

Sweetpotato Quality Improvement Plan and Road Map

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Summary

In 2021 the need to lift the quality of sweetpotatoes was recognised with the funding of a new project PW20000. A key deliverable of that project is a Quality Improvement Plan which was published in December 2022. The development of the Quality Improvement Plan follows 17 months of retail quality monitoring, supply chain data measurements and grower and retailer engagement which took place from 01/07/2021 to 1/11/2022.

This project aims to improve the quality of sweetpotatoes by engaging key stakeholders across the value chain including growers, wholesalers, processors and retailers so quality can be monitored and maintained.

A wide range of quality issues have been identified in store and in distribution centres. These are often caused by skin damage/ skinning, fungal or bacterial rots and temperature related stresses.

Data logging sweetpotatoes during distribution showed significant time delays, reducing shelf life, and high or low temperature abuse.

Issues were further exaggerated by dehydration and decay of sweetpotatoes on loose store displays.

The Sweetpotato Quality Improvement Roadmap identifies opportunities for the industry to reduce quality and financial losses and increase consumer uptake.

Elements identified for improvement vary by sweetpotato type, but also have some common elements. Improvement pathways have been identified for each major issue.

The key outcomes for the Sweetpotato Quality Improvement Plan will be to:

- Drive accountability across all key stakeholders (growers, wholesalers, major supermarkets) to focus upon on-shelf quality, resulting in greater consumer acceptability;
- Continue to drive best practice across the supply chain from growers to retail and drive a positive culture focused on high quality standards for Australian sweetpotatoes; and
- Build capacity and understanding for quality improvement across the supply chain, with regular feedback provided.

Quality Data and Issues Identified

1. Identification of Pre and Postharvest Quality Issues

During the observation period from 1/07/2022 to 1/11/2022, quality in stores was monitored for ALDI, Coles, Woolworths and Independents. The assessments were for displayed stock and varied from single touch ¼ full – 2 full crates of gold skinned loose products to displays of loose 150 tubers for each skin colour plus pre-packs.

Quality Assessment data from the retailers' DC inspections was also assessed for that time period.

Quality deterioration, particularly for skin marking defects, was worse than expected and is likely to be a purchase barrier for consumers.

The following data is based on % sweetpotatoes displayed in the 3 major retailers and independent store exhibiting specific major or minor defects. Stock was inspected every week during the observation period.

As shown in Figure 1 for **gold skinned, loose** sweetpotatoes, major defect levels were high at 30% compared to the 2% specification limit of the retailers.

Most marked issues were skin damage and skinning/ dehydration as well as bacterial rots. Other significant issues were related to splitting, chilling injury and fungal rots.

Minor defects generally have specification limits of 10% and were found at 16% on average. As Figure 2 shows, minor defects included light skinning (pre-cursor to more extensive dehydration), minor skin damage and superficial

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insect damage and skin dryness.

Defect levels were consistently high throughout the year, even though bacterial rot issues were most pronounced after prolonged rain episodes starting last summer.

One driver for a high degree of skinning and skin damage on display in stores may be that customers select the better stock. However, that was not always the case as displays were often inspected after stock replenishment in the morning.

Bronzing was most pronounced in the months of September to January. While bronzing is thought to be associated with slow growth in the colder month (July to September), it appears that aged sweetpotatoes were harvested due to low market demand and oversupply.

Figure 1: Major Defects Identified at Store Level (Gold, Loose)

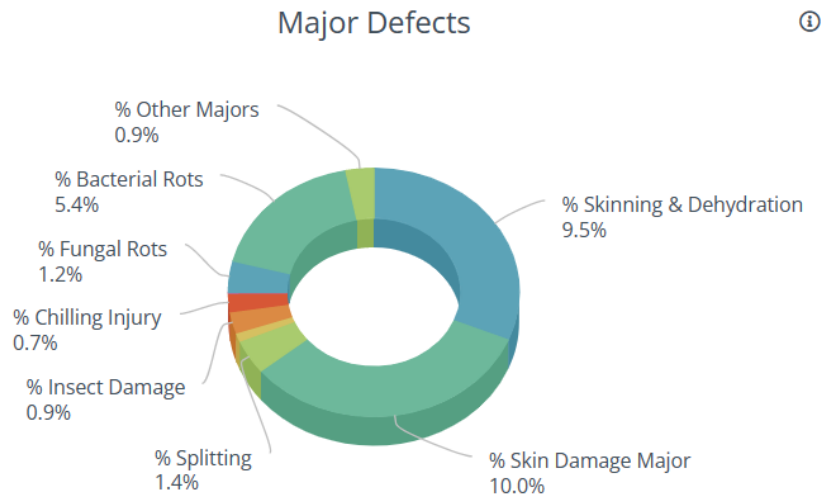
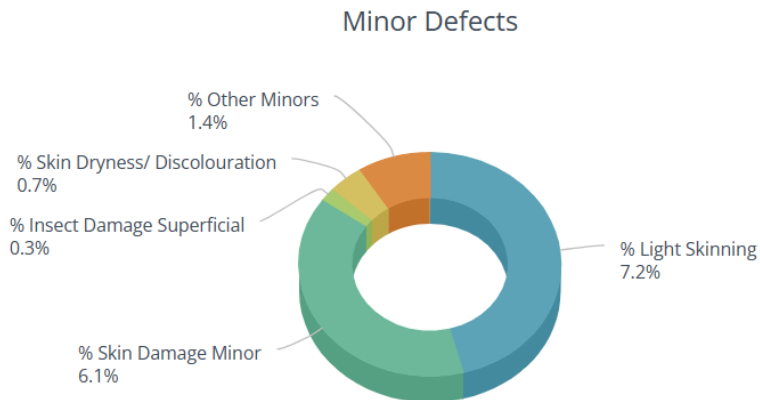


Figure 2: Minor Defects Identified at Store Level (Gold, Loose)



Pre-packed gold skinned sweetpotatoes generally had less severe skinning issues (2.5% on average), as the high humidity in pack stopped dehydration of these patches. However, condensation was an ongoing issue depending on pack format. This was made worse by temperature fluctuations. As a result, rots on cut ends were an occasional issue.

Overall, major defects affected 11% of the stock and minor defects affected 17% of the stock.

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Figure 3: Major Defects Identified at Store Level (Gold, Prepacked)

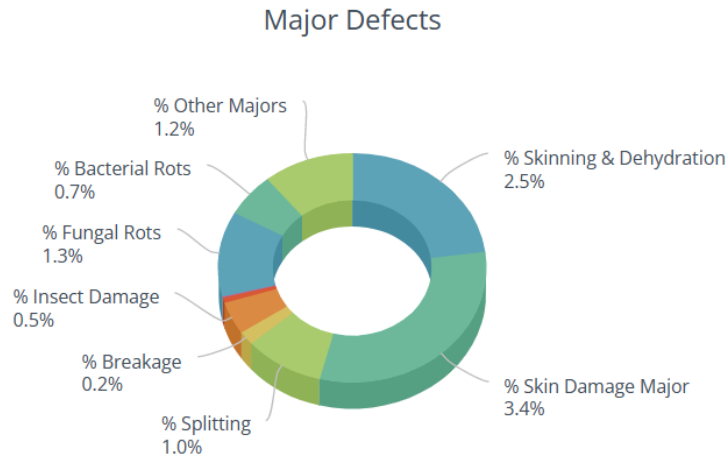
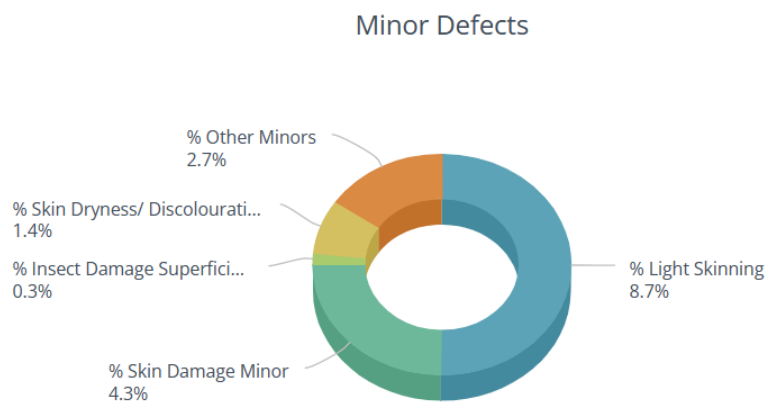
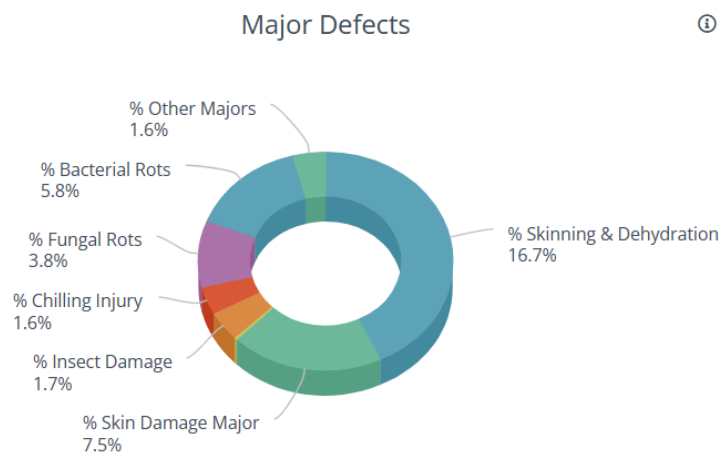


Figure 4: Minor Defects Identified at Store Level (Gold, Prepacked)



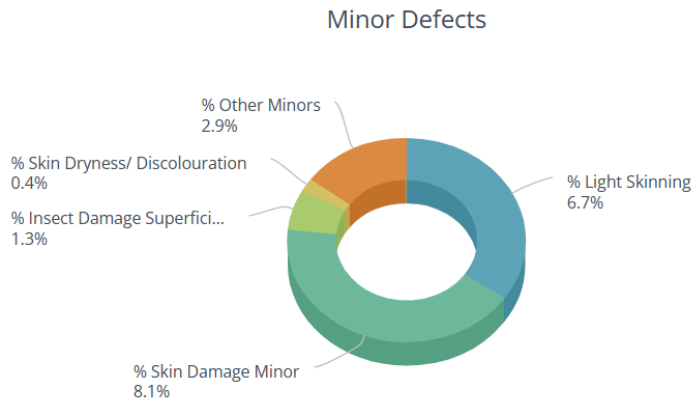
Organic, gold skinned sweetpotatoes were kept in refrigerated conditions at the start of the project. However, after communicating that this was causing chilling injury, the retailers moved them out of the refrigerated displays. Across the year, major defects were high at 39% and minor defects sat at 19%. Moving the tubers out of the fridge in stores by the retailers prevented further chilling injury. However, dehydration accelerated and resulted in more visible issues related to skinning. Fungal rots were also more pronounced. Dehydration was particularly a problem for loose and netted organic tubers, but cling film overwrap of cardboard trays minimised that.

Figure 5: Major Defects Identified at Store Level (Gold, Organic)



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Figure 6: Minor Defects Identified at Store Level (Gold, Organic)



Purple, loose sweetpotatoes mainly had outer skinning damage (purple under-skin exposed) caused by rubbing and dehydration followed over time. The varieties on display appeared to be mainly Northern Star and Star that will experience skinning as a flaky look due to their double skin. Older tubers also showed a generalised dryness/whitening of the outer skin. Fungal rots also caused significant issues. Major defects affected 33% of stock whereas minor defects were at 37%.

Figure 7: Major Defects Identified at Store Level (Purple, Loose)

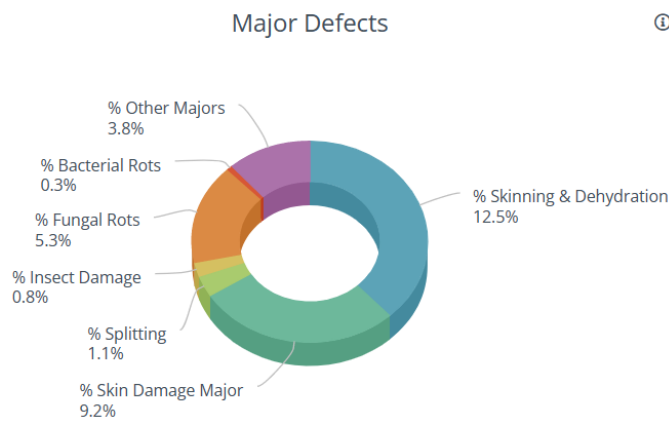
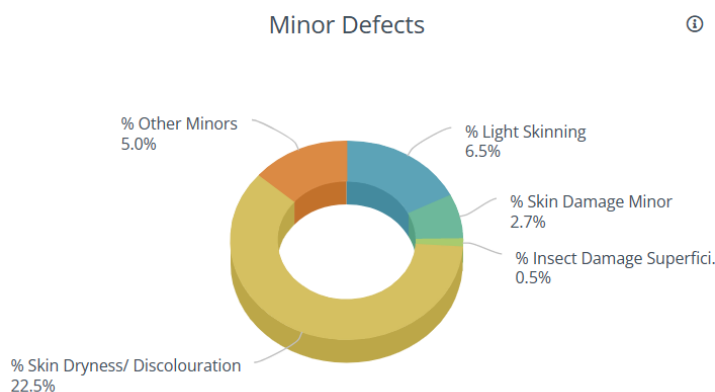


Figure 8: Minor Defects Identified at Store Level (Purple, Loose)



White skinned, loose sweetpotatoes 37% major and 33% minor defects. Many of the defects were linked to skin damage and fungal/ bacterial rots. Insect/ nematode damage was also more noticeable on the white skins.

A major contributor to poor quality perception was that a high amount of stock looked aged and yellowed on the shelf. Soil adhesion was also more noticeable compared to other types.

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Figure 9: Major Defects Identified at Store Level (White, Loose)

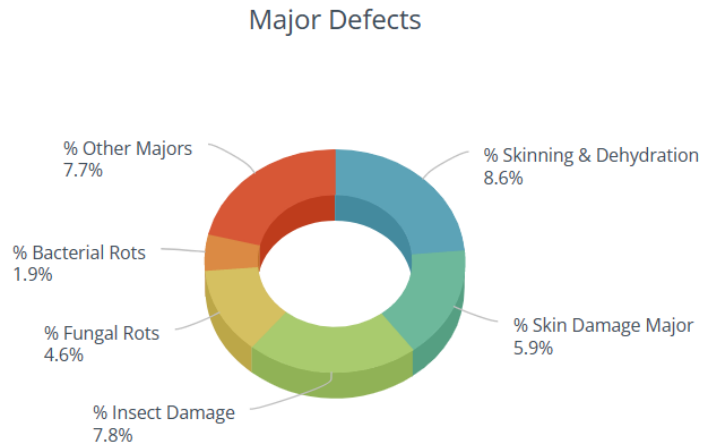
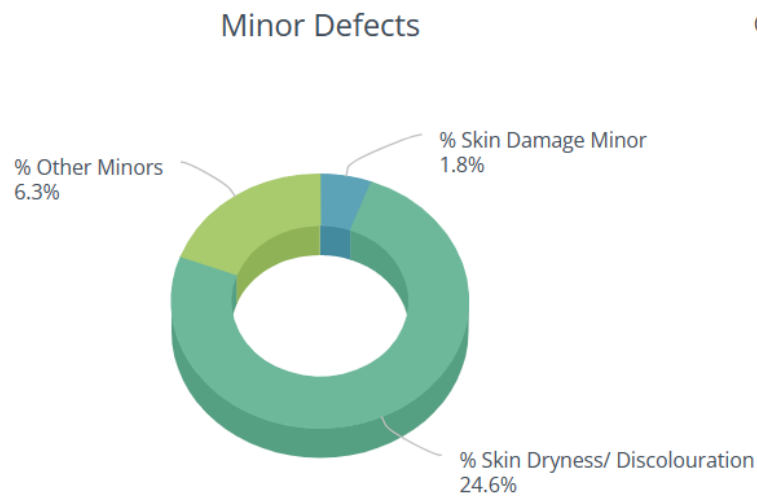


Figure 10: Minor Defects Identified at Store Level (White, Loose)



2. Retailer Distribution Centre Data

Inspection data collected in the distribution Centres of the 3 major national retailers (ALDI, Coles and Woolworths) showed less focus on sweetpotatoes than on other produce categories unless there were very obvious issues. Data covers 530,489 cases in shipments that were inspected. The rejection rate for these was 3.3% with warnings for another 2.6%.

Rejections of stock primarily occurred for fungal rots (Figure 11). These were very obvious during inspections. Additionally, stock was rejected for pest damage, breakage and sprouting as well as other more sporadic issues.

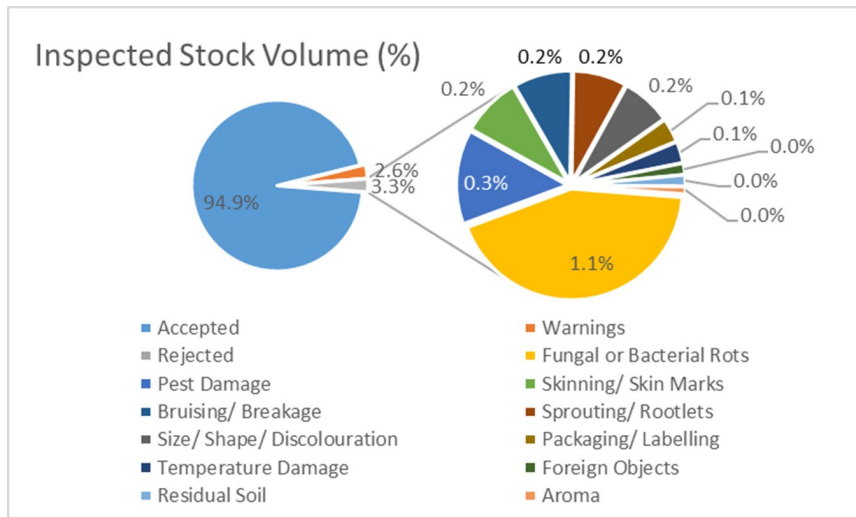
Skin damage, skinning and bacterial lesions (in second half of the financial year), the main issues found in store, had few rejections as they were deemed to be less important in the inspections.

They were also generally progressive, meaning that the issues were relatively minor in the distribution centres and became worse in store and impacted significantly on the appearance of the stock.

Waste levels in store (markdown or disposal due to poor quality) were remarkably low at 0.18% over a 2-year period. When considering the degree of defects on shelf, it would be expected that more poor stock would be removed at store level.

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Figure 11: DC Inspection Outcomes for Sweetpotatoes for January 2019 to April 2022

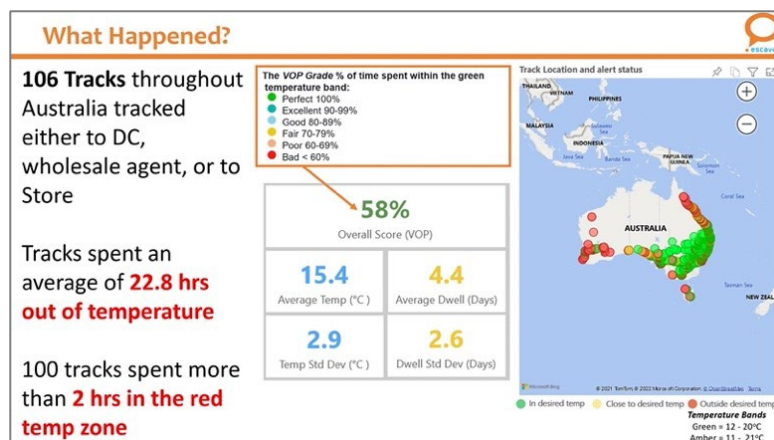


3. Escavox Datalogger Trial

An initial proof of concept trial with Escavox dataloggers was conducted. A total of 106 loggers were used with 2 growers (Sweet Potatoes Australia, Bundaberg, and Cudgen Farms, Tweed) in the period of October 2021 to January 2022. The key results were:

- 94% tracks did not meet temperature requirements
 - >2 hrs in the red temp zone
 - 30% of transit legs are too cold
- Potential for chilling injury and condensation as temperature fluctuates
 - 25% of transit legs are too hot
- Potential for bacterial lesions/ mould to accelerate, breakdown and of sprouting
- Average 'dwell time' of 4.4 days in transit plus the 2.6 days at DC
 - Sweetpotatoes are sitting idle for periods reducing shelf life and quality to customers

Figure 12 Escavox Data Trace Summary



After having completed the supply chain mapping with 4 key growers, it became apparent that quality issues were different at different times of the year and the data logging trial was extended for a continuous 12-month period until February 2023.

This will provide a comprehensive insight into the extent of potential temperature, humidity and delay issues within the supply chain across the country.

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Business Case for Improving Sweetpotato Quality

As the 'Australian sweetpotato consumer insights research (PW18003)' project found, quality is a main driver for consumer purchase for 63% of respondents. Based on this research (see below) there is a significant opportunity to shift 'medium users' (45% of sample) of sweetpotatoes from doubling their consumption. This group is heavily impulse purchase driven and quality will significantly impact on their purchase behaviour. 'Light users' can also be influenced to increase purchase, but this is mainly by improved product knowledge. A small shift in consumer purchasing frequency in these two consumer segments can double consumption by these consumers.

Industry feedback suggests that marketing and promotional activities have not been working over the last 5 years or so. There seems to be a strong link between that and the fact that quality on shelf has been variable.

Over the last 10 years, the sales volume has grown 95%, but farm gate value only 60%. Farm gate value is currently around \$83 million. Per capita consumption in Australia is 3.7kg (Sweetpotato Strategic Investment Plan 2022-2026, Hort Innovation).

This suggests that volume has grown to a level where price deflation has set in. To regain strong returns to growers, consumer demand needs to be increased. This is strongly linked to having a good quality product that consumers will choose in a competitive market with similar use products such as potatoes and pumpkins.

Recent industry insights indicate that crop production is about to decrease by 10-15% with several growers exiting the industry. That may have an effect of increasing farm gate pricing and ability to invest in quality improvements.

Roadmap Outlining the Key Solutions to the Issues Identified

The Distribution Centre data indicated that significant distribution issues such as fungal rots (associated with high and low temperature injury) occur at times.

Also, datalogger traces by Escavox indicated that significant exposure to high and low temperatures occurred in the supply chain. This supports the findings in the distribution centres of temperature related issues.

The store level data showed mainly issues related to skin damage/ skinning as well as rain related bacterial lesions. Issues with skinning and bacterial lesions were progressive issues in store and became a major determinant of poor quality being identified in store. Fungal rots were not as significant as in the DCs, presumably by being removed from the supply chain when severe.

The data set will be further extended through the extended Escavox data logging trial and the Hort Innovation project on managing skinning and skin damage at farm level (Causes and management strategies for skin loss in sweetpotatoes (PW21002)). This will be an essential part of addressing elements of the road map.

The key elements to the Quality Improvement Plan for sweetpotatoes are shown in Table 1.

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Table 1: Key Quality Defects and Improvement Pathways for Sweetpotatoes

Sweetpotato Type	Quality Defect	Improvement Pathway	Impact
Generic	<ol style="list-style-type: none"> 1. Skin damage and skinning 2. Low Temperature Injury 3. High Temperature Injury 4. Shelf-life loss 5. Nematode and other defects, sizing and shape 	<ol style="list-style-type: none"> 1. Improve pre-harvest, harvest and handling techniques, mixed grades specification to not allow more skin defects 2. Identification & mitigation of key stages in supply chain for temperature abuse 3. Identification & mitigation of key stages in supply chain for temperature abuse 4. Identification of supply chain stages with delays, minimization of delays, less temperature fluctuations, increased stock turn in store 5. Specification compliance by growers and checks by retailers 	<ol style="list-style-type: none"> 1. High 2. High 3. High 4. High 5. High
Gold skinned, loose	<ol style="list-style-type: none"> 6. Skinning and dehydration 7. Bacterial lesions 8. Bronzing 	<ol style="list-style-type: none"> 6. Increase stock turn, remove poor product from display, investigate water loss reduction strategies 7. Improved post-wash drying strategies, potential for short term wound healing 8. Varietal selections, managing growing period 	<ol style="list-style-type: none"> 6. High 7. Medium 8. High
Gold skinned, prepack	<ol style="list-style-type: none"> 9. Condensation and rots 	<ol style="list-style-type: none"> 9. Packaging improvements and minimising temperature fluctuations 	<ol style="list-style-type: none"> 8. Medium
Gold skinned, organic	<ol style="list-style-type: none"> 10. Skinning and dehydration 	<ol style="list-style-type: none"> 10. Increase stock turns or improve packaging to control weight loss; avoid storage in refrigerated conditions 	<ol style="list-style-type: none"> 9. Medium
Gold skinned, mini	<ol style="list-style-type: none"> 11. Excessive dehydration 	<ol style="list-style-type: none"> 11. Change format for mini sweetpotatoes 	<ol style="list-style-type: none"> 10. Low
Purple skinned, loose	<ol style="list-style-type: none"> 12. Skinning and dehydration issue 	<ol style="list-style-type: none"> 12. Identification of supply chain stages with delays, minimization of delays, increased stock turn in store; improvement of washing procedures to reduce flaking; rotation of varieties to take advantage of different varietal characteristics at different times of the year 	<ol style="list-style-type: none"> 11. Medium
White skinned, loose	<ol style="list-style-type: none"> 13. Stock age 14. Nematode damage 15. Handling 	<ol style="list-style-type: none"> 13. Identification of supply chain stages with delays, minimization of delays, increased stock turn in store 14. Implement more rigorous nematode control as varieties are relatively, but not fully, resistant 15. Minimise damage from rough handling during harvest and washing 	<ol style="list-style-type: none"> 12. Medium 13. Medium 14. Medium

The following breaks down the supply chain stages at which quality improvements need to be driven.

A. Seed Stock

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- Selection of gold skinned varieties less prone to skin damage, splitting and bronzing (Quality Factor 1 and 8). A gold variety suitable for planting from September to December is available for most areas; this has a firmer skin at harvest and presents with a smoother skin at retail – timeline of 12 months.

B. Production

- Minimisation of excessive in-ground holding of gold skinned varieties during winter (Quality Factor 8) – timeline of 12 months.
- Sufficient pre-harvest topping period to allow skin hardening (Quality Factor 1, 6, 10 and 12) – timeline of 12 months.
- Ground preparation and selection to minimise nematode pressure (Quality Factor 5 and 14) – timeline of 12 months.

C. Harvesting

- Equipment design and handling practices to minimise skin damage during harvest (Quality Factor 1, 6, 10 and 12) – timeline of 12 months.

D. Packing

- Wash process design to minimise skin damage (Quality Factor 1, 6, 10 and 12) – timeline of 12 months.
- Wash water sanitiser and post-wash drying to control bacterial and other pathogens (Quality Factor 7) – timeline of 12 months.
- Post-wash short-term holding prior to cooling to allow wound healing and/or application of edible coating to stop dehydration of skin (Quality Factor 6, 7, 10 and 10) – timeline of 12 months.
- Optimisation of packaging material for pre-packed sweetpotatoes, including of material, gauge and perforations, to minimise condensation and associated rots (Quality Factor 9) – timeline of 6 months.
- Packing according to specification in relation to size, shape and defects such as nematode damage (Quality Factor 5 and 14) – timeline of 12 months.

E. Road Transport

- Loading stock at correct temperature (Quality Factor 2 and 3) – timeline of 6 months.
- Pre-cooling trucks to suitable temperature (Quality Factor 2 and 3) – timeline of 6 months.
- Maintaining suitable airflows and consistently correct temperatures (Quality Factor 2, 3, 9) – timeline of 6 months.
- Secure stowage to reduce mechanical damage (Quality Factor 1) – timeline of 6 months.
- Transport with compatible co-loads (temperature, cross-contamination) (Quality Factor 2 and 3) – timeline of 6 months.

F. Cross-Docking and Wholesaling

- Maintaining appropriate temperatures throughout and eliminating temperature fluctuations (Quality Factor 2, 3 and 6) – timeline of 12 months.
- Elimination of delays and storage at excessively low temperatures (Quality Factor 4, 12 and 13) – timeline of 12 months.

G. Retailer Distribution Centres

- Consistent use and enforcement of specifications to prevent quality erosion and price collapse (Quality Factor 1, 5, 7, 12 and 15) – timeline of 12 months.
- Elimination of delays through minimising carry over stock (Quality Factor 4, 12 and 13) – timeline of 6 months.
- Maintaining appropriate temperatures throughout (e.g. receival area, banana room storage) and eliminating temperature fluctuations (Quality Factor 2, 3, 6 and 9) – timeline of 24 months.

H. Retail Stores

- Purchasing consistency for specific varieties to maximise uniform product appearance on shelf (Quality Factor 5) – timeline of 12 months.

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- Increasing stock turns on shelf through minimal carry over from day to day, stock rotation and removing poor quality waste stock (Quality Factor 4, 6, 10, 11, 12 and 13) – timeline of 12 months.
- More consistent pricing strategy (i.e. avoiding high/ low pricing) to drive faster, more consistent throughput (Quality Factor 4, 6, 10, 11, 12 and 13) – timeline of 12 months.
- Review range for suitability, e.g. mini sweetpotatoes displayed loose (Quality Factor 9, 10 and 11) – timeline of 12 months.

The Quality Improvement Project, including the extended data logging work, is well suited to work with the *Causes and Management* strategies for skin loss in sweetpotatoes (PW21002) project. The skin loss project will be able to drive some of the improvements suggested in this project, while Quality Improvement Roadmap highlights the wider framework that the skin damage reduction needs to happen within.

Part of the aims of the Quality Improvement Roadmap may only be effectively addressed in collaboration with the retailers. Discussions with retailers will be about on-shelf quality issues and stock turnover velocity. The discussions will also include understanding of staff training, ordering and impacts on in-store waste.

Roadmap Timeline

The timelines for the quality improvement plan are shown in Figure 13.

Specific Industry Engagement Activities are:

- February 2023: Grower roadshow in Cudgen and Bundaberg (Milestone 105)
- February -March 2023: Engagement with retailers (buying and technical) (Milestone 105)
- February -March 2023: Aggregator engagement at central markets (VIC, NSW) (Milestone 105)
- February 2023: Develop two 1-page flyers for retailers and growers of what good looks like (Milestone 105)

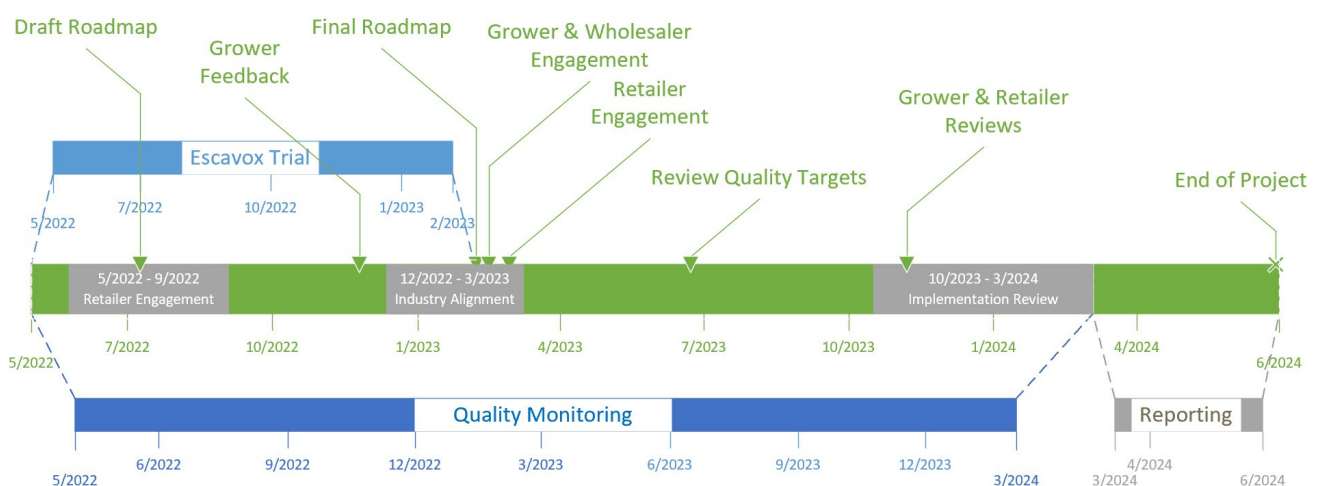
After the engagement activities, quality of product will continue to be monitored. This is to monitor changes to quality that have been achieved due to implementation of the quality improvement plan.

These observation will be reviewed against the quality finding pre-improvement plan:

- October-November 2023: Interim reviews with growers, wholesalers and retailers. (Milestone 106)
- February-March 2024: Final reviews with growers, wholesalers and retailers. (Milestone 106)

On completion of the final review, the project reports will be finalised. (Milestone 190)

Figure 13: Quality Improvement Roadmap



Outcomes

The outcome of the Quality Improvement Roadmap will be a comprehensive plan for the sweetpotato industry to improve quality across the supply chain, including on-farm, distribution and in-store. Overall the Quality Improvement Plan will:

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- Drive accountability across all key stakeholders (growers, wholesalers, major supermarkets) to focus upon on-shelf quality, resulting in greater consumer acceptability;
- Continue to drive best practice across the supply chain from growers to retail and drive a positive culture focused on high quality standards for Australian sweetpotatoes; and
- Build capacity and understanding for quality improvement across the supply chain, with regular feedback provided.