



Energy Analysis of Walnut Processing in California

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Background and Purpose

The United States is the third largest walnut producer in the world,¹ and California is the largest producer in the United States.² Many steps taken during walnut processing are energy intensive, including harvesting, drying, processing, and transportation. **Therefore, the purpose of this project is to identify and categorize areas of energy consumption during walnut processing in California.** Because energy estimates have not been updated within the last ten years, there is a need to re-evaluate current practices. By understanding the energetic costs of each step, walnut-processing methods can be improved.

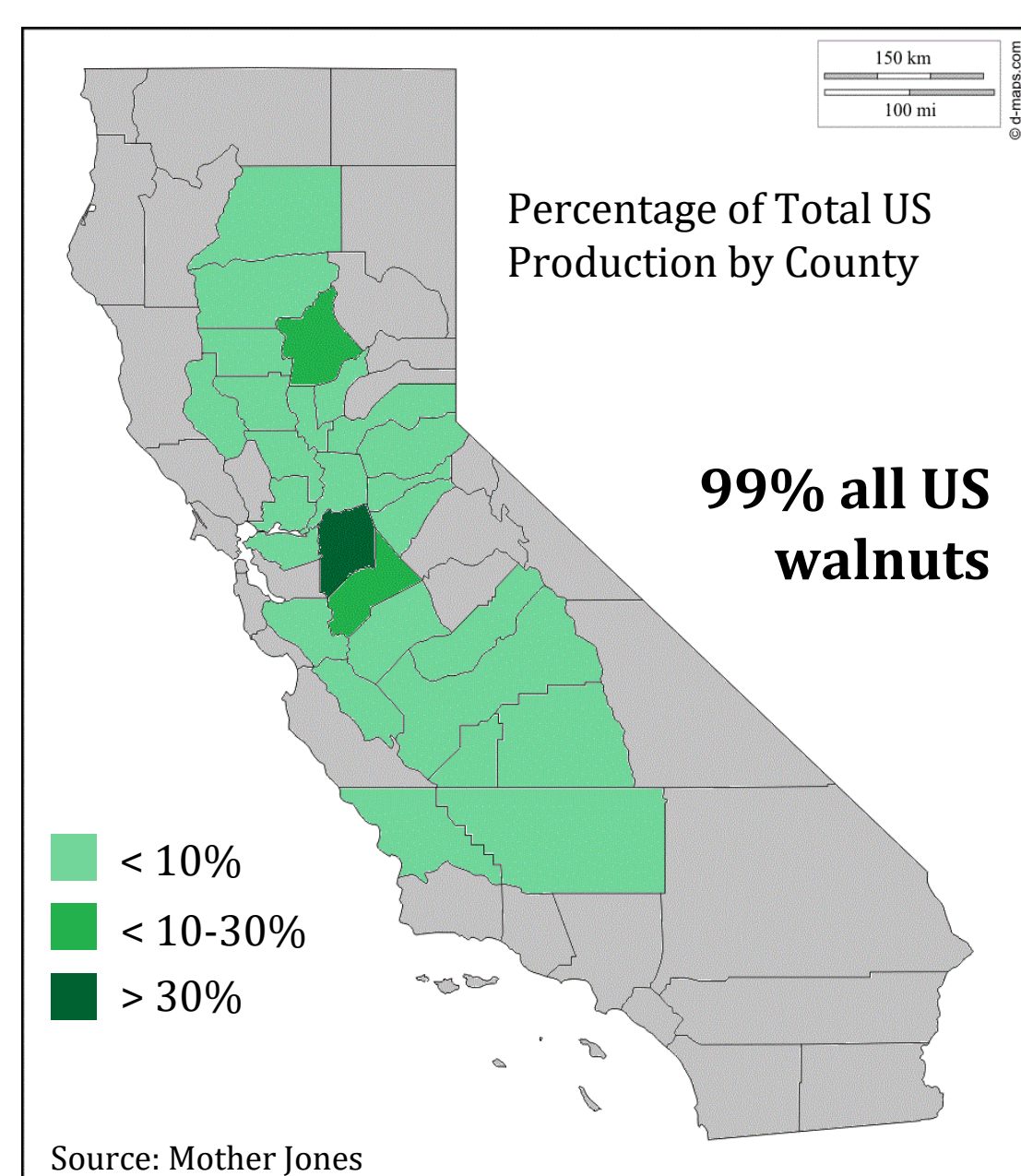


Figure 1: Map of walnut producing counties in California

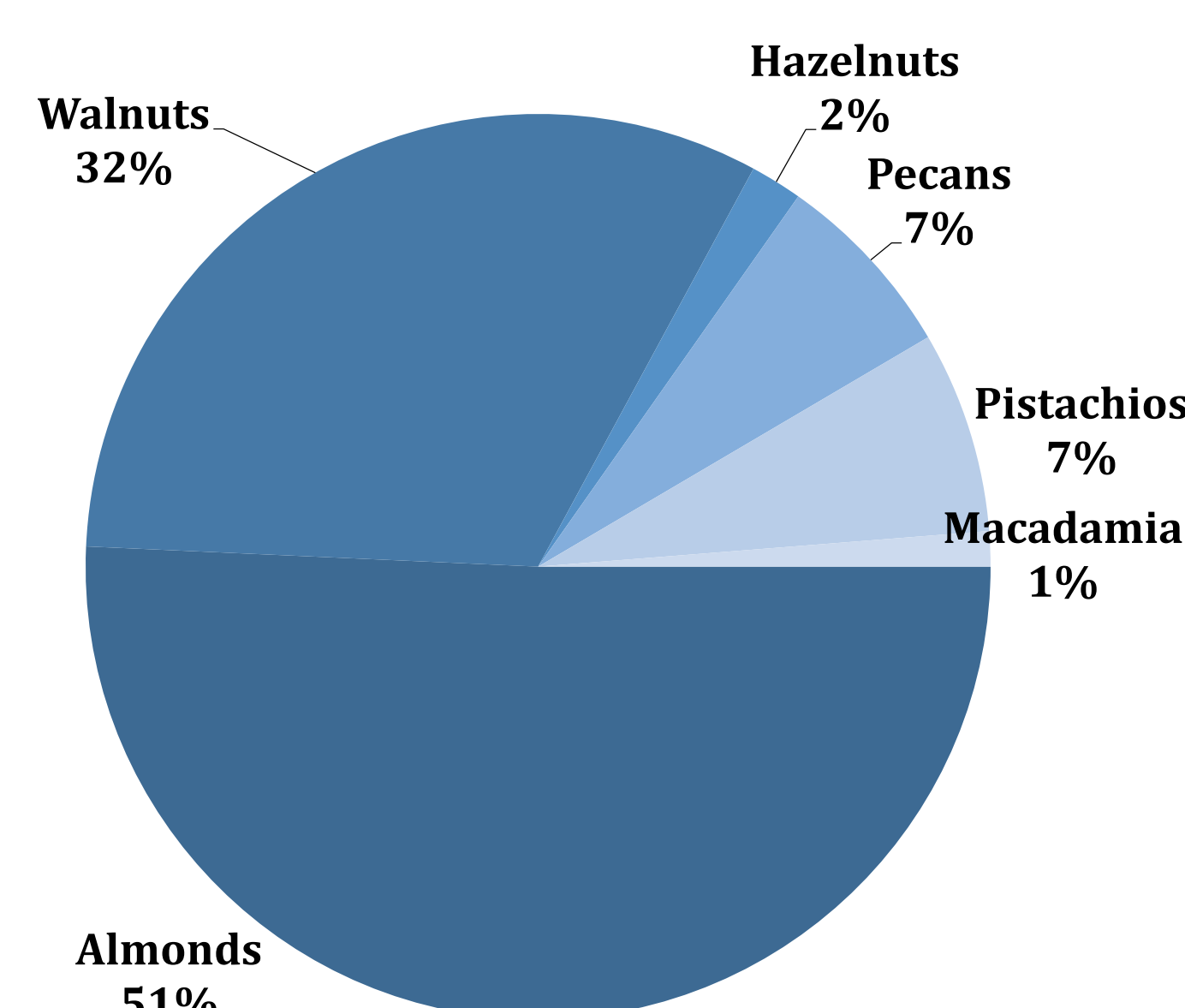


Figure 2: U.S. Tree Nut Production in 2015



Figure 3: Two samples of walnut meat post-dehydration. The sample on the right has been over-dried



Figure 4: A typical walnut dehydration facility. Photo courtesy of Moody Walnut Dryer

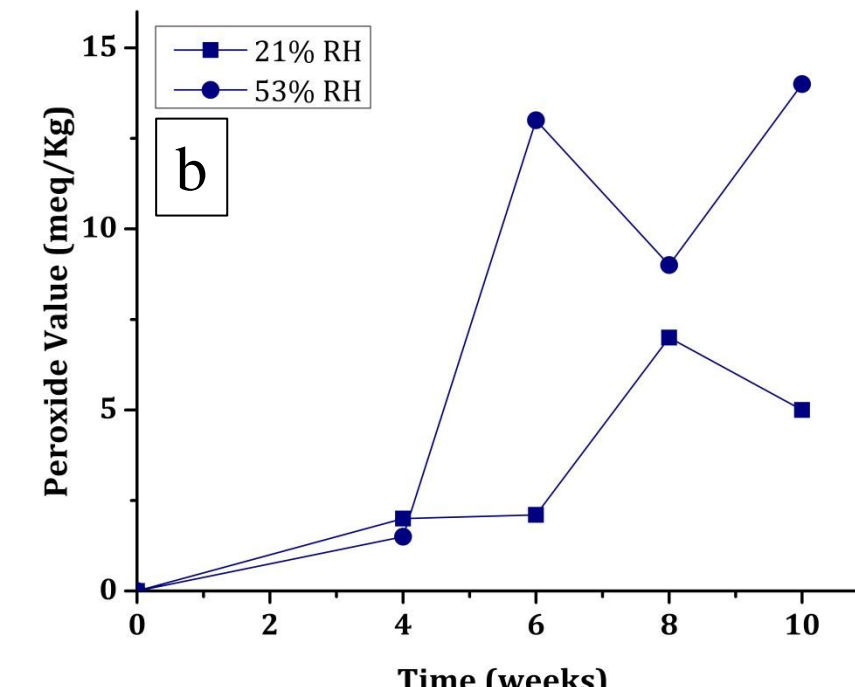
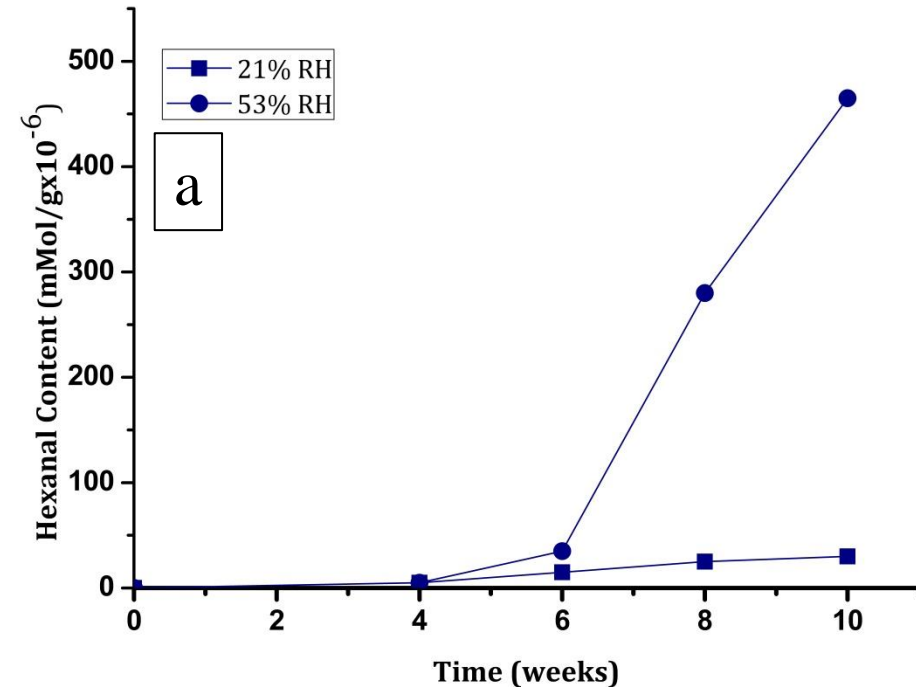


Figure 5: Plots of indicators of rancidity in walnut meats during post-dehydration storage: (a) hexanol content and (b) peroxide value both vary widely depending on the relative humidity. See reference 6.

Results

Based off participant data, drying accounts for 47% of the energy use in 1980, 11% in 2009, and 47% in 2017. In 2017, drying facilities used 22 MJ per kilogram of walnuts produced. In 2009 and 1980, 13 MJ and 39, respectively, were used. In 2009, there was a 72% drop in energy consumption from 1980. However, the data from 2017 suggests that overall there has been a 44% decrease in energy usage from 1980 to 2017.

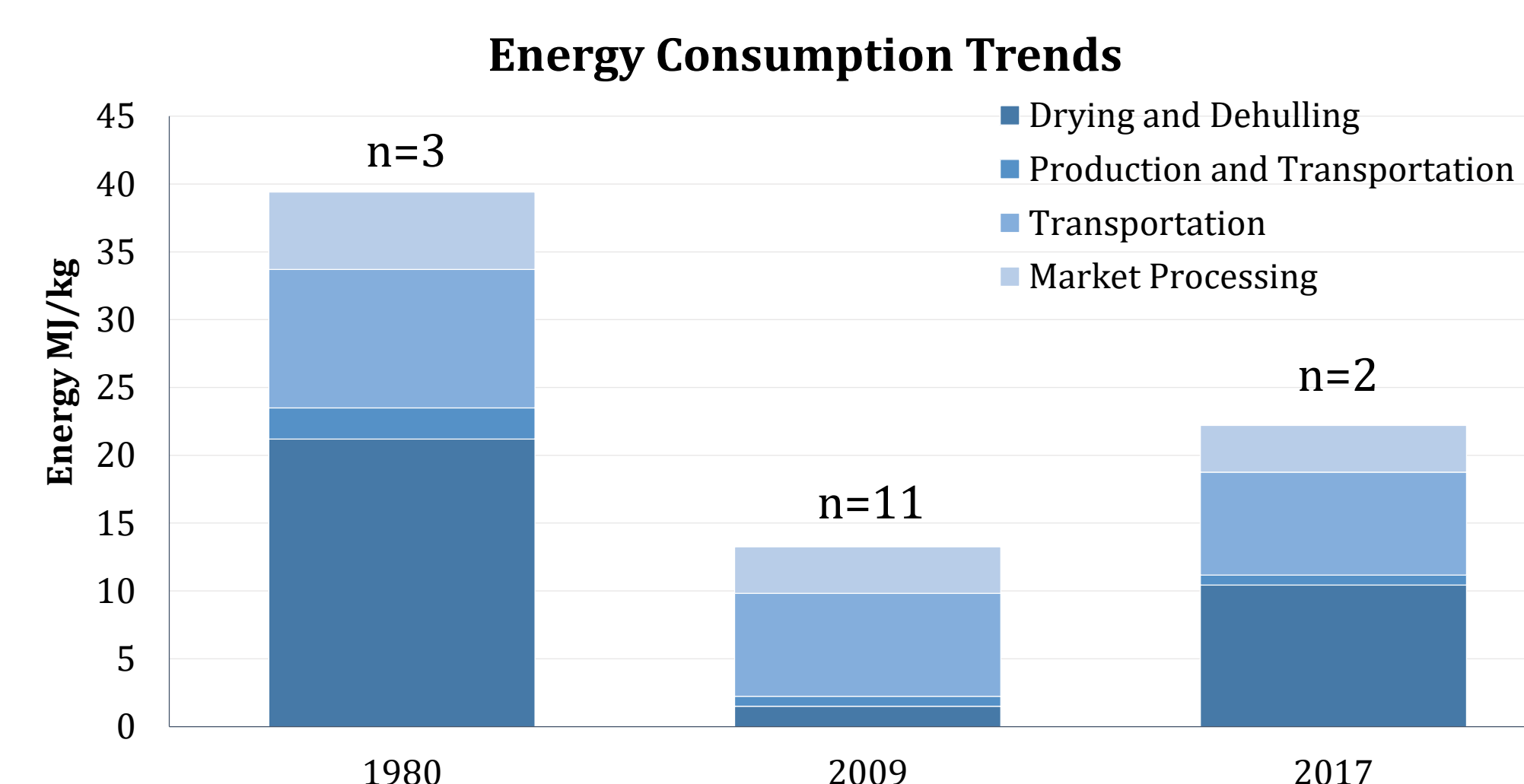


Figure 6: Contribution of each of the four processing steps to total energy consumption in each of the three time periods analyzed. n=number of facilities in survey

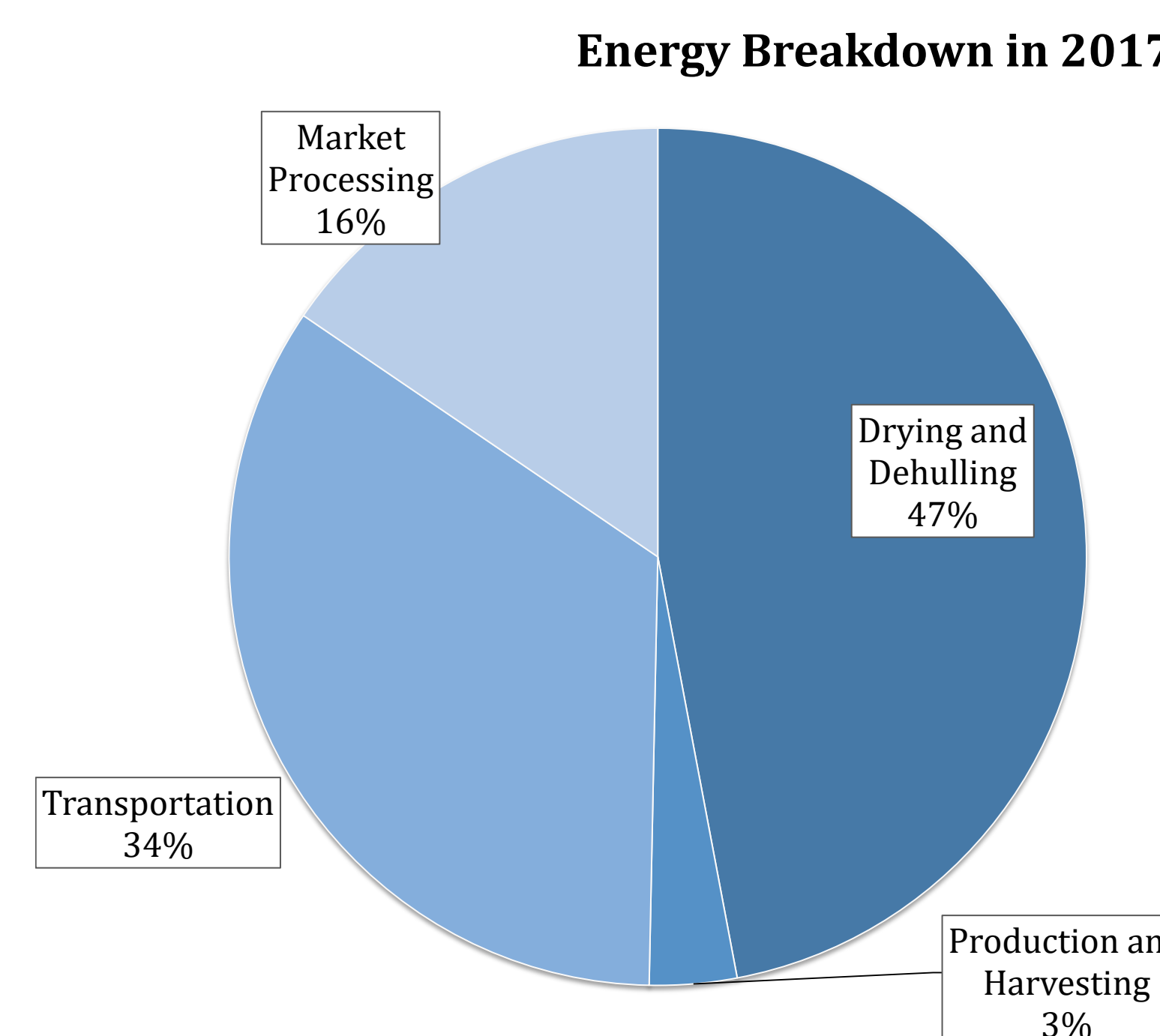


Figure 7: Fractional contribution of each processing step to total energy use in 2017.

Energy Distribution during Drying and Hulling

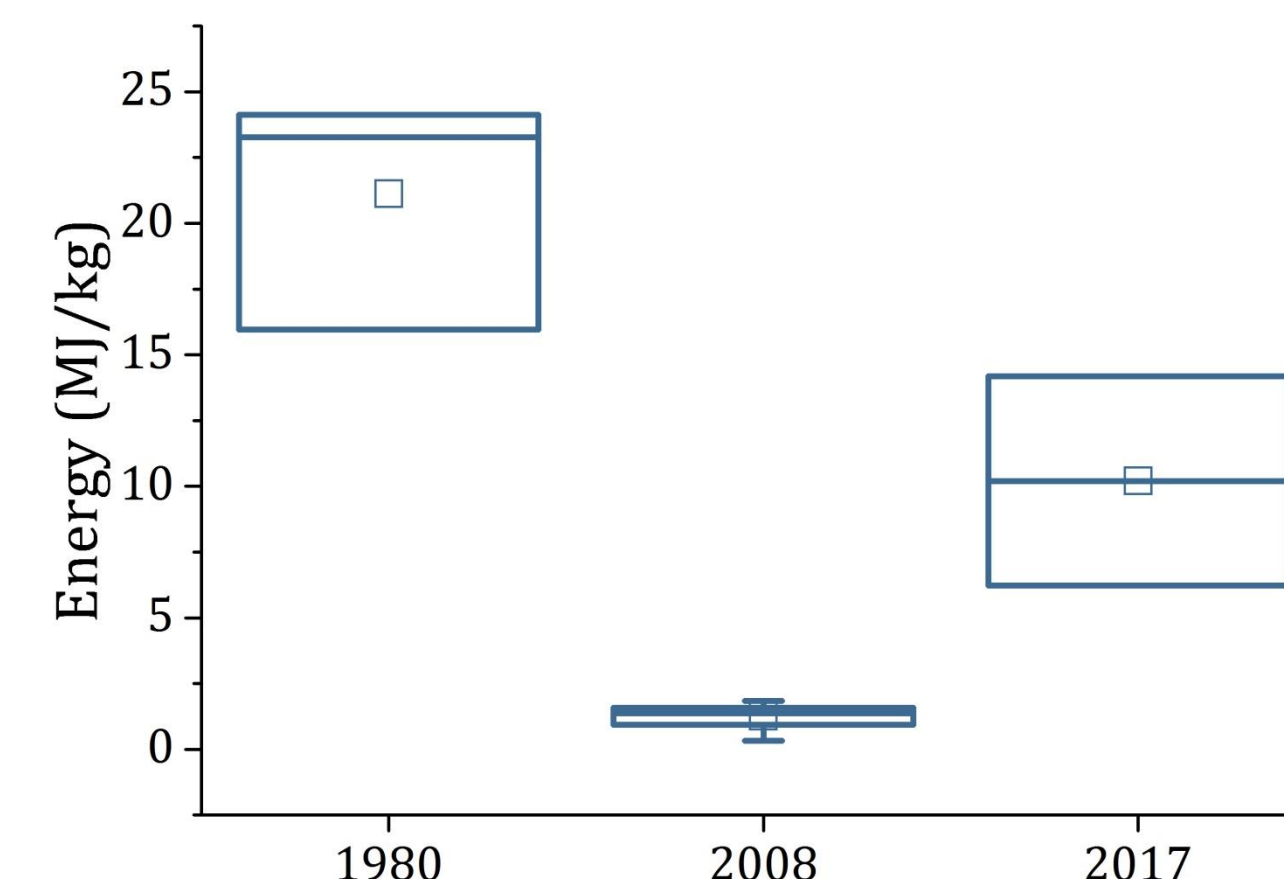


Figure 8: Spread of results obtained through survey data in each of the three time periods.

Method

Drying data collected from drying facilities in northern California were gathered by administering phone and e-mail surveys. These data were compared to similarly collected data from 2009 and 1980. Data related to the other steps (harvesting, processing and transportation) in walnut processing were evaluated using published work.

Processing Step	Collection	Assumptions
Drying and Hulling	Survey Data	Data set represents all CA production.
Production and Harvesting	Published Work	Northern California region, energy in machinery only.
Transportation	Published Work	All nuts in US travel same average, scaled by fuel efficiency.
Market Processing	Published Work	Shelling and Cold Storage. Stored for 6 mo. at 0°C

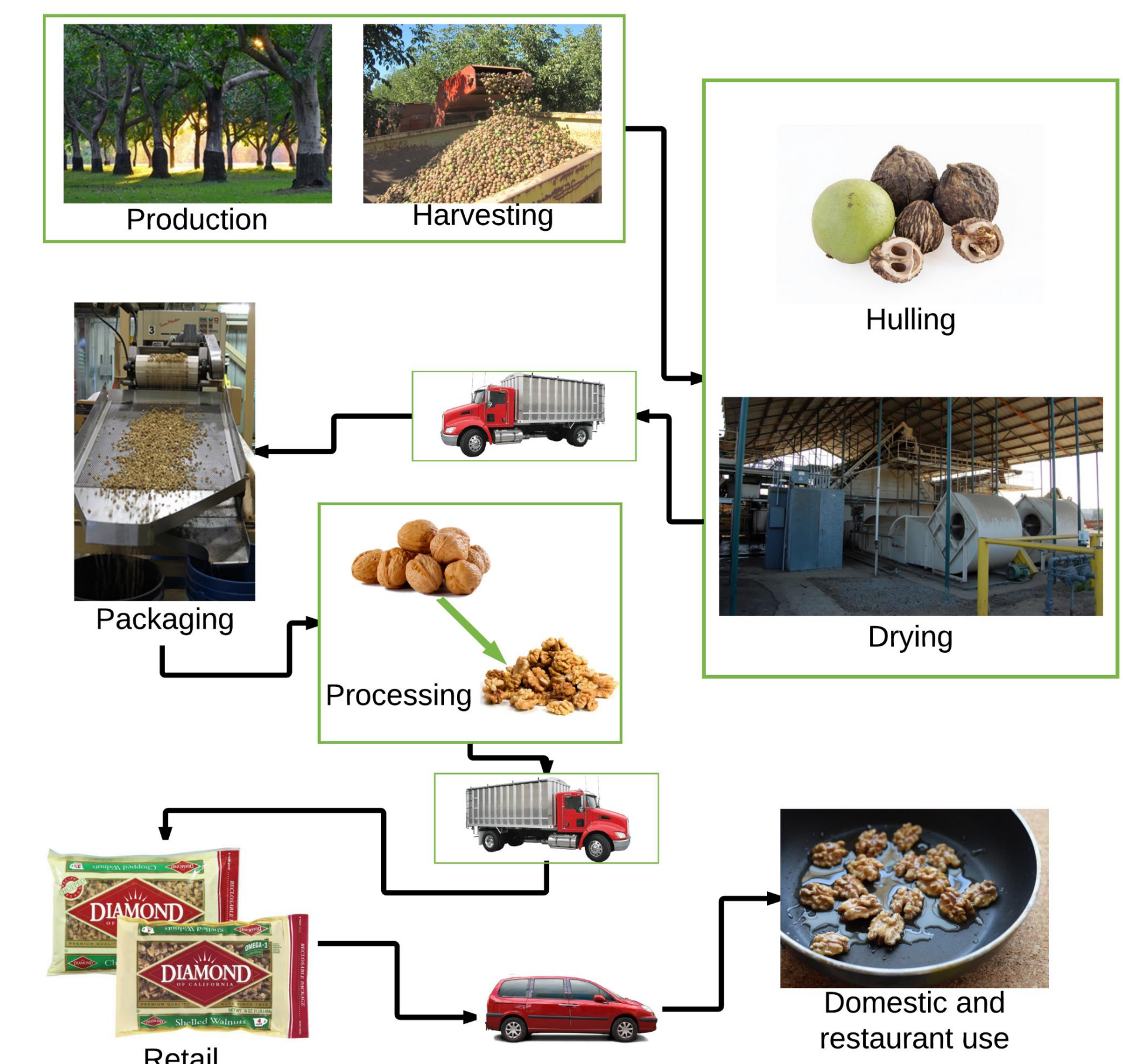


Figure 9: Walnut processing flow diagram. Green boxes indicate steps which were included in this analysis.

Conclusions

- Drying accounts for a substantial amount of energy use
- Energy consumption among producers varies greatly
- Data are not readily available and are difficult to obtain
- Based on available survey data, energy use appears to be decreasing from 1980's levels

Recommendations & Future Work

- Continue collecting data from local processors
 - Obtain more contacts from regional advisers
 - Modify survey based on feedback
- Obtain utility data for larger sample set of energy use
- Decrease uncertainty in calculation of all processing steps

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Acknowledgments

We would like to thank Dr. Irwin Donis-Gonzalez, Dr. James Thompson and Dr. Kurt Kornbluth for their support throughout the quarter.