**Student projects using the North Wyke Farm Platform data**

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**Projects offered:**

Each project has 6 themes – meaning potentially 12 x 6 = 60 projects in total

Visualisation projects are listed elsewhere.

**1. Crop Yield Productivity and Management**

* **Goal**: Predict/forecast crop yield using AI-driven models (including data-driven plus process-based hybrids) informed by environmental and farm management data.
* **Data**: Crop (grass / arable) yield data, soil moisture levels, weather data, management data, satellite remote sensing data. Future climate scenarios data.
* **Brief Description**: This project develops an AI model to accurately predict and forecast crop yield while responding to changes in environmental conditions, like soil moisture and weather patterns. The project will capture all key aspects of uncertainty.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil moisture.

**2. Livestock Productivity and Management**

* **Goal**: Predict/forecast livestock productivity through AI-driven feature engineering. AI tools include data-driven and process-based hybrids.
* **Data**: Livestock weight gain, condition scores, farm grass/silage data, feed intake, weather data, satellite remote sensing data. Future climate scenarios data.
* **Brief Description**: The project builds an AI model that analyses livestock performance data. This includes a sensitivity analysis of feeding patterns, grass type and conditions, and environmental conditions for improved productivity. An assessment of both outdoor and indoor livestock performance is possible. The project will capture all key aspects of uncertainty.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil moisture.

**3. Carbon Budgeting for Arable Systems**

* **Goal**: Track carbon emissions in arable crop (wheat, oats) production.
* **Data**: Soil carbon data, crop yield data, GHG emissions, emissions to water, fertilizer use, weather data, satellite remote sensing data.
* **Brief Description**: This project develops an AI tool to manage the carbon footprint of arable farming by tracking soil carbon sequestration and offering insights to reduce emissions and improve soil health. The project will capture all key aspects of uncertainty. Tool provides the farmer with actionable insights.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil moisture.

**4. Carbon Budgeting for Livestock Systems**

* **Goal**: Track carbon emissions in indoor and outdoor livestock farming.
* **Data**: GHG emissions, emissions to water, livestock feed, waste data, soil carbon data, fertilizer use, relevant environmental conditions, weather data, satellite remote sensing data.
* **Brief Description**: This project develops an AI tool to track carbon emissions from livestock systems, providing farmers with actionable insights to reduce carbon emissions while maintaining productivity through sustainable livestock management. The project will capture all key aspects of uncertainty.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil moisture.

**5. Livestock vs. Non-Livestock Farming for Carbon Dynamics**

* **Goal**: Compare carbon dynamics between livestock and non-livestock systems.
* **Data**: Soil carbon data, fertilizer use, crop yield data, GHG emissions, livestock data, satellite remote sensing data.
* **Brief Description**: Using AI tools, this study compares the carbon efficiency of livestock-based farming systems against crop-only systems, providing insights on reducing emissions while maintaining productivity. The project will capture all key aspects of uncertainty.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil moisture.

**6. Biodiversity Status for Arable versus Grassland (livestock) farms**

* **Goal**: Monitor and classify biodiversity status for livestock and non-livestock systems using AI tools.
* **Data**: Bioacoustics data for species counts, biodiversity field surveys, species richness data, insect trap data, environmental data, farm management data, satellite remote sensing data.
* **Brief Description**: Using biodiversity data, this project identifies plant and animal species and other biodiversity indicators in agricultural environments, potentially helping farmers assess the ecological impact of farming practices and adjust accordingly to protect biodiversity. The project use AI tools and will capture all key aspects of uncertainty. Opportunities to relate to pests and diseases. Opportunities to relate to crop pollination.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for further bioacoustics. Further, more manual surveys possible, say as those for earthworms and soil health, or for dung beetles.

**7. Livestock Welfare and/or Health for Indoor versus Outdoor Farms**

* **Goal**: Monitor and assess livestock welfare and/or health for outdoor and indoor livestock farms using AI tools.
* **Data**: livestock welfare surveys, vet (health) records (including cattle and sheep parasite data), farm management data, environmental data (especially temperature), feed intake, feed quality.
* **Brief Description**: Livestock data will be used to build AI models that monitor and predict future welfare and health outcomes, enabling early interventions and more efficient management of livestock welfare and health. If the project has an extreme events theme (see below), can assess how extreme weather events like droughts and heatwaves impact livestock health and productivity, helping farmers prepare for adverse conditions.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** This project will require additional welfare and health surveys. If this project has a sample / sensor design theme, then it requires deployment and costings of sensors - such as those for an animal’s heart rate or temperature.

**8. Life Cycle Assessment (LCA)**

* **Goal**: Designing an impact assessment method to calculate GWP\* within LCA software
* **Data**: various
* **Brief Description**: LCA for different NWFP systems. The LCA methodology can have different assumptions and focus.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Additional Data:** Likely to require data that is external to NWFP. Need to link LCA-focussed data sets from the Hestia initiative at Oxford (https://www.hestia.earth/).

**9. Nutrient Use Efficiency (NUE)**

* **Goal**: Investigate macro- and micro- nutrient use efficiency for each outdoor farm using AI tools.
* **Data**: water chemistry, soil chemistry and related datasets.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Brief Description**: This project investigates NUE. It directly relates to soil, plant and livestock health. Nutrient losses to water are also pollutants.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil chemistry.

**10. Water Use Efficiency**

* **Goal**: Optimize water use for crops (arable and grasses) using AI and real-time data.
* **Dataset**: Soil moisture, rainfall, run-off, weather, water usage records
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Brief Description**: This project uses predictive AI models to optimize water use based on weather and soil water data, enhancing water conservation and crop yield. Farmers can cut down on water costs while ensuring crops get the moisture they need at the most critical growth stages, improving yields and resource efficiency.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network, say for soil moisture.

**11. Drone based projects**

* **Goals**: (a) Detect crop diseases early using drone technology; (b) Monitor livestock health using drone surveillance and predictive models; (c) Develop a fleet of AI-driven autonomous drones that work together to monitor crop health, detect pests, apply targeted treatments, and optimize irrigation across large-scale farms; (d) Develop a smart weed detection system that uses drone imagery and AI to apply herbicides only where needed, reducing chemical usage.
* **Data**: Drone imagery and thermal data, various ground-reference collections.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Brief Description**: (a) This project focuses on building a system that integrates drone-based imagery and AI to detect crop diseases early, allowing farmers to intervene before large-scale damage occurs; (b) Drones are used to capture real-time footage of livestock, with AI tools predicting health risks based on behaviour and environmental conditions, reducing the need for manual inspections; (c) This project focuses on creating a network of AI-powered drones that can autonomously survey farmland, detect health issues, and apply treatments in real time. Each drone would collaborate with others in the swarm to optimize coverage and efficiency, ensuring that the right amount of water, pesticides, or nutrients is applied precisely where needed. This approach minimizes resource use and labour while maximizing yield and crop health; (d) By targeting herbicide application only to areas with weed infestation, this project reduces the amount of herbicide used, lowering chemical costs while protecting the crops from unnecessary chemical exposure. It also promotes sustainable practices and lowers labour costs associated with manual weeding.
* **Additional Data:** This project requires a designed and coherent deployment of drone flights plus additional ground-reference data. For topic (d) - weed infestation maps, herbicide usage data.

**12. Resilience based projects**

* **Goal**: Investigate for signs of declining resilience in key processes of each outdoor farm. Use AI tools.
* **Dataset**: soils, crops, livestock, weather.
* **Themes:** (i) Prediction and uncertainty; (ii) Effects of outliers and anomalies on outcomes; (iii) Effects of extremes in weather on outcomes; (iv) Effects of basic versus advanced quality control / data pre-processing on outcomes, (v) Optimal sample / sensor designs (or re-designs) and cost benefit analyses for data collections; and (vi) Potential for real-time (right-time) monitoring and decision making.
* **Brief Description**: This project uses standard and AI-based tools for early warning signals of declines in resilience in each outdoor farm system.
* **Additional Data:** None foreseen. Satellite remote sensing data freely available from Google Earth Engine. If this project has a sample / sensor design theme, then it could explore options for the deployment of a low-cost sensor network.

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**Projects for the future (not available now):**

**A.** **Predictive Maintenance for Farm Machinery Using IoT Sensors**

* **Goal**: Reduce downtime and repair costs by predicting machinery maintenance needs based on sensor data.
* **Data**: IoT sensor data from farm machinery, maintenance logs, operational data (run times, fuel consumption).
* **Brief Description**: This project uses IoT sensor data to predict when farm machinery needs maintenance, preventing costly breakdowns and reducing operational downtime. By optimizing machinery upkeep, farmers can reduce repair costs and increase productivity during critical farming periods.

**B. Precision Feeding System for Indoor Livestock via Real-Time Health and Growth Data**

* **Goal**: Develop an automated feeding system that adjusts livestock diets in real-time based on health, growth rate, and feed efficiency data to maximize productivity and minimize waste.
* **Data**: Real-time livestock health data (weight, feed intake), growth rate data, feed conversion efficiency, environmental conditions.
* **Brief Description**: This system adjusts feed portions based on each animal’s growth rate and health status, reducing feed costs and improving feed-to-weight gain ratios. Optimizing feed allocation ensures that resources are used more efficiently, which reduces waste and increases profitability by shortening the time to market weight.

**C.** **Smart Herd Management for Optimizing Breeding and Productivity**

* **Goal**: Use data-driven tools to optimize herd management, focusing on breeding schedules and improving reproductive success rates.
* **Data**: Livestock reproductive data (fertility rates, breeding cycles), genetic data, environmental factors.
* **Brief Description**: This project develops tools to optimize breeding schedules and manage herd genetics for better reproduction outcomes, improving herd productivity and economic efficiency. Better timing and selective breeding result in healthier animals, more efficient growth, and improved overall herd productivity.

**D.** **Automated Monitoring and Energy-Efficient Climate Control for Livestock Facilities**

* **Goal**: Develop a system that automates climate control in livestock facilities to maintain optimal living conditions while minimizing energy costs.
* **Data**: Real-time temperature, humidity, ventilation data; energy usage records.
* **Brief Description**: The project creates an automated system that monitors livestock facility conditions and adjusts heating, cooling, and ventilation in real-time. By keeping energy usage minimal while ensuring optimal living conditions for livestock, it reduces energy costs, improves livestock health, and boosts productivity, translating into economic benefits.

**E.** **RFID-Based Livestock Tracking for Improved Grazing and Health Monitoring**

* **Goal**: Implement an RFID-based (GPS) tracking system to monitor livestock grazing patterns and health, optimizing pasture use, and reducing labour costs.
* **Data**: RFID tag data, pasture quality data, health monitoring records.
* **Brief Description**: This system tracks individual livestock movements to optimize pasture rotation and grazing efficiency, improving forage use while minimizing overgrazing. It also enables automated health monitoring through real-time location and activity tracking, which reduces labour costs and increases the economic efficiency of livestock operations.

**F.** **Bioacoustics for Early Warning of Wildlife and Livestock Predators**

* **Goal**: Develop real-time bioacoustics monitoring system that detects and classifies wildlife sounds to provide early warnings of predators near livestock or crops.
* **Data**: Acoustic recordings from farms, wildlife species data, predator event logs.
* **Brief Description**: This project leverages bioacoustic sensors placed around farmlands to detect the presence of wildlife predators (such as wolves, coyotes, or wild boars) by analyzing their vocalizations. Using AI models trained to identify specific predator sounds, the system will alert farmers when predators are nearby, enabling them to take preventative measures to protect livestock and crops. It combines cutting-edge technology with ecological monitoring to safeguard farm assets.

**G**. **Regenerative Agriculture Monitoring Using Blockchain for Transparent Supply Chains**

* **Goal**: Implement a blockchain-based system to track and certify regenerative agricultural practices, providing transparent, tamper-proof data from farm to consumer.
* **Dataset**: Soil health metrics, crop rotation data, carbon sequestration data, farm management practices, supply chain transactions.
* **Brief Description**: This project develops a blockchain platform to track regenerative agriculture practices, ensuring that farmers are adhering to sustainable techniques like no-till farming, crop rotation, and carbon sequestration. The system creates an immutable ledger from the farm to the final consumer, verifying the integrity of the farming process and providing transparency in the supply chain. Consumers can scan a QR code to view the environmental impact of their food, while farmers benefit from premium pricing for verified sustainable practices. This brings accountability and value to sustainable agriculture while building trust with consumers.