BAMS
Meeting Summary

Addressing Air Quality, Agriculture, and Climate Change across the Southwest and Southern Plains

A Roadmap for Research, Extension, and Policy

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Southwest and Southern Plains Air Quality and Production Agriculture Science and Applications Workshop

What: Nearly 60 professionals from agricultural, environmental, and health sectors met to identify knowledge gaps and progress barriers within the agriculture–air quality–climate change nexus for the Southwest and southern Plains regions. Discussion resulted in a roadmap of needs to navigate for policy, research, and land management.

When: 17 February 2021

Where: Online, hosted by the USDA Southwest Climate Hub

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In February 2021, the USDA Southwest Climate Hub hosted the virtual event called the Southwest and Southern Plains Air Quality and Production Agriculture Science and Applications Workshop. The workshop follows the culmination of a nationwide effort assessing the current state of knowledge of air quality impacts on agricultural production, and vice versa. This benchmark effort necessitates further discussion, addressing remaining knowledge gaps and progress barriers with the expectation of a changing climate. The goal of the workshop was to identify these needs for the Southwest and southern Plains region and develop a roadmap of next steps intended for those in policy, research, and land management.

Bringing focus to the Southwest and southern Plains summons local characteristics and capacities into perspective for impactful strategy development. Midcentury projections of intensifying droughts, seasonality shifts, and extreme weather events threaten to challenge the Southwest and southern Plains region. These climatic variations create new, and exacerbate current, air quality issues with implications for public well-being, agricultural production, and environmental health. Given the constancy of climate change projected for this region, greater attention must be given to the air quality–agriculture relationship with climate change inherent to these explorations.

The workshop convened professionals from health, agricultural, and environmental sectors, joining from 11 states and three countries (Canada, India, and the United States). Short presentations detailed the national assessment results, current mitigation options and resources available for the agricultural sector, current USDA Natural Resources Conservation Service (NRCS) air quality priorities, evolving indicators and models for emissions, and current measurement networks. Engagement activities throughout the workshop and a discussion session welcomed a flow of learning across all involved in the workshop, outlining a regional cross section of needs and priorities to be explored further.

General needs

For research, policy, and land management to fulfill the needs outlined in this roadmap successfully, several broad requisites should be considered. Attention to these general needs ultimately calls for intensified communication and collaboration across science, policy, and the general public.

Data accessibility. A significant barrier to research and practice includes the lack of accessibility to air quality data. Catalyzing progress entails making data available to the diversity of partners in the air quality, agricultural, and policy fields. By creating these channels, a stronger network of knowledge transfer becomes feasible. This accessibility can fortify faster avenues to solutions as "hidden" information becomes available to a wider suite of people who can use it toward their research and programs.

Innovation accessibility. Strategies to monitor and reduce agricultural-based emissions of particulate matter, especially those involving technology, risk excluding a variety of potential users due to implementation costs. Sustainability—and thus, overall effectiveness—of these strategies necessitates the development of options or programs that increase accessibility to all user populations.

Air quality awareness. Implications of air quality are multidimensional, expanding beyond urban centers and populations. Raising awareness of air pollutant sources and impacts across agricultural areas can prepare these communities with the information needed to plan with agricultural advisors, make changes to their operations, or advocate for air quality needs.

Government support. Research and monitoring efforts require greater prioritization and funding by state and federal government. This support ensures important research questions are not left unsolved, monitoring efforts cover a larger footprint, and predictive tools and forecasts can provide accurate and timely early warning. Further, some air quality issues that challenge health and agricultural production of these communities requires backing by political figures and community leadership to ensure sources are held accountable, especially when industry powers outweigh the voices of the public.

Justice perspective. Monitoring shortcomings, such as those pertaining to instrument locations and concentrations, mean that some populations—and implications to their health and livelihoods—remain drastically unstudied. Further, these areas may bear the effects of poor air quality, such as ozone, from sources not their own. Commonly, these populations are rural, agricultural communities whose characteristics, and capacities to address these issues, differ from urban areas. These factors demand prioritization of environmental justice and critical geography ideology when addressing the needs outlined in this roadmap.

Needs by topic

This roadmap is intended to serve as a foundation for future air quality and agriculture efforts by identifying current needs for policy, research, and land management. Five major areas of air quality and agriculture guide the organization of this roadmap:

- Role of drought and land-use change on dust generation and management
- Ammonia emissions from feed yards and dairy operations
- Impacts of ozone on agriculture
- Mitigation options
- Early warning: Tools, indicators, interpretations, and monitoring.

Role of drought and land use/change on dust generation and management. Dust has been identified as a significant issue for the Southwest and southern Plains (Achakulwisut et al. 2018), with drought and human land disturbance as significant contributors to high dust levels (Tanaka and Chiba 2006; Reynolds et al. 2007; Rivera et al. 2010; Carmona et al. 2015). Among 10 air quality challenges in agriculture, workshop participants prioritized dust-related events as the top concerns (Fig. 1). Climate scientists project that drought severity, duration, and occurrence are likely to increase through the end of the century (Kandakji et al. 2021), potentially influencing the frequency and extent of agricultural-based dust events. While agricultural operations both endure the impacts of dust events, and can contribute to them, there is a heightened need to address agricultural dust generation and management in both croplands and rangelands. Addressing these needs relies on action and coordination across research, government, and producer spaces.

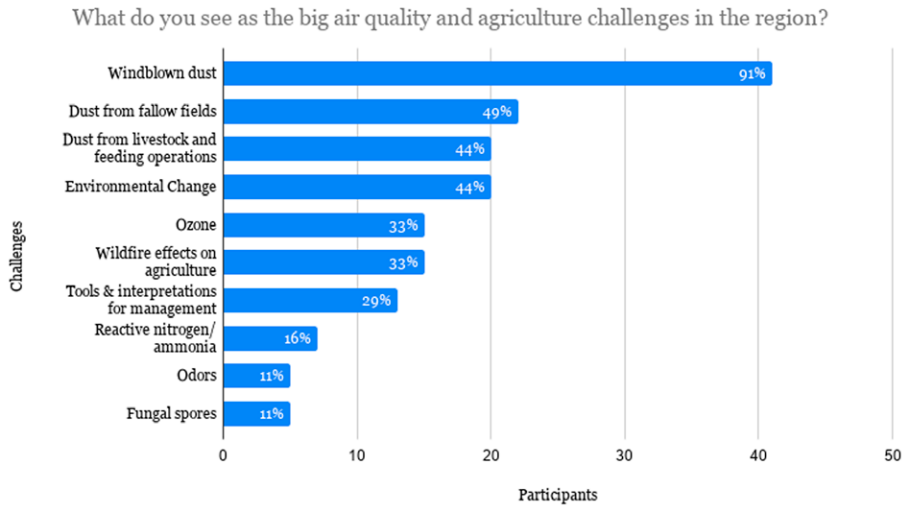

Fig. 1. Workshop participants voted on what air quality challenges they perceive as the most daunting, with dust-related events as top-ranking.

Identifying and filling gaps. Current monitoring techniques do not adequately capture all of the spatial and temporal characteristics of dust events, leaving critical details unknown. Remote sensing currently leads as the most accurate detection method of dust sources and is useful for tracking dust emission, land use, and drought effects concurrently. Alternatively, Earth-bound sensors do not meet the number and placement needs necessary to capture events extensively, let alone all of the events that likely take place. Such instruments are also located in population centers or remote sites (e.g., national parks), and so there is currently very little coordinated monitoring of eroding dust source areas. New lower-cost air sensors may provide an opportunity fill in some gaps; however, validation studies will be needed to ensure that the air sensors are capability and reliable to measuring dust. Coupling satellite techniques with Earth-bound sensors and expanding sensor networks across agroecosystems could elevate dust detection efforts by complementing data that are missed by either method.

State and federal government support. A major barrier to the aforementioned data needs includes the lack of support from state regulatory agencies. Particulate matter (PM) monitoring is expensive and likely only implemented if mandated by law. However, mandates are guided by population, which often results in an urban–rural disparity for instrument locations. Not only are rural populations neglected by this approach, with glaring justice and health implications, but the incidence of rural environments and agricultural operations is highly correlated. This occurrence suggests that rural, agricultural populations face unique air quality challenges that require different monitoring techniques and solutions. The population-based guidance—or more generally, federal monitoring policy—needs to be reevaluated to ensure stable funding avenues exist for these needs.

Drought resilient crop and management styles. Both drought and land use can accelerate dust emissions; however, co-occurrence significantly increases the odds of dust emission frequency and severity (Kandakji et al. 2021). For example, less water can lead to fallow or abandoned fields, increasing wind erosion and blowing dust risks. On rangelands, reduced ground cover during drought can increase landscape susceptibility to wind erosion as well. Strong wind events can uproot plants and damage plant tissue, leading to plant mortality. In the worst conditions, loss of perennial grasses can lead to irreversible landscape state transitions. These understandings stress the importance of appropriate land management. Drought-adapted management or crops may be further incentivized by the knowledge that air quality impacts agriculture, potentially inciting cyclic occurrences of drought, poor air quality, and degraded landscapes.

Ammonia emissions from feed yards and dairy operations. Approximately 90% of airborne ammonia comes from the agricultural sector (Insausti et al. 2020). This atmospheric presence contributes to accumulation of hazardous PM and nitrogen, threatening human and ecosystem health. To address this problem, the agricultural sector needs improved livestock feeding and housing, manure management, and fertilization practices (Insausti et al. 2020). Achieving this goal requires effective and accessible methods for identifying and monitoring ammonia emissions to illustrate the challenge of ammonia fully and accurately.

Stronger communication channels. The sources of ammonia must be identified and understood to devise effective strategies to reduce emissions. However, measurement techniques and data sources have challenged researchers and producers alike. Data from state agency monitors have only recently been made available to researchers, whereas cheap and easy-to-use tools designed for producers have yet to be deployed broadly. As a means to expedite progress on this front, general communication between those actively gathering data now and those who might use it in science and practice is essential.

Advancing feed management practices and accessibility. Producers often use high-protein, and nitrogen-rich, feeds to meet the nutritional needs of livestock; however, processes in excretion contribute to higher levels of nitrogen and ammonia in the atmosphere. Identification of alternative feed ingredients, especially those more suited to dry and drought-influenced landscapes, would help minimize nitrogen and ammonia levels. Feed management offers a promising option for decreasing these emissions. Though many large feedlots and dairies are investing in these techniques, the number of cost-effective strategies should grow to ensure options for a wider range of producers. Traceable feed would elevate these efforts by identifying ammonia sources and supporting the evaluation process of ammonia-reduction strategies.

Effective and affordable ammonia capture and reuse options. To bolster ammonia reduction efforts, there is a need to develop ammonia capture methods available across the agricultural sector. Ammonia reuse techniques would sustain these efforts, especially if these techniques reduced costs of other inputs necessary to operations.

Impacts of ozone on agriculture. Surface ozone, commonly experienced as smog or haze, disrupts plant growth and biomass accumulation. These impacts exacerbate problems such as climate change and food insecurity (Unger et al. 2020). While ozone is often associated with major urban areas, ozone concentrations can occur anywhere, traveling via wind and accumulating in remote places (EPA 2020). Agricultural operations, such as prescribed burns and engine emissions, contribute to ozone formation in the atmosphere, although not to the extent that emissions from the transportation or power sectors might. A wider awareness of the ozone–agriculture relationship is necessary to address this growing issue, especially as rural communities experience the health and ecosystem effects often from remote sources.

Deeper understanding of ozone effects unique to agricultural communities. An abundance of scientific literature details the effects of ozone on crop yields and quality; however, communicating these findings in effective and actionable ways to agricultural producers, advisors, and the agricultural community at large, needs improvement. Educational campaigns or outreach programs detailing ozone impact on both health and agriculture may serve as methods to bridge the knowledge gap. Awareness will not only bolster preparation and resilience but also advocacy efforts and policy changes.

Transition support from oil and gas development. Oil and gas emissions contribute significantly to ozone formation in the atmosphere. In rural communities that are economically dependent on the oil and gas industry, there is a perceived reluctance to acknowledge the health issues associated with ozone, and a political lack of will to address it. Circumstances may be exacerbated when the same communities also rely on agriculture, which is negatively impacted by ozone effects. Strides must be taken—by trustworthy community leaders, for example—to hold these sources accountable and generate alternative avenues for economic prosperity. In the agricultural sector, incentive opportunities could complement educational efforts, achieving ozone reduction goals even if cultural and economic shifts take longer to establish.

Mitigation options. Options to mitigate dust include a variety of conservation practices, tools, and resources that can accommodate a diversity of land types and conditions. Additionally, NRCS and Farm Services Agency (FSA) offer programs to facilitate and fund these practices. To synthesize the extent of dust mitigation resources available, NRCS and the USDA Southwest and Southern Plains Climate Hubs created the "Dust Mitigation Handbook" (Smarik et al. 2019) for resource managers working together with producers to craft solutions to dust challenges. However, changing environments beckon a reflection on remaining barriers and areas of opportunity in dust mitigation strategies.

Land surface management integration. Location and land practices play a sizable role in air quality. For instance, bio-crust aids in reducing dust emissions, improving air quality. However, for arid areas experiencing drought, these places become sources of windblown dust when cattle movement breaks the soil surface. This phenomenon contradicts other ranching environments where hoof action can be beneficial to soil health. Moreover, data on at-source PM emissions are scarce, which significantly impacts development of predictive models and forecasts to support land management. Linking land management with expanded air quality monitoring will hasten action and clarify needed mitigation strategies.

Affirming best practices despite poor results. Frequently, producers will experience dust challenges even if they are employing the best management practices. These instances will not only hinder confidence among producers who commit to dust mitigation, but can also convince producers these practices are futile or wrong. Until improved technologies and tools are developed to address this problem, communication strategies to affirm producers' efforts are crucial to maintaining momentum and morale in dust mitigation efforts. Similarly, some places may be so overcome with drought, producers may experience overwhelming helplessness. Managers and producers can work together to temper expectations and develop realistic goals that accommodate the situation.

Anticipating change. Challenges associated with drought are projected to worsen with climate change. Regions experiencing these effects now could expand to a larger geographic scope. Anticipating and evaluating where that scope expands could help managers plan and adjust accordingly. Areas where these challenges were not a concern historically will be a challenge for land managers, as they will have to learn new strategies. However, neighboring, impacted areas could serve as a source for examples and resources. Anticipating changes might motivate partnerships and capital/strategy-sharing.

Early warning: Tools, indicator, interpretations, and monitoring. A variety of air quality early warning and monitoring networks, models, and forecasts exists, covering multiple scales and provided by a diversity of institutions. These resources are important for informing mitigation strategies and evaluation of air quality objectives (Webb et al. 2020). Creating quicker, more accurate, and far-reaching monitoring and detection strategies is important for expediting response and remediation to air quality concerns.

Sensor network flexibility, expansion, and integration. Air quality monitoring networks rely on monitoring sites that typically have fixed locations. As population centers expand, and new land uses and disturbances emerge that impact air quality, flexibility in monitoring locations and expanded monitoring are needed to detect impacts. Current monitoring locations may fail to detect degraded air quality as cities expand and disturbances change. Low-cost air sensors offer a convenient, accessible option for collecting important air quality information. Adoption of low-cost sensors presents opportunities to increase the amount of air quality data available to the public and managers. Integrating networks of sensors through increased cooperation among the public, organizations, and agencies at various scales, and through common data-sharing platforms, could support monitoring for early warning, research, and identification of management options. Easily accessible, digestible data would catalyze this synergy. Integration would necessitate improved communication across these groups and, ideally, hasten response times to public-identified air quality concerns.

Focus on PM properties. In the effort to increase the amount and types of air quality data collected, greater attention should be paid to PM properties. This need is in recognition that the mineralogical, heavy metal, and microbiological content of PM is important for human and livestock health. Techniques must possess the ability to detect a wider range of particulate sizes, as well as matter traveling with the particulates (e.g., bacteria, fungi, chemicals), or else inhalable, harmful, and unmonitored particulates can threaten human and ecosystem health.

Data interpretations for management. Developing tools accessible to managers that translate data into meaningful interpretations is needed. Without interpretations, data that are produced can be difficult to understand, and thus, challenging to identify when a problem or elevated risk exists. Interpretive tools are needed that enable land managers to understand when and where there is an air quality risk, whether that risk is associated with current management practices, and which management practices are most appropriate for mitigating the risks. For wind erosion, risks may occur for soils and ecosystems as well as air quality. Approaches that link information about soils, vegetation, and wind erosion processes to descriptions of local site potential and ecological dynamics (e.g., Ecological Site Descriptions) could be incorporated into existing workflows for identifying resource concerns and conservation practices used by federal land management agencies.

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