

Final Report

Sweetpotatoes: The relationship between retail price and household demand

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Project code:

PW20003

Project:

Sweetpotatoes: The relationship between retail price and household demand (PW20003)

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Funding statement:

This project has been funded by Hort Innovation, using the sweetpotato research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

ISBN 978-0-7341-4842-1

Published and distributed by: Hort Innovation

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www.horticulture.com.au

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Summary

The purpose of this project was to undertake a detailed analysis to understand the relationship between the retail price of sweetpotatoes and total volume of demand for sweetpotatoes in retail outlets. The technical term for this relationship is called the 'elasticity of demand'. Findings from the study will assist industry to answer questions like, if the retail price was raised by 5 percent, how much would total demand change, and what would be the impact on total revenue from sales?

This document summarises the findings from the analysis using plain English terms. A full technical report is provided as an appendix.¹

The study set out to estimate how changes in the retail price of sweetpotatoes affects the demand by Australian households (i.e. how responsive consumers are to changes in price) and investigate opportunities for growth that are based on an optimal value/volume mix. The findings were then used to estimate the optimal volume supplied and average retail price to maximise industry revenues and support overall growth. This study focussed on demand for fresh sweetpotatoes at the household level, thus demand by the food services, processing and export markets were not part of this analysis. Findings from the report provide useful insights for sweetpotato levy payers, Horticulture Innovation Australia, industry stakeholders and value chain members.

The study involved a review of the literature to investigate the key drivers of demand for sweetpotatoes and the data required to estimate how consumers respond to changes in the retail price of sweetpotatoes. The literature review was also used to check and ensure that the best modelling approaches are used in the study given data availability. Household consumption data was supplied by ACNielsen from their Homescan market panel data for Australia. This data provides grocery transaction information for 10,000 Australian households for the period April 2018 to May 2021.

The price elasticity of demand (or consumer responsiveness to price changes) for sweetpotatoes was estimated at -0.91. This indicates that a 1% increase in the average retail price of sweetpotatoes leads to a 0.91% decrease in the household demand for sweetpotatoes. The analysis also considered the impact of changes in price for close substitutes for sweetpotatoes, i.e. potatoes and pumpkins. Our estimates indicate that the 1% increase in the retail price of sweetpotatoes will lead to a 0.22% and 0.08% increase in the demand for potatoes and pumpkins, respectively. Thus, potatoes are a stronger substitute for sweetpotatoes than pumpkins. It is important to understand these relationships to avoid decisions that would result in inadvertent losses of market share to substitute products.

Based on the estimated price elasticity of demand (consumer responsiveness to price changes) for sweetpotatoes, an optimal value/volume mix was estimated based on the most recent (2019/20) retail price and volume data. It was estimated an average price increase of 4-5% at the retail level will lead to a 0.21% (approximately \$415,000) increase in total revenue from retail sales. Some of this additional revenue should benefit farmers through higher farm-gate prices. These results indicate a relatively limited growth in industry value. This is an outcome of a saturated household demand market. Over the last seven years, the production volume of sweetpotatoes has almost doubled while household penetration (the proportion of households that actually buy sweetpotato) has stayed around 65% since 2016, and volume purchased per shopping trip has remained stable at around 0.73kg. However, production volumes have undergone a rapid growth from 55,000 tonnes to 107,000 tonnes between 2013 and 2020.

Overall, household demand analysis indicates that there is only a limited growth opportunity to grow the industry in Australia through increases in value or volume from retail fresh supply. These results indicate that there are limited opportunities to boost household consumption without an increase in population or a change in people's preferences. Given these findings and observations, it is worth noting that this does not necessarily mean that the industry has exhausted its overall growth potential. Potential industry growth could be pursued through increasing the proportion of production that goes to processing and export markets to limit oversaturation of the domestic market. Other considerations include value adding product, developing deeper understanding of consumer attitudes and behaviours to support increasing purchase intent. The findings from this study are relevant for sweetpotato levy payers, Horticulture Innovation, industry stakeholders and value chain members.

¹ Natural Capital Economics (2021). Price elasticity of demand for Australian fresh sweetpotatoes, Technical report. Report for Hort Innovation Australia.

Keywords

Price elasticity of demand; econometrics; sweetpotatoes; demand analysis; household consumption; potato; pumpkin; optimal value; optimal volume

Introduction

The Australian sweetpotato industry is a significant and growing vegetable industry. Recent data indicates that between 2013 and 2020, sweetpotato production volume has almost doubled from 54,969 to 106,715 tonnes per year while production value has increased by 60% from \$52 million to \$83 million. Over the same period, net trade has more than trebled from 386 tonnes per year to 1,576 tonnes (Hort Innovation, 2020) and the fresh supply volume has increased by 81% from 52,934 tonnes to 95,881 tonnes (Hort Innovation, 2020). In 2020, most of the sweetpotato production was sold to the domestic fresh markets (95,881 tonnes), with only 2,371 tonnes exported and imports account for relatively small proportion of domestic consumption (795 tonnes). Domestic demand has been the key driver of overall demand for Australian produced sweetpotatoes. In 2020, the volume of retail supply was 75,795 tonnes (i.e. 79% of the fresh supply). Thus, household purchases at retail shops represent a significant proportion of the Australian demand for fresh supply. However, household penetration and volumes purchased have remained relatively stable over the last seven years to 2020.

Retail price is a key driver of the volume demanded in the market. It is therefore important to have a good understanding of how price changes affect consumer demand. To better understand the impact of price changes on consumer purchases, a review of the literature and an econometric analysis were undertaken. Econometric analysis is a specific type of statistics that is designed to understand the relationships between two different variables such as product price and demand. The literature review was undertaken to ensure that the best modelling approaches are used in the study given data availability. The econometric analysis was undertaken to estimate how demand changes when the retail price of sweetpotatoes change (own price elasticity) and when the relative price changes compared to close substitute products – potato and pumpkin (cross-price elasticities of demand). The findings contribute to improved understanding of consumer purchase behaviour and their responses to changes in price of sweetpotatoes and their close substitutes (i.e. potatoes and pumpkins).

The key objectives of the study were:

- To determine how consumer demand for sweetpotato responds to changes in price, and
- To identify opportunities for the sweetpotato industry to unlock opportunities for segment growth through optimal value/volume mix.

The findings from this study are relevant for sweetpotato levy payers, Horticulture Innovation, industry stakeholders and value chain members. This project contributes to the first industry outcome of the Hort Innovation and Sweetpotato Fund Strategic Investment Plan 2017-2021 i.e. 'retain and expand domestic market consumption and demand for fresh sweetpotato with differentiation from competing products based on consistent quality and nutritional value' (Hort Innovation, 2016). This outcome was achieved by identifying retail price thresholds which, if crossed could lead to both short- and long-term loss of market share to substitute products. Additionally, the project outcomes contribute to improved industry cohesiveness between business and industry value chain firms to effectively engage in implementation of the outcome 4 'By 2021, the Australian sweetpotato industry has secured and strengthened its good reputation with the community, customers and governments'. This will be achieved through a shared understanding of the effects of retail pricing on consumer demand and overall market share or demand for sweetpotatoes.

Methodology

The study methodology involved a review of the literature, data collection and demand analysis. A review of the literature was undertaken to investigate what previous price elasticity of demand studies have been undertaken for sweetpotatoes and similar products. As part of the review, we identified the common methods used and the data requirements for the different methods. The following sections provide a summary of our findings from the review of the literature. Further details on the methodology are provided in the appendix.

Literature review

The review of the literature was focused on studies of price elasticity of demand for agricultural produce, particularly those undertaken for Australian or other Organisation for Economic Co-operation and Development (OECD) countries which are more likely to relate most to the Australian context. It was evident that there are not many published studies in Australia or with a sweetpotato focus. However, there were two studies, one by Ulubasoglu et al. (2016) which estimated price elasticities for 15 food categories for Australian households, and another by Hasan & Sinning (2018) which studied a much wider range of food demand categories, also at the Australian household level. Fresh vegetables were one of the categories analysed and it was found to have an elasticity of -0.63. This implies that across fresh vegetables a 1% increase in price will lead to 0.63% drop in demand. Table 1 provides estimated price elasticity of demand for fresh vegetables and fruits from past studies. Findings from past studies indicate that the responsiveness of customers to price varies, for example in the US, Naanwaab et al. (2012) found that a 1% increase in the price of carrot can lead to a 0.30% change in demand, while Durham & Eales (2010) found that a 1% price change for grapes in US can lead to a higher (1.62%) drop in demand.

Table 1. Sample results from price elasticity of demand studies

Commodity	Elasticity value (% change from a 1% increase in price)	Location	Study
Fresh vegetables	-0.63	Australia	Ulubasoglu et al. (2016)
Fresh vegetables	-0.815	Australia	Hasan & Sinning (2018)
Vegetables	-0.58	US	Andreyeva et al. (2010)
Organic potatoes	-1.0	US	Greenway et al. (2011)
Fresh fruits (bananas)	-0.98	US	Durham & Eales (2010)
Fresh fruits (grapes)	-1.62	US	Durham & Eales (2010)
Potatoes	-1.57	Jordan	Jabarin & Al-Karablieh (2011)
Carrot	-0.30	US	Naanwaab et al. (2012)

While there are different demand analysis methods for estimating how consumers respond to changes in prices, the most widely used method is the Almost Ideal Demand System (AIDS), first proposed by Deaton and Muellbauer (1980a, 1980b). The AIDS model has been used to analyse household demand for a variety of household consumption commodities such as vegetables, meat, rice, and fruits among others.

Key point

All studies reviewed showed that when prices increase, demand will decline.

Consideration for substitutes and model attributes

A robust demand analysis study should consider the effect of substitute products and socio-demographics. Substitute products refer to those products which a consumer can replace the product of interest with, while socio-demographics refer to attributes such as household income or household size. These factors can have an impact on the level of demand for sweetpotatoes.

A recent study commissioned by Horticulture Innovation found that 94% of households surveyed indicated that they would use potatoes as substitute for sweetpotatoes (Edentify, 2019). Other top substitutes were pumpkin

(88%) followed by carrots (38%) (Edentify, 2019). A review of a sample of 12 recipes with sweetpotatoes as an ingredient posted on Australian websites supported the findings from the survey by Edentify (2019). For example, 50% of the recipes mentioned that sweetpotato could be substituted with potatoes while another 50% recommended the use of pumpkin as a substitute. Only one of the 12 recipes mentioned carrot as a substitute for sweetpotatoes.

Many studies consider the importance of other key variables that may affect the demand for food products. The most common variables tested were income levels, household size, region (including rural versus urban), and shopper demographics (e.g. age, gender, education, and ethnicity). Other variables tested included display area and promotions – which is often driven by seasonality (Durham & Eales, 2010), specific store identifiers (Durham & Eales, 2010), and number of stores in area (Greenway et al., 2011).

Key point

Both potato and pumpkin are considered substitutes for sweetpotato. Therefore, it is important to consider those products within the analysis.

Data used in the analysis

The data used in the econometric modelling was sourced from ACNielsen's Homescan market panel data for Australia. This data is based on an average of 10,000 households' purchasing behaviour with observations recorded on a weekly basis between April 2018 and May 2021. Specific data collected for sweetpotatoes, and its two substitutes included: retail prices, volume purchased, amount spent, promotions, and seasonality the data. Additional variables such as shop location (rural or urban), age of main shopper, household size and income were also captured. A detailed list of data collected and used in the analysis is provided in the Appendix.

Key point

The analysis is based on the actual purchasing choices of around 10,000 households and should be considered a good indication of the whole Australian fresh food marketplace.

Note: There were limitations with the data used in this study. The data used in this study was based on NielsenIQ Homescan data. This data had an assumption on the average weight per sweetpotato which is higher than the current industry average (see Box 1 in the document referenced in Appendix A). The overall results from our analysis are still valid as the own-price elasticity estimates are unlikely to change. The estimates for the optimal price-volume mix will likely change as the corrected weights will change the unit prices used in our analysis. We caution against the use of the findings from the optimal value/volume mix to guide future decisions.

Outputs

The following outputs were developed/delivered through this project:

- Household consumption data: we sourced and cleaned a dataset detailing historical purchase of sweetpotatoes, potatoes and pumpkin from April 2018 to May 2021.
- A technical report titled "*Price elasticity of demand for Australian fresh sweetpotatoes*".
- Workshop presentations to Hort Innovation and industry stakeholders x1.
- A non-technical report of the study for industry and other stakeholders (this report)
- A 1-page article for use by Hort Innovation and other stakeholders in newsletters and websites (*work in progress*).
- The project team is currently developing a journal article for peer-review and publication in a journal (*work in progress*).

Outcomes

This study has generated new knowledge and insights about how changes in the retail price of sweetpotatoes could affect the demand for fresh sweetpotatoes by Australian households. The findings were then used to estimate the optimal volume supplied and average retail price to maximise industry revenues and support overall growth.

Consumer responsiveness to retail price

The first stage involved obtaining estimates for how responsive consumer demand is to changes in retail prices. A summary of the results is provided in Table 2.

Table 2. Summary of modelling results

Variable	Elasticity value (% change from a 1% increase in price)
Demand responsiveness to retail price for sweetpotatoes (own price elasticity)	-0.913%
Demand responsiveness to retail price for potatoes (own price elasticity)	-0.926%
Demand responsiveness to retail price for pumpkins (own price elasticity)	-0.856%
Impact of changes in retail price of potatoes on demand for sweetpotatoes (cross-price elasticity)	0.224%
Impact of changes in retail price of pumpkin on demand for sweetpotatoes (cross-price elasticity)	0.080%

Based on our results, the information reported in Table 2 could be interpreted as follows:

- The own price elasticity for sweetpotatoes is -0.913. This indicates that a 1% increase in the retail price of sweetpotatoes decreases the demand for sweetpotatoes by 0.913%.
- A 1% increase in the retail price of sweetpotatoes will lead to a 0.224% increase in the demand for potatoes.
- A 1% increase in the retail price of sweetpotatoes will lead to a 0.080% increase in the demand for pumpkin.
- A 1% increase in the retail price of potato will lead to a 0.264% increase in the demand for sweetpotatoes.
- A 1% increase in the retail price of pumpkin will lead to a 0.089% increase in the demand for sweetpotatoes.

The estimates of the relationships between the market for sweetpotato and the markets for potato and pumpkin indicate that there is a stronger substitution between sweetpotatoes and potatoes than between sweetpotatoes and pumpkin. This somewhat reflects the survey results by Edentify (2019).

There are also some key takeaways from the assessment of other demand drivers. They are as follows:

- Higher income levels result in an increased demand for sweetpotatoes.
- Older shoppers tended to have lower demand for sweetpotatoes than younger shoppers.
- Household size had a limited impact on demand for sweetpotatoes.
- Female shoppers tended to have greater demand for sweetpotatoes than male shoppers.
- Urban shoppers tended to have lower demand for sweetpotatoes than rural shoppers.
- Promotions do affect demand for sweetpotatoes. As expected, promotions for sweetpotatoes have a positive effect (i.e. result in greater demand), while promotions for the other two commodities have a negative effect (i.e. result in lower demand).

Key point

Buyers are sensitive to changes in prices, even small increases in the retail price of sweetpotato result in a reduction in demand. Modelling results indicate that buyers will increase their demand if prices decrease.

Changes in the retail price of substitutes will also result in changes in the demand for sweetpotato. This is to be expected when products are such close substitutes.

Optimal value/volume mix

The analysis also assessed the volume and retail price that should maximise revenue. The aggregate retail supply of sweetpotatoes in 2019/20 was 75,795 tonnes (Hort Innovation, 2020). Based on the demand analysis undertaken, if average retail prices were to increase by 1%, the volume demanded is estimated to decrease by approximately 0.913% to 75,103 tonnes. Given that the decrease in volume demanded is outweighed by the increase in retail price, the total sales revenue would increase. The magnitude of this effect at the current production levels is limited, however, with the resulting retail supply revenue increase being approximately 0.08% (or about \$156,000). This is because consumers are only slightly unresponsive to price changes. For comparison a price change in the other direction is also illustrated here.

If the average retail prices were to be decreased by 1% (i.e. with the intention to sell greater volumes), then the volume demanded would only increase by 0.913%. The net effect here would be a decrease in revenue by 0.10%. Figure 1 provides of illustration of the impact of two industry strategies on volume demanded and total revenue, one is a 1% increase in average retail price and the other is an average retail price decrease of the same magnitude.

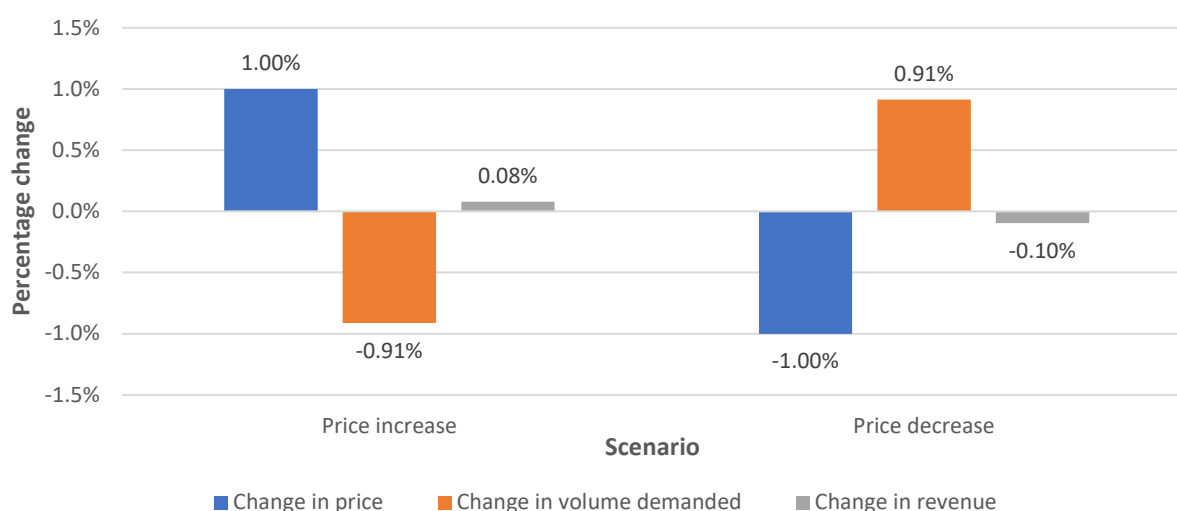


Figure 1. Illustration of impact of price change on volume demanded and industry revenue

The estimated optimal average retail price is \$2.77 per kilogram (compared to current average price of \$2.64 per kg), which corresponds with an optimal volume demanded of 72,498 tonnes. This optimal retail price is based on the analysis of changes to average retail prices and the consumer responsiveness to those changes. This increase is equivalent to a 4.76% increase in average retail prices and a 0.21% (approx. \$415,000) industry revenue increase. It is important to note that these scenarios assume consumer responsiveness does not vary as retail prices change. In reality, consumer responsiveness is likely to change as the price level changes for sweet potatoes. However, for relatively small price changes the effect of this should be limited. The implication of this assumption is that as retail price increases, consumers are likely to become more responsive to changes in price.

It should also be noted that the industry can increase average retail prices by up to 9.53% before the increase in average retail prices leads to a loss in revenue. Figure 2 shows that at the current pricing level of \$2.64 per kilogram, the industry retail sweetpotato supply is 75,795 tonnes, and revenue is \$200.1 million, however, the same industry revenue could be attained by setting retail price at an average of \$2.89 and a supply 69,200 tonnes of fresh sweetpotatoes to the retail sector.

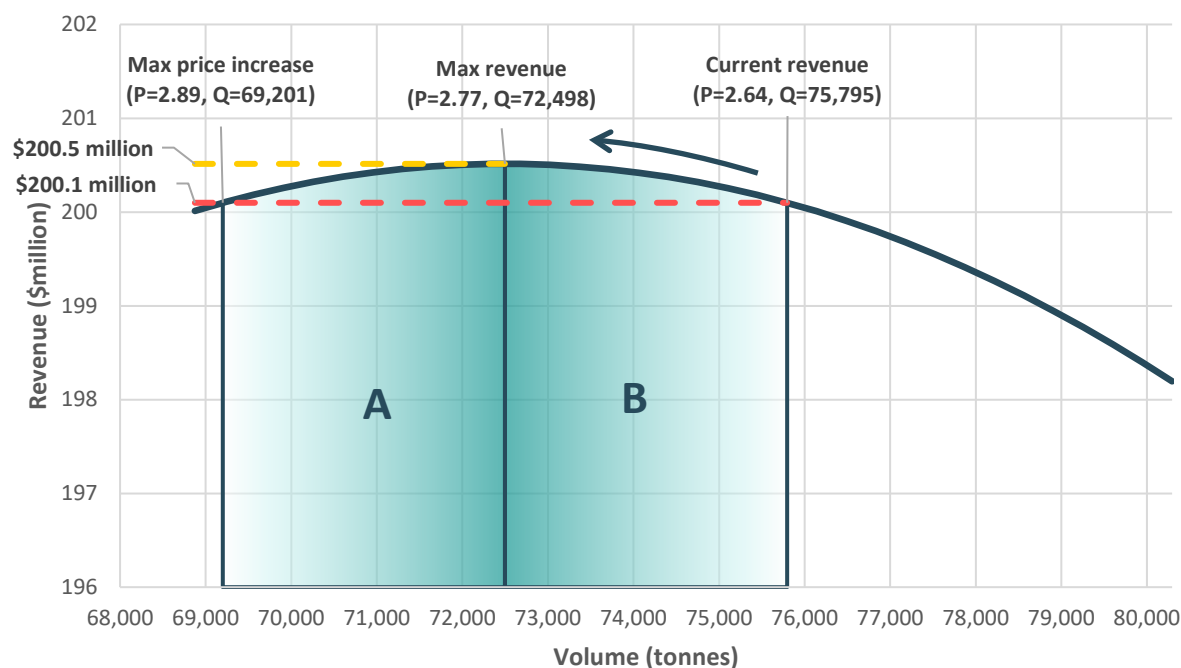


Figure 2. Estimated revenue curve with key price-volume mixes highlighted

Note: The findings for the estimated optimal price-volume mix will be affected by the data limitations in our analysis. The results illustrated here should be taken with caution.

Key points

The analysis found there is likely to be some limited opportunity to increase average retail price that will also result in greater total retail sales revenue. However, this is very negligible, indicating that the domestic fresh market is possibly at saturation point without an investment in marketing.

Data limitations. The data used in this study was based on NielsenIQ Homescan data. This data had an assumption on the average weight per sweetpotato which is higher than the current industry average. The overall results from our analysis are still valid as the own-price elasticity estimates are unlikely to change as there will be an adjustment based on a constant value. The estimates for the optimal price-volume mix will likely change as the corrected weights will change the unit prices used in our analysis. More detail on this can be found in Box 1 of the Technical Report.

Monitoring and evaluation

Monitoring and evaluation was not a key part of this project; however, the impact of this work could be assessed by extent of industry uptake and the consideration of recommendations from the study in future industry strategy development.

Recommendations

We have developed two sets of recommendations for the industry. The first set is based on the direct findings from the demand analysis while the second set are additional consideration informed by our interpretation of the overall findings and current industry status. The modelling and results presented in this study are based on specific assumptions and the limitations are discussed in detail in the appendix.

Recommendations from modelling results

Recommendation 1

It is recommended that, in order to maximise industry revenue, any average retail price increase should not be more than the stated 4-5%. Our estimates indicate that an average retail price increase of 4-5% (to about \$2.75-2.77 per kg) will optimise average industry revenue levels. Overall, the number of households purchasing sweetpotatoes and the amount they purchase has remained relatively unchanged while the volume of production has increased by almost doubled from 55,000 tonnes in 2013 to 107,000 tonnes in 2020. This implies that there is a limited opportunity to increase industry revenue by increasing volume supplied to the retail sector if there are no changes in consumer preferences and all other variables are held constant. However, there are opportunities to gradually increase supply of fresh sweetpotatoes to retailers at the same rate as population growth. Where production is expanding at rates greater than the rate of population, the risk of market saturation and driving down retail prices to clear the market is higher.

Recommendation 2

It is recommended that the industry engage in promotion and marketing of the nutritional benefits, taste, versatility, and ease of cooking attributes of sweetpotatoes to improve household penetration and volumes purchased per shopping trip.²

Recommendations based on additional considerations

The conclusions and recommendations outlined above are based on an assessment of demand for sweetpotatoes at the household level. However, it is important to consider the broader industry context and overall industry market opportunities and challenges. Therefore, the following recommendations are based on additional observations from the demand analysis and assessment of existing industry data.

Recommendation 3

It is recommended that the sweetpotato industry engage with retailers to illustrate the impacts of pricing on demand. This engagement should be used to inform a supply chain strategic view to understanding volumes and supply levels that are compatible with industry growth. This knowledge sharing will help with the implementation of strategies that are based on findings from this study.

Development of supply and demand forecasting can be developed and used to inform pricing expectations and strategies. For example, in a successful season, the expectations could be that supply will outweigh demand and thus to boost purchases prices should be relatively low. Forecasting supply and pricing strategies can be used to inform the pricing levels and supply levels for that season.

Recommendation 4

It is recommended that the industry explore non-household level consumption of fresh sweetpotatoes such as food services. Given the limited opportunity to grow the industry by increasing either price or volume supplied for household consumption, it is worth investigating growth opportunities from other markets.

The industry should also look beyond domestic consumption of sweetpotatoes by considering the investment in value-adding through processing and product transformation³, and/or opening up export markets. Such strategies will help avoid an over-supply of fresh produce in the domestic fresh market which could lead to lower retail prices and increased wastage.

Recommendation 5

It is recommended that the sweetpotato industry should monitor the key demand drivers in order to effectively

² These key promotion attributes are based on study by Edentify (2019)

³ This could include processed product for human consumption or alternative uses such as the core ingredient in dry pet food.

respond to changes in demand and short-term opportunities for higher margins to maximise profit. For example, our modelling results indicate that potatoes are strong substitutes for sweetpotatoes, thus it is important to monitor changes in the supply and pricing of potatoes in the domestic fresh supply market.

Recommendation 6

It is recommended that the industry undertake research to estimate cost of production and develop a growth strategy that seeks not only to optimise production and industry value but develop a strategy that optimises profits for growers. Further investigations on estimating the relationships between volume and cost of supply will provide valuable information to help avoid adverse effects on profitability for growers.

Key points

In order to maximise revenue through a price change, the price increase should be limited to no more than 4-5% of the current average retail prices (\$2.64 per kg). This would correspond with a decrease in the total volume demanded by 4%. Changes in average retail prices will require consultation with the retail sector.

In order to further increase total revenue, the industry may be able to increase total demand for household consumption by engaging in promotion that leads to increased household penetration and/or increased purchases per shopping trip. Both household penetration and volume purchased have not improved since 2013.

It is recommended that the sweetpotato industry should monitor the key demand drivers in order to effectively respond to changes in demand and short-term opportunities for higher margins to maximise profit.

The industry should seek growth opportunities from other market opportunities such as food services, export markets and other value-adding transformation such as processing.

Consideration of producer and supply chain costs will help improve the industry's ability to better respond to market demand by setting price and production levels at a profit maximising levels. It is recommended that a subsequent study be undertaken to provide insight on how producers can maximise industry profits.

Refereed scientific publications

None to report.

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Intellectual property, commercialisation and confidentiality

None to report.

Acknowledgements

The authors would like to acknowledge the support and guidance from Professor John Rolfe, Claire Maslen (Sweetpotatoes Australia), Alastair Boyd (NielsenIQ), Adam Briggs (Hort Innovation), Brendan O’Keeffe (Hort Innovation).

Appendices

Appendices include:

- Natural Capital Economics (2022). Price elasticity of demand for Australian fresh sweetpotatoes. Technical Report.