

DRAFT - Sustainable Infrastructure Recommendations

Recommendation 1: The federal government should consider subsidizing the use of IoT in farms.

The federal government should consider programs to help growers and producers adopt IoT technologies. This should include subsidies around connectivity, sensors, and digital applications. The programs could be similar to other subsidies that the USDA has for farmers around agricultural inputs or climate smart agriculture. The use of IoT in agriculture will benefit all stakeholders, including the farmer, the policy makers, the agricultural companies, and the consumer.

Justification:

- The upfront cost of IoT typically limits the adoption of data-driven agriculture
- Subsidies can help scale the technology, which will drive down costs.

Implementation Considerations:

- Public/private/academia partnership
- This should leverage Ag Extension Centers as well
- Marginalized farmers and smallholder farmers might need more help to leverage this technology
- Should we make it specific to applications of IoT in Ag, e.g. for Water, Climate, Carbon

Potential implementation barriers:

- Limited expertise in the market and industry; resources and expertise may be difficult to secure

Possible participating agencies:

As agriculture impacts sustainability and water, and biofuels, it cuts across the scope of multiple federal agencies, there should be participation, support and coordination from multiple agencies, including:

- Department of Energy (biofuels, carbon emissions, etc.)
- Department of Commerce/NIST (standards, cybersecurity, GCTC, regulatory, etc.)
- USDA, FSA (NIFA grants, extensions, etc.)
- NRCS (Natural Resource Conservation Services)

Federal considerations:

- Role of states should be defined. In particular, some BIL and IRA funding may be given to states to manage and allocate.
- This could make a good addition to the Farm Bill of 2023

Recommendation 2: The federal government should consider fully funding the deployment of a “farm of the future” setup in every land grant university nationwide. This nationwide test-farm IoT network should span different forms of agriculture, including, but not limited to broadacre, horticulture, livestock, and aquaculture.

Description:

The proposed initiative advocates for the federal government to allocate sufficient funding to implement a "farm of the future" setup in all land grant universities across the United States. This would involve creating a comprehensive IoT network that spans various forms of agriculture, such as broadacre, horticulture, livestock, and aquaculture. By establishing a nationwide test-farm IoT network, the government can significantly enhance agricultural productivity, while also promoting sustainable agricultural practices. The implementation of this initiative will require substantial financial investments from the federal government. However, the benefits of having a comprehensive agricultural data

DRAFT - Sustainable Infrastructure Recommendations

network in place will likely lead to better decision-making, increased efficiency, and improved sustainability across the agricultural sector.

Justification:

The implementation of a nationwide "farm of the future" IoT network in land grant universities would be tremendously useful in several ways.

- First, it would become a showcase for farmers in the region on how to collect and analyze data from their farms. This will enable farmers to collect and analyze vast amount of real-time data about crops, livestock, and farm operations. This would allow them to monitor the health and growth of their plants and animals more closely, identify issues early on, and make informed decisions about how to optimize their yield and reduce waste.
- Second, the data collected by the IoT network could be used to develop and refine machine learning algorithms, which could help farmers predict future crop yields and identify potential issues before they occur. This would enable farmers to be more proactive in their approach to crop management, leading to more efficient use of resources, reduced costs, and improved sustainability.
- Third, the nationwide "farm of the future" IoT network would enable universities to share data and insights with each other more easily, fostering a collaborative approach to agriculture. This could lead to the development of new best practices, improved knowledge sharing, and a more cohesive and sustainable agricultural industry overall.
- Finally, the implementation of a nationwide IoT network in land grant universities could help to advance research and development in agriculture, leading to the creation of new technologies and practices that could benefit farmers and consumers alike. This could include everything from new crop varieties that are more resilient to climate change, to new precision farming tools that enable farmers to more accurately target their use of resources.

Implementation considerations:

- While it is easy to say "you shall incorporate IoT technologies", it is more difficult to specify what IoT technologies should be acceptable to be used. Some concrete and specific IoT applications should be defined for inclusion in the project and funding requirements, based on project types. This may require coordination with other federal agencies in alignment with their objectives.
- Different land grant universities might pose different challenges with respect to implementation, including connectivity, tech readiness, etc.
- It is important to include every university, including the HBCUs.

Potential implementation barriers:

- Project owners may have limited IoT awareness of knowledge
- Limited expertise and resources in marketplace to support IoT in the projects
- How much will it cost? [connected combine + aquaculture] e.g. 100 land grant universities

Possible participating agencies

- All federal agencies that provide grants and funding for projects where IoT may be incorporated, including the USDA, DOE (for biofuels)

Federal considerations:

DRAFT - Sustainable Infrastructure Recommendations

- IoT may introduce cybersecurity vulnerabilities into the project or system, so some minimal requirements for cybersecurity should be defined and specified for the IoT and smart technologies to be incorporated.

Recommendation 3: The federal government should consider increasing funding and accelerating implementation of broadband deployment across rural America.

Description:

The federal government currently offers limited funding and grants (ex. Department of Agriculture – Community Connect Grant Program) to help fund broadband deployment in rural communities, however, these opportunities have not advanced quickly enough to provide broadband coverage for certain areas of rural America. Increasing the broadband infrastructure across the U.S. will be a critical component for IoT connectivity in agriculture.

Justification:

- A recent USDA report reported that 60% of US farmland doesn't have good Internet connectivity
- Point to point solutions, or satellite-based connectivity, quickly become expensive, and do not get connectivity to the middle of the farm

Implementation Considerations:

- Mandate broadband infrastructure deployment across rural areas until U.S. coverage is complete.
- Current federal funding operates across several programs making it difficult to identify and find the opportunities available to specific areas. Although there are initiatives to increase awareness of the funding, the processes need to be simplified to accelerate implementation.
- Funding may include options for supplying energy sources such as solar power, wind power, or micro-hydro power where access to reliable electricity is limited.
- Taking advantage of modern communications tech, such as 5G MBB, fixed wireless, LEO satellites to the farm
- Agricultural specific needs, e.g. more uplink than downlink

Potential implementation barriers:

- May be limited to eligible service providers in certain areas

Possible participating agencies:

- All federal agencies that provide grants and funding for projects where IoT may be incorporated, including the USDA, DOE (for biofuels)

Federal considerations:

- How to improve the already available broadband funding in order for connectivity across rural America to keep up with technology advancement for IoT.
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Other:

- Labor shortage

DRAFT - Sustainable Infrastructure Recommendations

- **Automation**

Recommendation 4: The federal government should actively promote and support the adoption of satellite narrowband IoT systems for agricultural IoT, with the aim of improving connectivity, data collection, and decision-making in rural and remote agricultural areas.

Justification: Satellite IoT systems provide a reliable and efficient means of connectivity and data transfer in remote agricultural areas where traditional terrestrial connectivity options may be limited or unavailable. Encouraging the adoption of satellite IoT systems will enable farmers to optimize their operations through real-time data management, resulting in benefits for various stakeholders, including farmers, policy makers, agricultural companies, and consumers.

Implementation Considerations:

1. Harmonize standards for satellite narrowband IoT: This is an early stage tech, but having appropriate standards will help drive the ecosystem. For example, should sensors be allowed to communicate with IoT satellites from different providers?
2. Establish a public-private-academia partnership: This partnership should involve satellite service providers, IoT technology companies, Agriculture data-platform providers, Ag Extension Centers, research institutions, and relevant government agencies. The goal of this partnership would be to support the development, implementation, and adoption of satellite IoT systems in agriculture.
3. Define specific agricultural applications: Consider specific use cases for satellite IoT in agriculture, such as precision farming, crop monitoring, water management, livestock tracking, and supply chain traceability. Tailor solutions to address these specific needs to maximize the impact of satellite IoT technology in the agricultural sector.
4. Develop financial incentives and subsidies: Provide incentives or subsidies to facilitate the adoption and integration of satellite IoT systems by farmers and agricultural businesses. These incentives could include tax breaks, grants, or low-interest loans to help offset the upfront costs associated with implementing satellite IoT systems.
5. Promote education and training: Create educational programs and resources to help farmers and agricultural professionals understand the benefits of satellite IoT technology and how to effectively implement and use these systems. This can be achieved through collaborations with Ag Extension Centers, universities, and industry experts.

Possible Participating Agencies: Department of Agriculture/USDA, Department of Commerce/NIST, Federal Communications Commission (FCC), National Aeronautics and Space Administration (NASA), and National Oceanic and Atmospheric Administration (NOAA).

Federal Considerations: The role of states should be clearly defined, and funding for satellite IoT infrastructure and adoption may be allocated to states to manage and distribute. Incentives or

DRAFT - Sustainable Infrastructure Recommendations

subsidies for satellite IoT adoption and integration could be considered as part of the upcoming Farm Bill or other relevant legislation. There might be international coordination, along with spectrum considerations with the ITU.

Potential Implementation Barriers: High upfront costs and limited expertise in satellite IoT technology may hinder widespread adoption. Additionally, effective collaboration between multiple agencies, stakeholders, and the private sector will be necessary to ensure successful implementation. Ensuring data privacy and security, as well as addressing any potential regulatory or licensing issues, will also be crucial factors to consider.

Recommendation 5: The federal government should actively promote and support the adoption of Generative AI applications for agricultural IoT, with the aim of improving decision-making, optimizing resource utilization, and enhancing productivity in the agricultural sector through innovative and data-driven solutions.

Justification: Generative AI applications have the potential to revolutionize the way farmers analyze and use the data collected from IoT devices in agriculture. By leveraging advanced algorithms and machine learning techniques, Generative AI can enable farmers to identify patterns, optimize resource allocation, and make better-informed decisions. This will result in benefits for various stakeholders, including farmers, policy makers, agricultural companies, and consumers.

Implementation Considerations:

1. Establish a public-private-academia partnership: This partnership should involve AI technology companies, IoT solution providers, Ag Extension Centers, research institutions, and relevant government agencies. The goal of this partnership would be to support the development, implementation, and adoption of Generative AI applications in agricultural IoT. The partnership should also facilitate the sharing of best practices and the development of open-source solutions to encourage innovation.
2. Define specific agricultural applications: Consider specific use cases for Generative AI in agriculture, such as
 - a. Yield prediction: Generative AI can analyze historical and real-time data from IoT devices to predict crop yields more accurately, helping farmers to make better-informed decisions regarding planting, harvesting, and marketing.
 - b. Pest and disease management: Generative AI can use data collected from IoT sensors to identify patterns in pest and disease occurrences, enabling farmers to adopt targeted and timely interventions for prevention and control
 - c. Irrigation scheduling: Generative AI can optimize irrigation schedules by analyzing data from IoT devices such as soil moisture sensors, weather stations, and satellite imagery, ensuring efficient water use and reducing water waste.
 - d. Supply chain optimization: Generative AI can analyze data from IoT devices throughout the supply chain to optimize logistics, reduce food waste, and increase overall efficiency.
3. Develop financial incentives and subsidies: Provide incentives or subsidies to facilitate the adoption and integration of Generative AI applications by farmers and agricultural

DRAFT - Sustainable Infrastructure Recommendations

businesses. These incentives could include tax breaks, grants, or low-interest loans to help offset the upfront costs associated with implementing Generative AI solutions.

4. Promote education and training: Create educational programs and resources to help farmers and agricultural professionals understand the benefits of Generative AI technology and how to effectively implement and use these applications. This can be achieved through collaborations with Ag Extension Centers, universities, and industry experts. Offer workshops, webinars, and online courses to ensure widespread access to knowledge and training opportunities.

Possible Participating Agencies: Department of Agriculture/USDA, Department of Commerce/NIST, National Science Foundation (NSF), and National Institute of Food and Agriculture (NIFA).

Federal Considerations: The role of states should be clearly defined, and funding for Generative AI infrastructure and adoption may be allocated to states to manage and distribute. Incentives or subsidies for Generative AI adoption and integration could be considered as part of the upcoming Farm Bill or other relevant legislation.

Potential Implementation Barriers: Limited expertise and understanding of Generative AI technology may hinder widespread adoption. Additionally, effective collaboration between multiple agencies, stakeholders, and the private sector will be necessary to ensure successful implementation. Ensuring data privacy and security, as well as addressing any potential ethical concerns related to the use of AI in agriculture, will also be crucial factors to consider. Furthermore, the integration of Generative AI applications with existing agricultural IoT systems may require significant technical and operational adjustments.

[Recommendation 6: Develop a comprehensive national strategy for agricultural IoT to establish a clear vision and roadmap for the integration of IoT in agriculture, addressing current challenges, fostering innovation, and promoting long-term sustainability and competitiveness of the agricultural sector.](#)

Description:

The federal government should create a comprehensive national strategy that outlines the objectives, goals, and milestones for integrating IoT technologies in the agricultural sector. This strategy should be developed in collaboration with stakeholders, such as farmers, technology providers, industry experts, and research institutions, to ensure broad consensus and commitment to its implementation.

Justification:

As IoT technologies continue to advance, their adoption in agriculture can significantly enhance productivity, resource efficiency, and environmental sustainability. However, without a cohesive national strategy, the potential benefits of agricultural IoT may be hindered by fragmented initiatives, limited interoperability, and a lack of clear direction.

DRAFT - Sustainable Infrastructure Recommendations

Implementation Considerations:

1. Identify and prioritize the most pressing challenges faced by the agricultural sector that can be addressed through the use of IoT technologies, such as water management, pest control, and labor shortages.
2. Develop specific goals, timelines, and milestones for the integration of IoT in agriculture, ensuring alignment with broader national objectives related to food security, environmental sustainability, and economic growth.
3. Establish an interagency task force to oversee the development and implementation of the national strategy, involving relevant agencies such as the USDA, FCC, and DOE.
4. Engage with stakeholders from the agricultural industry, technology providers, research institutions, and academia to ensure a collaborative and inclusive approach to strategy development.
5. Develop a monitoring and evaluation framework to track progress against the strategy's goals and milestones, enabling data-driven decision-making and adaptation as needed.
6. Allocate resources and funding to support the implementation of the strategy, including investments in research and development, infrastructure, and capacity building.

Potential implementation barriers:

1. Resistance to change or lack of awareness among farmers about the benefits of IoT technologies.
2. Limited access to adequate broadband infrastructure in rural areas, hindering the adoption and effectiveness of IoT solutions.
3. Data privacy, security, and ownership concerns related to the collection and use of agricultural data.

Possible participating agencies:

USDA, FCC, DOE, and other relevant federal agencies, in collaboration with state and local governments, industry stakeholders, technology providers, research institutions, and academia.

Federal considerations:

1. Assess the existing policies, programs, and initiatives related to agricultural IoT to identify gaps and areas for improvement.

DRAFT - Sustainable Infrastructure Recommendations

2. Consider the potential impact of emerging technologies, such as 5G and artificial intelligence, on the future of agricultural IoT and incorporate these developments into the strategy.
3. Ensure the strategy is aligned with international efforts and standards in agricultural IoT to promote global competitiveness and collaboration.

Other recommendations:

1. **Encourage interoperability and standardization:** Work with stakeholders, including technology providers, farmers, and industry experts, to develop and adopt common standards and protocols for agricultural IoT systems. This will ensure seamless integration of various IoT devices and applications, enable efficient data sharing, and reduce the barriers to entry for new market participants.
2. **Enable low-spectrum UHF and VHF bands** usable for Agricultural IoT under part 15 rules.
3. **Partner with USDA on the creation of a nationwide dynamic soil map**
4. **Establish data governance frameworks:** Develop clear guidelines and regulations for data ownership, privacy, and security in the context of agricultural IoT. This will help to protect farmers' rights and interests, as well as promote trust and confidence in the use of IoT technologies.
5. **Support research and development:** Increase funding for research and development in agricultural IoT, with a focus on addressing current challenges and exploring innovative applications. Collaborate with universities, research institutions, and private companies to drive advancements in IoT technology and its application in agriculture.
6. **Foster public-private partnerships:** Encourage collaboration between government agencies, technology providers, and the agricultural industry to accelerate the development and adoption of IoT solutions. These partnerships can help to pool resources, knowledge, and expertise, leading to more effective and efficient implementation of IoT in agriculture.
7. **Develop incentive programs for early adopters:** Offer financial incentives, such as grants or tax breaks, to farmers who adopt IoT technologies and demonstrate measurable improvements in productivity, resource efficiency, or environmental sustainability. This will encourage the wider farming community to embrace IoT solutions and drive market demand.
8. **Promote awareness and knowledge sharing:** Organize conferences, workshops, and other events to raise awareness about the benefits of IoT in agriculture and share best practices and success stories. This will help to create a supportive community of farmers and industry stakeholders who can learn from each other's experiences and drive further innovation in the sector.
9. **Support workforce development:** Invest in educational and training programs to equip farmers and agricultural professionals with the necessary skills and knowledge to effectively

DRAFT - Sustainable Infrastructure Recommendations

use and manage IoT technologies. This may include partnering with universities, vocational schools, and industry experts to develop targeted curricula and training resources.

10. **Evaluate and monitor progress:** Establish a system for regularly assessing the impact of IoT implementation in agriculture, including the effectiveness of policies and programs in achieving desired outcomes. This will enable the government to make data-driven decisions, adapt strategies as needed, and ensure the long-term success of IoT in agriculture.