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State of the Tree Fruit Industry in Washington State

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- Challenges-labor
  - Farm worker visa program H-2A
  - Robotics
  - Other technologies
- Challenge-climate change
  - New technologies

Economic Relevance of Agriculture for Washington State

Source: WSDA, 2023

Washington is a top producer of several agricultural crops in the United States

Number 1
U.S. Producer of:

APPLES
BLUEBERRIES
HOPS
PEARS
SPEARMINT OIL
SWEET CHERRIES

Number 2
U.S. Producer of:

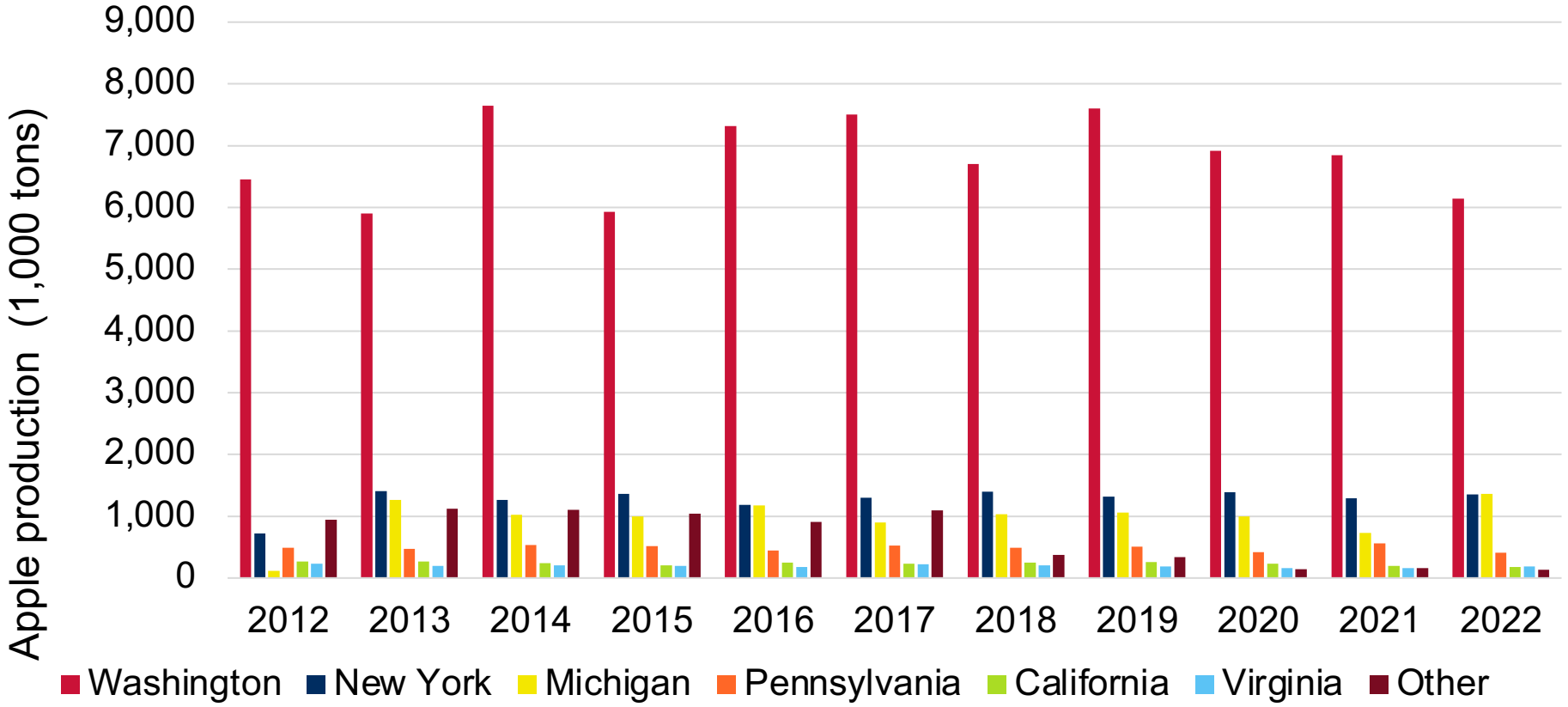
APRICOTS
ASPARAGUS
DRY ONIONS
GRAPES
POTATOES
RASPBERRIES
WINTER WHEAT

Number 3
U.S. Producer of:

DRIED PEAS
LENTILS
PEPPERMINT OIL
WHEAT

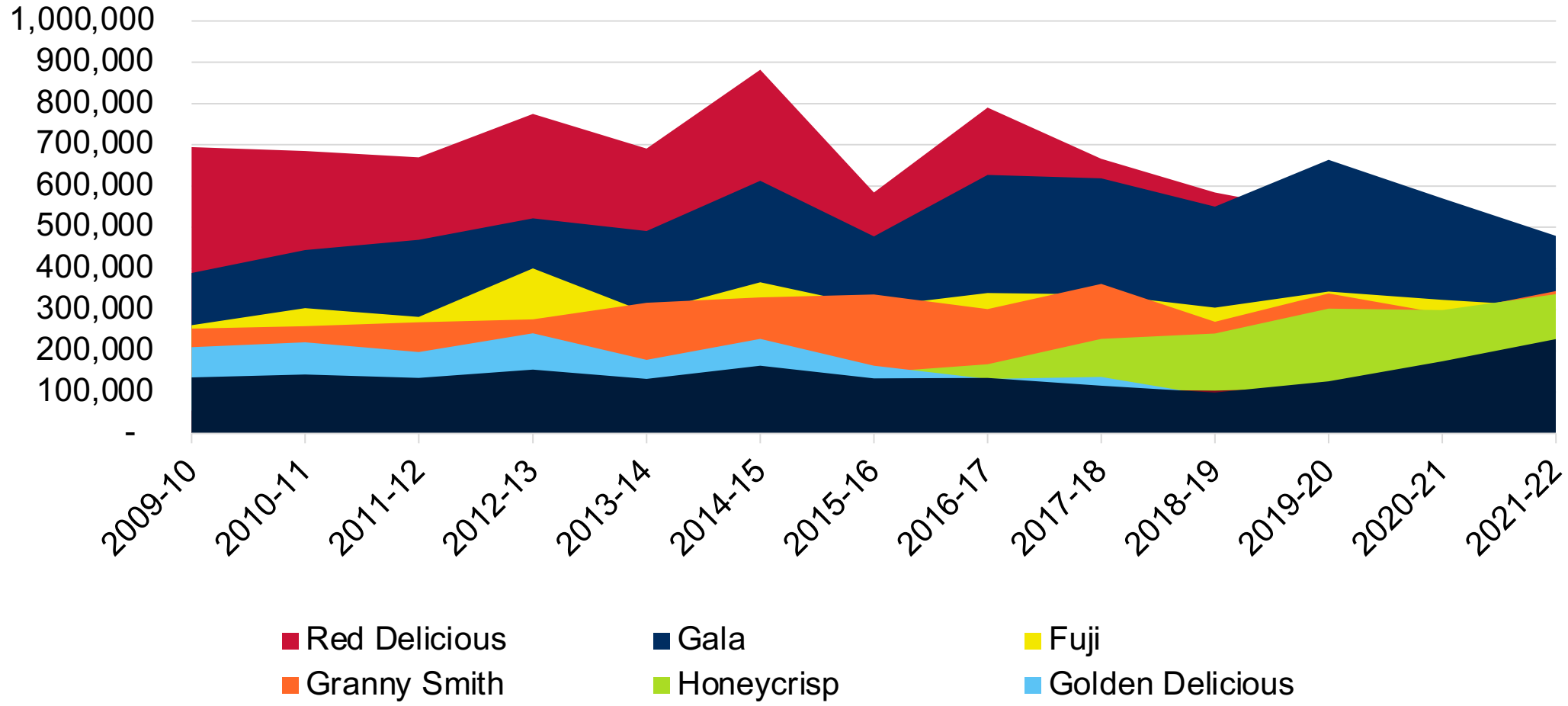
Source: WSDA, 2023

U.S. fresh apple production: Washington absorbs about 60%



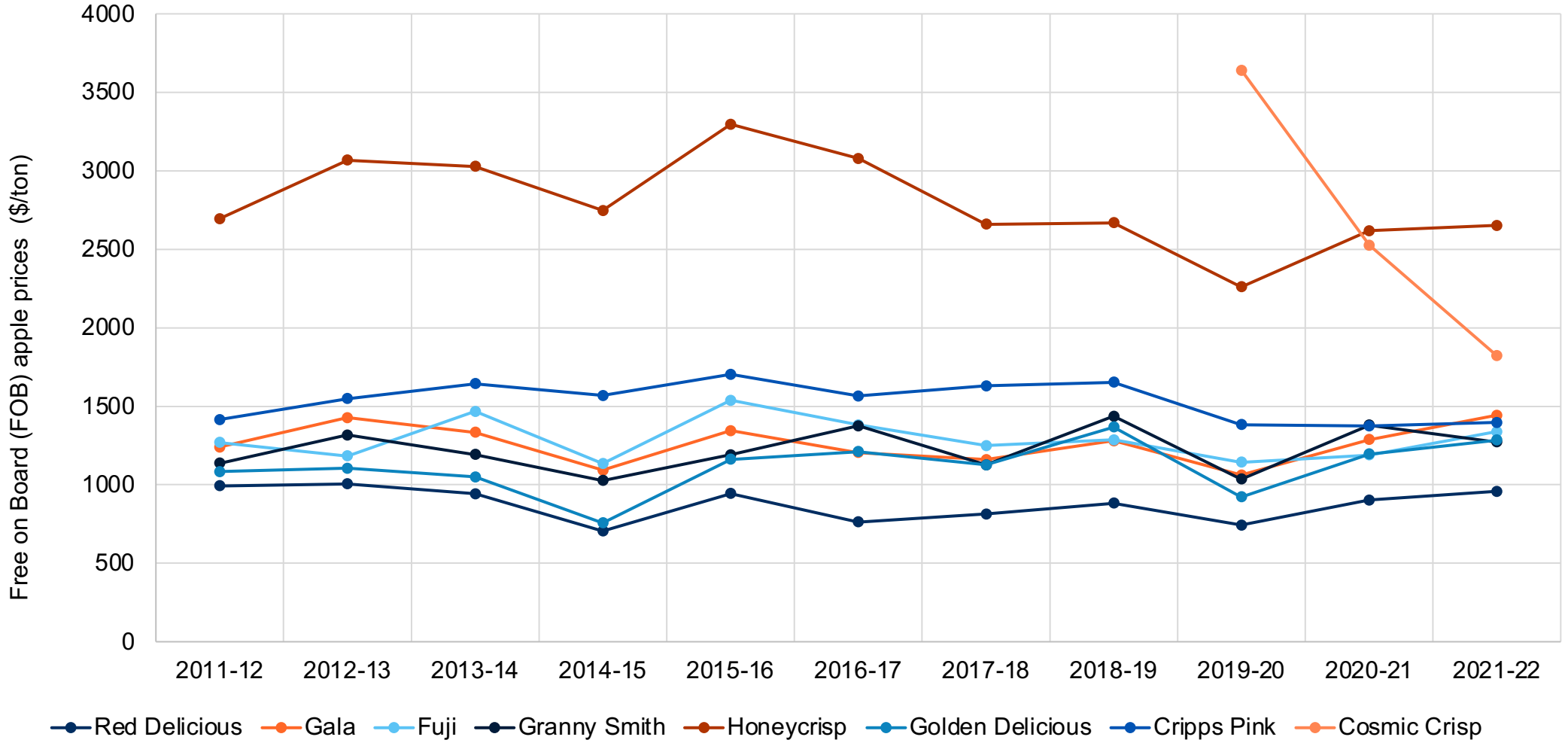
Source: USDA, ERS, 2023. Fruits and Tree Nuts Summary.

Washington state fresh apples: Evolution of Variety Mix



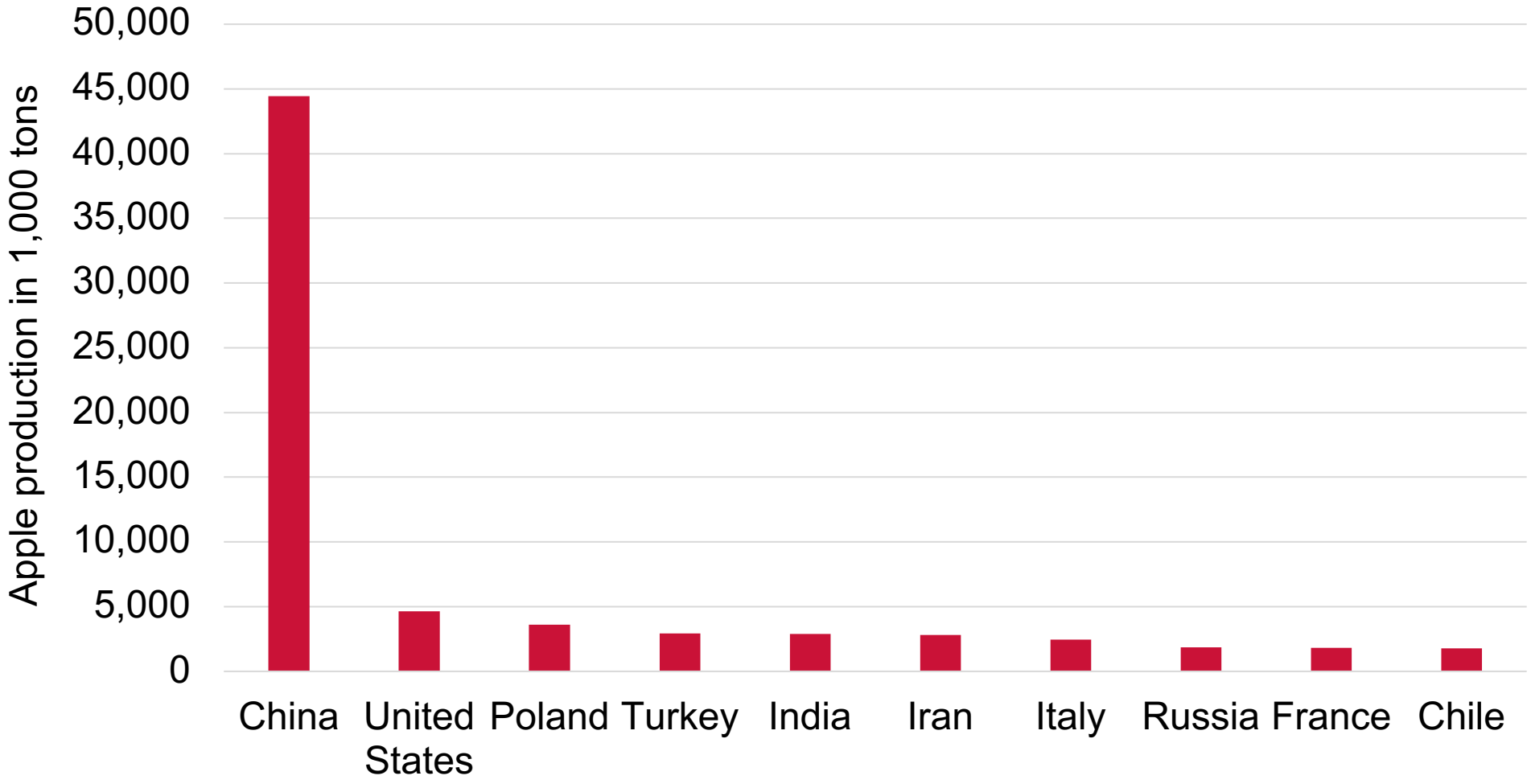
Source: Washington Tree Fruit Association. 2023.

Washington state fresh apples: Evolution of Variety Mix



Source: Washington Tree Fruit Association. 2023.

Worldwide fresh apple production, where does the U.S. stands?



Source: U.N. FAO. 2023.

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Market Challenges

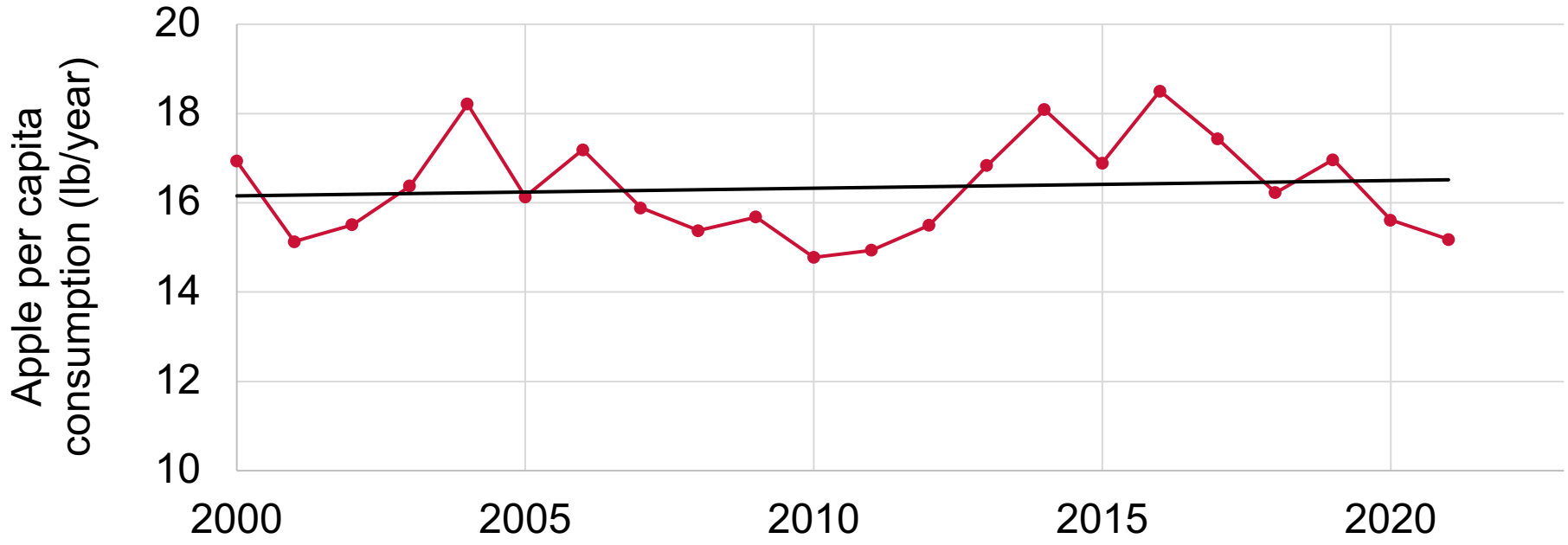
Market challenges: Grower receives the residual price of the supply chain

	Price $/lb	%
Consumer price per pound at the retail market. Example- Gala apple.	2.00	100
Retailer	1.48	74
Packinghouse + Marketer	0.25	13
Grower	0.27	14

2022 Food dollar: Marketing bill (nominal)

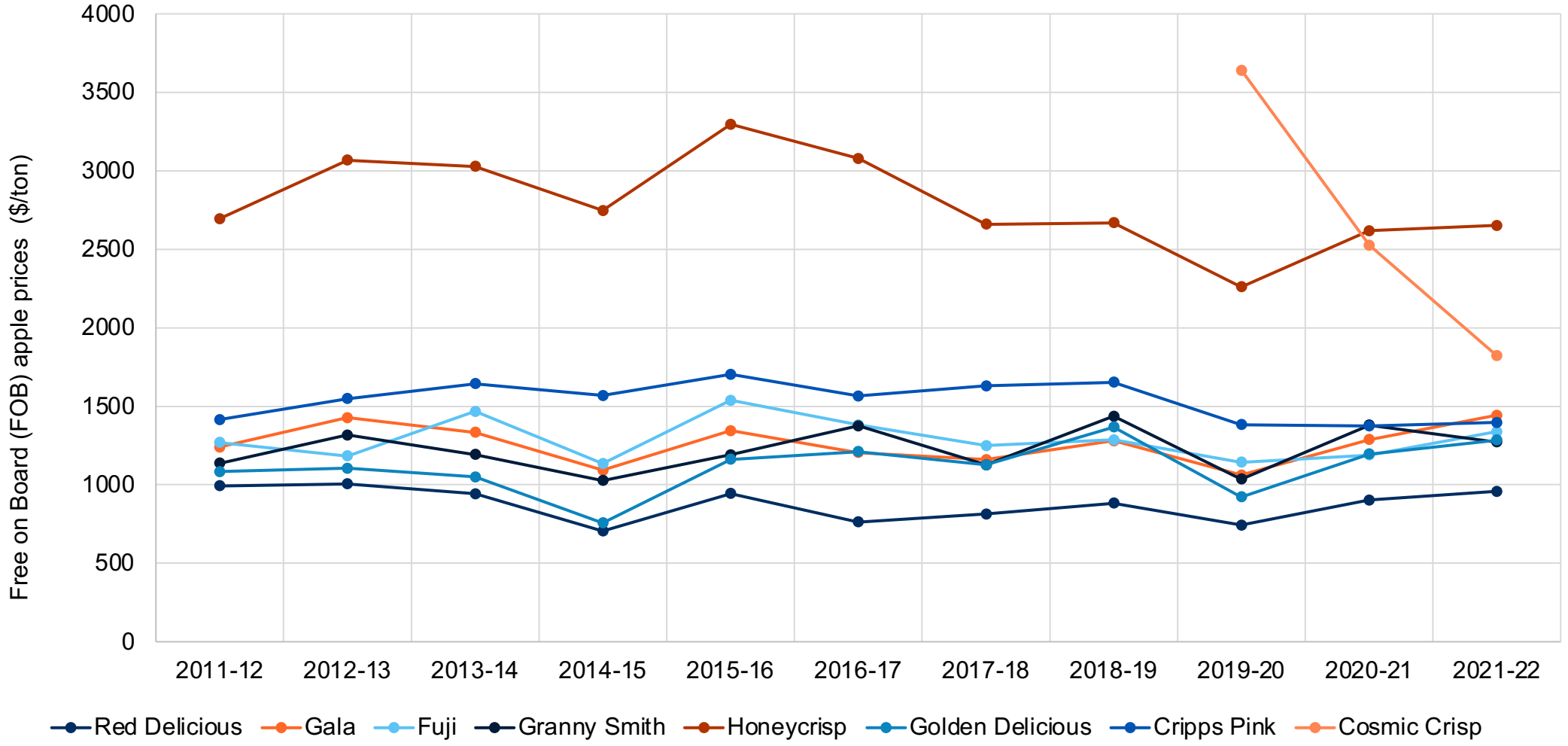
Source: https://www.ers.usda.gov/data-products/food-dollar-series/documentation/#:~:text=For%20calendar%20year%202022%2C%20the,remainder%20of%20the%20food%20dollar.

U.S. per capita consumption of fresh apples



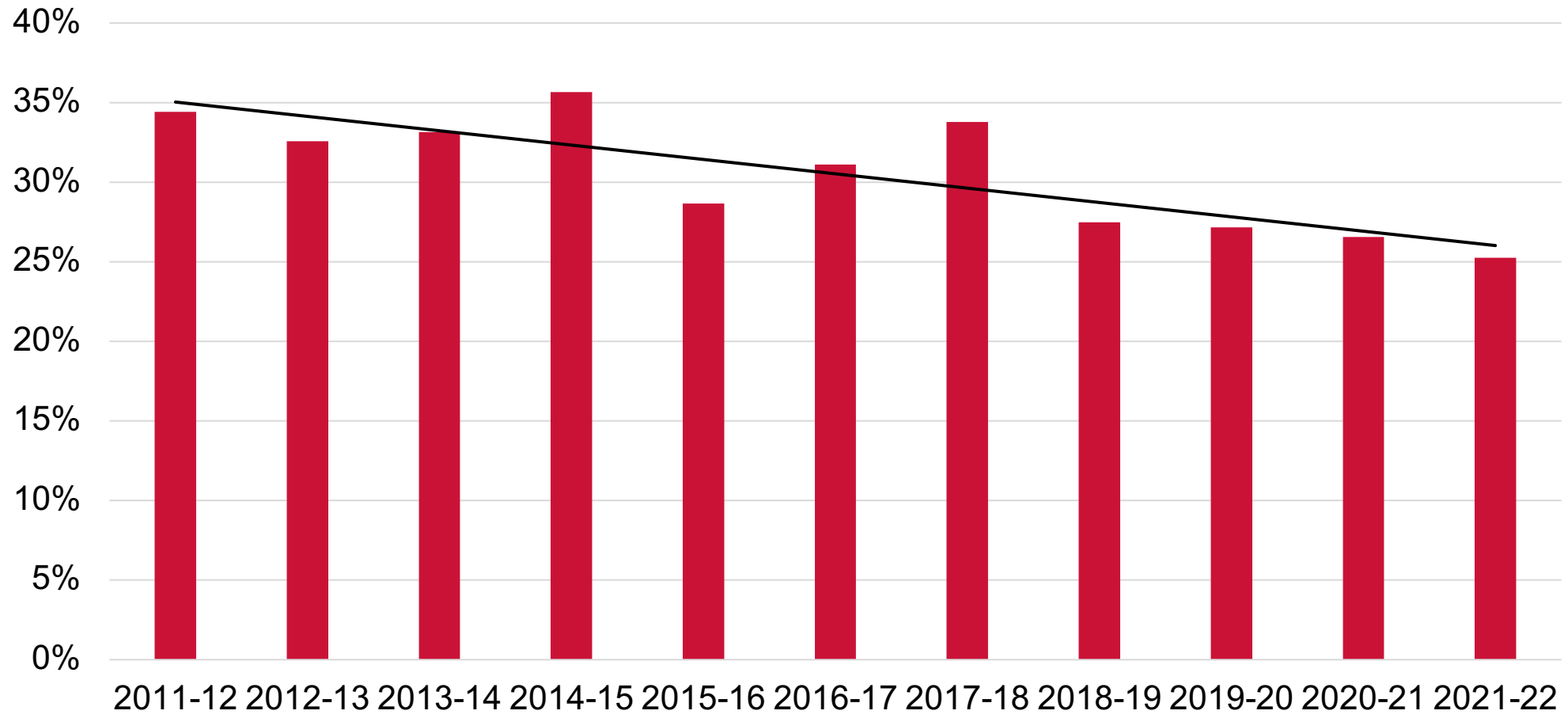
Source: USDA, ERS, 2023. Per capita fresh fruit consumption.

Washington state fresh apples: Evolution of Variety Mix



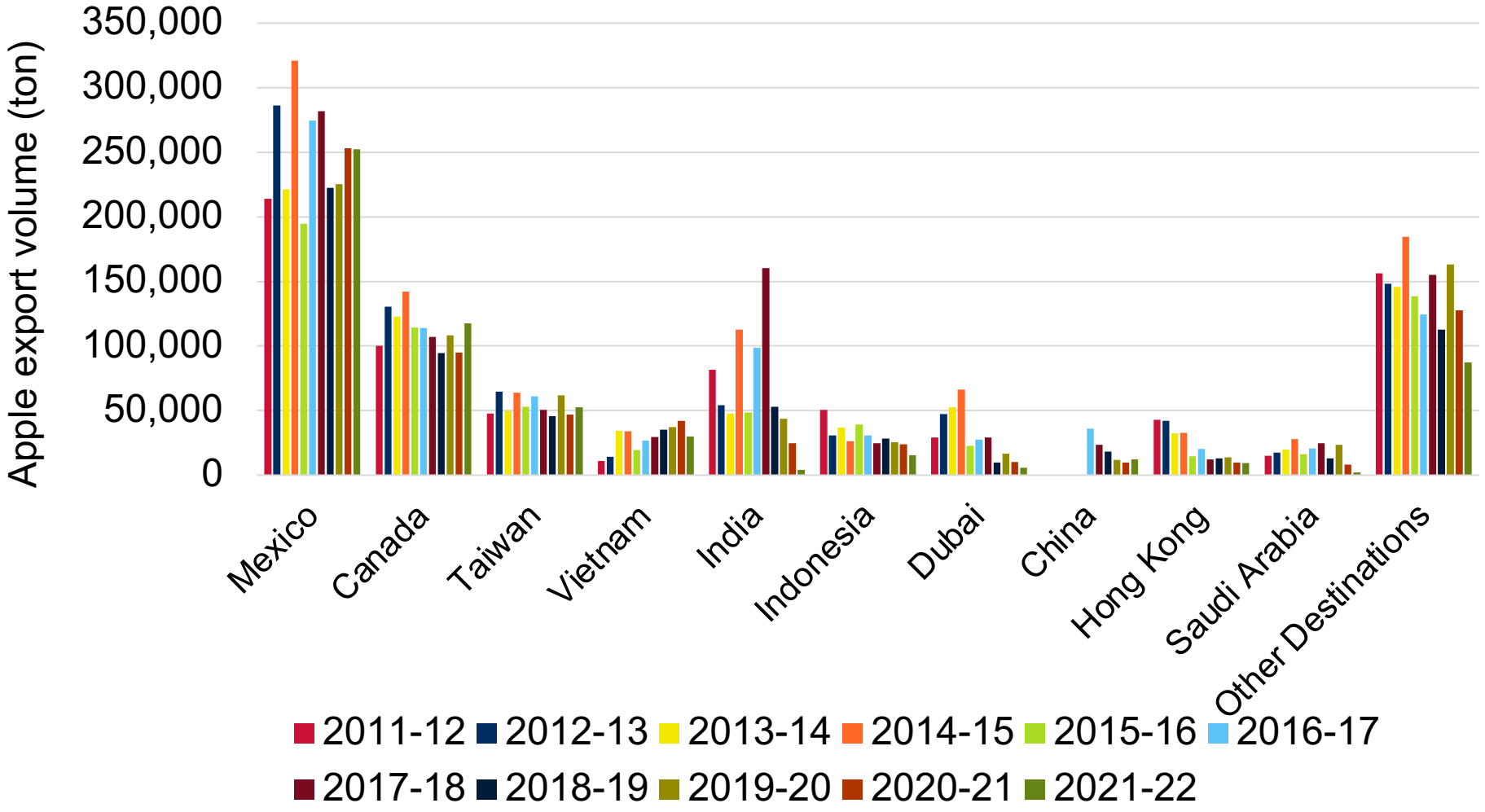
Source: Washington Tree Fruit Association. 2023.

Washington exports about 25% of the fresh apple production



Source: Washington Tree Fruit Association. 2023.

Washington fresh apple exports, mix



Source: Washington Tree Fruit Association. 2023.

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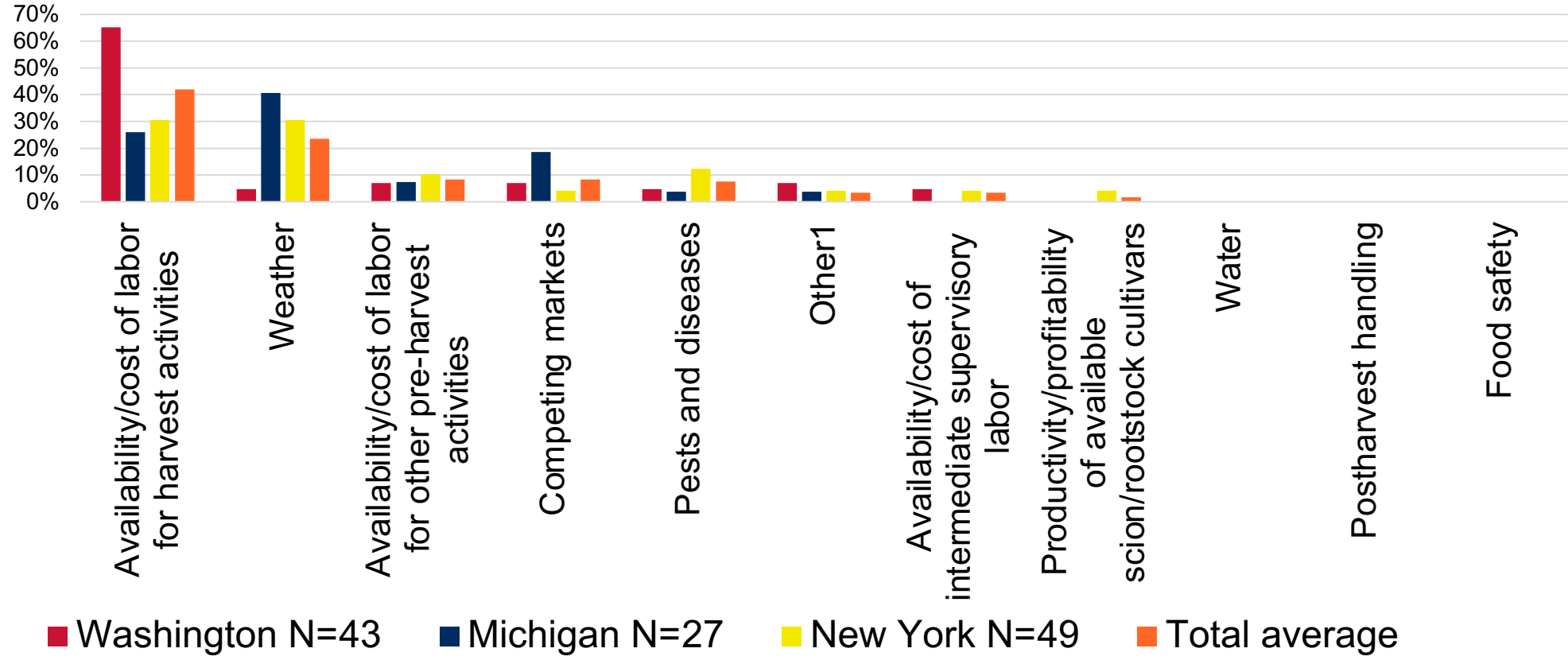
Labor challenges

Challenges

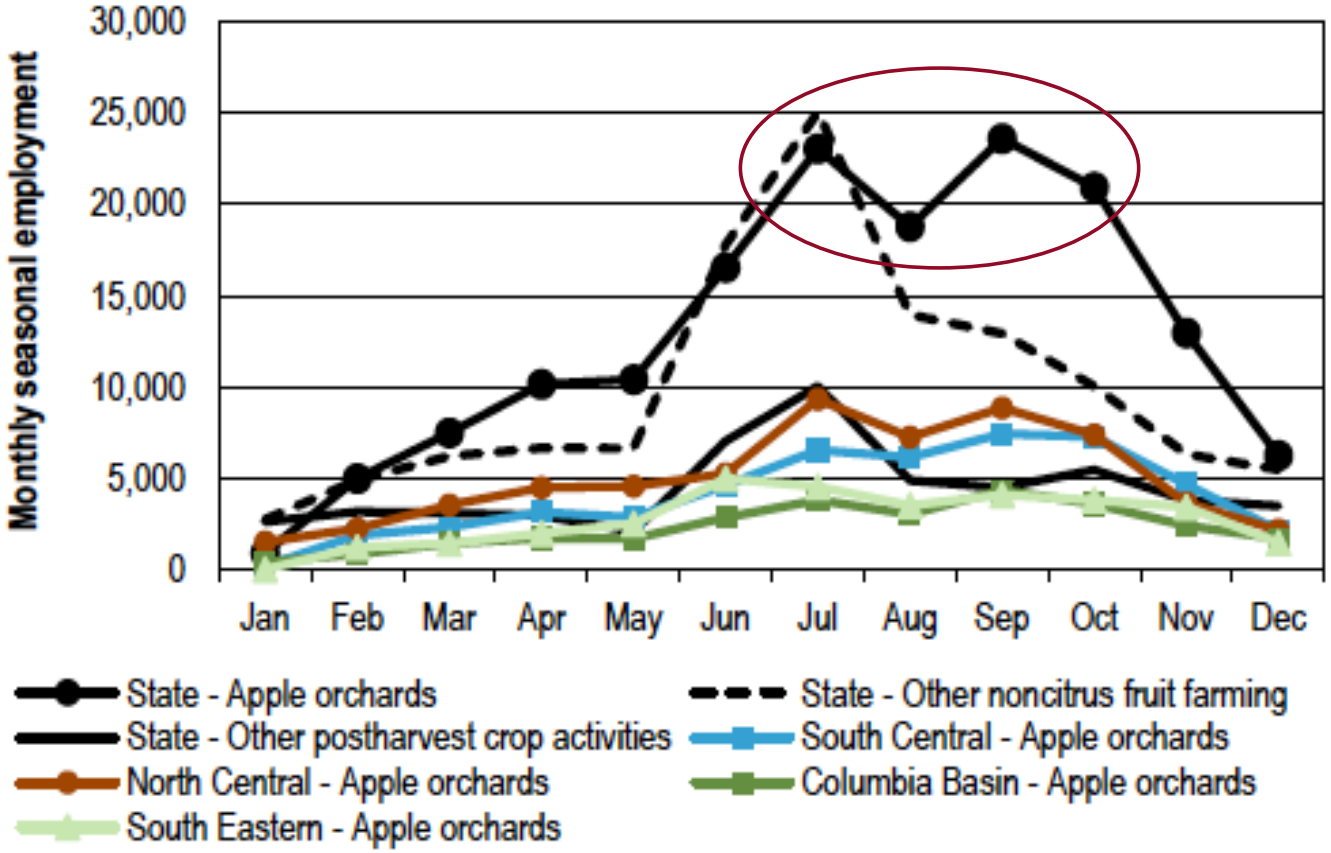


Results from a 2017 survey to 119 growers in Washington, Michigan, and New York.
Other: Regulatory demands, new marketable cultivars available to all growers not solely club members, inadequate information on performance of new scion cultivars on various rootstocks, fire blight, farm succession, government intervention, and lack of autonomous equipment.

Source: Gallardo et al. 2019

Fresh fruit: High dependence on seasonal labor

Monthly variable covered employment by select agricultural industries Washington state and selected agricultural reporting areas



Source: Employment Security Department LMEA. U.S. Bureau of Labor Statistics QCEW 2017.

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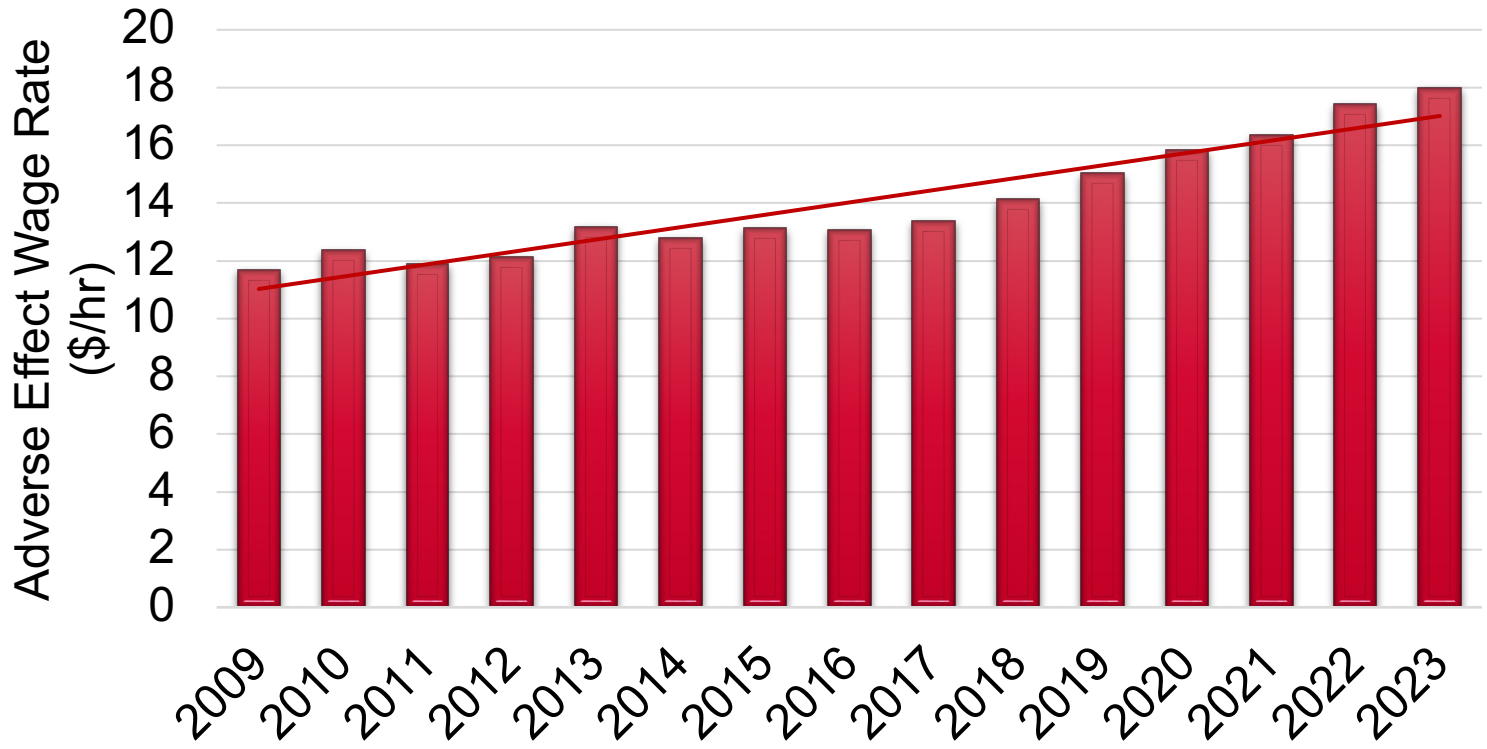
Washington state: Yearly increases in farm labor wages

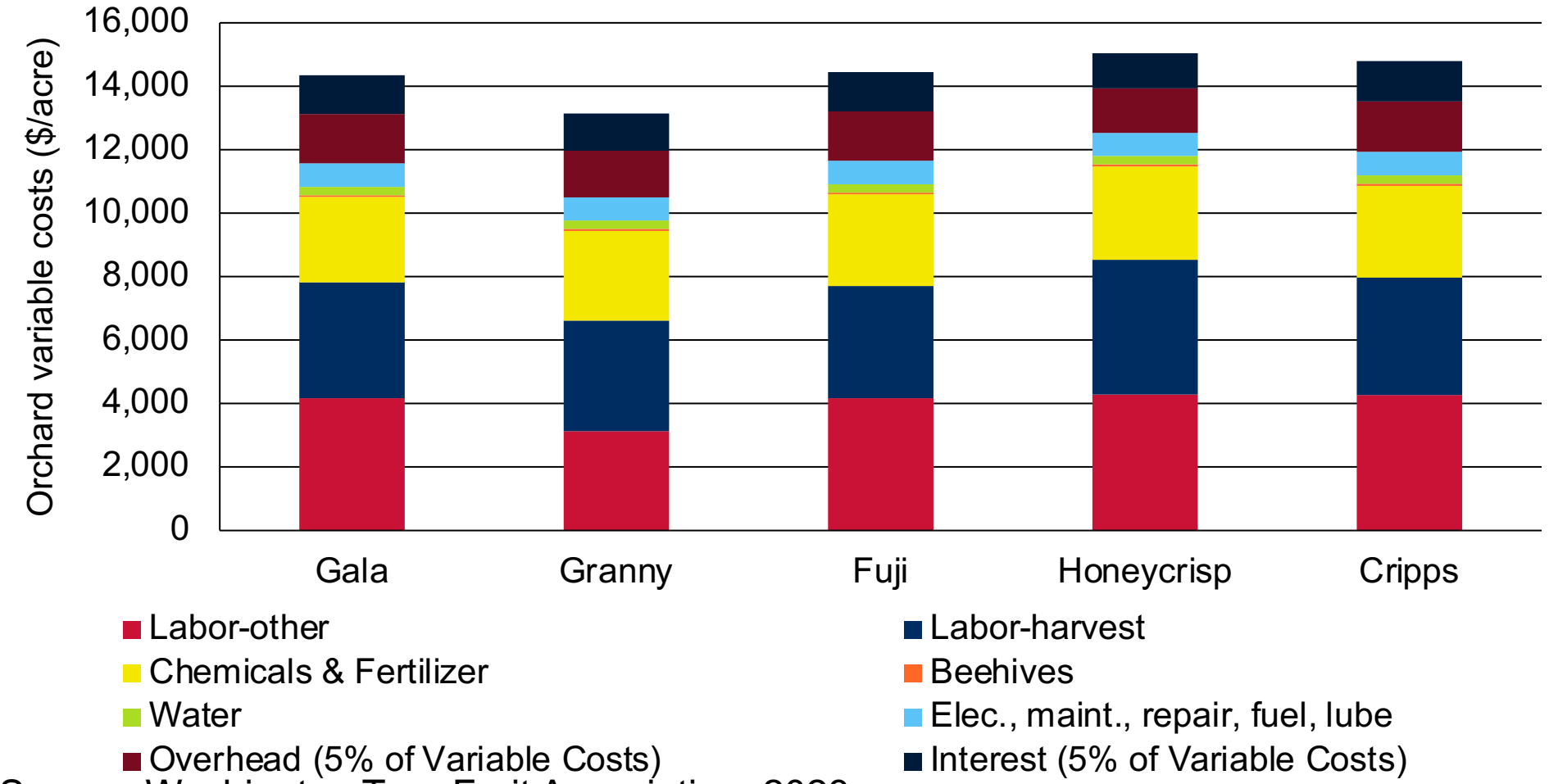
H2A Adverse Effect Wage Rate in Washington State (nominal)



Source: U.S. Department of Labor, various sources

Washington state: Labor is the major production cost center

- Labor represents 50%-57% of orchard variable costs for WA state apples



Source: Gallardo and Galinato 2020

Source: Washington Tree Fruit Association. 2023.

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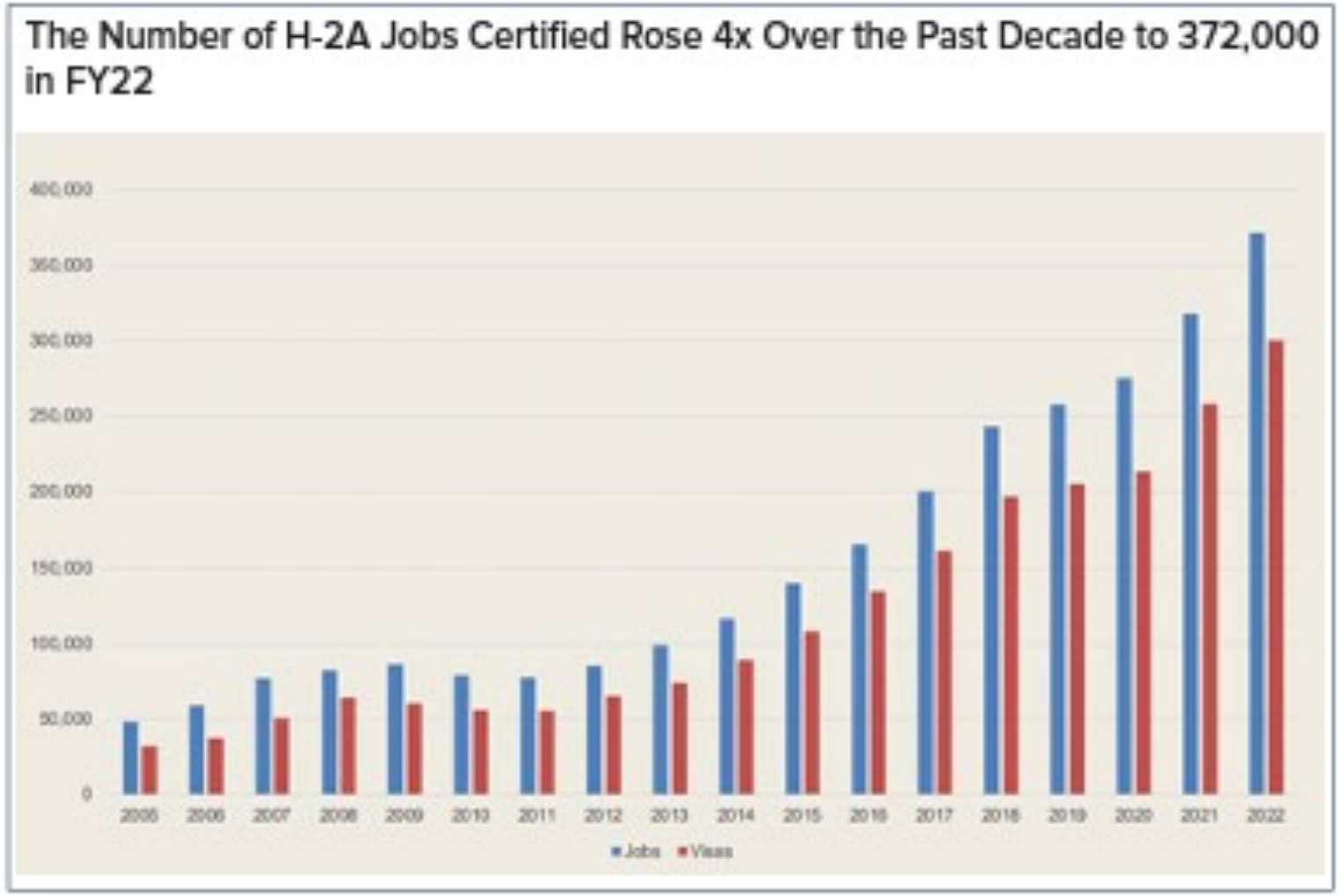
Solutions for the farm labor problem

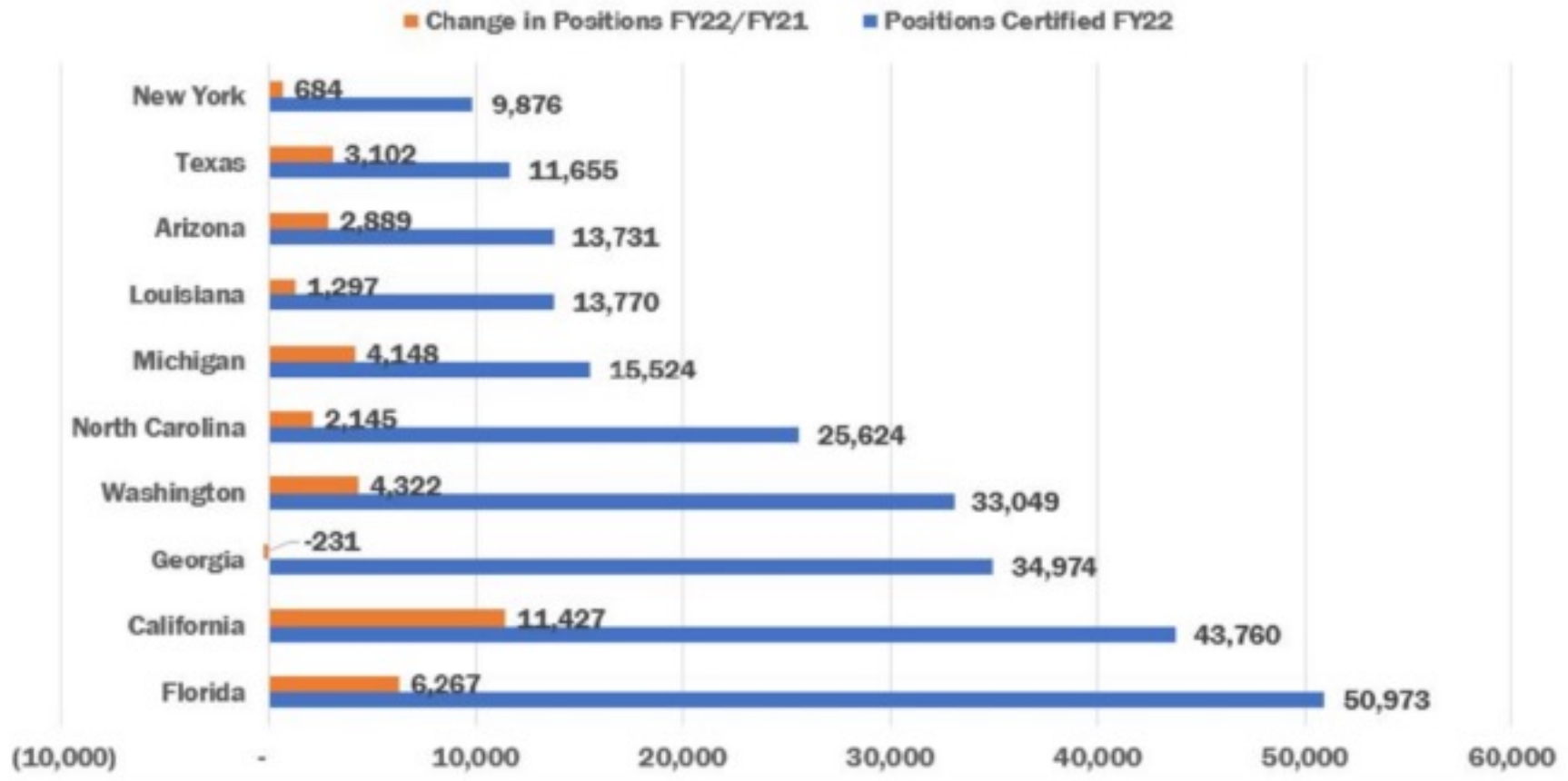
- Three options:
  - Invest in farm worker visa programs, H-2A.
  - Adopt mechanization/automatization solutions.
  - Go out of business and import fruit from other countries.

Farm worker visa program in the United States



Source: Phil Martin 2022. Rural Migration News. December.

10 U.S. states account for 2/3 of total H-2A certified jobs in FY22



Source: American Farm Bureau Federation.

Issues with H2A

- The employment of H-2A workers should cause no harm to the wages and working conditions of similarly employed U.S. domestic workers.
- Two mechanisms:
  - Employers must demonstrate effective recruitment of domestic workers (less than 5% of U.S. domestic workers accept H-2A job offers).
  - Employers must pay H-2A workers the Adverse Effect Wage Rate (AEWR) which is higher than the federal or state minimum wage In 2023, the national AEWR is equivalent to $16.14/hour, and in Washington State, the AEWR is $17.97/hour.

Issues with H2A: Costly and highly bureaucratic

- The application process requires the employer to submit a job order to the State Work Force Agency 60 to 75 days before the start of the job.
- The order must include the number of workers requested, duration of employment, job duties, employment benefits, workers' minimum number of weekly hours, and hourly wages.
- Next, the employer must submit another application for Temporary Labor Certification to the Department of Labor no less than 45 days before the job starts. This application must certify the knowledge and compliance with all requirements of the H-2A program and that the job was advertised on the Department of Labor online platform.
- Two other federal agencies are involved: the U.S. Citizenship and Immigration Services (USCIS) and the U.S. Department of State. Once the Department of Labor grants the temporary labor certification, the employer must submit the I-129 Petition for Nonimmigrant Workers to USCIS. After the I-129 is approved, the worker candidate submits the approved I-129 along with other application documents to the U.S. Department of State at the U.S. Consular office in the worker's home country. This latter entity issues the H-2A visa.

Issues with H2A: Costly and highly bureaucratic (cont.)

- The employer must provide the workers a contract that stipulates all terms and conditions of the work in clear language to the worker.
  - Beginning and end dates of the contract period, location of work, payment for transportation, housing, meals, rest days, work hours per day and days per week, crops to be worked with and jobs to be performed, applicable rates for each type of crop or job, provision of tools for the job, compensation insurance, and any deduction not otherwise required by law.
- Employers must pay for the application, visa processing fees, transportation to and from the country of origin, and daily transportation to the work site and **housing.**

Farm labor modernization act

- Farmers and ranchers across the United States are in desperate need of a high-quality, reliable workforce, farmworkers need a stable future, and the current H-2A guestworker program needs meaningful, bipartisan reform.

The bill:

- Reforms the H-2A program to provide more flexibility for employers, while ensuring critical protections for workers.
- Establishes a program for agricultural workers in the United States to choose to earn legal status through continued agricultural employment and contribution to the U.S. agricultural economy.
- Focuses on modifications to make the program more responsive and user-friendly for employers and provides access to the program for industries with year-round labor needs.
- Passed twice in the House, stalled in the Senate.

Source: Rep. Dan Newhouse, Washington 4th District

We asked H-2A workers: Sample size 154

Variable	Coefficient estimate	Standard error
Mean		
Prefer current job bundle – Neither alternative presented (alternative specific constant)	10.213***[a]	2.236
The company offers an opportunity to take short vacations[b]	10.583***[a]	0.742
Machine operator training (i.e., Tractor) and free English classes [c]	10.184***	1.180
Free English classes [c]	9.278***	1.708
The company offers housing amenities[d]	7.999***	0.710
Training in machine operation (i.e., Tractor)[c]	7.655***	0.986
Work as many hours as a worker and employer agree[e]	6.210***	0.895
For all hours over 40/week, earn overtime pay of $2 per bin[e]	1.946**	0.886

[a] *, **, *** indicates statistical significance at the 10 percent, 5 percent, and 1 percent levels. [b] Relative to "No opportunity to take short vacation." [c] Relative to "No training opportunity." [d] Relative to "No offer of housing amenities." [e] Relative to "Work a max. of 40 hours/week – there is no overtime opportunity."

Source: Gallardo et al. in review

We asked H-2A workers

- H-2A workers interviewed **favor the most** having the opportunity to take short vacations within the contract length. They are willing to pay their travel expenses.
- They value the opportunity to receive training: English classes and machinery operation.
- They value the least the housing amenities.
- When asked about overtime pay:
  - They perceive the overtime pay as limiting the number of hours they can and are willing to work, and their opportunity to make more money.

Source: Gallardo et al. in review

Automation: Robots when harvesting apples

- Currently, robots are in the experimental stage in apple production
  - Robots are being developed for pruning, thinning, chemical spraying, and harvesting.
- Charlton et al conducted break-even analyses to determine
  - the maximum feasible up-front cost for the robotic harvester that will yield the same profits as manual harvesting,
  - how the economically feasible up-front cost changes for different picking speeds, robot-induced damage rates, and picking efficiency,
  - the tradeoff between the wage rate and changes in the three robotic parameters (picking speeds, robot-induced damage rates, and picking efficiency) given an initial up-front robot cost.

Source: Charlton et al. In review

Robots for Harvesting Fresh Apples Findings

- Assuming the performance of a robotic prototype:
  - 5% robot-induced damage rate
  - Picking rate of 3 seconds per arm
  - Assuming the robot misses 10% of harvestable apples in the orchard)
- Baseline wage rate of $18.79
- The up-front robot cost of **$461.10** for 90 acres amortized over 10 years would result in equal profits from robotic and manual harvest
- The table shows different combination of picking efficiency, robot induced damage and picking speed.

		Robot-Induced Damage Rates			
		0.01	0.025	0.05	0.075
Panel 1: Time to Pick One Apple, 1 Second per Arm					
Picking efficiency	0.80	-4,899	-147,475	-385,101	-622,727
	0.85	359,233	207,746	-44,731	-297,209
	0.90	723,365	562,967	295,638	28,309
	0.95	1,087,497	918,188	636,007	353,826
Panel 3: Time to Pick One Apple, 3 Seconds per Arm					
Picking efficiency	0.80	-267,279	-409,854	-647,480	-885,107
	0.85	80,455	-71,032	-323,510	-575,987
	0.90	428,188	267,790	461	-266,868
	0.95	775,921	606,613	324,432	42,251

Robots for Harvesting Fresh Apples
Sensitivity Analyses Wage and Robot Parameters

- We utilize a root-finding algorithm to calculate the robot-induced damage rate, percentage harvested, or picking speed that corresponds to a wage rate such that the net revenues from both operations are equal for an assumed annual cost of a robotic harvester of $40,000 for a 90-acre farm.
- By repeating this break-even analysis for various wage rates, we compute the corresponding robot-induced damage rate and then calculate the elasticity of the robot-induced damage rate to the wage rate. This elasticity is computed as the percent change in the robot-induced damage rate ($rp = \gamma_M - \gamma_R$) divided by the percent change in the wage rate:

$$\varepsilon_{rp,wage} = \frac{\%\Delta rp}{\%\Delta \text{Wage}}.$$

- Through similar analyses, we can calculate the elasticity of the percentage harvested and the picking speed to the wage rate.

- For every 1% increase in the wage rates,
  - Robots could have a 4.37% increase over the current robot-induced damage rate
  - Robots could have a 0.22% decrease in the picking efficiency
  - Robots could be 6.69% slower than the current picking speed
- Holding other parameters constant.

Robots for Harvesting Fresh Apples
Concluding thoughts

- Robot profitability is affected by robot parameters: Picking speed, robot induced damage, picking efficiency *AND* wage.
- Elasticities estimates indicate that profitability changes due to wage increases are most sensitive to (1) Picking speed, (2) Robot induced damage, and (3) Picking efficiency.
- Robots will not eliminate the need for workers in the field
- For example, robotic strawberry harvesters (currently used on only a few commercial farms) require an operator who turns the robot at the ends of rows and repairs robotic arms as needed, along with a crew of workers who pick strawberries that the robot missed
- The operator needs additional training: Motivated H-2A workers could qualify
- Farms had to change their worker incentive structure since workers will not work piece rate to follow a robot and pick leftover fruit
- Quality of work is arguably more comfortable, slower paced, and allows more opportunities to acquire new skills and for upward mobility.

Other automated technologies used in tree fruits

- Automatic sprayers
  - Wireless/ultrasonic sensors to dispense precise chemical rate.
- Automatic guided vehicles
  - Adaptability to carry a diverse array of implements: chemical sprayers, tree canopy shakers, weed elimination
- Drones
  - To provide information on crops
  - Release sterilized codling moths

Photo: Good Fruit Grower, 2021

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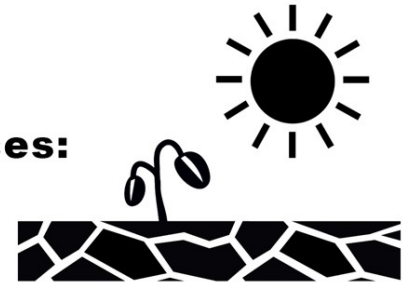
Climate Change

Climate Change

- What climate change implies for agriculture:
  - Appearance and increased recurrence of pests and diseases
  - Decreased water sources in quality and quantity
  - Increased temperatures: heat resistant crops
- How will the agricultural industry adapt to climate change?

Climate change is altering the way food is produced by reshaping weather patterns and causing a rise in global temperatures.

Resulting in the following consequences:



Droughts and heatwaves

Extreme weather events

Broadening the geographical distribution of pests and diseases that intensifies pest-related challenges leading to more extensive pesticide usage. Disturbances in the traditional schedules for planting and harvesting. Disruption of ecosystem, negatively impacting pollination and biological control potential.

What tools do we have to survive as humans?

- New technologies
  - Would consumers understand that agricultural activity cannot be the same as in the 1800s (**Not a Michael Pollan book**) due to climate change and evolving market conditions?
- Society in general is very accepting of new technologies in their daily life, but NOT when coming to agri-food production and processing
  - Early days pasteurization
  - Microwave, irradiation
  - Antibiotic use
  - Biotechnology: Genetically modified, gene editing

Society's Rejection to New Technologies in Agriculture and Food Processing

- Deterrent effect
  - Not realizing in their entire magnitude, the benefits that new technologies imply.
- Consumers are more acceptant to technologies depending on the implication of the benefit
  - More accepting of technologies which benefit directly affects the consumer: improve taste and eating experience, improve nutrition and health benefits
  - Information diminishes the discount for gene editing for improved animal welfare
  - Strong reluctance if the benefit is just realized at the production side, for example, herbicide tolerance

Concluding thoughts

- Washington is a leader in agriculture activity in the nation and in the World.
- Pressing issues, include stagnant market prices, ever-increasing labor challenges and climate change.
- Policies should be oriented to guarantee domestic production of high-quality food, considering all un-intended consequences.
- Acceptance of scientific innovation, by consumers and farmers.

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Thank you

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