



Sugar Research Australia Builds AWS-Powered Next-Generation Harvesting Application for Sugarcane Growers and Harvesting Contractors

Executive Summary

Sugar Research Australia (SRA) is an organisation that invests in and manages a portfolio of research, development, and adoption projects (RD&A) to improve farming and milling profitability and productivity in the Australian sugarcane industry.

Profitability of the sugarcane industry is closely tied to harvester operation. The primary challenge is striking a balance between minimising cane and sugar loss, maintaining cane quality, and optimising throughput to effectively manage harvesting costs. Harvest losses, including cane loss, billet damage, and high extraneous matter, have been estimated to exceed \$86 million annually. Recent research on the impact of suboptimal harvest practices on profit loss has led to increased awareness among industry stakeholders.

In partnership with the Department of Agriculture and Fisheries Queensland (DAF), SRA developed a complex, proprietary algorithm and associated decision support tool to help increase harvest yield, quality and productivity for sugarcane growers and harvesters.

By working with AWS partner Clevvi, SRA was able to transform a harvest decision support tool, into a web and mobile application powered by AWS, for broader use. SRA's new online Harvesting Predictive Tool (HPT), **Harvest Mate** now enables growers and harvesters to understand and implement optimal harvesting practices given their unique conditions, encouraging the adoption of harvesting best management practice.

About SRA

Established in 2013 as a sugarcane grower- and miller-owned company, **Sugar Research Australia** is a non-profit Industry Services Body for the Australian sugarcane industry, investing in research, development, and adoption activities to improve farming and milling profitability in the sugarcane industry.

SRA's Novel Algorithm to Increase Sugarcane Yields

Australia is the second largest exporter of raw sugar in the world. The country harvests more than 30 million tonnes of sugarcane across 355,000 hectares of farms annually to produce about 4 million tonnes of raw sugar, of which 85 per cent is exported as a bulk commodity worth about \$1.9 billion to the Australian economy.

“Cane growers harvest their cane from May to December each year (bi-annually in New South Wales) with their own equipment or contract a harvesting operator to complete the job.

- Phil Patane, SRA Agricultural Machinery Specialist

“For optimal returns, the sugarcane harvest needs to meet the goal of maximising the amount of cane successfully removed from the paddock and placed in the bin with the least amount of damage or loss, during an optimal period of cane maturity or ‘ripeness’.”

“The farmer and contractor’s costs involved in this operation routinely include labour, petrol and oil, plus machinery depreciation and maintenance.”

“Current cane loss monitors do not incorporate economic considerations to assist growers and contractors in determining optimal operational options. This project has introduced an innovative decision support tool called Harvest Mate, aimed at assisting sugarcane growers in making more profitable decisions during harvest.

To create this tool, SRA and DAF leveraged findings collected from years of agronomic trials and economic analyses of harvesting operations.”

SRA’s research found that by adjusting the extractor fan speed and ground speed, harvesters could improve both sugarcane yield and quality. The incorporation of economics by DAF added a new understanding of the cost changes when adjusting harvesting practices. The optimisation of harvester settings can provide a win-win scenario for both farmers and contractors.

Numerous algorithms were developed by SRA and DAF to predict the interactions between key production and agronomic variables. The early offline version of the harvesting tool was developed and tested with growers and contractors over several years to prove the efficacy of the model. However, the project needed an experienced solutions provider to bring the offline harvesting tool to a wider audience online.

“The original offline version was not suitable for wider distribution or use by someone that doesn’t have deep knowledge and experience both with the tool and the science behind it.

- Daniel Keller, Senior Consultant at Clevvi

The goal was to turn the offline harvesting tool into an online application that was easy to use and could support multiple users and roles.



\$1.9 billion

added to the Australian economy per year from raw sugar exports

Working with Clevvi

After a competitive bidding and a rigorous selection process, SRA engaged Queensland-based AWS partner **Clevvi** for the task. Clevvi has deep expertise in building AWS-based solutions and developing custom applications for the agriculture and manufacturing industry.



“ We were able to showcase other scenarios for other industry research organisations, where we’ve been able to take up proven, scientific research and commercialise those into practical tools.

- James Deck, CEO of Clevvi

Previously, Clevvi had developed a whitefly detection app for Australian cotton growers that analyses images of pests and recommends pesticide spray patterns—based on a similar model jointly developed by the Cotton Research and Development Corporation (CRDC) and the University of Southern Queensland (USQ).

Clevvi also designed a solution that used Radio Frequency Identification systems (RFID), image recognition, and machine learning to inspect and trace the labeling of all packaged products of a major Australian agricultural food processor to ensure 100 per cent accuracy of labeling.

The Challenge

With SRA, Clevvi’s task was to develop both a web and a mobile application from the Excel-based model. The **user interface had to be simple for users with varying levels of computer literacy**, thereby maximizing its possibilities of adoption.

The application had to allow both growers and harvesters to examine incentivized payment arrangements within limited operating hours, bin fleets, and contractor availability to select the most profitable settings.

In addition, the application had to allow SRA to update metadata continuously, such as new pricing and season opening/closing dates, and push out research findings and algorithms without extensive programming knowledge.

Finally, the solution had to be **cost effective and easily maintainable by SRA**.

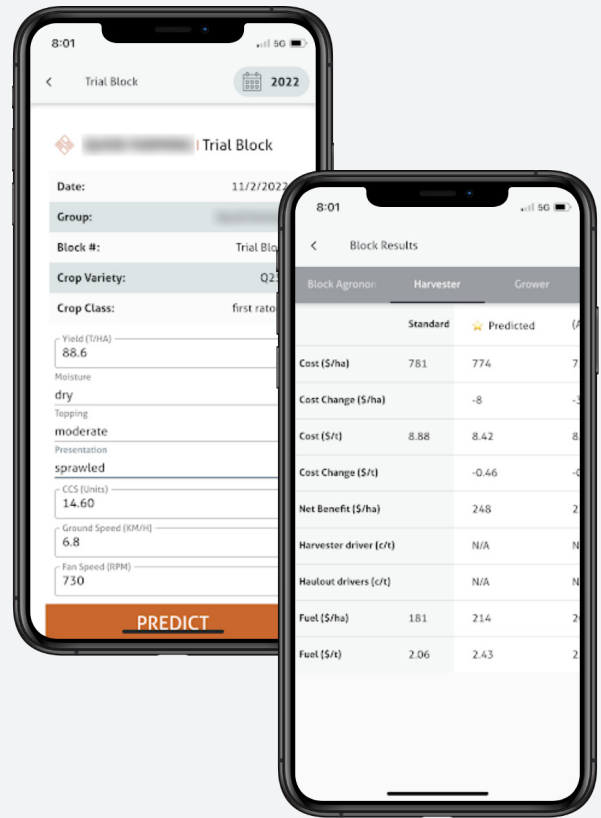


The Solution

Within eight months, the Clevvi team delivered the complete solution in four stages using the agile methodology. The first phase included detailed analysis, wireframing, UI/UX design, and data model/API design. The next phase saw the team build the web UI and the Android version and release those for alpha testing. Based on extensive feedback from this phase, the third phase introduced both the Android and iOS versions, and the application entered the beta testing phase. The last phase included user acceptance testing and the final release and handover.

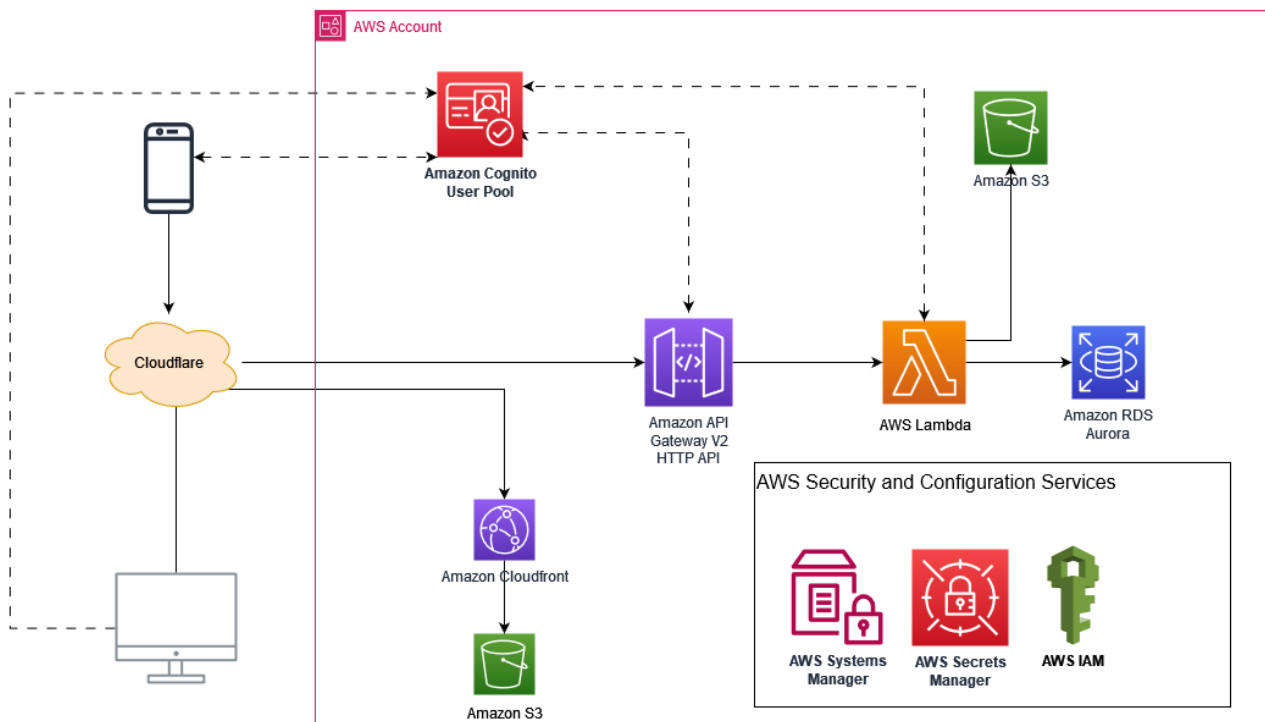


The Harvest Mate Web Application Log-in Screen



The Harvest Mate Mobile App Data Entry Screen and Economic Prediction Results Screen

The Harvest Mate Backend Architecture



Leveraging Serverless Architecture for Low-Maintenance

Given the seasonality of the sugarcane industry (a harvesting period which generally runs from May to December each year), the need for little to no-maintenance efforts for SRA administrators, and to ensure cost-efficiency, Clevvi chose to architect the backend with **AWS serverless technologies**.

“It was greenfields for us to design an architecture,” says Clevvi’s James Deck.

What was really important for us was NOT handing something to SRA’s IT department that would need a lot of maintenance and support. What appealed to us was that AWS has a suite of managed services and platforms-as-a-service.

- James Deck, CEO of Clevvi

The application front end is built with AngularJS and served by an **AWS CloudFront distribution**. **Amazon Cognito** handles user registration, authentication, and authorisation in the backend. Once an authenticated user initiates a request, it’s forwarded to the **Amazon API Gateway**, which then routes it to one of the AWS Lambda functions running in the background. Altogether, more than 100 Lambda functions comprise the backend computing layer.

The Clevvi team meticulously translated complex Excel calculations and macros into a Python library, which was packaged into a Docker image and uploaded to an **Amazon Elastic Container Registry** (ECR) repository. The Lambda functions run the containerised application created from this image and call its different routines using different handlers.

The application uses an **Amazon Aurora Serverless** PostgreSQL instance to store both metadata and user data.

Aurora Serverless PostgreSQL’s automated backup, multi-AZ deployment model, and autoscaling feature made it an ideal candidate for a cost-efficient, low-maintenance data store. To perform CRUD operations, the Lambda functions connect to the database instance using credentials stored in the **AWS Secrets Manager**.

For the database part, Clevvi engineers first built a logical entity-relationship model representing the Excel spreadsheet’s data elements. Then they used a Lambda function, a Python tool called SQLAlchemy, and a lightweight database migration tool called Alembic to create the database and table structures from that logical model. The database migration scripts were saved in an EFS (**Amazon Elastic File System**) volume mounted to the Lambda function, as Alembic required a history of all changes made through it.

One of the solution’s functionalities allows harvesters to bulk upload Excel files that they receive from the mills (yield estimate per field). Instead of uploading each file separately, users can upload all the files in one go, which are then saved in an **Amazon S3** bucket. Access to the S3 bucket is provided via pre-signed URLs. SRA can tweak the metadata or upload new algorithms using a separate management interface. Besides storing user data, S3 also hosts the Angular application files for CloudFront distribution.

Clevvi also applied the **AWS Well-Architected Framework** to create an **AWS Organization** with three AWS accounts for SRA to manage their development, staging, and production environments. The setup uses **AWS Control Tower** and Landing Zone for security best practices. Other security best practices ensured **AWS Config** was enabled, and all logs were ingested into **AWS CloudWatch**.



Solution Benefits

“SRA estimates that optimised harvesting could add \$44 million to Australian sugarcane growers’ revenue,” says Clevvi’s Daniel Keller. The initial version of the application includes various hints and tips for growers and contractors to optimise their revenue. The application includes both historical data and customisable settings to create an optimal contract between the harvester and the grower.

With an AWS-managed, serverless architecture, SRA can automatically scale down its services during the months before harvest begins when HPT usage is low. This optimizes the cost and reduces maintenance activities for SRA staff. “From a technical value-add perspective,” says Clevvi’s James Deck, “SRA can use the well-architected landing zone as a basis for future workloads as part of their cloud journey.”

Next Steps

By regularly adding new optimisation algorithms and predictive models to Harvest Mate, SRA aims to help growers and harvesters create new incentivised arrangements. Such benefits can easily see increased adoption of the tool in the sugarcane farming community, which SRA hopes will help continually promote Harvesting Best Practices within the Australian sugarcane industry.

SRA staff are currently supporting 12 growers and harvesting contractors in the Mulgrave, South Johnstone, Tully/Kennedy, Herbert and Mackay districts - across 1,000,000 tonnes of cane – as early users of Harvest Mate this season who will provide feedback on the tool.

About Clevvi

Based in Gold Coast, Queensland, Clevvi is an AWS Partner Network (APN) Advanced Tier Partner and has been operating since 2004. As a digital innovation consultancy, Clevvi’s cloud expertise includes designing and developing secure and cost-optimized AWS solutions. Its close-knit team excels in using cross-functional knowledge to create complex integration systems, build web portals and cloud-enabled innovative solutions, and provide IT strategy and consulting services to businesses for digital transformation.



AWS Services Used

- Amazon Cognito
- Amazon API Gateway
- AWS Lambda
- Amazon Elastic Container Registry
- Amazon Aurora Serverless
- AWS Secrets Manager
- Amazon Elastic File System
- Amazon S3
- AWS Control Tower
- AWS Config
- AWS CloudWatch
- AWS CloudFront

This project was funded through Sugar Research Australia and the Department of Agriculture and Fisheries (Queensland).

