Vegetable production: land use perspective

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Poster Outline

Introduction

Food deserts are the geographic areas where people do not have easy access to nutritious, healthy foods, such as produce, berries, and vegetables (called collectively vegetables in this paper). Increasing local production of vegetables might help alleviate the problem of food deserts (Schupp, 2019; Savary et al., 2020). North Carolina has a significant number of food deserts (ERS, 2021). The state also has a sizable fresh vegetable production, and cropland that is periodically fallowed (NCDA&CS, 2019; USDA, 2021). However, there is little understanding on where the state's vegetable production is located in relation to food deserts. Nor it is known what portion of fallow land could be available to produce vegetables if sufficient incentives become available to farmers. The poster to be presented documents the spatial and temporal patterns of land under vegetables and fallow in North Carolina, and analyzes how the land use patterns are related to soil productivity, climatic conditions, and economic and policy drivers.

Research methodology

Study areas: We investigate the use of land for growing vegetables for three North Carolina counties, which exemplify the physio-geographic diversity of the state's growing conditions and crop production dynamics. According to the 2017 Census of Agriculture, Bladen county in the coastal (eastern) area, main crop production area of the state, has 180,000 ac in farms, up 54% from 2012, with the top acreage under corn, soybeans, berries, and peanuts; Guilford county in the piedmont (central) area has 76,000 ac in farms, down by 11% from 2012, with the top acreage under forage, soybeans, wheat, corn, and tobacco; and Rutherford county in the mountain (western) part of the state has 60,000 ac in farms, down by 3% from 2012, with the top acreage under forage, soybeans, corn, and vegetables. All study counties have at least one census tract recognized as a food desert as reported in the online Food Access Research Atlas, developed by the USDA ERS (ERS, 2021).

Methods: For each of the study areas, we follow a three-stage procedure for the analysis.

Stage 1: A GIS-based geo-database is developed to store, manage and analyze: 1) the Cropland Data Layer (CDL) from 2008 to 2019, which is annually created using remote sensing data (Landsat) at the spatial resolution of 30 m (USDA, 2021); 2) the National Commodity Crop Productivity Index (NCCPI) derived from the SSURGO soil database (ESRI, 2021), which assigns every parcel of land an index taking on the values between zero and one where the higher values correspond to more productive soils; and 3) climate data(e.g. precipitation, temperature and information on flooding, hurricanes, fires) from the NC CRONOS Database (https://climate.ncsu.edu/cronos) and NOAA's National Weather Service (https://www.weather.gov/); and 4) other open source geospatial data such as topography information to support data analysis.

Stage 2: The first order Markov chain models are estimated to evaluate the land use transition probabilities, i.e., the probabilities of the changes in land cover from one year to another. The models are estimated on 11 pairs of consecutive years, one at a time, i.e., for 2008-09, 2009-10, and so on, through 2018-19.

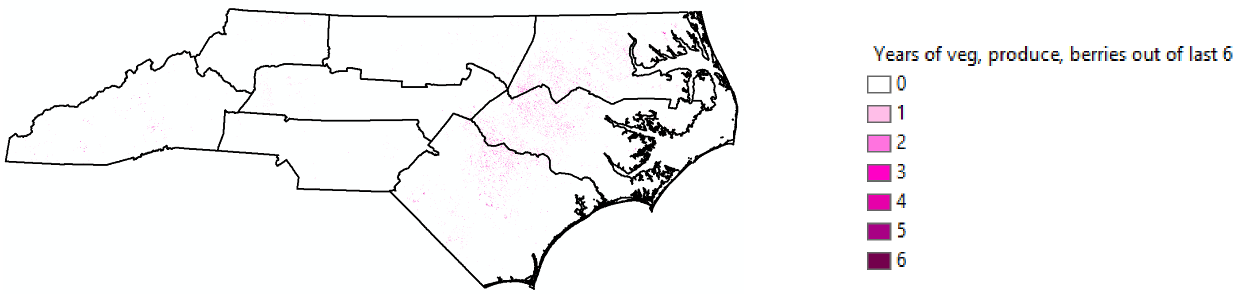
Stage 3: We analyze the spatial and temporal patterns of the transition probabilities. For the spatial patterns, we calculate and investigate several indices to describe both the patterns for the specific land cover classes of interest, vegetables and fallow, and the overall landscape patterns. The indices include the proportions of the cover classes of interest in the total cropland; nearest neighbor probabilities; indices of land cover dominance (the values approaching one indicate that a landscape is dominated by one or a few land uses while the indexes approaching zero - the landscapes with land uses represented in approximately equal proportions); and the index of adjacency of land-cover types (the values approaching one indicate a landscape with a clumped pattern of land cover types, while the values approaching zero –

when the pattern is dispersed) (Turner et al., 1996). The results are overlaid on top of soil quality, climate and topography data for additional spatio-temporal data analyses. We posit that the probabilities of transition are affected by climatic events such as hurricanes, policies such as the state's incentive programs to stimulate specific crops (NCDA&CS, 2019), and changing commodity prices.

Preliminary results

Based on the CDL, we find that fallow land occupied 448,000 ac, while vegetables – 55,000 ac per year on average over the 2008-19 for the state as whole, and the majority of land used to grow vegetables is on the state's coastal area (Figure 1).

Figure 1. North Carolina: Location of land used to grow vegetables at least once over the last six years. The within-state boundaries show the outlines of the eight Agricultural Statistical Districts (ASDs) (https://www.nass.usda.gov/Data_and_Statistics/County_Data_Files/Frequently_Asked_Questions/county_list.txt, accessed June 2021).

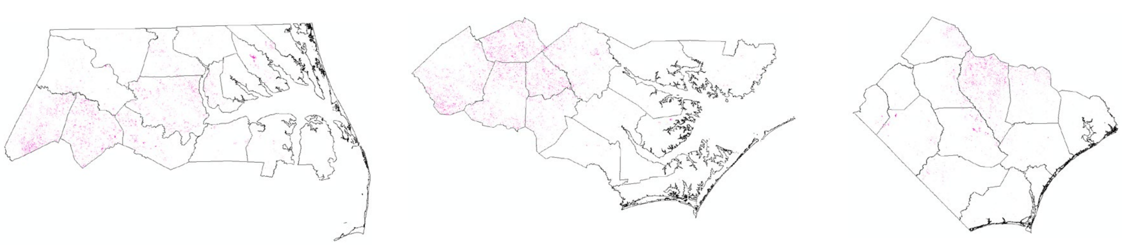


When the entire coastal area is considered, vegetable production is spread almost equally from the north to the south (Table 2 and Figure 2), and if land is used for vegetables, then only one to three years out of the last six years (Table 1).

Table 1. Pixel count for the land that has been used to grow vegetables at least once over last 6 years.

Years used for vegetables	ASD 70		ASD 80		ASD 90	
1	388,952	77%	442,289	73%	299,783	69%
2	97,929	19%	143,267	24%	102,480	24%
3	15,396	3%	19,750	3%	24,442	6%
4	1,837	0%	750	0%	6,094	1%
5	204	0%	44	0%	1,299	0%
6	15	0%	1	0%	86	0%
Total	504,333	100%	606,101	100%	434,184	100%

Figure 2. Location of land used to grow vegetables at least once over the last six years, coastal ASDs



Panel a): ASD 70 Panel b): ASD 80 Panel c): ASD 90

Although the three study counties are of approximately the same size, the largest acreage for vegetable production, 1,700 ac, is in Bladen county, with Guilford and Rutherford averaging less than 100 ac per year. Bladen county also showed the largest acreage fallowed, 12,000 ac, with estimated 8,000 ac and 1,000 ac in Guilford and Rutherford counties per year, respectively.

Markov chain estimation reveals that neither vegetable not fallow land use have a high probability of remaining in the same cover the following year: the probabilities of remaining in the same use range from 0.05 for vegetables in Guilford to 0.45 for fallow in Bladen. For all study areas the land in vegetables is most likely to be planted with non-vegetable crops in the subsequent year. These findings on the temporal patterns point to the need to explicitly consider crop rotations in the analysis.

Preliminary results on spatial patterns suggest that vegetables are mostly grown on the soils of high quality and that yearly vegetable production shows a dispersed pattern, while the parcels on which vegetables have been grown at least once over a six year time period – more clumped pattern.

Preliminary Conclusions

The study addresses an urgent need to understand the patterns of alternative uses of cropland in the physio-geographically diverse Southeastern U.S. The improved understanding of the spatial and temporal patterns of fallowing cropland and vegetable production are expected to contribute to more efficient regional policies aimed at stimulating specific crop production, including the policies targeting the alleviation of food desert problems.

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