration priorities, including:

- The Department’s Strategic Goal 1 to *Assist Rural Communities to Create Prosperity so They Are Self-Sustaining, Repopulating, and Economically Thriving*, and Goal 2 *Ensure Our National Forests and Private Working Lands Are Conserved, Restored, and Made More Resilient to Climate Change, While Enhancing Our Water Resources*.
- Delivering results on action items in the President’s America’s Great Outdoors Initiative to build a 21st century conservation agenda; and
- Advancing innovative approaches to accelerating conservation through environmental markets.

Priority Strategic Goal 3: Assist rural communities to build and maintain prosperity through increased agricultural exports through key indicator targets and a baseline of growth over the last 5 fiscal years (FY2006-2010).

This priority goal directly relates to two of the four strategic goals outlined in the *USDA Strategic Plan*.

- Through trade facilitation, increased exports create jobs and increase prosperity domestically, which relates to Goal 1 (*Assist Rural Communities to Create Prosperity so They Are Self-Sustaining, Repopulating, and Economically Thriving*).
- By promoting and increasing exports, including biotechnology exports, this goal also helps to enhance food security around the world, which relates to Goal 3 (*Help America Promote Agricultural Production and Biotechnology Exports as America Works to Increase Food Security*)

Executive Directives and USDA's Role

Climate change challenges the mission, operations, and programs of nearly every Federal agency. Ensuring that the Federal government has the capacity to execute its missions and maintain important services in the face of climate change is essential.

Council on Environmental Quality (CEQ) and Adaptation

By Executive Order in October 2009, the Interagency Climate Change Adaptation Task Force (co-chaired by the Council on Environmental Quality (CEQ), the National Oceanic and Atmospheric Administration (NOAA), and the Office of Science and Technology Policy (OSTP)) was established to examine this challenge and was asked to recommend how the policies and practices of Federal agencies can be made compatible with, and reinforce a national climate change adaptation strategy. The Task Force, composed of more than 20 Federal agencies and Executive branch offices including USDA, was charged to consider the capabilities of the Federal Government to respond to climate change effects on select sectors, institutions, and agency responsibilities, and ultimately to develop recommendation reports. EO 13514 challenged Federal agencies to set sustainability goals for agency operations and directed agencies to improve their environmental, energy and economic performance. Under this EO, each Federal agency is evaluating agency climate change risks and vulnerabilities to manage both the short- and long-term effects of climate change on the agency's mission, programs, and operations.

To facilitate the effort, multiple workgroups, that included USDA scientists and technical experts, were developed. One significant outcome was the recommendation to encourage and mainstream adaptation planning across the Federal Government. This planning includes:

- Implement adaptation planning within Federal agencies
- Employ a flexible framework for agency adaptation planning
- Use a phased and coordinated approach to implement agency adaptation

CEQ issued a set of Implementing Instructions for Federal Agency Adaptation Planning on March 4, 2011. The Instructions provided agencies with templates for preparing strategies to integrate climate change adaptation into their planning, operations, policies, and programs, as recommended by the Interagency Climate Change Adaptation Task Force in its Interim October 2010 Progress Report to the President. On October 28, 2011 the Task Force released the 2011 Interagency Climate Change Adaptation Task Force Progress Report outlining the Federal Government's progress in better understanding, preparing for, and responding to extreme events and other climate change effects. The report provided an update on actions in key areas of Federal adaptation and provided climate information and tools to help decision-makers manage climate risks. The climate adaptation plans will be made publicly available through CEQ's website once finalized and approved.

USDA and its agencies are participating in developing risk and vulnerability assessments and adaptation implementation plans with guidance from CEQ in response to the Task Force recommendations. In response to the March 2011 CEQ Instructions, USDA prepared an

adaptation planning document as part of its 2011 Strategic Sustainability Performance Plan <http://greening.usda.gov/USDASSPP2011.pdf> , a Preliminary High-Level Analysis of Agency Vulnerability to Climate Change in September 2011 and a Final High-Level Analysis http://www.usda.gov/oce/climate_change/files/HighLevelVulnerabilityAnalysis_Sept2011.DOCX in March 2012. USDA has also prepared a Department-wide climate change adaptation policy statement issued in the form of a Departmental Regulation (DR-1070-001) in June 2011 that instructs each of its agencies with climate change responsibilities to prepare individual Adaptation Climate Change Plans. USDA is including this USDA Climate Change Adaptation Plan as part of its 2012 Strategic Sustainability Performance Plan. The final report will be posted to the Department’s climate change website http://www.usda.gov/oce/climate_change/ .

II. Vulnerability Assessment

Climate change has the potential to confound USDA efforts to meet the core obligations and responsibilities to the Nation. USDA agencies are responding to the risks and vulnerabilities associated with climate change with the following possible strategies:

Strategic Goal	Objective/ Pillar	Risks and vulnerabilities	Agencies Involved ²	Possible response strategies
1. Assist Rural Communities to Create Prosperity to be Self-Sustaining, repopulating and Economically Thriving	1.1 Enhance rural prosperity <ul style="list-style-type: none"> Facilitate sustainable renewable energy development 	Energy crops subject to new and challenging growing conditions.	RD, ARS, NIFA, FS, FSA, NRCS, ERS	Renewable energy can offset GHG emissions. Develop new energy crop varieties that can withstand changing climate conditions Promote resource-efficient cropping
	<ul style="list-style-type: none"> Develop and support regional food systems 	Climate change effects across regions will vary. Some regions will face greater challenges in adapting to changes in extreme events such as droughts and storms.	RD, FSA, AMS, RMA, ARS, NIFA	Better prepare farmers with adaptive responses to climate, encourage regional networks. Develop new crop varieties to withstand changing climate conditions.
	<ul style="list-style-type: none"> Capitalize on 	Ecosystem services	AMS, FAS, FSA,	Work with

² Agency Abbreviations: AMS: Agricultural Marketing Service, ARS: Agricultural Research Service, APHIS: Animal, Plant Health Inspection Service, ERS: Economic Research Service, FS: Forest Service, FAS: Foreign Agriculture Service, FSA: Farm Service Agency, NASS: National Agricultural Statistics Service, NIFA: National Institute of Food and Agriculture, NRCS: Natural Resource Conservation Service, RD: Rural Development, RMA: Risk Management Agency

	opportunities presented by the nation's efforts to develop markets for ecosystem services and mitigate climate change	may be stressed by climate changes and natural disasters.	FS, NRCS, RD, ERS	producers to diversify agricultural practices and protect ecosystem services, promote crops with the mitigation potential and most adaptable to environmental changes
	<ul style="list-style-type: none"> Generate and retain green jobs and economic benefits through natural resource and recreation programs 	Tourism activities and green jobs will be positively (warm-weather activities) and negatively (snow-related activities) affected by climate change. Coastal tourism could be affected by sea-level rise.	FS, RD	Work with rural communities to manage lands for tourism and outdoor recreation and find ways to use lands to enhance green employment opportunities.
	1.2 Create thriving communities	Clean air, clean water, and access to outdoor recreation will be threatened as climate changes.	RD, FS	Establish community forestry programs and develop 'green' and resilient infrastructure.
	1.3 Support a sustainable and competitive agricultural system	Climatic changes will stress some crops and potentially affect sustainability and competitiveness of farming and ranching.	ARS, FAS, FS, FSA, NIFA, NRCS, RMA, ERS	Conduct research to improve seed and feed, improve agricultural practices, and develop ecosystem markets. Provide outreach and education to ensure all producers have necessary risk management tools and knowledge.
2. Ensure Our National Forests and Private Working Lands are Conserved, Restored and	2.1 Restore and conserve the nation's forests farms, ranches, and grasslands	Degradation of resources may lead to increased GHG emissions, and threaten wildlife, fish, plants, lands, water, recreation,	FS, NRCS, FSA	Work with private landowners and public managers to restore and protect forests, crop, and grazing lands, provide incentives

Made Resilient to Climate Change		community, and prosperity.		to maintain working lands, preserve open space, and restore public forests.
	2.2 Lead efforts to mitigate and adapt to climate change	Healthy soils and plants are challenged by a changing climate.	FS, NRCS, ARS, ERS, NIFA, FSA, RMA	Integrate research results into policies and conservation practices, disseminate information, and support land managers who use these practices
	2.3 Protect and enhance America's water resources	Drought, infiltration limitations and runoff pose problems for increasingly limited quantities and quality of water resources.	FS, NRCS, RMA	Encourage producers and forest managers to preserve wetlands, use sustainable practices that put minimal stress on water resources
	2.4 Reduce risk from catastrophic wildfire and restore fire to its appropriate place on the landscape	Parts of the country, especially in the west, are increasingly threatened by drought and longer fire seasons.	FS, NRCS	Work with communities to ensure they are fire-adapted, return prescribed fires to ecosystems where needed
3. Help America Promote Agricultural Production and Biotech to Increase Food Security	3.1 Ensure US agricultural resources contribute to enhanced global food security	Ensuring global food security will become more challenging as countries address a growing global population, land degradation, scarce water supplies, and climate change.	NIFA, ARS, FAS, FSA, NASS, ERS, APHIS	Research should continue to improve and protect US staple crops to adapt to changing climate conditions, markets can be opened to spread these resources abroad

	3.2 Enhance America's ability to develop and trade agricultural products	Risks to food security and human health increase as shifts in distribution and nature of diseases, invasive species and agricultural pests increase.	FAS, APHIS	Enhance protection of agriculture, natural resources through adaptive risk analysis models, engaging larger number of stakeholders
	3.3 Support sustainable agriculture production in food-insecure nations	Many nations may experience failing crops and food insecurity due to droughts and natural disasters.	NIFA, ARS, FAS	Research into climate-resilient crops and farming practices can be disseminated to world farmers to help them become self-sufficient
4. Ensure All America's Children have access to Safe, Nutritious and Balanced Meals	4.3 Protect public health by ensuring food is safe	Flooding effects on ready to eat crops, and increases in temperature potential effects food storage.	APHIS, AMS	Ensure and certify foods are safe to purchase and eat
	4.4 Protect agricultural health by minimizing major disease and pests to ensure access to safe, plentiful, and nutritious food	Diseases, including plant and animal pests and pathogens, are expected to change in distribution as the climate warms and precipitation increases.	APHIS, ARS, FAS, NIFA, ERS	Identify pests and diseases before they enter the US, and continue research into prevention and suppression of disease
Priority Strategic Goal 2: Accelerate Protection of Clean, Abundant Water Resources		Ecosystem services will be stressed by changes in climate variability and extremes, making long-term application of targeted practices more critical.	FSA, FS, NRCS, ERS	Implement high-impact targeted practices in critical and/or impaired watershed and quantify improvements in water quality
Priority Strategic Goal 3: Assist Rural Communities to Build and		Agricultural production is affected by increasing temperatures,	FAS with cooperator groups from a cross-section of US food and	Increase agricultural exports through key indicators and a baseline of growth over the last 5 years

Maintain Prosperity		changing extremes and precipitation changes.	agricultural industries	
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Climate Change Effects on USDA Functions

Climate change presents new challenges for regulatory and response agencies. Public safety is increasingly at risk due to fast-moving wildfires, unpredictable extreme weather events such as flash flooding and associated sudden appearance of disease vectors. Risks to food safety, ecosystem health, and human health associated with many animal and plant diseases, invasive species, and pests may change. Endemic and exotic pests, weeds, and diseases are increasing concerns for agriculture and forestry, with widely seen consequences for productivity and ecosystem health. Although the influence of these factors is increasingly recognized by scientists and policy makers, the role of climate change on their proliferation is often not well understood. USDA is conducting basic and applied research on the interacting effects of climate change on endemic and exotic pests, weeds and diseases, and their resistance to management actions designed to control these types of species.

USDA’s costs for administering services such as disaster assistance, crop insurance, conservation and energy programs, and technical assistance are likely to increase as a result of climate change. Severe weather and other climate-related events such as associated excess moisture, drought, pest infestations, and heat stress place pressure on the capacity of agencies to meet demands.

Shifts in climate may also affect USDA infrastructure, particularly in areas of rising sea level and in areas of increased recurrence of extreme, damaging storms, tornadoes, and hurricanes. USDA facilities, lands, and operations may be increasingly and less predictably affected by these events. Rising temperatures influence the energy costs associated with aging structures constructed when energy costs were a less significant portion of agency budgets.

Climate Change Effects on Agricultural Production

Mechanisms for adapting to climate change are critical for continued agricultural production and stewardship of natural resources. An understanding of the effects of climate change on natural and managed ecosystems provides the insights needed to formulate strategies for assessing vulnerabilities and risks, and for leveraging potentially beneficial aspects of climate change. Mechanisms for identifying and detecting indicators of effects are a key to formulating effective management responses. Adaptive responses to climate change must be evaluated for changes in ecosystem function, economic implications, potential feedbacks to the climate system and their consequences for sustainability, and reinforcement of climate change mitigation strategies. Only then can adaptive management be successful.

Key vulnerabilities attributed to climate change in the United States are increasing temperature, precipitation changes, and sea level rise. The US is projected to warm by 1-2°C in the next 40 years and as much as 3-6°C by the 2080’s¹. Temperatures across the country

are expected to increase, with the largest increases expected to occur in Polar Regions throughout interior and northern Alaska and across the northern tier of interior continental US states. The coastal regions of the continental United States are expected to warm less rapidly than inland regions, and heat waves are likely to become more frequent across North America. Changes in drought frequency, higher night-time temperatures, higher annual extreme minimum temperature, and more intense storms and their effects are likely.

Shifts in the amount, intensity, duration, timing, and distribution of precipitation, both regionally and locally are expected to accompany temperature changes. Projected increases in the variability of precipitation will influence agricultural production because of the uncertainty in water availability within the growing season.

Global sea level is projected to rise over this century. Hurricane rainfall and storm intensity is expected to increase in response to climate change. Coastal regions should anticipate sea level rise, increased hurricane intensity, and the associated increases in coastal erosion and damage. Coastal storms, especially of tropical origin, could produce more frequent damaging winds, leading to greater extreme wave heights along the coast.

The agricultural sector has a strong record of innovation and adaptability, but the magnitude of climatic changes projected for this century including increased frequency of extreme events, exceed the variations that have been managed in the past and will challenge all elements of agricultural production systems. USDA agencies need to be prepared to address these issues through carefully planned adaptive strategies. The Synthesis and Assessment Product (SAP) 4.3³ outlined important effects that a changing climate have had and can have on agriculture and forestry. These effects present threats to agricultural production systems as well as opportunities to improve and expand production. Increasing carbon dioxide levels in the atmosphere may alter plant responses, including possible increases in vegetative productivity, weed pressures, and geographic expansion of invasive species. Indirect impacts of climate change must also be considered such as altered host-pathogen relationships that can increase incidence and damage to agricultural and natural ecosystems. Anticipated adaptation to climate change in production agriculture includes adjustments in management practices, including tillage, crop species, crop rotations, and harvest strategies. New research will increase the resilience of agronomic systems to climate change and will enable exploitation of opportunities that may arise.

Agricultural production volatility due to climate variability and change can lead to surplus and deficits in regions where food insecurity is common or food is difficult to obtain due to transportation disruptions. Food assistance programs can expect to experience increases in the number of requests for assistance under severe weather conditions such as flooding, hurricanes, and tornadoes.

Climate Change Effects on Forests and Grasslands

³ Synthesis and Assessment Product (SAP) 4.3, The Effects of Climate Change on Agriculture, Land Resources, Water Resources and Biodiversity in the U.S., 2008.

National forests and grasslands and surrounding farms, ranches, private forests, and range lands help protect water quality; provide wildlife habitat, lumber, and other products; and offer places to recreate. Open space, and the ecological and socioeconomic benefits these ecosystem services provide are lost when forests and working lands are converted for urban and industrial uses. Helping private landowners and communities maintain and manage their open space as sustainable forests and grasslands will become more difficult as climate change affects ecosystem services and factors that influence land use.

Forests and derivative ecosystem services occur in rural areas where human population densities are low and forest cover dominates and in urban settings where trees may provide a high per-capita value even though present in low density stands⁴. Land-use shifts in rural areas could involve conversion of forests to other uses. The extent of wildland-urban interface and urban areas are projected to increase, often at the expense of rural forests. For example, climate change could lead to declines in productivity of agricultural land or increased desirability of land for residential housing that results in the conversion of forest and rangelands to accommodate these needs. Higher temperatures coupled with population growth may increase the value of urban trees for mitigating climate change but may also make it more difficult to maintain healthy trees in urban environments.

The resilience of diverse ecosystems within forests and grasslands is fundamental to the multiple socioeconomic and ecosystem benefits they provide. Climate change affects those benefits, for example, by changing forest and rangeland productivity and composition, which in turn influences biomass availability for livestock and wildlife grazing, wood products, and energy. Any change in ecosystems that affects water resources will typically result in a significant loss of ecosystem services. The increased occurrence of severe drought or other extreme events such as catastrophic fires and insect or disease outbreaks can alter the long-term ecosystem composition, structure, and function as plant and animal species respond to climate change. The most rapidly visible and most significant short-term effects on forest ecosystems will be caused by altered disturbance regimes, including increased wildfires, insect infestations, disease, pulses of erosion and increased drought, all of which have an increased potential for cascading interactions.

International agricultural and forest trade enhances global food security, but provides conduits for geographic expansion of invasive species. Disease, pests and non-native species are easily and rapidly transported globally to countries where no natural predators exist or the where a climate contributes to the species overrunning the natural ecosystem.

Despite attempts to restore fire to appropriate landscape locations, increased effects from catastrophic wildfire are additional threats from climate change. Recent trends indicate increased fire occurrence and severity will affect annual acreages burned, particularly in the western United States even with conservative assumptions in rates of climate change. In addition, fires encompassing extremely large geographic areas are less responsive to suppression efforts.

⁴ Vose, J.M. et al., National Climate Assessment – Forest Sector Technical Report. US Forest Service General Technical Report

A series of risk management frameworks for the forest sector were necessary to help quantify the magnitude and likelihood of environmental and other effects. These frameworks have existed for years but applying them to projecting climate change effects is relatively new³. Risk assessments need to be tailored to particular regions and time frames and modified by an estimate of confidence in the projections made. For example, management strategies for Alaska, where climate change affects permafrost and disturbance regimes, are quite different from the strategies needed for the Pacific Northwest, the Pacific territories, or the Southeastern US. In the Pacific Northwest, climate projections indicate a future unfavorable to parts of the current range of Douglas-fir. Strategies for low-lying islands such as those of the Pacific territories must address the stressors created by increased storm activity, sea level rise, and population demands. Different strategies for the Southeast include competition for water due to rapidly increasing populations combined with increased drought frequency resulting in potential water shortages. Federal agencies have made progress in developing scientifically-based principles and tools for adapting to climate change in forest management that are focused on education, assessment of vulnerability of natural resources and development of adaptation strategies. Science-management partnerships working collaboratively with stakeholders are key to successful adaptation efforts. Although uncertainty exists, land managers are already using climate-related practices such as thinning and fuel treatments to reduce fire hazard to increase ecosystem resilience. Regardless of the approaches, forest and grassland ecosystems in the US at the end of the 21st century will differ from those of today as a result of changing climate, but a broad range of options will be available for managing these resources sustainably.

Economic Effects of Climate Change on US Agriculture

The economic effects of climate change are shaped by an array of institutions from local to global scales ranging from commodity markets to systems of research, development, education, communication, and transportation. These institutions define opportunities and constraints in which stakeholders can modify or adapt their behavior to minimize losses and take advantage of new opportunities for gain associated with changing climatic conditions. The economic implications of climate change in the US are sensitive to yield effects and adaptation opportunities, as well as constraints in the US and abroad. US farmers' capacity to adapt, as well as shifting trade patterns, will mitigate potential effects on domestic producers and consumers. However, future climate scenarios with even mild rates of climate change may result in more severe implications for food security for the very poor and vulnerable populations worldwide.

Adaptive behavior can include changes in consumption, production, education and research. The aggregate effects of a changing climate ultimately depend on the effectiveness of the a network of adaptive responses -- from the local producer adjusting planting patterns in response to crop yield, to seedling producers investing in more drought-tolerant varieties, to nations changing trade restrictions in response to food, fiber, and fuel concerns at a global level. Producers' financial viability will be affected by change in management costs associated with changing biophysical stressors, the effects of variability and extreme weather events, and potential credit or resource constraints. Regional capacity for expanding agriculture, forestry or irrigated production will depend heavily the availability of land and

water. Because agricultural, forest, and natural ecosystems are complex, the manner in which production and consumption systems adapt to biophysical changes and incorporate lessons from research and education will determine the overall effects of a changing climate.

Adaptive behavior can mitigate the potential effects of climate change on food production, agricultural and forest-based income, and food security by moving production out of regions with newly reduced comparative advantages in specific production sectors and into areas with improved relative productivity. Reilly et al, (2007)⁵ find that with adaptation, the production effects of climate change are reduced to one-fifth to one-sixth of initial yield effect.

Attempts to quantify the economic effects of climate change are dependent on number of elements including climate and yield projections, treatment of adaptation constraints and the methods and models used. For example, if global yields are generally lower, global prices rise regardless of domestic yield increases. The resulting price increases could benefit US producers but not necessarily the US consumer. Uncertainty in climate projections is also a critical element in assessing economic effects.

Agency Assessments of Risk and Vulnerability

USDA is composed of many agencies with differing missions. Agencies were requested to assess their risk and vulnerability to climate change. The responses are broad and address risks and vulnerabilities at global, national, regional, and local scales as they relate directly to a particular agency mission.

Physical and Biological Climatic Concerns

USDA agency missions are affected by shifts in climate, extreme events, and climate variability.

- Agricultural Marketing Service (AMS) – AMS administers commodity procurement for programs that address food-security in at-risk populations. Changing climate trends present the need for a baseline to identify and develop indicators to streamline these programs for the future.
- Agricultural Research Service (ARS) – ARS maintains experimental stations and field plots across the US. The following examples of climate change effects illustrate the risks to ARS's capacity to meet its mission. *Extreme conditions and animal research:* Extreme conditions associated with climate change affect livestock, and potential effects on ARS research may be significant. Direct effects are related to the intensity and frequency of animal summer heat stress. *Effect of climate change on crop research:* There are many ways that climate change and weather extremes may affect ARS crop research and allocation of resources to crop research. Included are the many documented effects of increasing CO₂ concentrations, heat, precipitation extremes, and the various combinations on crop growth, reproduction, and yield. Greater uncertainties are associated with the effects on pests and

⁵ Reilly, J, et al., (2007) Energy Policy, 35(11): 5370-5383

pathogens. In general, the geographic distribution of pests is largely dependent upon climate, whereas the incidence and severity of outbreaks are largely dependent upon weather. *Effect on food safety research:* Flooding can have a major food safety impact. A Food and Drug Administration (FDA) rule now considers ready-to-eat crops that have been in contact with flood waters to be adulterated due to potential exposure to sewage, animal waste, heavy metals, pathogenic microorganisms, or other contaminants. To reduce the effect of seasonal extreme weather events, a significant amount of land susceptible to flooding has been taken out of production. This has affected ARS' ability to continue some of its important produce-related research. *Implications for natural resources in research:* Short and long-term water shortages (drought) and excesses (too much, too fast) are expected to increase in frequency with changing climate. Research that has always been based on rain-fed plots may thus require irrigation for the first time. Even among field plots that have been irrigated all along, greater amounts of water may be required, which can alter or compromise research objectives and/or progress. Water shortages may result in the loss of experimental material (plants, soil, animals), delay planting dates, suppress yield quantity and/or quality, and increase the threat of fire on grazing lands research locations. Water shortages will affect research priorities, especially when reduced water availability for research and industry alters what, where and how a crop or livestock can be grown.

- Animal and Plant Health Inspection Service (APHIS) – APHIS protects and promotes US agricultural and forest health, regulates genetically engineered organisms, administers the Animal Welfare Act and carries out wildlife damage management activities. Climate change will affect the distribution of plant pests, diseases and weeds and the population dynamics and number of generations per year for insect pests and therefore the level of risk to food security and associated human health. APHIS in coordination with Customs and Border Protection monitors weather, pest trends and disease outbreaks throughout the world to enhance protection at ports and airports. The approach rate and probability of establishment for invasive alien species will also be affected by climate change and require additional vigilance.
- Farm Service Agency (FSA) – FSA administers financial assistance programs for farmers and ranchers, biomass crop assistance programs, and USDA's largest private lands conservation programs. Vegetative practices and energy crops can be expected to become more difficult to establish and to maintain as a result of more frequent and/or more intense episodes of excess moisture, moisture deficit, and heat stress, increased pest populations, and increased competition from invasive species. Successful practices may require greater amounts of technical and financial assistance. Structural practices, built to withstand precipitation based on historical events, can be expected to fail more often as a result of increased frequency and intensity of severe weather events. Specifications for new structural practices in many regions will need to be redesigned to handle increased and/or more intense run-off. Since yield effects of climate change can be expected to make cropland relatively expensive, annual payments to compensate for foregone returns may also rise. The cost of SURE (SUPplemental REvenue Assistance Payments), a disaster/emergency assistance program and other disaster-related programs could increase as more disasters occur as a result of more frequent and/or more intense episodes of excess moisture and heat stress and increased frequency and intensity of severe weather events. Producers least able to cope with

climate change may be those with limited access to credit, such as beginning and disadvantaged producers, often farming more susceptible marginal lands. Disaster assistance directed toward producers suffering loss from extreme weather may be the short-term support needed for their operations to sustainably bridge and adapt as climatic conditions change.

- **Foreign Agricultural Service (FAS)** – FAS administers scientific exchanges and capacity building programs to engage countries on climate change priorities that enable the U.S. and international counterparts to jointly promote economic development and environmental quality in the agricultural sector and overall promote global food security. FAS also participates in Feed the Future (FtF), a global-scale initiative with working groups that assess conditions, define priorities and align US Government resources that can develop agricultural sectors of food insecure countries. Increasing food security of FtF partner countries will help them become more resilient to climate-related food shortages. Another mission of FAS is to forecast world-wide agricultural production and trade. Variability in global production places demands and risks on FAS to provide market intelligence and commodity analysis for key producing countries and key markets. Without appropriate predictive models, these analyses become more uncertain with increasing climate variability. The World Agricultural Supply and Demand Estimates (WASDE) and USDA Agricultural Long-Term Projections reports are examples of FAS supported analyses that may become more challenging to produce in the face of climate change.
- **Forest Service (FS)** – The FS mission is impacted by shifts in temperature and precipitation patterns and amounts, extreme events, and climate variability. The FS manages public forests and grasslands and works with States, Tribes and private landowners to restore and sustain the health, diversity and productivity of the Nation’s forests and grasslands. Changes in key climate variables affect the seasonality of hydrologic regimes, reproduction cycles of pests and pathogens, length of fire seasons and ultimately ecosystem composition. In the West, fire seasons have increased by 78 days since the mid 1980s.⁶ Disturbance facilitates the introduction and spread of invasive species that disrupt ecosystem processes and functions and increases extinction risks for native species. The changing climate is already altering species ranges and has the potential to alter ecosystem structure in the future as evidenced by the mountain pine beetle (a native insect) epidemic in the West. Management will require forward-looking approaches to novel ecosystems instead of depending on historical ranges of variability. These effects pose challenges to sustaining forests and grasslands and the supply of goods and services upon which society depends, such as clean drinking water, forest products, recreation opportunities, and habitat.
- **National Institute of Food and Agriculture (NIFA)** - NIFA’s mission is to support exemplary research, education, and extension. NIFA will need to balance the increasing demand for scientific research, modeling, educational programs, and extension activities to address climate change issues with those of other research needs. For example, investigations of climate stressors and tipping points will become more essential to climate adaptation science research and will need to be balanced with vulnerable areas of crop and livestock production research and formal and informal state educational programs. NIFA plans a comprehensive

⁶ Westerling, Hidalgo, Cayan, and Swetnam. 2006. *Science* 313: 940-943.

Climate Change Science Plan to integrate climate change adaptation science and resiliency, mitigation and decision support into relevant NIFA policies, programs and operations.

- Natural Resources Conservation Service (NRCS) – NRCS provides conservation assistance to private landowners under a range of locality-specific conditions. Climate change presents a spectrum of conditions that extend beyond local variability, including conditions that are more extreme than the locality-specific tolerances currently integrated into the NRCS conservation practice standards. Conservation planning needs to be designed to accommodate changes in precipitation (drought, flood frequency, rainfall intensity), temperature (higher night-time temperatures, higher annual or extreme minimum temperatures), and other climatic variables. Conservation planning in coastal regions should anticipate sea level rise, increased hurricane intensity, and the associated increases in coastal erosion and damage. NRCS will evaluate these and other climatic effects on conservation practices, systems engineering designs, nutrient and manure management and work with private landowners to address these issues.
- Risk Management Agency (RMA) – The principal vulnerability to climate change is through insurance coverage offered through crop insurance policies. RMA administers the Federal crop insurance program and provides coverage to farmers and ranchers for flood, drought and other natural disasters. Farming practices may change and growers may approach growing crops differently by adapting to earlier growing seasons, planting new varieties or shifting locations of their farming operations to adapt to climate change. RMA has evaluated the potential risks climate change presents to the Federal crop insurance program and to the tax payer. RMA will continue to monitor climate data and research to the extent that climate changes over time and update program parameters (e.g. sales closing dates, final planting dates, and other program dates) as needed to reflect such changes.

Marketing and Trade Concerns

Disruptions in the traditional commodity supply chain concern USDA agencies whose missions include commodity trading and marketing. These disruptions include transportation and planned emergency hunger relief operations from climate changes, induced diseases outbreaks, invasive species, changing historical recurrence intervals of extreme events, and prolonged droughts or flooding.

- Agricultural Marketing Service (AMS) – Increasing temperatures can affect production that in turn affects the need for employees in grading and auditing of how products are produced, processed and packaged.
- Animal and Plant Health Inspection Service (APHIS) - Climate change and associated shifts in disease and pest prevalence may overwhelm the current ability of off-shore programs to provide real-time information regarding pest and disease potential and may increase risk to US agriculture. Existing surveillance and diagnostic networks for animal and plant health diseases (e.g., avian influenza, foot and mouth disease, agricultural and forest and pests, etc.) could be overwhelmed. Increased requirements for commodity and pathway risk analyses may overwhelm existing capacity.

- Forest Service (FS) - Climate change may influence the demand for energy and its mix of sources. Woody biomass is gaining attention as a renewable energy source. An increasing demand for renewable energy may affect how forests are managed and influence a wide range of ecosystem services, such as water quantity and quality, wildlife habitat, and carbon sequestration. Management options to maintain healthy ecosystems include thinning stands to reduce moisture stress and regenerating stands where they have been decimated by insects or disease. Because of the demise of the forest industry in many rural and local areas, a major marketing effort will be necessary to reestablish mills and processing plants. Climate change may adversely affect river-based outdoor recreation opportunities through changes in the timing and volumes of stream flow; thereby affecting many rural communities dependent on favorable water flow and a river based economy.
- Foreign Agricultural Service (FAS) - The international demand for FAS-administered food aid programs could increase significantly in regions that experience decreased domestic production due to climate change or extreme climate events. Increased frequency of extreme weather events may destabilize import markets, develop long-term strategies for building markets, and increase the volatility of prices. Climate change may lead to production shortfalls and export bans abroad, undermining FAS efforts to promote free trade. Warmer average temperatures may increase the range and severity of disease outbreaks in the US raising technical barriers to trade and sanitary or phyto-sanitary concerns abroad. Climate change may lead to an increased number of countries that request FAS administered food assistance, and, thereby collectively intensify pressure on FAS' limited resources.

Infrastructure Concerns

Many USDA agencies have established research experimental sites and built facilities to withstand climatic variability and extreme events based on historical weather records. These records insufficiently represent future climatic changes.

- Agricultural Research Service (ARS) – The ARS is the largest research agency in USDA and has experimental stations and field plots throughout the United States. Extreme weather events have recently, and will continue to damage research facilities and infrastructure. Experiments have been disrupted due to plant and animals loss. Heavy snowfall and rain events leading to flooding have affected the agency's ability to care for animals, and greenhouse plants. Flooding of research facilities and fields has occurred. Drought has affected experimental fields and animal facilities. Energy use has varied considerably from past experience due to prolonged high and low temperatures. Heating and cooling expenses for workers, laboratories, and greenhouses have varied such that projecting needs and costs is increasingly difficult. Increased vigor of weeds and appearance of invasive species have required additional resources to control in experimental plots and fields. Wide temperature and precipitation swings affect work force health and food safety and increase likelihood of pathogens and skin irritants. Water quantity and quality needed to maintain research may become an issue for locations where prolonged drought occurs or where water-treatment plants are compromised by weather events. These occurrences may require a shift in research priorities. Incorporating additional environmental factors related to climate change

must be considered in research planning for developing new crop varieties, management strategies, and conservation practices.

- Animal and Plant Health Inspection Service (APHIS) - APHIS has established animal and plant health emergency frameworks to facilitate coordinated timely responses to disease and pest emergencies and established frameworks to address all hazards (e.g., hurricanes, floods, wildfires) both for effects on plant and animal health, and on the needs of individuals with household pets and service animals. In the event of wide-ranging climate disruption events, capacity could be overwhelmed and assistance from other USDA and Department of Homeland Security emergency response resources would be required. State, local, tribal, industry and other stakeholders with key roles in threat mitigation may also be overwhelmed.
- Forest Service (FS) – The recreation infrastructure, including ski areas, reservoirs and campgrounds, is strongly influenced by past and current climate. Preserving high-quality recreational experiences will depend not only on the condition of the land, facilities, and transportation infrastructure but also on where such opportunities can be accommodated safely and managed under a changing climate. The projected increase in US population and the continual decline of public access to privately-owned land will increase demand for more recreational opportunities on public land. With increasing intensity of rain events, the extensive road systems of the National Forest System will require increased maintenance and/or modifications to culverts, bridges, and erosion control measures.
- National Agricultural Statistics Service (NASS) - Evidence of effects from extreme weather events on NASS assets, operations, resources, security infrastructure, economic activities, or coordination over the past decade include: 1) In each of the past six years, NASS has had to conduct a reinterview survey for one or more time periods. Reinterviews add additional respondent burden to previously sampled and enumerated farm operators and agribusinesses and result in delayed information to the public for affected crops and states; 2) An increasing demand for quick response, ad hoc requests to the NASS Remote Sensing unit to support the monitoring and assessment of extreme weather on agency operations and agricultural production; 3) Following extreme weather events, requests for information (often demanding a quick response) increase significantly from news media, businesses, and government officials seeking additional information. Any increase in frequency and/or intensity of such events poses an additional burden on NASS staff responding to the information demands; 4) Comparison of changes to average planting dates, as compiled by NASS from prior publications (1997 and 2010), reveal earlier planting dates for corn in 10 major states. This suggests that the NASS *Crop Progress* reports, now beginning on the first week in April, may need to be started earlier in the future to adapt to an earlier seasonal climate regime.
- National Institute of Food and Agriculture (NIFA) – NIFA will need to improve notification of employee and invited panels of expert reviewers and gather status information in the event of national capitol area disasters, extreme weather events and increased severity of air quality warnings. NIFA is examining new ways to increase telework capacity and hold virtual review panels rather than on-site meetings in the capitol area. Climate will also affect the technological infrastructure in the national capitol area where information systems are housed and require a controlled temperature and humidity environment.

- Rural Development (RD) – RD is committed to helping improve the economy and quality of life in rural America. Climate change challenges rural communities to strengthen utility infrastructure and rural housing programs, prepare community facilities, businesses and agricultural producers to respond to weather related events, mitigate the environmental effects of climate change and adapt to changing conditions.
- Risk Management Agency (RMA) – When losses occur, the Standard Reinsurance Agreement requires that approved insurance providers send loss adjusters into the field to determine the extent of damage and the appropriate losses under the insured’s policy. The health of RMA employees and loss adjusters sent to assess damages could be affected by extreme weather events and more frequently than in the past.

Capacity Building

USDA agencies are developing plans to educate its employees and their stakeholders, and accommodate expected changes associated with climate change vulnerabilities and risks.

- Agricultural Research Service (ARS) – ARS is communicating internally, externally to stakeholders, and to customers the need to elevate the importance of changing climate as a factor affecting agency operations and research results. ARS sets its research priorities, develops National and management unit-level research plans, and implements its plans through a highly developed process that includes established procedures for obtaining formal input from a wide variety of customers, stakeholders, and research partners. Research project plans are developed by agency scientists in response to input from customers, stakeholders, and partners and peer-reviewed by non-ARS scientists for adequacy of research approaches and likely successes. ARS anticipate that the agency’s customers, stakeholders, and partners will identify changes to research programs and changes in allocations of research resources to address pressures from climate variability and change.
- Animal and Plant Health Inspection Service (APHIS) – APHIS is working with ARS to develop a list of research needs that ARS scientists will investigate to learn how pests and diseases adapt to climate change. APHIS has international partners in climate modeling and closely follows research in universities. In addition, APHIS is increasing coordination and collaboration with domestic and international partners to develop predictive modeling capabilities, develop regulatory strategies and leverage resources. For example, Animal Care Emergency Programs (ACEP) work to protect the public in supporting the well-being of pets and animals at facilities regulated by the Animal Welfare Act (AWA). Although ACEP does not have expertise to directly analyze the effect of climate change scenarios on disasters, it uses information provided by NOAA, FEMA, and other subject matter experts on the implications of climate change on disaster risk. Current ACEP efforts toward capacity building focus on enabling regulated facilities and pet owners to plan for disasters to decrease the time from the event to full recovery. APHIS works with federal, state,

university, and industry partners to enhance detection, identification and response to animal and plant health emergencies.

- Economic Research Service (ERS) – ERS is the primary source of economic information and research for USDA. This mission is not vulnerable to climate change in the same way that USDA agencies responsible for land management, applications and technology transfer, and assistance are. Changing climate conditions do not compromise ERS’ ability to conduct research in support of its strategic goals. ERS efforts to address mission challenges related to climate change center around building research capacity in the area of climate change effects and adaptation, including building linked economic models, resource and economic data systems, as well as developing improved in-house modeling and analysis capacity to implement the most up-to-date science and methodologies available. Specific research priorities are established based on formal and informal strategic planning efforts that incorporate input from customers, stakeholders, and USDA and external partners.
- Foreign Agricultural Service (FAS) – FAS relies on its Climate Change Working Group to raise awareness and disseminate information across FAS about emerging climate change issues that may affect the mission, activity pillars, and objectives of FAS. FAS is currently engaged in assessing the risks and opportunities associated with climate change. There are various means by which FAS understands and evaluates these risks and opportunities. They include engaging in climate change related intra- and inter-departmental working groups (e.g. USDA’s Climate Change Task Force, and Feed the Future working groups). FAS also relies on the extensive intelligence gathering of Foreign Service Officers, who are the “on-the-ground” source of information for over 100 countries. FAS also monitors and advises the work of many international organization (e.g. FAO, OECD, World Bank) and participates in many United Nations negotiations (e.g. Framework Convention on Climate Change, Committee on Trade and Development, Sustainable Development Council). The FAS Climate Change Working Group will further consider *additional actions* to better understand the risks and opportunities that may affect its key pillars.
- Forest Service (FS) – The FS provides a wide variety of climate change communication materials and training opportunities for its employees, other agencies, and the public. These range from basic awareness education to highly technical seminars, workshops, and courses for conducting vulnerability assessments and developing adaptation and mitigation strategies. Partnerships between scientists and land managers are being strengthened to improve the focus of research and technology to address current and emerging science and information needs. Resource inventory, monitoring, and assessment activities and decision support tools are being better aligned and coordinated across FS programs and with partner agencies at multiple scales. Examples of ongoing and newly initiated capacity-building efforts are: Conservation Education Programs, Climate Change Resource Center, Environmental Threat Assessment Centers and Inventory, Monitoring and Assessment Strategy.
- National Agricultural Statistics Service (NASS) – NASS’ numerous reports provide the information necessary to facilitate research to address issues related to climate change. Changes in climate conditions influence crop variability and will influence information NASS collects and publishes, such as crop yields and production data. Farmland use and

conservation practices also affect crop production and contribute to carbon storage in the soil.

- National Institute of Food and Agriculture (NIFA) - NIFA collaborates or has formal working partnerships with many institutions and individuals. NIFA's key partners are the institutions of higher learning making up the Land-Grant University System, however, NIFA also partners with other federal agencies, within and beyond USDA; non-profit associations; professional societies; commodity groups and grower associations; multistate research committees; private industry; citizen groups; foundations; regional centers; the military; task forces; and other groups. NIFA and its partners focus on critical issues such as climate change that affects people's daily lives and the nation's future. NIFA will advance research and educational technologies that empower people and communities to solve problems and improve climate adaptation and mitigation efforts at the local level. NIFA also supports the base programs of state Agricultural Experiment Stations and the Cooperative Extension System nationwide at land-grant universities. NIFA helps ensure that a high-quality higher education infrastructure will be available at the nation's land-grant universities to address national needs, and it uses the infrastructure of scientific expertise from these and other colleges and universities, and also of public and private laboratories, to partner in addressing national priorities, such as climate change. NIFA is expanding the Climate Change Community of Practice within eXtension (www.extension.org) to reach a broader audience.
- Natural Resources Conservation Service (NRCS) – NRCS will examine human capital, expertise areas and levels and other agency infrastructure components relative to climate change effects. NRCS has developed an online curriculum for climate change that is accessible to employees and stakeholders. To date nearly 9,000 (80% of total employees) NRCS employees nationwide have completed the “Air Quality, Climate Change and Energy” online course. The NRCS also has formed a Climate Change Coordination Team that has completed a climate change vulnerability assessment recommending adaptation approaches for NRCS to guide future agency planning. This is expected to be the start of a sustained effort to better integrate changing climate and climate variability into natural resource conservation planning.
- Natural Resources Conservation Service (NRCS) and Forest Service (FS) - Management practices, technologies, and quantitative tools that do not account for climate change will hinder the ability of private land owners and federal land managers to plan and manage resources. Existing decision support tools and their supporting databases need to be reviewed and new approaches to decision support must be developed to enhance their ability to address complex issues facing private landowners and land managers, such as linkages among ecosystems, water resources, and regional species migration patterns.
- Risk Management Agency (RMA) - RMA will increase its outreach to policyholders to inform them of choices when dealing with drought and flood related events that may have prevented them from planting insured crops. RMA is increasing the number of press releases, interviews, factsheets and questions and answer pages on RMA's website to inform stakeholders and others of our policies when dealing with the severe climate and weather

events. Through a partnership with Oregon State University's PRISM Climate Group (Parameter-Elevation Regressions on Independent Slopes Model) PRISM is also building a Climate and Weather web portal that will be used by RMA and by the 16 approved insurance providers that sell and service crop insurance for services, such as adjusting producer's crop losses quickly and accurately. In addition, the portal can be used by producers to make planting and production decisions every day.

Processes for Assessing Effects and Vulnerabilities

USDA agencies have established various pathways and processes to assess agency vulnerabilities to climate change effects:

- Agricultural Marketing Service (AMS) – AMS gathers information internally for evaluation and does not address climate change directly. Many stakeholders are proactively and voluntarily taking steps to address sustainability through their own business models.
- Agricultural Research Service (ARS) - ARS has been engaged in dialogue across program theme areas (Natural Resources and Sustainable Agriculture, Crop Production and Protection, and Animal Production and Protection) to determine adjustments to research approaches needed to incorporate climate change adaptation. This adaptation plan will be reviewed during the first quarter of each fiscal year by the ARS Deputy Administrator for Natural Resources and Sustainable Agricultural Systems (NRSAS), in consultation with the other three subject-matter Deputy Administrators of the Office of National Programs, the National Program Leader for Climate Change, Soils, and Emissions, the Director of the Human Resources Division, and the Director of the Facilities Division. Prior to that review, the Deputy Administrator for NRSAS will solicit information from the eight Area Directors to ascertain occurrences of significant interference from climate and weather with research goals, personnel, or facilities during the previous fiscal year coordinate responses whenever possible. Knowledge gained from agency-wide, national information will be used to identify priorities and update the plan.
- Animal and Plant Health Inspection Service (APHIS) – To better understand risk, APHIS will adapt risk analysis models both epidemiological and forecasting to incorporate changes in the distribution of environmental and biological attributes predicted under different climate scenarios. Model results will help prioritize likelihood and severity of threats and focus activities on specific high-impact diseases or agricultural pests and pest categories. APHIS will develop or revise surveillance and detection strategies for changes in distribution, transmission and outbreak of pests and diseases known to affect food and human health. APHIS will engage more partners and stakeholders in gathering information, evaluating modeling and supporting decision-making to enhance protection of agriculture, natural resources and trade.
- Economic Research Service (ERS) - ERS is working closely with other USDA and federal agencies to develop a solid, spatially detailed baseline of current and past conditions related to land resources, climate, and land use and farmer decision-making. Such a baseline will be

necessary to support robust analyses of how changes in the climate, and associated changes in the resource base, will affect farmer decision-making. In particular, ERS works closely with NASS to identify and collect the data needed to assess impact of climate change on farming operations. This effort also involves a comprehensive integration into ERS analyses of key data sets from FSA, NRCS and NASS as well as close collaboration with other Federal agencies such as U.S. Department of Energy and U.S. Environmental Protection Agency. Development and enhancement of integrated economic, crop, climate and environmental process models expand ERS' capacity to meet expected increases in demands for information about the costs, benefits and policy implications of climate adaptation strategies in both the crop and livestock sectors. ERS participates in the USDA Global Change Task Force to further enhance integration and coordination with other USDA agencies working in this arena. ERS tracks stakeholder requests for information and impacts of activities, and incorporates that information regular program reviews.

- Farm Service Agency (FSA) – FSA will review programs and policies to ascertain the extent and improvement of response to producers for climate change adaptation information. Review would include asking whether programs encourage adaptation or status quo, how to target enrollment of specific lands for Conservation Reserve Program, simplification of field trials, loan investments emphasizing investments that reduce water and heat stress and how well disaster programs encourage adaptation rather than return to current practices following losses. FSA will also partner with USDA Research, Education and Economics mission area and outside organizations to make appropriate decision support tools more accessible to field offices.
- Foreign Agricultural Service (FAS) – FAS will continue to rely on its Climate Change Working Group to coordinate annual reviews and updates to the Climate Change Adaptation Plan. The review process will include in-depth discussions with each FAS program area and final approval at the administrator level. Additionally, the input of stakeholders and Foreign Service Officers will be considered when developing updates to the plan. Prioritization of climate change adaptation actions will include: (1) Effect on FAS mission and potential to improve services to stakeholders; (2) Financial resources and the availability of trained personnel; and (3) USDA priorities for foreign affairs associated with climate change. FAS will rely on a diverse set of information sources to aid in developing the Climate Change Adaptation Plan over time. FAS will consider the needs and input of stakeholders, the intelligence gathered by Foreign Service Officers, as well as technical information on climate change effects reported in the National Climate Assessments. FAS relies on the USDA Global Change Task Force to provide linkages to cutting-edge scientific developments about climate change and agriculture. Additionally, FAS employees can subscribe to the National Agricultural Library's climate change and agriculture newsfeed to receive weekly updates on current events. The FAS Climate Change Working Group will be the coordinating body for evaluating FAS performance on climate change adaptation. As part of the annual review process, each FAS program area will be asked to provide input on progress towards addressing the vulnerabilities and opportunities related to each FAS activity pillar.
- Forest Service (FS) – The FS has a number of comprehensive policies, strategies and processes being implemented or developed including a National Roadmap for Responding to Climate Change, Climate Change Performance Scorecard, Forest Service Global Change

Research Strategy (2009-2019), a new Planning Rule, a Watershed Condition Framework and Terrestrial Condition Assessment, a Forest and Rangeland Renewable Resources Planning Act (RPA) Assessment, an Inventory, Monitoring and Assessment Strategy, and the Genetic Resource Management and Climate Change Strategy. In response to climate change stresses, these strategies allow FS to create responsive planning, improve FS' capacity to deliver science, resource information and tools to forest managers to assess and monitor forest conditions, and to focus attention on helping localities improve resilience of urban and community forests. In addition, comprehensive risk assessments are being completed when planning recreation infrastructure projects and a risk assessment of all developed recreation sites recently was conducted to identify and mitigate public safety issues related to extreme weather events.

- National Agricultural Statistics Service (NASS) – NASS programs and policies are regularly reviewed both internally and externally. Adapting to the dynamic agricultural industry requires constant vigilance and assessment of the statistical and informational needs of the entire food and fiber sector. NASS works closely with other USDA Agencies, such as ERS to identify and collect the data needed to assess effects of climate change on farming operations. The Cropland Data Layer (CDL) Program annually produces digital categorized geo-referenced products using satellite imagery. The completion of a conterminous National CDL and web portal CropScape fills a data gap critical for research and decision support for conservation, climate change, and water resources. NASS plans to integrate climate change adaptation into policies, programs, and operations as follows 1) NASS, along with other USDA agencies, conducts annual “Data User” meetings with public users of USDA and NASS data. NASS also has an Advisory Committee on Agriculture Statistics. NASS will propose Climate Change Adaptation Planning to be a topic for discussion with stakeholders; 2) Internally, NASS senior executives will be briefed on past and potential effects of the changing climate; 3) As educational opportunities become available, NASS employees will be offered opportunities to “learn from the experts,” how the changing climate may affect agriculture and possible impacts on their work and employment; 4) Continue to develop the science and operational capacity of the NASS Remote Sensing program to support agency natural disaster response, produce time-sensitive monitoring and assessment data and products, and expand support to the NASS Mission.
- National Institute of Food and Agriculture (NIFA) - NIFA conducts a portfolio review of its projects and programs to evaluate the program success in achieving goals for the environment and natural resources. The portfolio review makes use of NIFA's established knowledge areas of which Weather and Climate is one. In addition, a knowledge area for Alternative Uses of Land is focused on climate change. A new portfolio review process has been developed by NIFA that includes a portfolio planning, assessment, and quality improvement plan. Continuous assessment through Post-Award management of successfully-funded grants is needed to identify gaps that NIFA's unique approach can fill. NIFA will establish new opportunities to better understand vulnerability through science-based assessments to assess vulnerability, monitor climatic effects, and project outcomes based on scenarios through collaborative interagency funding, marketing strategies and promoting partnerships. NIFA will establish a Science Priority-making process team with an established management structure and guidance from the NIFA science leadership

council. This team will address portfolio goals as well as planning for competitive and non-competitive funding lines related to climate change.

- Natural Resources Conservation Service (NRCS) – The NRCS Climate Change Coordination Team has developed a climate change vulnerability assessment with recommended adaptation strategies. NRCS will use this report and an adaptation plan to design and implement specific actions over the coming few years to make conservation activities more resilient to both short and long-term changes in climate. The NRCS collects critical high-elevation climate data with its Snow Telemetry (SNOTEL) network. These data are used by NRCS to develop water supply forecasts for the entire western U.S., and are necessary for assessing changes in climate (snow, precipitation, temperature, etc.) in these otherwise unmonitored regions. The agency also collects and soil moisture and temperature data throughout the US including Alaska, Hawaii, and island territories in the Caribbean and the Pacific with its automated Soil Climate Analysis Network (SCAN). These two networks play a critical role in assessing trends in climate variability and change, and are the only such soil climate observational national data networks in the U.S.
- Risk Management Agency (RMA) – RMA monitors the premium rating methodology, loss adjustment standards, underwriting standards, and other insurance program materials as well as research results to ensure that they are appropriate for new production regions or for changes in practices within existing regions. RMA is also increasingly monitoring the widening scope of pest problems associated with crops and crop loss. RMA uses climate and weather services provided through a partnership with Oregon State University’s PRISM Climate Group (Parameter-Elevation Regressions on Independent Slopes Model) climate mapping system to strengthen RMA’s underwriting and oversight of the Federal crop insurance program. PRISM will provide high quality climate and weather data that will assist RMA with its Actual Production History (APH) modernization effort by developing crop suitability maps based on climate and soils to more accurately assess the production potential of land being farmed; to account for variations in climate due to elevation, rain shadows, coastal effects, temperature inversions and other conditions that may affect crop production; and it is assisting RMA in developing nationwide Bio-fuel resource mapping. RMA will continue to evaluate and monitor potential risks that climate change presents to the Federal crop insurance program. With over a million crop insurance policies in force and the world’s most extensive database of actual farm yields, RMA will use PRISM and other risk management tools to monitor the effects of climate change on crop yields, provide a reality check for crop yield guarantees and to update program parameters such as the crop planting dates as needed to reflect the changing risks resulting from climate change.

USDA Challenges in Identifying Effects and Vulnerabilities

The challenges faced by USDA and its agencies in identifying climate change effects and vulnerabilities have common themes. These are based in part on capacity and resources but equally on the need for better forecasting and reduced uncertainties associated with climate change.

- Difficulties in forecasting climatic stress at relevant scales: One of the most commonly occurring challenges is the inability to forecast changes in climate, climate variability, extreme events and weather on scales that are meaningful to USDA agency missions and their stakeholders. Climatic changes are important to understand and anticipate at regional and national scales and are extremely useful, but for the individual land owners' needs, the effects are exceedingly difficult to predict.
- Lack of effective tools to identify and predict climate change effects on different time and different spatial scales. It is difficult to definitively decouple the effects that can be attributed to climate change from other factors that traditionally influence operations.
- Challenges in precisely forecasting how and where climate change is most likely to influence risk pathways for pests, agricultural diseases, and food-borne pathogens that could potentially affect global food security and natural and agricultural ecosystems.
- Uncertainties in methodologies (empirical and process-based) used to evaluate any changes in climate with specific resource effects.
- Climate dynamics are extremely complex, and projected shifts in climate conditions are associated with a great deal of uncertainty, particularly with respect to changes in precipitation patterns and in the variability of weather patterns and the frequency and intensity of extreme events. Such uncertainty presents a challenge in the ability to generate policy-relevant research results for the spatial implications of prospective climatic changes that can affect resource distribution, targeted policy and program recommendations, and for adaptation strategy design. An additional challenge is supporting analytics for adaptive strategic planning that systematically varies both regionally and by sector.
- Public perceptions of climate change discussions can create resistance to the importance of climate change education. Information needs to be presented in a manner that stakeholders can relate to and accept more easily.

III. Federal Government Activities on Climate Change and USDA's Role

Climate change has the potential to confound USDA efforts to meet the core obligations and responsibilities to the Nation. USDA strongly supports activities across government that helps its agencies adapt to and become positioned to meet the risks, challenges, and opportunities presented by climate change and variability. USDA participates in these climate change activities in the following ways:

USDA Climate Change Science Plan

The USDA Climate Change Science Plan, developed by an interagency USDA team, provides a guide for the Department and its stakeholders to enable clear and consistent consideration of current and potential investments in climate change science activities. This research provides farmers, ranchers, foresters, land owners, resource managers, policy-makers

and Federal agencies with science-based knowledge to manage the risks, challenges, and opportunities of climate change and position themselves for the future. It offers a framework for assessing priorities to ensure consistency with USDA's role in the Federal Government's broader US Global Change Research Program (USGCRP) and related efforts. The document identifies important roles and responsibilities for USDA agencies and areas in which USDA agencies are reliant on other agencies and stakeholders for cooperation. This is the first document of its kind in USDA.

US Global Change Research Program

USDA and its agencies play an important role in Federal climate change research, mitigation and adaptation activities. USDA is one of the 13 Federal departments and agencies comprising the US Global Change Research Program (USGCRP) that Congress mandated in the Global Change Research Act (GCRA) of 1990. The USGCRP was tasked with improving the understanding of uncertainties in climate science research, expanding global observing systems, developing science-based resources to support policymaking and resource management and communicating findings broadly among scientific and stakeholder communities. USDA agency research scientists and program managers participate by serving on a variety of working groups and strategic planning and program report committees. The USGCRP recently restructured and is re-evaluating the types of working groups and their charges. USDA is playing an active role in the new strategy and structure. The USGCRP provides an annual report entitled *Our Changing Planet* as a supplement to the President's Budget. USDA research activities and plans are included in these annual reports.

National Climate Assessment

The GCRA also requires that USGCRP agencies produce periodic (not less than four years) National Climate Assessments (NCA) that integrate, evaluate, and interpret findings of the USGCRP and discuss associated uncertainties. The assessments also provide analysis of the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity. Finally, the assessments analyze current trends in global change, both human-induced and natural, and project major trends for the subsequent 25 to 100 years. USDA has an important role in the preparation of the 2013 NCA in organizing writing teams to provide technical reports on agriculture, forestry, land use, biogeochemical cycling, rural communities, and regional sector studies, and supports the process through participation in the Interagency National Climate Assessment Task Force and the National Climate Assessment and Development Advisory Committee. USDA scientists are leaders and participants in writing the 2013 document itself. The Office of Science and Technology Policy (OSTP) is leading the government-wide NCA.

Previous NCA reports were built around Federal agency-led studies, technical reports, and extensive scientific literature that addressed historical and potential effects of climate change and climate variability on managed and unmanaged ecosystems and their constituent biophysical processes. These reports included the agency-led Synthesis and Assessment Products (SAPs) from 2006–2009. USDA led SAP 4.3, entitled *The Effects of Climate*

Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States' (2008), which discussed the nation's ability to identify, observe, and monitor stresses that influence agriculture, land resources, water resources and biodiversity. It evaluated the relative importance of these stresses and the likelihood that they would change in the future. SAP 4.3 also identified changes in resource conditions and examined whether these changes might be attributed in whole or in part to climate change. The report covered the recent past through the 2030-2050 period. USDA authors also addressed adaptation options for US National Forests in SAP 4.4, 'Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources'.

IV. USDA Agency Plans

In the next section, USDA Agencies have provided their Agency Climate Change Adaptation Plans. These agencies are: Agricultural Research Service (ARS), Animal, Plant Health Inspection Service (APHIS), Economic Research Service (ERS), Foreign Agricultural Service (FAS), Farm Service Agency (FSA), Forest Service (FS), National Agricultural Statistics Service (NASS), National Institute of Food and Agriculture (NIFA), Natural Resources Conservation Service (NRCS), Rural Development (RD), Risk Management Agency (RMA), and the Climate Change Program Office (CCPO).