IAgrE Student Awards

NOMINATION SUMMARY

Student Project Award*
Safety Award*
***please delete as appropriate:**

PROPOSER: (usually Course Director/Head of Department)

Name: Rhys James

Position: Level 3 Course Director

University/College: ColegSirGar, Gelli Aur Camps, Home Farm, Golden Grove, Camarthen SA32 8NJ

Contact details:	**Tel:01554748583**	**Email: rhys.james@colegsirgar.ac.uk**

DETAILS OF NOMINATION:

Name of Student/Group of Students: Thomas Richards

Personal contact details (i.e not college) to enable us to contact the student(s) once their course has ended:

Noyadd Barn, Cilmery, Builth Wells, Powys LD2 3NT	07754767581	**Email: thomasrichards155@gmail.com**

Name of course studied: Level 3 City and Guilds Extended Diploma in Land based Technology

Period studied	**From: September 2024**	**To: July 2026**

Qualification to be gained:
180 Credit extended diploma

Project Title: Automatic Rain sensor fitted to a stand alone trailer/ chaser bin

Details of material submitted with nomination: (Project/Exec Summary/videos etc)

Powerpoint presentation

SIGNED BY PROPOSER: DR James	**DATE SUBMITTED:** 18/09/26

If you wish to provide any additional information to support this nomination, please do so in a covering letter. When complete, return this form, together with the supporting documents, to

The Secretariat, IAgrE, The Bullock Building (Bldg 53), University Way, Cranfield, Bedford MK43 0GH
secretary@iagre.org

NB All work submitted is treated with complete Confidentiality; no part of the paper will be published by IAgrE except for the Title and Name of the winner in each category.

Automatic Rain-Sensing Trailer Cover

Final Year Agricultural Technology Project

Presented by **Thomas Richards**



Background

About Me

My name is **Thomas Richards** and I am 18 years old. I was raised on a mixed sheep and beef farm, giving me a strong foundation in practical agriculture from an early age.

Richards Bros Contracting

Our family also runs a small contracting business called **Richards Bros**, providing agricultural services including baling, hedge cutting, and much more. This hands-on experience has directly informed the practical focus of this project.

Research

Agricultural Events

Attended the **Agritechnica, LAMMA Show**, **Royal Welsh Show**, and **Royal Welsh Winter Fair** to examine machinery currently on the market and gather ideas for potential improvements and innovations.

Online & Industry Research

Conducted online research and read industry publications such as **Farmers Guardian** to investigate new machinery designs, emerging technologies, and current trends within the agricultural sector.

On-Farm Assessment

Assessed machinery used on my own farm and discussed **existing operational and safety concerns** with farmers to identify areas where practical improvements could be made.

Peer & Colleague Consultation

Spoke with peers and work colleagues to gather opinions on products that could be redesigned or modified to improve **efficiency, usability, and safety** for agricultural operators.



Previous Concept 1 — Tractor-Drawn Cage Dipper





My first concept was to design a **tractor-drawn cage dipper** — making this equipment more accessible to smaller operations, as commercial dippers are currently only available on articulated lorries.

Hydraulic Legs

Four hydraulic levelling legs to handle uneven farmyard surfaces.

Self-Stored Water

Onboard water tank for farms without a direct water supply.

Safe Exit Ramp

Extended exit ramp to prevent sheep injury during disembarkation.

Concept 2 — Wrap & Net Carrier with Toolbox

My third concept was to design a **wrap and net carry system with an integrated toolbox**, ideal for contractors who need to transport large quantities of bale wrap and net efficiently.

- Angled tubes to allow easier loading and placement of wrap rolls
- Integrated toolbox for storing equipment on the move
- Lights and marker steps for improved visibility at night
- Designed for mounting on the front linkage of a tractor





Concept 3 — Quickfencer Front Attachment





My third concept was a **quickfencer attachment** that mounts to the front of a digger, designed to speed up and simplify the fencing process on farm.

No Heavy Lifting

The roll of netting does not need to be manually lifted, reducing operator strain and risk of injury. As manual handling rules sate only lifting of 25kg and a 250 m roll of netting weighs 120 kg

500m Rolls

Supports larger 500m netting rolls, significantly increasing fencing speed and reducing time lost joining wire.

Concept Weighting & Evaluation

Each concept was scored across five criteria to determine the strongest candidate for further development. Higher scores indicate better performance against each criteria.

Criterion	Cage Dipper	Quick Fencer	Roll-Over Sheet
Cost	1	6	7
Commercial Value	10	9	7
Ease of Making	2	3	6
Safety	8	9	9
Profitability	8	8	8
Mean Score	**6**	**7**	**8 ✓**

The **Roll-Over Sheet** concept achieved the highest mean score of 8, making it the strongest candidate to take forward for development.

Proposed Concept — Automatic Rain Sensing Trailer Cover

The Core Idea

A sensor-activated cover system that **automatically closes when rain is detected**, protecting trailer contents without requiring operator intervention. The kit is designed to retrofit onto trailers that already have an automatic sheet fitted.

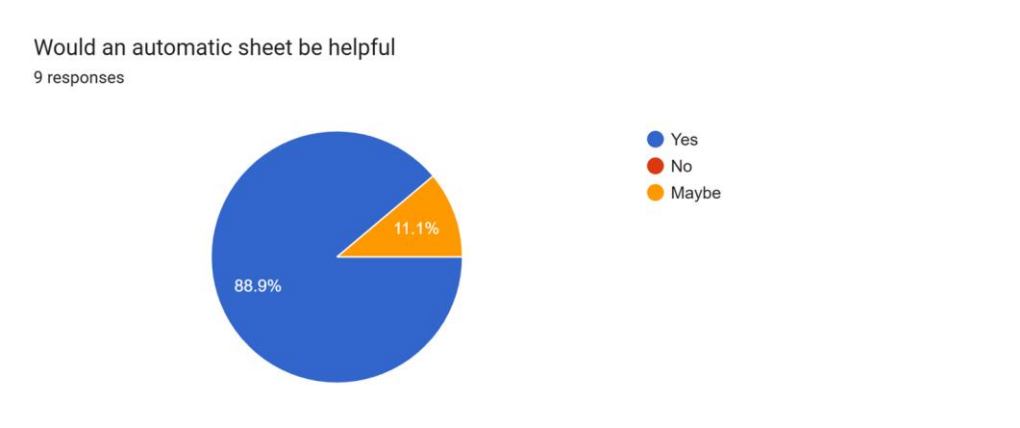
Key Design Features

- Lifting arms on each side raise the sheet over the load
- Avoids damage caused by bands catching on manure loads
- Retrofittable to a wide range of existing trailers
- Rain sensor triggers automatic closure

Acknowledged Challenges

- Complex design requiring careful engineering
- Higher manufacturing cost and time investment
- Time constraints within the project deadline

Issue to Overcome — Justification of the Idea



The Problem

Farmers and contractors regularly face the challenge of protecting trailer loads — including **grain, feed, fertiliser, and manure** — from unexpected rainfall. Moisture exposure can degrade product quality and lead to significant financial loss.

Existing roll-over sheets can be damaged when transporting loose materials such as manure, as support bands can catch on the load and require removal, costing valuable time.

Survey Evidence

A Google Form survey was conducted to gauge demand for this concept:

9/10

Found It Helpful

Respondents said this system would benefit their operation.

£300+

Willingness to Pay

Most respondents would pay £300 or more — well above the estimated production cost.

What's Already on the Market?

Existing Systems

Companies such as **Shur-Co, Roll-Rite, and Transcover** already produce electric or hydraulic trailer cover systems. However, all existing systems require operator input to deploy — via a cab-mounted switch, remote control, or driver activation.

My concept takes this further by incorporating a **moisture sensor and Arduino controller** to automatically deploy the cover when rain is detected, and retract it when conditions are dry — requiring no driver input whatsoever.

The Gap in the Market

> ⓘ No evidence was found of any manufacturer currently marketing a **rain-sensing, autonomous deployment system** for agricultural trailers. Current systems all require:

- Driver input via cab-mounted switch
- Remote control operation
- Manual intervention when trailer is unattended

The closest comparable technology is **rain-sensing awnings** used on RVs and buildings — the same principle applied to an agricultural trailer context.

Target Market



Farmers

Arable and mixed farmers transporting grain, animal feed, and fertiliser who need reliable weather protection for high-value loads.



Agricultural Contractors

Contractors operating across multiple farms who need a dependable, low-maintenance system that works even when trailers are left unattended.



Haulage Operators

Operators transporting woodchip, manure, and bulk agricultural materials who operate in areas where weather can change rapidly and unpredictably.

As the kit is **designed to retrofit onto existing trailers**, it appeals to customers who want automatic sheeting benefits without the expense of purchasing a new trailer.

Design Options Considered

1

Bolt-On Lifting Arm System

Fitted to the sides of an existing trailer, making it highly suitable for **retrofitting** and reducing both installation time and cost. Arms raise the sheet over the load to avoid damage.

2

Side Mounted Roller System

Sheet stored on a roller at the side of the trailer and pulled over the load using **electric motors**. Simple, reliable, and well-suited to flat, even loads.

3

Folding Frame Design

Lightweight aluminium arms that rise and lower the sheet. Offers reduced weight and improved corrosion resistance, though more complex to manufacture using CNC machining and welding.





Chosen Design

Why This Design?

After evaluating all concepts and conducting further research, it became clear that fully bespoke retrofit sheet systems already exist on the market at **£2,500–£3,000** — significantly over budget. The decision was therefore made to **fit a rain-sensing kit to an existing sheet system**, combining practicality with cost-effectiveness.

Key Advantages

- Retrofits to existing trailers with minimal modification
- Front-mounted roller provides simple, reliable sheet storage and deployment
- Lifting arms raise the cover clear of the load, preventing sheet damage on manure or uneven loads
- Best balance of functionality, reliability, and manufacturing feasibility
- Directly meets the project objective of automatic weather protection



Engineering Calculations

Several key calculations were completed to ensure the system is correctly sized, safely wired, and capable of reliable operation.

Sheet Area

The trailer dimensions were measured to calculate the required sheet coverage:

Sheet Area = Trailer Length × Trailer Width
2.3 m × 6.7 m = **15.41 m²**

Minimum Fuse Rating

Circuit protection rules require a fuse sized to handle continuous current while accommodating motor inrush spikes (which can exceed 100 A):

Minimum Fuse Rating = 50 A × 1.25 = 62.5 A

Cable Cross-Sectional Area

For a 12 V system, voltage drop must remain below 3–4% (0.36–0.48 V) to prevent motor torque loss or stalling:

A = (2 × L × I × ρ) ÷ Vdrop
(2 × 2.7 m × 60 A × 0.0175) ÷ 0.36 = **15.75 mm²**, rounded up to **16 mm²**

Wire Size Calculations

$$A = \frac{2 \times L \times I \times \rho}{V_{drop}}$$

Substituting our fixed values into the formula:

$$A = \frac{2 \times L \times 60 \times 0.0175}{0.36}$$

$$A = \frac{2.1 \times L}{0.36}$$

$$A = 5.833 \times L$$



Simplified Formula

A simplified multiplier was derived from the full cable sizing formula, allowing quick calculation based on cable run length. For example:

5.833 × 4 m = 23.33 mm², rounded up to **25 mm²**

This ensures the copper wire can safely carry the motor's operating current without excessive voltage drop, overheating, or torque loss during operation.

One-Way Distance (L)	Mathematical Area Required	Standard Commercial Cable Size	Equivalent AWG Size
Up to 2.7 metres	Up to 15.75 mm^2	**16 mm^2**	6 AWG

Arduino Control Code

The system is controlled by an Arduino microcontroller. The code monitors the rain sensor and manual override button, then activates the appropriate relay to open or close the sheet motor. Key variables and logic are shown below.

Pin Definitions & Variables

```
const int rainSensorPin = 2;
const int relayOpenPin = 8;   // Motor OPEN
const int relayClosePin = 9;  // Motor CLOSE
const int manualButtonPin = 3; // Push button
bool sheetOpen = false;
bool lastButtonState = HIGH;

void setup() {
  pinMode(rainSensorPin, INPUT_PULLUP);
}
```

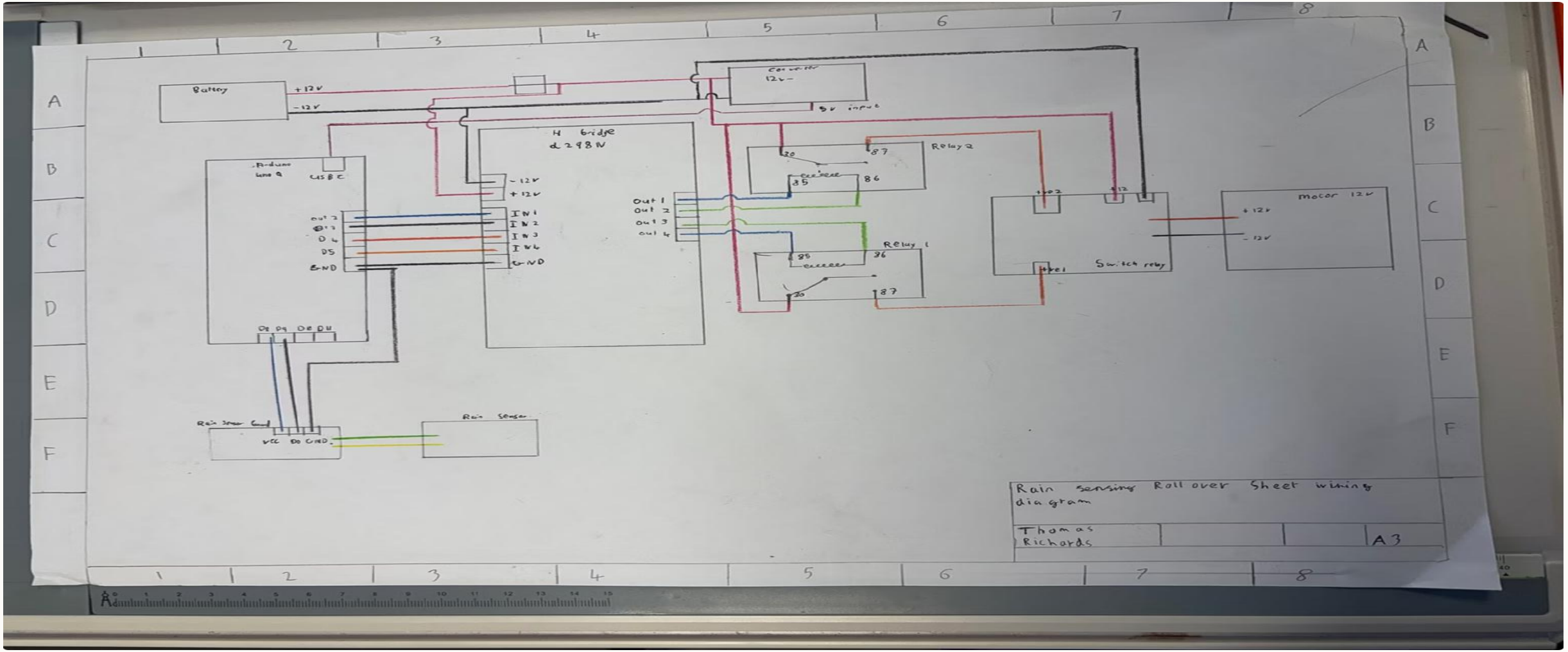
Open / Close Logic

```
void closeSheet() {
  if (sheetOpen) {
    digitalWrite(relayOpenPin, LOW);
    digitalWrite(relayClosePin, HIGH);
    delay(25000); // 25 sec to close
    digitalWrite(relayClosePin, LOW);
    sheetOpen = false;
  }
}

void loop() {
  bool rainDetected =
    (digitalRead(rainSensorPin) == LOW);
  // Motor OPEN sequence:
  digitalWrite(relayClosePin, LOW);
  digitalWrite(relayOpenPin, HIGH);
  delay(17000); // 17 sec to open
  digitalWrite(relayOpenPin, LOW);
  sheetOpen = true;
}
```

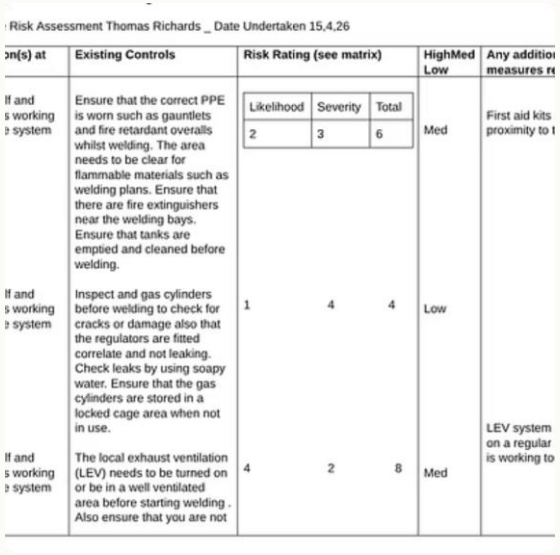
ⓘ The timed delays (25 seconds to close, 17 seconds to open) were determined through physical testing of the motor and sheet travel distance on the trailer.

System Wiring & Circuit Diagram



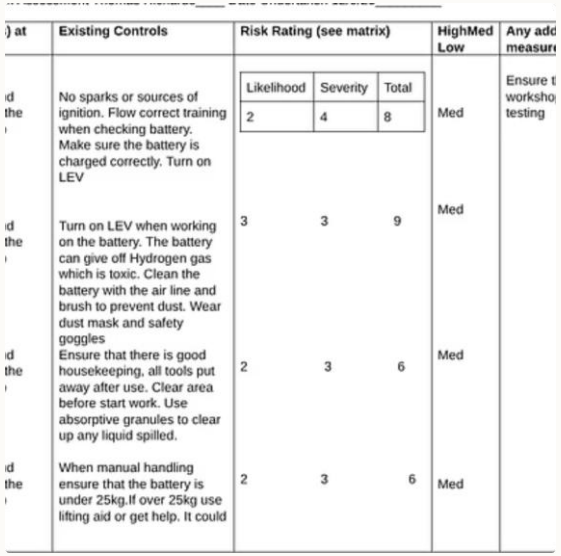
Risk Assessment

A thorough risk assessment was carried out to identify potential hazards during manufacture and operation of the system, and to ensure appropriate control measures are in place.

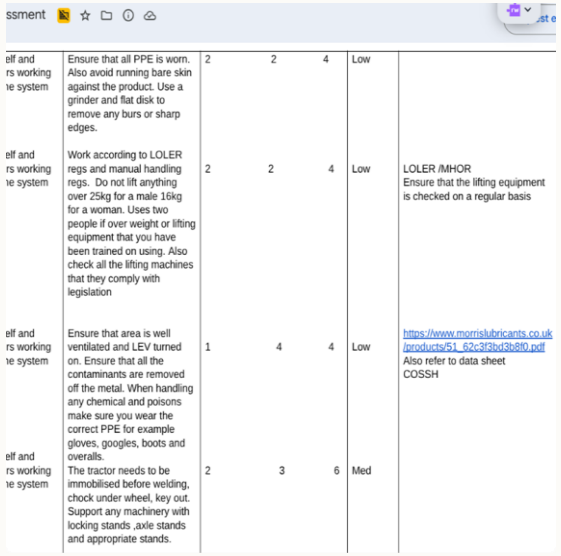


Risk Assessment Thomas Richards _ Date Undertaken 15,4,26

on(s) at	Existing Controls	Risk Rating (see matrix)			HighMed Low	Any additio measures re
		Likelihood	Severity	Total		
lf and s working e system	Ensure that the correct PPE is worn such as gauntlets and fire retardant overalls whilst welding. The area needs to be clear for flammable materials such as welding plans. Ensure that there are fire extinguishers near the welding bays. Ensure that tanks are emptied and cleaned before welding.	2	3	6	Med	First aid kits proximity to t
lf and s working e system	Inspect and gas cylinders before welding to check for cracks or damage also that the regulators are fitted correlate and not leaking. Check leaks by using soapy water. Ensure that the gas cylinders are stored in a locked cage area when not in use.	1	4	4	Low	
lf and s working e system	The local exhaust ventilation (LEV) needs to be turned on or be in a well ventilated area before starting welding . Also ensure that you are not	4	2	8	Med	LEV system on a regular is working to

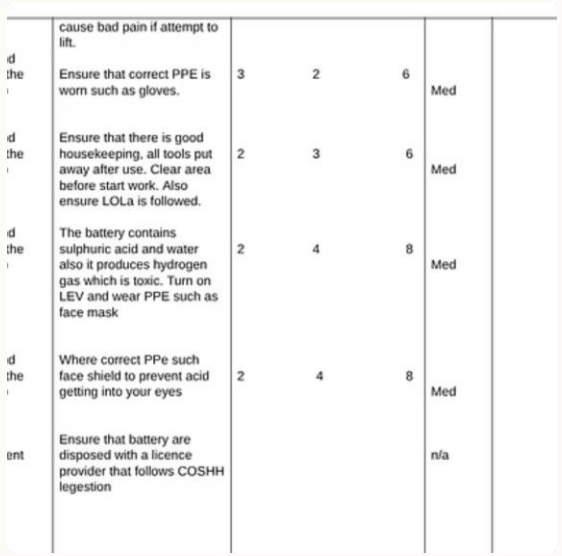


) at	Existing Controls	Risk Rating (see matrix)			HighMed Low	Any add measur
		Likelihood	Severity	Total		
d the	No sparks or sources of ignition. Flow correct training when checking battery. Make sure the battery is charged correctly. Turn on LEV	2	4	8	Med	Ensure t worksho testing
d the	Turn on LEV when working on the battery. The battery can give off Hydrogen gas which is toxic. Clean the battery with the air line and brush to prevent dust. Wear dust mask and safety goggles	3	3	9	Med	
d the	Ensure that there is good housekeeping, all tools put away after use. Clear area before start work. Use absorptive granules to clear up any liquid spilled.	2	3	6	Med	
d the	When manual handling ensure that the battery is under 25kg.If over 25kg use lifting aid or get help. It could	2	3	6	Med	



ssment

elf and rs working e system	Ensure that all PPE is worn. Also avoid running bare skin against the product. Use a grinder and flat disk to remove any burs or sharp edges.	2	2	4	Low	
elf and rs working e system	Work according to LOLER regs and manual handling regs. Do not lift anything over 25kg for a male 16kg for a woman. Uses two people if over weight or lifting equipment that you have been trained on using. Also check all the lifting machines that they comply with legislation	2	2	4	Low	LOLER /MHOR Ensure that the lifting equipment is checked on a regular basis
elf and rs working e system	Ensure that area is well ventilated and LEV turned on. Ensure that all the contaminants are removed off the metal. When handling any chemical and poisons make sure you wear the correct PPE for example gloves, googles, boots and overalls.	1	4	4	Low	https://www.morrislubricants.co.uk/products/51_62c3f3bd3b8f0.pdf Also refer to data sheet COSSH
elf and rs working e system	The tractor needs to be immobilised before welding, chock under wheel, key out. Support any machinery with locking stands ,axle stands and appropriate stands.	2	3	6	Med	



	cause bad pain if attempt to lift.				
d the	Ensure that correct PPE is worn such as gloves.	3	2	6	Med
d the	Ensure that there is good housekeeping, all tools put away after use. Clear area before start work. Also ensure LOLa is followed.	2	3	6	Med
d the	The battery contains sulphuric acid and water also it produces hydrogen gas which is toxic. Turn on LEV and wear PPE such as face mask	2	4	8	Med
d the	Where correct PPe such face shield to prevent acid getting into your eyes	2	4	8	Med
ent	Ensure that battery are disposed with a licence provider that follows COSHH legestion				n/a

Project Timeline

1

Jan

Idea Generation — identifying the problem and potential concepts

2

Feb

Research — existing products, market analysis, and design exploration

3

Mar

Design Development — engineering calculations and material selection

4

Apr

Manufacturing & Fabrication — frame construction and component assembly

5

May

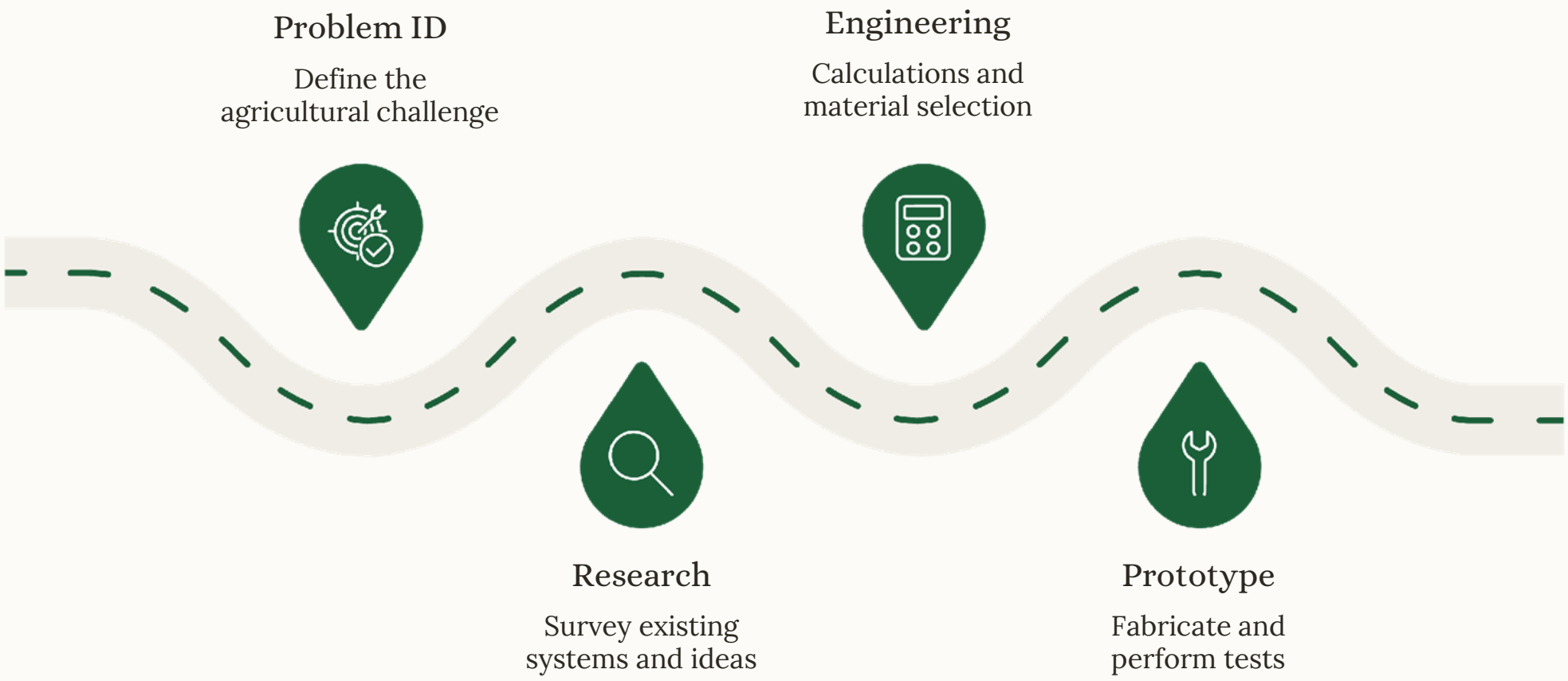
Assembly & Testing — full system testing under simulated conditions

6

Jun

Final Report & Submission — evaluation, documentation, and presentation

Methodology



The project followed a structured engineering design process. Starting from identifying the agricultural problem, through research into existing systems, concept evaluation, engineering calculations, and prototype construction, each stage informed the next. The final evaluation stage assesses performance against the original objectives and identifies improvements for future development.

Fabrication & Manufacturing

The following images document the fabrication and build process, from initial frame construction through to final assembly on the trailer.



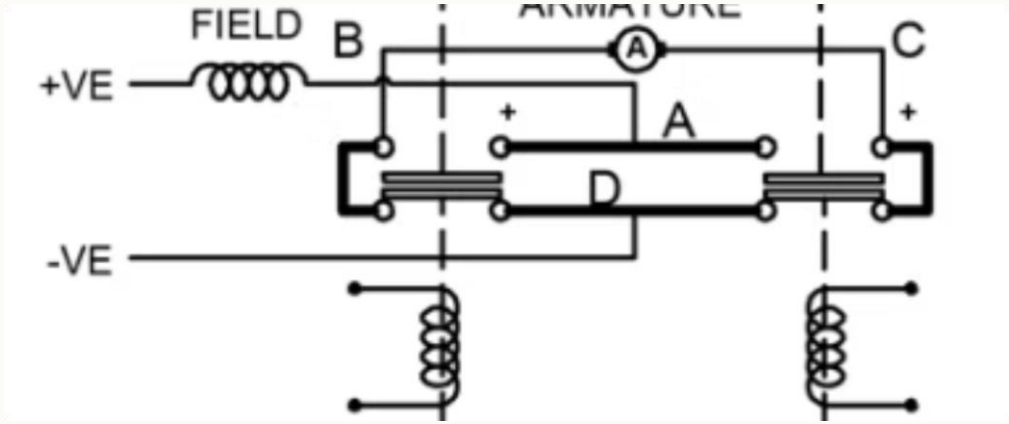






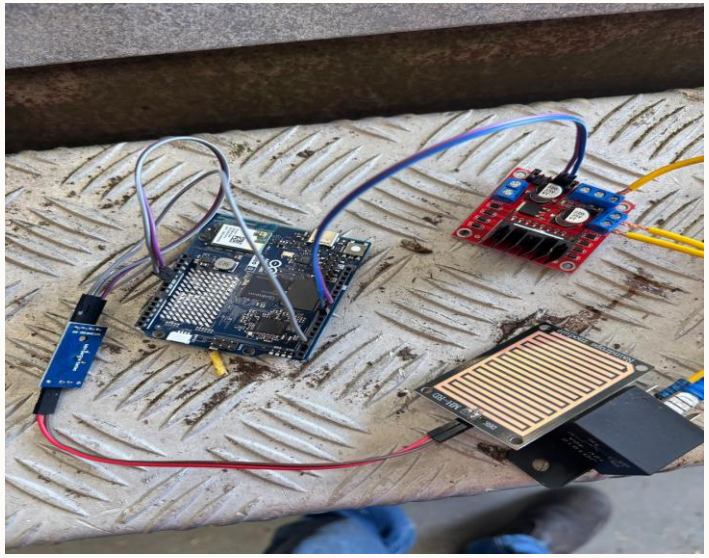












Testing

1 Rain Sensor Calibration

The sensor was tested to confirm it only activates the system under consistent moisture, reducing false triggers from dew, condensation, or splashes.

2 Motor & Lifting Arms

The motor and arms were tested to verify the cover opened and closed smoothly without jamming or placing excessive strain on the system components.

3 Frame Strength & Stability

The frame was checked for structural integrity and stability, with particular attention to performance under windy conditions.

4 Limit Switches & Full System Test

Limit switches were tested to ensure the system stopped correctly at fully open and closed positions. A final real-world test assessed overall performance against the original design objectives.



Bill of Materials & Costs

Component	Cost 1	Cost 2
Superwinch 12V Motor — Powerdrive S4000 (SW801-005C)	**£120**	
Reversing Relay	**£70**	
Arduino Microcontroller	**£55**	**£55**
Manual Override Switch	**£5**	**£5**
Wiring & Connectors	**£10**	**£10**
Total	**£260**	**£70**

At a total component cost of **£70**, and with survey respondents willing to pay **£300 or more**, this system offers strong commercial viability and a healthy profit margin.

Possible Future Improvements



Advanced Weather Sensing

Replace the basic moisture sensor with a more accurate weather detection system to reduce false triggers from dew, splashes, or condensation.



Wind Sensors

Add wind speed detection so the sheet only deploys in safe conditions, preventing damage to the cover or frame in high-wind situations.



Lighter Materials

Use aluminium or composite sections to reduce the overall weight of the frame, decreasing motor strain and improving long-term durability.



Solar Power

Integrate a small solar panel to provide self-sustaining power, making the system more suitable for remote trailers far from mains supply.



Smart App & GPS Integration

Link the system to a mobile app or GPS weather forecast, enabling remote monitoring and smarter automated deployment based on predicted conditions.

Skills Developed

What This Project Taught Me

This project required the integration of multiple disciplines — from agricultural problem-solving through to electronics, coding, and fabrication. It demanded both theoretical understanding and hands-on practical ability.

Engineering Maths & Calculations

Sized lifting arms, motor torque requirements, sheet dimensions, and cable cross-sectional areas to ensure safe and effective operation.

Welding & Fabrication

Applied workshop skills in planning the construction of the frame and mounting system for the prototype.

Bench Fitting & Assembly

Ensured accurate alignment and smooth operation of all mechanical components during assembly.

Problem-Solving & Design Thinking

Evaluated multiple concepts and refined the final design through structured analysis, research, and feedback.



Feedback & Testimonials

The concept was seen as a **practical solution to a real agricultural problem**, particularly due to its potential to protect trailer loads from weather damage while reducing the need for manual sheeting.

Design Strengths Recognised

Feedback highlighted the strength of combining a **lifting arm system with a front roller design**, improving both reliability and ease of installation on existing trailers.

Safety Suggestions Incorporated

Tutors and peers recommended incorporating **limit switches and manual override controls** — both of which were subsequently integrated into the final design.

Overall Direction Supported

The general consensus from feedback supported the project direction while also identifying clear **areas for improvement and further development** in a future iteration.



Vote of Thanks

I would like to sincerely thank everyone who supported me throughout this project.

Lecturing Team

For their guidance, advice, and constructive feedback at every stage of the design and development process.

Peers & Colleagues

For their support and suggestions, which helped sharpen my thinking and improve the final design concept.

Special Thanks

Rhys James, Jordan Hill, Geraint Evans & Colin Jones for their encouragement and valued input throughout the project.

Workshop Support

Julian for providing essential practical support in the workshop, including fabrication assistance and technical advice.

Questions

Thank You

Thank you for taking the time to listen to my presentation on the **Automatic Rain-Sensing Trailer Cover** system. I hope it has clearly demonstrated the design process, engineering thinking, and practical outcomes of this project.

I would now like to open the floor to any questions you may have regarding my project, design process, proposed system, or future development plans.