

STRUCTURAL, INDUSTRY, AND POLICY DETERMINANTS OF U.S. LIVESTOCK  
FARMS' REDUCED DEPENDENCE ON H-2A FOREIGN FARM WORKERS

by

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(Under the Direction of Cesar L. Escalante)

ABSTRACT

This thesis investigates the determinants of H-2A labor demand across U.S. agriculture, with a novel focus on livestock farms. While crop and nursery operations have rapidly adopted the H-2A program, livestock farms have shown limited participation. Using panel data from 2020 to 2023 across all 50 states, this research estimates sector-specific random effects models to explore structural, industry, and policy-related factors affecting H-2A labor intensity. Results reveal significant drivers in the crop sector such as crop composition, nursery wages, and national H-2A demand while livestock demand remains weakly associated with most variables, suggesting potential mismatches in program design and labor needs. Robustness checks, including time-fixed effects and pooled OLS comparisons, support the main findings. The study underscores the need for reforms like year-round H-2A eligibility under the Farm Workforce Modernization Act to enhance program utility for livestock farms and promote long-term labor sustainability in U.S. agriculture.

INDEX WORDS: H-2A labor, livestock farms, crop production, guest workers, labor policy,  
U.S. agriculture

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## DEDICATION

I would like to dedicate this thesis to my mother, Lily Islam, whose unwavering love, strength, and support have been my greatest source of inspiration throughout this journey.

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## CHAPTER 1

### INTRODUCTION

Agriculture is very important to ensure food security and economic prosperity across the globe. Agriculture is a key industry in the United States, contributing significantly to the economy. According to data from the Bureau of Economic Analysis, agriculture, food and related industries contributed roughly \$1.537 trillion to U.S. gross domestic product (GDP) in 2023, 5.5% of total GDP (USDA, 2024). According to USDA Economic Research Service in 2022, 22.1 million full- and part-time jobs were related to the agricultural and food sectors which is 10.4 percent of total U.S. employment. Unlike other industries, agriculture presents unique characteristics, including its reliance on land and biological factors, the seasonal demand for low-skilled labor and the influence of seasonality (Charlton & Castillo, 2021; Luckstead et al., 2021; Richards, 2018). Labor is a vital component of agricultural production, accounting for about 13% of input expenses across all farms in with specialty crop farms such as those producing fruits, vegetables, and nursery products facing the highest labor intensity, as labor expenses made up 39% of their total cash costs, according to data from the Agricultural Resource Management Survey (ARMS) (Economic Research Service 2020).

Many of the persons employed by U.S. agriculture lack the immigration status needed to work legally in the United States. The U.S. Department of Labor's National Agricultural Workers Survey (NAWS) estimates that about half of hired workers in U.S. crop agriculture are unauthorized, with the majority coming from Mexico (Carroll et al., 2011, Stegelin et al., 2011). Approximately three-quarters of hired workers in crop agriculture are immigrants, the majority

originating from Mexico, and around 60% lack legal authorization to work in the United States (Hernandez and Gabbard, 2018). Although agriculture depends heavily on labor inputs, the sector continues to struggle with sustaining an adequate labor supply for labor-intensive production (Hertz and Zahniser 2013; Richards 2018).

One of the primary challenges facing U.S. agriculture is the persistent reluctance of domestic workers to take on farm jobs. In the United States, statistics have shown that the domestic workforce has been moving away from agricultural employment. The USDA National Agricultural Statistical Service's Farm Labor Survey reported that, between 1950 and 2000, the number of family and self-employed farmworkers declined from 7.6 million to 2.06 million (Castillo et al., 2025). This trend is an example of important shifts within the agricultural profession. Despite competitive wages in some agricultural sectors, these jobs remain largely unattractive due to their physically demanding nature, seasonal instability, and lack of benefits such as health insurance and retirement plans (Emerson, 2007; Kandel, 2008; Escalante et al., 2011). Furthermore, agricultural work is often associated with harsh working conditions, including extreme weather exposure and labor-intensive tasks, which discourage local workers from pursuing employment in the sector (Luo & Escalante, 2017; Stegelin et al., 2011). Geographic and demographic factors also play a role, as many farm jobs are located in rural areas, while a majority of the workforce resides in urban and suburban regions, making relocation or commuting impractical.

To mitigate the worsening shortage of domestic farm labor, producers in labor-intensive agriculture have pursued several adaptive strategies. A key response has been the substitution of labor with capital by investing in mechanization. Although machines such as harvesters and sorters are commonly used in row crops, tree nuts, and processed fruit and vegetable industries, their broader adoption in many specialty crops remains constrained by both technological and economic

barriers (Calvin and Martin, 2010; Gallardo and Zilberman, 2016; Gallardo and Sauer, 2018). Alternatively, producers increasingly turn to the H-2A Agricultural Guest Worker Program, a nonimmigrant visa initiative that permits the employment of foreign laborers for seasonal agricultural work. As a result, the persistent domestic labor shortage has intensified reliance on foreign-born workers and legally sanctioned guest worker programs such as H-2A.

The demand for agricultural labor in the United States particularly within the framework of the H-2A Agricultural Guest Worker Program has long attracted considerable scholarly attention. The H-2 visa program, first established in 1952, evolved into the H-2A program in 1986 to alleviate seasonal labor shortages by permitting U.S. farmers to hire foreign workers on a temporary basis. Its roots trace back to World War II-era guest-worker arrangements that recruited laborers from the Caribbean under contracts resembling those of the U.S.–Mexico Bracero Program. The Immigration and Nationality Act (INA) of 1952 institutionalized this practice by formally recognizing the need for temporary agricultural workers and creating the H-2 visa category. Unlike earlier government-to-government labor accords, the H-2 framework transferred authority to individual U.S. employers, enabling them to directly recruit foreign workers from any country. Subsequently, the Immigration Reform and Control Act (IRCA) of 1986 divided the program into two streams: H-2A for agricultural and H-2B for non-agricultural employment, aiming to address unauthorized immigration while offering a regulated legal channel for seasonal farm labor. Figure 1 illustrates the trend in the number of H-2A workers certified from 2008 to 2023, highlighting a steady increase over time, with significant growth observed after 2012.

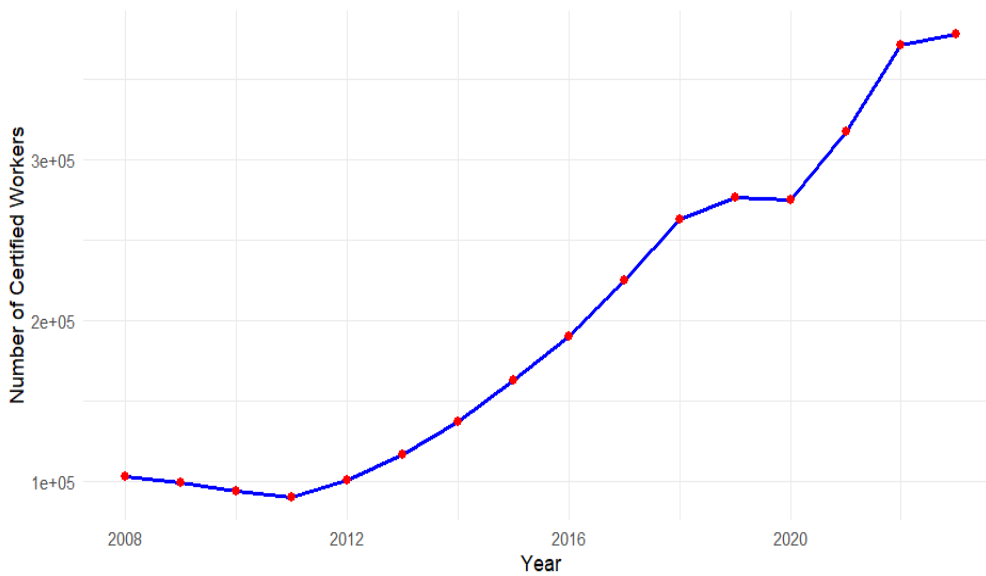


Figure 1: Growth of H-2A Certified Workers (2008-2023)

Source: U.S. Department of Labor

The U.S. farm sector has usually relied on foreign workers to fill in seasonal unskilled labor positions (Luo and Escalante, 2017; Escalante et al., 2011). Many entered the U.S. through guestworker programs such as the Bracero Program (1942–1964), the H-2 Visa Program (1953–1985), and the H-2A Temporary Agricultural Program (1986–present), while others arrived through authorized or unauthorized immigration. The availability of low-wage foreign labor has historically supported the expansion of U.S. production in labor-intensive crops, even as the domestic agricultural workforce continued to decline (Martin, 2003). In recent decades, however, tighter immigration policies have disrupted this labor supply, impacting approximately 12 million undocumented immigrants in the United States, of whom around 40 percent are employed in agriculture (Seid, 2006; Levine, 2004). Despite expectations that such restrictions might reduce unemployment among U.S. citizens, domestic workers have shown little inclination to fill agricultural positions. Even when farm employers increased wages or made concerted efforts to

recruit local labor, these attempts were largely unsuccessful (Escalante et al., 2016; Escalante et al., 2011).

The H-2A program, designed to mitigate seasonal labor shortages in agriculture, is predominantly used by fruit, vegetable, and nursery/greenhouse farms. Since 2005, the number of H-2A certifications has increased fivefold, and by 2019, H-2A workers filled about 10% of U.S. full-time equivalent jobs in crop agriculture (Costa and Martin, 2020). In contrast, livestock farms account for only 4-8% of all H-2A workers (Castillo et al., 2022). Figure 1 depicts the differences between the sectors in terms of total number of H-2A labor certified from 2019-2023.

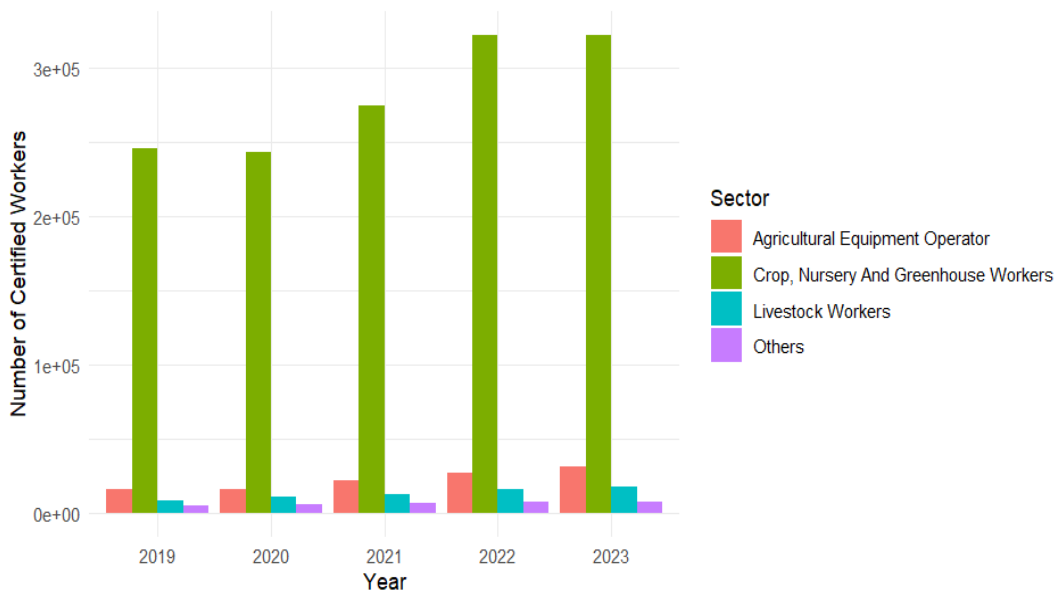


Figure 2: Total Number of H-2A Labor Certified by Sector (2019-2023)

Source: U.S. Department of Labor

This underutilization of H-2A labor in the livestock sector warrants an in-depth exploration of the factors (e.g., labor market dynamics, structural, economic, demographic, and behavioral conditions) that hinder broader adoption of the program by livestock farms.

Several structural challenges limit the adoption of the H-2A program in the livestock industry. One significant issue is the program's design, which is tailored for seasonal labor needs, while livestock operations typically require year-round labor. Existing H-2A regulations allow for initial employment or extension of employment for a maximum duration of one year. Therefore, farmers face the challenge of recruiting and training (often at a significant cost) new workers every year instead of retaining their workforce from year to year. Among livestock farms, this lack of farm labor continuity causes uncertainty and inefficiencies in farm management. This misalignment has deterred many livestock farmers from utilizing the program. Proposed amendments to the H-2A program under the Farm Workforce Modernization Act (FWMA), which include provisions for year-round visas and extending maximum work term (to 3 years) for H-2A visa holders, may address this limitation and encourage greater adoption of the program by livestock farms (Congressional Research Service, 2023). However, these legislative efforts only gained approval at the Congress but were always turned down in the Senate; thus, this bill has never progressed in the legislation process.

Economic factors, such as wage disparities between domestic and foreign labor, also influence the demand for H-2A workers. Livestock farms generally offer higher wages and better fringe benefits compared to crop and nursery farms, which may reduce their reliance on foreign labor. Additionally, the classification of livestock labor as skilled rather than unskilled further complicates demand dynamics. For example, evidence from the dairy sector suggests that farms offering training and skill development programs are better able to attract and retain domestic workers, thus reducing the need for H-2A labor.

Regional disparities significantly influence the demand for H-2A agricultural workers, with notable variations across different parts of the United States. Recent data indicates that the

Southern U.S. has emerged as the dominant region for H-2A labor, with demand increasing substantially in recent years. Between 2019 and 2021, the number of certified H-2A positions in the South surged by over 20%, with the region consistently accounting for approximately 43-45% of all certified positions nationwide (Escalante & Acharya, 2023). This growth has been largely driven by the labor-intensive fruit, vegetable, and horticulture industries, which heavily rely on H-2A workers to meet seasonal labor demands (Escalante & Acharya, 2023). Interestingly, the H-2A patronage rates in major livestock producing regions (such as the Midwest and the Plains) have been comparably lower than the South. Recently, the Southeast posted larger swings in H-2A patronage than other regions (Castillo et al., 2022; Gutierrez-Li, 2021). In the past several years, more than half of H-2A workers were hired in 5 states (California, Florida, Georgia, North Carolina, and Washington). These states now account for 52 percent of H-2A jobs, a significant jump from their 34 percent share in 2007 (Martin & Rutledge, 2022). To illustrate geographic variation in H-2A labor utilization, Figure 3 presents a choropleth map showing total certified H-2A positions across all 50 U.S. states in the year 2023.

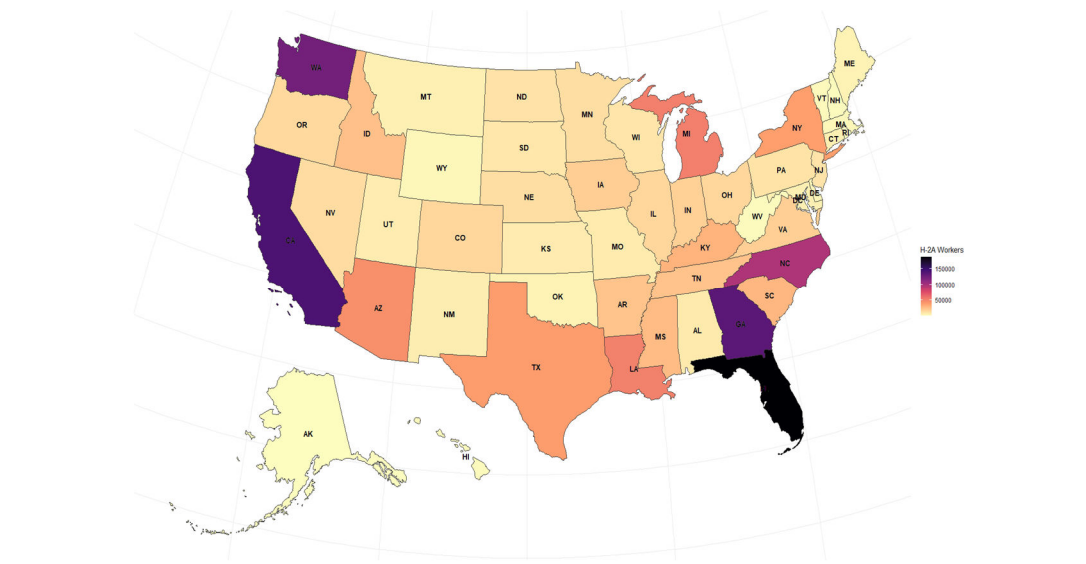


Figure 3: Total Number of H-2A Labor Certified in 2023 Across States

Source: U.S. Department of Labor

Behavioral factors, such as farmers' perceptions of foreign labor and the regulatory burdens associated with the H-2A program, also influence its adoption. Many farmers perceive the program's administrative requirements as burdensome, deterring them from participation. Furthermore, social attitudes toward immigrant labor and concerns about community integration may impact farmers' decisions to hire H-2A workers.

The sustainability of livestock farms is increasingly tied to their ability to secure a stable and skilled workforce. Domestic labor alone may not be sufficient to meet the growing demands of the livestock sector, making the role of H-2A workers critical in ensuring the long-term viability of these farms. While significant research has focused on the impact of the H-2A program on crop and nursery farms, there remains a gap in literature regarding its specific effects on the livestock sector. Most existing studies generalize findings across agricultural sectors, neglecting the unique structural and operational characteristics of livestock farming. This study aims to address this gap by offering a sector-specific analysis of H-2A labor demand in the livestock industry. It investigates the labor dynamics and sustainability of livestock farms, focusing on their demand for foreign labor and reliance on the H-2A Agricultural Guest Worker Program. This research evaluates whether proposed amendments under the Farm Workforce Modernization Act (FWMA), if eventually passed by the next U.S. administration, can enable more livestock and dairy farms to adopt the H-2A program. By analyzing labor market dynamics, structural constraints, and behavioral factors, the study also aims to determine whether historically low H-2A utilization in the livestock sector is primarily due to program design or external conditions such as year-round labor requirements and regional variations.

The purpose of this research is to understand if H-2A workers are a crucial input for farm sustainability or simply supplementary to domestic labor options. Specifically, the analysis will utilize national data on H-2A employment, wage and hired labor statistics at the sectoral and industry levels, and demographic, financial, and structural data collected by the U.S. Department of Agriculture. Analytical models will be designed to identify crucial determinants of livestock farms' demand for H-2A workers. The study's hypotheses revolve around the livestock farms' relative better worker remuneration arrangements (higher wages and perhaps availability of fringe benefits) and offering of training opportunities for workers and the subsequent re-classification of these workers' jobs from unskilled to skilled status. These could downplay the non-farm employment migration tendencies of local residents, hence, perhaps minimizing the livestock farms' demand for alternative workers hired through the H-2A program. It will also explore the potential implications of proposed policy changes under the FWMA.

In summary, while much has been written about the factors affecting H-2A labor demand in crop and nursery sectors, there is a clear need for more focused research on livestock farms. This study seeks to fill this gap and contribute to a better understanding of the challenges and opportunities presented by the H-2A program for the U.S. livestock industry.

## CHAPTER 2

### DATA AND METHODOLOGY

#### 2.1 Data Source

This study utilizes a panel dataset compiled at the U.S. state level, integrating information from three primary sources: (1) H-2A labor certification records from Department of Labor, (2) sectoral value of farm production (VFP) data from the United States Department of Agriculture (USDA), and (3) employment and wage statistics from the U.S. Bureau of Labor Statistics (BLS). The final dataset spans the years 2020 to 2023 and includes all 50 states.

##### (i) H-2A Disclosure Data

The primary source of labor certification data is the Department of Labor's H-2A Disclosure Dataset, which contains detailed records from 2008 onward. For this study, data were aggregated at the state-year level for the years 2020 through 2023. Each record includes information on the worksite location, job classification, and number of workers certified under the H-2A Temporary Agricultural Guest Worker Program.

To categorize certified workers by agricultural subsector, the following occupational classifications were used:

##### Livestock Workers:

- Farmworkers, farm, ranch, and aquaculture
- Meat, poultry, and fish cutters and trimmers

##### Crop, Nursery, and Greenhouse Workers:

- Farmworkers and laborers
- Farmworkers and laborers, crop

- Farmworkers and laborers, crop, nursery, and greenhouse
- Graders and sorters, agricultural products
- Packers and packagers, hand
- Pesticide handlers, sprayers, and applicators, vegetation
- Landscaping and groundskeeping workers

Agricultural Equipment Operators:

- Agricultural equipment operators
- Heavy and tractor-trailer truck drivers
- Logging equipment operators

Occupations that did not fall under these categories were grouped as “Others”. The number of certified H-2A workers in each category was then summed at the state level to calculate total certified labor by sector annually.

#### (ii) USDA Value of Farm Production (VFP) Tables

Data on the value of farm production was obtained from the USDA's Economic Research Service (ERS). These tables provide annual state-level estimates of agricultural output disaggregated by commodity group. Using these data, sectoral ratios such as the share of livestock, dairy, meat, crop, fruit, and vegetable production in overall agricultural output were constructed. These ratios serve as proxies for the economic composition of agricultural activity in each state.

#### (iii) Bureau of Labor Statistics (BLS) Employment and Wage Data

Annual average employment and weekly wage data were sourced from the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW). Employment statistics were categorized using the North American Industry Classification System (NAICS), allowing the identification of labor trends within specific agricultural subsectors (e.g., crop production: NAICS 111; animal production: NAICS 112).

To standardize across sectors, all BLS weekly wage data were converted into hourly wages by dividing by 40, representing a standard full-time work week. These wage measures are used to

compute relative wage comparisons, particularly between the Adverse Effect Wage Rate (AEWR) and wages in agricultural, goods-producing, and broader labor markets.

## 2.2 Dependent Variable

This study examines the determinants of H-2A labor demand in the United States agricultural sector, focusing on livestock and crop production. The dependent variables are constructed as ratios to reflect the intensity of certified H-2A labor use relative to average annual employment in each sector.

For the livestock labor equation, the dependent variable is defined as:

$$\frac{\textit{Certified Livestock H2A}}{\textit{NAICS 112 Annual Ave Employment}}$$

Where NAICS 112 corresponds to Animal Production and Aquaculture

For the crop labor equation, the dependent variable is:

$$\frac{\textit{Certified Crop H2A}}{\textit{NAICS 111 Annual Ave Employment}}$$

Where NAICS 111 corresponds to Crop Production.

These ratios are constructed using data from the U.S. Department of Labor (for H-2A certifications) and the U.S. Bureau of Labor Statistics (BLS) for employment figures. The purpose of these variables is to quantify each state's relative reliance on temporary foreign agricultural labor under the H-2A program.

## 2.3 Independent Variables

A range of independent variables are included in both the livestock and crop labor equations to examine sectoral characteristics, labor market dynamics, and macro-level influences on H-2A labor demand. These variables are grouped into five major categories: (1) Farm

Production Structure, (2) Employment Composition, (3) Relative Wages, (4) National H-2A Labor Demand, and (5) Regional Dummies.

(i) Farm Production Structure

These variables describe the composition of farm output within each state, emphasizing the relative importance of specific subsectors within livestock and crop production.

- Livestock Model:
  - $\text{Animal and Product Share} = \text{VFP (Animal and Products)} / \text{VFP (All)}$
  - $\text{Dairy Share} = \text{Cash Receipts (Dairy)} / \text{Cash Receipts (Animal Production)}$
  - $\text{Meat Share} = \text{Cash Receipts (Meat)} / \text{Cash Receipts (Animal Production)}$
- Crop Model:
  - $\text{Crop Share} = \text{VFP (Crop Production)} / \text{VFP (All)}$
  - $\text{Fruit and Nut Share} = \text{Cash Receipts (Fruits and Nuts)} / \text{Cash Receipts (All Crops)}$
  - $\text{Vegetable and Melon Share} = \text{Cash Receipts (Vegetables and Melons)} / \text{Cash Receipts (All Crops)}$

These variables provide insights into the economic specialization of agricultural production and its implications for labor demand.

(ii) Employment Composition

These variables are derived from BLS annual average employment data and reflect the distribution of employment across agricultural subsectors.

- Livestock Model:
  - $\text{Livestock Share in Ag Labor} = \text{NAICS 112} / \text{NAICS 11}$
  - $\text{Cattle Share in Livestock Labor} = \text{NAICS 11211} / \text{NAICS 112}$
  - $\text{Dairy Share in Livestock Labor} = \text{NAICS 11212} / \text{NAICS 112}$
  - $\text{Ag Share in Goods-Producing Labor} = \text{NAICS 11} / \text{GOODS 101}$
  - $\text{Ag Share in All Sectors} = \text{NAICS 11} / \text{ALL 10}$
- Crop Model:

- Crop Share in Ag Labor = NAICS 111 / NAICS 11
- Vegetable and Melon Share in Crop Labor = NAICS 1112 / NAICS 111
- Fruit and Tree Nut Share in Crop Labor = NAICS 1113 / NAICS 111
- Greenhouse and Nursery Share in Crop Labor = NAICS 1114 / NAICS 111
- Ag Share in Goods-Producing Labor = NAICS 11 / GOODS 101
- Ag Share in All Sectors = NAICS 11 / ALL 10

These indicators measure sectoral labor concentration, which may influence the likelihood of H-2A employment.

### (iii) Relative Wage Variables

Wage variables are constructed using the Adverse Effect Wage Rate (AEWR) and BLS sectoral wage data. Weekly wages from BLS are converted into hourly wages by dividing by 40, the standard number of working hours in a week. These ratios capture the cost competitiveness of hiring H-2A workers relative to alternative labor sources.

- Both Models:
  - AEWR / ALL 10 (Total Industries)
  - AEWR / GOODS 101 (Goods-Producing Sector)
  - AEWR / NAICS 11 (Agriculture)
- Livestock Model:
  - NAICS 112 / AEWR
  - NAICS 1121 / AEWR (Beef Cattle)
- Crop Model:
  - NAICS 111 / AEWR
  - NAICS 1112 / AEWR (Vegetables and Melons)
  - NAICS 1113 / AEWR (Fruits and Tree Nuts)
  - NAICS 1114 / AEWR (Greenhouse and Nursery)

These wage comparisons help identify economic incentives or barriers to hiring H-2A labor.

### (iv) National H-2A Labor Demand

This variable accounts for macro-level demand for H-2A workers across all agricultural sectors:

$$\text{National H2A Labor Demand} = \frac{\text{ALL CERTIFIED H2A}}{\text{NAICS 11 Annual Ave Employment}}$$

This controls for broader national trends in H-2A program participation and potential crowding or diffusion effects across states.

#### (v) Regional Dummy Variables

To account for geographical heterogeneity in climate, crop suitability, labor availability, and policy environment, the model includes fixed effects for five regions based on U.S. Census groupings:

- Atlantic Region: North Carolina, Virginia, West Virginia, Maryland, Connecticut, Massachusetts, New York, Vermont, New Hampshire, Maine, New Jersey, Rhode Island, Delaware
- Midwest Region: Minnesota, Iowa, Wisconsin, Illinois, Missouri, Indiana, Ohio, Pennsylvania, Michigan
- Plains Region: Nebraska, Kansas, Texas, North Dakota, South Dakota, Oklahoma
- West Region: California, Washington, Oregon, Idaho, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Alaska, Hawaii
- South Region: Arkansas, Florida, Georgia, Louisiana, Mississippi, Alabama, Tennessee, South Carolina, Kentucky

Dummy variables were created for each region, with the South Region serving as the reference (base) category. Consequently, estimated coefficients for the other regions represent their differential effect on H-2A labor intensity relative to the South. Including these regional dummies controls for unobserved region-specific effects that may systematically influence H-2A labor utilization across states.

**Table 1: Variable Description for Estimating Equations<sup>1</sup>**

Variable Types	Variable	Definition / Formula	Data Source	Model(s) Used
Dependent Variable (Livestock)	Livestock_H2A_Intensity	Certified Livestock H-2A / NAICS 112 Employment	DOL, BLS	Livestock
Dependent Variable (Crop)	Crop_H2A_Intensity	Certified Crop H-2A / NAICS 111 Employment	DOL, BLS	Crop
VFP (value of farm production) VARIABLE S	Animal_Product_Share	VFP (Animal and Products) / VFP (All)	USDA ERS	Livestock
	Dairy_Share	Cash Receipts (Dairy) / Cash Receipts (Animal Production)	USDA ERS	Livestock
	Meat_Share	Cash Receipts (Meat) / Cash Receipts (Animal Production)	USDA ERS	Livestock
	Crop_Share	VFP (Crop Production) / VFP (All)	USDA ERS	Crop
	Fruit_Nut_Share	Cash Receipts (Fruits and Nuts) / Cash Receipts (All Crops)	USDA ERS	Crop
	Vegetable_Melon_Share	Cash Receipts (Vegetables and Melon) / Cash Receipts (All Crops)	USDA ERS	Crop
EMPLOYMENT VARIABLE S	Livestock_Labor_Share	NAICS 112 / NAICS 11	BLS	Livestock
	Cattle_Labor_Share	NAICS 11211 / NAICS 112	BLS	Livestock
	Dairy_Labor_Share	NAICS 11212 / NAICS 112	BLS	Livestock
	Crop_Labor_Share	NAICS 111 / NAICS 11	BLS	Crop
	Veg_Melon_Labor_Share	NAICS 1112 / NAICS 111	BLS	Crop
	Fruit_Tree_Labor_Share	NAICS 1113 / NAICS 111	BLS	Crop
	Nursery_Labor_Share	NAICS 1114 / NAICS 111	BLS	Crop
	Ag_Goods_Share	NAICS 11 / GOODS 101	BLS	Both
	Ag_Total_Share	NAICS 11 / ALL 10	BLS	Both
Wage Variables	AEWR_All_Sectors	AEWR / ALL 10	DOL, BLS	Both
	AEWR_Goods_Sectors	AEWR / GOODS 101	DOL, BLS	Both
	AEWR_Ag_Sector	AEWR / NAICS 11	DOL, BLS	Both
	Livestock_Wage_Relative	NAICS 112 / AEWR	BLS	Livestock
	Cattle_Wage_Relative	NAICS 1121 / AEWR	BLS	Livestock
	Crop_Wage_Relative	NAICS 111 / AEWR	BLS	Crop
	Vegetable_Wage_Relative	NAICS 1112 / AEWR	BLS	Crop
	Fruit_Wage_Relative	NAICS 1113 / AEWR	BLS	Crop
	Nursery_Wage_Relative	NAICS 1114 / AEWR	BLS	C
	National_H2A_Demand	All Certified H-2A / NAICS 11 Employment	DOL, BLS	Both
	Regional_Dummies	Atlantic, Midwest, Plains, West, South	Author-defined	Both

<sup>1</sup> NAICS Code Key

NAICS 11: Agriculture, Forestry, Fishing and Hunting, NAICS 111: Crop Production, NAICS 1112: Vegetables and Melon Farming, NAICS 1113: Fruit and Tree Nut Farming, NAICS 1114: Greenhouse, Nursery, and Floriculture Production, NAICS 112: Animal Production and Aquaculture, NAICS 11211: Beef Cattle Ranching and Farming, NAICS 11212: Dairy Cattle and Milk Production, GOODS 101: Goods-Producing Industries, ALL 10: All Private Sector Industries

## 2.4 Statistical Analysis

To empirically examine the determinants of H-2A labor demand in U.S. agriculture, we employ a state-level panel regression framework using annual data from 2020 to 2023. Given structural and policy differences across production systems, separate models are specified for the livestock and crop sectors.

### 2.4.1 Model Structure

The dependent variable in each model is defined as the ratio of certified H-2A workers in a given sector (livestock or crop) to the sector's total annual average employment, capturing state-level H-2A labor intensity. Explanatory variables include sector-specific production structure, employment composition, relative wage indicators, a national H-2A demand control, and region-specific dummy variables. The general model takes the form:

$$H2A\_Intensity_{it} = \alpha + \beta X_{it} + \gamma R_i + \varepsilon_{it}$$

Where  $H2A\_Intensity_{it}$  represents livestock or crop H-2A intensity in state  $i$  and year  $t$ ,  $X_{it}$  is a vector of covariates,  $R_i$  denotes regional dummies based on U.S. Census groupings, and  $\varepsilon_{it}$  is the error term.

### 2.4.2 Estimation Approach

Model selection was guided by the Hausman specification test. In both the livestock and crop models, the test failed to reject the null hypothesis, suggesting no significant correlation between the unobserved heterogeneity and the explanatory variables. Consequently, the random effects (RE) specification was deemed appropriate for both models. Estimation was carried out using the Generalized Least Squares (GLS) method through a random effects specification, which accounts for unobserved heterogeneity across states. To address heteroskedasticity and within-panel serial correlation, cluster-robust standard errors were applied.

### **2.4.3 Robustness and Alternative Specifications**

To validate the chosen random effects specifications for both the crop and livestock models, several additional estimations were conducted. A Breusch-Pagan Lagrange Multiplier test was performed for the livestock equation to formally assess whether the random effects model was statistically preferred over a pooled OLS specification. In addition, time fixed effects extensions were estimated for both the crop and livestock equations by including year dummies to capture unobserved temporal shocks, such as nationwide policy changes or macroeconomic disruptions that might influence H-2A labor demand across all states. Furthermore, pooled OLS models were estimated for both equations to assess the sensitivity of coefficient estimates and to provide comparative baselines. This approach enabled the evaluation of how coefficient magnitudes and significance levels changed when unobserved heterogeneity across states was ignored. Collectively, these alternative specifications serve to test the robustness of the main random effects models and ensure that the core findings are not driven by model-specific assumptions or the omission of relevant fixed effects.

### **2.4.4 Diagnostic Tests and Post-Estimation Procedures**

Several diagnostic procedures were employed to validate model assumptions and ensure the reliability of inference. Multicollinearity was assessed using Variance Inflation Factors (VIF), with particular attention paid to identifying variables exhibiting high collinearity for potential revision. Residual diagnostics, including histograms and Q-Q plots, were generated to evaluate the distributional assumptions of the error term and detect signs of skewness or kurtosis. Additionally, predicted versus actual value plots were constructed to assess model fit visually. All estimations

and diagnostics were conducted using the RStudio statistical computing environment, employing relevant panel data and econometrics packages.

## CHAPTER 3

### RESULTS

This section presents the empirical results of the panel data analysis evaluating the determinants of H-2A labor demand across U.S. states in the livestock and crop sectors.

#### 3.1 Descriptive Statistics

Table 2 presents the summary statistics for all variables used in estimating the crop sector model, including the certified H-2A labor intensity and various structural, employment, and wage-related indicators across U.S. states from 2019 to 2023.

The dependent variable, `Crop_H2A_Intensity` exhibits substantial variation (mean = 0.641; SD = 0.758), with some states displaying no certified H-2A usage and others reaching intensities above 4.1, reflecting uneven seasonal labor reliance.

Structural crop production indicators show notable diversity. `Crop_Share`, the value of crop production relative to total farm output has a mean of 0.43, indicating its significant contribution in many states. Within crop production, `Fruit_Nut_Share` (mean = 0.056) and `Vegetable_Melon_Share` (mean = 0.067) capture the specialization in higher-value crops. Their relatively high standard deviations suggest regional heterogeneity in production patterns.

Employment allocation variables are constructed using employment ratios from BLS NAICS classifications. `Crop_Labor_Share`, the share of crop employment in total agricultural employment (NAICS 111 / NAICS 11), averages 42.9%. Sub-sectoral employment shares such as `Veg_Melon_Labor_Share`, `Fruit_Tree_Labor_Share`, and `Nursery_Labor_Share` reflect the varying degrees of labor dependency across different horticultural activities. For instance,

Nursery\_Labor\_Share shows a relatively high mean of 0.372 and a wide range (0 to 0.899), confirming its high labor demand in certain states.

Broader structural variables such as Ag\_Goods\_Share and Ag\_Total\_Share indicate the share of agriculture in the goods-producing sector (NAICS 11 / GOODS 101) and in the overall economy (NAICS 11 / ALL 10), respectively. Though agriculture typically occupies a small portion of state economies, these shares vary depending on the regional economic base.

Wage competitiveness is captured through multiple relative wage ratios. Crop\_Wage\_Relative the ratio of crop sector wages to the Adverse Effect Wage Rate (AEWR) has a mean of 1.307, suggesting that crop wages are, on average, 30.7% higher than the AEWR. Other sector-specific wage variables such as Vegetable\_Wage\_Relative and Fruit\_Wage\_Relative illustrate sectoral wage differences, with Fruit\_Wage\_Relative having the lowest mean (0.843), potentially explaining the higher H-2A demand in fruit sectors.

The AEWR is also expressed relative to various economic sectors: AEWR\_All\_Sectors (mean = 0.49), AEWR\_Goods\_Sectors (mean = 0.432), and AEWR\_Ag\_Sector (mean = 0.686), showing how the AEWR compares to average earnings across different labor market segments.

Lastly, National\_H2A\_Demand, defined as the ratio of total certified H-2A workers to national agricultural employment (NAICS 11), serves as a proxy for nationwide H-2A market pressure. With a mean of 0.342 and maximum of 1.642, it captures significant variation in federal H-2A labor usage that may influence state-level decisions.

Table 3 presents descriptive statistics for the variables used in the crop sector model. The table includes the mean, standard deviation, minimum, and maximum values for each variable.

**Table 2: Descriptive Statistics for Crop Model**

Variable	Mean	Std. Dev.	Min	Max
Crop H2A Intensity	0.641	0.758	0.0	4.112
Crop Share	0.43	0.165	0.139	0.825
Fruit Nut Share	0.056	0.107	0.0	0.558
Vegetable Melon Share	0.067	0.111	0.0	0.501
Crop Labor Share	0.429	0.16	0.0	0.721
Veg Melon Labor Share	0.146	0.1	0.002	0.455
Fruit Tree Labor Share	0.114	0.136	0.0	0.612
Nursery Labor Share	0.372	0.201	0.0	0.899
Ag_Goods_Share	0.053	0.042	0.0	0.296
Ag Total Share	0.01	0.009	0.002	0.051
AEWR All Sectors	0.49	0.1	0.0	0.638
AEWR Goods Sectors	0.432	0.085	0.0	0.597
AEWR Ag Sector	0.686	0.14	0.0	0.931
Crop Wage Relative	1.307	0.206	0.0	1.879
Vegetable wage Relative	1.132	0.396	0.0	2.254
Fruit Wage Relative	0.843	0.439	0.0	1.667
Nursery Wage Relative	1.273	0.319	0.0	2.062
National H2A Demand	0.342	0.327	0.004	1.642

Table 3 reports the descriptive statistics for variables included in the livestock sector model, capturing cross-state variation in certified H-2A labor usage and structural characteristics of the livestock industry from 2019 to 2023.

**Table 3: Descriptive Statistics for Livestock Model**

Variable	Mean	Std. Dev.	Min	Max
Livestock H2A Intensity	0.157	0.637	0.0	5.054
Animal Product Share	0.42	0.168	0.079	0.737
Dairy Share	0.226	0.23	0.001	0.838
Meat Share	0.382	0.283	0.006	0.946
Livestock Labor Share	0.303	0.166	0.027	0.707
Cattle Labor Share	0.178	0.192	0.0	0.874
Dairy Labor Share	0.289	0.251	0.0	0.899
Ag Goods Share	0.053	0.042	0.0	0.296
Ag Total Share	0.01	0.009	0.002	0.051
AEWR All Sectors	0.49	0.1	0.0	0.638
AEWR Goods Sectors	0.432	0.085	0.0	0.597
AEWR Ag Sector	0.686	0.14	0.0	0.931

Livestock Wage Relative	1.472	0.407	0.0	3.841
Cattle Wage Relative	1.274	0.257	0.0	1.749
National H2A Demand	0.342	0.327	0.004	1.642

The dependent variable, `Livestock_H2A_Intensity`, is measured as the ratio of certified H-2A livestock workers to total employment in the NAICS 112 livestock sector. On average, H-2A intensity in livestock production is notably lower than in crop production, with a mean of 0.157. However, the wide standard deviation (0.637) and maximum value (5.054) suggest that some states have substantial H-2A reliance, while others report no usage.

Sectoral composition is represented by variables derived from the value of farm production and cash receipts. `Animal_Product_Share`, the share of total farm output attributable to animal and animal product production has a mean of 0.42, indicating that livestock is a dominant component in many states. Within animal production, `Dairy_Share` (mean = 0.226) and `Meat_Share` (mean = 0.382) reflect the relative importance of dairy and meat products, with high variability across regions. Some states are heavily specialized, as shown by maximum shares exceeding 0.8 for dairy and 0.9 for meat.

Employment variables constructed from BLS NAICS data provide insight into labor distribution within the agricultural sector. `Livestock_Labor_Share`, defined as NAICS 112 employment over total agricultural employment (NAICS 11), averages 30.3%. Sub-sector measures such as `Cattle_Labor_Share` and `Dairy_Labor_Share` show diverse employment patterns, with some states exhibiting significant cattle or dairy-specific labor intensity.

Structural labor market indicators `Ag_Goods_Share` and `Ag_Total_Share` are included to contextualize the role of agriculture in the broader economy. As in the crop model, agriculture typically contributes modestly to state employment, with `Ag_Total_Share` averaging just 1%.

Relative wage metrics offer a picture of competitiveness in the livestock labor market. The `Livestock_Wage_Relative`, calculated as the ratio of wages in the NAICS 112 sector to the AEW, has a mean of 1.472, suggesting that wages in livestock often exceed the prevailing H-2A wage threshold. `Cattle_Wage_Relative` is somewhat lower (mean = 1.274), but still consistently above 1 in most cases. These ratios indicate that many livestock employers pay above the federally mandated AEW, which may reduce their incentive to hire H-2A workers.

The AEW itself is included in three relative forms: `AEW_All_Sectors`, `AEW_Goods_Sectors`, and `AEW_Ag_Sector` to control for the variation in wage floors across different segments of the economy. The AEW relative to agriculture (`AEW_Ag_Sector`) shows the highest average at 0.686, underscoring its stronger influence within agricultural labor markets.

Finally, `National_H2A_Demand`, a macro-level control defined as total certified H-2A workers over national agricultural employment, has a mean of 0.342. This variable reflects the broader labor market environment in which state-level H-2A hiring decisions are made and captures annual changes in nationwide demand pressures.

### 3.2 Model Selection and Specification Tests

#### 3.2.1 Hausman Test (Fixed vs. Random Effects)

**Table 4: Hausman Test Result**

Equation	Chi-Square ( $\chi^2$ )	Degrees of Freedom (df)	P-Value	Null Hypothesis ( $H_0$ )	Alternative Hypothesis ( $H_1$ )	Decision	Conclusion
Crop Equation	16.826	17	0.4662	Random-effects model is appropriate; provides consistent and efficient estimates.	Random-effects model is inconsistent; fixed-effects model should be used.	Fail to reject $H_0$	Random-effects model preferred
Livestock Equation	13.547	14	0.4839	Random-effects model is consistent and appropriate.	Random-effects model is inconsistent; fixed-effects model is more appropriate.	Fail to reject $H_0$	Random-effects model preferred

#### 3.2.2 Diagnostic Tests for Heteroskedasticity and Serial Correlation

**Table 5: Diagnostic Tests for Heteroskedasticity and Serial Correlation**

Model	Test Type	Chi-sq / BP Value	Degrees of Freedom	p-value	Conclusion
Crop	Breusch-Pagan (Heteroskedasticity)	121.9	21	3.19e-16	Heteroskedasticity detected
Crop	Breusch-Godfrey (Serial Correlation)	14.272	4	0.0065	Serial correlation detected
Livestock	Breusch-Pagan (Heteroskedasticity)	104.84	18	2.85e-14	Heteroskedasticity detected
Livestock	Breusch-Godfrey (Serial Correlation)	42.519	4	1.30e-08	Serial correlation detected

### 3.3 Main Regression Results

#### Crop Equation

Table 6 presents the regression estimates for the crop sector model, analyzing the determinants of certified H-2A labor intensity across U.S. states. The model performs well statistically, explaining a significant portion of the variance in H-2A intensity, as indicated by an R-squared value of 0.6846 and an adjusted R-squared of 0.6474. The F-statistic of 386.31 confirms the overall significance of the model.

The coefficient on `Crop_Share` is  $-0.5416$  and statistically significant at the 1% level. `Nursery_Labor_Share` also shows a statistically significant negative effect with a coefficient of  $-0.5219$  ( $p < 0.05$ ). Among the wage-related variables, `Vegetable_Wage_Relative` is positively associated with H-2A labor intensity and is highly significant (coefficient =  $0.1221$ ,  $p < 0.001$ ). `Nursery_Wage_Relative` is also positively signed and significant at the 5% level (coefficient =  $0.1278$ ).

`National_H2A_Demand` has a coefficient of  $1.4674$  and is statistically significant at the 1% level, indicating a strong association with certified H-2A usage in the crop sector.

Among the regional variables, `REGIONPL` (Plains region) exhibits a significant negative association ( $-0.6603$ ,  $p < 0.05$ ).

Several variables show marginal statistical significance, including Fruit\_Nut\_Share ( $-0.4973$ ,  $p \approx 0.06$ ), Crop\_Wage\_Relative ( $-0.2114$ ,  $p \approx 0.05$ ), Fruit\_Wage\_Relative ( $0.1942$ ,  $p \approx 0.07$ ) and REGIONW ( $-0.4394$ ,  $p \approx 0.10$ ).

Other variables such as Vegetable\_Melon\_Share, Crop\_Labor\_Share, Veg\_Melon\_Labor\_Share, Fruit\_Tree\_Labor\_Share, Ag\_Goods\_Share, Ag\_Total\_Share, AEWL\_All\_Sectors, AEWL\_Goods\_Sectors, AEWL\_Ag\_Sector, and the remaining regional dummies do not exhibit statistical significance at conventional levels.

**Table 6: Crop Model Results (Cluster-Robust Standard Errors)**

Variable	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	1.0247	0.4995	2.0515	0.0417**
Crop_Share	-0.5416	0.1822	-2.9727	0.0034 ***
Fruit_Nut_Share	-0.4973	0.2607	-1.9078	0.0580 *
Vegetable_Melon_Share	-0.0727	0.3196	-0.2275	0.8203
Crop_Labor_Share	-0.1002	0.0690	-1.4516	0.1484
Veg_Melon_Labor_Share	-0.2828	0.3606	-0.7842	0.4339
Fruit_Tree_Labor_Share	0.2774	0.3529	0.7859	0.4330
Nursery_Labor_Share	-0.5219	0.2507	-2.0814	0.0388 **
Ag_Goods_Share	-0.0526	0.8611	-0.0610	0.9514
Ag_Total_Share	0.8948	5.5992	0.1598	0.8732
AEWL_All_Sectors	-1.0817	0.7893	-1.3706	0.1722
AEWL_Goods_Sectors	0.8689	0.9558	0.9091	0.3645
AEWL_Ag_Sector	-0.0696	0.0725	-0.9599	0.3384
Crop_Wage_Relative	-0.2114	0.1089	-1.9413	0.0538 *
Vegetable_wage_Relative	0.1221	0.0326	3.7508	0.0002 ***
Fruit_Wage_Relative	0.1942	0.1074	1.8074	0.0724 *
Nursery_Wage_Relative	0.1278	0.0635	2.0143	0.0455 **
National_H2A_Demand	1.4674	0.3940	3.7240	0.0003 ***
REGIONATL	-0.4048	0.2484	-1.6296	0.1050
REGIONMW	-0.3665	0.2521	-1.4539	0.1477
REGIONPL	-0.6603	0.2844	-2.3219	0.0214**
REGIONW	-0.4394	0.2601	-1.6894	0.0929*

Model Summary:

Total Sum of Squares: 114.2049, Residual Sum of Squares: 1.366

R-Squared: 0.6846, Adjusted R-Squared: 0.6474, F-statistic: 386.3124

### **Livestock Equation**

Table 7 presents the regression results for the livestock sector model, which examines the determinants of certified H-2A labor intensity across U.S. states. The model includes 14 explanatory variables and 4 regional dummies. The R-squared value is 0.3655 and the adjusted R-squared is 0.3024, indicating moderate explanatory power. The model's F-statistic of 104.28 confirms its overall statistical significance.

Most explanatory variables in the model do not exhibit statistically significant relationships with livestock H-2A labor intensity at conventional levels. Among the structural variables, `AEWR_All_Sectors`, is marginally significant at the 10% level, with a positive coefficient of 2.3613 ( $p \approx 0.05$ ). `AEWR_Goods_Sectors`, has a negative coefficient of  $-3.5136$  and is also marginally significant ( $p \approx 0.07$ ).

The variable `National_H2A_Demand`, which reflects the national ratio of certified H-2A workers to total agricultural employment (NAICS 11), has a positive coefficient of 1.0545, though it is not statistically significant at the 10% level ( $p = 0.1148$ ). None of the sectoral composition variables `Animal_Product_Share`, `Dairy_Share` or `Meat_Share` nor the employment-related variables `Livestock_Labor_Share`, `Cattle_Labor_Share`, or `Dairy_Labor_Share` show significant effects on livestock H-2A intensity.

Likewise, labor structure indicators such as `Ag_Goods_Share`, `Ag_Total_Share` do not exhibit statistically meaningful relationships. Measures of sub-sector specialization within

livestock, including Livestock\_Wage\_Relative and Cattle\_Wage\_Relative, also yield insignificant coefficients. Regional dummy variables do not show significant associations with H-2A labor intensity in the livestock sector either.

In summary, while the livestock model is statistically valid overall, few individual predictors reach conventional significance levels. The marginal significance of AEWL\_All\_Sectors and AEWL\_Goods\_Sectors suggests that broader structural employment conditions may play a modest role in shaping H-2A labor usage in the livestock sector, but further evidence is needed to confirm these effects.

**Table 7: Livestock Model Results (Cluster-Robust Standard Errors)**

Variable	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	0.7627	0.6946	1.0979	0.2737
Animal Product Share	-0.6700	0.5373	-1.2469	0.2140
Dairy Share	0.1743	0.3291	0.5297	0.5970
Meat Share	0.0795	0.1238	0.6425	0.5214
Livestock Labor Share	0.2949	0.4668	0.6317	0.5284
Cattle Labor Share	-0.4531	0.6709	-0.6754	0.5003
Dairy Labor Share	-0.4556	0.4145	-1.0991	0.2732
Ag Goods Share	-0.9497	1.1585	-0.8197	0.4135
Ag Total Share	7.8989	6.3001	1.2538	0.2115
AEWL All Sectors	2.3613	1.2033	1.9623	0.0513 *
AEWL Goods Sectors	-3.5136	1.9032	-1.8462	0.0665 *
AEWL Ag Sector	0.0316	0.0600	0.5269	0.5989
Livestock Wage Relative	-0.0155	0.0426	-0.3639	0.7164
Cattle Wage Relative	-0.3005	0.3026	-0.9933	0.3219
National H2A Demand	1.0545	0.6656	1.5844	0.1148
REGIONATL	0.0383	0.1996	0.1918	0.8481
REGIONMW	-0.0109	0.2070	-0.0529	0.9579
REGIONPL	0.2853	0.3052	0.9348	0.3511
REGIONW	0.1524	0.3094	0.4926	0.6229

#### Model Summary

Total Sum of Squares: 80.8076, Residual Sum of Squares: 1.8311

R-Squared: 0.3655, Adjusted R-Squared: 0.3024, F-statistic: 104.2813

### 3.4 Robustness Checks

To ensure the robustness of the main random effects results, several additional estimations were conducted. First, the Breusch-Pagan Lagrange Multiplier test was used for the crop model and livestock model to assess the necessity of a panel structure, comparing the random effects model to pooled OLS. Second, pooled OLS regressions were estimated for both crop and livestock equations to examine whether coefficient magnitudes and significance levels differed under an unstructured framework. Third, time fixed effects were introduced in both models by including year dummies, capturing unobserved national shocks potentially influencing H-2A labor demand. Collectively, these checks help confirm the stability and consistency of the findings.

#### 3.4.1 Breusch-Pagan Lagrange Multiplier (LM) test

The Breusch-Pagan Lagrange Multiplier tests were conducted to determine whether random effects specifications were statistically warranted over pooled OLS models for both the crop and livestock equations.

Null Hypothesis ( $H_0$ ): Variance across panels (states) is zero: pooled OLS is sufficient.

Alternative Hypothesis ( $H_1$ ): Variance across panels is significant: random effects model is preferred.

**Table 8: Breusch-Pagan Lagrange Multiplier test result**

Model	Chi-squared ( $\chi^2$ )	Degrees of Freedom	p-value	Decision
Livestock	250.70	1	< 2.2e-16	Reject $H_0$ , RE preferred over Pooled OLS
Crop	196.19	1	< 2.2e-16	Reject $H_0$ , RE preferred over Pooled OLS

For the livestock model, the test yielded a chi-squared statistic of 250.70 ( $df = 1, p < 0.0001$ ), while the crop model resulted in a chi-squared statistic of 196.19 ( $df = 1, p < 0.0001$ ). In both cases, the null hypothesis of no significant panel-level variance was strongly rejected. These results confirm the presence of meaningful unobserved heterogeneity across states and support the use of random effects models for both equations.

### 3.4.2 Pooled OLS Comparison

Pooled Ordinary Least Squares (OLS) regressions were estimated for both the crop and livestock sector models to serve as comparative baselines. These models treat the panel data as a simple cross-section and do not account for unobserved heterogeneity across states or over time. The crop model exhibits high explanatory power with an R-squared of 0.866 and an adjusted R-squared of 0.850, while the livestock model explains approximately 51.4% of the variation in H-2A labor intensity, with an adjusted R-squared of 0.466. Both models are statistically significant overall, as indicated by F-statistics of 54.77 (crop) and 10.64 (livestock), respectively.

**Table 9: Crop Model Results (Pooled OLS)**

Variable	Estimate	Std. Error	t-value	Pr(> t )
(Intercept)	1.1821	0.3338	3.5415	0.0005***
Crop_Share	-0.4939	0.1755	-2.8141	0.0054***
Fruit_Nut_Share	-0.6969	0.3602	-1.9347	0.0546*
Vegetable_Melon_Share	0.7440	0.3358	2.2156	0.0279**
Crop_Labor_Share	-0.5444	0.2083	-2.6140	0.0097***
Veg_Melon_Labor_Share	0.1280	0.3387	0.3780	0.7059
Fruit_Tree_Labor_Share	0.5989	0.3281	1.8256	0.0696*
Nursery_Labor_Share	-0.4132	0.1935	-2.1359	0.0341**
Ag_Goods_Share	-0.4282	2.3996	-0.1784	0.8586
Ag_Total_Share	-1.0174	11.1582	-0.0912	0.9275

AEWR All Sectors	-0.3779	0.6629	-0.5701	0.5693
AEWR Goods Sectors	-0.0025	0.7868	-0.0032	0.9975
AEWR Ag Sector	-0.0601	0.3254	-0.1848	0.8536
Crop Wage Relative	-0.6524	0.2317	-2.8164	0.0054***
Vegetable wage Relative	-0.0411	0.0840	-0.4889	0.6255
Fruit Wage Relative	-0.0279	0.0761	-0.3668	0.7142
Nursery Wage Relative	0.6933	0.1323	5.2413	0.0000***
National H2A Demand	1.6833	0.0967	17.4056	0.0000***
REGIONATL	-0.4081	0.1008	-4.0491	0.0000***
REGIONMW	-0.2536	0.1047	-2.4219	0.0164**
REGIONPL	-0.5124	0.1170	-4.3808	0.0000***
REGIONW	-0.3837	0.1176	-3.2618	0.0013***

### Model Summary

Total Sum of Squares: 114.2, Residual Sum of Squares: 15.306

R-Squared: 0.86598, Adjusted R-Squared: 0.85016, F-statistic: 54.7672

**Table 10: Livestock Model Results (Pooled OLS)**

Variable	Estimate	Std. Error	t-value	Pr(> t )
(Intercept)	-0.0008	0.2887	-0.0028	0.9977
Animal Product Share	-0.8121	0.3001	-2.7064	0.0075***
Dairy Share	0.2996	0.4398	0.6812	0.4966
Meat Share	-0.2484	0.2896	-0.8579	0.3921
Livestock Labor Share	0.3996	0.3795	1.0532	0.2936
Cattle Labor Share	0.1724	0.3172	0.5436	0.5874
Dairy Labor Share	0.0646	0.4075	0.1586	0.8742
Ag Goods Share	1.5490	3.9644	0.3907	0.6965
Ag Total Share	0.4781	18.3057	0.0261	0.9792
AEWR All Sectors	6.0252	0.9381	6.4230	0.0000***
AEWR Goods Sectors	-7.4563	1.1811	-6.3132	0.0000***
AEWR Ag Sector	0.9098	0.4514	2.0153	0.0454**
Livestock Wage Relative	0.3154	0.1223	2.5788	0.0107**
Cattle Wage Relative	-0.9308	0.2510	-3.7086	0.0002***
National H2A Demand	1.5098	0.1555	9.7068	0.0000***
REGIONATL	0.0691	0.1448	0.4772	0.6338
REGIONMW	0.0689	0.1842	0.3741	0.7088
REGIONPL	0.4343	0.2136	2.0334	0.0435**
REGIONW	0.1280	0.1903	0.6725	0.5021

Model Summary:

Total Sum of Squares: 80.808, Residual Sum of Squares: 39.271

R-Squared: 0.51402, Adjusted R-Squared: 0.46569, F-statistic: 10.6356

To assess the robustness of results, panel regression estimates (with cluster-robust standard errors) are compared with pooled OLS models. While pooled OLS provides initial insights, it does not account for unobserved heterogeneity across states or over time, which the panel models are designed to address.

In the crop sector, several variables demonstrate consistent significance across models. `Crop_Share`, `Nursery_Labor_Share`, and `National_H2A_Demand` are statistically significant and directionally stable in both the panel and pooled models. `Nursery_Wage_Relative` is also positive and significant across specifications, reinforcing its role in influencing H-2A labor demand. However, discrepancies appear with `Vegetable_Melon_Share`, `Fruit_Tree_Labor_Share`, and `Crop_Wage_Relative`, which are significant in the pooled model but either insignificant or only marginal in the panel model. Additionally, while all regional dummies are significant in the pooled model, only `REGIONPL` is significant in the panel specification, suggesting that state-level clustering dampens cross-regional variation.

In the livestock sector, the differences between model types are more pronounced. The pooled OLS model identifies several significant predictors, including `Animal_Product_Share`, AEWR-related variables, `Livestock_Wage_Relative`, `Cattle_Wage_Relative`, and `National_H2A_Demand`. These variables show strong effects and high significance. In contrast, the panel model yields few significant results: only `AEWR_All_Sectors` and `AEWR_Goods_Sectors` approach marginal significance, and `National_H2A_Demand` becomes

insignificant. This divergence suggests that pooled OLS may be capturing spurious associations not robust to the inclusion of unobserved state-level effects.

### 3.4.3 Time Fixed Effects

As a robustness check, time fixed effects were incorporated into both the crop and livestock random effects models by including year dummies. This approach aimed to account for unobserved temporal shocks such as national policy changes, labor market disruptions, or macroeconomic fluctuations that may influence H-2A labor demand.

**Table 11: Crop Model with Time Fixed Effects**

Variable	Estimate	Std. Error	z-value	Pr(> z )
(Intercept)	1.0694	0.3971	2.6928	0.0071 **
Crop Share	-0.4987	0.1864	-2.6751	0.0075 **
Fruit Nut Share	-0.5026	0.4147	-1.2121	0.2255
Vegetable Melon Share	-0.1224	0.4188	-0.2923	0.7701
Crop Labor Share	-0.1119	0.1002	-1.1161	0.2644
Veg Melon Labor Share	-0.2799	0.4416	-0.6338	0.5262
Fruit Tree Labor Share	0.2228	0.4238	0.5258	0.5990
Nursery Labor Share	-0.5574	0.2521	-2.2112	0.0270 *
Ag_Goods_Share	0.0011	1.8989	0.0006	0.9996
Ag Total Share	0.8748	10.9463	0.0799	0.9363
AEWR All Sectors	-1.3157	1.0536	-1.2488	0.2117
AEWR Goods Sectors	1.0167	1.2206	0.8329	0.4049
AEWR Ag Sector	-0.0495	0.1613	-0.3066	0.7591
Crop Wage Relative	-0.2077	0.1296	-1.6031	0.1089
Vegetable wage Relative	0.1225	0.0468	2.6171	0.0089 **
Fruit Wage Relative	0.1956	0.0847	2.3104	0.0209 *
Nursery Wage Relative	0.1349	0.0703	1.9203	0.0548 .
National_H2A_Demand	1.4355	0.1234	11.6352	< 2.2e-16 ***
REGIONATL	-0.4155	0.1738	-2.3910	0.0168 *
REGIONMW	-0.3814	0.1830	-2.0842	0.0371 *
REGIONPL	-0.6736	0.2045	-3.2938	0.0010 ***
REGIONW	-0.4461	0.1829	-2.4391	0.0147 *
factor(YEAR)2021	-0.0053	0.0223	-0.2353	0.8140
factor(YEAR)2022	0.0052	0.0237	0.2207	0.8253
factor(YEAR)2023	0.0121	0.0241	0.5020	0.6157

Model Summary Statistics:

Total Sum of Squares: 4.3439, Residual Sum of Squares: 1.3639

R-Squared: 0.68603, Adjusted R-Squared: 0.64297

Chi-squared: 382.376 on 24 DF, p-value: < 2.22e-16

**Table 12: Livestock Model with Time Fixed Effects**

Variable	Estimate	Std. Error	z-value	Pr(> z )
(Intercept)	0.6986	0.4636	1.5069	0.1318
Animal Product Share	-0.6772	0.3176	-2.1325	0.0330 *
Dairy Share	0.1602	0.2202	0.7273	0.4671
Meat Share	0.2044	0.2826	0.7232	0.4696
Livestock Labor Share	0.2385	0.4582	0.5206	0.6027
Cattle Labor Share	-0.4516	0.2652	-1.7026	0.0887 .
Dairy Labor Share	-0.4373	0.3104	-1.4087	0.1589
Ag Goods Share	-0.8020	2.2401	-0.3580	0.7203
Ag Total Share	7.1798	12.9618	0.5539	0.5796
AEWR All Sectors	2.2524	1.3916	1.6186	0.1055
AEWR Goods Sectors	-3.1996	1.6326	-1.9598	0.0500 .
AEWR Ag Sector	0.0183	0.1585	0.1157	0.9079
Livestock Wage Relative	-0.0101	0.0780	-0.1292	0.8972
Cattle Wage Relative	-0.3343	0.1812	-1.8451	0.0650 .
National_H2A_Demand	1.0935	0.1601	6.8285	8.582e-12 ***
REGIONATL	0.0560	0.2640	0.2121	0.8321
REGIONMW	-0.0203	0.3073	-0.0661	0.9473
REGIONPL	0.2336	0.3581	0.6524	0.5141
REGIONW	0.1317	0.2907	0.4530	0.6505
factor(YEAR)2021	-0.0162	0.0251	-0.6462	0.5181
factor(YEAR)2022	0.0008	0.0293	0.0258	0.9794
factor(YEAR)2023	-0.0204	0.0301	-0.6799	0.4966

Model Summary:

Total Sum of Squares: 2.8881, Residual Sum of Squares: 1.8213

R-Squared: 0.36936, Adjusted R-Squared: 0.29496

Chi-squared: 104.254 on 21 DF, p-value: 5.0651e-13

In the crop sector, the model with time fixed effects explains approximately 68.6% of the variation in H-2A labor intensity (adjusted  $R^2 = 0.643$ ). The variable `Crop_Share` remains negative and statistically significant ( $-0.4987, p < 0.01$ ), as does `Nursery_Labor_Share` ( $-0.5574, p < 0.05$ ). Among wage-related variables, `Vegetable_Wage_Relative` ( $0.1225, p < 0.01$ ) and `Fruit_Wage_Relative` ( $0.1956, p < 0.05$ ) are positively associated with H-2A labor usage, and `Nursery_Wage_Relative` is marginally significant ( $p \approx 0.05$ ). `National_H2A_Demand` remains highly significant ( $1.4355, p < 0.001$ ). Regional dummies `REGIONATL`, `REGIONMW`, `REGIONPL`, and `REGIONW` are all statistically significant and negative, consistent with earlier models. The year dummies for 2021, 2022, and 2023 are not statistically significant, suggesting limited time-specific shocks within this period.

In the livestock sector, the time fixed effects model accounts for 36.9% of the variation in H-2A intensity (adjusted  $R^2 = 0.295$ ). `Animal_Product_Share` is statistically significant and negatively associated with H-2A usage ( $-0.6772, p < 0.05$ ). `AEWR_Goods_Sectors` is marginally significant with a negative coefficient ( $-3.1996, p \approx 0.05$ ), while `Cattle_Wage_Relative` also approaches marginal significance ( $p \approx 0.07$ ). `National_H2A_Demand` continues to show a strong, statistically significant positive effect ( $1.0935, p < 0.001$ ). Regional variables and year dummies do not display statistical significance in the livestock model.

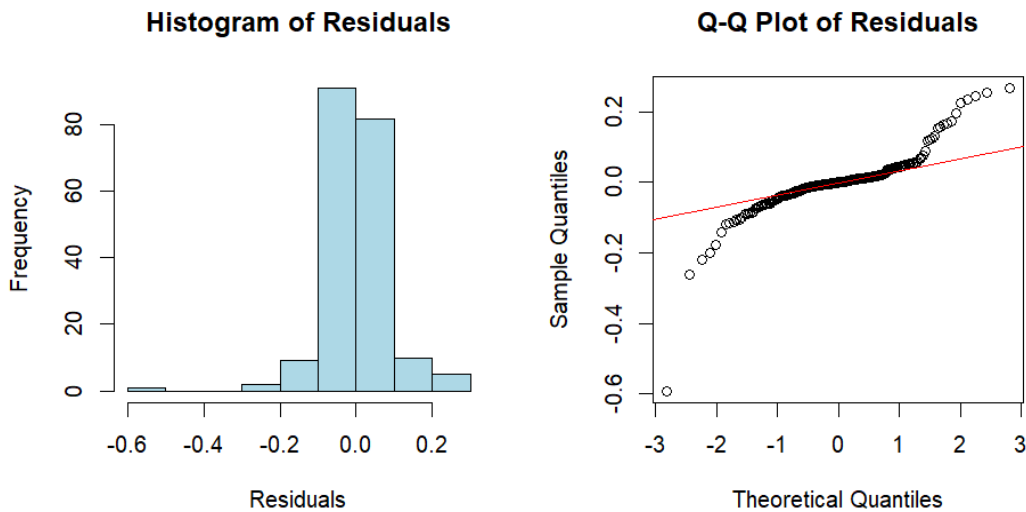
These results provide additional support for the robustness of the main findings while confirming that time-specific factors had limited influence on H-2A labor demand over the sample period.

### 3.5 Model Fit Diagnostics

#### 3.5.1 Residual plots (normality/skew)

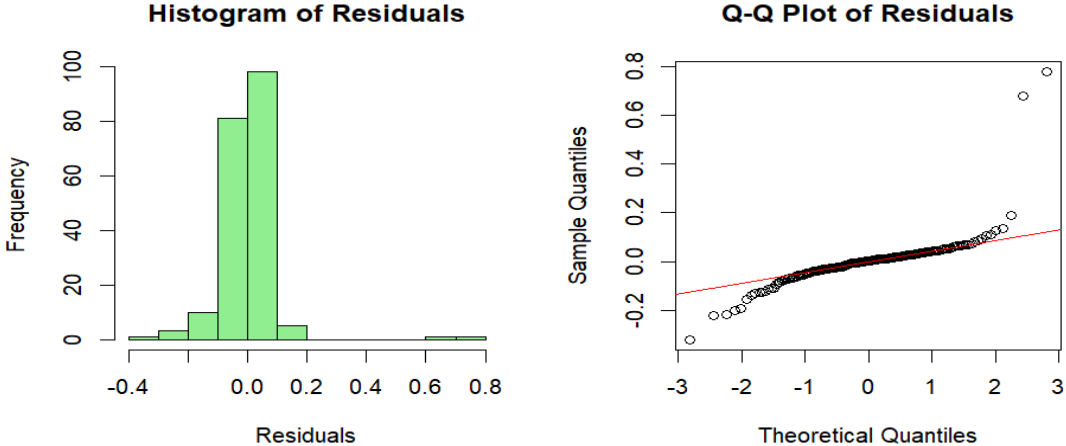
To assess the normality and distributional assumptions of the error terms in the estimated models, residual histograms and quantile–quantile (Q-Q) plots were generated for both the crop and livestock equations.

The histogram of residuals for the crop model exhibited a roughly symmetric bell-shaped distribution centered around zero, suggesting approximate normality. The corresponding Q-Q plot indicated a generally linear trend, though some deviation was observed at the distribution tails. This suggests mild departure from perfect normality, but not enough to raise serious concerns regarding the validity of inference.



**Figure 4: Histogram and Q-Q Plot of Residuals in Crop Model**

For the livestock model, the residual histogram appeared slightly right-skewed, and the Q-Q plot revealed moderate departures from the reference line, particularly in the upper quantiles. This pattern suggests heavier tails or some degree of non-normality in the residual distribution. Nevertheless, given the use of cluster-robust standard errors, the model remains resilient to minor deviations from normality, and the estimates can still be interpreted with confidence.



**Figure 5: Histogram and Q-Q Plot of Residuals in Livestock Model**

### 3.5.2 VIF values

To assess potential multicollinearity among explanatory variables, Variance Inflation Factors (VIFs) were computed for both crop and livestock models. Specifically, the square root of the generalized VIF ( $\sqrt{GVIF^{(1/(2 \times Df))}}$ ) was used, as this measure is suitable for factors with more than one degree of freedom (e.g., categorical variables like region).

**Table 13: VIF Results of Crop Model**

Variable	GVIF	GVIF <sup>^(1/(2*Df))</sup>
Crop Share	1.939	1.393
Fruit Nut Share	3.449	1.857
Vegetable Melon Share	3.214	1.793
Crop Labor Share	2.578	1.606
Veg Melon Labor Share	2.631	1.622
Fruit Tree Labor Share	4.594	2.143
Nursery Labor Share	3.485	1.867
Ag_Goods_Share	23.738	4.872
Ag Total Share	21.183	4.602
AEWR All Sectors	10.195	3.193
AEWR Goods Sectors	10.232	3.199
AEWR Ag Sector	4.790	2.189
Crop Wage Relative	5.293	2.301
Vegetable wage Relative	2.558	1.599
Fruit Wage Relative	2.579	1.606
Nursery Wage Relative	4.128	2.032
National H2A Demand	2.322	1.524
REGION	18.796	1.443

**Table 14: VIF Results of Livestock Model**

Variable	GVIF	GVIF <sup>^(1/(2*Df))</sup>
Animal Product Share	2.326	1.525
Dairy Share	9.389	3.064
Meat Share	6.153	2.481
Livestock Labor Share	3.659	1.913
Cattle Labor Share	3.391	1.842
Dairy Labor Share	9.592	3.097
Ag Goods Share	25.678	5.067
Ag Total Share	22.595	4.753
AEWR All Sectors	8.091	2.844
AEWR Goods Sectors	9.138	3.023
AEWR Ag Sector	3.655	1.912
Livestock Wage Relative	2.277	1.509
Cattle Wage Relative	3.822	1.955
National H2A Demand	2.380	1.543
REGION	27.971	1.516

In the crop model, most variables had GVIF-adjusted values well below the conservative threshold of 5, indicating acceptable levels of collinearity. However, a few variables exhibited elevated VIF values, notably `AG_share_in_goods_labor` (GVIF-adjusted = 4.87), `Ag_share_in_all_labor` (4.60), and the regional dummy (`REGION`, 1.44), although none exceeded a critical  $\text{GVIF}^{1/(2 \times \text{Df})}$  value of 5. These variables were retained due to their theoretical relevance and explanatory importance to the model structure.

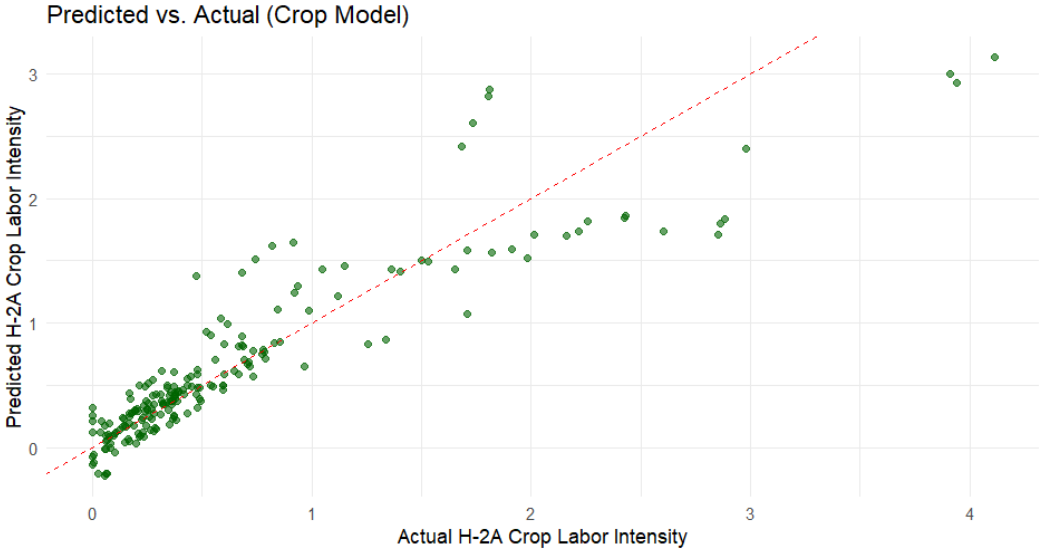
Similarly, in the livestock model, the highest GVIF-adjusted values were observed for `AG_share_in_goods_labor` (5.07) and `Ag_share_in_all_labor` (4.75), followed by `dairy_share_in_lvstk_share` (3.10) and `GOODS_101_RATIO` (3.02). Despite a few elevated values, all remained below the commonly used threshold of 10, and were therefore not considered problematic.

Overall, the multicollinearity diagnostics indicate that while certain predictor variables are moderately correlated, the models do not suffer from severe multicollinearity. The retained variables are theoretically justifiable and contribute to the robustness and completeness of the empirical models.

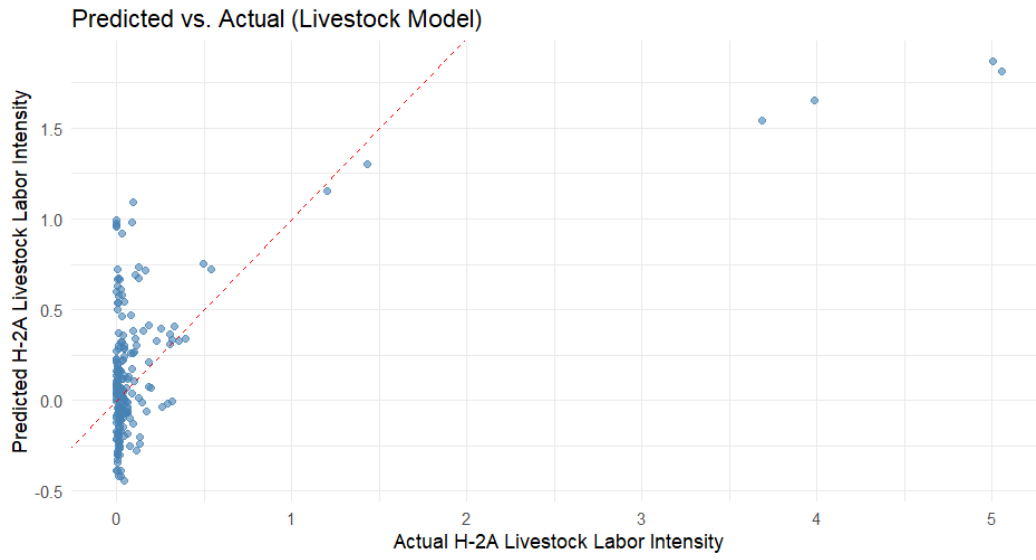
### **3.5.3 Predicted vs actual plots (brief visual assessment)**

To evaluate the overall fit and predictive performance of the estimated models, predicted values were plotted against observed (actual) values for both the crop and livestock equations. A well-fitting model should show points closely aligned along the 45-degree reference line, indicating that predicted labor intensities closely match actual intensities. For the crop model, the predicted versus actual plot revealed a strong linear alignment, particularly in the mid-range of values, suggesting reliable predictive accuracy. Deviations from the reference

line were more pronounced in the higher range, implying the model may slightly underpredict labor intensity at extreme values. In contrast, the livestock model exhibited a more dispersed pattern, with substantial clustering around zero and a few outliers. While the model captures general trends, its predictive accuracy is lower relative to the crop model, especially in cases of high observed H-2A labor intensity. These results are consistent with lower R-squared values observed in the livestock model and further highlight sectoral differences in H-2A labor dynamics.



**Figure 6: Predicted VS Actual Values (Crop Model)**



**Figure 7: Predicted VS Actual Values (Livestock Model)**

## CHAPTER 4

### DISCUSSION

This study set out to explore the determinants of certified H-2A labor demand across U.S. states in the crop and livestock sectors, aiming to understand how sectoral, structural, and wage-related factors contribute to the variation in H-2A intensity. The results offer valuable insights into how the two sectors, each with distinct production systems and labor needs, interact with the institutional framework of the H-2A program.

In the crop sector, the findings validate much of the existing literature that links H-2A usage to labor-intensive crop systems. The significant negative coefficient on Crop\_Share variable ( $-0.5416, p < 0.01$ ) indicates that as the contribution of crop production to total agricultural value declines, the demand for H-2A labor increases. This finding suggests that farms in the crop sector increasingly rely on foreign guest workers to sustain output and productivity levels as their relative share within the overall agricultural economy diminishes. The result aligns with previous evidence that H-2A workers are often perceived as more dependable and productive than domestic workers, enabling producers to stabilize operations even when the crop sector's economic prominence declines.

Similarly, the Fruit\_Nut\_Share variable ( $-0.4973, p \approx 0.06$ ) exhibits a negative and marginally significant association with crop H-2A intensity. A declining fruit and nut share appears to correspond with greater utilization of H-2A labor, suggesting that producers may increasingly depend on foreign workers to perform labor-intensive tasks such as pruning, thinning, and harvesting where productivity gains from H-2A participation are most evident. This trend

reinforces the notion that foreign labor has become an integral component of sustaining production in perennial and specialty crop industries, where seasonal and task-specific demands are high.

The Nursery\_Labor\_share variable ( $-0.5219, p < 0.05$ ) also displays a significant negative relationship with H-2A employment. This finding implies that as domestic employment in nursery operations decreases, H-2A hiring intensifies to offset labor gaps. Nursery operations often involve physically demanding and repetitive tasks that require endurance and skill, which may make them less attractive to domestic workers. Consequently, nursery employers increasingly turn to H-2A labor as a reliable alternative workforce.

The positive and statistically significant coefficients on Vegetable\_Wage\_Relative and Nursery\_Wage\_Relative suggest that as domestic wages rise in these sub-sectors (relative to the AEWR), farms are more likely to hire H-2A workers. This may indicate that employers turn to H-2A labor as a relatively less expensive and more dependable alternative when faced with rising wage demands from domestic workers. The positive relationship reflects the cost-efficiency and productivity advantage of H-2A labor, particularly in labor-intensive operations like vegetable and nursery production, where maintaining reliable seasonal labor is crucial.

In contrast, the negative coefficient on Crop\_Wage\_Relative, whose mean ratio is greater than one, implies that H-2A usage increases as crop wages approach the AEWR. This may be driven by rising AEWRs, which despite making H-2A labor more costly do not deter employers due to the perceived productivity benefits of H-2A workers. Employers may continue to rely on H-2A labor even amid wage increases because of its role in boosting or sustaining productivity.

The positive but marginally significant coefficient on Fruit\_Wage\_Relative further supports this trend, suggesting that as domestic fruit wages rise, farms may supplement their workforce with H-2A labor to meet peak seasonal demand efficiently.

The positive and significant coefficient on `National_H2A_Demand` reflects the dominant role of the crop sector in shaping overall H-2A usage trends nationwide. Given that crop-related employment accounts for the vast majority of H-2A certifications, national-level increases in H-2A demand are largely driven by crop-sector dynamics. This finding indicates that state-level crop H-2A usage is closely aligned with broader national patterns, reinforcing the sector's influence in dictating overall program trends.

The negative and statistically significant coefficient for the Plains region (`REGIONPL`), along with the negative signs on the other regional dummies, suggests that crop H-2A usage is concentrated in the South, which serves as the baseline category in the model. This implies that the South's crop farms dominate national H-2A employment patterns, and other regions regardless of their production systems engage less intensively with the program. The South's predominance may be linked to its long-standing reliance on labor-intensive crop systems such as fruits, vegetables, and nursery production, which align well with the seasonal structure of the H-2A program.

Turning to the livestock sector, the model shows considerably lower explanatory power than the crop model, as evidenced by the R-squared of 0.3655. This suggests that the drivers of H-2A labor demand in livestock are either more diffuse or more context-specific than in crop production. Most of the livestock model's explanatory variables are statistically insignificant, including the sectoral variables such as *Animal\_Product\_Share*, *Dairy\_Share*, and *Meat\_Share*. This implies that the value composition of animal production is not a key determinant of H-2A labor intensity, possibly because most livestock operations are smaller-scale or less inclined to engage with formal visa processes.

One notable observation is the marginal statistical significance of *AEWR\_All\_Sectors* and *AEWR\_Goods\_Sectors*. The positive coefficient on *AEWR\_All\_Sectors* suggests that higher minimum wage requirements for H-2A employment may be correlated with greater H-2A usage, possibly reflecting the increased costs of hiring unauthorized or domestic workers. However, the negative coefficient on *AEWR\_Goods\_Sectors* may indicate substitution effects, where livestock farms are deterred from hiring H-2A workers due to wage constraints imposed on all goods-producing industries. These contradictory effects signal the complex wage environment facing livestock employers.

The variable *National\_H2A\_Demand* is again positively signed, although not significant at conventional levels. This aligns with crop sector findings and supports the idea that national-level labor market conditions are important influencers of H-2A labor usage, regardless of sector. However, its lack of significance in the livestock model may indicate weaker responsiveness or lower program penetration in this sector.

The relative insignificance of livestock-specific labor share variables (e.g., *Cattle\_Labor\_Share*, *Dairy\_Labor\_Share*) reflects the underutilization of the H-2A program by livestock farms and suggests that operational size or employment type may be more influential than aggregate employment structure. The nonsignificant effects of regional dummies in the livestock model further imply that geographical factors are less determinative of H-2A usage for livestock than they are for crop farms, perhaps due to the homogeneity in H-2A disinterest across regions.

Together, the findings reinforce the central argument introduced at the outset: the design of the H-2A program is better suited to the seasonal labor needs of crop producers than to the continuous, year-round demands of livestock operations. The relatively low uptake of the H-2A

program among livestock farms does not necessarily reflect a lack of need for labor but is more likely a result of structural and institutional misalignments. Key limitations, such as the program's restriction to seasonal work, burdensome administrative procedures, and annual reapplication requirements, create substantial barriers to participation for farms that require long-term labor stability.

The results from the crop sector model reveal that economic incentives (e.g., relative wage differentials), sectoral labor composition, and national trends in H-2A usage are significant drivers of certified labor demand. These relationships suggest that crop producers are not only more attuned to fluctuations in labor costs but are also more responsive to broader systemic labor market conditions. In contrast, the livestock model demonstrates a weaker and more inconsistent relationship between these variables and H-2A labor intensity. This muted responsiveness suggests that livestock operations operate within a more rigid institutional context, where regulatory and operational constraints outweigh economic incentives in shaping labor decisions.

The discussion of wage variables in the livestock model, particularly the marginal effects of AEWR indicators, underscores the complexity of labor market signals in this sector. While higher wages might typically indicate stronger demand for labor, their relationship with H-2A utilization appears ambiguous in livestock operations. This may be due to a higher prevalence of skilled work classifications in livestock sectors like dairy and cattle production, which do not align well with the H-2A program's eligibility framework designed for unskilled, seasonal positions.

Further evidence of this sectoral divergence is seen in the regional dummy variables. As noted in the introduction, Southern states have historically exhibited higher H-2A usage, largely driven by labor-intensive fruit, vegetable, and nursery production. However, this pattern does not translate to livestock operations in other major producing regions like the Midwest and Plains.

Despite significant output in these areas, H-2A utilization remains relatively low, further indicating that regional labor needs alone do not explain the program's adoption patterns, regulatory fit and structural compatibility are also critical factors.

Robustness checks using pooled OLS models and fixed effects specifications reinforce the consistency of these core findings. While these alternative models confirm the stability of the main crop-sector results, they also reveal the limits of traditional econometric approaches in fully capturing the complex, multi-layered decision-making processes of livestock employers. In particular, residual diagnostics show greater dispersion and right-skewness in the livestock model, suggesting that unobserved heterogeneity such as farm-level management strategies, employer attitudes, or institutional constraints may play a substantial role in shaping labor choices.

From a policy perspective, these results support a growing consensus that a uniform agricultural labor policy is insufficient for addressing the sector-specific realities of U.S. agriculture. Proposed reforms under the Farm Workforce Modernization Act (FWMA) especially provisions allowing for year-round H-2A visas and multi-year employment terms represent a promising step toward addressing the current program's misalignment with livestock labor demands. However, as highlighted in the introduction, these reforms have repeatedly stalled in the Senate, leaving livestock producers with limited legal pathways to secure stable foreign labor.

Finally, this study demonstrates that while crop farms are significantly influenced by economic signals and national labor trends in their use of H-2A workers, livestock farms face deeper structural constraints that limit their participation in the program. These findings underscore the urgent need for a differentiated labor policy framework, one that recognizes the unique demands and challenges faced by different agricultural subsectors. Implementing targeted reforms to enhance the accessibility and flexibility of the H-2A program for year-round operations could

improve labor supply conditions and support the long-term sustainability of the U.S. livestock industry in an increasingly constrained domestic labor market.

## **CHAPTER 5**

### **CONCLUSION**

This study contributes to the growing literature on agricultural labor markets by offering a comparative, sector-specific analysis of the determinants of H-2A labor demand in U.S. crop and livestock production systems. Using state-level panel data from 2020 to 2023, the analysis reveals significant differences in how structural, economic, and labor-related variables influence reliance on H-2A labor across the two sectors.

The findings confirm that crop farms particularly those specializing in labor-intensive activities like vegetable, melon, and nursery production are significantly more reliant on the H-2A program. Key determinants such as sectoral production structures, relative wage competitiveness, and national trends in H-2A hiring were found to significantly influence H-2A labor intensity in the crop model. In contrast, the livestock sector displayed a weaker empirical relationship with the tested variables, reflecting more complex labor requirements and deeper structural barriers to H-2A adoption.

These results highlight the inadequacy of current labor policy frameworks in addressing the year-round workforce needs of livestock farms. While the H-2A program has proven critical in filling seasonal labor shortages in crop agriculture, its seasonal and short-term design remains misaligned with the operational realities of livestock production, where continuity and skill retention are vital. Legislative proposals such as those outlined in the Farm Workforce Modernization Act (FWMA) offer promising solutions particularly the provision for year-round visas and longer employment terms but political deadlock has impeded meaningful reform.

Ultimately, this research underscores the urgent need for targeted policy adaptations that reflect the heterogeneity of labor demand within U.S. agriculture. As the domestic labor supply continues to decline and immigration policies remain restrictive, the sustainability of U.S. agriculture particularly livestock operations may increasingly depend on a more flexible and inclusive guestworker framework. Future research may examine how growth in the value of farm production (VFP) influences H-2A labor demand. While this study focuses on sectoral production shares to reflect structural composition, using VFP growth or level measures could reveal whether rising farm revenues rather than shifts in production mix drive increased reliance on H-2A workers. Comparing the explanatory power of production shares versus VFP growth would help clarify the broader economic conditions shaping agricultural labor demand. Future research may also explore farm-level behavioral factors, employer cost-benefit analyses, and the effects of evolving immigration policies to develop a more comprehensive understanding of labor dynamics in the agricultural sector.

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