INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 2 | February 2023

Climate Degradation: A Threat to Mankind and Agriculture

Dr. Deepali Jain

Associate Professor, Department of Chemistry, Govt. Girls College, Chomu, Rajasthan, India

---***---

Annotation: Climate change is one of the most defining concerns of today's world and has greatly reshaped or in process of altering earth's ecosystems. Although climate change has been a constant process on earth, but in recent times, approximately last 100 years or so, the pace of this variation has increased manifolds. Due to the anthropogenic activities the average temperature has risen by 0.9 °C since nineteenth century, mainly due to greenhouse gas (GHG) emissions in the atmosphere. As per estimates this rise is expected to be 1.5 °C by future or may be even more, the way deforestation is occurring, GHG emission is increasing and soil, water bodies and air are being polluted. The unprecedented hike in temperature has resulted in increased events of droughts, floods, irregular patterns of precipitation, heat waves and other extreme happenings throughout the globe.

Keywords: climate change, threat, mankind, degradation, agriculture, deforestation, land, earth.

Introduction

Transboundary animal diseases are highly contagious and easily transmitted within and between livestock populations. They therefore threaten the economic health of the livestock sector, the livelihood of farmers, and ultimately food security. Zoonotic transboundary animal diseases may impede livestock production for public health reasons.[1] A good example of this is the global epidemic of the highly pathogenic avian influenza (H5N1) originating in East Asia in 2003. The massive outbreak of foot-and-mouth disease in Great Britain, 2001, with losses estimated at around 3.1 billion GBP, illustrates well the threat from transboundary animal diseases to livestock production and food security. The impact of a contagious disease depends on the virulence of the pathogen,[2] the production system, livestock and farm density, biosecurity routines, the capacity of veterinary services, the extent of trade in the animals and animal products, and human and wildlife population densities and their proximity to livestock. The relative weight of these factors varies and can depend on economic development and governance.[3]

There has been a notable increase in the number of farmed animals in East Asia, especially in poultry and pigs reared in confined production systems. Generally, large-scale intensive animal production units are established in densely populated areas. In these large-scale systems, outbreaks of infection may be devastating-something that serves to highlight the importance of effective biosecurity. [4] The urbanization in type A and type B countries also brings with it an increase in small-scale, backyard animal production in cities, where there is bound to be contact between humans and animals.[5]

Changes in ecosystems can also facilitate the transmission of transboundary animal diseases between wild and domestic animals[6]. A classic example of this is the transmission of the Nipah virus from fruit bats to domestic pigs, and ultimately to humans, in Malaysia in 1999. Once established, an infection can rapidly spread to countries with vulnerable livestock populations through international travel and through trade in animals, animal products, and foodstuffs, threatening livestock production. The importance of trade was apparent in the outbreak of swine fever in Great Britain in 1986. The disease was thought to have been caused by the feeding of unprocessed food swills containing imported pig meat. Key elements of plant disease epidemics that determine the occurrence and severity of a particular plant disease include abundance and susceptibility of the host (crop plant), abundance and virulence of the pathogen, and favourable environmental conditions[7]. Agricultural practices that increase host

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 2 | February 2023

density such as increase of field aggregation, field size and crop species uniformity tend to increase the severity of plant disease epidemics, as such practices both increase host vulnerability and facilitate movement of the plant pathogen. In addition, genetic uniformity of cultivars contributes to a greater vulnerability of the host, and low genetic variation is associated with few traits conferring resistance to a particular pathogen [8].Thus, if the pathogen evolves to overcome the genetic resistance, the result can be crop failure on a massive scale. Abundance of plant pathogens is also largely influenced by international exchange of seed and planting stock. In fact, global trade and exchange has contributed to the dispersal of many pathogens into regions of the world where they previously did not exist[9]. Also, the movement of people from and between low and middle-income countries, carrying there own food and dodging border controls, may contribute to the spread of pathogens. Hence, the specialized agriculture commonly found in the industrial world with large fields devoted to uniform crop cultivars, higher planting densities and increased usage of fertilizers may increase the risk of spread of a plant disease. However, it is generally difficult to predict the spread of plant diseases ,and the magnitude of their effects depend both on environmental conditions and plant-pathogen interactions.[10]

Discussion

A growing global population and changing diets are driving up the demand for food. Production is struggling to keep up as crop yields level off in many parts of the world, ocean health declines, and natural resources-including soils, water, and biodiversity-are stretched dangerously thin. A 2020 report found that nearly 690 million people-or 8.9 percent of the global population-are hungry, up by nearly 60 million in five years. The food security challenge will only become more difficult, as the world will need to produce about 70 percent more food by 2050 to feed an estimated 9 billion people.[11]

The challenge is intensified by agriculture’s extreme vulnerability to climate change. Climate change’s negative impacts are already being felt, in the form of increasing temperatures, weather variability, shifting agro ecosystem boundaries, invasive crops and pests, and more frequent extreme weather events. On farms, climate change is reducing crop yields, the nutritional quality of major cereals, and lowering livestock productivity. Substantial investments in adaptation will be required to maintain current yields and to achieve production and food quality increases to meet demand. The problem also works in reverse. Agriculture is a major part of the climate problem. It currently generates 19–29% of total greenhouse gas (GHG) emissions. Without action, that percentage could rise substantially as other sectors reduce their emissions. [12] Additionally, 1/3 of food produced globally is either lost or wasted. Addressing food loss and waste is critical to helping meet climate goals and reduce stress on the environment.

Achieving the Triple Win of CSA

Climate-smart agriculture (CSA) is an integrated approach to managing landscapes-cropland, livestock, forests and fisheries-that addresses the interlinked challenges of food security and accelerating climate change. CSA aims to simultaneously achieve three outcomes:

1. Increased productivity: Produce more and better food to improve nutrition security and boost incomes, especially of 75 percent of the world’s poor who live in rural areas and mainly rely on agriculture for their livelihoods.
2. Enhanced resilience: Reduce vulnerability to drought, pests, diseases and other climate-related risks and shocks; and improve capacity to adapt and grow in the face of longer-term stresses like shortened seasons and erratic weather patterns.[13]
3. Reduced emissions: Pursue lower emissions for each calorie or kilo of food produced, avoid deforestation from agriculture and identify ways to absorb carbon out of the atmosphere.

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 2 | February 2023

While built on existing knowledge, technologies, and principles of sustainable agriculture, CSA is distinct in several ways. First, it has an explicit focus on addressing climate change. Second, CSA systematically considers the synergies and tradeoffs that exist between productivity, adaptation and mitigation. Finally, CSA aims to capture new funding opportunities to close the deficit in investment.

Find out more about CSA basics, planning, financing, investing, and more in the online guide to CSA developed in collaboration with the Research Program on Climate Change, Agriculture, and Food Security (CCAFS) of the CGIAR.[14]

Climate-Smart Agriculture and the World Bank Group

The World Bank Group (WBG) is currently scaling up climate-smart agriculture. In its first Climate Change Action Plan (2016-2020), as well as the forthcoming update covering 2021-2025, the World Bank committed to working with countries to deliver climate-smart agriculture that achieves the triple win of increased productivity, enhanced resilience, and reduced emissions. In 2020, 52 percent of World Bank financing in agriculture also targeted climate adaption and mitigation.[15]

The WBG portfolio will also increase its focus on impact at scale and be rebalanced to have a greater focus on adaptation and resilience. To enable these commitments, we are screening all projects for climate risks, and will continue to develop and use metrics and indicators to measure outcomes, and account for greenhouse gas emissions in our projects and operations. These actions will help our client countries implement their Nationally Determined Contributions (NDCs) in the agriculture sector, and will contribute to progress on the Sustainable Development Goals (SDGs) for climate action, poverty, and the eradication of hunger.[16]

The World Bank Group also backs research programs such as the CGIAR, which develops climate-smart technologies and management methods, early warning systems, risk insurance, and other innovations that promote resilience and combat climate change.

The Climate-Smart Agriculture (CSA) Country Profiles bridge a knowledge gap by providing clarity on CSA terminology, components, relevant issues, and how to contextualize them under different country conditions. These profiles are also a methodology for assessing a baseline on climate-smart agriculture at the country level (both national and sub-national) that can guide climate-smart investments and development. The World Bank has also developed more than 10 Climate- Smart Agriculture Investment Plans (CSAIPs) for Bangladesh, Zimbabwe, Zambia, Lesotho, Mali, Burkina Faso, Ghana, Cote D'Ivoire, Morocco, and The Republic of Congo. The CSAIPs identify CSA investments totaling more than US$2.5 billion, with the potential to benefit over 80 million people across the covered countries.[17]

Working Toward Resilience and Food and Nutrition Security, while Curbing GHG Emissions

The Bank's support of CSA is making a difference across the globe:

In Bangladesh, a project aims to boost the resilience of livestock farmers by improving animal health and addressing climate mitigation by improving emissions intensity and improving production efficiency, including improvements in feeding strategies, animal health, breeding, manure and waste management, as well as low-emission technologies for activities such as milk chilling and transport. In China, a suite of projects representing US$755 million of World Bank investments supports resilient and lower-emissions agriculture practices and institutions. One project has helped expand climate-smart agriculture through better water-use efficiency on 44,000 hectares of farmland and new technologies that have improved soil conditions, and boosted production of rice by 12% and maize by 9%. More than 29,000 farmers' cooperatives have reported higher incomes and increased climate resilience through this project. Another recently completed project has reduced greenhouse gas emissions by 23,732 tons of CO2 equivalent and increased the soil carbon sink by 71,683 tons CO2.[18]

Climate resilience is also being advanced in the Philippines, through a project that is improving the capacity of local government to better manage biodiversity conservation and fisheries resources. In Uruguay, the Bank is supporting sustainable agricultural production through a number of initiatives, including the establishment of an Agricultural Information and Decision Support System and the preparation of soil management plans. Since 2014, CSA has been adopted on 2,946,000 hectares and 5,139 farmers have been supported to make their farms climate-smart by improving energy efficiency and soil-management capacity. In Brazil, the country's Sustainable Production in Areas Previously Converted to Agricultural Use Project (ABC Cerrado) tested approaches for agricultural extensions to promote low-carbon agriculture while boosting private profitability. From 2014 to 2019, the project provided technical assistance and training to 20,025 direct beneficiaries (20% female). These included producers and their families, participants in field days, and collaborators working to adopt sustainable land management practices on approximately 378,513 hectares. It is estimated that these practices are likely to contribute to the sequestration of 7.4 million tons of CO2 equivalent over the next 10 years.[19]

The Colombia Mainstreaming Sustainable Cattle Ranching Project showed that through the adoption of silvopastoral systems (SPS), complemented by other landscape management tools, technical assistance and incentives, it is possible to deliver remarkable wins for farmers and the environment. Over the project's 10 years (2010 to 2020), participating producers transformed 38,390 hectares of pastureland to SPS. Compared to production areas without SPS, milk productivity increased by about 25%, cost of milk production decreased by 9% per liter, animal stocking rate increased by 26%, and farmer's income increased by as much as $523 per hectare per year. As a result of the Mexico Sustainable Rural Development project, 1,842 agribusinesses adopted 2,286 environmentally sustainable technologies that included renewable energy, energy-efficient technologies, sustainable waste management and biomass conversion. The Morocco Green Generation Program-for-Results aims to increase the economic inclusion of youth in rural areas and the marketing efficiency and environmental sustainability of agri-food value chains. It will strengthen climate resilience across all four dimensions of food security: availability, access, stability, and utilization. Specifically, it will promote precision agriculture, improved extension services on CSA practices, and a pilot initiative to promote agro-ecology to improve climate resilience. The technical extension supports farmers' adoption of additional climate-smart agriculture practices and will target 12,000 farmers.[20]

In North Macedonia, the Agriculture Modernization Project will support the country's efforts to contribute to the Intended Nationally Determined Contributions (INDC) goals by implementing climate change adaptation and mitigation activities, as well as activities that will reduce GHG emissions in the agricultural sector.[42]The Yemen Desert Locust Response Project provides support for farm management approaches that enhance resilience of farms and landscapes to changes in climate and pests, while improving the capacity to monitor metrological data. In Uzbekistan, the Bank is working with the government to facilitate a shift away from cotton and wheat monoculture toward a farming system that is more resilient to climate shocks–including horticulture–and applies climate-smart practices that improve soil health and reduce land degradation. In Niger, a Bank-supported project that is specifically designed to deliver climate-smart agriculture aims to benefit 500,000 farmers and pastoralists in 44 communes through the distribution of improved, drought-tolerant seeds, more efficient irrigation, and expanded use of forestry for farming and conservation agriculture techniques. To date, the project has helped 336,518 farmers more sustainably manage their land and brought 79,938 hectares under more sustainable farming practices. The Pakistan Punjab Irrigated Agriculture Productivity Improvement Program Project's main objective is to improve productivity of water use in irrigated agriculture. The project contributes to increased agricultural production, employment, and incomes, higher living standards and positive environmental outcomes. As of 2019, high-efficiency irrigation systems have been installed covering 23,500 hectares, with the installation of a further 3,677 hectares in progress; 11,916 watercourses have been improved with the improvement of 1,220 in progress; 5,000 laser land-leveling units have been deployed and 621 ponds have been constructed. Half a million farm families are directly benefitting from the project, 5.7 million acres of farmland benefit from the improved water management, and more than 15,000 full-time jobs have been created. [21]

In Kenya, the objective of the Climate Smart Agriculture Project is to increase agricultural productivity and build resilience to climate-change risks in smallholder farming and pastoral communities. This is done by scaling up climate-smart agricultural practices, strengthening climate-smart agricultural research and seed systems, and supporting agrometeorological, market, climate, and advisory services. Starting in 2015, a Bank-supported project has been helping pastoralists adopt climate-smart agriculture in the Sahel-namely Burkina Faso, Chad, Mali, Mauritania, Niger and Senegal. Interventions to improve animal health and rearing and promote more sustainable rangeland management are boosting productivity and resilience and helping to reduce emissions. In Malawi, the Bank is promoting CSA by enhancing the resilience of farmers to increasing and persistent droughts and improving soil health for increased agricultural productivity and climate change adaptation and mitigation. About 140,000 farmers have adopted a range of CSA practices, [22] while the soil health of nearly 28,000 hectares has been improved. The Maharashtra Project for Climate Resilient Agriculture, which at US$420 million is one of the largest CSA projects the Bank has financed to date, is estimated to yield climate change improvements of US$386 million. As of June 2020, 309,800 project beneficiaries have adopted climate-smart agriculture practices,[41] and 56,602 hectares of land have benefitted from improved irrigation and drainage technologies. In Kazakhstan, the Sustainable Livestock Development Program-for-Results, which runs from 2021 to 2025, aims to facilitate a profound transformation of the beef sector in Kazakhstan to foster sustainability and climate-change mitigation throughout. It addresses issues of land degradation, biodiversity conservation, pollution control, and mitigation of GHG emissions along the value chain. The West Africa Agricultural Productivity Program (WAAP) involves 13 countries and multiple partners, helping develop climate-smart varieties of staple crops, such as rice, plantains, and maize. Farmers also gain access to technologies such as efficient water-harvesting systems. As of July 2019, the project had directly helped more than 9.6 million people and more than 7.6 million hectares of land be more productive, resilient, and sustainable. Beneficiary yields and incomes have grown by an average of about 30%, improving food security for about 50 million people in the region[23].

Results

A key challenge for the agriculture sector is to feed an increasing global population, while at the same time reducing the environmental impact and preserving natural resources for future generations. Agriculture can have significant impacts on the environment. While negative impacts are serious, and can include pollution and degradation of soil, water, and air, agriculture can also positively impact the environment[40], for instance by trapping greenhouse gases within crops and soils, or mitigating flood risks through the adoption of certain farming practices. The OECD monitors the linkages between the environment and agriculture, identifies successful agricultural policies that mitigate the negative environmental impacts while enhancing the positive ones, and provides recommendations to improve policy coherence for environmental performance of the agricultural sector. Agriculture's impact on the environment has improved, but there is still much to do. In recent years, there have been some encouraging signs that the agriculture sector of OECD countries is capable of meeting its environmental challenges. In particular, farmers in many OECD countries have made improvements in the use and management of nutrients, pesticides, energy and water, using less of these inputs per unit of land. Farmers have also made good progress in adopting more environmentally beneficial practices, such as conservation tillage, improved manure storage, or soil nutrient testing.[24]

Notwithstanding these improvements, there is still more to do, with an important role for policymakers[39.] Nitrogen balances are increasing in several OECD countries, farmland bird populations continue to decline and the sector's contribution to water use and contamination is still high relative to other uses. To address these long-standing issues, more effort and co-operation is needed between farmers, policymakers, and the agro-food value chain. In addition, the twin policy challenge of ensuring global food security for a growing population while improving environmental performance will require raising the environmental and resource productivity of agriculture, enhancing land management practices, minimising pollution discharges, curtailing damage to biodiversity, and strengthening policies that avoid the use of production and input subsidies which tend to damage the environment.[25]

Monitoring and evaluating agriculture's environmental performance can help guide future policy choices

To help countries improve the sustainability of agriculture, the OECD has developed recommendations on how to develop cost-effective agri-environmental policies, how to manage water issues for agriculture, how to deal with climate change challenges, and how to preserve biodiversity and manage ecosystem [38] services related to agriculture. We have also developed insights on the potential environmental impact of agriculture policies by identifying possible policy mis-alignments and how to jointly address sustainability and productivity growth goals. While there is unlikely to be a "one-size-fits-all" solution for dealing with environmental concerns in agriculture, as agro-ecological conditions and public preferences differ across countries, policymakers must have at their disposal a deep understanding of, and capacity to measure, the linkages between policies and outcomes in order to evaluate and achieve better environmental outcomes in a cost-effective manner.[26] To support this work and help governments assess whether the policies they have in place are most likely to boost productivity and minimise environmental damage, the OECD developed a set of agri-environmental indicators (AEIs) More specifically, the AEI database can be used to:

- provide a snapshot of the current state and trends of environmental conditions in agriculture that may require policy responses;
- highlight where new environmental challenges are emerging;
- compare trends in performance across time and between countries, especially to assist policy makers in meeting environmental targets, threshold levels and standards where they have been established by governments or international agreements; and
- monitor and evaluate agriculture policies; and
- project future trends.[27]

Conclusions

Climate change may affect agriculture at both local and regional scales. Key impacts are described in this section.

1. Changes in Agricultural Productivity

Climate change can make conditions better or worse for growing crops in different regions. For example, changes in temperature, rainfall, and frost-free days are leading to longer growing seasons in almost every state.[8] A longer growing season can have both positive and negative impacts for raising food. Some farmers may be able to plant longer-maturing crops or more crop cycles altogether, while others may need to provide more irrigation over a longer, hotter growing season. Air pollution may also damage crops, plants, and forests. [37] For example, when plants absorb large amounts of ground-level ozone, they experience reduced photosynthesis, slower growth, and higher sensitivity to diseases. Climate change can also increase the threat of wildfires. Wildfires pose major risks to farmlands, grasslands, and rangelands. Temperature and precipitation changes will also very likely expand the occurrence and range of insects, weeds, and diseases. This could lead to a greater need for weed and pest control. Pollination is vital to more than 100 crops grown in the United States. Warmer temperatures and changing

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 2 | February 2023

precipitation can affect when plants bloom and when pollinators, such as bees and butterflies, come out. If mismatches occur between when plants flower and when pollinators emerge, pollination could decrease. [28]

2. Impacts to Soil and Water Resources

Climate change is expected to increase the frequency of heavy precipitation in the United States, which can harm crops by eroding soil and depleting soil nutrients. Heavy rains can also increase agricultural runoff into oceans, lakes, and streams.[36] This runoff can harm water quality. When coupled with warming water temperatures brought on by climate change, runoff can lead to depleted oxygen levels in water bodies. This is known as hypoxia. Hypoxia can kill fish and shellfish. It can also affect their ability to find food and habitat, which in turn could harm the coastal societies and economies that depend on those ecosystems. Sea level rise and storms also pose threats to coastal agricultural communities. These threats include erosion, agricultural land losses, and saltwater intrusion, which can contaminate water supplies. Climate change is expected to worsen these threats.[29]

3. Health Challenges to Agricultural Workers and Livestock

Agricultural workers face several climate-related health risks. These include exposures to heat and other extreme weather, more pesticide exposure due to expanded pest presence, disease-carrying pests like mosquitos and ticks, and degraded air quality. Language barriers, lack of health care access, and other factors can compound these risks. Heat and humidity can also affect the health and productivity of animals raised for meat, milk, and eggs[35]. Agriculture contributed more than $1.1 trillion to the U.S. gross domestic product in 2019. The sector accounts for 10.9 percent of total U.S. employment-more than 22 million jobs. These include not only on-farm jobs, but also jobs in food service and other related industries. Food service makes up the largest share of these jobs at 13 million. Cattle, corn, dairy products, and soybeans are the top income-producing commodities. The United States is also a key exporter of soybeans, other plant products, tree nuts, animal feeds, beef, and veal. Many hired crop farmworkers are foreign-born people from Mexico and Central America. Most hired crop farmworkers are not migrant workers; instead, they work at a single location within 75 miles of their homes. Many hired farmworkers can be more at risk of climate health threats due to social factors, such as language barriers and health care access[30.] Climate change could affect food security for some households in the country. Most U.S. households are currently food secure. This means that all people in the household have enough food to live active, healthy lives. However, 13.8 million U.S. households (about one-tenth of all U.S. households) were food insecure at least part of the time in 2020.[34] U.S. households with above-average food insecurity include those with an income below the poverty threshold, those headed by a single woman, and those with Black or Hispanic owners and lessees. Climate change can also affect food security for some Indigenous peoples in Hawai'i and other U.S.-affiliated Pacific islands. Climate impacts like sea level rise and more intense storms can affect the production of crops like taro, breadfruit, and mango. These crops are often key sources of nutrition and may also have cultural and economic importance.[31]

What We Can Do

Planting a pollinator-attracting garden with native species is just one of many ways to help pollinators like bees and butterflies thrive. We can reduce the impact of climate change on agriculture in many ways, including the following:

- Incorporate climate-smart farming methods. Farmers can use climate forecasting tools, plant cover crops, and take other steps to help manage climate-related production threats.
- Join AgSTAR. Livestock producers can get help in recovering methane, a potent greenhouse gas, from biogas created when manure decomposes.[33]

- Reduce runoff. Agricultural producers can strategically apply fertilizers, keep their animals out of streams, and take more actions to reduce nutrient-laden runoff.
- Boost crop resistance. Adopt research-proven ways to reduce the impacts of climate change on crops and livestock, such as reducing pesticide use and improving pollination.
- Prevent food waste. Stretch your dollar and shrink your carbon footprint by planning your shopping trips carefully and properly storing food. Donate nutritious, untouched food to food banks and those in need.[32]

References

1. U.S. Department of Agriculture (USDA), Economic Research Service (ERS). (2022). Ag and food statistics: Charting the essentials. Farming and farm income. Retrieved 3/18/2022.
2. USDA, ERS. (2022). Ag and food statistics: Charting the essentials. Farming and farm income. Retrieved 3/18/2022.
3. USDA, ERS. (2022). Ag and food statistics: Charting the essentials. Farming and farm income. Retrieved 3/18/2022.
4. Walsh, M.K., et al. (2020). Climate indicators for agriculture. USDA Technical Bulletin 1953. Washington, DC, p. 1.
5. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 393.
6. Walsh, M.K., et al. (2020). Climate indicators for agriculture. USDA Technical Bulletin 1953. Washington, DC, p. 22.
7. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 393.
8. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 401.
9. Nolte, C.G., et al. (2018). Ch. 13: Air quality. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 513.
10. EPA. (2022). Ecosystem effects of ozone pollution. Retrieved 3/18/2022.
11. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 401.
12. Ziska, L., et al. (2016). Ch. 7: Food safety, nutrition, and distribution. In: The impacts of climate change on human health in the United States: A scientific assessment. U.S. Global Change Research Program, Washington, DC, p. 197.
13. Ziska, L., et al. (2016). Ch. 7: Food safety, nutrition, and distribution. In: The impacts of climate change on human health in the United States: A scientific assessment. U.S. Global Change Research Program, Washington, DC, p. 197.

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 2 | February 2023

14. USDA. Pollinators. Retrieved 3/18/2022.
15. Walsh, M.K., et al. (2020). Climate indicators for agriculture. USDA Technical Bulletin 1953. Washington, DC, p. 20.
16. Walsh, M.K., et al. (2020). Climate indicators for agriculture. USDA Technical Bulletin 1953. Washington, DC, p. 40.
17. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 405.
18. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 409.
19. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 409.
20. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 405.
21. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 405.
22. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 405.
23. Gamble, J.L., et al. (2016). Ch. 9: Populations of concern. In: The impacts of climate change on human health in the United States: A scientific assessment. U.S. Global Change Research Program, Washington, DC, pp. 247–286.
24. Hernandez, T., and S. Gabbard. (2019). Findings from the National Agricultural Workers Survey (NAWS) 2015–2016: A demographic and employment profile of United States farmworkers. Department of Labor, Employment and Training Administration, Washington, DC, pp. 10–11 and pp. 40–45.
25. Walsh, M. K., et al. (2020). Climate indicators for agriculture. USDA Technical Bulletin 1953. Washington, DC, p. 20.
26. USDA, ERS. (2022). Ag and food statistics: Charting the essentials. Retrieved 3/18/2022.
27. USDA, ERS. (2022). Ag and food statistics: Charting the essentials. Retrieved 3/18/2022.
28. USDA, ERS. (2022). Ag and food statistics: Charting the essentials. Retrieved 3/18/2022.
29. USDA, ERS. (2022). Farm income and wealth statistics/cash receipts by commodity. Retrieved 3/18/2022.
30. USDA, ERS. (2022). Farm income and wealth statistics/cash receipts by commodity. Retrieved 3/18/2022.
31. USDA, ERS. (2020). Farm income and wealth statistics/cash receipts by state. Retrieved 5/11/2022.
32. USDA, ERS. (2020). Farm income and wealth statistics/cash receipts by state. Retrieved 5/11/2022.

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 2 | February 2023

33. USDA, ERS. (2020). Farm income and wealth statistics/cash receipts by state. Retrieved 5/11/2022.
34. Coleman-Jensen, A., et al. (2020). Household food security in the United States in 2020, ERR-298, USDA, ERS, p. v.
35. Coleman-Jensen, A., et al. (2020). Household food security in the United States in 2020, ERR-298, USDA, ERS, p. v.
36. Keener, V., et al. (2018). Ch. 27: Hawai'i and U.S.-affiliated Pacific islands. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 1269.
37. Mankin, J.S., et al. (2021). NOAA Drought Task Force report on the 2020–2021 southwestern U.S. drought. National Oceanic and Atmospheric Administration (NOAA) Drought Task Force; NOAA Modeling, Analysis, Predictions and Projections Programs; and National Integrated Drought Information System, p 4.
38. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 401.
39. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 409.
40. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 407.
41. Gowda, P., et al. (2018). Ch. 10: Agriculture and rural communities. In: Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, p. 415.