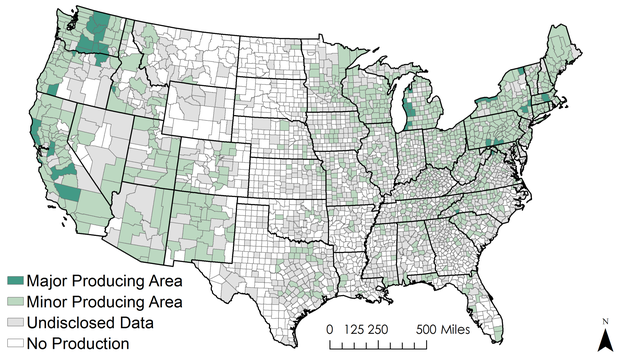
OPPORTUNITIES TO EXPAND APPLE AND PEAR PRODUCTION IN THE U.S.

INTRODUCTION

Fruits and vegetables (F&Vs) are key components of a healthy diet and Americans are consistently encouraged to eat more of these foods. While increased F&V consumption would have important health benefits for the population, the capacity to increase domestic production of these foods is not well documented. Most F&V crops require very specific growing conditions, which limits where they can be produced and total output. Additionally, the production of many F&Vs is currently concentrated in a few key regions of the country and it may not be possible to maintain or increase output from these areas due to natural resource constraints, climate change, and development pressures. This geographic concentration can also amplify the impacts of localized production disruptions, such as pest outbreaks or drought. Therefore, knowing *where* F&V production could occur is critical to understanding the capacity to meet future food needs, respond to changing conditions, and improve resiliency in the food system.

This project begins to address this knowledge gap by using suitability analysis to map land in the conterminous U.S. that is suitable for producing apples and pears based on biophysical factors. Additionally, the research explores the distribution of suitable land across regions and the proximity to current major production areas using zonal statistics. The suitability model developed here will be refined and expanded to other F&V crops as part of my dissertation research.

CURRENT PRODUCTION REGIONS



Major producing areas combined account for 75% of the total acreage. Major and minor producing areas combined account for 99% of total acreage. Counties will undisclosed data were not used in determining major and minor producing areas.

Tufts

METHODOLOGY

Suitability analysis was used to map land that is biophysically suitable for commercial production of apples and pears. The study area was the conterminous U.S. (Hawaii and Alaska were excluded due to data limitations). Land suitability was based on 10 key factors related to land cover and use, topography, soil properties, and climate. Crop growing requirements for each factor were used as the suitability criteria in the analysis. The suitability factors and growing requirements were identified through a literature review and are listed in Table 1 along with the spatial data source.

The spatial datasets were downloaded, re-projected, and processed to create a raster layer for each suitability factor at a 30m resolution. Then each raster was reclassified to represent suitable and unsuitable areas for an individual factor. Finally, the reclassified rasters were combined using raster calculator to identify and map suitable land. For this analysis, suitable land is defined as areas that meet all of the crop growing requirements. Suitable land was also mapped by county using zonal statistics.

The results of the suitability analysis were further analyzed to compare the location of suitable land to the location of current production in two ways. First, zonal statistics were used to estimate acres of suitable land within each U.S. region (based on NOAA Climate Regions). The distribution of suitable land across regions was compared to the distribution of current production (by acreage) across regions. Second, a multi-ring buffer was created around the current major producing counties at 25 mile increments. Then, zonal statistics were used to estimate the amount of suitable land that is located within those counties and within each buffer.

RESULTS & LIMITATIONS

The results of the suitability analysis indicate that a large amount of land is suitable for growing apples and pears – approximately 102.4 million acres. Thus, there is considerable capacity to increase domestic production given that there are currently less than 450,000 acres in production. However, a key limitation of this analysis is that it does not incorporate all relevant climate factors and is based on historical climate conditions. Tree crops can have a lifespan of 30+ years so considering the climate conditions expected in the near future is essential. Additionally, the data resolution for some factors may be too low to accurately represent the site. For example, the climate data may not capture microclimates within a site, an important factor in F&V production.

The results of the suitability and zonal analysis also indicate that there may be significant opportunities to geographically diversify production. There is suitable land in every region of the U.S. and it's more evenly distributed across the regions compared to current acreage. Additionally, only 35% of the suitable land was located within 200 miles of the current major production areas. This demonstrates that production could be expanded outside of these areas, which would minimize the impacts of highly localized production disruptions.

SUITABLE PRODUCTION AREAS

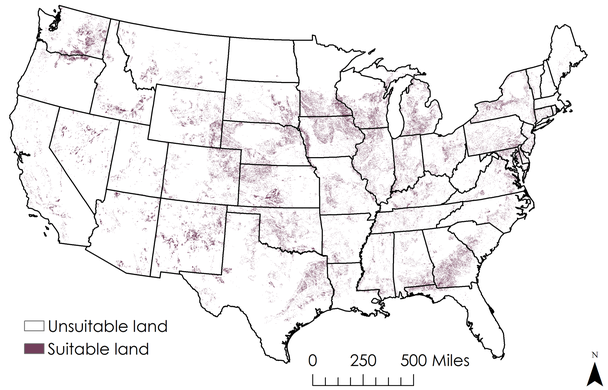


Table 2: Proximity of Suitable Land to Current Production Areas

Zone	Suitable Land	Share of U.S. Total
	(millions acres)	(%)
Major prod. counties	4.1	4.0
25 miles	9.5	9.3
50 miles	13.7	13.4
75 miles	17.9	17.5
100 miles	21.3	20.8
125 miles	24.4	23.8
150 miles	28.1	27.4
175 miles	31.7	31.0
200 miles	35.7	34.9
Total suitable land	102.4	100.0

Table 1: Suitability Criteria Used in the Analysis

Category	Suitability Factor	Crop Growing Requirement	Data Source
Soil Properties and Topography	Soil drainage class	Well drained, moderately well drained	USDA gSSURGO (2015)
	Soil depth to restrictive layer	90+ cm	USDA gSSURGO (2015)
	Soil pH	5.0 - 8.0	USDA gSSURGO (2015)
	Soil texture	Loam, sandy loam, silt loam, loamy sand	USDA gSSURGO (2015)
	Slope	2 - 12%	USDA gSSURGO (2015)
Climate	Annual frost free days	90 or more	USDA gSSURGO (2015)
	Minimum winter temperature	-25°F or higher	OSU PRISM (1981-2010)
	Annual accumulated chill hours	400 or more	MRCC (2017-2018)
Potential Agricultural Land	Current land cover class	Cultivated, grassland, forest, shrubland	USDA NLCD (2011)
	Protected/public land status	Excluded lands protected from cultivation and most public lands (i.e. National Parks)	USGS PAD-US (2015)

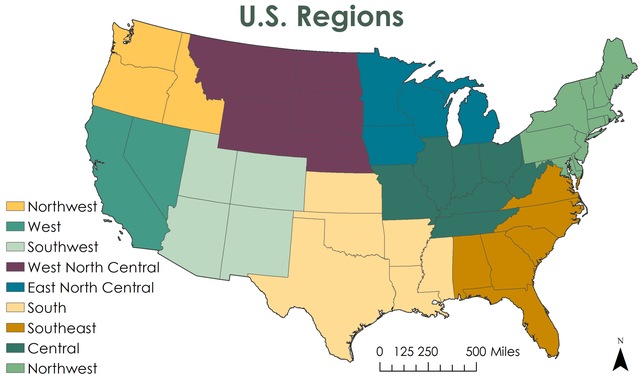
CONCLUSION & NEXT STEPS

Apples and pears are the most adaptable of the tree fruits grown in the U.S. in regards to climate and biophysical factors so it is not surprising that they are suited to most areas of the country. As the most popular fruit in the U.S., apples have been the target of many crop breeding efforts and this has resulted in varieties suited to a wide range of conditions. While the results of this project demonstrate opportunities to increase and geographically diversify production, there are economic and logistical barriers that need to be addressed through research, policy, and planning.

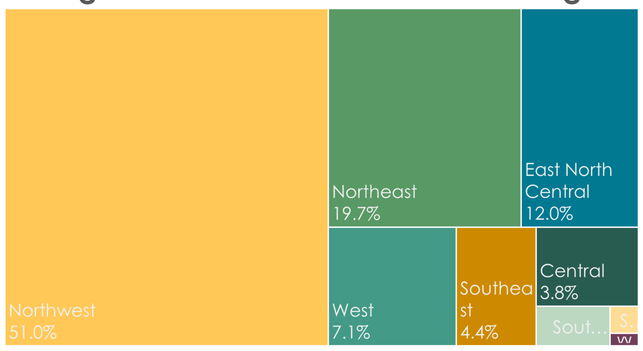
The next steps in this research include:

- Expanding the criteria used here to incorporate risk of adverse weather events that would discourage commercial production, such as wind and hail storms, late spring freezes, and extreme temperature fluctuation during the winter
- Incorporating indicators of economic suitability to identify areas where commercial production centers could be developed in the future
- Extending the analysis to other fruit crops and vegetables to provide a comprehensive assessment of the capacity to produce F&Vs domestically

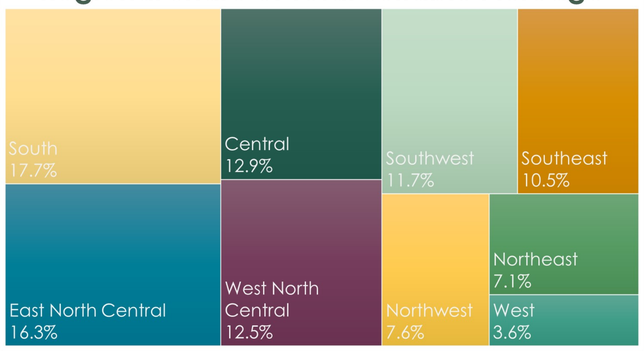
U.S. Regions



Regional Share of Total Current Acreage



Regional Share of Total Suitable Acreage



REFERENCES

Cartographer: Ashley C. McCarthy
Friedman School of Nutrition Science and Policy
Course: GIS 102 - Advanced Geographical Information Systems, Spring 2018

Map Date: May 8, 2018

Projection: Albers Equal Area Conic (USGS version)

Data Sources: US Census TIGER tracts; USDA NASS Census of Agriculture (2012); USDA NRCS National Land Cover Data (2011); USGS Protected Areas Database of the U.S. (2015); USDA NRCS Gridded Soil Survey Geographic database (2015); Oregon State University PRISM Climate Group (1981-2010); Midwestern Regional Climate Center, Accumulated Chilling Hours (2018)