



Executive Summary

Review of value propositions for a hyperspectral image analysis solution in red meat supply chains [Public version]

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Abstract

Multiple imaging modalities are currently utilised in the food and meat processing sector to value add and / or quality control meat products. These systems include x-ray, NIR and DEXA technologies for carcase metrics and meat composition assessment, hand-held devices for meat grading and colour analysis using RGB images, and hyperspectral solutions for foreign object detection and quality analysis.

To determine future use cases for image analysis solutions for meat processing, a desktop and customer insights analysis was undertaken using stakeholder discussion sessions. Desktop analysis included a review of the current meat safety and inspection standards as well as a review of past technology applications and competitor technology analysis. Imaging technologies, and specifically those targeted at quality analysis of offals were considered and the value proposition interrogated.

Key findings were that plant-walk throughs with key site personnel and observation of inspection processes (ante and postmortem) and offal processing were particularly valuable in identifying physical locations on the processing line and/or infrastructure where devices may be installed to add value to the plant's operation and inspection processes and may assist / provide support to meat inspectors. All stakeholders identified how technical solutions could provide support to meat inspectors and the improved utilisation and extraction of value of animal health/disease and offal product status.

In relation to inspection standards, potential amendments to CODEX to enable commencement of adoption of technical solutions was suggested through the investigation of the EU model where auxiliary inspection is utilised for pig, poultry, and bovine. It is understood that under the current standards, there is opportunity for technologies to provide pre-inspection status of conditions to the Meat Inspector, however the Meat Safety Inspector must inspect the carcase or carcase part in accordance with the standards. The location of assistive technologies prior to the Meat Safety Inspector will enable the provision of information to the Meat Safety Inspector to augment their inspection, however a value proposition for efficiency and cost effectiveness to needs to be considered.

When competitor technologies were considered, the number of technology providers operating in the Asia-Pacific is small compared to North America / Canada or Europe. This lack of co-locality suggests challenges for processor uptake / access to multiple solutions in the local market. The P&P Optica (PPO) hyperspectral system is the only system identified providing technical solutions for animal health/disease and offal product status. However, the pathway to a clear ROI remains to be established although assisted inspection remains a priority focus and an area in which increased quality assessment and reliability of feedback for producers is clearly acknowledged as an industry requirement.

In conclusion, significant opportunities exist for technologies to assist the meat inspection process, but without replacing inspectors on the line. New Objective Measurement (OM) technology to assist inspectors with more accurate disease classification and detecting sub-surface defects would provide value and increase quality assurance. Use of OM technologies gives an opportunity to increase utilisation and leverage from the On-site Veterinarians' significant training in public health and corporate knowledge to improve disease surveillance and add value, and the provision feedback of more accurate and consistent detection of animal health/disease status would enable livestock suppliers to implement on-farm / transport practices to deliver a product with improved quality assurance and transparency.

Executive summary

Background

The purpose of the project was to evaluate the value propositions for a hyperspectral image analysis solution in red meat processing applications. This desktop exercise involved collecting and collating insights and benefits on potential applications of hyperspectral imaging in red meat industry from existing P&P Optica (PPO) system commercial installs and in-kind red meat processing partners. Insights were proposed to be gathered through a series of interviews of current commercial users of PPO imaging solution in various manufacturing applications in USA, Canada and Europe, and from site visits of in-kind beef and/or lamb processing partners. The review proposed to also consider applications of competitor's camera technology. The outcome of the project is to deliver confidential and public final reports on the insights & benefits on potential applications of hyperspectral imaging in red meat industry, including recommendations on proposed next priority R&D phases. The deliverables include an investment R&D roadmap and summary PPT findings presented to the project steering group and in-kind partner(s).

Objectives

The overall objective of the project is to evaluate the value propositions for a hyperspectral image analysis solution in red meat processing applications.

The specific objectives are:

- A desktop exercise collecting and collating insights and benefits on potential applications of hyperspectral imaging in red meat industry from existing PPO system commercial installs and in-kind red meat processing partners.
- Review of competitor technology applications.
- Collection and reporting of insights on potential red meat applications of hyperspectral imaging analysis solutions gathered through:
 - a series of interviews of current commercial users of PPO imaging solution in current commercial manufacturing applications in USA, Canada and Europe; and
 - from site visits of in-kind beef and/or lamb processing partners.
- Development of an investment R&D roadmap and summary PPT findings presented to the project steering group and in-kind partner(s).

Methodology

A phased approach was applied in the project, including:

- i. **Project planning & schedule**
- ii. **Discovery exercise**

An engagement framework was developed as a guide to prompt discussions with beef and lamb processors in Australia and for P&P Optica clients. A set of open-ended questions were developed to be used as the framework for discussions with key stakeholders and for framing of questions and responses.

Site visits were undertaken to gain insights and understand the potential benefits, implications and propositions of existing and potential technical solutions in relation to animal health and disease. The

use of human inspectors and how their skills were used / applied was discussed at each location. The aim of this discovery and analysis is to understand where and how support can be provided to meat inspectors and the improved utilisation and extraction of value (from technical solutions) of animal health/disease and offal product status and pricing models.

Two beef and one lamb processors were considered as likely participants in the project based on previous interest in animal health / disease detection and / or were part of the industry group for offal defect detection (MLA project P.PSH.1350), as well as participants in the Industry Calibration Working Group (ICWG). The processors invited to participate in the project were one lamb and three beef processors. An independent meat inspection provider was also invited to participate as potentially providing valuable insights of the current meat inspection process and supplier of services to industry.

iii. Review relevant Australian meat inspection standards, including AS 4696:2023

A review was undertaken of the relevant Australian meat inspection standards, including AS 4696:2023 “Hygienic production and transportation of meat and meat products for human consumption” regarding the inspection requirements for offal, carcase and beef heads. The aim was to identify the requirements and/or considerations for the use of objective measurements/devices to augment or undertake meat inspection related activities with a particular focus on compliance and operational factors. In consideration of feedback from stakeholder engagement, opportunities for the application of objective measurement technologies in ante-mortem inspection were identified and also included within the scope of this review.

iv. Review of competitor technology applications

A competitors’ analysis was undertaken of existing & potential technologies that aim to support meat inspectors, including, but not limited to PPO Smart Imaging Systems, the Rapiscan dual sensor, the Offal Sensing Tunnel (AgResearch NZ/Scotts technologies), other vision systems (RGB, multispectral, hyperspectral), x-ray systems. The role these devices might play, and their potential efficacy in delivering meat inspection requirements was undertaken.

v. Final reports, recommendations & PPT summary.

Results/key findings

i) Discovery

1. The discovery approach involving open discussions (with a broad range of internal processor stakeholders where available) and site inspections (plant walk-throughs) proved extremely valuable in gaining insights, potential benefits and practical implications/propositions of existing and potential technical solutions in relation to animal health and disease. This was reinforced by stakeholder observations indicating that different stakeholders have different focus/value of the same data within a business.
2. The plant-walk throughs with key site personnel and observation of inspection processes (ante and post-mortem) and offal processing were particularly valuable in identifying physical

locations on the processing line and/or infrastructure where devices may be installed to add value to the plant's operation and inspection processes and may assist / provide support to meat inspectors.

3. All stakeholders identified how technical solutions could provide support to meat inspectors and the improved utilisation and extraction of value of animal health/disease and offal product status.
4. A significant number of opportunities, potential projects and areas for further investigation were identified.
5. Extraction of additional value from existing technologies was a priority before adoption of new technologies.

ii) Review of Standards

1. Under the current Australian meat inspection standards (AS 4696:2023), technologies are unable to replace Meat Safety Inspectors and manual inspection procedures due to the Standards specifying that: a Meat Safety Inspector must be present during slaughter and dressing of each animal; and a number of inspection activities require manual procedures (e.g. palpation, incision and odour).
2. It is understood that under the current standards, there is opportunity for technologies to provide pre-inspection status of conditions to the Meat Inspector, however the Meat Safety Inspector must inspect the carcass or carcass part in accordance with the standards.
3. The location of assistive technologies prior to the Meat Safety Inspector will enable the provision of information to the Meat Safety Inspector to augment their inspection, however a value proposition for efficiency and cost effectiveness needs to be considered.
4. Opportunities exist (pending meeting performance criteria) for technologies to augment Meat Safety Inspectors' inspection activities.
5. The Standards state that carcass and carcass parts are not to leave the Slaughter Floor until a post-mortem disposition is applied. This requirement requires further consideration if subsequent inspection outcomes by devices with higher specificity/granularity for offals differ from the final on-floor disposition outcomes based on human inspection outcomes.
6. Requirements within the Standards were also identified requiring device design and integration considerations.
7. Potential amendments to CODEX to enable commencement of adoption of technical solutions was suggested through the investigation of the EU model where auxiliary inspection is utilised for pig, poultry, and bovine.

iii) Competitor Analysis

1. A significant number of technologies are in use throughout the international meat processing industries primarily focussing on foreign matter detection.
2. Foreign matter is identified as a key priority for the application of technology solutions above the objective assessment of quality traits due to its significant value proposition and / or impact on business recalls / market access imperatives.
3. The number of technology providers operating in the Asia-Pacific is small compared to North America / Canada or Europe. This lack of co-locality suggests challenges for processor uptake / access to multiple solutions in the local market.

4. PPO's hyperspectral system is the only system identified providing technical solutions for animal health/disease and offal product status.
5. Observations re. adoption of new technologies include:
 - a. While attempting to launch hyperspectral systems, indications are that improvement in the accuracy of chemical lean measurement does not appear to be a high priority for customers, making it difficult establish an initial customer base and sites to demonstrate value in a real-world settings.
 - b. While application of technical solutions for quality assessment may be successful, the progress towards commercializing a new application of technologies can fail due to:
 - Practical reasons - footprint, product traceability, environment, etc.
 - Lack of a clear business proposition - cost, ROI.
 - Lack of planning for integration / implementation.

Benefits to industry

All stakeholders identified how technical solutions could provide support to meat inspectors and the improved utilisation and extraction of value of animal health/disease and offal product status. The benefits to industry identified through this project include:

1. Significant opportunities for technologies to assist inspectors to perform roles more efficiently rather than replacement of Inspectors.
2. New Objective Measurement (OM) technology to assist inspectors with more accurate disease classification and detecting sub-surface defects.
3. Opportunity to increase utilisation and leverage from the On-site Veterinarians' significant training in public health and corporate knowledge to improve disease surveillance and add value.
4. Opportunities for processors to gain more value (e.g. supplier feedback) through more granular (accurate) inspection data.
5. The provision/feedback of more accurate and consistent detection of animal health/disease status enables livestock suppliers to implement on-farm/transport practices to deliver a better quality product.
6. Processors welcome more objective measures to support & expand their current grid payment system with producers. Specifically, additional measures of value traits including animal health disease and carcase & offal inspection.
7. Value in Animal Health data being with a single entity to enable a full history to be observed (disease patterns etc.) and a role for MLA to assist producers in data interpretation (or to direct producers to third-party providers/data aggregators for analysis and action).
8. Significant value of information that is collected/verified/accurate (as expect significant cost incurred by over-inspection).

The quantification of benefits of the objective measurement of offals is outside the scope of this project and is the focus of other MLA projects.

Future research and recommendations

A significant number of opportunities, potential projects and areas for further investigation were identified.

Potential Projects / Further Investigation

Species	Location	Comments Summary
1. All	a. Ante-mortem	i. - Investigate potential for thermal imaging to assist in identifying lameness.
		ii. - Value in matching counts of animals off trucks to records.
	b. Ante-mortem / Post-mortem	i. Thermal Sensor (Live)
		ii. Pre-warning of conditions for inspectors.
		iii. Carcase inspection
	c. Post-mortem	i. Need to test hypothesis the disposition of carcase is not going to change if post inspection also occurs in the Offal Room.
		ii. Odour detection
		iii. Pathology classification vs consolidated condition.
		iv. Potential for hyperspectral for Intramuscular Fat (IMF) & Lean Meat Yield) LMY – (Fat, yield traits)
		v. Value in undertaking a baseline (e.g. 1 week) of liver status/performance.
		vi. Voice Recognition for recording defects on an individual carcase basis.
		vii. Neurofibromas – hard to detect. Can train camera, mainly base of heart (not commonly seen, need VR for training).
		viii. Pack offal on site, investigate value proposition for carton screening. Recommend baseline as unsure of magnitude of the problem.
		ix. Identify impact / relationship of detection of individual organs and impact on full disposition
	d. Whole process	i. Baseline - Production costs for all diseases (even if sub clinical)
		ii. Do baseline (How, Cost, Business case, Payback). - Need analysis of “human” cost compared to “co-product” cost.
		iii. Need improved pathology/diagnosis (start with one organ then build up)
2. Beef	a. Ante-mortem	i. Investigate if foetus detection technology will operate on moving animal.
	b. Ante-mortem / Post-mortem	i. Identify / pre-detect carcase issues (potential for UHF Technology?)
		ii. Investigate if an elevated body temperature at point of arrival subsequently cools down.
	c. Post-mortem	i. Investigate microwave technology for density (e.g. lumpy skin).
		ii. Potential for AI models for lumpy skin (lesions may be hot depending on stage). Potential at hide puller.
3. Ovine	a. Ante-mortem	i. Sheep – confirm if thermal will work due to wool.

	ii. Automated counting of livestock on arrival. Significant value in matching counts of animals off trucks to records.
b. Post-mortem	i. CLA – provide assistance to Meat Inspectors as condition are both visible and not visible.
	ii. OM for vaccinations, pussy pockets & cheesy gland.
	iii. Re-inspection for seeds post chilling.
	iv. Soft tissue tears are a significant issue (pelt pulling). Potential to include OM/cameras to scan carcasses as a 'pre-warning' of soft tissue tears.
	v. Believe over detection of nephritis. Suggest review / baseline study to understand extent of the issue.
c. Whole process	i. Develop an Animal Welfare score for a social license.