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Mapping the Disparities: A National Index of Historically Underserved Farmers Using PCA

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Introduction

The USDA defines historically underserved (HU) farmers and ranchers as those who are beginning, socially disadvantaged (SDFRs), veterans, or limited resource. These categories reflect key socio-demographic and operational characteristics, such as less than 10 years of farming experience, racial/ethnic group membership, military service, or specific income and sales thresholds.

While significant financial and technical assistance is available to HU farmers, especially after the Inflation Reduction Act (IRA), **no comprehensive analysis exists of their geographic distribution beyond the state-level**. This gap hinders effective resource allocation and outreach. This study aims to construct a national county-level underserved farmer index (UFI) using principal component analysis (PCA) and data from the 2022 Census of Agriculture (COA), helping to address this gap and guide equitable policy development.

Data and Methods

The UFI utilizes data from the 2022 COA, which provides detailed information on farm operators across the U.S., including land use, operator demographics, and financial conditions (**Table 1**).

Variable Transformation and Index Construction

1. To ensure comparability, variables were standardized using Z-scores.
2. PCA was applied to reduce dimensionality and extract dominant patterns from the data.
3. PCA loadings were used to calculate normalized weights for each variable, creating a composite index representing underserved farming communities (**Figure 1**).
4. Counties were ranked based on index scores and standardized to a 0-1 scale.
5. Counties above the 90th percentile were classified as high-need, targeting areas for policy intervention and resource allocation.

Results and Future Work

The index has a mean value of 0.5, with **308 counties being marked as underserved**. These counties are predominantly located in the southern region of the United States, which could reflect historical and socio-economic disparities in access to resources, infrastructure, and services. This distribution highlights potential regional inequalities that may need targeted interventions for improvement.

In terms of justifying the use of PCA, **Figure 2** shows the correlation matrix for the variables used to construct the index. Moderate correlations among some variables indicate that they move together in a linear fashion. **Figure 3** shows sensitivity analysis results, which tested the robustness of the PCA model by excluding and modifying variables and examining the effects on the UFI index. The findings suggest that small changes did not significantly alter the distribution or interpretation of the UFI values, reinforcing the stability and reliability of the index.

For this project, future work includes:

- Creating a publicly accessible data repository and web map
- Refinement of HU categories
- Publication of methodology

Table 1. UFI Variables

Category	Variable	Description
Socio-Demographic	PCT_NONWHITE	Percent of non-white operations
	PCT_HISPANIC	Percent of Hispanic operations
	PCT_FEMALE	Percent of female operations
	PCT_MILITARY	Percent of operations with veterans status
	PCT_BELOW35	Percent of operations with producer(s) below the age of 35
Farm Operations	PCT_FARMYEAR11	Percent of operations with producer(s) with less than 11 years of farming experience
Financial Characteristics	PCT_OPLOSS	Percent of operations experiencing an operating loss
	BELOWAVG_NETCASH	Percent of operations with below state average net cash

Figure 1. PCA Normalized Loadings

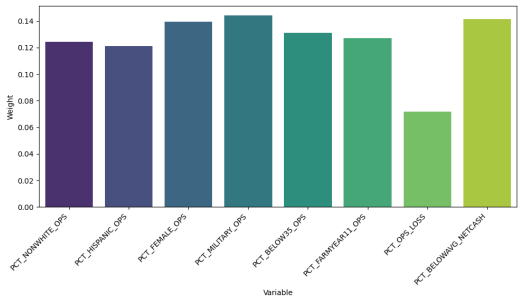

Figure 2. Correlation Matrix for UFI Variables

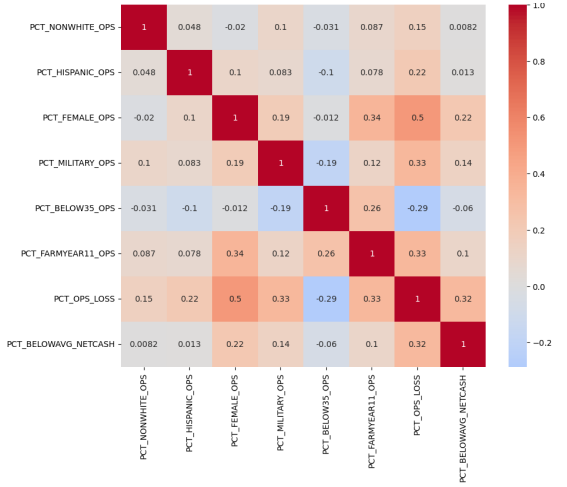

Figure 3. Sensitivity Analysis

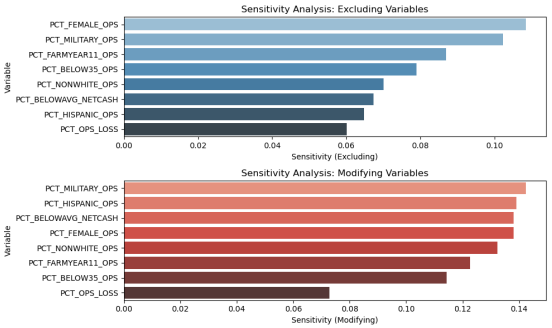

Figure 4. UFI Results