CLIMATEFOCUS

Sector Profile: United States

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A. Overview

The United States (US) has the largest economy in the world with a Gross Domestic Product (GDP) totaling USD 15.7trillion in 2012[1], and agriculture accounting for 1.2% of total GDP. The US agricultural sector contributed about USD 188billion to GDP in 2012, which makes the US the third largest producer of agricultural products in the world after China and India.[2] The US produces a broad array of agricultural commodities and leads the world in production of corn and soybeans (producing about 35% of the corn and soybeans grown in the world) with average corn yields nearly 80% higher than the world average.[3]

Historically, the US agricultural sector has made a positive contribution to US trade: since 1960, exports of US agricultural products have exceeded imports. In 2011, US agricultural exports reached a record USD 137billion and the trade surplus a record USD 43 billion. China emerged as the top US market in 2011 followed by Canada and Mexico. In 2010, the top commodities exported were feed grains, oil seeds and wheat. The top imports were fruit juices, malt beverages, fruits and nuts. Total exports for the US in 2011 amounted to USD 1,480billion and the trade balance was a negative USD 728billion. Historically, bulk commodities - wheat, rice, coarse grains, oilseeds, cotton, and tobacco - have accounted for most US agricultural exports. Since 1991, however, exports of high-value products - meats, poultry, live animals, oilseed meals, vegetable oils, fruits, vegetables, and beverages - have exceeded bulk commodities in value.[4]

After peaking at 6.8 million in 1935, the number of US farms fell sharply until 1978 before stabilizing at about 2.2 million. Although the total number of farms has changed only slightly over the past 30 years, the numbers of very small and very large farms have increased while the number of mid-sized farms has declined. Farm operations with annual sales of USD 1million or more (in constant 2007 dollars) more than doubled between 1982 and 2007 and accounted for

[1] International Monetary Fund. *World Economic Outlook Database*. 2012. Available at: http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx.

[2] Central Intelligence Agency. *The World Factbook: GDP – Composition by Sector of Origin*. 2012. Available at: https://www.cia.gov/library/publications/the-world-factbook/fields/2012.html.

[3] United States Department of Agriculture. *Foreign Agriculture Service: Corn Area, Yield, and Production.* 2014. Available at: http://www.fas.usda.gov/psdonline/psdreport.aspx?hidReportRetrievalName=BVS&hidReportRetrievalID=884&hidReportRetrievalTemplateID=1; United States Department of Agriculture. *Foreign Agriculture Service: Soybean Area, Yield, and Production*. 2014. Available at: http://www.fas.usda.gov/psdonline/psdreport.aspx?hidReportRetrievalName=BVS&hidReportRetrievalID=906&hidReportRetrievalTemplateID=1.

[4] United States Department of Agriculture. *Economic Research Service*. 2013. Available at: http://www.ers.usda.gov/topics/international-markets-trade/us-agricultural-trade.aspx#.UxVst_ZsP7p; United States Department of Agriculture. *Foreign Agriculture Service*. Available at: /http://www.fas.usda.gov/info/IATR/111611Exports/http://www.fas.usda.gov/info/IATR/111611Exports/.

59% of total farm sales. In 2008, over 90% of the total value of US agricultural production occurred on just 17% (378,172) of all farms.[5]

Crop cash receipts totaled USD 208billion in 2011. Receipts from corn and soybeans accounted for nearly half of total crop receipts and for over half of all harvested acreage.[6] Livestock receipts totaled USD 166billion in 2011. Beef receipts accounted for over one-third of total livestock sales. Dairy sales were slightly higher than poultry and egg sales and nearly double the sales from hogs.[7]

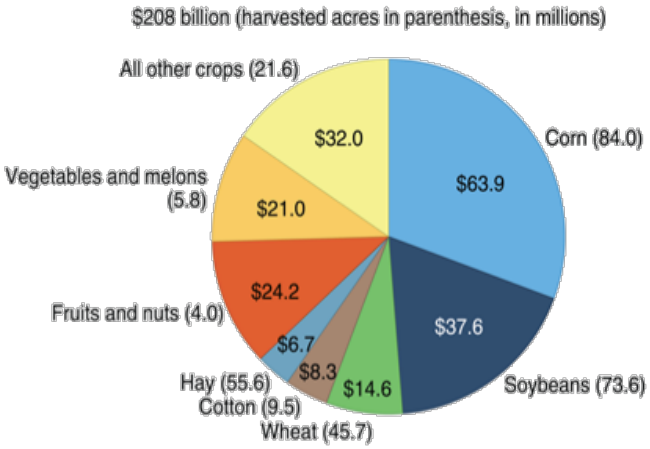

Figure 1: 2011 Crop cash receipts in billion USD.[8]

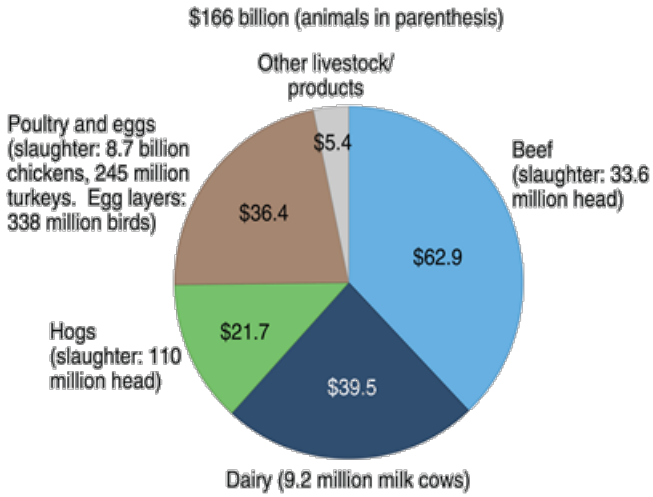

Figure 2: 2011 Livestock cash receipts in billion USD.[9]

[5] *United States Department of Agriculture*. National Agricultural Statistical Service: 2007 Census of Agriculture. 2007. Available at: http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/.
[6] United States Department of Agriculture. *Economic Research Service: Ag and Food Statistics: Charting the Essentials*. 2014. Available at: http://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials.aspx#.UxVuNvZsP7p.
[7] Ibid.
[8] Ibid.
[9] Ibid.

Gross farm cash income includes income from farm receipts, farm-related income, and government payments. Since 2000, gross farm cash income has increased from USD 227billion to USD 411billion in 2011. This reflects increasing cash receipts from farming. While government payments fluctuate, they declined in 2010-11.[10]

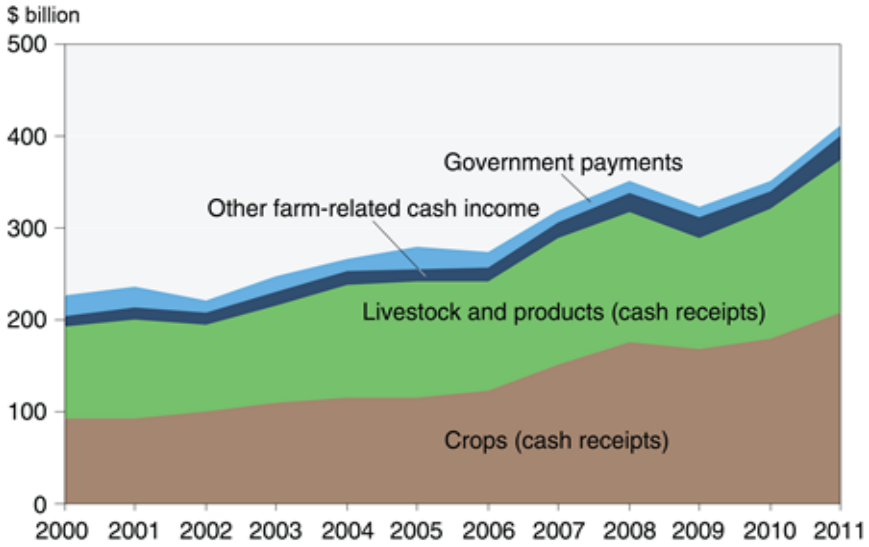

Figure 3: Gross cash income from farming, including farm cash receipts, government payments and other farm-related cash income, 2000-11.[11]

B. Major influences and trends

Land values. Rapidly rising land values are making it difficult for owners of smaller farms to expand in order to take advantage of economies of scale. Average cropland values in the US increased from 2012 to 2013 by USD 460 per acre (a 13.0% increase) to USD 4,000 per acre. Since 2004, agricultural land values have increased from about USD 1,750 an acre to about 4,000 an acre, an increase of nearly 130%.[12]

Labor and immigration policy. Hired labor (including contract labor) is an important factor in US agricultural production, accounting for about 17% of variable production expenses and about 40% of such expenses for fruits, vegetables, and nursery products. Over the past 15 years, roughly half of the hired laborers employed in US crop agriculture have lacked the immigration status needed to work legally in the United States. Thus, changes in immigration laws or policies could lead to markedly different economic outcomes in the agricultural sector and the market for hired farm labor.[13]

Technology. Technological developments in agriculture have been particularly influential in driving change in the farm sector. Advances in mechanization and the increasing availability of chemical inputs led to ever-increasing economies of scale that spurred rapid growth in the size of the farms responsible for most agricultural production. As a result, even as the amount of land

[10] Ibid.
[11] Ibid.
[12] United States Department of Agriculture. *National Agricultural Statistical Service: Land Values, 2013 Summary*. 2013. Available at: http://www.nass.usda.gov/Publications/TodaysReports/reports/land0813.pdf.
[13] Zahniser, S., Hertz, T., Rimmer, M. and Dixon, P. *The Potential Impact of Changes in Immigration Policy on US Agriculture and the Market for Hired Farm Labor: A Simulation Analysis*. Washington D.C.: United States Department of Agriculture, 2012.

and labor inputs used in farming declined, total farm output grew by nearly 50% between 1978 and 2009.[14]

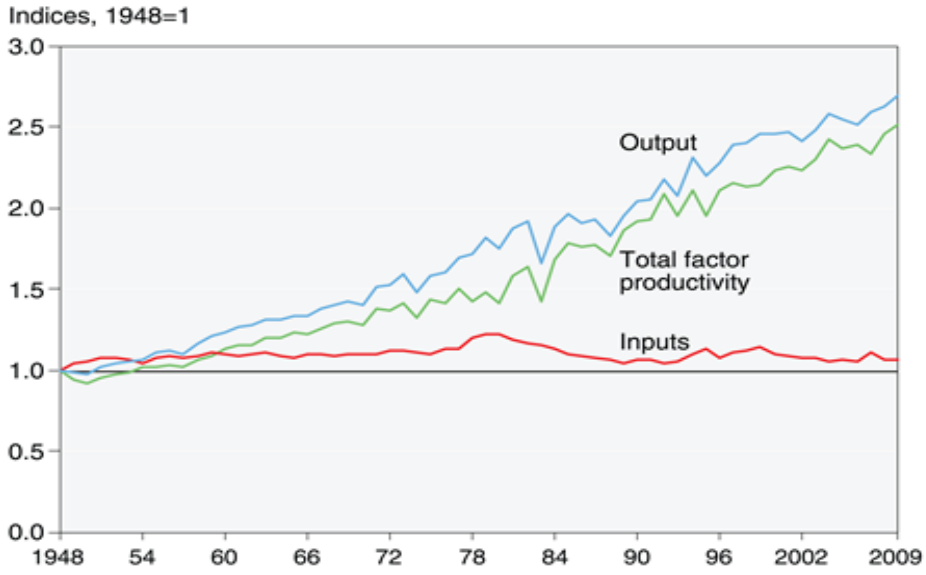

Figure 4: Agricultural output, input and total factor productivity, 1948-2009.[15]

Genetically engineered crops. Farmers have widely adopted genetically engineered crops since their introduction in 1996. US Department of Agriculture (USDA) survey data show that herbicide-tolerant crops accounted for 93% of US soybean acreage, 78% of cotton acreage, and 70% of corn acreage in 2010. Insect-resistant crops containing the gene from the soil bacterium Bt (*Bacillus thuringiensis*) have been available for corn and cotton since 1996. Plantings of Bt crops accounted for 73% of US cotton acreage and 63% of corn acreage in 2010.[16]

Pesticide use. During the period of 1990 to 2007, total use of herbicides, fungicides and other chemicals on five major crops - corn, soybeans, cotton, wheat and fall potatoes - increased modestly, while use of insecticides declined. Changes in herbicide application rates in corn, soybeans and cotton were due to the increased use of herbicide-tolerant seed varieties. The shift toward herbicide-tolerant crops has been accompanied by increased use of the herbicide glyphosate and a shift away from more toxic herbicides.[17] The adoption of Bt resulted in reduction of insecticides applied to corn and cotton.[18]

Conservation tillage. Conservation tillage typically reduces runoff, which in turn reduces soil erosion, sedimentation and surface losses of nutrients and pesticides. The soil water-holding capacity increases, soil organic-matter content and populations of beneficial organisms are maintained or enhanced, and soil stability improves. Stimulated by the prospects of higher economic returns and by public policies and programs promoting its conservation benefits, conservation tillage is practiced on an increasing share of the major crops grown in the US. Conservation tillage adoption is highest for soybeans due to soybeans having a very little low-

[14] United States Department of Agriculture. *Economic Research Service: Ag and Food Statistics: Charting the Essentials*. 2014. Available at: http://www.ers.usda.gov/essentials
[15] Ibid.
[16] National Research Council. *Impact of Genetically Engineered Crops on Farm Sustainability in the United States.* Washington D.C.: The National Academies Press, 2010.
[17] Ibid.
[18] Ibid.

yield risk under conservation tillage when compared to either corn or wheat production. Conservation tillage, especially for no-till soybeans, is a simple technology system compared to the more complicated management system for no-till corn or wheat production. Additionally, pest pressures (weeds, insects, and diseases) are more prevalent in conservation tillage corn and wheat than in soybeans.[19]

Box 1: Conservation tillage and its role in conservation

Under the Conservation Compliance provision of the 1985 Farm Bill, producers are ineligible for many federal farm program benefits if they do not meet the requirements of specific provisions for highly erodible lands (HEL), native sod ("Sodbuster") and wetlands ("Swamp buster"). Farming new or newly cultivated land requires farmers to limit soil erosion from their land to a minimum specified level. Noncompliance could lead to loss of price and income supports, disaster relief, loans, conservation payments, credit support and other benefits that the USDA provides to farmers and farmland owners. Program benefits are lost for all the land the farmer operates even if it includes non-HEL land. Conservation compliance applied to crop insurance as well until the 1996 Farm Bill. USDA estimates that, as of 2011, Conservation Compliance mechanisms applied to just over 100 million acres of US cropland that are considered highly erodible land—this is close to one-third of all commodity cropland under cultivation in 2011. The key for farmers being able to meet the requirements of conservation compliance was the rapid development of conservation tillage. The conservation compliance provision related to highly erodible lands serves as an excellent example of how technology, production requirements and environmental goals can be successfully integrated.

USDA's 1997 Conservation Compliance Status Review showed very high rates of compliance with Conservation Compliance provisions, ranging upward of 95%. Claassen conducted an analysis to separate incidental reductions in soil erosion due to changes in land use and conversion, as well as to identify the specific soil savings that can be directly attributable to Conservation Compliance. Their study estimates that 295 million tons of soil erosion reduction between 1982 and 1997 could be attributed to Conservation Compliance. That tonnage is equal to 89% of the 331 million acres of erosion reduction on HEL land that was cropped both in 1982 and 1997, and 25% of all soil erosion reduction over that time period. The following chart shows how gross erosion on cropland has declined since the implementation of conservation compliance.

Sources: Zinn, J. *A Conservation Compliance for Agriculture: Status and Policy Issues*. Washington D.C.: Environment and Natural Resources Policy Division, 1998; Claassen, R. *The Future of Environmental Compliance Incentives in US Agriculture: The Role of Commodity, Conservation, and Crop Insurance Programs*. Washington, D.C.: United States Department of Agriculture Economic Research Service, 2012. Doering, O. and Smith, K. *Examining the Relationship of Conservation Compliance and Farm Program Incentives*. Washington D.C.: The Council on Food, Agricultural and Resource Economics (CFARE), 2012; United States Department of Agriculture. *Natural Resources Conservation Service: National Resources Inventory*. Available at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri/.

Nutrient Application. US consumption of nitrogen has trended upward since 1982, while consumption of potash and phosphate has remained steady. Based on total fertilizer costs per acre, corn, sugarbeet, rice, peanut and cotton crops receive the most fertilizer. Corn receives the most nitrogen, and the recent trend of using corn as an ethanol feedstock has pulled more land into corn production and increased application of nitrogen. Manure can also be used as a source of nutrients. Nearly twice as much manure was added to about the same number of crop and pasture acres in 2008 as in 1996. Due to corn's high nutrient demand and use efficiency relative

[19] Zahniser, S., Hertz, T., Rimmer, M. and Dixon, P. *The Potential Impact of Changes in Immigration Policy on US Agriculture and the Market for Hired Farm Labor: A Simulation Analysis*. Washington D.C.: United States Department of Agriculture, 2012.

to other major crops, corn producers apply roughly 60% of all manure and at higher rates than most other users.[20]

Consumption. The US population is growing at just under 1% per year, requiring more food and fiber to be produced on agricultural lands. In addition, the average American eats more food every year - 1,911 pounds per person in 2008 compared to 1,689 pounds per person in 1980.[21] During this period, per capita consumption of poultry, milk products such as cheese, vegetables, vegetable fats and oils, corn sweeteners, and flour and cereal products increased while consumption of red meat, animal fats, fruit, and other sugars and sweeteners, particularly refined sugar, declined. Some of these changes are in response to relative price trends, and others are the result of longer run changes in population age and demographics. Finally, some of these changes reflect emerging shifts in consumer food preferences. Examples include growing demands for organic foods, prepared foods for home consumption and ready-to-eat convenience food products.[22]

Vertical integration. A growing share of US farm output is produced and sold under agricultural contracts. In 2005, contracts covered 41% of the total value of agricultural production, up from 11% in 1969.[23] By reducing price risk, rewarding contract farmers for increasing production efficiency, and in many cases, becoming more specialized, contract sales have encouraged large farmers to increase capital investments and further consolidate production.[24]

Food safety. Increasing concern about contamination of fresh produce by animal borne bacteria has potential to influence adoption or maintenance of conservation measures. For example, the Resource Conservation District of Monterey County surveyed 600 irrigated row-crop growers throughout the Central Coast region of California in 2007, and reported that growers were under significant pressure from buyers to remove conservation practices such as conservation buffers that could bring wildlife in close proximity to produce fields.[25]

Organic agriculture. The demand for and supply of organic food has grown rapidly over the past decade. By 2009, organic products accounted for more than 3.5% of food sold for at-home consumption. Organic sales account for much higher percentages of specific commodities, particularly fruits and vegetables. While the supply of organic food has grown to meet demand, certified US organic crops still accounted for less than 1% of total crop acreage in 2008.[26] Organic farms tend to be smaller than farms using conventional practices.

Bioenergy markets. Ethanol grew from just over 1% of the US gasoline supply in 2000 to 7% in 2008.[27] In the process, corn used to produce ethanol rose from 6% of the US corn supply to roughly 25% over this 7-year period. Federal policy incentives have helped generate the market for biofuels (and increased the demand for corn production). These policies include the Energy

[20] Zahniser, S., Hertz, T., Rimmer, M. and Dixon, P. *The Potential Impact of Changes in Immigration Policy on US Agriculture and the Market for Hired Farm Labor: A Simulation Analysis*. Washington D.C.: United States Department of Agriculture, 2012.

[21] Wells, H. and Buzby, J. *Dietary Assessment of Major Trends in US Food Consumption 1970-2005*. Washington D.C.: United States Department of Agriculture Economic Research Service, 2008.

[22] United States Department of Agriculture. *RCA Appraisal: Soil and Water Resources Conservation Act*. Washington, D.C: United States Department of Agriculture, 2011.

[23] MacDonald, J. and Korb, P. *Agricultural Contracting Update, 2005*. Washington, D.C.: United States Department of Agriculture, 2008.

[24] United States Department of Agriculture. *RCA Appraisal: Soil and Water Resources Conservation Act*. Washington, D.C: United States Department of Agriculture, 2011.

[25] Beretti, M. and Stuart, D. "Food safety and environmental quality impose conflicting demands on Central Coast growers." *California Agriculture Vol. 62*, 2008: 68-73.

[26] Greene, C., Dimitri, C., Lin, B., McBride, W., Oberholtzer, L., and Smith, T. *Emerging Issues in the US Organic Industry*. Washington, D.C.: United States Department of Agriculture, 2009.

[27] Westcott, P. "Full throttle US ethanol expansion faces challenges down the road." *Amber Waves Vol. 7*, 2009: 28-35.

Policy Act of 2005 and the Energy Independence and Security Act of 2007. This trend has not only increased the amount of land planted to corn, including lands that were formerly used for grazing or were idle, but also reduced the acreage planted to other crops.[28]

Farmers can also contribute to reducing Greenhouse Gas (GHG) emissions by growing the feedstocks used for biofuels or by installing wind turbines or solar panels on their land. However, indirect land use effects arising from increased demand (in the case of biofuel feedstocks) or reduced supply (in the case of wind or solar power) of crops may lessen or even eliminate the emissions reduction.[29]

The Energy Independence and Security Act (EISA) of 2007 established a Renewable Fuels Standard (RFS2) that mandates that increasing volumes of renewable fuels be used in the US, reaching 36 billion gallons per year by 2022. This is roughly 26% of the projected annual US motor gasoline consumption of about 140 billion gallons. Beginning in 2015, EISA places a 15-billion-gallon limit on conventional biofuels' (ethanol derived from corn starch) annual contribution to the mandate and calls for increasing use of advanced biofuels to reach 21 billion gallons per year by 2022. Advanced biofuels include ethanol derived from cellulosic biomass, animal waste, and food and yard waste, or from non-corn sugar or starches; biodiesel; biogas (including landfill gas and sewage waste treatment gas); butanol or other alcohols from renewable biomass; or other fuels derived from cellulosic biomass. Materials from Federal land are excluded as a source of renewable biomass to meet EISA renewable fuels mandates.

Ethanol from corn grain dominates the current US biofuels market, accounting for 10.75 billion gallons in 2009, with production capacity up to 14.5 billion gallons. About 98% of domestic ethanol is made from corn grown in the Midwest.

The share of US corn production used for ethanol rose from 6% in 2000 to almost one-third in 2009. Increased ethanol production has raised demand for corn, contributed to higher corn prices, and increased acres planted to corn—rising from 79.5 million acres in 2000, peaking at 93.5 million in 2007, and fluctuating between 86 and 88 million acres over the past 3 years. Acreage planted to corn is expected to remain at about 89.5 million acres through 2019, with the share used for ethanol production increasing slightly. The increase in ethanol production also resulted in cultivation of some land that was formerly idled or in grazing uses.[30]

Water availability. The supplies of both surface water and groundwater are becoming increasingly scarce, especially in the West and the Great Plains. The Ogallala Aquifer covers about 174,000 square miles in the Great Plains and is the single most important source of water in the High Plains region, providing nearly all the water for residential, industrial and agricultural use. Because of widespread irrigation, farming accounts for 94% of the groundwater use. Irrigated agriculture forms the base of the regional economy. It supports nearly one-fifth of the wheat, corn, cotton and cattle produced. Crops provide grains and hay for confined feeding of cattle and hogs and for dairies. The cattle feedlots support a large meatpacking industry. Irrigation withdraws much groundwater, yet little of it is replaced by recharge. Since large-scale irrigation began in the 1940s, water levels have declined more than 30 meters (100 feet) in parts of Kansas, New Mexico, Oklahoma and Texas. In the 1980s and 1990s, the rate of groundwater mining, or overdraft, lessened, but still averaged approximately 82 centimeters (2.7 feet) per year.[31]

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[28] United States Department of Agriculture. *RCA Appraisal: Soil and Water Resources Conservation Act.* Washington, D.C: United States Department of Agriculture, 2011.

[29] Fargione, J., Hill, J., Tilman, D., Polasky, S. and Hawthorne, P. "Land Clearing and the Biofuel Carbon Debt." *Science 29*, 2008: 1235-1238.

[30] United States Department of Agriculture. *RCA Appraisal: Soil and Water Resources Conservation Act.* Washington, D.C: United States Department of Agriculture, 2011.

[31] *Water Encyclopedia: Ogallala Aquifer.* Available at: http://www.waterencyclopedia.com/Oc-Po/Ogallala-Aquifer.html.

Technical capacity. USDA's National Institute of Food and Agriculture's functions include research, education, and extension. One of its five priority Science Areas is climate change. It works with 109 partner land-grant universities across the US and administered a USD 1.36billion budget in 2012. In addition, The Agricultural Research Service was funded at USD 1.15billion in 2012 and provided core USDA intramural research capacity. The Natural Resources Conservation Service, funded at USD 3.79billion in 2012 provides technical and financial assistance to farmers and ranchers to install and adopt conservation practices. Because of on-going Federal budget deficit concerns, funding for the USDA technical capacity has been declining.[32]

C. Agricultural policies

The primary strategic policy device in the US is the Farm Bill, which historically has been enacted on a five-year cycle. The Farm Bills provide policy guidance and funding for risk management, conservation and research, among other areas. The current Farm Bill is set to expire on September 30, 2013 and Congress has apparently reached an impasse. Policy makers expect that rather than voting on a Farm Bill in the fall of 2013 it will instead pass an extension of the 2008 Farm Bill.

In addition, the Administration, through USDA, develops a strategic plan,[33] as required by the Government Performance and Results Act. The four goals of the current strategic plan are to:

- Assist rural communities to create prosperity so they are self-sustaining, re-populating and economically thriving;
- Ensure that national forests and private working lands are conserved, restored and made more resilient to climate change, while enhancing water resources;
- Help America promote agricultural production and biotechnology exports as America works to increase food security; and
- Ensure that all of America's children have access to safe, nutritious, and balanced meals.

With respect to climate change, USDA appears to be placing greater focus on climate change adaptation than mitigation. In early 2013, the US Supreme Court ruled that EPA had the power to regulate greenhouse gases under the authorities of the Clean Air Act. In June 2012, the Administration announced that based on the Supreme Court ruling and lack of Congressional interest, it would move forward with regulating GHGs. Experts expect that this action will set-off a long series of legal and political battles.[34]

The Conservation Reserve Program (CRP). Until passage of the Food Security Act of 1985, few payments were made to farm operators to encourage conservation. That Act's creation of the Conservation Reserve Program (CRP) changed the agri-economic landscape by providing payments to landowners to retire some 30 million acres of environmentally sensitive cropland from production. CRP offers payments to farmers to voluntarily retire highly erodible or environmentally sensitive cropland from production for 10-15 years. Enrolled land is then planted

[32] United States Department of Agriculture. *National Institutes of Food and Agriculture Fact Sheet*. Available at: http://www.nifa.usda.gov/newsroom/factsheet.pdf; United States Department of Agriculture. *Budget Summary and Annual Performance Plan*. 2013. Available at: http://www.usda.gov/wps/portal/usda/usdahome?navid=BUDGET.

[33] United States Department of Agriculture. *Strategic Plan FY 2010-2015*. 2010. Available at: http://www.ocfo.usda.gov/usdasp/sp2010/sp2010.pdf.

[34] Gillis, J. "Obama puts legacy at stake with Clean-Air Act." *The New York Times*. 26 June 2013. Available at: http://www.nytimes.com/2013/06/26/science/earth/clean-air-act-reinterpreted-would-focus-on-flexibility-and-state-level-efforts.html?ref=justingillis&_r=0.

to grass or trees, thereby reducing water pollution, improving wildlife habitat, sequestering carbon, and providing other environmental benefits. More than 34 million acres were enrolled in the CRP as of March 2008, either through general or continuous sign-up, making it the largest environmental program on private lands in the United States. The USDA Farm Service Agency (FSA) has estimated that those acres sequestered 48 million more metric tons of CO_2 than if the land had remained in previous uses.

The CRP also provides evidence of the acreage that landowners would be likely to offer in a carbon market through individual practices. Grass predominates in all regions except the Southeast and Delta. The small proportion of trees in most regions suggests that farmers were willing to plant trees on only a relatively small proportion of accepted acres at prevailing CRP payment rates. This result suggests that substantial numbers of tree-planted acres are likely to be offered to an offset market only if landowners receive higher payments.[35]

This helped reduce crop surpluses, and supply controls were subsequently phased out in the 1990s. Annual conservation program payments to farm operators began routinely exceeding USD 2billion. With passage of the Farm Security and Rural Investment Act of 2002, additional conservation funds were targeted at working lands, principally through the Environmental Quality Incentives Program (EQIP), further increasing inflation-adjusted annual conservation program payments to farm operators to about USD 3billion.

In 2008, about 17% of farms received conservation payments, with an average value of over USD 2,900 per operation, and 29% received commodity-related payments with an average value of over USD 6,300. Of the smaller 1.8 million farms, 15% received conservation payments, compared to about 26% of the larger farms. While these data do not reflect the number of farmers receiving technical assistance in the absence of financial assistance, they do indicate that considerable outreach opportunities exist to attract more producers to conservation programs.[36]

Environmental regulations. Regulatory policies that can affect agriculture include those promulgated under the Clean Water Act, the Clean Air Act, the Endangered Species Act, and the Federal Insecticide, Fungicide, and Rodenticide Act, among others. Under these Acts, agricultural producers may be required to obtain permits before undertaking regulated activities (such as draining wetlands) and the regulations may affect the availability of agricultural inputs. In addition, as livestock operations have grown in size, concentrated animal feeding operations (CAFOs) have come under closer scrutiny by the US Environmental Protection Agency (EPA) as potential sources of water pollution. As of September 2010, EPA had issued 8,295 National Pollutant Discharge Elimination System (NPDES) permits, covering 43% of the estimated CAFOs.[37] This requirement can restrict farmers' options for using manure and in some areas can increase the cost of manure disposal. Under the Clean Water Act, EPA and States are required to establish total maximum daily loads (TMDLs) for water bodies that do not meet water quality standards. TMDLs establish pollutant loadings for listed water bodies in order to meet water quality standards. Along with other sources, agricultural nonpoint sources can be assigned a load allocation under a TMDL that establishes upper limits on allowable discharges.[38]

Chino California Anaerobic Digester. The Chino, California basin is home to the largest concentration of dairies in the US with over 200 dairy farms and over 200,000 cows, heifers, and calves. Concerns were raised about water quality, air quality and the release of GHG especially methane and nitrous oxide. The dairy manure, wash water, bio-solids and food residuals are

[35] Horowitz, J. and Gottlieb, J. *The Role of Agriculture in Reducing Greenhouse Gas Emissions.* Washington, D.C.: United States Department of Agriculture, 2010.

[36] United States Department of Agriculture. *RCA Appraisal: Soil and Water Resources Conservation Act.* Washington, D.C: United States Department of Agriculture, 2011.

[37] Environmental Protection Agency. *National Pollutant Discharge Elimination System CAFO Rules Implementation Status – National Summary, Third Quarter 2010*. Washington D.C.: Environmental Protection Agency, 2011.

[38] United States Department of Agriculture. *RCA Appraisal: Soil and Water Resources Conservation Act.* Washington, D.C: United States Department of Agriculture, 2011.

trucked to the bio-digester, which produces methane for energy production (up to 3,000 kW) as well as compost. Financial assistance for this project came from USDA Natural Resources Conservation Service, the California Energy Commission, the Milk Producers Council and the California Dairy Power Production Program.

The Inland Empire Utilities Agency (IEUA) is using an innovative anaerobic digester to reduce the emission of GHG and pollutants associated with dairy manure. In order to address water management and other services for 700,000 people in California's Central Valley, the IEUA, as part of its management strategy, designed and installed two state-of-the-art anaerobic digesters that break down the manure and capture the gas for use as a fuel.[39]

Environmental Quality Incentives Program (EQIP). EQIP is the workhorse of the conservation programs. Through EQIP, NRCS helps producers to promote agricultural production and environmental quality as compatible goals, optimize environmental benefits, meet Federal, State, Tribal, and local environmental regulations. At least 60% of the available funds are for conservation activities related to livestock production. In 2012, EQIP financial assistance obligations by States were over USD 990million in 44,778 active and completed contracts covering an estimated 19.9 million acres. Between FY 2009-2012, NRCS entered into 151,589 contracts for USD 3,432,926,244, encompassing a total of 58,121,234 acres.[40]

EQIP technical and financial assistance. EQIP provides payments to farmers who adopt a wide range of conservation practices for crop and livestock production. To participate, a producer enters into a contract to implement a specific conservation practice for 1 to 10 years. Per-acre EQIP payments for two of the supported practices that have the potential to contribute to GHG reduction efforts - conservation tillage and nutrient management. EQIP paid out USD 42.5million in 2008 for conservation tillage contracts on 2.7 million acres. If those farms sequestered 0.59 tons of CO_2 per acre (an average estimate), then 1.6 million tons of CO_2 would have been sequestered through conservation tillage, translating to an equivalent outlay of USD 27 per ton of CO_2. As with the CRP calculations, actual costs of adopting no-till practices under a climate policy may be lower or higher, depending on the success of new policies in bringing in farms that have the lowest carbon sequestration costs but have not yet adopted no-till. EQIP paid out USD 35.7million in 2008 for nutrient management contracts on 4.0 million acres. Many different nutrient management practices are supported by EQIP, so it is not possible to provide a simple estimate of the GHG mitigation resulting from these contracts.[41]

D. Voluntary initiatives

Markets for ecosystem services. There are potential opportunities for farmers to market ecosystem services. For example, water quality credit trading programs allow farmers to sell credits for nutrient and sediment reductions. These credits can then be sold to industries that are subject to pollution abatement regulations. Similar markets exist for the preservation of wetlands and are being considered for greenhouse gas mitigation. When coupled with voluntary markets for ecosystem services and with labeling standards, such as USDA's organic label, these markets could compensate landowners for undertaking environmentally friendly farming practices.[42]

[39] *Inland Empire Utilities Agency: Chino Digester*. 2007. Available at: http://www.energytoolbox.org/gcre/bibliography/189m20davis.pdf.

[40] Natural Resources Conservation Service. *National Resources Inventory*. Washington, D.C.: United States Department of Agriculture, 2012.

[41] Horowitz, J. and Gottlieb, J. *The Role of Agriculture in Reducing Greenhouse Gas Emissions*. Washington, D.C.: United States Department of Agriculture, 2010.

[42] Ribaudo, M., Hansen, L., Hellerstein, D. and Greene, C. *The Use of Markets to Increase Private Investment in Environmental Stewardship*. Washington, D.C.: United States Department of Agriculture, 2008.

The Coalition on Agricultural Greenhouse Gases (C-AGG) is a multi-stakeholder coalition fostering a fact-based discourse on the development and adoption of voluntary incentives to reduce GHG emissions from the agricultural sector. C-AGG participants and stakeholders include agricultural producers and producer groups, scientists, environmental NGO's, carbon market developers, methodology experts, investors, and other proponents of voluntary agricultural GHG mitigation opportunities and benefits. C-AGG focuses on:

- Identifying key research, data, or modeling needs to develop sound carbon and environmental market protocols and other incentive-based GHG mitigation opportunities for agriculture;
- Characterizing, and contributing to the development of tools and calculators to enable agricultural producers to identify and compare GHG mitigation opportunities and potential benefits to their operations;
- Sharing challenges, successes and innovative solutions associated with GHG mitigation activities, including within carbon and environmental service markets, protocol and methodology development, sustainable supply chain initiatives and conservation programs; and
- Engaging with appropriate federal and state agencies and other relevant organizations to share knowledge, experiences, outcomes, and key recommendations in order to further develop voluntary GHG mitigation opportunities that provide value to the agricultural sector and society.

Field to Market: Alliance for Sustainable Agriculture is an initiative that brings together producers, agribusinesses, food companies and conservation organizations seeking to create sustainable outcomes for agriculture. The initiative is organized and facilitated by the Keystone Center, a non-profit dedicated to developing collaborative solutions to societal issues. Field to Market is developing indicators to estimate the environmental, economic, social and health outcomes of agriculture in the US. In its first report released in January 2009, Field to Market evaluated indicators for estimating land use, soil loss, irrigation water use, energy use, and greenhouse gas emissions for agriculture. Field to Market is continuing to develop metrics to estimate on-farm environmental, economic, social, and health outcomes. Wal-Mart is planning on requiring suppliers to use the "FieldPrint" index to document that the food was sustainably produced.

E. Actors

	Actor
Government	Senate Agriculture Committee House Agriculture Committee US Department of Agriculture US Environmental Protection Agency US Climate Change Research Program President's Council On Environmental Quality State Departments of Agriculture State Departments of Natural Resources
Research & technical assistance service providers	National Academies of Science Land Grant Universities Agricultural Retailers USDA Certified Technical Service Providers
Associations & cooperatives	Coalition on Agricultural Greenhouse Gases Agricultural Nutrient Policy Council Agriculture American Farm Bureau Federation The Farmers Union Agricultural Commodity Groups (e.g., National Pork Board, and Innovation Center for US Dairy) Keystone Center National Association of Farmer Cooperatives
Agribusiness	John Deere Monsanto DuPont Pioneer
Financial institutions	JP Morgan Chase Goldman Sachs Farm Credit System American Bankers Association
NGOs and Think Tanks	American Carbon Registry, Winrock Delta Institute Soil and Water Conservation Society National Association of Conservation Districts