Final report

Regrow - MLA's Digital Livestock 4.0 Pilot at Romani Pastoral Co

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Abstract

In response to the 2020 Request for Offer from MLA, Regrow implemented FluroSense crop and pasture monitoring solutions under MLA's Digital Livestock 4.0 pilot, hosted by Romani Pastoral Company.

The project objective was to use FluroSense analytics to deliver value to graziers to optimise livestock production, forage quality, quantity, and persistence.

FluroSense analytics engine accurately, and more importantly, numerically, tracks pasture growth parameters (such as biomass, chlorophyll and other vegetation cover performance indices) in order to maximise the forage production and consumption efficiency and improve crop and pasture productivity through variable-rate fertiliser management.

FluroSense tools were delivered to Romani Pastoral team throughout the 2020/21 season with:

- Regular crop performance emails
- In-season Nitrogen recommendation for Wheat and Barley based on the Agricultural Production Systems sIMulator (APSIM) crop model
- Variable rate application map for Nitrogen application
- FluroSense crop performance dashboard to measure pasture performance and dry matter availability

Romani decided not to apply variable rate application of Nitrogen during the test season but identified the interest of using remote sensing for guided scouting. This study also highlighted that while biomass is an important factor for monitoring broadacre crops development, for pastures, dry matter estimation is key for pasture management using remote sensing.

Executive summary

Background

The project objective was to provide an overview of FluroSense to optimise the management of large crop-livestock operations:

- Optimise livestock production, forage quality, quantity and persistence.
- Optimise nitrogen application, growth stages detection and performance analysis.

The solution was tested on Romani Smart Farm during 2020/21, with the objective to evaluate the use of FluroSense analytics for pastures and identify areas of improvement to better answer the industry challenges.

Objectives

- Track the pasture performance across paddocks to optimise the allocation of herds.
- Use FluroSense Nitrogen recommendations to optimise Nitrogen application and create nutrient variable rate (VR) application maps.

To answer the objectives above, FluroSense Crop performance and Crop Nutrition tools were used. If the objectives were not fully answered by the tools, the study gave a better understanding of the challenges of a mix crop-livestock operation using digital tools and how they could be addressed.

Methodology

FluroSense analytics transforms raw data into agronomic metrics available in the FluroSense dashboard, and through weekly email reports. Every new satellite image (captured every 2-5 days) is analysed and converted into:

- Crop performance metrics: growths stages, biomass rates and crop growth
- Nitrogen recommendation: Variable and flat rate recommendation maps

Results/key findings

- The accuracy of the planting date for an accurate growth stage detection
- The importance of Dry Matter detection for livestock pasture management.
- The importance of a sampling tool to optimise Nitrogen applications

Benefits to industry

- **Optimise the nitrogen strategy** for pastures and broadacre crops, by optimising tissue sample locations based on the leaves chlorophyll content and simplifying the creation of Variable rate application maps.
- **Be aware of abnormal crop development and crop stresses** in broadacre crops and pastures, to optimise production and simplify scouting.

Future research and recommendations

1. Data Integration between Agworld and FluroSense.
2. A new interactive version of the Crop Performance dashboard
3. A new crop stress detection algorithm suited for highly variable fields, such as grazeland.

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1. Background

Remote sensing can help solve many challenges in pastures and broadacre crops, helping producers and agronomists to monitor large-scale operations effectively and efficiently.

Regrow makes this possible by applying the latest in remote sensing, agricultural science, machine learning and AI across all relevant layers of data to create efficient agronomic workflows and provide timely, accurate, and actionable insights. What makes FluroSense analytics unique is the transformation of raw data (satellite imagery, weather) into agronomic metrics, easily accessible and usable by agronomists to make better-informed decisions.

The project objective was to provide an overview of FluroSense solutions for:

- Pastures to optimise livestock production, forage quality, quantity and persistence.
- Broadacre crop monitoring to optimise nitrogen application, growth stages detection and performance analysis.

1.1 Track the pasture performance across paddocks to optimise the allocation of herds.

Using the FluroSense dashboard and email reports, users can monitor the pasture performance in real-time to identify:
- the optimal fields to place livestock at the right time, to track pasture regrowth, and compare pasture growth/grazing rates across the farm.
- Identify poorly performing fields that require attention and scouting

1.2 Use FluroSense Nitrogen recommendations to optimise Nitrogen application and create nutrient variable rate (VR) application maps

For grains:

FluroSense Nitrogen recommendation is a unique solution on the market, incorporating proven scientific models like APSIM, developed by CSIRO and their research partners. FluroSense provides an in-season nitrogen recommendation to optimise cost margins, yield and reduce environmental impact by precisely addressing the crop's nutrient requirements.

These recommendations available for grains amongst other crop types are delivered via the FluroSense platform and are updated daily to reflect changing environmental conditions.

For other crop types:

Even if the Nitrogen recommendation isn't available for all crop types, satellite imagery can be used to create nitrogen variable rate application maps.

FluroSense utilises a specific index, the Canopy Chlorophyll Content Index (CCCI) well correlated with crop nutrition status, to divide the field into management zones (an exportable shapefile format), based on the field variability. Before exporting the zones, the user can input the product application rates for each zone and get a machinery-ready application file.

The management zones generated through FluroSense can be used on all crop types to create variable rate nitrogen application maps, improving crop and pasture productivity in a sustainable manner and indicating representative sampling locations to better estimate Feed on Offer (FOO).

2. Project objective

The project is using the FluroSense analytics engine to accurately and more importantly, numerically, track pasture growth parameters (such as biomass, chlorophyll content and other vegetation cover performance indices) in order to maximise the forage production and consumption efficiency. Specific objectives that the project focused on:

- Optimising stocking rates through dry matter variability mapping for improved grazing
- Detecting trends and anomalies in pasture growth parameters through remote sensing data and weather monitoring
- Improving crop and pasture productivity through variable-rate fertiliser management

3. Methodology

3.1 Track the pasture performance across paddocks to optimise the allocation of herds

Monitoring pasture or broadacre crop growth throughout the season to help with decision making is achieved by using the FluroSense Crop Performance tool.

FluroSense analytics, transforms raw data into agronomic metrics available in FluroSense dashboard and through weekly email reports. Every new satellite image (captured every 2-5 days) is analysed to derive the following 3 metrics:

- Crop status shows the general stage of development for each field. It is derived by analysing crop NDVI curves and represents different growth stages.

- Crop growth describes the rate of change in the crop's green biomass. The labels will range from high growth, moderate growth to declining growth.

- Crop biomass is based on the normalized difference vegetation index (NDVI), which is a measure of the "greenness" of vegetation cover. Plant NDVI indicates photosynthetic activity and thus, pasture/crop health.

Using the metric outlined above, fields can be benchmarked to highlight fields with the highest biomass to allocate the herd. It can also be used to detect the poorly performing fields that may require additional attention.

3.2 . Use FluroSense Nitrogen recommendations to optimise nitrogen application

Crop Nutrition application provides accurate, in-season nitrogen recommendations (NRx) tailored to particular crops, field management history and current growing conditions.

Defining the optimal rate of Nitrogen can be very complex as it depends on a wide range of parameters, such as soil type, crop variety, weather, market prices, target yield potential, etc.

To assist agronomists in providing nutrient recommendations, FluroSense developed a nitrogen recommendation tool, which combines 20 years of agronomic research done within CSIRO with new technologies developed by Regrow.

These recommendations are based on the world-renowned APSIM (Agricultural Production Systems Simulator) - a globally recognized and scientifically validated crop production model. The model is combined with remote sensing, farm data, weather, and economic objectives to find the right balance between yield potential, return on investment and environmental protection when providing nitrogen recommendations.

4. Results

4.1 Track the pasture performance across paddocks to optimise the allocation of herds.

FluroSense retrieved and analysed 37 satellite images over 29,728 ha alongside thousands of weather, soil and farm management data points between January and October 2020. This data has been translated into agronomic metrics and summarised in the FluroSense crop performance Dashboard and email reports delivered to the users.

Each week, Romani's team received a Crop performance report, benchmarking the field's performance per crop type and variety (Fig. 1)

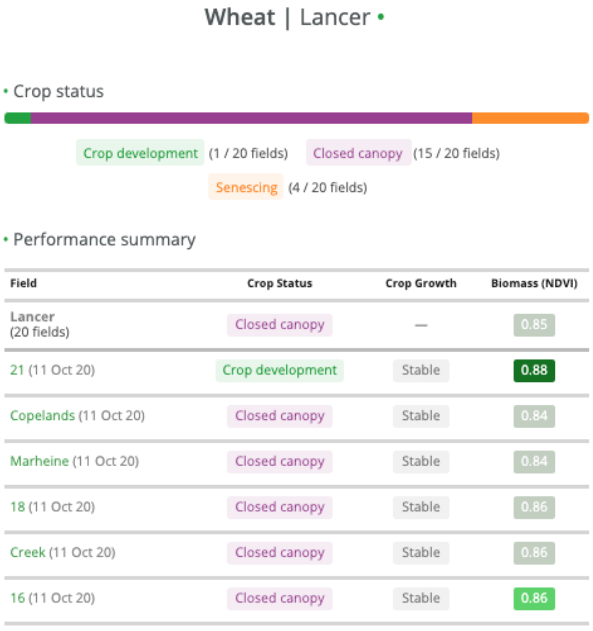

Figure 1: FluroSense crop performance report sent every Monday, comparing fields performance per variety and crop type. In this example, 6 wheat fields, variety Lancer, are compared on October 19th.

FluroSense analysis is also available directly in a dynamic online dashboard. The agronomic metrics can be viewed on a map and filter by crop type, variety, growth stage and performance to suit the analysis (Fig. 2)

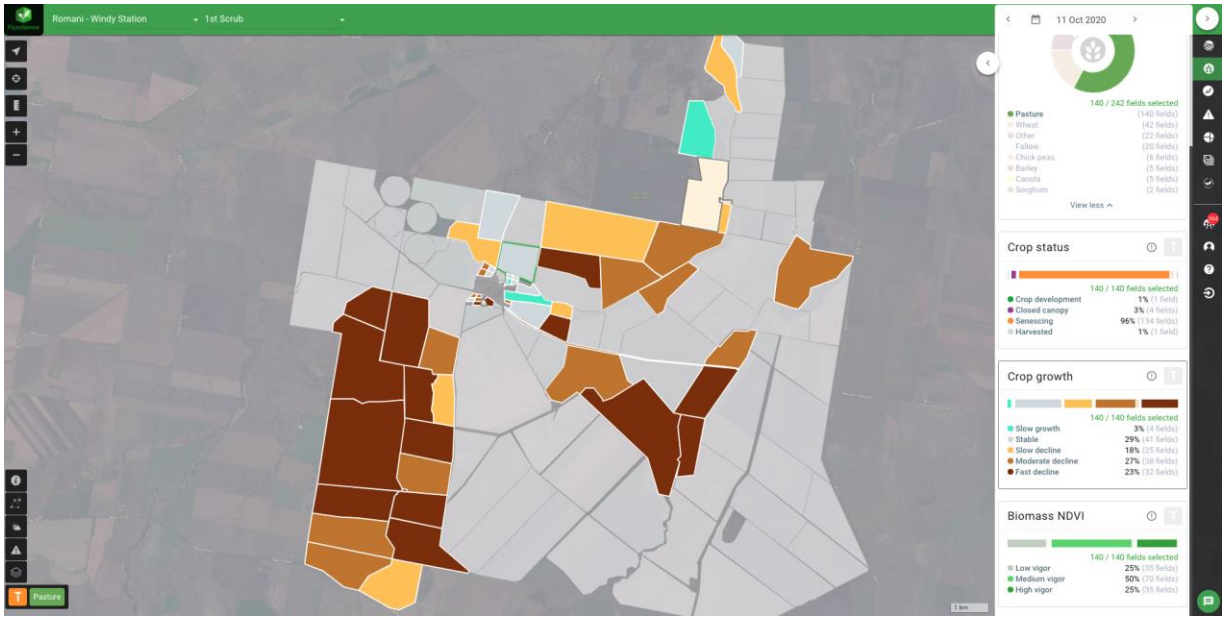

Figure 2: FluroSense tracks the crop performance and the weather data to help estimate the stocking rates and the status for each of the paddocks, and its readiness to be grazed. As seen on the map, fields are classified based on the crop growth rate. This growth rate helps estimate the pasture growth rate and herd allocation. Green fields see their biomass increase over the last week, while the biomass in the fields coloured in brown has decreased.

Romani Pastoral sees the value of using remote sensing imagery to direct scouting and track the field's performance over time. But, measuring dry matter content using satellite imagery is a major challenge that remains to be addressed, which would considerably improve pasture management.

Romani's team reviewed FluroSense crop performance emails and cross-referenced these results with field observations and Agworld's NDVI layer. They observed that in general, FluroSense growth stages tend to be too advanced compared to field measurements. This could be explained in two ways.

FluroSense crop status is based on crop NDVI curves from seeding. Therefore, the seeding date is crucial information that influences the results accuracy. In the current workflow the crop information is being imported manually from Agriwebb, which increases the chances of having inaccurate and non-up-to-date information.

FluroSense growth stages are sensitive to variation in crop health and biomass, before it can be seen by the naked eye. This sensitivity can explain why the crop might already be labelled as "senescing" in FluroSense, while it doesn't show any visual signs of senescence yet.

4.2 Use FluroSense Nitrogen recommendations to optimise Nitrogen application

For wheat and barley:

The recommendation has been provided for 10 fields. For each of these fields, the user receives a recommended Nitrogen rate per zone with the possibility of adjusting the recommendation according to economic parameters and the season's outlook. The recommendation map can then be exported into the machinery for the application. (Fig. 3)

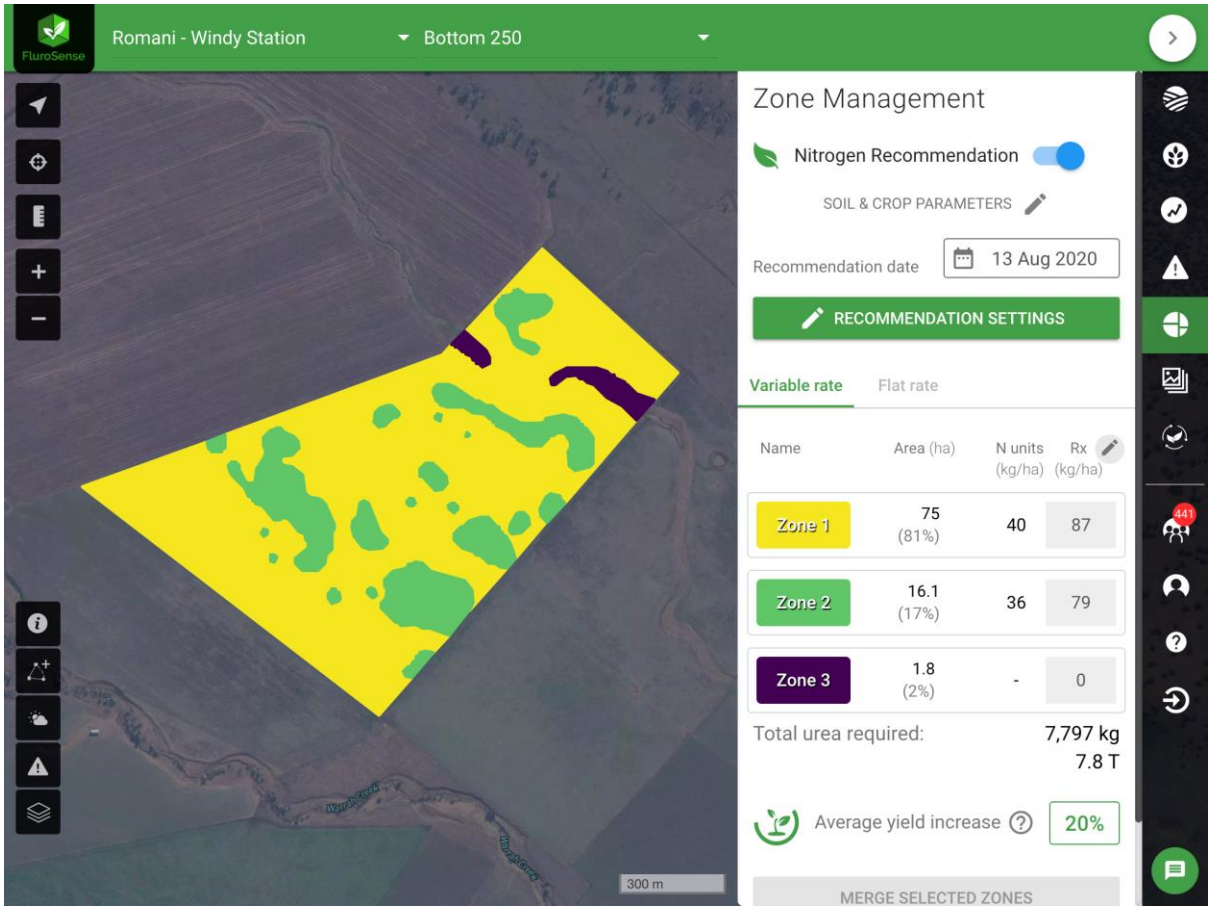

Figure 3: Nitrogen recommendation in FluroSense for the field "Bottom 250" generated on August 13th, 2020. Three different rates of Nitrogen are recommended for each management zone for an optimal application rate, taking into account the field variability and soil potential in each management zone.

The Romani pastoral team have been analysing FluroSense recommendations and variable rate application maps. The FluroSense Nitrogen recommendation model generally recommended a variable rate application with 2 to 4 zones per field.

Due to the variability of the fields and additional work, they decided to apply a flat rate recommendation. However, the use of satellite imagery to create variable rate application maps based on field variability shows a promising value in optimising field crop production. Romani's team suggests using the FluroSense zoning tool to take tissue samples from representative areas of fields and extrapolate the results into an application map (Fig. 4).

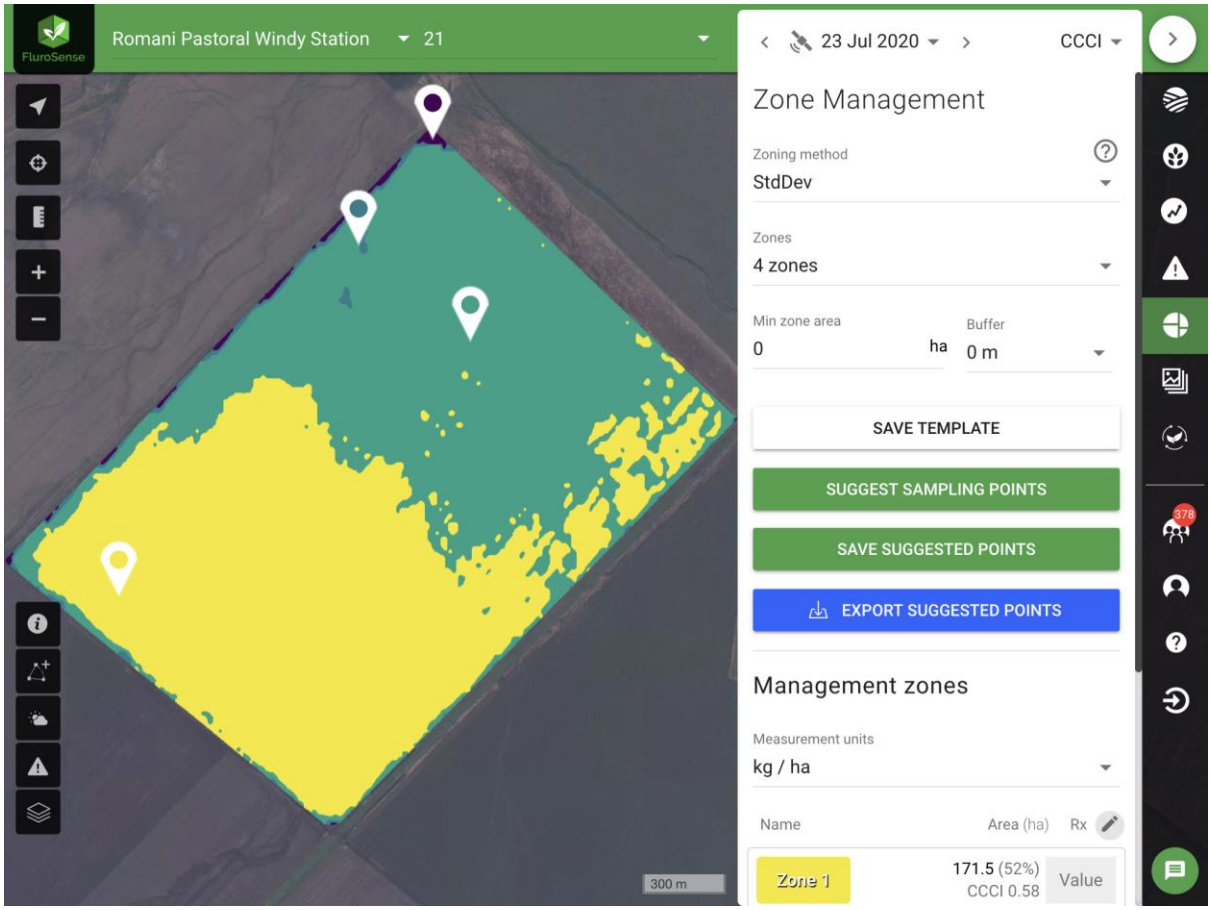

Figure 4: Variable application map created using the CCCI layer, that shows a high variability in field 21, due to a waterlogged area on the north side of the field. FluroSense automatically suggests sampling points in each area of the field. Once tissue sample results are available, they can be automatically saved in FluroSense, which will extrapolate your observations to generate a nitrogen map.

5. Conclusion

5.1 Key findings

- T**he accuracy of the sowing date** is extremely important for accurate detection of the growth stage using FluroSense algorithms. These sowing dates are coming from Farm management software programs used by Romani's team:
  - Agriwebb - livestock management
  - Agworld - broadacre crop monitoring.

  The sowing dates and crop information are progressively updated by Romani's team over the course of the season, and therefore couldn't be taken into account in FluroSense analytics. The recently deployed integration between FluroSense and Agworld will improve the accuracy of the recommendation, thanks to regular and easy resynchronisation of Agworld and FluroSense accounts.

- **The importance of Dry Matter** detection with remote sensing for livestock pasture management.

  Romani's team sees the value of using remote sensing, to monitor their operations and gain in precision and efficiency. The Romani agronomists are using satellite imagery to identify field variability, conduct more efficient scouting and monitor pasture growth.

  However, more than the biomass, it's the detection of the dry matter content and nutritional value that has been identified as a major challenge, which would considerably improve pasture management. Detection of dry matter content and nutritional value using remote sensing is still a challenge that needs to be addressed.

- **The importance of a sampling tool to optimise Nitrogen applications**

  Tissue sampling is important to define the nitrogen strategy for both pastures and broadacre crops. The use of satellite imagery to create variable rate application maps based on field variability show a promising value in optimising field crop production. Romani's team suggests using the FluroSense zoning tool to take tissue samples from representative areas of fields and extrapolate the results into an application map**.**

5.2 Benefits to industry

- **Optimise the nitrogen strategy** for pastures and broadacre crops, by optimising tissue sampling locations based on the leaves chlorophyll content and simplifying the creation of Variable rate application maps.
- **Be aware of abnormal crop development and crop stresses** in broadacre crops and pastures, to optimise production, conduct more efficient scouting and adjust management practices.

6. Future research and recommendations

Improvements to FluroSense "package" and increased confidence by producer in using the system will further unlock the value of the analytics:

1. Agworld is now fully integrated with FluroSense analytics. Boundaries and crop information can be automatically imported and updated from Agworld, which will increase the accuracy of the analytics.

2. Regrow released a new version of the Crop Performance dashboard allowing a visualisation of the different metrics in a map. This makes the tool even more user-friendly and proactively surfaces the actionable insights, particularly valuable on large operations such as Romani.

3. **A new crop stress detection** algorithm suited for highly variable fields, such as grazeland has been developed.

In 2020, FluroSense Crop Stress detection was tentatively used on Romani's operation. However, due to the high level of in-field heterogeneity on Romani's fields (soil types, creeks, rocks, trees), the crop stress wasn't able to highlight relevant crop stresses. The initial crop stress detection algorithm was based on the analysis of outstanding low and high performing areas, without taking into account the permanent variability of the field.

In 2021, Regrow developed a new version of the algorithm, capable of detecting only stresses related to an abnormal crop development agronomically relevant. This new detection is taking into account the historical field variability, by creating a permanent field productivity map, based on past season imagery. Rocks, creeks, trees, soil issues are now removed from the analysis.