



Sandpit to Seed (S2S) Fund

December - 2024

Final Report

BeefVantage



Executive summary

BeefVantage is an Al-powered solution tailored for beef producers in Tropical North Queensland, offering rapid, domain-specific advice to help solve on-farm challenges. Using natural language processing (NLP) and fine-tuned large language models (LLMs), the platform navigates users through complex AgTech and RD&E landscapes, delivering actionable recommendations for improved productivity and sustainability. Designed to outperform generic models such as ChatGPT which are flawed due to hallucinations and knowledge limitations, BeefVantage is anchored in domain-specific data, to strive for unparalleled accuracy and relevance. Beyond immediate utility, the system's scalability signals broader commercial prospects, including diversification into additional agricultural sectors. The ultimate goal is to revolutionise decision-making for beef producers in Australia by harnessing the power of AI.

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Problem

It is becoming increasingly complex for Beef producers to sift through an ever-expanding list of AgTech tools and the latest scientific insights to address on-farm challenges and improve grazing land management. While many solutions exist, finding the options that are relevant and a good fit for their operation, region and business presents a significant challenge. Scientific insights and technologies can improve many aspects of beef production including land condition, biosecurity, animal health, animal welfare, performance, theft detection, and supply chain traceability. Yet, the complexity of the landscape often leads to non-adoption or suboptimal decision-making, given the overwhelming range of technologies and information available. This is compounded by other variables such as economic shifts, inconsistent advice from multiple sources, and environmental challenges including drought resilience and soil conservation. Whilst Al tools such as ChatGPT offer potential to assist people in addressing these issues, they have drawbacks including hallucinations and knowledge limitations. Our product, BeefVantage, is designed to make this process easier for producers.

Solution

Powered by the latest AI technology, BeefVantage helps beef producers find the best solutions for their onfarm problems and goals. Our AI solution is fine-tuned using domain-specific data and employs Natural Language Processing (NLP) and Large Language Models (LLMs) to provide relevant and informed suggestions. The platform harnesses data from trustworthy sources, ensuring that it connects producers with relevant domain specific knowledge, scientific knowledge, and technology solutions, overcoming the hallucination problems and knowledge limitations of generative AI. This approach provides producers with actionable insights for immediate issues as well as long-term strategies such as grazing land management and supply chain traceability. By streamlining the decision-making process, BeefVantage enables producers to focus more on implementation, thereby accelerating their transition to more sustainable and resilient operations.

Potential Customers/End Users

BeefVantage primarily serves beef producers and their advisors, equipping them to identify and tackle specific agricultural challenges with cutting-edge technology and scientific insights. Beyond this core user

group, Natural Resource Management bodies, governmental agencies, and industry partners can also integrate BeefVantage into their operational frameworks to improve decision-making and extension activities. As the platform evolves, we see the opportunity to develop tailored versions to meet the distinct needs of various groups. This could include customised solutions or subscription services for specific agricultural sectors, increasing its potential impact and market reach.

The Landscape

To the best of our knowledge, there are no immediate competitors who are using language-based AI to recommend solutions in the agricultural sector, however the medical field is using similar solutions. Other providers in this space include platforms like AgTech Finder, as well as traditional consulting services that provide advice and solutions to farmers and the agricultural industry. Unlike these existing solutions, our BeefVantage system leverages cutting-edge AI technology to provide instant access to relevant information. In an innovative approach to competition, we also see an opportunity to collaborate with these entities. We are open to offering our product, modified according to their specific requirements, and working together to address the complex challenges faced by the agricultural community.

Problem-Solution Fit

BeefVantage is a bespoke solution, specifically designed for the beef sector in Tropical North Queensland, setting it apart from broader models like ChatGPT which have limitations including hallucinations, lack of regional and domain specific knowledge, and presenting irrelevant information. Rooted in advanced NLP techniques, our platform is driven by a fine-tuned LLM that delves deep into a rich array of domain-specific data, ensuring that beef producers receive advice that's both accurate and highly relevant. Beyond just immediate agricultural recommendations, the scalability and adaptability of BeefVantage offers immense commercial potential, signalling the possibility of diversifying into broader AgTech ventures in the future. Ultimately, our solution is poised to redefine agricultural decision-making in Australia, placing a strong emphasis on enhanced efficiency, sustainability, and growth.

The Team

Carrie-Ann Wilson: Carrie-Ann Wilson is a PhD student at James Cook University and Knowledge Adoption Officer at the Tropical North Queensland Drought Resilience Adoption and Innovation Hub. Her research explores the intersection of people, technology and business in rural Australia. Carrie's MPhil investigated

connectivity technology adoption, and her PhD is focused on AgTech adoption by graziers. Employing human-centred methodologies, she investigates the needs, motivations, and behaviours of individuals to inform the design of solutions and initiatives. Carrie has 9 years of experience as an IT specialist at Griffith University, including project management and development of customised technology solutions. Additionally, she has 7 years of experience in running her own business, providing customised digital solutions and websites to rural and regional businesses. She has lived on a cattle property for 10 years and is familiar with the agricultural sector.

Role: Project management; reporting; contribute knowledge of problems within the agricultural sector and AgTech solutions; collaboration with TNQ Drought Hub for knowledge sharing and testing.

Dr Usman Naseem: Dr Usman Naseem is a Lecturer at the College of Science and Engineering, James Cook University, Australia. His research interest lies in Natural Language Processing (NLP) and Computational Social Science, focusing on understanding human communication in social contexts and developing socially aware language technologies. His most recent research focuses on developing a knowledge graph-assisted explainable, fair, and diverse recommender system. Prior to pursuing his research, he worked in leading ICT companies for over 10 years. He publishes and serves as Program Committee, including the Area Chair for several top-tier venues, including ACL, EMNLP, NAACL, COLING, WSDM, Webconf, and AAAi. He also delivered several invited talks and a tutorial on recommender systems at Webconf 2023. His work in NLP has attracted attention from the World Health Organization and earned him the Nepean Blue Mountains Local Health District (NBMLHD) Board Chair's Quality Award in 2021 and the prestigious IEEE Best Transactions Paper Award in 2022.

Role: Expert consultant offering expertise in Natural Language Processing and Recommender Systems. He will support to achieve the deliverables and outcomes of the proposed project.

Ken (Zhihao) Zhang: Ken is a Natural Language Processing (NLP) expert, with a Master of Philosophy in Artificial Intelligence (NLP) from the University of Sydney. He is experienced in Large Language Model (LLM) research and development.

Role: Research assistant and engineer. He will develop the LLM deliverables of the project under the supervision of Dr Usman Naseem.

Haohui Lu: Haohui is a Natural Language Processing (NLP) expert, with a Doctor of Philosophy in Graph Machine Learning from the University of Sydney. He is experienced in Large Language Model (LLM) research

and development, with expertise in Knowledge Graph techniques.

Role: Research assistant and engineer. He will develop the LLM deliverables of the project under the supervision of Dr Usman Naseem.

Linwei Tao: Linwei is a Natural Language Processing (NLP) expert, with a Master of Philosophy in Computer Vision from the University of Sydney, currently undertaking a PhD in Computer Vision at the University of Sydney. He is experienced in artificial intelligence research and development, with expertise in Knowledge Graph techniques.

Role: Research assistant and engineer. He will develop the LLM deliverables of the project under the supervision of Dr Usman Naseem, following on from the work of Haohui Lu.

Dr Rachel Hay: Dr Rachel Hay is the Knowledge Broker for the Tropical North Queensland Drought Resilience Adoption and Innovation Hub. Her recent PhD focussed on 'The engagement of women and technology in agriculture'. As a social scientist working in behaviour change at James Cook University, Rachel's research and activity centres on trans-disciplinary approaches to sustained behaviour change in social marketing, drought resilience and adoption strategies, rural regional and remote internet connectivity and connectivity literacy, communications and environmental protection interventions (improving water quality on the Great Barrier Reef).

Role: Supervise progress, provide expert advice for the duration of the project.

Prof Yvette Everingham: Yvette is a specialist in multi-model data fusion and is dedicated to (i) identifying strategies that will deliver better student learning outcomes in STEM education, and (ii) helping agricultural industries implement profitable and eco-friendly ways to increase productivity in challenging climates.

Currently, Yvette holds positions as Director of the JCU Centre for Agriculture, Technology and Adoption and Professor in Data Science at James Cook University. Previous positions include Climate Impacts Scientist (CSIRO), Associate Dean Graduate Research Studies (JCU), Focus Area Chair for Agricultural Weather and Climate Services (World Meteorological Organisation, Geneva) and Associate Editor Journal of Agronomy for Sustainable Development.

Role: Supervise progress, provide expert advice during the initial stages of the project.

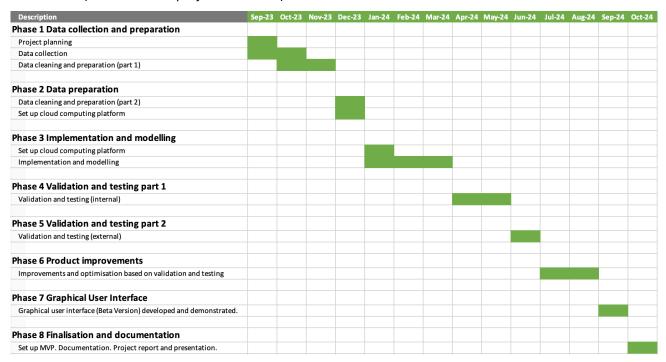
Project Plan

Project plan (revised due to project extension):

Phases	Start date	End date	Tasks	HR	Other Resources	Objectives/Delivera bles	Success Criteria
Phase 1 - Data collection and preparatio n	01/0 9/20 23	30/1 1/20 23	Project planning Data collection Data cleaning and preparation (part 1) Progress report	CW 0.1 FTE in-kind UN 0.05 FTE in-kind + 0.2 FTE for data analysis/tutoring RH 1 hour in-kind per week YE 1 hour in-kind per week	Access to source documents.	Part 1 of dataset that is pre- processed and ready to be used for LLM fine-tuning.	Collection of at least 80% useable data from the Future Beef website Validation of data integrity Completion of pre-processing within the defined timeline
Phase 2 - Data preparatio n	1/12/ 2023	31/1 2/20 23	Data cleaning and preparation (part 1) Set up cloud computing platform (part 1) Progress report	CW 0.1 FTE in-kind UN 0.05 FTE in-kind RH 1 hour in-kind per week YE 1 hour in-kind per week	Access to source documents. Cloud computing platform	Part 2 of dataset that is pre- processed and ready to be used for LLM fine-tuning.	Validation of data integrity Completion of pre-processing within the defined timeline
Phase 3 - Implement ation & modelling	31/1 2/20 23	31/0 3/20 24	Set up cloud computing platform (part 2) Implementation and modelling Progress report	CW 0.1 FTE in-kind and 0.2 FTE casual UN 0.2 FTE casual ZH 12 hours p/w casual RH 1 hour in-kind per week YE 1 hour in-kind per week	API for LLM. Cloud computing platform	The fine-tuned LLM (Large Language Model) saved as a model file (or files).	Model training completed by the defined end date
Phase 4 - Validation & testing part 1	01/0 4/20 24	31/0 5/20 24	Model validation and testing Progress report	CW 0.1 FTE in-kind and 0.2 FTE casual UN 0.2 FTE casual ZH 12 hours p/w casual HL 20 hours p/w casual RH 1 hour in-kind per week YE 1 hour in-kind per week	API for LLM. Cloud computing platform	Internal validation and testing. Strategy for improvements. Progress report.	Pass initial validation against a test dataset.
Phase 5 - Validation & testing part 2	01/0 6/20 24	30/0 6/20 24	Model validation and testing Progress report	CW 0.1 FTE in-kind and 0.2 FTE casual UN 0.2 FTE casual ZH 10 hours p/w casual HL 20 hours p/w casual RH 1 hour in-kind per week	API for LLM. Cloud computing platform	Implement initial improvements. External validation and testing. Strategy for further improvements. Solidify commercialisation strategy. Progress report	Pass validations against a test dataset.

Phase 6 –	01/0	31/0		CW 0.1 FTE in-kind		A fine-tuned LLM to	Pass validations
Product	7/20	8/20		and 0.2 FTE casual		match problems	against a test
improvem	24	24		UN 0.2 FTE casual		with solutions	dataset.
ents				ZH 10 hours p/w		and/or knowledge.	dataset.
				casual			
				HL/RA 10 hours p/w		A report detailing	
				casual		the model's	
				RH 1 hour in-kind per		performance based	
				week		on validation and	
						testing.	
						_	
						The model should	
						pass initial	
						validation against a	
						test dataset.	
						Progress report.	
Phase 7 -	01/0	30/0	Graphical user	CW 0.1 FTE in-kind	GUI	A sprint to produce	Completion of
Graphical	9/20	9/20	interface (Beta	and 0.2 FTE casual	software	a simple web-based	GUI within the
User	24	24	Version)	UN 0.2 FTE casual	(e.g. R-	GUI that can be	specified
Interface			developed and	ZH 10 hours p/w	Shiny) that works on	used for	timeframe
(GUI)			demonstrated.	casual		demonstration	Successful
			Integration of LLM into GUI	HL/RA 10 hours p/w casual	http	purposes	integration of the
			into Gui	RH 1 hour in-kind per			LLM into the GUI
				week			LLIVI IIILO LIIE GOI
				WEEK			
Phase 8 –			Review and final	CW 0.1 FTE in-kind		Set up compute and	Successful
Finalisatio			report	and 0.2 FTE casual		storage for MVP.	demonstration of
n and				UN 0.2 FTE casual			MVP.
document				ZH 10 hours p/w		Technical	
ation				casual		documentation.	
				HL/RA 10 hours p/w			
				casual		Marketing material.	
				RH 1 hour in-kind per			
				week		Project Report and	
						presentation.	

Gantt Chart (revised due to project extension):



Project Budget (revised due to project extension):

Phases	Milestone/	Salaries	Equipment	Overhead	Sum	Funding
	Payment	(incl. on-cost)		(travel, etc)		Status
Phase 1 - Data collection and preparation	01/09/2023	\$26,000	Computing /APIs	Travel	\$31,00	Received
			\$3,000	\$2,000	0	20/09/23
Phase 2 - Data preparation	01/12/2023	\$9,000	Computing/APIs		\$14,00	Received
			\$5,000		0	13/03/24
Phase 3 - Implementation & modelling	01/01/2024	\$51,000			\$51,00	Received
					0	13/03/24
Phase 4 - Validation & testing part 1	01/04/2024	\$39,000			\$39,00	Received
					0	23/04/24
Phase 5 - Validation & testing part 2	01/06/2024	\$5,000*			\$5,000	Received
						1/11/24
Phase 6 - Product improvements	01/07/2024	\$5,000*			\$5,000	Received
						1/11/24
Phase 7 - Graphical User Interface (GUI)	01/09/2024	\$5,000*			\$5,000	Received
						1/11/24
Phase 8 – Finalisation and	01/10/2024	-			\$0	N/A
documentation						
Total		\$140,000	\$8,000	\$2,000	\$150,0	
					00	

^{*}Partially covered by previous funds

Phase 1 - Data Collection and Preparation

General Project Progress

- Project resources: Project summary document created
- Ethics: Human Research Ethics provided an exemption letter stating that the project does not require a full review by the Human Research Ethics Committee.
- **Commercialisation:** JourneyTech has been informed of the project, and an initial meeting has been scheduled for 4 December for general guidance and advice.
- Data permission: The source data for the project, the Future Beef website, is licensed under the Creative Commons Attribution 3.0 Australia (CC BY) license which includes commercial use, so a formal agreement or MoU isn't required. In the interests of transparency and maintaining a good relationship with the Future Beef data custodian, Q DAF, we engaged with Dale Miller (Director, Extensive Livestock Systems RD&E, Animal Science) to ensure that Q DAF is aware of and supports the use of their data for the BeefVantage project. Dale expressed appreciation for our proactive communication and demonstrated both interest and support for our project. He emphasized the importance of cautious and responsible management in delivering advice, and is keen to receive updates on the project's progression. To solidify this cooperative relationship and ensure mutual understanding, we sought a formal expression of support from Q DAF on 25/10/23. Dale is currently consulting internally regarding this matter, but is currently waiting for the GM to return from leave before he can progress further. Naomi Galvin from JCU Grants Connect has confirmed that this approach is appropriate.

Data Collection Progress

Overview

We implemented a comprehensive data collection pipeline to extract and collect information from the FutureBeef website. This process included two primary components: a web parsing algorithm and a resource downloading subroutine, as depicted in Figure 1.

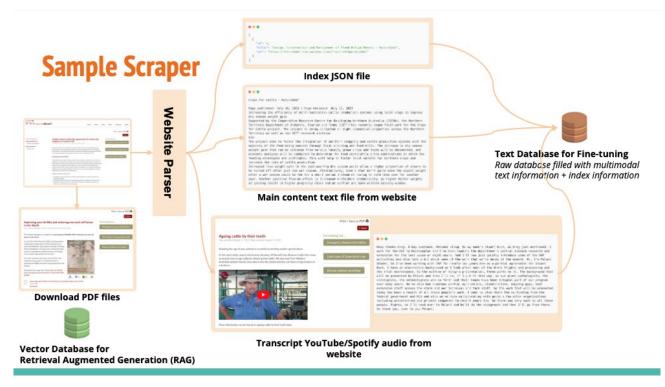


Figure 1: Web Scraping methodology

Methodology

- Web Parsing: We employed a web parsing algorithm to pragmatically extract text and URL information from the FutureBeef website. This algorithm was designed to navigate the complexities of web data extraction, ensuring both the accuracy and comprehensiveness of the information gathered. The primary goal of it was to systematically access web pages, parse HTML content, and extract relevant data. This data included raw textual content and hyperlinks, particularly those linking to additional resources such as PDF documents, videos, and podcasts. These requests are managed to handle network inconsistencies, server response issues, and mitigate the risk of server overload. The raw website text data was scraped and downloaded to OneDrive storage.
- Multimodal Information Handling: To further enrich the data, we also download the additional resources linked within the scraped text data from the Future Beef website, including PDFs, videos, and podcasts.

Pre-Processing Progress

Overview

We completed pre-processing of part 1 of the dataset - the website and PDF resources - to ready the dataset for model training. This phase encompassed categorisation and the implementation of best-practice LLM pre-processing techniques, setting a robust foundation for training. Part 2 of the dataset – the video

and podcast resources - will be transcribed and pre-processed in phase 2.

Methodology

• Categorisation: All data assigned unique IDs, categorised and indexed.

• LLM Pre-processing: Our approach encompassed best-practice language model (LLM) pre-

processing techniques, ensuring that the data was optimally refined and structured for

subsequent fine-tuning. For the web data scraped from the Future Beef website, we

implemented a selective content retention strategy. Our algorithm was designed to identify and

retain only the main content text, effectively excluding unnecessary elements such as

navigational menus, footers, and irrelevant URL links. This filtering ensured that the dataset

only includes substantive and contextually relevant information from the website.

Validation of data integrity

Overview

The pre-processed dataset has been validated through several key steps to ensure that the data used for

training is accurate, consistent, and reliable.

Methodology

Part 1 of the pre-processed dataset was validated through several key steps to ensure that the data used for

training is accurate, consistent, and reliable. This included cross-checking samples of data against the source

content.

Phase 1 Summary

Success criteria: Collection of at least 80% useable data from the Future Beef website.

Status: Data collection is now complete, including all usable data from the FutureBeef website. This includes a total of 775 website resources, 1135 PDF resources, 250 video resources, and 12 podcast resources.

Challenges: The data collected includes 64 case studies, which need to be evaluated on a case-by-case basis – if a case study identifies a person, or if a person's identity could be deduced from the case study, then either the data will be removed from the dataset, or the Human Research Ethics committee will be consulted for further advice regarding the usage of the data. This will be completed in phase 2.

Success criteria: Completion of pre-processing within the defined timeline.

Status: Pre-processing is now complete, and part 1 of the dataset is prepared for model training.

Success criteria: Validation of data integrity.

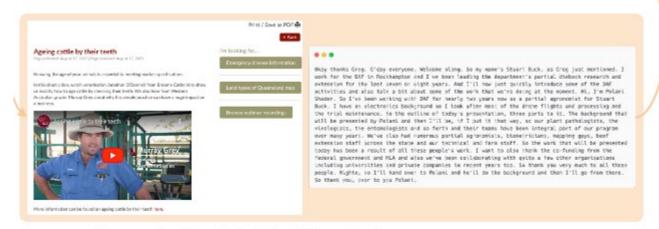
Status: Part 1 of the dataset is now validated for model training.

Phase 2 – Data Preparation

General Project Progress

- **Commercialisation:** An initial meeting with JourneyTech was held on 4 December for general guidance and advice. They provided the following advice regarding the source data for the project, the Future Beef website:
 - As promised, we have reviewed the T&C's for the FutureBeef website and the use of the data (see attached) and as you also found, we see no issues with using the data in the way you propose. However, you must give appropriate credit, provide a link to the license, and indicate if changes were made. You must do so in a reasonable manner, but not in any way that suggests the licensor endorses you or your use.
 - A follow-up meeting will be scheduled in January to discuss various matters including trademarking and domain names.
- **Data permission:** Dale from Q DAF is still consulting internally regarding this matter, last followed up on 20/12/23.

Pre-Processing Progress



Transcript YouTube/Spotify audio from website

Overview

We completed pre-processing of part 2 of the dataset - the video and podcast resources have been transcribed and pre-processed.

Methodology

- Categorisation: All data assigned unique IDs, categorised and indexed.
- LLM Pre-processing: Our approach encompassed best-practice language model (LLM) pre-processing techniques, ensuring that the data is optimally refined and structured for subsequent fine-tuning. The podcast and video data were transcribed using Whisper Large Model for maximum accuracy. This included 12 podcast files and 350 video files. Some challenges were faced in the automation of this process, however they were overcome through testing different techniques.

Validation of data integrity

Overview

The pre-processed dataset has been validated through several key steps to ensure that the data used for training is accurate, consistent, and reliable.

Methodology

Part 2 of the pre-processed dataset was validated through several key steps to ensure that the data used for training is accurate, consistent, and reliable. This included cross-checking samples of data against the source content.

Phase 2 Summary

Success criteria: Completion of pre-processing within the defined timeline.

Status: Pre-processing is now complete, and the complete dataset (part 1 and 2) is prepared for model training.

Success criteria: Validation of data integrity.

Status: Part 2 of the dataset is now validated for model training.

Phase 3 – Implementation and Modelling

General Project Progress

- **Commercialisation:** A second meeting with JourneyTech was held on 22 January for further guidance and advice. They provided the following advice regarding the project:
 - Trademark filing recommended shortly prior to using the name in public (e.g. on website or discussed at Beef Week).
 - Consideration for future funding opportunities and expansion into other agricultural domains.
 - A follow-up meeting will be scheduled in April and trademark filing process will be started prior to Beef Week.

Implementation & modelling

Overview

In Phase 3, we compared a range of open-source LLMs to serve as foundation models, conducted fine-tuning based on the data processed in earlier phases, and implemented a Retrieval-Augmented Generation (RAG) system to link answers to sources. In Phase 4, we'll make further improvements to the model as part of the validation and testing process, and in Phase 5, we'll set up a user interface.

Development Overview

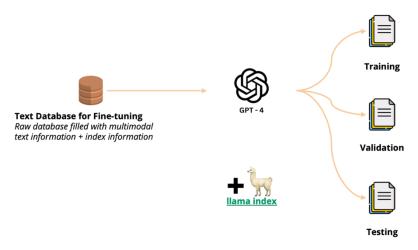


Methodology

Model Fine-tuning

The product was then fine-tuned from the second generation of Llama model. Llama is an open-source autoregressive LLM based on transformer architecture, comparable to GPT-3. It leverages three main improvements over prior proposed models, including pre-normalisation, SwiGLU activation function and rotary embedding. Llama-2 is the second generation of Llama, which competes with ChatGPT. It features twice the context windows and 40% more training data compared to the original Llama. These enhancements, along with grouped-query attention, enable Llama-2 to outperform original Llama on reasoning, coding, and knowledge tests, indicating its capability in diverse tasks. Therefore, we fine-tuned and validated the Llama-2-7B model with the collected instruct data. The entire model was trained using paged AdamW for a single epoch, with a warm-up step of 1 and learning rate of 1e-5. Our implementation is based on HuggingFace Transformer 6, following instruction from Alpaca. The process utilized 3 NVIDIA H100 GPUs over a duration of 5 hours.

Generate Training Dataset



Retrieval Augmentation Generation

After fine-tuning, LLMs can store factual knowledge within their parameters and provide promising results for completing simple in-domain tasks. However, their ability to precisely manipulate knowledge and handle out-of-knowledge queries remains limited, which is the main cause of model hallucination in knowledgeintensive tasks. To further improve the response accuracy, we prompt engineered the fine-tuned Llama-2 model with Retrieval Augmentation Generation (RAG). There are three components involved in establishing the RAG system: 1) vector database for knowledge context reference, 2) model serving for instant inference, and 3) prompt designing for hallucination reduction. We utilise Chromadb 7 to build a largescale vector database with all the available source documents. This vector database is constructed by truncating and embedding each document into text blocks, with a maximum of 500 tokens per block for context-related reference. The vector database can be updated with the latest external resources, and we index all documents with unique IDs along with their original source URLs to maintain the traceability of each text block. The fine-tuned model is served via Ollama 8, with a temperature of 0.1 and a repeat penalty of 1.15, to respond to in-coming queries with external context. Unlike traditional deep-learning pipelines that require complex dependencies and initial model loading for the first launch, Ollama serves the model as a system-wide service via a Docker-like container, making model inference simpler and faster. We integrate LangChain 9 prompt templates within the model RAG system by sending the most relevant text excerpts from the vector database, along with the queries, to the fine-tuned model. This approach allows the model's responses to include both its internal knowledge and external in-domain knowledge with proper references.

Vector Database

Vector database:

- Build vector database with all scrapped TXT and PDF files, it's available <u>here</u>.
- 2. Make the text chunk size 500 with 50 overlapping text.
- 3. Each piece of the text chunk will be saved in the vector database with unique ID.
- 4. Those text can be retrieved during inference through the similarity score .
- 5. The Vector Database can be updated easily with new input documents.



Retrieval Augmented Generation with Demo

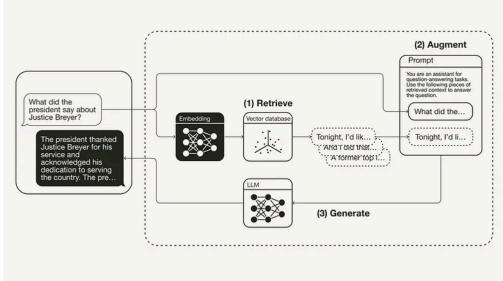


Image source: https://towardsdatascience.com/retrieval-augmented-generation-rag-from-theory-to-langchain-implementation-4e9bd5f6a4f2

Results

A set of 100 Al generated question-answer pairs was used to evaluate the model in 4 categories - relevance, completeness, clarity, and accuracy – evaluation was conducted by GP4 and a human evaluation of a subset of 25 questions. Several areas for improvement have been identified to improve the accuracy of answers

and reduce hallucination, which will be implemented in Phase 4, including reducing vector database text chunk size, and utilising newer open-source foundation models (a comparison test will be conducted), and prompting the model with a static response for queries beyond its knowledge scope.

Phase 3 Summary

Success criteria: Model training completed by the defined end date

Status: The team has successfully completed the objectives/deliverables for Phase 3 of the project in accordance with the established success criteria. Model training is completed, including fine-tuning and Retrieval Augmentation Generation (RAG). Strategy formed for model improvements, validation and testing in Phase 4.

Phase 4 – Validation and Testing Part 1

General Project Progress

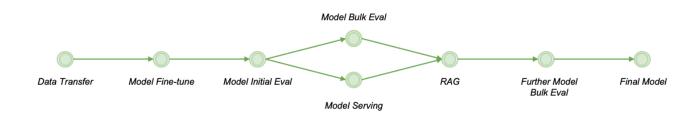
- **Commercialisation:** A third meeting with JourneyTech was held on 26 April for further guidance and advice. The following was discussed:
 - Considerations for solid commercialisation strategy (required prior to travel funding approvals) – provide return on investment.
 - JCU innovation disclosure form completed.
 - Consideration for future funding opportunities and expansion into other agricultural domains. For example, AEA (they will advise when this opens).
- Opportunities: Several amplification and development opportunities have recently emerged:
 - Carrie was interviewed on Beef TV at Beef Australia 2024 in Rockhampton on 10 May regarding the product concept.
 - Carrie has been invited to speak about BeefVantage at GroWQ Innovation Expo in Longreach on 25-26 July.
 - Carrie has been accepted for a presentation on the TNQ Drought Hub's digital tools for resilience (BeefVantage & AgValuate) at the Developing Northern Australia conference in Karratha on 26-28 August.
 - Nada Sukkarieh from Agricultural Innovation Australia expressed an interest in the product and appreciates it's potential to be used across various Research & Development

Corporations (RDCs) – she asked to be kept updated as the project progresses.

Implementation & modelling

Overview

In Phase 4, we completed initial internal validation and testing by comparing performance across various configurations of foundational LLMs, fine-tuning processes, and Retrieval-Augmented Generation (RAG) systems. In Phase 5, we'll conduct external testing and make further improvements to the model as part of the validation and testing process.



Model Improve (Mixtral-8x7b and Llama-3)

- Large Model: <u>Mixtral-8x7b</u> is a large model <u>Llama-3</u> is the latest model trained with massive documents
- Performance: <u>Mixtral-8x7b</u> and <u>Llama-3</u> are both the current state-of-the-art <u>open source</u> model that outperforms GPT-3.5
- **Less Hallucination**: Both model display more positive sentiments than Llama 2 on BOLD, with similar variances within each dimension
- Model selection: Due to the LLM's Catastrophic Forgetting issue, we will focus on the base model that is trained for chat/instruction.





Model Fine-Tuning ✓

- **Mixtral Model**: <u>Mixtral-8x7b</u> is a large model which required 7 x 80GB A100 for fine-tuning with all the collected data, but it has better reasoning capabilities after fine-tuning
- **Llama-3 Model:** <u>Llama-3</u> is a smaller model which only required 2 x 80GB A100 for fine-tuning with all the collected data, it has worse reasoning capabilities after fine-tuning
- **Performance**: <u>Mixtral-8x7b</u> and <u>Llama-3</u> are both performing <u>reasonable</u> well after fine-tuning for answering beef-related questions

Model selection:

- Due to the LLM's Catastrophic Forgetting issue, Llama-3 performs worse with complex reasoning task (such as RAT) after fine-tuning
- However, <u>original Llama-3</u> has been trained with much more documents and already has certain level of Beef industrial knowledge, we could directly apply original Llama-3 with RAG/RAT

Model Serving + RAG ✓

Serving the <u>Mixtral-8x7B</u> and <u>Llama-3</u> locally with Ollama library with input context **knowledge from future beef**.

Pros:

- 1. Ollama provides flexible serving options with CPU, GPU or quantisation inference.
- 2. Ollama is officially support by LangChain for RAG.
- 3. Quick inference speed with single run.

Cons:

- May have less reasoning output → the facts in the answer are correct but the answer logic may not really good
- 2. May still include some hallucination (~5%) but can be controlled by further prompt engineering



Internal validation and comparison of output:

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Results

A set of 100 AI generated question-answer pairs was used to evaluate 13 combinations of models in 4 categories - relevance, completeness, clarity, and accuracy – evaluation was conducted by GP4 and internally. Several areas for improvement have been identified to improve the accuracy of answers and reduce hallucination, which will be implemented in Phase 5, including Retrieval Augmented Thought (RAT) and Knowledge Graph, followed by human evaluation.

Model Serving + RAT ✓

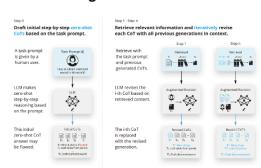
Serving the <u>Mixtral-8x7B</u> and <u>Llama-3</u> locally with Ollama library with input context **knowledge from future beef** and applying with **Chain-of-Thought**

Pros:

- 1. More reliable answers with reasoning
- 2. Self-reflection to reduce hallucination
- 3. Same benefits from Ollama as the model serving

Cons:

- 1. Requires model with complex reasoning capability
- 2. Slow due to multiple runs for a single answer
- 3. May forget fine-tuned knowledge in the CoT



Phase 4 Summary

Success criteria: Pass initial validation against a test dataset.

Status: The team has successfully completed the objectives/deliverables for Phase 4 of the project in accordance with the established success criteria. Internal validation of 13 combinations of models was conducted, with several options producing better results that the leading publicly available model, ChatGPT. Strategy formed for model improvements, external validation and testing in Phase 5.

Phase 5 – Validation and Testing Part 2

General Project Progress

- Commercialisation:
 - o Applied for Beanstalk Drought Venture Studio for commercialisation support

Opportunities:

 Carrie presented the concept to approximately 10-15 beef extension officers from Qld DAF and invited them to participate in evaluation and testing.

Implementation & modelling

Overview

In Phase 5, we completed further validation and testing by developing a comprehensive AI testing methodology to compare performance across 6 LLM configurations using 127 question-answer pairs. Additionally, a group of approx. 10-15 beef extension officers were invited to assist with evaluation, however, none of the participants did the survey. In Phase 6, we'll undertake product improvements and seek out additional opportunities to invite human experts to participate in validation and testing – for example, Carrie is presenting at the GroWQ event to approximately 200 attendees.

Human Evaluation

A presentation was delivered to a group of approx. 10-15 beef extension officers, who were invited to assist with evaluation by completing a Qualtrics survey that compared the output from 3 models. However, while the participants expressed interest in the project and asked insightful questions, none completed the survey (only one partial response) – feedback was that it was too much reading, and that they didn't have sufficient time to do it in one sitting (approx. 30-60 minutes). In Phase 6, we'll seek out additional opportunities to invite human experts to participate in validation and testing – for example, Carrie is presenting at the GroWQ event to approximately 200 attendees.

Pipeline Evaluation

To better understand the benefits of each method for LLM in the beef production domain, we evaluated different combinations using the same evaluation metric. The combinations include both the original Llama-3 and fine-tuned Llama-3, with and without RAG and Graph-RAG systems. Since human evaluation is expensive and non-experts cannot determine the correctness of the technical answers, we utilised GPT-4 as an evaluator by providing the ground-truth answers as guidance.

Evaluation Setup: We applied GPT-4 to generate 200 question-answer pairs from the collected beef agriculture documents. The detailed evaluation generation prompts is shown in Figure 1. After filtering out

the duplicate topics, there is a total number of 127 question-answer pairs that can represent the ground-truth dataset. We prompt the models with the questions and provide GPT-4 with the ground truth answers and model generated answers for evaluation.

Figure 1: Evaluation Prompt

Generate 5 question and answer pairs for the following content in the <content></content> tag:

<content> {content} </content>

Follow these steps to ensure the questions and answers are practical, detailed, and suitable for farmers and industry professionals:

1. Understand the Context: Ensure each question and answer is relevant to the

northern Australian beef industry and addresses real-world concerns of farmers.

2. Use Simple Language: Write in clear, straightforward language that a beef

producer would use and understand. Avoid technical jargon unless it is commonly known in the industry.

3. Cover a Wide Range of Topics: Include questions from the topic list below

to ensure comprehensive coverage.

4. Ensure Practicality: Each answer should provide actionable advice or information that can be directly applied by farmers in the Australian beef

industry.

- 5. Reference Provided Knowledge Set: Base your answers on the documents provided as the ground truth dataset. Ensure the answers are directly supported by and verifiable within these documents.
- 6. Reflect Real-World Concerns: Craft questions that mirror the actual problems and scenarios beef producers encounter. This includes daily operational issues, long-term planning, and unexpected challenges. Instructions for Generation:

Step 1: Start with a broad topic from the list.

Step 2: Identify a specific issue or common question within that topic.

Step 3: Formulate a clear and concise question a farmer might ask.

Step 4: Provide a detailed, actionable answer directly supported by the ground truth dataset.

Step 5: Repeat the process, ensuring no duplication of questions or answers.

Evaluation Metrics: To better reflect the application in the industry domain, we introduce three different evaluation metrics:

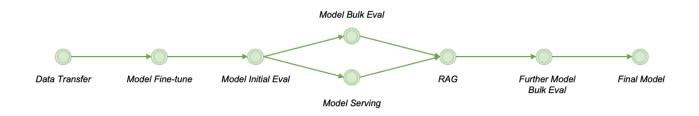
- 1. Relevance: How closely the model answer addresses the specific question.
- 2. Groundedness: The correctness of the answer compared with the ground truth.
- 3. Helpfulness: The usefulness the answer can be utilised or implemented by a beef farmer. For each metric, GPT-4 will provide a score from 1 to 10, where 1 is the worst and 10 is the best. We take the mean value of each combination and linearly scale up the scores to 100 for evaluation.

Llama3-8B	Relevance	Groundedness	Helpfulness
OG	75.12	78.74	74.49
OG-RAG	76.14	78.35	72.76
OG-GRAG	76.46	79.37	73.31
FT	78.19	80.39	74.49
FT-RAG	68.11	73.54	63.78
FT-GRAG	69.76	76.14	66.46

Table 1: Evaluation results. "OG" represents Original Llama3-8B model. "FT" represents Fine-Tuned Llama3-8B model. "GRAG" represents Graph RAG.

Evaluation Result: The evaluation results are summarised in Table 1. Compared with original Llama3-8B

model, both RAG system and fine-tuned model have better performance in relevance and groundedness. The Helpfulness are slightly worse in RAG system and remains the same in fine-tuned models. This might due to the technical knowledge injection into the model, which lead to more technical language during question answering. For original Llama3-8B model, Graph RAG improve its answer in all three metrics comparing with original RAG. For fine-tuned Llama3-8B model, it's worth noting that the integration of RAG and Graph RAG decrease the performance of the model. This might be caused by catastrophic forgetting where model can loss its major reasoning capability while acquiring new domain knowledge (Luo et al., 2024). However, we observe that even under this circumstance, Graph RAG still outperform RAG in all three metrics. We also compare the performance with the proprietary models, although their performance are better than the open-source models, the concerns about privacy and cost-efficiency preventing deploying them into real-world application.



Phase 5 Summary

Success criteria: Pass validations against a test dataset.

Status: The team has successfully completed the objectives/deliverables for Phase 5 of the project in accordance with the established success criteria. The team completed further validation and testing by developing a comprehensive AI testing methodology to compare performance across 6 LLM configurations using 127 question-answer pairs. The results informed the selection of models for further development. Strategy formed for model improvements in Phase 6.

Phase 6 – Product Improvements

General Project Progress

- Commercialisation:
 - We are actively exploring several avenues to maximize the impact and reach of our product.

- The application for the Beanstalk Drought Venture Studio for commercialisation support was unsuccessful. Denise from JourneyTech has recommended looking into similar programs including CSIRO On Prime.
- On 20 August, Carrie and Rachel met with Paul Gibson, Group Manager Research Development Innovation, and Des Woolfield, Group Manager – IT & Systems, from Australian Country Choice. They expressed strong interest in our product and requested a demo once the MVP is ready. They are seeking an AI solution that integrates across their entire supply chain, utilising existing data that they collect. They are particularly interested in AI data analysis to support decision-making. To enhance our offering, we might consider partnering with an agtech company specialising in data analysis. This collaboration could combine their analytical expertise with our product's beef research knowledge base.
- As part of the T Program, Mohammad Farjoo connected with Bill Haylock, Director of PX4 Software, who expressed a keen interest in developing AI tools capable of parsing and extracting data and clauses from both Acts of Parliament and various business agreements. Mohammad informed Bill that our team has already developed a similar solution for the beef industry and possesses the necessary capacity, experience, and expertise to potentially adapt our methods to meet PX4 Software's needs. Further discussions are pending.

Opportunities:

- Carrie presented the concept at GroWQ Innovation Expo in Longreach on 25 & 26 July to approximately 192 producers and industry professionals, and invited them to participate in evaluation and testing – 9 people filled in the EOI form.
- Carrie presented the concept at the Developing Northern Australia conference in Karratha on 27 August to approximately 80 attendees, and invited them to participate in evaluation and testing – 5 people filled in the EOI form.
- O The team submitted a demo paper to the 2024 Conference on Empirical Methods in Natural Language Processing (EMNLP). To safeguard intellectual property (IP), we excluded code, data, and data sources from the paper, sharing only one prompt to demonstrate overcoming a specific challenge. While finer technical details were omitted to protect IP, there are concerns about potential rejection due to this lack of detail. After discussing with Denise from JourneyTech, it was agreed to proceed with the submission.

Phase 6 Objectives/Deliverables

• A fine-tuned LLM to match problems with solutions and/or knowledge.

A report detailing the model's performance based on validation and testing.

• The model should pass initial validation against a test dataset.

Overview

In Phase 6, we completed further product improvements after comparing performance across various LLM

configurations.

Human Evaluation

During Phase 6, we expanded our efforts to involve human experts in model validation and testing. Carrie

presented at the GroWQ Innovation Expo and the Developing Northern Australia conference, securing 14

Expressions of Interest (EOIs). We have developed a Qualtrics survey for human evaluation of our latest

model results, currently under review by the Human Research Ethics Committee.

Improvements

We have implemented restricted online searches using a list of trusted sources, testing with SerpAPI and

Ravily APIs.

Our knowledge graph, aimed at enhancing reasoning for large language models (LLMs) and extracting more

relevant information, is similar to a vector database but the initial iteration has resulted in increased

inference times. We've started refining the graph by using ChatGPT-4, optimizing to reduce non-essential

information, and adjusting degree centrality to remove less significant nodes. We've cut down unnecessary

nodes by approximately 17% to 98,976 and relationships by about 3% to 489,507. These improvements will

progress alongside UI development in the next phase.

Further system prompt enhancements have been made for more precise instruction following and reasoned

responses. We're also testing new foundational models, including Llama 3 and Llama 3.1, in both 8B and

70B versions. A new evaluation method inspired by a <u>study from arXiv</u> involves AI-generated questions with

definitive answers to score model responses.

Model Results

S2S Fund 2023/4 Final Report

BeefVantage

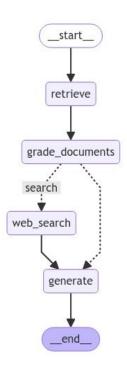
27

Groundedne 2 78.74 4 78.35 6 79.37	74.49 72.76
4 78.35	72.76
16 79 37	
75.57	73.31
3 7.7960526	7.2631579
8.2302632	7.7039474
2 7.7631579	7.006579
7.8533333	7.0866667
3 7.9342105	7.3881579
	7.5167785
	7.7631579 7.8533333

 $Note: "Remove don't know" \ refers to \ model \ instructed \ to \ remove \ "don't \ know" \ answers, \ as \ Llama \ 3.1 \ tends \ to \ be \ cautious \ in it's \ responses.$

Agent Flow

An additional improvement includes developing an agent flow to enhance process efficiency: attempting to extract model answers from the RAG system before resorting to web searches, and if uncertain, defaulting to "don't know" to prevent misinformation. This workflow is being improved to better handle edge cases.



User Interface Development

We have begun exploring an open-source solution akin to ChatGPT for the user interface, featuring admin capabilities for feedback review and user accounts with saved history, with early tests looking promising.

Planning for the Next Phase

S2S Fund 2023/4 Final Report
BeefVantage

The upcoming phase will focus on completing the user interface, refining the agent flow, finalizing the new knowledge graph, conducting further AI evaluations with the new model configurations, and performing human evaluations pending HREC approval.

Reporting

This summary is accompanied by a demo paper that details our model's performance, based on validation and testing, submitted to the 2024 EMNLP conference. The paper serves as the comprehensive report on the model's performance for this phase of our project.

Phase 6 Summary

Success criteria: Pass validations against a test dataset.

Status: Phase 6 of the project has been successfully completed, with all objectives and deliverables achieved according to our predefined success criteria. The phase focused on extensive model improvements, rigorous validation, and testing via an Al-centric methodology, leading to the selection of optimised models slated for inclusion in the MVP. As we transition into Phase 7, a detailed strategy is in place to further refine these models and finalise the User Interface.

Phase 7 – Graphical User Interface (GUI)

Finalisation of Model Configurations and Evaluation

The agent flow technique was refined, and the new knowledge graph was successfully completed. All configurations were evaluated using the automated AI method outlined in Phase 5, which involved 127 question-answer pairs. The highest-performing configuration was identified as Llama-3.1-70B with Agent-RAG-Web, which demonstrated an optimal balance of domain relevance, groundedness, and practical utility.

User Interface Development

For the user interface, we selected Open WebUI, an open-source solution comparable to ChatGPT, offering admin functionality for feedback review and user account management with saved histories. The top-performing model configuration was integrated into this interface. Features were selected and implemented to align with the project objectives and target audience, with an emphasis on usability and flexibility. The interface will successfully support demonstration of the MVP.

Phase 7 Summary

Success criteria: Completion of GUI within the specified timeframe; Successful integration of the LLM into the GUI.

Status: Phase 7 of the project has been successfully completed, meeting all predefined objectives and deliverables. This phase focused on finalising the highest-performing model, integrating the LLM into the GUI, and testing and refining the interface and features.

Phase 8 – Finalisation and Documentation

Compute and storage for the MVP were set up using Runpod for hosting both the model and user interface, with Tavily providing support for integrating limited web search into the agent flow. Technical documentation was completed and stored in the project's GitHub account, with additional supplementary documentation maintained on OneDrive. The phase also included a successful MVP demonstration conducted for TNQ Drought Hub staff, as well as the finalisation of the final project report, and a meeting with Journey Tech regarding commercialisation pathways.

Phase 8 Summary

Success criteria: Successful demonstration of MVP.

Status: Phase 8 of the project has been successfully completed, with all objectives and deliverables met according to the predefined success criteria. This phase concentrated on finalising technical and project documentation and showcasing the MVP to TNQ Drought Hub staff.

HR Allocated

Position	Person	Level	Hours	Approval Period	Salaries
Casual research	Zhihao	HEWL 7	260	16/10/2023 to 19/01/2024	\$18,658
assistant	Zhang	Step 10	(20/week)	(13 weeks)	
	(Ken)		228	20/01/2024 to 31/05/2024	\$17,025
			(12/ week)	(19 weeks)	
			200	(01/06 to 18/10/2024)	\$14,897
			(10/ week)	(20 weeks)	
Casual research	Haohui Lu	HEWL 7	340	04/03/2024 to 21/06/2024	\$25,005

assistant		Step 10	(20/week)	(17 weeks)	
Casual research	Linwei Tao	HEWL 5	208	01/07/2024 to 18/10/2024	\$12,164
assistant		Step 10	(13/ week)	(16 weeks)	
Casual project	Carrie-Ann	HEWL 8	152.25	01/02/2024 to 28/06/2024	\$13,132
manager	Wilson	Step 20	(7.25/ week)	(21 weeks)	
			116	01/07/2024 to 18/10/2024	\$10,631
			(7.25/ week)	(16 weeks)	
Casual researcher	Dr Usman	HEWL 9	152.25	01/02/2024 to 28/06/2024	\$15,395
(LLM expert)	Naseem	Step 40	(7.25/ week)	(21 weeks)	
			116	01/07/2024 to 18/10/2024	\$12,463
			(7.25/ week)	(16 weeks)	
					\$139,370

Expenditure

Account Number: 1150.11602.0130

Account Name: S2S BeefVantage

Balances below are in AUD exclusive of GST as at: 03/11/2024

2023 Expenditure

ACCOUNT BALANCES

INCOME	Debit	Credit	Net Income	Current Commitment
6990 - Internal Income Allocation		31,000	31,000	
Total Income		31,000	31,000	

EXPENDITURE	Debit	Credit	Net Expense	Current Commitment	Future Commitment
Salaries and Oncosts - Casual	13,440		<u>13,440</u>		
Subtotal	13,440		13,440		
8150 - Computing Software (<\$100,000)	206		<u>206</u>		
9000 - Internal Funds Transfer	1	1			
Subtotal	207	1	206		
Total Expenditure	13,647	1	13,646		

2024 Expenditure (as at 18/12/24)

ACCOUNT BALANCES

INCOME	Credit	Net Income
6990 - Internal Income Allocation	119,000	119,000
Total Income	119,000	119,000

EXPENDITURE	Debit	Credit	Net Expense
Salaries and Oncosts - Casual	119,601		119,601
Subtotal	119,601		119,601
8150 - Computing Software (<\$100,000)	13,362	522	<u>12,841</u>
9000 - Internal Funds Transfer	1	1	
Subtotal	13,363	523	12,841
Total Expenditure	132,964	523	132,442

Total project expenditure (as at 18/12/2024): \$132,442

Account Number: 1150.11602.0130
Account Name: S2S BeefVantage

Fund Source: 0@ Base Operating Other > 0130 - Division / College Research

3 Balances below are in AUD exclusive of GST as at 18/12/2024

Opening Balance	Budget Available to Spend	Add Income	Less Expenditure	Balance of Account	Less Current Year Commitment	Funds Left to Spend
0	17,353	119,000	132,442	3,911	0	3,911

Financial Summary

Project expenditure was within budget. The remaining funds are allocated to hosting the MVP for demonstrations over the next 2–3 months. After this period, the funds will be exhausted, and alternative funding will be required to continue hosting the MVP.

Risk Management

Identify and list Hazards	List Current Risk Controls	Risk Rating	List Additional Controls and mitigation strategy	
Quality/quantity of data	Regular data quality checks	Medium (likelihood possible, consequence moderate)	Implement rigorous data validation and collection protocols; utilise reputable sources; regular monitoring and adjustments	
Risks of team member departure	Defined roles, clear communication	Medium (likelihood unlikely, consequence moderate)	Create backup plans; cross-train team members; establish a supportive work environment; develop succession planning; foster strong team collaboration	
Financial risks	Regular budget monitoring	Medium (likelihood unlikely, consequence major)	Implement strict financial controls and regular audits; include contingency budget	
Compliance with regulations	Regular legal and industry standard checks	Medium (likelihood unlikely, consequence moderate)	Maintain up-to-date knowledge of relevant regulations and industry standards; continuous monitoring, training, and implementation of required changes	

Lessons Learned

- Some technical challenges took longer than expected to resolve.
- Combining multiple NLP techniques can degrade performance due to noise.
- Rigorous evaluation at every stage is essential for meaningful comparisons.
- Al evaluations were inconsistent across researchers.

Human evaluation is time-consuming and challenging due to difficulty in recruiting volunteers.
 Consequently, a single, comprehensive human evaluation of the best model configuration will be conducted before the public MVP release

Next Steps

- HREC approval has been received for human evaluation (Application ID H9610). Due to the time of
 project completion (December), this will be conducted in January. This evaluation will use a
 Qualtrics survey and aims to compare human and AI-generated scores but also confirm the rankings
 between different models to validate the AI-driven improvements observed throughout the
 development process.
- Following the human evaluation, we aim to open up the MVP to a closed group of industry experts and producers for closed testing pending ethics amendment approval.
- Before the MVP can go out to a more public audience, legal statements and disclaimers will be needed on the tool, Denise Hodge from Journey Tech will advise on this and work with JCU Legal, IT, and DVCR as needed:
 - o Legal statements (particularly for animal health advice)
 - o Copyright compliance
 - o Liability disclaimers
- Carrie to work with Emily Harrington to ensure branding, acknowledgements, and copy are
 appropriate, and set up landing page with information on the project. Initial meeting held in
 December, work to continue in January followed by PR strategy.

Engagement Opportunities

- Demo paper has been accepted at COLING 2025 Abu Dhabi in January 2025. The team is currently seeking funding to present at this conference.
- Paper was accepted at International Rangeland Congress 2025 Adelaide, June 2025.
- Potential to present at Millenia of Ag event in Cairns 10-11 February prior to Evoke Ag 2025.
- Potential to network and engage with interested parties about product at Evoke Ag in Brisbane 18 19 February 2025, and use as a launchpad.
- Carrie applied for the Advance Qld Stack+ program in December (mentorship/networking/access to opportunities)

Commercialisation Opportunities

- DPI Partnership
 - O During December, three closed demos of the MVP were held with DPI (Dale Miller, Nicole Sallur, Pieter Conradie). Feedback thus far indicates there is interest, and they would like to see the outcomes of human evaluation and closed MVP testing. In particular they are interested in data analytics potential (regional topic trends, user interests/needs) to inform development of extension resources, and the potential to identify gaps in Future Beef content.
- Potential AgTech Licensing Opportunities
 - o Potential Target companies: Pairtree, AgriWebb, Black Box Co
 - Funding opportunity: <u>Regional University Industry Collaboration Program</u> Up to \$50k matched funding available
 - o Considerations:
 - Liability would transfer to licensee
 - Denise available to sit in on discussions
 - Requires DVCR approval
- User-Paid Model (Fallback Option)
 - o Minimum fee to cover hosting costs
 - o Requirements:
 - Technical development for billing/subscription
 - Would need to discuss with Denise and JCU re: payment structure, where it sits, and who takes liability
- Other partnerships / opportunities can be explored, including:
 - o Demo to Beanstalk (Hilary, Anna) in Brisbane office
 - o Demo to hub directors
 - o MLA, GRDC, FDAD, 3T Consulting, other consultants.
 - o International Drought Resilience Observatory Platform
 - Large vertically integrated beef supply chain companies such as AACo, ACCC, NAPCO,
 Hewitt etc.

Potential Strategic Direction

- **Growth Strategy and Competitive Edge:** Focus on developing deep expertise in the beef industry rather than diversifying into other agricultural sectors. Strive to establish and maintain a position as the global leader in beef knowledge exploration. As a world first, securing funding will be critical to sustain momentum and outpace emerging competition.
- Global Growth Potential:
 - Facilitate international knowledge transfer.
 - Foster community building within the industry.
 - Pursue partnership opportunities across the industry ecosystem and supply chain.