Assessing the Viability of Urban Fringe Agricultural Lands for Sustainable Energy and Food Production: A Scenario-Based Analysis

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Introduction

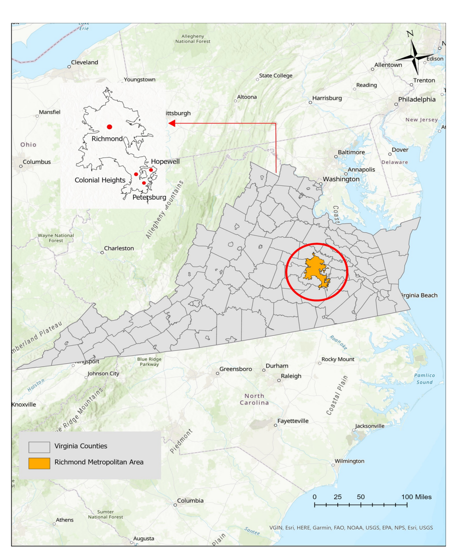
The United States is facing two major issues: climate change and the loss of agricultural land. Various legislative measures, such as the Bipartisan Infrastructure Law of 2021, the Inflation Reduction Act of 2022, and the Protecting Future Farmland Act of 2023, have been enacted to tackle these challenges. Virginia's 2020 Clean Energy Act aims for 100% renewable power by 2045. However, solar and wind power currently make up only 3% of the state's energy.

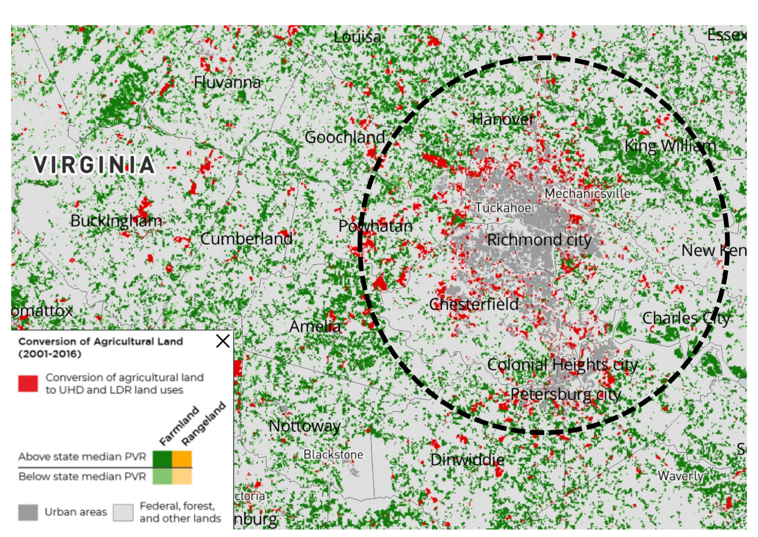
Since 1982, the U.S. has been losing a significant amount of farmland, with around 25 million acres lost, equivalent to 2,000 acres per day between 2001 and 2016. In Virginia, 339,800 acres of farmland were converted to urban or residential use from 2001 to 2016. This conversion negatively affects the potential renewable energy supply and undermines food production.

This research aims to explore agrivoltaics as an innovative and potential solution to preserving farmland around the urban fringe, linking agricultural productivity with solar energy.

Research Question and Methodology

Due to Virginia's extensive land area and multitude of urban hubs, the Richmond metropolitan area—encompassing Richmond City, Petersburg City, Hopewell City, and Colonial Heights City—was selected as a case study for this research.

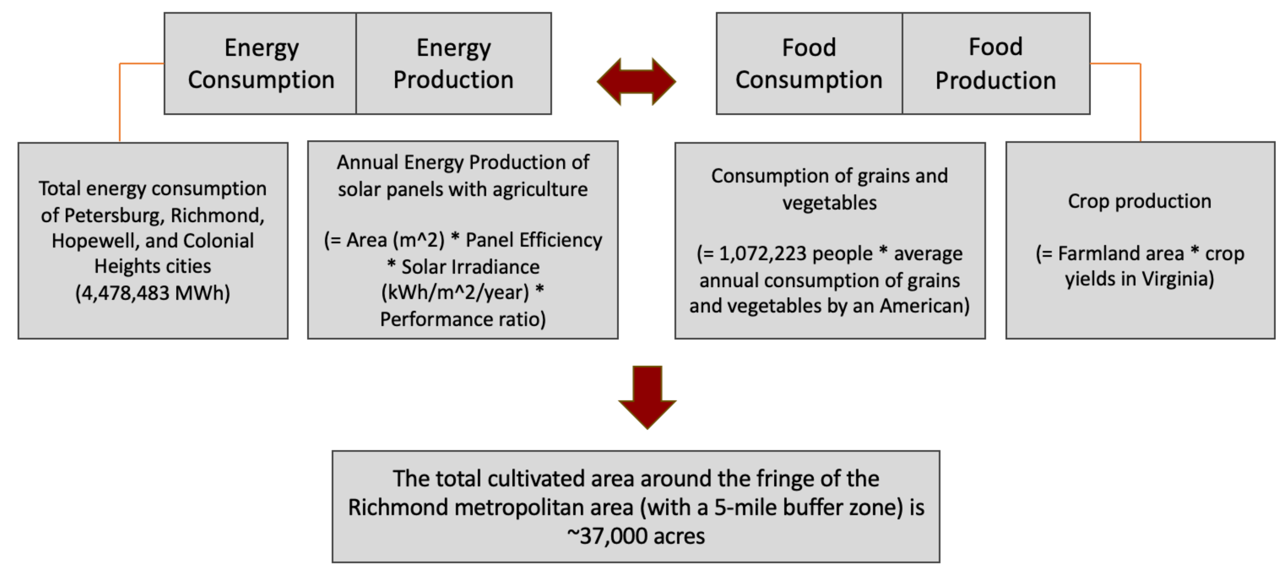


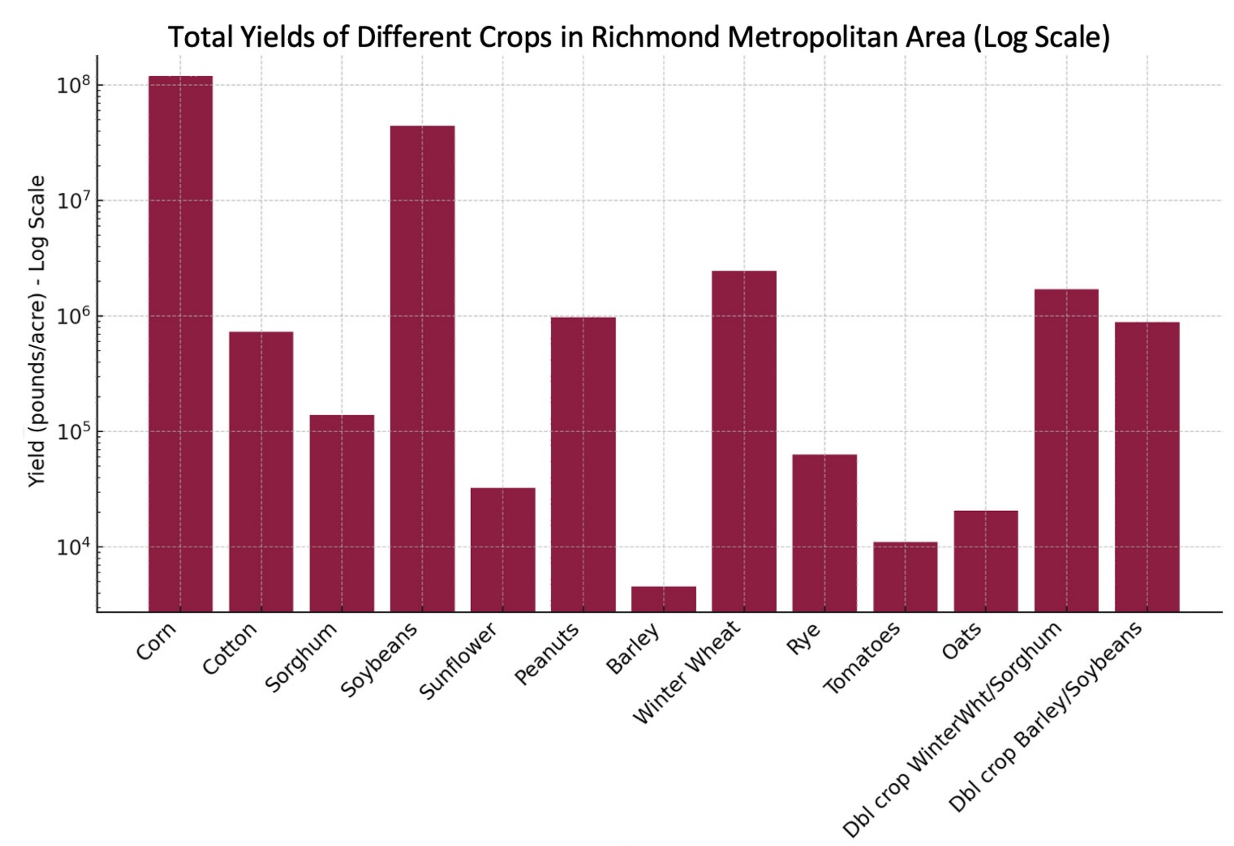


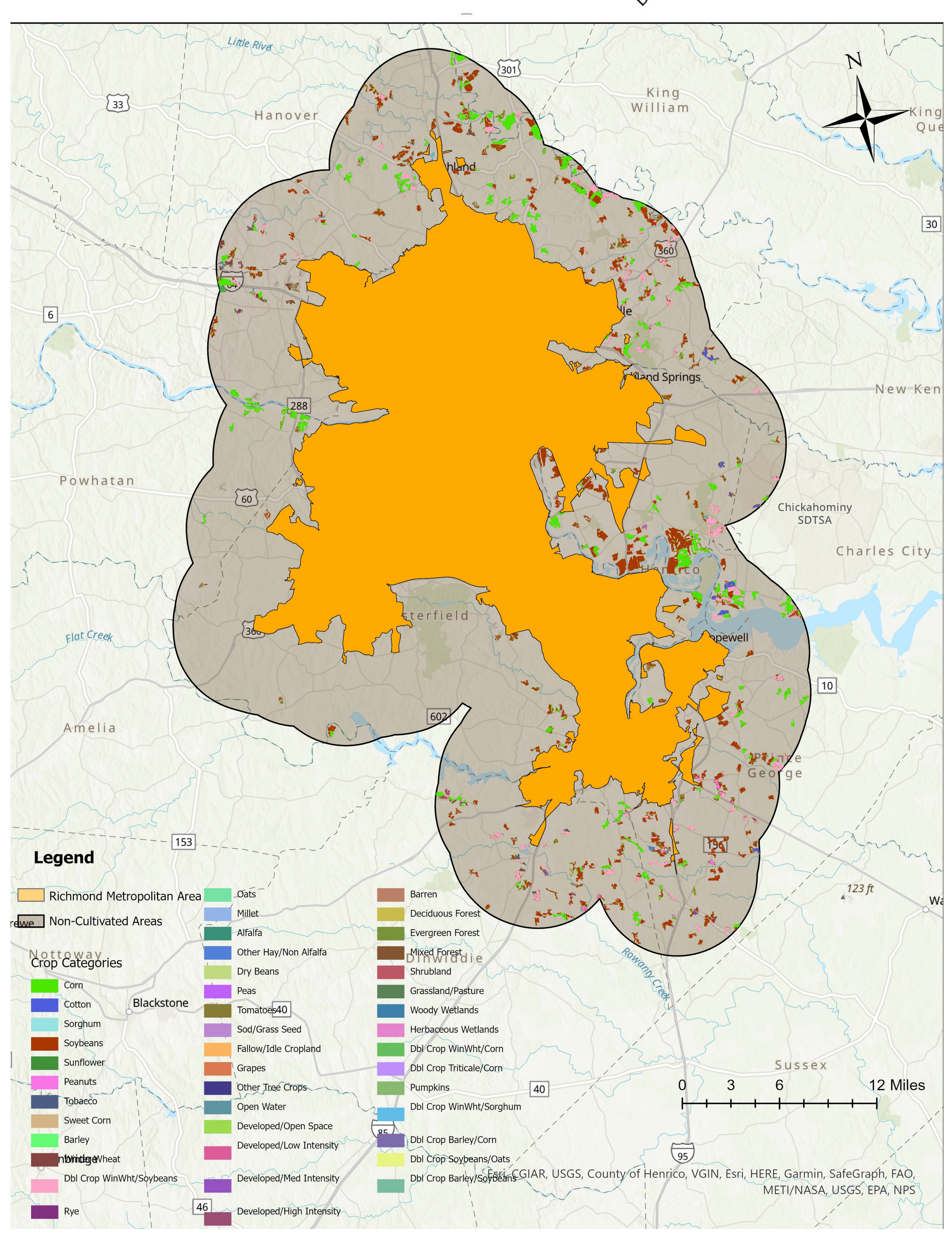
This study addresses the following question: Under what conditions and to what extent can farmlands around the urban fringe of the Richmond metropolitan area support energy and food self-sufficiency?

The research methodology utilizes geospatial analysis using a Geographic Information System (GIS) and land use mapping techniques. In this study, the fringe of the Richmond metropolitan area is defined with a 5-mile buffer from its perimeter.

Data



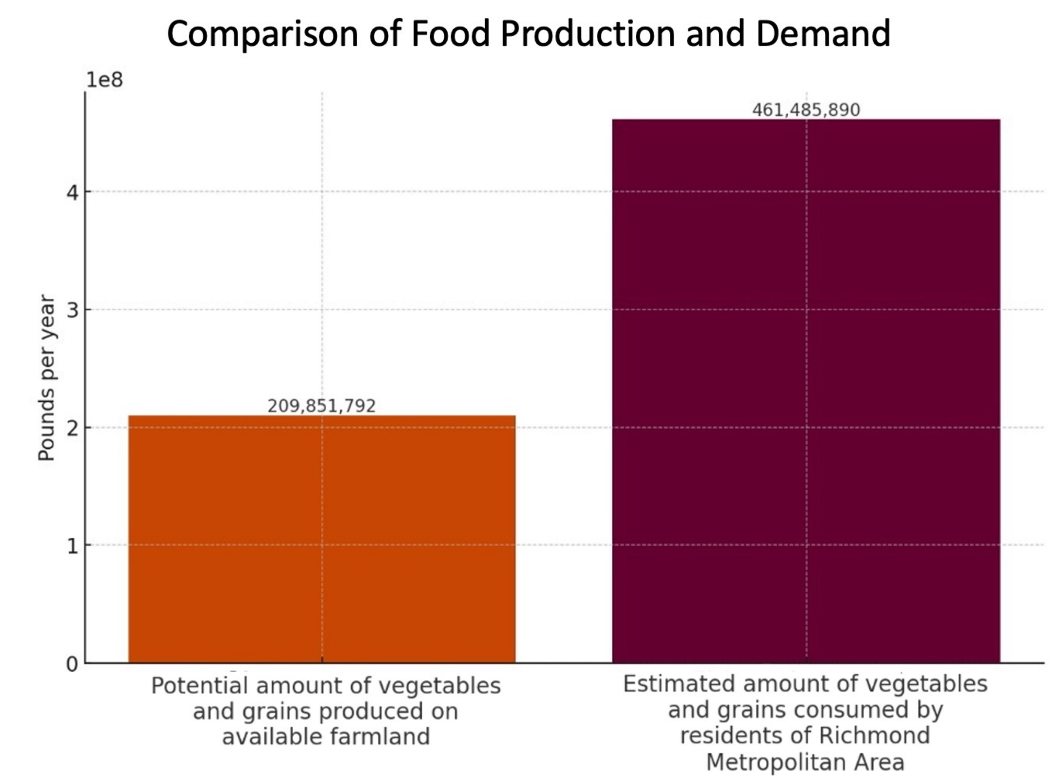


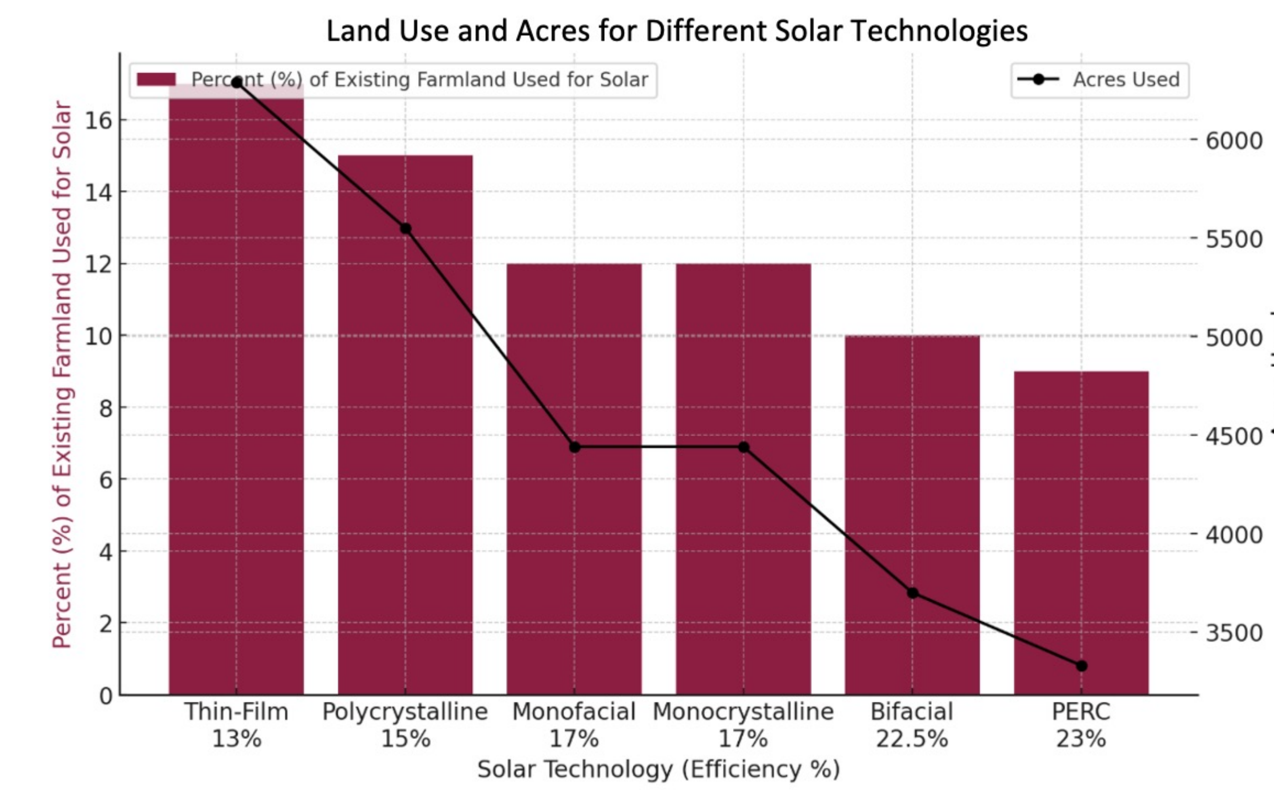


Assumptions and Results

Results indicate that approximately 37,000 acres of farmland around the urban fringe can potentially be used for crop production. Such activity would produce a total of 209,851,792 pounds of food per year within the 5-mile buffer. Comparatively, the Richmond metropolitan area's demand for grains and vegetables is around 461,485,890 pounds per year. These findings imply that the available farmland could potentially supply about 30% of the metropolitan area's grain and vegetable needs, highlighting the crucial role of these agricultural areas.

The Richmond metropolitan area consumes a total of 4,478,483 MWh of energy. The analysis suggests that if 10% of the farmland surrounding the urban fringe were allocated specifically for bifacial solar panels, the metropolitan area could rely 100% on solar energy.





Future Works and Limitations

Due to the lack of data concerning the consumption of vegetables and grains by individuals residing in the Richmond metropolitan area, food consumption was estimated by utilizing population statistics and the average annual consumption of the typical American. Furthermore, there was an absence of vector files containing information about crop layers, their respective areas, and the corresponding crop yields for each farm. To address this, the farming areas were determined using raster data from the crop layer and data from the USDA's Virginia crop yield table.

Future research will involve pinpointing ideal farmland locations for solar panel placement, assessing potential agricultural productivity losses from agrivoltaics, and selecting the appropriate solar technology for each specific location.

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